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Ecological Potential Analysis of Green Open Space (GOS) for the Karebos Field Complex Before and After Revitalization

Abstract

The study of cities and their relation to green open spaces is a topic that has received much attention in research, and green open spaces have become an essential element in urban models oriented toward sustainable cities. The development of green open spaces, both new and existing ones, and then developed or revitalized, is seen by various parties as much detrimental in terms of the ecological function of these green open spaces. Therefore this study aims to analyze changes in the ecological potential of the Karebosi Field Complex Green Open Space after revitalization, this study uses a survey method with descriptive analysis, the measuring instrument used to calculate the ecological potential with a table that contains a comparison of the ecological potential before and after revitalization, the value of water absorption potential, production oxygen, and carbon dioxide reduction per unit area was adopted from the results of previous studies. It was found that there was a decrease in water absorption by 3,087 M3/year, an increase in oxygen production by 8,573.91 tons/year, and a reduction in carbon dioxide of 11,745.69 tons/year after revitalization. Another beneficial result after the revitalization is that there are no more stagnant water in the rainy season and the existing green open space is much more representative than before the revitalization.

Keywords: Green Open Space, Ecological Potential, Revitalization.

1. Introduction

The reduction in the amount of vegetation per unit area on the GOS surface due to urban development, housing, and agricultural land clearing, greatly reduces the amount of CO_2 absorbed by plants, this gives rise to a natural phenomenon called global warming. Charles Keeling proved the ability of vegetation to absorb CO_2 in the air at the Hawaii Research Institute. The study was conducted in an area with a four-season climate and it was found that CO_2 concentrations reached a maximum point in late winter when the trees lost all their leaves and reached a minimum at the end of summer when trees have high leaf density (T. Karyono, 2010);(Bratasida L, 2011); (Samidjo & Suharso, 2017);(Setyono et al., 2018);(Fourier, n.d., 2019).

Ideally, a city has green open space of at least 30% of the total city area, referring to the EaGOS Summit in Rio de Janeiro, Brazil (1992), and confirmed at the Johannesburg Summit, South Africa (2002), (Samsudi, 2010), also regulated in article 29 Law Number 26 of 2007 and Permendagri Number 1 of 2007 and Minister of Public Works Number 5 of 2008 (Sahalessy et al., 2019). For areas with strong urban characteristics, they will always be faced with the condition of decreasing the quality and quantity of green open space that can be allocated, due to the pressure for the growth of urban facilities and infrastructure, as a consequence of the dynamics of the increasing need for urban residents for activities.

The increasing number, needs, and activities of the community lead to competition for land use for various activities, especially economic activities. The competition for land use that occurs causes space that should be used as a Green Open Space (GOS) to be built to meet the development needs of other activities, because Green Open Space (GOS) is seen as economically unprofitable, for example, the Green Line is eliminated to create an area in-out route hotels (Mastuti, 2017).

Public Green Open Space (GOS) can be a comprehensive tool for long-term environmental protection through improving the quality of life and air quality, reducing urban heat, and increasing property values in terms of aesthetics and comfort as recreational facilities and relaxation facilities are easily accessible, can accommodate community activities and are adequate both in quality and quantity, as stated by Atiqul Haq. (2011) in (Mastuti, 2017).

Urban social life will be better and healthier if it is sufficient, planned, and organized green open space. This condition will provide healthy and positive mental growth for all age levels. Children can play in green open spaces safely, not on a dangerous street. Teenagers can exercise and will grow up with a healthy mind and body as well. City people can relax and restore freshness and fitness, and generate the creativity so that they can work passionately for the welfare of their families. Humans organize the environment with green open space, then the environment will provide support again for the benefit of a better human life (Dollah & Rasmawarni, 2018). GOS also provides aesthetic value, shaping the appearance of the city to be more natural with a role as a balancer in the composition of buildings and between elements of space in the city. Overall, green open space will improve the quality of the city area which in turn triggers an increase in the health quality of city residents, affects lifestyle, values , and behavior, and will increase appreciation for the environment and the establishment of the city (Sakkar & Rahim, 2015); (Malek et al., 2015).); (Ahmad et al., 2011).

The Karebosi Field Green Open Space Complex is the largest green open space in Makassar City with an area of 11.29 hectares (Mahsyar, 2015). Its location is at kilometer zero and is one of the marking points for Makassar City which is easily recognized as a city identity, or as a landmark that forms the city's image. (Lynch, 2020); (Zahnd, 1999). The position of the Karebosi Field GOS Complex on the Makassar City map is shown in Figure 1.

Figure 1. The Position of the Karebosi Field Complex in Makassar City
Source: Processed and Modified from Google Maps

Along with the development of the city of Makassar, the green open space has also developed through a revitalization program that began in 2007 (Mahsyar, 2015). Before the revitalization of this green open space, it was in a non-representative condition as something that could be the pride of Makassar City. In the rainy season, there will be puddles of water, on the outside of the field, there are many street vendors' tents that look shabby, at night they become a place for transvestites to peddle themselves, as well as several rickshaw vehicles milling about taking people who are lazy to walk from east side to west side, especially school children. This condition makes the City Government revitalize. Revitalization of Karebosi Field is an effort to optimize public land in the city center with the main function as a Green Open Sports Park and with regional support functions as parking spaces (cluster parking) and shopping spaces (commercial spaces) (Samsyuriani; Gunung, 2012).

This revitalization has changed the surface of the GOS Karebosi Field Complex, before the revitalization, it consisted of six football fields, and there was a road surrounding the inside of the field, there was a ceremonial stage as well as basketball, tennis, and volleyball courts, then after the revitalization, the surface turned into three football fields. , there is a courtyard for helicopter landings, which can also be used for ceremonies made of concrete, there is a jogging track, there is a tranbesi tree planting (samanea saman), there is a parking lot lined with papin blocks, there are softball, basketball, tennis, volleyball courts and there is a ceremonial stage.

There are two major components of changes that occur on the surface of the GOS Karebosi Field Complex after the revitalization when viewed from an ecological aspect, namely the change in the surface from which there were six soccer fields to three soccer fields and a helicopter landing platform made of concrete. Under the courtyard, there is a cavity in the form of space designated for parking and shopping places (Wikantari, R., Latif, M.S & Moh. Mochsen. M.S, 2012). On the outside of the three soccer fields, jogging paths are made and on the left and right sides of the jogging paths are planted with trambesi trees (samanea saman). The situation of the Karebosi Field GOS Complex before and after the revitalization is shown in Figure 2.

Figure 2. Situation of GOS Karebosi Before and After Revitalization (Kompasiana.com, 2015; Makassarmetro.com, 2020).

In Figure 2, above from the left, you can see six soccer fields that are bordered by paths and there is a pavilion that is used as a place for officials when there are ceremonial activities and the like. The bottom picture shows the situation of the Karebosi Field Complex GOS after the revitalization, three football fields surrounded by trees as well as a helicopter landing platform and a ceremony stage.

In various descriptions, it is said that changes or development of an open green space, which is carried out by the government in collaboration with the private sector, whether it is revitalization or other forms of development, will generally reduce the ecological function and social function of the green open space, for this reason, this research will examine the ecological potential of the complex. GOS Karebosi Field before and after revitalization. The ecological potential to be analyzed includes the ecological potential of vegetation and the ecological potential of groundwater absorption. The findings of this study will provide an overview of the pluses and minuses of revitalization activities.

Research related to the ecological potential of green open space that has been carried out, among others, was carried out by Andini, F.E et al, with the title "Evaluation of the Ecological Function of Urban Green Open Space as Water Catchment Areas in Pontianak City, Case Study of Taman Alun Kapuas", the focus of the analysis is to determine the rate of infiltration during daytime conditions. not raining and rainy conditions, as well as the influence of physical characteristics of soil and vegetation on the infiltration rate and the amount of green open space water infiltration potential (Andini, 2016); Nastiti, F.N, and Giyarsih, S.R. (2019) with the title "Green Open Space in Urban Areas: A Case in The Government Office of Boyolali Indonesia, focusing on the analysis of the suitability of building functions and green open space and the suitability of green open space with oxygen demand (Strategies, 2020). Febriani, A.F., et al (2018) with the title "Analysis of Urban Forest Needs as Anthropogenic (CO2) Gas Absorbent in Semarang City", the focus of the analysis on CO_2 gas emissions in relation to oil and gas needs based on population and CO_2 gas concentration in the air based on daily traffic activities (Strategies, 2020). The research mentioned has not yet studied changes in the ecological potential in relation to revitalization.

2. Metode Penelitian

This research is a survey research with descriptive analysis, carried out from March to May 2020. The research location is in Makassar City. Determination of the sample of green open space using purposive sampling technique, for that purpose the Karebosi Field Complex GOS was chosen as the object of research, because this green open space is the most extensive, has the most dynamic activity, has the most facilities and has been revitalized.

Data on green open space after revitalization was collected using observation techniques through direct observations of researchers in the field, then documented by recording and shooting. Meanwhile, the data before the revitalization was done by searching for documents via a google search and related agencies. GOS more, a literature study was carried out as a normative reference and the basis for theoretical analysis, especially those related to green open space and revitalization. The collected data is then analyzed by calculating the ecological potential of landscape elements that have ecological value based on theoretical studies before and after revitalization. The results of these calculations are then juxtaposed to see which ecological values are increasing and which are decreasing.

3. Theoretical Review

Revitalization is essentially a process, method, and or action to revive or reactivate a program or activity or revive vitality. According to Rais (2007) in (Hermawan & Rustiana, 2019), revitalization is an effort to revitalize an area or part of a city that used to live but then suffered a setback. In the process of revitalizing an area, the aspects covered include improvements in the physical, economic, and social aspects. Danisworo & Martokusumo (2002), in (Wuisang et al., 2019), the physical decline of an area occurs due to time/age factors, weather, earthquakes, tsunamis, motor vehicle smoke pollution, or due to poor maintenance mechanisms then internal and external factors. external area. Internal factors are more due to the building being unable to technically/functionally support existing needs, while external factors in the area result in the need for modification or additional functions related to building performance, another factor is public perception.

Green open space is a medium that can reduce CO_2 concentrations in the atmosphere, if there is green open space, there will be carbon assimilation by plants which will reduce carbon in the atmosphere (Jatnika et al., 2019), (Zong, 2017), (Kusminingrum, 2008). The absorption of CO_2 in trees is influenced by leaf cover, the wider the canopy, the greater the absorption rate (Zhong et al., 2017). Increasing the amount of vegetation will function as a filter and neutralizer of air pollutant materials so that it can be used as a bioindicator for monitoring air quality and as a producer of oxygen which is needed by humans (Azzahro et al., 2019). The ability of trees to produce oxygen was stated by Ahda Imran in (Kusminingrum, 2008), that one tree trunk can provide oxygen for the breathing needs of 2 people. Green Open Space is an oxygen producer whose function has not been replaced, as a benchmark, on an area of 1,600 M^2, of which there are 16 trees with a canopy diameter of 10 M capable of supplying Oxygen (O_2) of 14,000 liters per day. Dahlan E. N.'s research results published in (Dahlan, Endes N.; Kaleka, 2018) stated that the trambesi tree produces 28.5 tons of oxygen/tree/year.

Every hour, one hectare of green leaves can absorb 8 Kg of CO_2 which is equivalent to CO_2 exhaled by about 200 people at the same time (Management &

Tropika, 2011), saving 900 M^3 of groundwater per year (Sri Wanita et al., 2017), transferring 4,000 liters of water per day or equivalent to a temperature reduction of four to eight degrees Celsius, equivalent to the ability of five units of air conditioners with a capacity of 2,500 Kcal/20hours; reduce noise by 25-80 percent; reduce wind strength by 75-80 percent. (Prihandono, 2009), in another study it was said that the trambesi tree has a CO_2 absorption capacity of 23.33 kg CO_2/hour (Jatnika et al., 2019), various studies in the tropics show the average absorption of carbon dioxide by plants (CAU = carbon dioxide). absorption unit) is generally 10 g CO_2/m^2/day. (Mangkoedihardjo and Samudro, 2010) in (Fidayanti, 2016), also stated, that the type of plant with fairly high absorption of carbon dioxide is broadleaf Acacia (Accasia mangium) with an absorption capacity of 0.01519 tons/tree/year, Angsana (Pitherocarphus indicus) has an absorption capacity of 0.01112 tons/tree/year and Tanjung (Mimusops elengi) has an absorption capacity of 0.03429 tons/tree/year. According to Prasetyo in Gratimah (2009), the ability to absorb carbon dioxide in vegetation has different values according to the type of land cover, such as forests capable of absorbing 58.2576 tons of CO_2/ha/year, plantations 52.3952 tons of CO2/ha/year, shrubs 3,2976 tons CO_2/ha/year and grass 3,2976 tons CO_2/ha/year.

The ability of various trees to absorb CO_2 was stated by (Dahlan et al., 2007) in their research as shown in Table 1.

Table 1. The ability of Trees to Absorb Carbon Dioxide

No	Local Name	Scientific Name	CO_2 Absorption (Kg/tree/year)
1	Trembesi	Samanea saman	28.488,39
2	Beringin	Ficus benyamina	535,90
3	Mahoni	Swettiana mahagoni	295,76
4	Bungur	Langerstroemia speciosa	160,14
5	Akasia	Acacia auriculiformis	48,68
6	Tanjung	Mimusops elengi	34,29
7	Angsana	Pterocarpus indicus	11,12
8	Palm Raja	Roystonea regia	1,71
9	Kamboja	Plumeria acuminata	16,43

Source: Dahlan, 2007.

Oxygen (O_2) production is estimated using the development formula of the CO_2 absorption formula by multiplying the CO_2 absorption value by the conversion factor of CO_2 to O_2 atoms. The conversion factor for CO_2 to O_2 atoms is 0.73 (Purnawan, 2016), based on this conversion factor, the oxygen production by tree species is as shown in Table 2.

Table 2. The ability of Oxygen Production Tree

No	Local Name	Scientific Name	CO_2 Absorption (Kg/tree/year)	O_2 production (Kg/tree/year)
1	Trembesi	Samanea saman	28.488,39	20.796,52
2	Beringin	Ficus benyamina	535,90	391,21
3	Mahoni	Swettiana mahagoni	295,76	215,90
4	Bungur	Langerstroemia speciosa	160,14	116,90
5	Akasia	Acacia auriculiformis	48,68	35,54
6	Tanjung	Mimusops elengi	34,29	25,03
7	Angsana	Pterocarpus indicus	11,12	8,12
8	Palm Raja	Roystonea regia	1,71	1,25
9	Kamboja	Plumeria acuminata	16,43	11,99

Source: Conversion Calculation Results.

Iverson at, all. (1993) in (Ruslan & Rahmad, 2012) categorizes the value of carbon dioxide absorption based on the form of green open space, as shown in Table 3.

Table 3. Absorption of Green Open Space Against Carbon Dioxide

No	GOS type	Absorption	
		C(ton/ha)	CO_2(ton/ha)
1	Forest	15,9	58,353
2	Plantation	14,3	52,481
3	Bush	0,9	3,303
4	Grass	0,9	3,303

Sumber : Iverson et. al, 1993, dalam (Ruslan & Rahmad, 2012)

Urban green space also has the ability to conserve groundwater. The criteria for open green space as an absorber of rainwater runoff include having a minimum area of 0.5 ha, having a large tree canopy and leaves, high tree canopy density, and pavement of less than 45 percent (Madjowa, 2017). the determinants of the effectiveness of the ecological function of open green space as shown in Table 4.

Table 4. Determinants of the Effectiveness of the Ecological Function of Green Open Space

No.	Variable	Criteria	Value	Category	Citation
1.	Tree Distribution	Uneven	1	Low	Amir (2002),
		Equally	2	Tall	Inmendagri No.14
2.	Structure	Strata2	1	Low	Amir (2002), SchoGOS, dkk., (1999), Asdak (2004)
		Strata3	2	Currently	
		Many Strata	3	Tall	
3.	Header Shape	Cone, dangle	1	Low	Amir (2002),Park dan Cameron (2008), Mechram, dkk., (2012)
		Column, Oval	2	Currently	
		Circular	3	Tall	
4.	Density Tree	1-2 trees/100m^2	1	Low	Amir (2002), Inmendagri No. 14 1988, Asdak (2004)
		3-6 trees/100m^2	2	Currently	
		7-12 trees/100m^2	3	Tall	
5.	Pavement	>50%	1	Low	Amir (2002), Khairunnisa (2013)
		30-50%	2	Currently	
		<30%	3	Tall	

Majowa, NF. 2017.

Urban green space is one solution that is considered able to accommodate and withstand large enough rainwater runoff. The ability of green open space to store groundwater is very helpful for city residents in providing raw water sources during the dry season, besides helping to withstand seawater intrusion, the capacity of green open space in storing groundwater reaches 900 M^3/ha/year (Sakkar, A. & Rahim, R. 2015).

4. Results and Discussion

Based on the results of the survey, the distribution of tree distribution in the Karebosi Field GOS Complex is classified as uneven or in the low category, it can be seen that the dominance of tree planting is around the soccer field, on the east-west jogging path and the path between the north-south soccer fields when viewed based on the structure, then included in strata 3 or moderate category, if viewed based on the shape of the canopy included in the circular shape or high category, the majority of the existing trees are the type of Trambesi (samanea saman) which has a leaf crown forming a grove with an average span of 7-10 meters. Likewise, tree density is included in the high category with the number of trees 7-12 trees/100m2, if viewed based on the pavement, it is in the medium category with a cover of 30-50 percent. The largest paving cover was the helipad and its surroundings, then the tennis courts, then the kiosk courts, and basketball courts. The layer of hardening that is carried out, especially on the helicopter pad and its surroundings is a fairly thick layer of concrete because underneath there is a cavity designated for parking and shopping areas so that the water infiltration function can be said to be non-existent.

The water absorption capacity of the GOS Karebosi Field Complex is calculated based on the total surface area minus the surface area that has been coated with hardening, then multiplied by the water capacity of the green open space/ha/year, as shown in table 5.

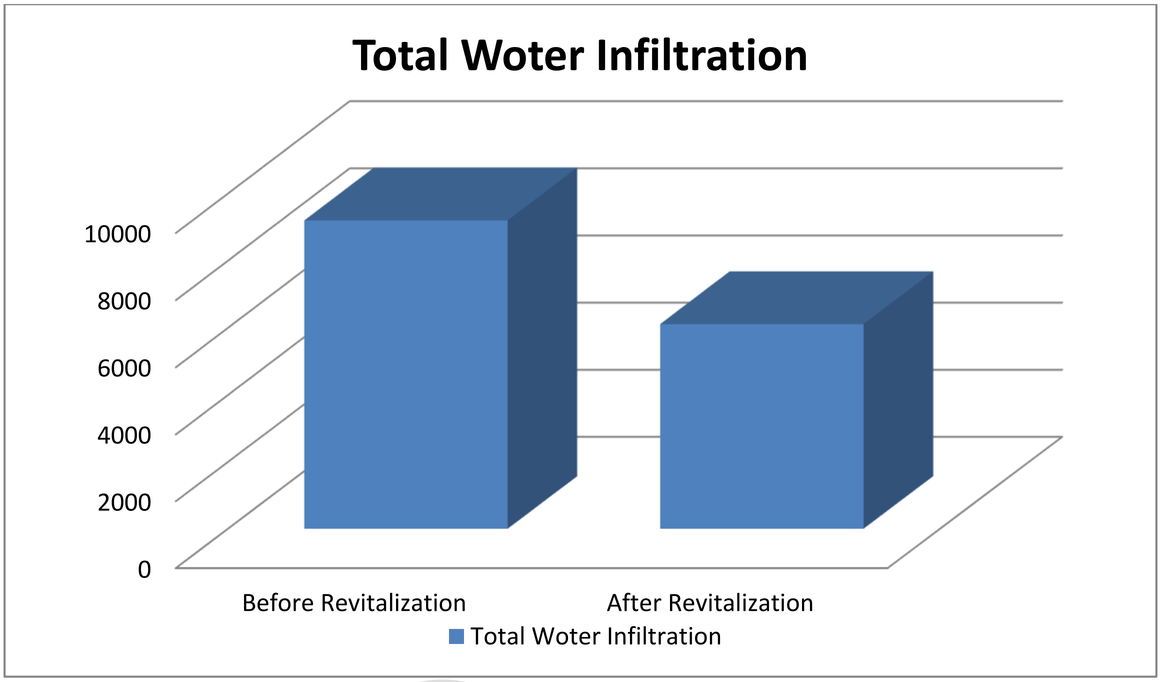
Table 5. Surface Area of Water Infiltration and Hardening

No	Description	Area (M^2)	
		Before Revitalization	After Revitalization
1	Total surface area	112.900	112.900
2	Pavement	2.850	-
3	Tennis court	5.543	5.543
4	Basketball court	1.964	1.964
5	Gazebo	350	-
6	Jogging track	-	2.941
7	Ceremonial stage	-	500
8	Heli landing/ceremonial grounds	-	28.743
9	Kiosk yard	-	5.340
10	The surface area of water absorption after deducting hardening	102.193	67.869
11	Total water absorption	9.198 M^3	6.111 M^3

Source: Analysis results

Based on the water absorption capacity of 900 M^3/ha/year, before revitalization, the water absorption capacity of the Karebosi Field Complex RTH is 9,198 M^3, and after the revitalization is 6,111 M^3. There was a decrease in water absorption by as much as 3,087 M^3/year. Graphically, the production of water infiltration is shown in Figure 3.

Figure 3. Graph of Water Infiltration Before and After Revitalization



Source: Analysis Results

The calculation of the ability to produce oxygen and absorb carbon dioxide is based on the number of trees, because the Karebosi Field Green Open Space Complex does not match the categories shown in table 1. so the space for sports fields is not possible to plant trees. There are several types of trees in this green open space, namely trambessi trees, mahogany trees, ansana trees and palm trees, banyan trees, and frangipani trees. Mahogany trees and ansana trees and palm trees are trees that existed before the revitalization. Mahogany and ansana trees are trees planted on the side of Jalan Jenderal Sudirman, Jalan Kartini, and Jalan Kajao Ladiddo, while palm trees are planted on the side of the road inside the Karebosi Field complex. The trambesi, frangipani, and banyan trees are generally trees planted after revitalization. Based on the oxygen production capacity and carbon dioxide absorption as shown in table 1, the calculation of oxygen production and carbon dioxide absorption is shown in table 6.

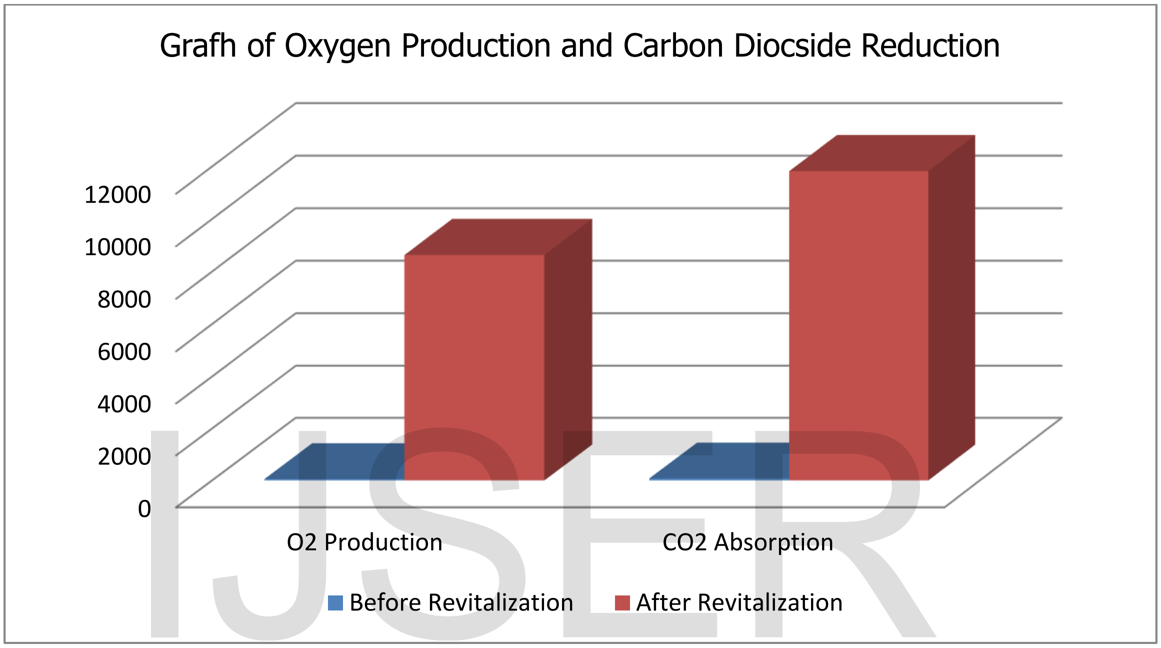
Table 6. Oxygen Production and Carbon Dioxide Uptake

No	Description	Number of Trees		O_2 production (Kg/tree/year)		CO_2 Absorption (Kg/tree/year)	
		Before Revitalization	After Revitalization	Before Revitalization	After Revitalization	Before Revitalization	After Revitalization
1	Trambesi	2	414	41,60	8.609,76	56,98	11.794,860
2	Mahoni	60	53	12,95	11,44	17,75	15,680
3	Angsana	29	29	0,24	0,24	0,33	0,325
4	Palem	72	23	0,09	0,03	0,12	0.039
5	Beringin	-	18	-	7,04	-	9,650
6	Kamboja	-	19	-	0,28	-	0,312
	Total	163	556	54,88	8.628,79	75,18	11.820,87

Source: Analysis results

As seen in Table 6, there was an increase in the number of trees after the revitalization of 393 trees. The addition of the number of trees was dominated by the trambesi tree (samanea saman), while the reduction in the number of trees was quite large in the palm tree. This reduction in palm trees is due to the location of the trees being displaced by heaps. The surface of the field at the time of revitalization was raised in increments of about one meter, the embankment material was taken from the excavation of underground cavities for parking and shopping areas under the helicopter pad and its surroundings. Prior to the revitalization, most of the field surface conditions were below the surface of the road surface, so that during the rainy season there would be puddles of water as shown in Figure 1. Based on oxygen production, it can be seen that there was an increase in oxygen production of 8,573.91 tons/year. The tree's contribution to the addition of oxygen is mostly produced by the trambesi tree (samanea saman), this tree in various studies is categorized as the largest oxygen producer and carbon dioxide absorber, while based on CO2 absorption there is also an increase of 11,745.69 tons/year.

Table 6. Oxygen Production and Carbon Dioxide Uptake



Source: Analysis results

5. Conclusion and Suggestions

There has been a change in the potential ecological function of the RTH Karebosi Field Complex after the revitalization. In the water absorption function, there is a reduction in the capacity of 3,087 M^3/year, while in the oxygen-producing function there is an increase in production capacity of 8,573.91 tons/year, as well as for the carbon dioxide absorption function and an increase in infiltration capacity of 11,745.69 tons/year. Based on these findings, the revitalization carried out on the Karebosi Field Complex RTH from the aspect of ecological potential is beneficial. Besides that, another advantage gained from the revitalization is that there will be no more puddles during the rainy season. According to the findings of this study, this is not the case with the revitalization of the RTH Complex in the Karebosi Field Complex. This finding is in line with research conducted by Juwito and colleagues (Juwito et al., 2019) with the finding that due to revitalization there has been an improvement in the quality and quantity of the environment in a sustainable manner.

To increase the ecological potential, the addition of shrubs and the improvement of the grass on the soccer field and its surroundings, which look inadequate, should be maximized, because shrubs and grasses have the potential to produce oxygen and reduce carbon dioxide, as shown in table 3.

Further research is needed to determine changes in social function in the Karebosi Field Complex RTH after the revitalization.

Bibliography.

Ahmad, H., Maulan, S. Bin, Mariapan, M., & Habib, S. (2011). Users' preferences of usability and sustainability of old urban park in Tabriz, Iran. *Australian Journal of Basic and Applied Sciences*, *5*(11), 1899–1905.

Andini, F. E. (2016). Evaluasi Fungsi Ekologis Ruang Terbuka Hijau (Rth) Perkotaan Sebagai Areal Resapan Di Kota Pontianak (Studi Kasus: Taman Alun Kapuas). *Jurnal Teknologi Lingkungan Lahan Basah*, *4*(1), 1–10. https://doi.org/10.26418/jtllb.v4i1.13553

Azzahro, F., Yulfiah, & Anjarwati. (2019). Evaluasi Pemilihan Spesies Pohon Pengendali Polusi Udara Pabrik Semen. *Jurnal Teknik Lingkungan Universitas Kebangsaan*, *2*(1), 19–23. http://jurnal.universitaskebangsaan.ac.id/index.php/envirosan/article/view/259

Bratasida L, et al. (2011). *Pioneers in Green Science: Beberapa Model Penerapan Konsep Ramah Lingkungan di Indonesia* (et al Praptono (ed.); Pertama). Dian Rakyat.

Dahlan, Endes N.; Kaleka, D. . (2018). Mengatasi Polusi Udara dengan Pohon Trembesi.

Kompasiana Beyond Blogging, 28. https://www.kompasiana.com/rofinusdkaleka/5a65ef88dd0fa8536c26fd63

Dahlan, E. N., Kusmana, C., Sopandie, D., & Pertiwi, S. (2007). *Analisis kebutuhan luasan hutan kota sebagai sink gas CO2 antropogenik dari bahan bakar minyak dan gas di Kota Bogor dengan pendekatan sistem dinamik* [Institut Pertanian Bogor]. http://iirc.ipb.ac.id/handle/123456789/40542

Dollah, A., & Rasmawarni. (2018). Analisis Ruang Terbuka Hijau (RTH) Dari Aspek Keterlaksanaan Fungsi Sosial Di Kota Makassar. *Jurnal Linears*, *1(2)*(Environment Architecture), 62–71. unismuh.ac.id

Fidayanti, N. (2016). Analisis serapan karbondioksida berdasarkan tutupan lahan di kota palangka raya. *Matematika, Sains Dan Teknologi2*, *17*(September 2016), 77–85.

Fourier, R. C. (n.d.). **Dr. Bhumika Gupta Associate Professor Institut Mines- Telecom Business School*.

Hermawan, Y., & Rustiana, E. (2019). Peningkatan Produktivitas Melalui Kohesivitas Kelompok dan Revitalisasi Kondisi. *Jurnal Ilmu Administrasi: Media Pengembangan Ilmu Dan Praktek Administrasi*, *16*(1), 51–65. https://doi.org/10.31113/jia.v16i1.205

Jatnika, L., Zuhair, F., Studi, P., Lingkungan, T., & Efarina, U. (2019). *Korelasi antara ruang terbuka hijau dengan konsentrasi karbon dioksida (co2) dan oksigen (o2) di kampus universitas efarina pematangsiantar*.

Juwito, J., Wikantiyoso, R., & Tutuko, P. (2019). Kajian Persentase Ruang Terbuka Hijau pada Implementasi Revitalisasi Taman Kota Malang. *Local Wisdom : Jurnal Ilmiah Kajian Kearifan Lokal*, *11*(1), 16–41. https://doi.org/10.26905/lw.v11i1.2686

Karyono, T. (2010). *Green Architecture: Pengantar pemahaman arsitektur hijau di Indonesia* (T. H. Karyono (ed.); Pertama). Rajawali Pers.

Kusminingrum, N. (2008). Potensi Tanaman Dalam Menyerap Co2 DAN Co untuk Mengurangi Dampak Pemanasan Global. *Jurnal Permukiman*, *3*(2), 96. https://doi.org/10.31815/jp.2008.3.96-105

Lynch, K. (2020). "The City Image and its Elements." In *The City Reader*. https://doi.org/10.4324/9780429261732-67

Madjowa, N. F. (2017). Fungsi Ekologi sebagai Penyerap Limpasan Air Hujan pada Taman Kota. *Fraktal*, *2*(2), 41–50.

Mahsyar, A. (2015). Public Private Partnership: Kolaborasi Pemerintah Dan Swasta Dalam Pengelolaan Aset Publik Di Kota Makassar. *Jurnal Administrasi Publik*, *12*(1), 71–80.

Malek, N. A., Mariapan, M., & Rahman, N. I. A. A. (2015). Community Participation in Quality Assessment for Green Open Spaces in Malaysia. *Procedia - Social and Behavioral Sciences*, *168*, 219–228. https://doi.org/10.1016/j.sbspro.2014.10.227

Manajemen, J., & Tropika, H. (2011). Prediksi Kebutuhan Hutan Kota Berbasis Oksigen di Kota Padang, Sumatera Barat (Predicting Oxygen-base Urban Forest Needs in Padang City, West Sumatera). *Jurnal Manajemen Hutan Tropika*, *10*(2), 47–57. https://doi.org/10.7226/jmht.10.2.

Mastuti, A. (2017). Kondisi Dan Prospek Pengembangan Eksisting Ruang Terbuka Hijau (RTH) Publik di Kota Surakarta. *Journal of Politic and Government Studies*, *6*(3), 131–140.

Prihandono, A. (2009). Penyediaan Ruang Terbuka Hijau (RTH) Menurut UU No.6/2007 Tentang Penataan Ruang Dan Fenomena Kebijakan Penyediaan RTH Di Daerah. *Jurnalpermukiman.Pu.Go.Id*, *26*, 13–23. http://jurnalpermukiman.pu.go.id/index.php/JP/article/view/173

Purnawan, E. I. (2016). *Teknik Estimasi Cadangan Karbon Serapan Karbondioksida & Produksi Oksigen Hutan Alam Dipterocarpa*. 0–20.

Qathrunnada, A., & Fuady, M. (2021). *Evaluasi Fungsi Ekologis Ruang Terbuka Hijau Taman Pusat Kota Banda Aceh (Studi Kasus Taman Bustanussalatin dan Blang Padang)*. *5*(4), 38–43.

Ruslan, M., & Rahmad, B. (2012). Kajian Ruang Terbuka Hijau Dalam Rangka Pembentukan Hutan Kota Di Banjarbaru Study of Green Open Space in Urban Forest Establishment in Banjarbaru South Kalimantan. *Jurnal Hutan Tropis*, *13*(1), 73–91.

Sahalessy, A., Krisantia, I., & Budiyanti, R. B. (2019). Evaluasi Ketersediaan Ruang Terbuka Hijau Publik Menurut Peraturan Menteri Pekerjaan Umum Nomor 5 Tahun 2008 di Kecamatan Gambir, Jakarta Pusat. *Seminar Nasional Pembangunan Wilayah Dan Kota Berkelanjutan*, *1*(1), 283–288. https://doi.org/10.25105/pwkb.v1i1.5291

Sakkar, A., & Rahim, R. (2015). *Taman Edukasi* (Sakkar A; Rahim R. (ed.); 1.). Alauddin University Press. sinta jurnal sains

Samidjo, J., & Suharso, Y. (2017). Memahami Pemanasan Global dan Perubahan Iklim. *Majalah Ilmiah Pawiyatan*, *24*(2), 36–46.

Samsudi. (2010). Ruang Terbuka Hijau Kebutuhan Tata Ruang Perkotaan Kota Surakarta. *Journal of Rural and Development*, *Vol. 1*(No. 1), Hal. 11-19.

Samsyuriani; Gunung, R. (2012). *Perubahan Fungsi Lapangan Karebosi dari Ruang Terbuka Hijau Publik Menjadi Ruang Komersial Di Pusat Kota Makassar.* [Gajah Mada]. http://etd.repository.ugm.ac.id/home/detail_pencarian/54443

Setyono, P., Dan, S., & Himawan, W. (2018). Effects of Greenhouse Gases and Global Warming on Environment and Climatic Conditions of Boyolali,Central Java Indonesia. *Journal of Climatology & Weather Forecasting*, *06*(03). https://doi.org/10.4172/2332-2594.1000236

Sriwanita, C., Mubarak, M., & Nurhidayah, T. (2017). Analisis Luasan Hutan Kota Berdasarkan Kemampuan Menyerap CO2, Kebutuhan O2 dan Kebutuhan Air di Kota Pekanbaru. *Dinamika Lingkungan Indonesia*, *4*(2), 75. https://doi.org/10.31258/dli.4.2.p.75-85

Strategies, S. (2020). *Inquiry Regional Science*. *June*.

Wikantari, R., Latif, M.S & Moh. Mochsen. M.S. (2012). Konektivitas Ruang Bawah Tanah Dengan Ruang Terbuka Hijau Pada Arsitektur Karebosi-Link Makassar. *Prosiding Seminar Hasil Penelitian Fakultas Teknik Universitas Hasanuddin*, 12.

Wuisang, C. E. V., Sutrisno, A., & Sondakh, J. A. R. (2019). *Strategi Revitalisasi Kawasan Heritage di Pusat Kota Lama Kota Manado*. *March 2021*, A103–A110. https://doi.org/10.32315/ti.8.a103

Zahnd, M. (1999). *Perancangan Kota Secara Terpadu : Teori Perancangan Kota dan Penerapannya.* (Heinz Frick (ed.); 07 ed.). Penerbit Kanisius dan Soegijapranata University Press. www.kanisiusmedia.com

Zhong, B., Wang, L., Liang, T., & Xing, B. (2017). Pollution level and inhalation exposure of ambient aerosol fluoride as affected by polymetallic rare earth mining and smelting in Baotou, north China. *Atmospheric Environment*, *167*, 40–48. https://doi.org/10.1016/j.atmosenv.2017.08.014

Zong, B. at al. (2017). Pollution level and inhalation exposure of ambient aerosol fluoride as affected by polymetallic rare earth mining and smelting in Baotou, north China. *Atmospheric Environment*, *167*, 40–48. https://doi.org/2017.08.014