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# Green City MIS as a Sustainable Urban GOS Provision Control Implementation Model

*Case Study: The GOS provision in the Brantas riverbanks revitalization, Malang City, Indonesia*

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**Key words**: Green City's MIS; Green Open Space; Sustainable City

**Abstract**: A Green City Management Information System (MIS) has been designed to support a reliable and comprehensive database of Green Open Space (GOS) development policies in Malang City. This paper aims to acquire feedback on the development of a Green City MIS as a provider of spatial and non-spatial data in planning and design of green cities, for the monitoring and control of sustainable urban green open spaces. In this study, the location as a sample for monitoring and control of green open space with a Green City MIS was carried out in densely populated areas on the banks of the Brantas River in the city of Malang. This MIS can be effectively used to monitor urban dense residential areas such as Warna-Warni Kampong (Picturesque Village) and Biru Kampong (Blue Village) on the banks of the Brantas River. The results of this study were used to conduct a review of the development policies of the Brantas riverbank area, especially in determining urban green spaces, as a control model for the implementation of urban spatial planning.

## 1. INTRODUCTION

One of the global issues of urban development today is ensuring the sustainability of urban development (Wikantiyoso, Respati & Tutuko, 2013) The main principle of sustainable urban development is to integrate the economic, environmental, and social aspects to realize a quality of city life that is better for present and future generations. Planning and design of green cities presents sustainable urban development. A city's green open space (GOS) as an element of the urban landscape has social, cultural and economic dimensions, and urban ecological issues (TÎRLĂ et al., 2014; Newman & Jennings, 2012). Thus, the existence of urban GOS has a very strategic function to create an urban environment for the interaction between the human life order and the natural environment, harmoniously and sustainably. The question is, how can GOS be managed naturally, toward a

natural setting conducive to harmonious, integrated (Olsson, 2012) and sustainable urban human activities (Shi & Woolley, 2014; TÎRLĂ et al., 2014).

City development, with its various problems, has placed the position of urban GOS on the dilemma side. Uncontrolled urban growth can reduce the carrying capacity of the city environment, as well as the condition of cities that are susceptible to various diseases due to degradation of environmental functions (Kearns, 2012; Newman & Jennings, 2012). The status of 'imbalanced spatial implementation,' if it continues, results in a decrease in the quality of life physically, economically and socio-culturally, which is often referred to as 'urban disaster' (Buyadi, Mohd, & Misni, 2013). A balance between green space and space developed with an integrated environmental infrastructure system will increase the carrying capacity of an urban environment. Socio-cultural activities around river banks are a common phenomenon in Indonesia, so planning for settlement facilities around rivers needs to be considered (Tutuko, Subagijo, & Aini, 2018). In planning and city design, management of urban space functions (planning of metropolitan area spatial data) should be integrated and sustainable. A green city development policy is a concept model that can be used as a conceptual framework to realize harmonious and sustainable city development.

This paper aims to acquire feedback on the development of a Green City Management Information System (MIS) as a provider of spatial and non-spatial data in planning and design of green cities, monitoring and controlling sustainable urban green open spaces. A Green City MIS has been designed to support a reliable and comprehensive database of GOS development policies in Malang City. A WEB-based Green City MIS was built using a GIS database that was able to guarantee the accuracy and validity of city spatial information (Dewi Anggadini, 2013; Karsidi, 2016). The city planning and design approach model with GIS application can ensure the sustainable development of the region because of the accuracy and validity of the data (Tuturoong et al., 2013).

The database supply model with GIS applications has become a new approach in the process of planning and designing efficient and rational urban development. Planning and designing particular areas such as green open space currently faces very complex development problems. The process of formulating regional development policies is presently carried out by manual analysis of spatial, physical data which has operational limitations in managing urban development data. This limitation results in the study of the city plan and decision-making not being integrated, and cannot guarantee the sustainability of urban development.

The implementation of spatial planning in densely populated residential areas such as the Brantas river bank has very complex problems. The Brantas riverbank area, which has been designated as an urban green area, faces a dilemma due to Warna-Warni Kampong's (Picturesque Village) development policy. Integration of policy development, with its implementation, is needed to avoid policy conflicts that hurt the quality of the urban environment. The Green City MIS is beneficial for monitoring urban dense residential areas such as Warna-Warni Kampong. The results of this study were used to conduct a review of the development policy of the Brantas riverbank area, especially regarding the determination of its urban green areas as metropolitan blue space areas. The Green City MIS acts as a control model for the implementation of urban spatial planning.

Determination of the area along the Brantas riverbank in the GOS Masterplan is inappropriate given the current policy because the potential of

Brantas water can be developed as an area of blue space supported by linear green space on both sides.

## 2. LITERATURE REVIEW

### 2.1 The Importance of MIS in Planning

The development of cities in the global era, known as the Era of Industrialization 4.0, has both challenges and opportunities in realizing integrated and sustainable development (Tao, 2013). The 'green city' as one of the great concepts of smart city development (Arafah & Winarso, 2017; Anguluri & Narayanan, 2017) integrates all aspects of socio-cultural, economic and public service governance, as well as municipal facility services (Tao, 2013), requiring one keyword, "integrated system planning" (Singkavongxay, Jensen, & Bull, 2010; Henderson & Lowe, 2015; Ahern, Cilliers, & Niemelä, 2014). The development of MIS applications for green cities is one part of the substance supporting spatial planning (Anguluri & Narayanan, 2017).

Green city development policies have an essential role in improving the social, economic, and ecological functions of the city (Wikantiyoso, Respati & Tutuko, 2013). Efforts to realize conceptually open space have been carried out through various provisions and regulations, but have not substantially functioned as guidelines and directives for the provision and improvement of the quantity and quality of open spaces (Wikantiyoso, Respati & Suhartono, 2018). Development of a Green City MIS application uses the Waterfall Method. This method is a systematic and sequential approach to software development, starting with the specification of user needs through the stages of planning, modelling, construction, and the delivery of the system to customers/users (Presman, 2012) .

Urban planning and design approaches with GIS applications strongly support the integrated planning process and ensure the sustainability of regional development due to the accuracy and validity of the data provided in the system (Wikantiyoso, R, 2000). The database supply model with GIS applications can be a new approach in an efficient and rational urban planning and design process. Planning and design of particular areas such as green open space currently faces very complex development problems. At present, the policy formulation process is still carried out with a manual data analysis process that has limited operational and regional data processing (*Figure 1*).

### 2.2 The Green City Development Program

The Ministry of Public Works of Indonesia adopted the concept of a green city as a metaphor for sustainable development that is more oriented towards improving the urban area's environment. The Green City Development Program (GCDP) framework is used as the basic framework in developing planning and design policies for urban space utilization. Spatial planning is a tool to coordinate urban development sustainably. Following the mandate of Article 3 of Law 26 of 2007, urban development needs to advance by paying attention to the harmony between the natural environment and the artificial environment. One effort to increase

community awareness and involvement in recognizing sustainable urban living is through the GCDP.

The GCDP as a concept realizes environmentally friendly cities by effectively and efficiently utilizing water and energy resources, reducing waste, implementing integrated transportation systems, ensuring environmental health, and synergizing the natural and artificial environment, based on urban planning and design using sustainable development principles (Lundqvist, 2007). The concept of green cities is a response to address the issue of climate change through adaptation and mitigation actions. The GCDP is a collective movement of all elements of city stakeholders and requires initiatives based on various practices in the application of sustainable urban development values. The logical flow of the Green City MIS database structure is shown in *Figure 1*.

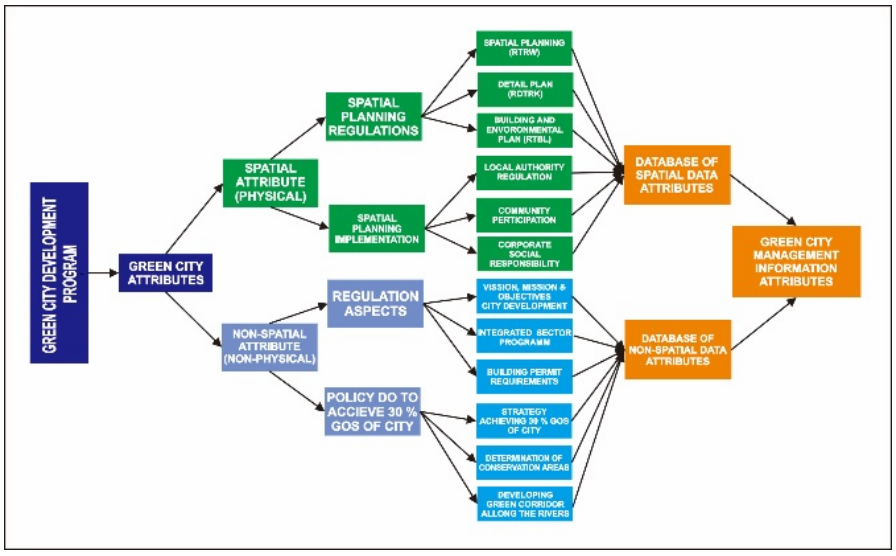


*Figure 1.* Green city MIS database structure

The WEB-based Green City MIS is developed based on the essence of the green city concept, which is outlined in the GCDP, and should refer to the factors used in the GCDP implementation. A review of the spatial policy as intended above has produced a portrait of policies related to the strategy and execution of urban GOS development in Malang City. The results of the spatial planning policy review show only three of the eight green city attributes contained in the GOS master plan action plan:

1. Planning and design of cities that are sensitive to the green agenda,
2. Revitalizing urban GOS, and
3. The active role of the community in developing green cities.

## 2.3 The GOS Provision

Based on the Minister of Home Affairs' Regulation of Indonesia No. 1 of 2007 concerning Preparation of GOS in Urban Areas, urban GOS planning requires an ideal area of GOS of at least 30% for each urban region (Article 9, Paragraph 1), where the GOS area consists of both public and private green space (Article 9, Section 2). The extent of the provision of open green space is the responsibility of the city government, which is carried out in stages following the financial capabilities of each region (Article 9, Paragraph 3). The provisions of private green space are the

responsibility of the private sector or institutions, individuals, and communities that are controlled through the use of space permits by the city government (Article 9, Paragraph 4).

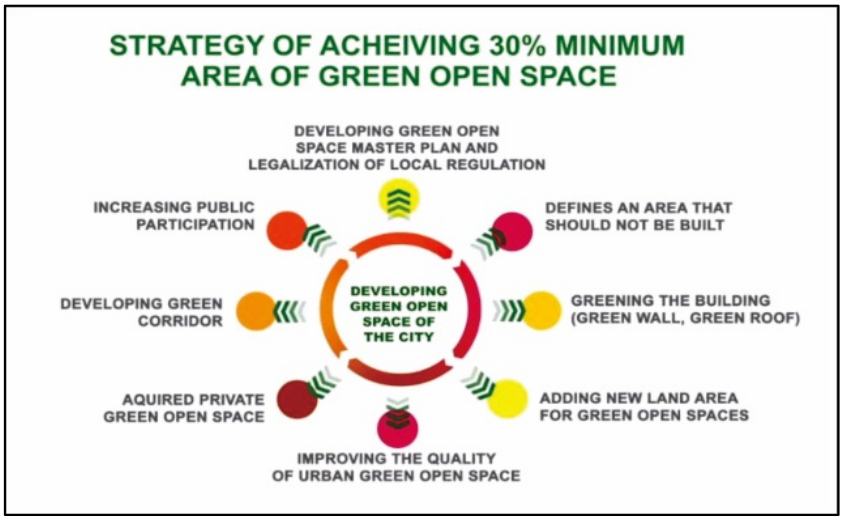


*Figure 2*. GOS provision strategy for achieving 30 % of urban space

The policy of providing and utilizing space for the development of urban GOS is intended to maintain the sustainability and balance of urban ecosystems that cover elements of the social and cultural environment. Provision and utilization of GOS functions as an effort to improve, maintain the microclimate, aesthetic value, absorb ground water, and create a balance and harmony in the physical environment of the city (*Figure 2*). The existence of GOS is essential in controlling and maintaining environmental integrity and quality. Urban development control must be carried out proportionally and balanced between development functions and the environment. Another study also discusses the use of GOS as an inclusive public space as also very important, especially regarding GOS that has historical values in a city that needs preservation. This is done so that the GOS continues to function as a historic public space in the city (Subadyo, Tutuko, & Cahyani, 2018). Malang City's GOS planning pays attention to the movement patterns of cities that form the design of space in the city of Malang.

GOS has essential roles and functions to improve the quality of the city environment, that is; pollution control (air, land, sound); water conservation; prevention of landslides; purifying the atmosphere; controlling urban microclimate; and improve the quality of urban life through the psychological effects of the environment and other social impacts (Wikantiyoso, Respati & Pindo, 2014; Badiu et al., 2016). According to TÎRLĂ et al. (2014), GOS based on the scope and type of activities can be divided into public green areas in the form of parks, main road corridors, national plantations, and urban forests; Green areas with limited access (green regions with restricted access) in the form of sports fields, private or public gardens; and particular green regions in the way of botanical gardens, zoological gardens, and cemeteries.

Conceptually, the provision of urban open space has been carried out through regulatory requirements related to the provision of urban public space. However, technical regulations still do not function as guidelines and

directives for the provision and improvement of the quality of open urban areas. The needs of Malang's GOS can be divided into two categories, namely: (1) Increasing the quantity of urban public space, and (2) Improving the quality of the city's green open space through a revitalization program and improvement of the visual quality of urban areas. According to the Malang GOS Master Plan, the condition of Malang's public GOS is currently 18.14% of the city of Malang. A controlling device that can function as a monitoring tool that can guarantee the availability of 30% of urban green open space is required. The Green City Management Information System is a model that is expected to be able to answer the issue of supply and utilization, and control of urban GOS. A Green City MIS that is accountable and open is needed by all stakeholders for monitoring and controlling the availability of urban GOS.

## 3. METHODS

The approach used is MIS-based, namely MIS-based mapping that displays maps and interactivity functions that exist in GIS applications. The result is visualization in two or three dimensions of several layers of maps. It is instrumental a tool to analyse, monitor, and implement changes in urban green space functions and substitution efforts. In this research, this application is used to determine the location of GOS that has been transformed into a dense residential area, such as Warna-Warni Kampong (Picturesque Village), and Biru Kampong (Blue Village), the location of the research sample. GIS applications visualized in two, or three dimensions can run on a desktop or on the web. This capability is beneficial as a tool to analyse, monitor, and implement changes in the function of urban green spaces and substitution efforts (Bilgili & Gökyer, 2012).

Implementation of the GOS-MIS in revitalizing the open space of the riverbank corridor is based on four parameters: (1) linear green space along riverbanks, (2) areas of high control zones, (3) ownership status of riverside land, and (4) typology of riverbank structures. The determination of the city and typology is carried out through the analysis of a map overlay according to the four parameters.

The analysis area is selected based on three criteria: (1) Brantas riverbank area that is densely populated; (2) areas that can be relatively intervened on by city government policies; and (3) areas that have the potential for urban development. Based on these criteria two regions have been chosen, Warna-Warni Kampong and Biru Kampong, Jodipan villages of Malang City. The two communities are located on the right and left sides of the Brantas Bridge in Malang City.

## 4. RESULT AND DISCUSSION

The location of Malang City is in East Java Province, Indonesia. Malang City is the second largest city after Surabaya. Located 90 km south of Surabaya, with a population of about 858,891 and a total area about 110.06 km. Malang City has assets of planning and city design that were designed by Thomas Karsten in 1933 (Bogaers & Ruijter, 1983). The development of Malang City based on planning by Karsten has resulted in a

character of city design that incorporated boulevard design and parks/open spaces, especially in the northern part of Malang.

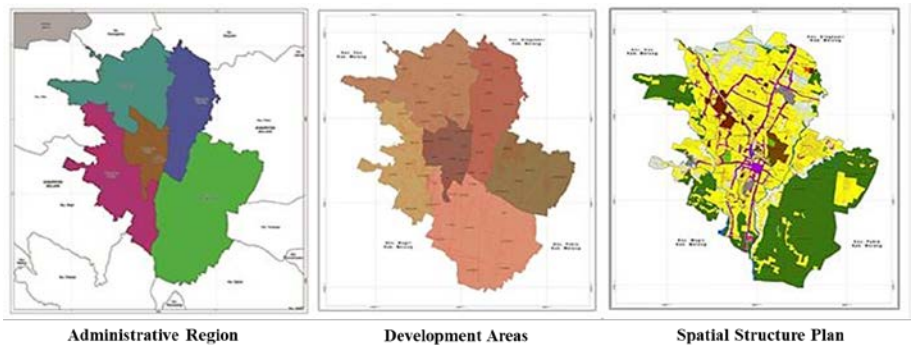


*Figure 3.* Map of Malang City Spatial Plan 2010-2030

The area of Malang City is 110.06 km$^2$ and is divided into five districts, namely Kedungkandang, Sukun, Klojen, Blimbing, and Lowokwaru districts. However, in its regional spatial planning (RTRW) Malang City is divided into six development area units, namely Central Malang, West Malang, North Malang, Northeast Malang, East Malang, and Southeast Malang development areas. Determination of development areas is not based on administrative boundaries but based on the potential for accelerating the growth of an urban area. Administratively, a few obstacles will be encountered when implementing the plan.

*Table 1.* The distribution of GOS in Malang City

| No. | Sub-district | Total area (Ha) | Green Open Spaces (m$^2$) | | | | Total GOS (m$^2$) |
|---|---|---|---|---|---|---|---|
| | | | Green Belt | City Park | Residential Park | Other | |
| 1 | Klojen | 883.00 | 20,635 | 259,715 | 63,180 | 98,455 | 441,985 |
| 2 | Blimbing | 1,776.65 | 10,588 | 4,075 | 16,306 | 165,463 | 196,432 |
| 3 | Sukun | 2,096.57 | 12,467 | 77,858 | 14,272 | 276,940 | 381,537 |
| 4 | Lowokwaru | 2,260.00 | 26,479 | 7,718 | 9,942 | 107,871 | 152,010 |
| 5 | Kedungkandang | 3,989.44 | 8,900 | 16,670 | 27,773 | 77,925 | 131,228 |
| Total Area | | 11,005.66 | 79,069 | 366,036 | 131,433 | 726,654 | 1,303,192 |

The GOS distribution data of Malang City (*Table 2*), shows that the city centre of Malang (Klojen district), has historically been well designed (in the Dutch colonial era of 1914-1939). *Table 1* shows that Klojen district, the smallest area (8%), has the most extensive GOS area, about 441,985 m$^2$, compared with other areas, and it has a GOS area of 34% of the total GOS in Malang City. Five main rivers cross Malang City; the watershed has the most significant contribution to the provision of GOS, which is 62.92%, or 11.41 % of the total city area, thus revitalizing GOS along riverbanks is a strategic approach (see *Table 2*). Based on Malang Spatial Plan data, the total GOS of Malang City is 18.14%, or around 1752.15 ha.

The problem of GOS provision in Central Malang is more dominant in locations along the banks of the Brantas River. Field data analysis, by separating the spatial functions along the Brantas River, produces several spatial data layers. The approach taken is to use several layers of maps as considerations for analyzing optimal decisions in the area (see *Figure 4*). The output of this analysis is a thematic map of the river basin that is

illegally occupied by the community. By using this application, monitoring and control of changes in use of space along the Brantas riverbanks will be easier

*Table 2*. Green open space in Malang City

| Type of Green Open Space | Areas (Ha) | Percentage of GOS | Percentage of Total City area |
|---|---|---|---|
| Urban Forest | 33.56 | 1.92 % | 0.35 % |
| City Park | 175.49 | 10.02 % | 1.82 % |
| Field | 59.19 | 3.38 % | 0.61 % |
| Cemetery | 94.73 | 5.41 % | 0.98 % |
| Green line road (median road, boulevard) | 218.64 | 12.48 % | 2.26 % |
| Riverbank boundary | 1102.43 | 62.92 % | 11.41 % |
| Railway line boundary | 43.11 | 2.46 % | 0.45 % |
| Extra High Voltage Connection boundary | 25 | 1.43 % | 0.26 % |
| Total | 1752.15 | 100 % | 18.14 % |

*Source*: Master Plan of GOS of Malang City in 2012 -2032

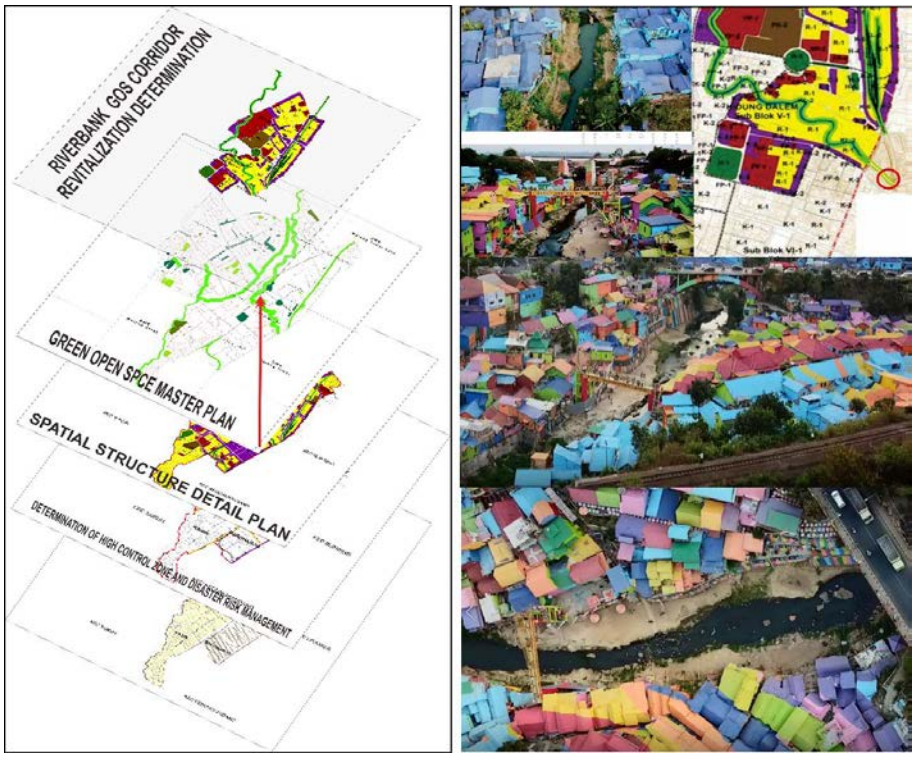


*Figure 4*. Riverbank GOS Corridor Revitalization Determination using Green City MIS and Thematic Overlays Map based on GIS Database

Changes in spatial function along the riverbank will be monitored, and well-controlled interventions to the role of the areas will be actioned. If a space is used in a way that violates the purpose of that space, it will be immediately known and control and revitalization can be directly carried out. The current conditions at the study site indicate a dominance of dense settlement land use in the Brantas river basin. *Figure 4* shows that, the two kampongs are located on the right and left the side of the Brantas River Bridge in Malang City. The study covers an area of 1,653 meters on the left and right of the Brantas River Bridge. Based on river boundary lines, there

are relatively steep contour typologies and the average width is 20 meters. The area with potential as open space in this area is 33,060 square meters. The results of the spatial analysis considering this MIS application are as follows: (1) Open space area is 4,066.38 square meters or 12.3%; (2) Residential area is 25,952.10 square meters or 78.5%; and (3) Remaining land divided by other functions covers an area of 3,041.52 square meters or 9.2% (see *Table 3*).

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*Table 3.* Land use of the Brantas riverbanks area in the Warna-Warni Kampong-Biru Kampong section

| No. | Land Use | Total Area (square meters) | Percentage |
|---|---|---|---|
| **1** | Open Space | 4,066.38 | 12.3 % |
| **2** | Residential Area | 25,952.1 | 78.5 % |
| **3** | Other Functions | 3,041.52 | 9.2 % |
| | **Total Area** | 33,060 | 100 % |

In the 2012-2032 City GOS Master plan document, it is illustrated that all river basins that cross the city of Malang are planned as green corridors. In actual fact, the riverbank area has been dominated by residential buildings; it has become a formidable challenge for the city government to implement its master plan. Improving the quality of open space in the planning area should be supported by technical guidance in an effort to improve the quality of the river basin as an ecological public space. Through improving the quality of green open space and the quality of the Brantas River flow, the Brantas River area has the potential to become a blue space.

According to the GOS master plan, the use of open space along the riverbank shows that the edge of the river is to be developed to increase the quantity of GOS. The GOS provision problems in Malang City are:

1. The low proportion of public green open space in Malang City areas due to the high demand for land for urban economic activities.
2. Act No. 26, 2007, Article 29, which states that 30% of urban area should be green open space.
3. The average proportion of GOS area in major cities in Indonesia today is almost 15% (GOS of Malang City is now almost 18.14 %) of the urban area.
4. The local government has difficulty meeting the provision of urban GOS (30% of the urban area as established by Act No. 26 of 2007 on Spatial Planning, specifically Article 29) because of urban land dominated by private ownership.
5. Community participation is one solution to reduce the local government budget.

The situation regarding the existence of settlements along riverbanks is a phenomenon that is commonly found in cities in Indonesia, as well as in Malang City. *Figure 5* illustrates that there is a discrepancy between green space plans along the Brantas watershed and the fact that watershed space is used by the community for illegal housing.

The master plan requires a lot of effort by local government to be realized. Law enforcement efforts are needed to enforce implementation of established spatial regulations, due to the illegal use of land. Houses along the riverbanks are mostly illegal; houses have been built on the riverbanks without land ownership documents. This condition is a serious problem, given the residents have to be moved elsewhere to implement GOS. Efforts

to acquire land for green corridors along the river as stipulated in the master plan will face very serious social obstacles. A social approach is needed for the sustainability of the development of this area. The riverbank area should be immediately designated as an environmental conservation area - this effort has been set out in the detailed spatial plan of the city of Central Malang.

*Figure 5*. The real conditions of the Brantas river basin, defined as GOS in the Central Malang Detail Plan

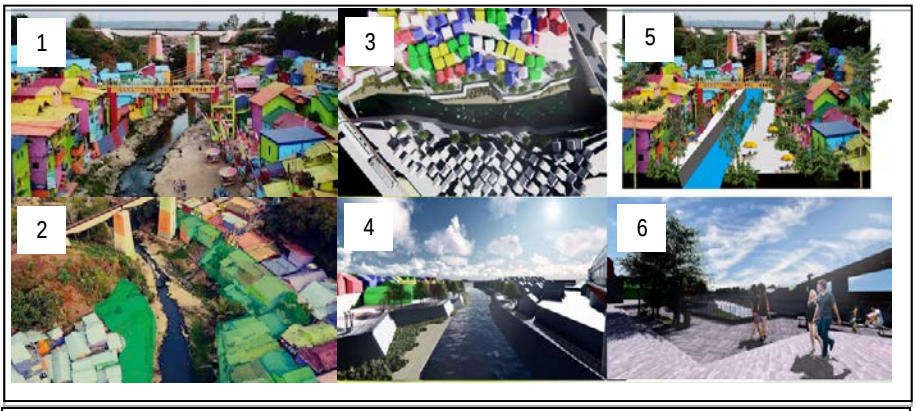
Due to the trend of development along the Brantas riverbank, which tends to decrease the carrying capacity of the environment, a special policy is needed for the development of green corridors along the Brantas River. This area must be designated as High Control Zones in order to implement disaster risk management through urban GOS corridor revitalization, with the quality and carrying capacity of the environment being the main priority of the development of riverbanks. The development of the Brantas riverbank area must consider mitigating floods and landslides.

Urban GOS as an urban landscape element exhibits social, cultural, economic and ecological dimensions of the city. Thus, the existence of urban GOS has a very strategic function in efforts to create a conducive city environment for a harmonious and sustainable interaction between the order of human life and the natural environment. The question is, how can we manage GOS that naturally exists in a natural environment in a way that is conducive to harmonious, integrated and sustainable urban human activities. Preparation of river basin planning and environmental planning should consider:

1. How to minimize social impacts during relocation of illegal houses to other places that are healthier and fit for housing;
2. Improving water quantity and quality in the Brantas River; and
3. Mitigating floods and landslides.

The Brantas River quantity and quality improvement efforts need adequate physical and non-physical data to prepare a technical action plan. Technical data related to efforts to increase river water quantity and quality is available in the green city information system database, which includes span of river width, river water quality, river water depth and social conditions of the community along the river flow. The action plan is related

to efforts to utilize river corridors as active green open spaces, by making the area along the river as a front area for settlements on the banks of Brantas River. The waterfront city concept is very appropriate for the development of river corridors (see *Figure 6*).




**Captions:**

1. Determination of riverfront GOS areas as a Warna-Warni Kampong tourism destination by the government.
2. Riverfront houses that are prone to landslides and floods. Alternatives are relocation, or maintenance through treatments to improve environmental sanitation.
3. A solution to revitalizing the river corridor as public space by relocating houses along the riverbank corridor.
4. New environmental performance with a waterfront concept of improving the quality of green open space and the quality of the Brantas river flow to establish a blue space along the Brantas River.
5. Alternative solution for river corridors without relocation of residents' houses through improvement of environmental sanitation along the river corridor and providing public green open space.
6. New environmental performance by adding active spaces and structuring green corridors as transition spaces between river bodies and dense settlements.

*Figure 6.* Proposed design of Warna-Warni Kampong Revitalization

The best practices of GOS provision to date show an increase in government efforts in the provision of urban green open space. The performance of the Malang city government in this effort in the last five years has shown good results (Wikantiyoso, Respati & Suhartono, 2018). Some city parks, road medians, pedestrian infrastructures, and urban forests have increased social benefits and aesthetics, but this effort has both positively and negatively impacted on the reduction of GOS. Changes in park functions from passive parks to active parks represent the demands of Non-Green Open Space (NGOS) as public space. Improving the quality of green space established by the Malang city government is done through the utilization of CSR from corporate bodies and residents of Malang City. In the last three years, more than 17 GOS development projects have been funded using CSR funds (Wikantiyoso, Respati & Suhartono, 2018). This strategy needs to be improved by minimizing the impact of reducing green open space, through communication and negotiating the design of GOS revitalization.

The GOS development problems of Malang can actually be solved by equating perceptions, interests and actions with an objective to increase the use of urban space that is more harmonious - to create a comfortable environment, or a decent city for all city residents. The Green City MIS is one tool that can help to provide an integrated and sustainable urban GOS.

The revitalization of the river border as a green space corridor is a strategic effort and must be realized immediately to realize the achievement target of green open space as stipulated in the 2012-2032 GOS Master Plan.

## 5. CONCLUSION

The development of cities in the global era, known as the Era of Industrialization 4.0, has both challenges and opportunities in realizing integrated and sustainable development. The 'green city' concept, as one of the great concepts for developing an integrated planning system across both socio-cultural and environmental aspects, requires one keyword "integrated system planning". The development of the Green City MIS is one of substance in integrated and sustainable spatial planning.

The results of this study were used to conduct a review of the development policy of the Brantas riverbank area, particularly in the determination of urban green areas with potential to become urban blue space areas, as a control model for the implementation of urban spatial planning. Monitoring and controlling the utilization of riverbank space is to be carried out to restore the function of the river border area as a green area as stipulated in Malang City spatial planning, by establishing the area along the Brantas river as a blue area of the city. The Green City MIS with spatial GIS data processing, as a provider of spatial and non-spatial data in green city planning and design, can function as a monitoring tool and enable control of the provision of a sustainable city's green open space. Using this MIS riverbank areas that must be freed from residential buildings and other functions can be identified. It can be an effective tool as a source of information on efforts to revitalize the Brantas River waterfront area. Information about water quality, the legality of occupancy along the river, as well as the basic development policies set by the government are incorporated in the use of the tool. This information becomes a control device that is useful in implementing existing spatial regulations.

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## REFERENCES

Ahern, J., Cilliers, S., & Niemelä, J. (2014). "The Concept of Ecosystem Services in Adaptive Urban Planning and Design: A Framework for Supporting Innovation". *Landscape Urban Planning, 125*, 254-259.

Anguluri, R., & Narayanan, P. (2017). "Role of Green Space in Urban Planning: Outlook Towards Smart Cities". *Urban Forestry Urban Greening, 25*, 58-65.

Arafah, Y., & Winarso, H. (2017). "Redefining Smart City Concept with Resilience Approach". Proceedings of IOP Conference Series: Earth and Environmental Science, pp. 012065.

Badiu, D. L., Iojă, C. I., Pătroescu, M., Breuste, J., Artmann, M., Niță, M. R., . . . Onose, D. A. (2016). "Is Urban Green Space Per Capita a Valuable Target to Achieve Cities' Sustainability Goals? Romania as a Case Study". *Ecological Indicators*, *70*, 53-66.

Bilgili, B. C., & Gökyer, E. (2012). "Urban Green Space System Planning". *Landscape planning*, *360*.

Bogaers, E., & Ruijter, P. (1983). *Ir. Thomas Karsten En De Stedebouw in Nederlands-Indië 1915-1940*. Universiteit van Amsterdam (UvA), Planologisch en Demografisch Instituut.

Buyadi, S. N. A., Mohd, W. M. N. W., & Misni, A. (2013). "Green Spaces Growth Impact on the Urban Microclimate". *Procedia-Social Behavioral Sciences*, *105*, 547-557.

Dewi Anggadini, S. (2013). "Analisis Sistem Informasi Manajemen Berbasis Komputer Dalam Proses Pengambilan Keputusan". *Majalah Ilmiah UNIKOM*.

Henderson, H., & Lowe, M. (2015). "Conceptualising 'Integration'in Policy and Practice: A Case Study of Integrated Planning in Melbourne".

Karsidi, A. (2016). *Kebijakan Satu Peta (One Map Policy) Roh Pembangunan Dan Pemanfaatan Informsi Geospatial Di Indonesia [One Map Policy the Spirit of Development and Utilization of Geospatial Information in Indonesia]*. (Budiman, M. Ed. 2nd ed.). Cibinong: Sains Press.

Kearns, P. (2012). "Learning Cities as Healthy Green Cities: Building Sustainable Opportunity Cities". *Australian Journal of Adult Learning*, *52*(2), 368-391.

Lundqvist, M. (2007). "Sustainable cities in Theory and Practice: A comparative study of Curitiba and Portland"

Newman, P., & Jennings, I. (2012). *Cities as Sustainable Ecosystems: Principles and Practices.* Island Press.

Olsson, H. (2012). "Integrated Green Spaces in Urban Areas - a Case Study of Inner Brisbane".

Presman, R. S. (2012). "Rekayasa Perangkat Lunak Buku Satu Pendekatan Praktisi Edisi 7". *Yogyakarta: Penerbit ANDI*.

Shi, W., & Woolley, H. (2014). "Managing for Multifunctionality in Urban Open Spaces: Approaches for Sustainable Development". *Journal of Urban Management*, *3*(1-2), 3-21.

Singkavongxay, S., Jensen, P. G., & Bull, N. (2010). "Guideline in Integrated Spatial Planning for Sustainable Development in Lao Pdr Guideline in Integrated Spatial Planning Water Resources and Environment". *Vientien Capital, Lao PDR: SIDA*.

Subadyo, A. T., Tutuko, P., & Cahyani, S. D. (2018). "Assessment of Inclusive Historical Public Spaces in Achieving Preservation of Such Areas in Malang, Indonesia". *International Review for Spatial Planning Sustainable Development*, *6*(4), 76-92.

Tao, W. (2013). "Interdisciplinary Urban Gis for Smart Cities: Advancements and Opportunities". *Geo-spatial Information Science*, *16*(1), 25-34.

TÎRLĂ, M.-L., Manea, G., Vijulie, I., Matei, E., COCOS, O. J. C. i. t. g. w., theoretical, T. a., & empirical perspective. University Press: Sofia, B. (2014). "Green Cities–Urban Planning Models of the Future". 462-479.

Tutuko, P., Subagijo, E., & Aini, N. (2018). "The Planning and Design of Residential Facilities in Poor Areas with Limited Land". *International Review for Spatial Planning Sustainable Development*, *6*(3), 22-36.

Tuturoong, N., Rindengan, Y., Kawulur, S., & Karouw, S. (2013). "Perancangan Sistem Informasi Geografis Ruang Terbuka Hijau Kota Manado". *Seminar Nasional Sistem Informasi Indonesia*, *2013*, 284–289.

Wikantiyoso, R. (2000). *Aplikasi Sistem Informasi Geografis (SIG) pada Perencanaan dan Perancangan Kota*, Universitas Merdeka Press, Malang.

Wikantiyoso, R., & Pindo, T. (2014). "Editorial Introduction: Special Issue on Local Wisdom for Better City Planning". *International Review for Spatial Planning Sustainable Development*, *2*(4), 1-3.

Wikantiyoso, R., & Suhartono, T. (2018). "The Role of Csr in the Revitalization of Urban Open Space for Better Sustainable Urban Development". *International Review for Spatial Planning Sustainable Development*, *6*(4), 5-20.

Wikantiyoso, R., & Tutuko, P. (2013). "Planning Review: Green City Design Approach for Global Warming Anticipatory". *International Review for Spatial Planning Sustainable Development*, *1*(3), 4-18.