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INFORMATION SYSTEM MODEL OF ENVIRONMENTAL CARRYING CAPABILITIES BASED ON INTERACTIVE GEOSPATIAL TECHNOLOGY IN THE REALIZATION OF SUSTAINABLE CITY

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Abstract. *In the last ten years, the public has begun to pay attention to the application of digital technology in city planning management. One of them is that spatial prediction of environmental carrying capacity conditions is a complex technical process and requires the help of tools in the form of computer programs. A computer-based application, EnvicaSim, was developed in response to these planning needs. EnvicaSim is an application for analyzing the carrying capacity conditions of the living environment based on Geographic Information Systems. This research aims to create a model that simplifies calculating environmental carrying capacity. The result is that EnvicaSim is an application that has advantages compared to existing similar applications. EnvicaSim is a modeling tool with advantages for regional and city planning, whereas others focus on the field of Geography. The advantages of EnvicaSim include the basic algorithm scheme feature for multi-analysis using one model framework, outstanding simulation results, can set dynamic constraints (constraint growth), excellent target-based simulation planning, display/GUI (Graphic User Interface), there are output files for each iteration stage, as well as Multi-Tasking Simulation. In simple terms, the concept of the built model takes into account aspects of land capability and suitability and the concept of environmental carrying capacity. After carrying out the carrying capacity analysis process, the next step is to carry out a simulation of Regional Development, which will later considered in the Spatial Planning.*

Keywords: *information system, carrying capacity, geospatial, envicasim*

1. INTRODUCTION

Regional and city planning is a process for forming and determining the function, form and role of cities in the order of life and interaction of the activities of a city's residents. This process requires a mechanism for extracting data and phenomena that occur spatio-temporally. The preparation of development plans and policies related to spatial planning has a future orientation and requires deeper analysis, not only carrying out tabular studies, moreover, spatial studies are an important aspect such as the conditions of the carrying capacity of the environment. Inappropriate interpretation of the environmental carrying capacity conditions will have negative impacts in the future, for example flood phenomena, uncontrolled development on the edge of urban areas, traffic jams, pollution, agricultural land conversion, energy availability crisis, and so on. This indicates that the spatial dynamic mechanism of environmental carrying capacity is a very important thing to do in the regional and city planning process.

In Indonesia, the regional and city planning processes (such as spatial planning documents) that have been carried out so far have been carried out without implementing a spatial prediction mechanism for the carrying capacity of the environment, so that they are not able to accommodate the impacts they will cause in the future, where the impacts -This impact is starting to be felt in several regions, especially big cities in Indonesia. This is because city planners are constrained by the methods, methods and tools needed, so instant mechanisms based on intuition are often used.

In the last ten years, the public has begun to pay attention to the application of digital

technology in city planning management (Geertman and Stillwell 2020). One of the reasons underlying this is technological and global developments as well as political, social and economic encouragement to develop concepts and applications that support smart cities (Sabri 2020). Technology must create an integrative and collaborative ecosystem that facilitates continuous networking and information flow for planning harmonization, environmental sustainability, quality of place and life, and efficiency in cities (Sabri et al. 2016).

One of them is that spatial prediction of environmental carrying capacity conditions is a complex technical process and requires the assistance of tools in the form of computer programs to do it. In response to these planning needs, a computer-based application, EnvicaSim, was developed. EnvicaSim is a software designed to carry out spatial analysis of the carrying capacity of the living environment based on a Geographic Information System that can be used in the context of regional and city planning. This innovation is a form of change in planning practices and codes of ethics in dealing with digital technology in city planning and city management which cannot be avoided (Sabri n.d.)

During its development, there are several things that will be built into this EnvicaSim product. Product development is based on input from discussions with the team and Planner experts obtained directly. This prototype will be developed with a user friendly user interface, so improvements need to be made in order to increase the value of the product and attract more potential users. Apart from that, there will also be development of the output information issued by the product to maximize user interpretation results. This increase in output is an innovation so that the results produced can be more easily understood and can be directly used as visualization in preparing plans related to spatial planning.

The social impact that can be caused by this innovative development of the EnvicaSim application, among others, is that it becomes easier for planning experts and spatial policy makers to explore current and future spatial dimensions (predictions), and it is hoped that the plans made will be better and more supportive. sustainable development. Then the economic impacts that arise include the ability to predict spatially, the resulting spatial planning policies can improve the city's economy, development efficiency, and anticipate environmental impacts that will arise in the future.

2. LITERATURE REVIEW

EnvicaSim is an application for analyzing the carrying capacity conditions of the living environment spatially based on Geographic Information Systems. Currently spatial researchers/planners (regional and city planners, forestry experts, geologists, transportation experts, agricultural experts, environmental experts, real-estate developers) have used GIS (Geographic Information System) technology for various needs. This need becomes primary during the process of creating, managing, visualizing, analyzing spatial data, and establishing spatial plans related to the carrying capacity of the environment in the future. The spread of GIS influences many policies in education, business, society thereby democratizing GIS, data creation and analysis (Ramirez Aranda, De Waegemaeker, and Van de Weghe 2023).

When related to population in regional planning, carrying capacity can be defined as the number of people and the level of activity that an area can sustain indefinitely without causing significant environmental changes. Carrying capacity estimates derived and interpreted remain an obstacle in the application of this concept as a basis for land planning and evaluation. Where carrying capacity has been used to assess environmental limitations, decisions regarding population and resource pressures have been tempered by uncertainty and imprecision (Lein 1993). To provide better estimates of carrying capacity, these uncertainties and imprecisions need to be incorporated into the assessment procedure. This study introduces an alternative methodology for carrying out environmental carrying capacity under conditions of uncertainty using a more capable system. This is because, until now, researchers/spatial planners have had problems knowing the conditions of the carrying capacity of the environment in the future, which is especially needed when making a spatial plan that has a time orientation of 10,

20, 50 years or other (examples of urban planning plans, transportation plans, forest protection plans, property development plans).

EnvicaSim software is the only application in Indonesia and is a modeling tool that has many advantages for the field of regional and city planning when other similar software focuses on the field of Geography. EnvicaSim's application fields include Regional and City Planning, Geospatial Technology, and Geographic Information Systems. The EnvicaSim application makes it easier for regional and city planners to be able to see future conditions when making plans that will be proposed through scenario planning. Scenario planning through identifying environmental carrying capacity conditions can be used to develop substantive planning programs in order to minimize impacts that will occur in the future (such as land conversion, border area dynamics, etc.).

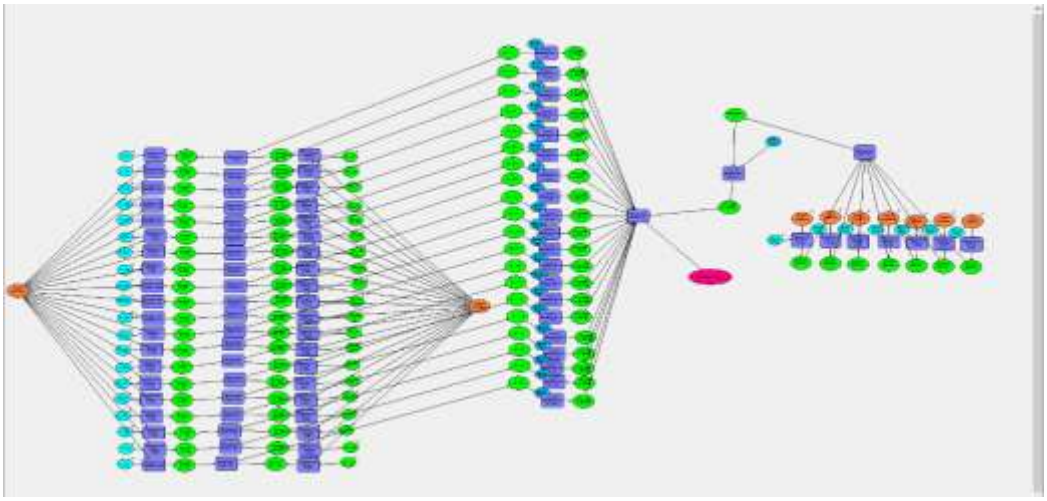
The concept of three pillars of sustainability (social, economic and environmental), generally represented by three intersecting circles with overall sustainability at the center, has been used elsewhere (Purvis, Mao, and Robinson 2019). In the concept of sustainability, we know the concept of "The Three Spheres of Sustainability", where each sector has a significant role in supporting the achievement of sustainable development. In principle, the concept of sustainability is to explore the relationship between economic development, environmental quality and socio-cultural conditions. This initial conception of sustainable development was motivated by the need for economic development, with its social and economic goals, to consider conservation by considering limited resources and the carrying capacity of ecosystems (Purvis, Mao, and Robinson 2019). Sustainable Development is a process of dynamic change in which resource exploitation, investment, technological development orientation, and institutional changes are carried out consistently by considering future and current needs. Environmental carrying capacity as part of the Natural Resources and Environmental Management Instrument in Implementing Sustainable Development. In the book Mapping Ecosystem Services (2017), the concept of environmental services reflects the value of nature for humans so that it needs to be protected and managed sustainably.

The Carrying Capacity of the Environment is a medium for Synchronization between sectors in mainstreaming sustainable development. A more technical explanation is needed to apply the Carrying Capacity of the Environment in the planning, implementation and control (monev) stages of development activities in each and/or between sectors.

3. RESEARCH METHODS

The concept of the model built is to take into account aspects of land capability and suitability as well as the concept of environmental carrying capacity. After carrying out the environmental carrying capacity analysis process, the next step is to carry out a simulation of Regional Development which will later be taken into consideration in the Spatial Planning.

The model that is built will simplify the process of analyzing the Carrying Capacity of the Environment, because the process is carried out in only one run. The model built is a model that simplifies 90 (ninety) analyzes into 1 (one) analysis. It is hoped that in the future the spatial model that is built can speed up the process of identifying environmental carrying capacity analysis.



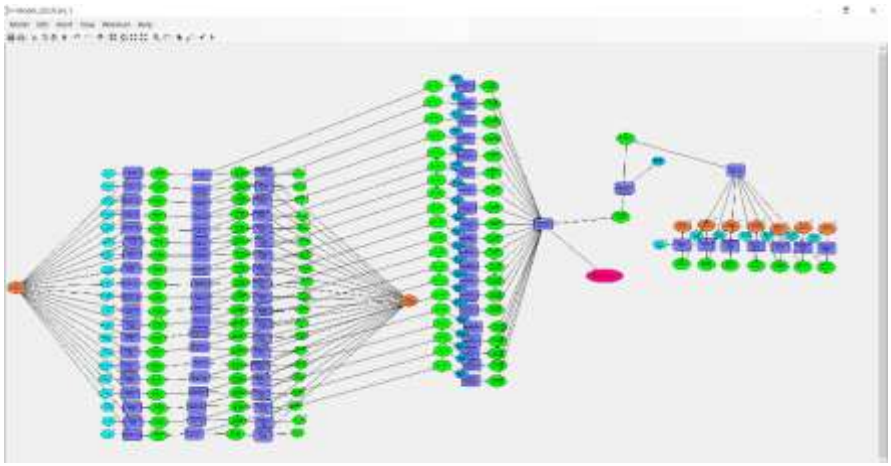
4. RESULTS AND DISCUSSION

The carrying capacity concept can be described through a demand and supply side framework. The demand side is based more on needs and consumption patterns for natural resources and ecosystem services such as land, water and other natural resources. This need will be greatly influenced by population development in both an administrative area and an ecoregion. The interaction of the need for natural resources and ecosystem services with the amount extracted will show the ecosystem footprint per unit of resource use (MA, 2005). Ecosystem function is the ability of ecosystem components to carry out natural processes in providing the materials and services needed to meet human needs, both directly and indirectly (De Groot, 1992). On the other hand, natural resources provide goods and services that can be used to meet the needs of the population. The supply side describes how much (both in terms of quantity and quality) natural resources are able to support human needs. This supply side can be described, for example, by the water balance, resource and environmental balance, land balance, land potential to meet production needs equivalent to rice and so on. The interaction of provision and use will describe the carrying capacity of natural resources and the environment (carrying capacity). The balance of the supply side and demand side of natural resources, which is described by the Ecological Footprint and Carrying Capacity, will determine the amount of carrying capacity and carrying capacity of the environment and the status resulting from the use of these natural resources.

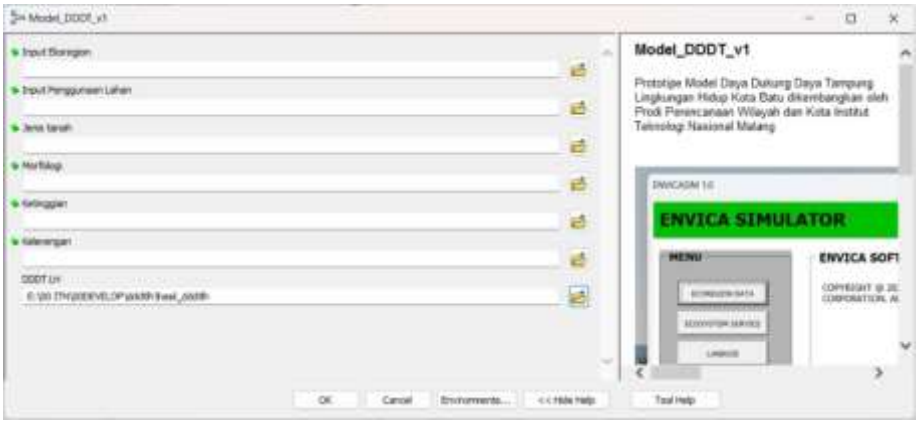
Population growth and increased economic activity in a region result in an increase in land requirements and encourage land use changes. In fact, each type of land cover has different ecosystem services. Covering land that has low ecosystem services will result in environmental damage and reduced land productivity.

In simple terms, the concept of environmental carrying capacity is simplified so that the system can be operationalized. In simple terms, the concept of the model built is to take into account aspects of land capability and suitability as well as the concept of environmental carrying capacity. After carrying out the Regional Development Potential Analysis process, the next step is to carry out a Regional Development Simulation which will later be taken into consideration in the Spatial Planning Plan.

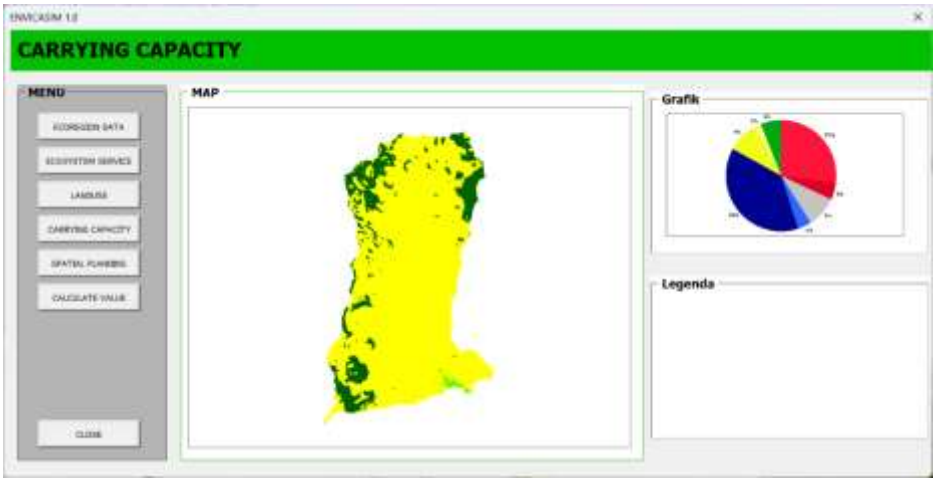
The model that is built will simplify the process of analyzing Carrying Capacity, because the process is carried out with just one run. It is hoped that in the future the spatial model that is built can speed up the process of identifying environmental carrying capacity analysis.



The results of the model are then made into software designs that can be used by many people. Where the design of the prototype is based on a model that has been created, the following is the design of the Envica Sim software:



In this simulator, indicators are included that are used to determine carrying capacity, so that later you can see the spatial results of carrying capacity as follows:



Apart from the spatial results, the value of each indicator will be obtained in determining the enviromental carrying capacity of an area which visually on the simulator will appear as follows:

CONCLUSION

The model in EnvicaSim effectively assists in the process of identifying environmental carrying capacity analysis. This can shorten the time of work or research activities using this prototype. However, it needs to be used as a basis that the data element is an important aspect in using prototypes, the better the data you have, the greater the accuracy of the prototype results and vice versa.

Indonesia itself does not yet have a similar application product, so EnvicaSim is the first software for modeling environmental carrying capacity. With the EnvicaSim product, regional and city planning in Indonesia can be better in the process of becoming better, where in general planners are often unable to consider the relationship between environmental carrying capacity and planning, and more use intuition in planning layouts. land use.

The social impacts that can be caused by this innovation in the development of the EnvicaSim application include that it will be easier for planning experts and spatial policy makers to explore spatial dimensions accurately, and it is hoped that the plans made will be better and support sustainable development. Then the economic impacts that emerge include the ability to identify the carrying capacity of the environment spatially, the resulting spatial planning policies can improve the regional economy, development efficiency, and anticipate environmental impacts that will arise in the future.

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