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Projection of Settlement/Building Development and Land Suitability Class Conditions for Depok City Spatial Planning

Yoga Hepta Gumilar

System Dynamics Center

Corresponding author:
System Dynamics Center
Komplek IPB 2, Jl. Merkurius, Blok C, No. 4. Kel. Ciherang Kec. Dramaga – Bogor
phone: (+62) 8579-2222-417
e-mail: yogahepta@gmail.com

ABSTRACT
Settlement development will be directly proportional to population growth and population needs for housing. The need to know projections of future land-use, especially residential and building land, is a must for policymakers. This study uses a spatial dynamics method to project land up to 2032 and uses an overlay method to determine land-use classes. Inland projections in 2032, it is known that population growth occurs in class I land capacity covering an area of 8,111.06 hectares, which means that settlements and buildings are included in the best class for development. However, if the growth and conversion of land into settlements are not limited, there will be environmental damage, one of which is air pollution due to the lack of green open space. A solution that has been simulated and has succeeded in reducing the growth rate of residential land is the creation of vertical housing and this is followed up by the drafting of a regional regulation on restrictions on building construction. With these two simulations, the results show that the growth rate of residential land is reduced and land conversion slows down. In 2032, the developing settlements will be in the first land capacity class of 8,111.06 hectares, which means that class I is the most widely used as a residence for the people of Depok City and is the best land capability class.

KEYWORDS
Land Change, Spatial Dynamics, Land Capability Class

Introduction

The need for land for housing will continue to increase in line with the population growth. This increase in population is correlated with the increased need for housing and other facilities which has an impact on land conversion [1]. Land-use change is a global phenomenon that becomes concern in various countries in the world [2] because changes in land-use will have an impact on the natural environment which will experience degradation. The development of settlements and buildings is one of the land changes that will continue to occur in line with the many needs for housing and urban development. Urban development relies on human activities, human activities in urban areas have brought changes, one of which island, both on a local and global scale [3].

Land quality and capability are some of the physical constraints that can disrupt a development [4]. This constraint is a phenomenon that must be considered in utilization in the form of the construction of settlements and other buildings. The ability of the land to be able to support its utilization efforts will greatly depend on the basic physical factors contained in the land, both in the form of the hydrological, geomorphological, geological, and atmospheric environment [5].

Depok City is one of the big cities in Indonesia, especially West Java. The development of Depok City will continue along with the advancement of Jakarta City, this is very influential because Depok City is one of

the buffer cities for the City of Jakarta in terms of residence. Depok City is designed as a dormitory town or city to accommodate workers who cannot afford housing in Jakarta City [6]. Therefore, the need for a place to stay in Depok City is very large.

The need for these buildings does not pay attention to the land capability class, especially the land capability class of the slope. This land capability unit analysis is intended to determine land conditions related to stability and ease of land development for residential activities [7]. Depok City in 2018 has an area of settlements in the land capability class areas IV and V covering an area of 59.13 hectares and the largest in class II covering an area of 1,523.84 hectares. For class II itself, it is good to be used as a settlement because the obstacles that will occur are few and easy to find a solution, while for class V there must be an effort for the land to be built properly.

During its development, Depok City will continue to experience development, but this development must pay attention to land capability classes, both existing buildings, and buildings that are planned to be built. The purpose of this research is to see the projection of settlement development until 2031 and 2040 according to the applicable RTRW along with the land capability class of Depok City. It is hoped that this research can be taken into consideration for decision-makers in the construction of housing and buildings in Depok City.

Method

The method used in this research is spatial dynamics. A spatial dynamics model is a form designed to mimic a phenomenon or process based on spatial data analysis [8]. This spatial dynamics method is a combination of spatial projection and system dynamics. The spatial projection in this study uses Markov and CA Markov on the Terrset software. Spatial projection is a mapping method to see land changes that occur, in this case, changes in agricultural land. Meanwhile, system dynamics is a method used to describe, model, and simulate a system dynamics (from time to time constantly changing).

The data used in this study are time-series data on land-use in 2015 and 2018 and land class data. With these two data, it can be seen that there is a change in function conversion along with the projection of land and land capability classes in Depok City.

1. Land change analysis
   In this process, graphs or tabulations of land changes that occur in the Pasirwangi District are generated. At this stage, it is more focused on agricultural land which is the object of research.
2. System dynamics modeling analysis
   At this stage, model projections and simulations are carried out to provide an overview of what will happen in the future by changing several variables in the simulations. So that the best simulation can be found to overcome land degradation to keep it under control and control.
3. Land capability class analysis
   Comparison of land capability classes is carried out to determine the differences in residential and building land classes between 2015 and 2018 and the extent can be determined.

Results and Discussion

Land Change

Land changes that occur in Depok City that occur continuously and uncontrollably will cause more severe environmental damage. One of them is pollution, this happens when the green open space is converted into a residential area. Thus there are no more plants that can absorb pollutants produced by human activities and in the end, these pollutants will continue to accumulate and increase in the air. This incident will not only have a negative impact on the environment and nature but also on human health.

Land changes that have occurred in Depok City have occurred quite a lot because of the need for land for settlements and also the need for development to complement the urban infrastructure and for the development of office and trade/service areas. This land change can be obtained with temporal data [9]. In this study, the comparison of land changes using data from 2015 and 2018.

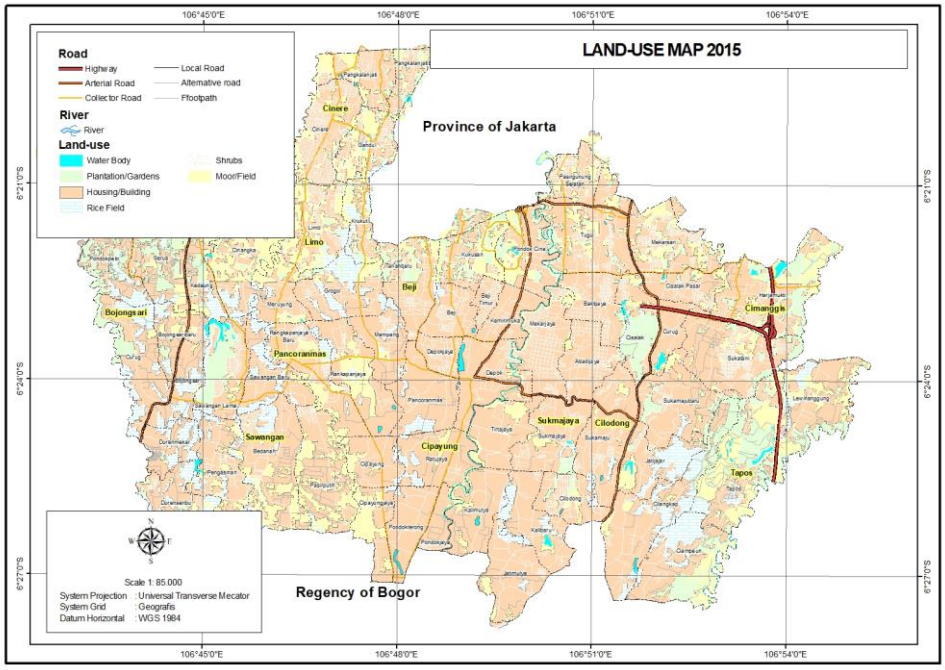

Fig 1 Land-use map 2015

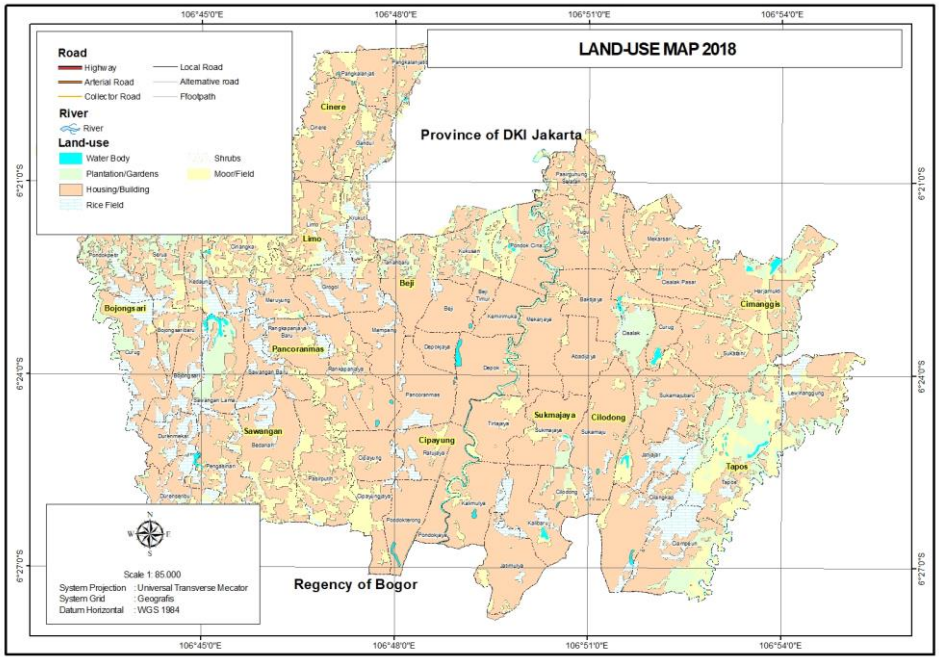

Fig 2 Land-use map 2018

Table 1 Area of Land Use in 2015 and 2018

Information	Year 2015	Year 2018
Paddy field	1,693.32	1,681.25
Watershed	164.47	164.47
Field/Moor	3,050.15	2,823.44
Shrubs	5.61	12.78
Garden	1,751.90	1,609.07
Settlement	13,396.58	13,768.02

Based on the map that has been made, there have been significant land changes. For example, paddy fields have experienced land degradation of 12.07 hectares, the gardens that have decreased by 142.83 hectares, while housing and buildings have increased by an area of 371.44 hectares. Based on these data results, projections to determine land use in the coming year can be found.

Spatial Dynamics Modeling

Spatial dynamics modeling aims to determine the development and growth rate of residential land in Depok City. By using this method, it can be seen that the development of settlements and buildings in a certain year will make it easier for the government as a policy-making institution. Spatial dynamics modeling can also be used as input for environmentally friendly spatial planning [10].

In a land-use model, there is a special phenomenon because the land is of constant strength, does not decrease, and does not increase, there is only an increase or decrease caused by a change.

There is a mutual influence or reciprocal relationship in a land-use change in Depok City between garden land, rice fields, forest, empty land, and dry land However, the settlements that are the objects of this study are influenced by rice fields, forests, and gardens. For more details, see the following Causal Loop Diagram

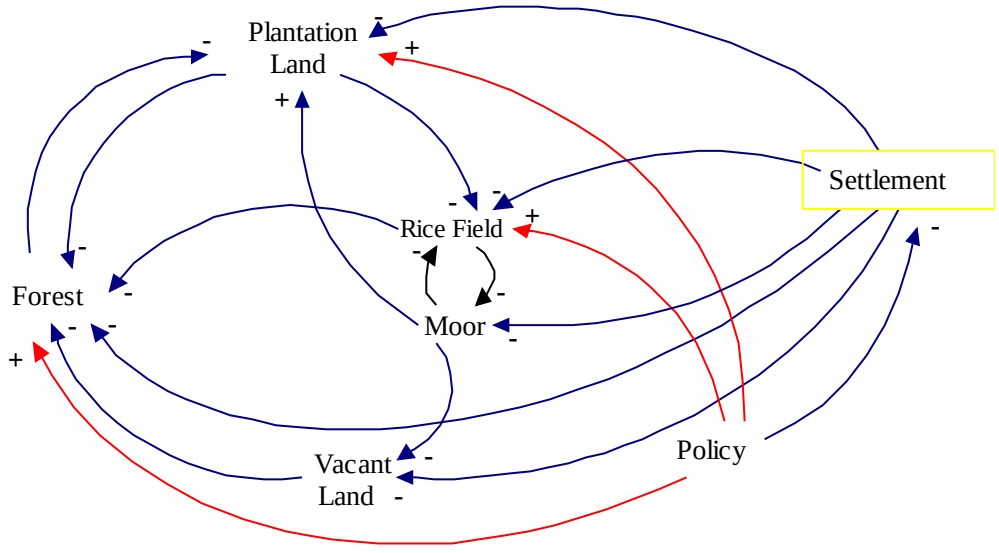

Fig 3 Causal Loop Diagram Land-use Change

The increasing number of settlements and buildings in Depok City due to the need for land for housing comes from the growing population of Depok City and also from workers from Jakarta who live in Depok City. To determine the development of residential land and buildings in the future, land-use projections are carried out. In this study, projections will be carried out until 2032 using the Markov and CA-Markov methods.

The use of Markov and CA-Markov aims to determine land changes based on the closest pixel so that it will be more optimal in projecting land. Thus it can be seen the natural changes that occur in Depok City. For more details, it can be seen in the following figure

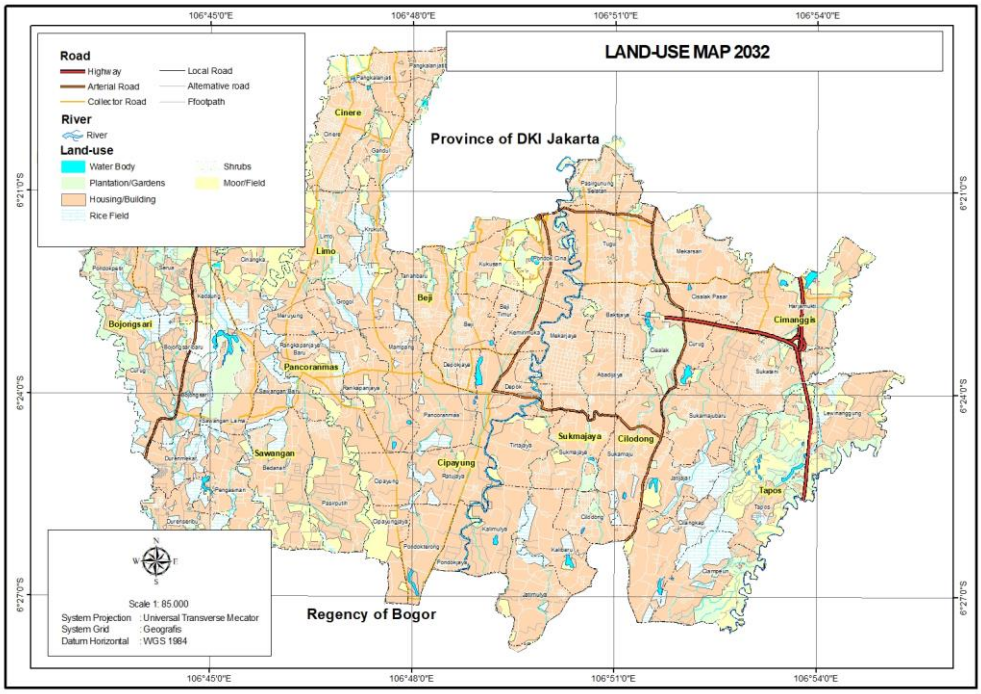

Fig 4 Land-use map year 2032

Table 2 Land Use Area in 2032

Information	Year 2032
Paddy field	1,427.16
Watershed	164.47
Field/Moor	1,249.66
Shrubs	19.96
Garden	1,306.15
Settlement	14,531.28

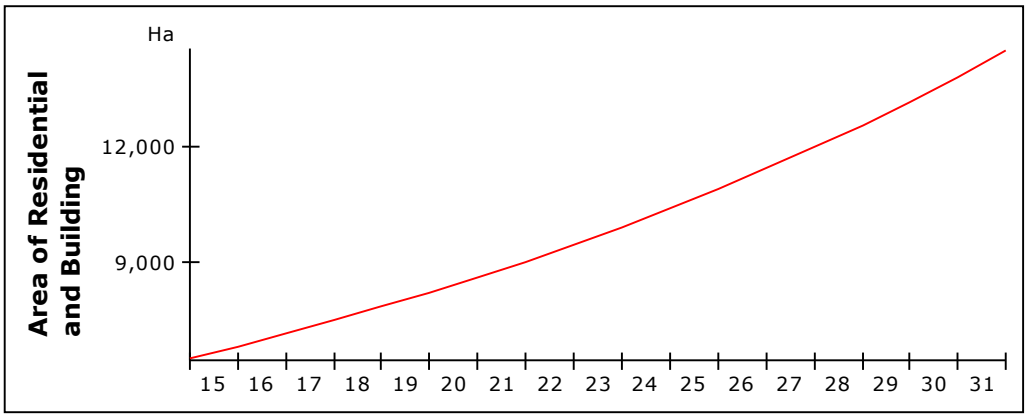

Fig 5 Graph of the Development of Settlements and Buildings

Land-use in 2031 is projected using the help of TerrSet and Powersim software. After the projection is carried out in 2031, it can be seen that the increase in settlements and buildings from 2018 covers an area of 763.23 hectares in 13 years. From this projection, it can be seen that the growth of buildings, especially in the form of settlements in Depok City, is very high. However, the reduced paddy fields by 254.08 hectares, the same thing happened to the reduced fields of the land area of 1,573.79 hectares. Thus, the possibility of the conversion of paddy fields and fields to housing is very large.

To overcome land changes to settlements, solutions must be sought, such as the creation of vertical housing, with vertical housing it is hoped that the need for housing or shelter is fulfilled with limited land. Besides, this can also be done by implementing or issuing regional regulations on tightening the construction of new buildings.

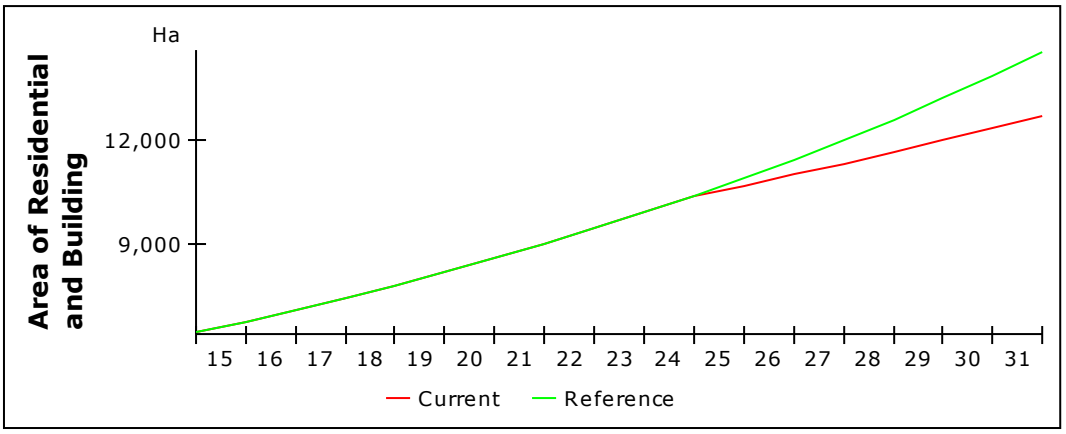

Fig 6 Scenario Graph of Settlement and Building Development

In this graph, it can be seen that there is a slowdown in land conversion to buildings due to the policy of making vertical housing that can be used in 2025 (red line). This vertical housing can suppress land conversion while still meeting the needs for housing and living space for the people of Depok City. However, with the development of vertical housing when there is no strict supervision from the government to address land conversion, the conversion of residential land will continue to increase. In this study, a scenario of additional monitoring policies and land-use change regulations can also be made to tighten land-use change by the community.

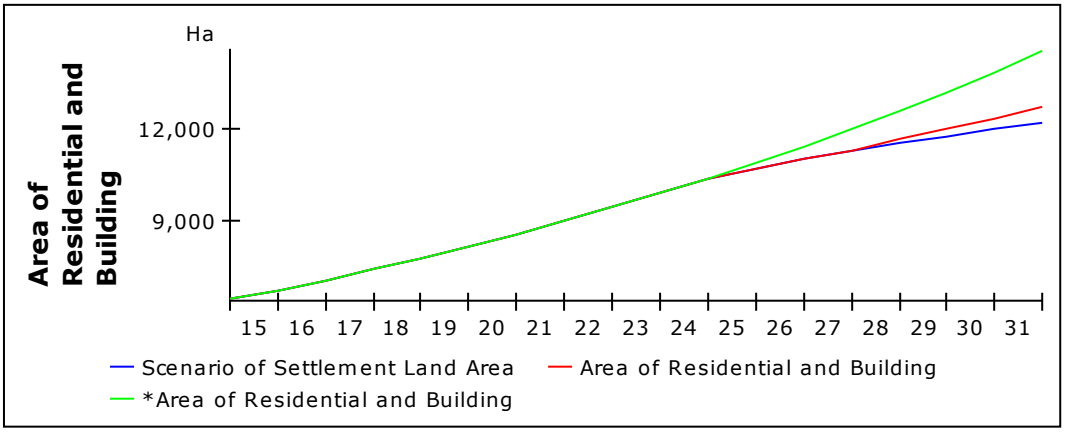

Fig 7 Scenario graph of residential and building land growth

It can be seen that there is a slowdown in land conversion when in 2027 a regulation is issued that limits permit for land conversion to buildings (blue line). When the two scenarios are implemented, it will be seen

that there is a very large difference between the area of land built for settlements and buildings before the simulation is carried out and after the simulation is carried out.

Land Ability Class

Land capability can be reflected in the form of a land capability map. The land capability map can be described in terms of spatial potential land classes and can be used to determine general land-use directions [11]. This land capability map was created using the matching method. The matching method itself is a method that makes comparisons between the value of the inhibiting factor in land units and the conversion table [12]. The inhibiting factors are slope, soil erosion sensitivity, level of erosion, soil depth, soil texture, permeability, drainage, rock/gravel percentage, and the threat of flooding.

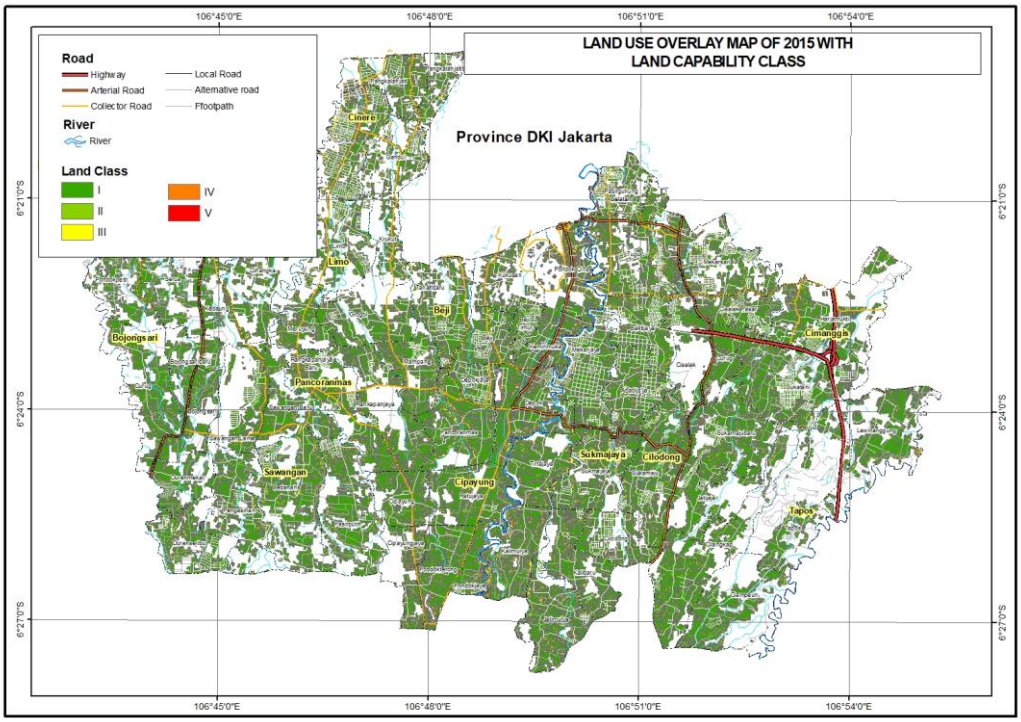

Fig 8 Land Use Overlay Map 2015 and Land Capability Class

Table 3 Land Use Area in 2031

Class	Area (Ha)
I	1266.38
II	4362.77
III	680.06
IV	117.03
V	9.82

In 2015, the most dominant types of land use for Settlements and Buildings in Depok City were in class II covering an area of 4362.77 hectares. Class II was very good for the construction of housing or dwellings and other buildings. In this class, the obstacles that will occur will be very small and it will be easy to find solutions. In this class, the slope of the slope is flat and the potential for disasters of ground motion and landslides is low.

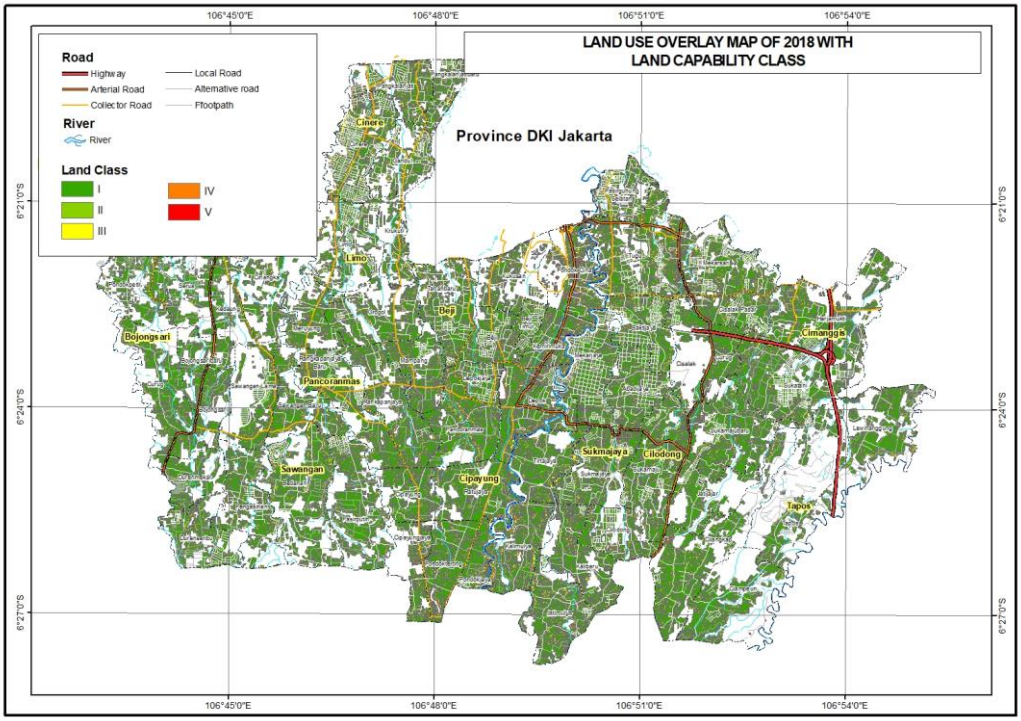

Fig 9 Overlay map of land-use year 2018 and land capability class

Table 4 Total area of land-use in year 2018

Class	Total (Ha)
I	7,796.99
II	4,525.54
III	1,245.84
IV	180.71
V	12.94

In 2018 the development of settlements was in class I totaling 7,796.99 hectares. class I is the best class in terms of land capability to support urban development, especially the construction of a settlement or residence. In this class, residential development will be very easy because the characteristics of the land also tend to be sloping, so there is no need for special handlings such as making talud and others.

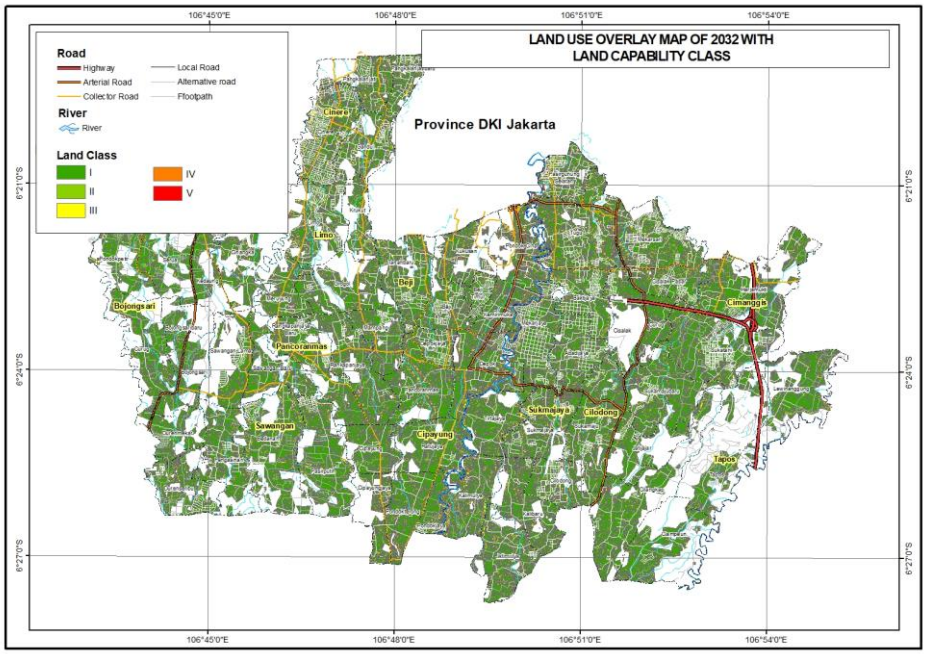

Fig 10 Overlay map of land-use year 2032 and land capability class

Table 5 Land capability class year 2032

Kelas	Luas (Ha)
I	8,111.06
II	4,797.20
III	1,377.28
IV	222.12
V	23.63

In the projection of land-use in 2032, the projection of the class of settlements in a certain land class is obtained. In 2032 class I becomes the most dominant class covering an area of 8,111.06 hectares followed by class II, if the development or improvement of settlements is in class I, the potential for landslides and other obstacles can be minimized.

The most important point in this research is that any additional land-use and buildings that will be planned must consider the land class, when there are still land classes I to III they can occupy that land class, for land classes IV and V it can be used if the best land class cannot build again.

Conclusion

This study discusses projections of land change until 2032 in terms of land capability classes. The purpose of this study is to determine the development of settlements in 2032 so that they can be used as material for consideration and recommendations by local governments as decision-makers for urban development. The results obtained from this study are:

1. The change in the function of paddy fields, gardens, and fields to settlements, this land conversion was caused by the local community's need for land to live in and also the impact of the designation of Depok City as a residence town.
2. In 2032 there will be a very significant increase within area of settlements and buildings, this increase in the use of residential land and buildings must be quickly addressed. The solution obtained from modeling the system dynamics is the creation of vertical housing so that the need for housing is met with limited land and the making of local regulations regarding restrictions on land conversion so that housing and building development can be slowed down.
3. Based on the projections that have been carried out in 2032, the development of residential land and buildings in Depok City will develop in class I land capabilities, which means that the development of settlements and buildings that have been planned is very well built inland class I because in this class there are fewer obstacles that will be experienced.

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