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THE DYNAMICS OF LAND COVER CHANGE AND LEVEL OF SUSTAINABILITY DEVELOPMENT IN DEPOK CITY

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Abstract. The massive development of Depok City has had an impact on improving the economic level but has also caused a decline in environmental sustainability and quality. This research aims to determine trends in land cover change and predictions for the future as well as the level of sustainability of development in Depok City. Land cover change trends in Depok City were carried out using the overlay method in ArcGIS software using land cover data for 2000, 2009, and 2019. Land cover changes were predicted until 2039 using the Land Change Modeler (LCM) analysis method with a business-as-usual scenario (BAU). Meanwhile, sustainability status is analyzed using the Rapfish Multidimensional Scaling (MDS) method using data/attributes from economic, social, and environmental dimensions. The research results show that changes in land cover in Depok City from 2000 - 2019 were dominated by agriculture to residential areas. Some open land is expected to experience a significant decline by 2039, while residential areas will continue to increase. The results of the MDS Rapfish analysis show that sub-districts in Depok City have different sustainability statuses, both in economic, social, and environmental dimensions.

Keywords: Built-Up Area; Land Change Modeler; Rapfish Multidimensional Scalling; Sustainability

[Judul: Perubahan Tutupan lahan dan Tingkat Keberlanjutan Pembangunan di Kota Depok]. *Pembangunan Kota Depok yang sangat masif berdampak pada meningkatkan taraf perekonomian namun juga menyebabkan penurunan kelestarian dan kualitas lingkungan. Penelitian ini bertujuan mengetahui tren perubahan tutupan lahan dan prediksinya di masa mendatang serta tingkat keberlanjutan pembangunan di Kota Depok. Tren perubahan tutupan lahan di Kota Depok dilakukan dengan metode overlay pada software ArcGIS menggunakan data tutupan lahan tahun 2000, 2009 dan 2019. Prediksi perubahan tutupan lahan dilakukan hingga tahun 2039 menggunakan metode analisis Land Change Modeler (LCM) dengan skenario business-as-usual (BAU). Sedangkan status keberlanjutan dianalisis dengan metode Rapfish Multidimensional Scaling (MDS) dengan menggunakan data/atribut dari dimensi ekonomi, sosial, dan lingkungan. Hasil penelitian menunjukkan perubahan tutupan lahan di Kota Depok dari tahun 2000 – 2019 didominasi oleh pertanian menjadi pemukiman. Beberapa lahan terbuka diperkirakan akan mengalami penurunan yang signifikan pada tahun 2039, sementara kawasan pemukiman akan terus bertambah. Hasil analisis MDS Rapfish menunjukkan kecamatan di Kota Depok mempunyai status keberlanjutan yang berbeda-beda, baik dalam dimensi ekonomi, sosial, dan lingkungan.*

Kata Kunci: *Lahan Terbangun; Land Change Modeler; Rapfish Multidimensional Scalling; Keberlanjutan*

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1. INTRODUCTION

Land cover is the physical appearance of the earth's surface, which can also provide critical information for modeling and understanding natural phenomena on the earth's surface (Sampurno & Thoriq, 2016). Land use is human activity on the earth's surface, for example reforestation (Baja, 2012). Land cover change is characterized by land use conversion, which often occurs in urban areas (Nurry & Anjasmara, 2014). Urbanization will be seen as a determinant of how a city can develop physically, socially, and environmentally (Harahap, 2013). Land conversion is caused by increasingly dense population growth, giving rise to land use problems (Anitasari, 2008). Land cover change is the increase of one land cover type from one type to another within a certain period (Pravitasari et al., 2019). In general, changes in land cover are irreversible; for example, changing a forest into built-up land will require much effort to change it back into a forest (Rustiadi et al., 2021). However, changes in land cover are also reversible; such as converting forests into empty land and vice versa. Agricultural land cover is often converted into construction land (Wahyudi, Munibah, & Widiatmaka, 2019). Land conversion occurs to get a low land rental value to a higher rental value. Economic value is obtained from land when it owned and used for production process (Astuti, 2022).

The increasing population growth, especially in urban areas, causes the need for land to increase, triggering conflicts over the conversion of vegetated land into built-up areas (Pravitasari et al., 2018). The increase in population also increases the need for built-up land, one of which is development for housing, while the amount of land is fixed and does not increase. The high population growth is caused by natural and urbanization factors (Sari & Yuliani, 2021). The land is important to users because of its function in the community as a place of residence and a source of livelihood (Nurchamidah, 2017). West Java is the region most prone to land conversion into urban areas (Pravitasari et al., 2024; Pravitasari, Rustiadi, & Saizen, 2016). Several factors influencing the expansion of mega-urban areas are population density, population, socio-economic conditions, distance to the city center, and road access (Pravitasari et al., 2018).

Economic development requires adequate land for other land uses such as settlements, industry, infrastructure, and services (Misa, Moniaga, & Lahamendu, 2018). Apart from that, what drives changes in land cover is the decline in the productivity of rice fields to generate greater profits (Astuti & Lukito, 2020). The large number of activities and population will increase the number and type of facilities, thereby impacting regional growth and increasing demand for land (Libriyanto, Pravitasari, & Ardiansyah, 2022; Murtadho, Wulandari, Wahid, & Rustiadi, 2018). Therefore, it cannot be denied that changes in land cover are one of the impacts on the growth and development of an area.

Depok City is one of the cities that is experiencing relatively rapid development. Depok City's population increased due to the high migration of people to Depok City due to the rapid development of the city, which can be seen from the increasing development of residential areas (Rustiadi et al., 2021). The physical changes that occur so quickly with the pattern of life in big cities have an influence on the urban development of Depok City as a whole, which includes the construction of physical facilities and infrastructure such as schools, small and large industries, offices and trade ranging from small, medium to large scale (Ristianingrum, 2015; Sa'at, 2014). This can be seen clearly with the increasing number of service and trade sector services emerging in Depok City, such as restaurants, malls, business places, and other services (Aeni, 2017). Economic development often causes resource exploitation, which sometimes results in environmental damage in an area (Romhadhoni, Faizah, & Afifah, 2019). Depok City is currently experiencing a decline in environmental quality, as seen from the increasing intensity of various

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disaster events, such as floods and landslides, as well as the area of paddy fields, which tends to decrease over time (Pires, Nasr, Zenati, & Dhieb, 2014).

Sustainable development is a process of change in resource exploitation, investment direction, technological development orientation, and institutional change, which are harmonious and increase the present and future potential to meet human needs and aspirations. Sustainable development is an interconnected system that influences each other (Carmela, 2013; Davies, 2015; Deng, 2015; Le Blanc, 2015). Sustainable development includes three factors, namely economic, social, and environmental sustainability; which must be balanced not to ignore social and environmental development (Nurahmatulah, 2019; Suparmoko, 2020).

The relationship between land cover dynamics and sustainable development is a critical area of research, given the profound impact of land use changes on environmental systems, economic activities, and social well-being. Understanding these dynamics is essential for promoting sustainable land management practices that balance human needs with environmental preservation (Bakri, 2017).

This literature review explores key studies that have examined the intersection of land cover dynamics and sustainable development, focusing on the environmental, economic, and social implications.
The economic dimension of land cover dynamics is closely linked to resource management and land use efficiency. Verburg et al. (2015), discuss how land system science contributes to understanding and managing land changes for sustainable development. They argue that economic activities, particularly agriculture and forestry, are primary drivers of land cover change, but these activities must be balanced with the need to conserve natural resources.

Economic sustainability also involves addressing the trade-offs between land use for economic development and the preservation of ecosystem services. Turner, Lambin, and Reenberg (2007), note that land change science plays a crucial role in identifying and mitigating these trade-offs. Their research suggests that integrating economic models with land cover data can help policymakers develop strategies that promote both economic growth and environmental sustainability.

Land cover dynamics also have profound social implications, particularly in terms of land tenure, food security, and human well-being. Ellis and Ramankutty (2008), introduce the concept of anthropogenic biomes, highlighting how human activities have transformed natural landscapes into human-dominated ecosystems. This transformation often leads to conflicts over land use, especially in regions where land resources are scarce and livelihoods are directly tied to land access.

Social sustainability requires equitable access to land and resources, as well as the protection of local communities' rights. Ramankutty et al. (2007), emphasize the importance of understanding the social drivers of land cover change, such as population growth and economic development, to address issues of land degradation and resource depletion. They argue that sustainable land management must consider the needs and rights of local populations, ensuring that development efforts do not exacerbate inequalities or lead to social unrest.

To achieve sustainable development, it is essential to integrate land cover dynamics into broader environmental and socio-economic planning. Pielke et al. (2002), discuss how land use and land cover changes influence the climate system, arguing that climate change policies must account for these changes to be effective. Their research highlights the need for a holistic approach to sustainable development that considers the interconnectedness of land, climate, and human activities.

Verburg et al. (2015), further support this view, advocating for the integration of land system science into global sustainability agendas. They suggest that land management strategies should be informed by a comprehensive understanding of land cover dynamics, which includes recognizing the complex interactions between environmental, economic, and social factors.

The literature on the relationship between land cover dynamics and sustainable development underscores the importance of sustainable land management practices that balance environmental preservation, economic growth, and social equity. As land use changes continue to shape the global landscape, it is crucial for policymakers, researchers, and practitioners to work together to develop strategies that promote sustainable development while mitigating the negative impacts of land cover changes. By integrating land cover dynamics into sustainable development frameworks, we can ensure that land resources are managed in a way that meets current needs without compromising the ability of future generations to meet their own (Suparmoko, 2020).

The objectives of this research are: (1) to identify the land cover change in Depok City in 2000, 2009, and 2019; (2) to analyze land cover prediction in Depok City in 2039; and (3) to determine the value and status of development sustainability index of Depok City.

2. METHODS

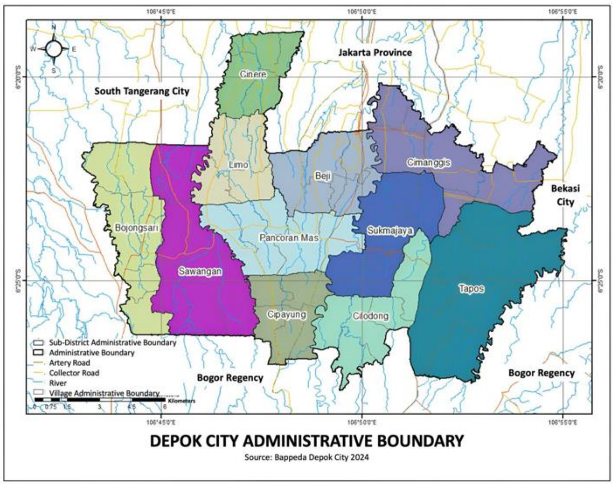

Figure 1. Study Location Map

This research was conducted in Depok City (Figure 1). This research was conducted by reviewing secondary data from the Ministry of Environment and Forestry (KLHK) and the Central Statistics Agency (BPS) of Depok City. This includes administrative map data, West Java land cover imagery data (2000, 2009, 2019), Depok City in Figures 2021, and Village Potential (PODES) 2020.

The software used in this research is ArcGIS 10.3, Idrisi Selva 17.2, and Microsoft Excel. The research flowchart is presented in Figure 2.

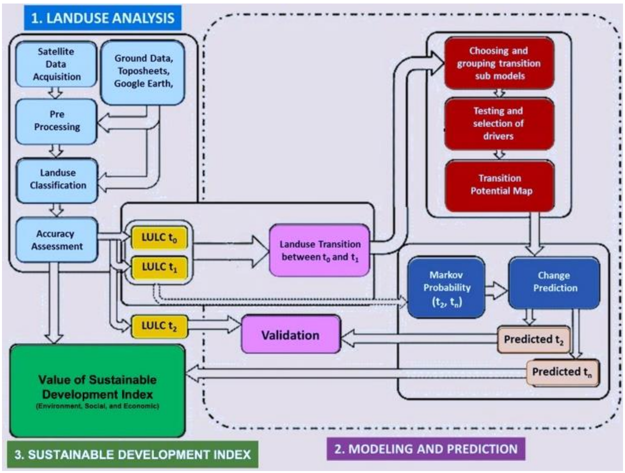

Figure 2. Research Flowchart

2.1 Land cover change in Depok City

Identify changes in land cover types using land cover data in West Java for 2000 - 2019 sourced from the Ministry of Environment and Forestry using the dissolving method using ArcGIS software. The method for analyzing the dynamics of land cover changes uses the interpretation of land cover data, which was carried out at three points in the year, namely 2000, 2009, and 2019, with five land cover classes including water bodies, dry land agriculture, mixed dry land agriculture, settlements, and paddy fields which were then carried out overlay with an administrative map to determine land cover changes that occur in each sub-district.

2.2 Prediction land cover change Depok City in 2039

Land cover prediction analysis for the next 20 years (2039) was carried out using the LCM method with the BAU scenario. It is necessary to model land use change (Land Change Model) because the population growth rate (2019-2039) is predicted to be 61%. This strong growth mainly occurred in developing countries such as Indonesia (Fragkias & Seto, 2008). LCM aims to determine changes and predict the development of construction land in a particular year (Zahrotunisa, 2017). Business As Usual (BAU) is a scenario that describes projected future conditions which are assumed to proceed according to trends that have occurred and are currently occurring using transition areas to illustrate the suitability of land use transitions (Fadhli, Rifardi, & Tarumun, 2020; Rajagukguk, Pakiding, & Rumbayan, 2015). In general, the BAU scenario is widely used to predict. energy emissions in good and directed management of energy resources that will make the potential of an area develop and be utilized optimally (Surya & Gasali, 2017). Predictive analysis was carried out using land cover images from 2000, 2009 and 2019, which had been converted to the Initial Data Entry process raster format contained in the prop layer in Idrisi Selva, then ensured that the base point and end point data used were in UTM 48S. In the prediction stage, either validation tests or prediction maps for the coming year, the Overall Kappa value will be obtained (Adhiatma, Setiawan, & Wibowo, 2020).

2.3 Analysis of the status of sustainable development in Depok City

Analysis of the sustainability status of Depok City development was carried out using MDS (Multidimensional Scaling) analysis. MDS is a multivariate statistical analysis technique that functions to determine the position of an object by referring to its similarity or dissimilarity between sizes and can assess sustainability status in each dimension (Kholil, Dharoko, & Widayati, 2015; Mahida, 2020). This method is a scenario based on sustainable development because it is considered capable of maintaining the quality of the region's carrying capacity for future generations in the form of prediction of future land use using applications from previous research, for example, expanding road maps (Handayanto, Gunarti, & Samsiana, 2015; Handayanto, Tripathi, Kim, & Guha, 2017). MDS is a statistical analysis to assess the similarities and dissimilarities of variables described in geometric space (Kholil et al., 2015). Many methods are used to analyze the current state of sustainable development, including MICMAC and MACTOR (Fauzi, 2019). MDS analysis uses three dimensions, each with six attributes (Table 1), while the dimensions used are economic, social, and environmental. As the output of this analysis, the results of the sustainability status index for each sub-district will be obtained from various dimensions (Table 2). The results obtained need to be carried out with normalization tests and validation tests as a benchmark for the accuracy of the research that has been carried out. The attributes of development sustainability's economic, social, and environmental dimensions were determined using 2020 village potential data.

Table 1. Dimensions and Attributes of MDS Analysis

Dimension	Attributes	Unit
Economic	Malnutrition Sufferers	%
	Active Cooperatives	%
	Traditional Market	%
	Government and Commercial Banks	%
	Hotel Facilities and Infrastructure	%
	Road Surface Type	%
Social	Social Organizations	%
	Eradication of Illiteracy	%
	Skill Education Institution	%
	High School Facilities	%
	Theft Crime Incidents	%
	Accessing Health Facilities (Hospital)	%
Environment	Air Pollution Incidents	%
	Soil Pollution Incidents	%
	Polluted River Water	%
	Landslide Incident	%
	Flood	%
	Families in Slum Area	%

Table 2. Category of Sustainability Status based on MDS Analysis

Index	Sustainability Status
0 – 24.9	Very low
25 – 49.9	Low
50 – 74.9	Moderate
75 - 100	High

3. RESULT AND DISCUSSION

3.1 Dynamics Land Cover Change

Land cover changes in Depok City are changing rapidly. Based on (Figure 3), the development of Depok City has become settlements dominating the city center and shifting to the city's outskirts. The continuing increase in urban population growth has changed the shift in population growth, which initially only occurred in the city center to shift to the outskirts of the city (Pravitasari et al., 2018; Sukwika & Firmansyah, 2021). This shift ultimately had an impact on increasing the rate of settlement.

Apart from that, the large number of Jakarta workers who choose to live in Depok has caused the development of built-up land in this city to be relatively high compared to Jakarta, Bogor, and Tangerang (Zain et al., 2015). Adding enough construction land to this rapid growth shows that urban expansion and urbanization are relatively high because Depok City directly borders DKI

Jakarta province, and the planning process and control of regional spatial management could have worked better (Zain, Syahban, & Ermyanyla, 2013). In addition, other factors may encourage this land cover change: expansion of city boundaries, rejuvenation of city centers, development of infrastructure networks, especially transportation networks, and growth and loss of focus on specific activities (Sigit & Setiawan, 2019).

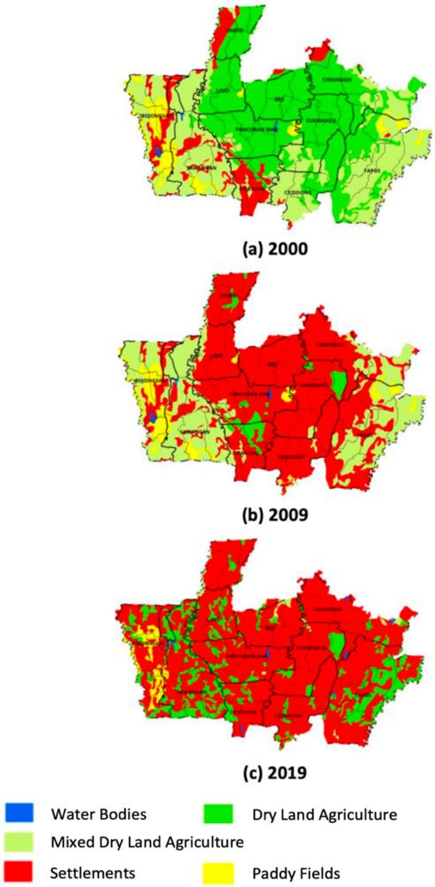

Figure 3. Land cover in Depok City in 2000, 2009, and 2019

Table 2. Total Area and Percentage of Land Cover in Depok City (2000, 2009, and 2019)

Land Cover	Areas (Hectare)			Percentage (%)		
	2000	2009	2019	2000	2009	2019
Water Bodies	54,86	54,86	80,02	0,27	0,27	0,4
Settlements	1838,31	12292,93	15405,25	9,2	61,54	77,11
Dry Land Agriculture	9433,63	673,23	3761,35	47,22	3,37	18,83
Mixed Dry Land Agric.	7544,01	5882	209,86	37,76	29,44	1,05
Paddy Fields	1106,27	1074,05	520,6	5,54	5,38	2,61
Total	19977,07	19977,07	19977,07	100	100	100

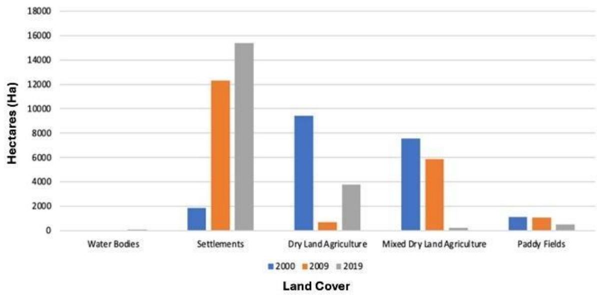

Figure 4. Comparison of Land Cover Change in 2000, 2009, 2019 (in hectare)

In Figure 4, settlements increased from 2000 to 2009 by 52.34% and from 2009 to 2019 by 15.57%. This data indicates that settlements still dominate land cover in Depok City for ten years. The use of built-up land includes residential areas, commercial facilities (industry, trade, and services), educational facilities, office facilities, and community services. The most extensive built-up land is in Tapos District, with an area of 1,839 ha, and Cimanggis, with an area of 1,743 ha. This is understandable because these districts are a concentration of commercial and residential areas (BPS Kota Depok, 2020).

The land cover of Depok City in 2000 was dominated by dry land agriculture with an area of 9,433.63 ha or 47.22% of the total land area, followed by mixed dry land agriculture of 7,544.01 ha, settlements of 1,838.31 ha, paddy fields 1,106.27 ha, and water bodies 54.86 ha. In contrast to 2000, Depok City 2009 experienced a rapid increase in settlements by 52.34%. Depok City experienced a change in land cover dominance from dry land agriculture to residential areas with an area of 12,292.93 ha. This was followed by mixed dry land farming of 5,882 ha, paddy fields of 1,074.05 ha, dry land farming of 673.23 ha, and water bodies of 54.86 ha. The changes in Depok City always lead to increased settlements (Aji, Ardiansyah, & Gunawan, 2020). Apart from that, the change in residential land cover was getting more extensive; from 1996, settlements rose by 14% to 37% in 2006 and then rose again by 54% in 2016 (Ristianingrum, 2015). The land cover of Depok City in 2019 Depok City was increasingly dominated by settlements, with an area percentage of 77.11% of the total area. The initial function of Depok City as a residential city after being designated as a Municipality was directed toward the correct targets (Mudaryanti, 2016). Apart from that, in 2019, Depok City was dominated by settlements. Four other land covers, including water bodies and dry land agriculture, experienced an increase, while mixed dry land agriculture and paddy fields experienced a decrease in area. One of the impacts is the cultural transition from an agricultural society to a non-agricultural culture, leading to changes in social, economic, and cultural structures (Prihatin, 2015).

The development of Depok City, which is increasingly dominated by residential areas, could have negative impact, so the Depok City Government must develop a tourism development program in the form of natural tourism, manufactured tourism, cultural tourism, and educational tourism (Sofiani & Octariana, 2021).

3.2 Prediction Land Cover Change of Depok City in 2039

The land cover change model uses two-year points, namely 2000 as the base point and 2009 as the endpoint. The graph of area increase and decrease can be seen in Figure 5. The purple color indicates a decrease in area in land cover, while the green color indicates that a land area has experienced an increase in area (Adhiatma et al., 2020).

Table 3. Dominance of Land Cover Change in 2000-2009

LUCC	Area (Ha)
PLK to PMK	8683,99
PLKC to PMK	1774,07
PLK to PLKC	75,48
SWH to PLK	32,41

Note: PLK: dry land agriculture; PLKC: mixed dry land agriculture; PMK: settlements; SWH: paddy fields.

Figure 5. Gains and Losses of Land Cover in 2000 and 2009

Four dominant land cover changes occurred from 2000 to 2009, including dry land agriculture into settlements, mixed dry land agriculture (PLK) becoming settlements, dry land agriculture (PLK) becoming mixed dry land agriculture (PLKC), and paddy fields becoming agriculture. Mixed dry land (PLKC). Based on Table 3, the change in the area of PLK land cover is very significant because most of the land has been converted into settlements and PLKC, namely 8,683.99 ha and 75.41 ha. Apart from that, there was land conversion from PLKC to settlements amounting to 1,774.07 ha and paddy fields to PLKC amounting to 32.41 ha. So, in the past nine years, Depok City has experienced a decrease in PLK area and an increase in settlements.

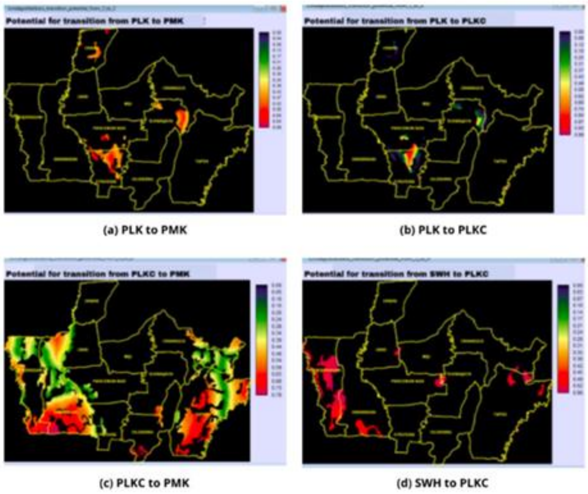

Figure 6. Potential of Land Cover Change

The prediction stage uses 2000 as the base point and 2009 as the final point. It is also necessary to carry out indicator analysis to determine the potential for changes that occur. Indicators used include roads and rivers. If the image shows purple, pink, or red, the area is experiencing relatively high changes. In contrast, if the color is yellow and increasingly turning green, it indicates that the area is probably not experiencing changes. The potential changes that occur in the four dominant land cover changes can be seen in Figure 6.

The modeling carried out is first validated to see whether the model can predict land cover in the coming year (Adhiatma et al., 2020). Land cover predictions in 2019 were obtained from analysis using the BAU Scenario compared with the 2019 Ministry of Environment and Forestry data. Through this analysis, an Overall Kappa value or similarity value of 0.9038 was obtained. The results of the study by Nouri, Gharagozlou, Arjmandi, Faryadi, and Adl (2014); Munibah (2008); Kamusoko, Aniya, Adi, and Manjoro (2009); Wang, Zheng, and Zang (2012), also showed that Kappa values ranged from 0.86 to 0.99, placing it in the good category. The Kappa accuracy value from 0.80 to 1.00 is very suitable so that the model can predict land use (Rwanga & Ndambuki, 2017). With the similarity values obtained, it can be close to perfect results to be used to predict distribution patterns and areas of land cover in 2039. The comparison map of land cover can be seen in Figure 7.

Predictions using one type of model is the Business As Usual (BAU) model, where in this model, changes follow historical patterns from the previous year (Adhiatma et al., 2020). Land cover changes between 2000 and 2009 were used as the base and endpoints. The predicted map of land cover changes in 2039 can be seen in Figure 8. Some open land is projected to experience a significant decrease in area in 2039. Meanwhile, built-up land will continue to increase in area. Based on Figure 7 and Table 4, it can be seen that in 2019 (actual) and 2019 (BAU), there were several differences. The difference can be seen in the area of PLK. In 2019 (actual), PLK had a larger area, namely 3,761.35 ha, whereas in 2019 (BAU), it was only 10.22 ha. This also happens to PLKC land cover. In 2019 (actual), PLKC had a larger area than PLK, with an area of 4,357.57 ha.

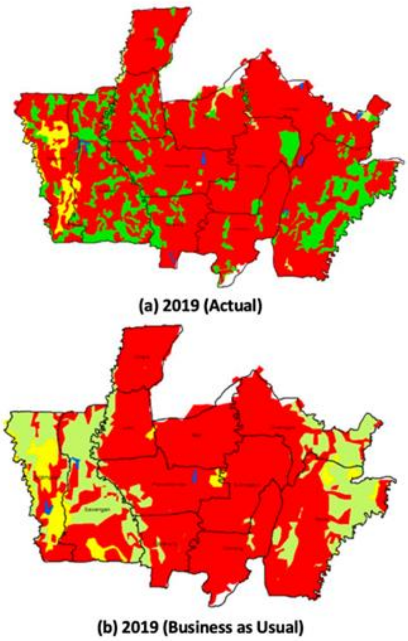

Figure 7. Predicted 2019 and Actual 2019 Land Cover Changes

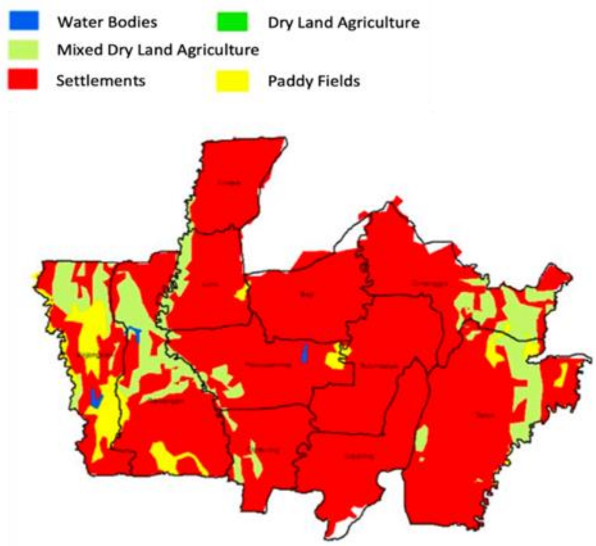

Figure 8. Predicted Land Cover Changes in 2039 using BaU Scenario

Table 4. Differences in land cover area in 2019 and 2039

Land Cover	Areas (Hectare)			Percentage (%)		
	2019 (Actual)	2019 (Bau)	2039 (BaU)	2019 (Actual)	2019 (Bau)	2039 (BaU)
Water Bodies	80,02	54,59	54,59	0,4	0,27	0,27
Settlements	15405,25	14513,7	16453,24	77,11	72,65	82,36
Dry Land Agriculture	3761,35	10,22	1,27	18,83	0,05	0,01
Mixed Dry Land Agriculture	209,86	4357,57	2468,35	1,05	21,81	12,36
Paddy Fields	520,6	1040,99	999,62	2,61	5,21	5
Total	19977,07	19977,07	19977,07	100	100	100

The land cover prediction analysis in 2039 is projected to experience an extensive decline in PLK land cover. Apart from that, some open land cover, such as water bodies and rice fields, also experienced a decline, namely only 0.27% and 5% of the total area. This is inversely proportional to the increasing number of settlements. From 2019 to 2039, it is projected that the percentage of settlements will increase by 5.25% of the total area so that the total area of settlements is 82.36%. This is quite a departure from the primary function of the establishment of Depok City. Apart from being a residential city, Depok City is a water catchment city. The strategy to increase the need for 30% green open space in Depok City is carried out by adding pollution-absorbing trees along green space corridors such as arterial roads, primary roads, river border pedestrians and railway borders, adding urban forests and city parks, purchasing land from the community for use as public open space, and greening in the form of roof gardens and vertical gardens on buildings (Hayati, Sitorus, & Nurisjah, 2013).

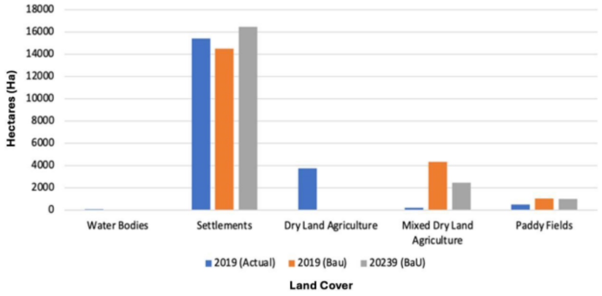

Figure 9. Comparison of Land Cover Change in 2019 (Actual, BaU) and 2039 (BaU) in hectare

3.3 Sustainability Status in Depok City

Results of analysis of the Depok City Development Sustainability Index shows various sustainability statuses based on economic, social, and environmental dimensions. The results of the sustainability index value are influenced by the results of scoring bad and good scores on the attributes of each dimension. Policy making for attributes with good score criteria is to maintain existing conditions. In contrast, for attributes with flawed score criteria, improvements need to be made in order to increase sustainability status.

The development sustainability index values for the social and economic dimensions are generally higher than those for the environmental dimension. West Java Province is a moderately sustainable province where the social and economic dimensions of development are more developed. Based on the analysis results of the average R2 value for each The sub-district has a value close to 1, while the stress value shows an average of less than 0.25 (Fauzi & Anna, 2005). According to Nababan, Sari, and Hermawan (2017), in principle, the constraint measures how close a two-dimensional distance value is to a multidimensional distance value. If the distance between these two values is near, the length is small, and the stress value is low. The smaller the stress value, the better. Acceptable stress values are usually less than 25% to 30%. The stress and R2 values for each sub-district are presented in Table 5. This shows that the analysis can be distributed normally, and the attributes used do not require addition. Meanwhile, the leverage attribute results for each sub-district in Depok City show varying results in each dimension used.

Table 5. Index and Sustainability Status in Depok City

Sub-District	Economy		Social		Environment	
	Index	Status	Index	Status	Index	Status
Sawangan	42,78	Low	31,74	Low	59,01	Moderate
Bojongsari	44,56	Low	48,45	Low	87,07	High
Pancoran Mas	73,73	Moderate	68,75	Moderate	38,6	Low
Cipayung	44,56	Low	42,48	Low	92,11	High
Sukmajaya	73,73	Moderate	46,22	Low	42,84	Low
Cilodong	64,53	Moderate	35,68	Low	76,69	High
Cimanggis	77,82	High	57,85	Moderate	67,11	Moderate
Tapos	54,15	Moderate	62,12	Moderate	44,25	Low
Beji	72,88	Moderate	67,61	Moderate	10,11	Very Low
Limo	16,31	Very Low	22,76	Very Low	94,14	High
Cinere	51,38	Moderate	47,33	Low	32,99	Low

Based on the results of the leverage analysis that has been carried out, the results obtained in the economic dimension, the attribute that most influence the development sustainability index of Sawangan, Pancoran Mas, Sukmajaya, Cilodong District is the number of government and private commercial banks. Meanwhile, Cimanggis District is the number of hotel facilities and infrastructure, and Beji District is the number of active cooperatives. Then, the percentage of traditional markets is the attribute that most influences the development sustainability index in Tapos and Cinere Districts. Apart from that, Bojongsari and Cipayung sub-districts each have two attributes that influence the most, including the number of hotel facilities and infrastructure and the number of active cooperatives. For the Limo District, the attributes that influence the most are the number of public and private banks and the number of traditional markets.

The results of the leverage analysis on the social dimension show that the dominant attribute that has the most influence on the development sustainability status index is the number of skills education institutions, which include Sawangan, Bojongsari, Pancoran Mas, Cipayung and Tapos sub-districts. Then, Cilodong, Cimanggis, and Cinere sub-districts have several high school (SMA) facilities. Meanwhile, the Limo sub-district attribute that most influences the development sustainability index is the eradication of illiteracy. For Sukmajaya and Beji Districts, the two attributes that influence the most are the number of high school (SMA) facilities and skills education institutions. The urbanization process in suburban areas occurs due to changes in the buffer function of the central city. This condition is caused by repositioning the central city in the regional division of labor system. This regional division of the labor system causes suburban communities with a simple mindset to change their mindset to become more rational gradually. The pattern of socio-economic transformation gives birth to shifts in behavior, thought patterns, and community culture (Januar, 2016). Conditions like this emerged after the presence of social organizations.

In the environmental dimension of Sawangan, Pancoran Mas, Sukmajaya, Tapos, and Cinere sub-districts, the attribute that most influences the development sustainability index is the percentage of land pollution incidents. Then, for Bojongsari and Cimanggis Districts, the percentage of river water polluted by waste, and for Cipayung and Beji Districts, the percentage of air pollution incidents. Meanwhile, for the Limo and Cilodong sub-districts, the most influencing attributes are the number of slum families and the incidence of landslides. Population growth and increasing population activities have caused a decline in environmental quality. The increasingly high population growth in urban areas will affect the environmental quality of the relevant urban areas, and it can decrease the quality of human life in urban areas. Development conditions and increasing population density have converted land into construction land. The increase in construction land area causes increased activities on construction land. It increases the need for drinking water, thereby reducing water levels and groundwater pollution, as well as reducing discharges from PDAM water sources (Noeraga, Yudana, & Rahayu, 2020).

4. CONCLUSION

The rapid land cover changes in Depok City highlight a significant shift from agricultural land to urban settlements, driven by both population growth and urban expansion. Over the past two decades, the city has transformed from a predominantly agricultural area into a densely populated urban region, with settlements now occupying over 77% of the land area by 2019. This urban sprawl is not just a reflection of population dynamics but also a consequence of the city's proximity to Jakarta, which has spurred both residential and commercial development.

As the urban core of Depok becomes saturated, development pressures have shifted to the outskirts, further expanding the built environment at the expense of agricultural and natural lands. This pattern is indicative of broader trends in metropolitan fringe areas, where urbanization often outpaces effective spatial planning and regulation, leading to haphazard growth and increased strain on local infrastructure and resources.

The ongoing urbanization has led to several environmental and social challenges, including the loss of agricultural land, which has significant implications for food security and local livelihoods. Moreover, the decline in green and open spaces has exacerbated environmental issues such as reduced groundwater recharge, increased surface runoff, and higher pollution levels, all of which threaten the sustainability of urban living in Depok.

Looking ahead, projections for 2039 indicate that these trends will continue, with further reductions in agricultural land and an increase in urban settlements. This trajectory underscores the urgency for more sustainable urban planning strategies that balance development needs with environmental conservation. The city's status as a water catchment area further complicates the situation, as continued urban expansion without adequate green space could undermine its ability to manage water resources effectively.

The sustainability status of Depok City, as assessed across economic, social, and environmental dimensions, reveals a concerning imbalance. While the economic and social dimensions show moderate development, the environmental dimension lags, reflecting the negative impacts of rapid urbanization. The varied sustainability statuses across different sub-districts suggest the need for localized policy interventions that address specific challenges and leverage local strengths.

The future of Depok City hinges on adopting a more integrated approach to urban planning that prioritizes environmental sustainability alongside economic and social development. This includes expanding green spaces, improving water management, and ensuring that urban growth is managed in a way that preserves the city's ecological functions. Without such measures, the long-term livability and resilience of Depok City are at risk, with potential repercussions for both its residents and the broader region.

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