LAND USE AND LAND COVER PREDICTION IN SURABAYA METROPOLITAN, INDONESIA

THESIS

in Partial Fulfillment of the Requirements for Master Degree in Urban and Regional Planning

DOPIT SAPUTRA
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MASTER OF URBAN AND REGIONAL PLANNING
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A Master's Thesis
Submitted to the Department of Urban and Regional Planning
Faculty of Engineering, Diponegoro University

by:

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in Partial Fulfillment of the Requirements
for Master Degree in Urban and Regional Planning

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STATEMENT OF AUTHORSHIP

I, Dopit Saputra (student number 21040120413032), declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research. I confirm that; this work was done wholly or mainly while in candidature for a master degree at the department of Master of Urban and Regional Planning, Diponegoro University; where any part of this thesis has previously been submitted for a degree or any other qualification at Diponegoro University or any other institution, this has been clearly stated; where I have consulted the published work of others, this is always clearly attributed; where I have quoted from the work of others, the source is always given, with the exception of such quotations, and this thesis is entirely my own work.

February 10, 2023

Dopit Saputra

DEDICATION PAGE

I would like to express my gratitude to my parents and the rest of my family for their unwavering love, support, and prayers throughout the years. And, all of you who are working hard to improve yourself are in my thoughts and prayers.

I can give you a six-word formula for success: Think things through - then follow through.

-Eddie Rickenbacker-

ABSTRAK

Banyak kota di dunia, baik di negara maju maupun negara berkembang, telah mengalami urbanisasi. Kota-kota di negara-negara industri telah mengalami urbanisasi selama beberapa tahun. Sebaliknya, kota-kota di negara berkembang, terutama di Asia, berada pada tahap awal urbanisasi. Beberapa kota di Indonesia, sebagai negara dengan jumlah penduduk terpadat keempat di dunia, telah mengalami urbanisasi pada tahap awal. Oleh karena itu, penelitian ini bertujuan untuk mengklasifikasikan kota-kota dan tingkat pertumbuhannya di Indonesia. Dengan menggunakan Kota Surabaya sebagai studi kasus, perluasan secara spasial kota telah dilakukan perhitungan dan prediksi. Klasifikasi kota dalam penelitian ini didasarkan pada principal component analysis dan analisis klaster. Kemudian, proyeksi pola tutupan dan penggunaan lahan (LULC) akan dilakukan dengan menggunakan dua metode yang berbeda, yaitu MLPNN dan ANN-CA. Pertama, Land Change Modeler dari TerrSet digunakan untuk mengimplementasikan metode MLPNN (multi-layer perceptron neural network) berbasis model Markov chain untuk mendapatkan proyeksi perubahan penggunaan dan tutupan lahan. Metode kedua, ANN-CA, digunakan pada data yang sama untuk tujuan yang sama. Setelah itu, perbandingan kedua pendekatan tersebut disajikan. Temuan studi menunjukkan bahwa 35 kota dapat dibagi menjadi lima kelompok. Selain itu, studi perubahan LULC di Surabaya menunjukkan adanya perluasan sebesar 60 persen antara tahun 2000 dan 2021, dengan penurunan yang besar pada luas lahan pertanian lebih dari 20%, yaitu sebesar 132,62 km^2 dalam kurun waktu yang sama. Selain itu, hasil matriks probabilitas transisi menunjukkan bahwa kecenderungan perubahan menjadi wilayah perkotaan relatif tinggi, dengan nilai 0,0903 dan 0,1033 untuk vegetasi dan pertanian. Namun demikian, perubahan dari kelas tutupan lahan lainnya menjadi kawasan perkotaan tidak begitu terlihat pada rentang waktu yang lebih pendek yaitu tahun 2000-2003, dengan kecenderungan perubahan dari vegetasi sebesar 0.0891 dan dari lahan pertanian sebesar 0.0956. Hasil proyeksi menunjukkan bahwa wilayah perkotaan akan menjadi kurang dari 350 km^2 dan membentang ke arah selatan dari Gresik (sisi barat Surabaya). Perbedaan utama antara MLPNN dan ANN-CA adalah bagaimana model-model tersebut dibangun. MLPNN menggunakan feedforward, sedangkan ANN-CA menggunakan feedforward dengan tambahan Cellular Automata.

***Kata kunci**: Urbanisasi, PCA, Cluster Analysis, Prediksi LULC*

ABSTRACT

Countless cities worldwide, in both developed and developing nations, have experienced urbanization. Cities in industrialized nations have experienced urbanization for several years. In contrast, cities in emerging nations, particularly in Asia, are at an early stage of urbanization. Several cities in Indonesia, the fourth most populous nation, have undergone an early stage of urbanization. Therefore, this study aims to classify cities and their growth rates in Indonesia. Using the city of Surabaya as an example, the spatial expansion of the cities has been forecasted. The classification of cities in this study is based on principal component analysis and cluster analysis. Then, LULC projection will be conducted using two different methods; MLPNN and ANN-CA. First, The Land Change Modeler from TerrSet was used to implement the multi-layer perceptron neural network-based Markov chain model method in order to obtain the land use and land cover (LULC) changes projection. The second method, ANN-CA, was used to similar data for the same objective. Afterwards, a comparison of the two approaches is presented. The study's findings indicate that 35 cities can be divided into five groups. Besides, the LULC changes study in Surabaya revealed a large expansion of 60 percent between 2000 and 2021, with a severe decline in agricultural land area of over 20 percent, amounting to 132.62 km^2 during the same time frame. Besides, the results of the transition probability matrix indicate that the tendency of transformation into an urban area is relatively high, with values of 0.0903 and 0.1033 for vegetation and agricultural, respectively. However, the change from other land cover classes to urban areas was not as apparent in the shorter time frame of 2000-2003, with a tendency of change from vegetation of 0.0891 and from agricultural land of 0.0956. The projection results indicate that the urban area will be just under 350 km^2 and stretch southward from Gresik (the west side of Surabaya). The main difference between MLPNN and ANN-CA is how the models are built. MLPNN uses feedforward, while ANN-CA uses both feedforward and Cellular Automata.

Keywords: Urbanization, PCA, Cluster Analysis, LULC Prediction

FOREWORD

This thesis was written for my master's degree in Urban and Regional Planning in Diponegoro University. The subject of this thesis is related to land use and land cover changes and its prediction in the future. This is a very fascinating research topic as it is useful for the study of urban regions, urbanization, which is influenced by its surroundings not only in the current state but also the dynamics from the past, and the possibility in the future.

After thanking Allah Almighty and my family for their endless support, I would like to thank a few people here;

1. I am really grateful to my supervisor, Prof. Dr.-Ing. Wiwandari Handayani, S.T., M.T., M.P.S. for her guidance and recommendations, and the examiners Prof. Dr.sc.agr. Iwan Rudiarto, S.T., M.Sc. and Dr. Fadjar Hari Mardiansyah, S.T., M.T., M.D.P., for their invaluable inputs to this study,
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Lastly, this report is far from ideal, numerous restrictions and fallacies exist. Future upgrades are necessary. The author hopes that individuals in need will find this report informative.

Semarang, February 10, 2023

Dopit Saputra

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LIST OF ACRONYMS AND ABBREVIATIONS

ANN	Artificial Neural Network
BMKG	*Badan Meteorologi, Klimatologi, dan Geofisika* (Meteorological, Climatological, and Geophysical Agency)
BPS	*Badan Pusat Statistik* (Central Bureau of Statistics, CBS)
CA	Cellular Automata
DEM	Digital Elevation Model
GDRP	Gross Domestics Regional Products
IDE	Integrated Development Environment
LULC	Land Use and Land Cover
MOLUSCE	Methods Of Land Use Change Evaluation
MLPNN	Multi-Layer Perceptron Neural Network
OSM	Open Street Map
PC	Principal Component
PCA	Principal Component Analysis
SLC	Scan Line Corrector