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Assessing land use/land cover change diversity and its relation with urban dispersion using Shannon Entropy in the Semarang Metropolitan Region, Indonesia

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Abstract

The Semarang Metropolitan Region (SMR) dynamic is difficult to control and related to the urban sprawl phenomenon. This study aimed to explore the relationship between land use/land cover changes (LULCC) diversity with an urban dispersion pattern of the SMR in 2010-2020 using Shannon Entropy. The SMR experienced significant urban growth in the last ten years. The built-up area spread from the downtown area to the peri-urban area of 14,285 ha (53%). Here, the normalised entropy of

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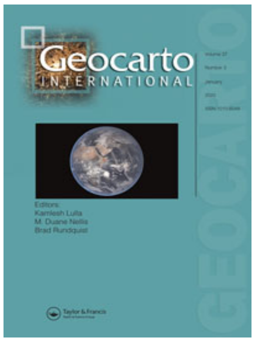

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Assessing land use/land cover change diversity and its relation with urban dispersion using Shannon Entropy in the Semarang Metropolitan Region, Indonesia

Dimas Danar Dewa[a], Imam Buchori[b] and Anang Wahyu Sejati[b]

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ABSTRACT

The Semarang Metropolitan Region (SMR) dynamic is difficult to control and related to the urban sprawl phenomenon. This study aimed to explore the relationship between land use/land cover changes (LULCC) diversity with an urban dispersion pattern of the SMR in 2010-2020 using Shannon Entropy. The SMR experienced significant urban growth in the last ten years. The built-up area spread from the downtown area to the peri-urban area of 14,285 ha (53%). Here, the normalised entropy of LULCC was found to be greater than 0.5 in the peri-urban area, indicating more heterogeneous LULCC dynamics. In addition, with a 12% growth rate per year, the SMR has the largest built-up patch area of 16,088 ha out of 25,793 ha, which means that 37% of the built-up area was a dispersed growth. This indicates that the built-up area spread sporadically with an irregular development pattern. Meanwhile, the built-up area increased in a more compact and orderly pattern in the downtown area. This study showed that LULCC diversity affects the spatial dynamics of urban growth in the SMR. The greater the LULCC diversity value, the greater the urban dispersion pattern, which is becoming increasingly dispersed.

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LULC; urban growth; spatial dispersion; Shannon Entropy; LULC diversity

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Introduction

Urbanisation and climate change are still one of the current global problems that influence urban development sustainability (Sugiri et al. 2011; Sejati et al. 2019; Koroso et al. 2020; K and Angadi 2021; Patias et al. 2021). In 2000-2014, there was an increase in urban areas globally with a growth of 1.28 times faster than the world's population growth (UN Economic and Social Council 2019). Urban development converted green areas (such as forest cover (FC) and agricultural land (AL)) into built-up areas (BA). The issue is that urban irregular growth (in a spatial context) has the potential to accelerate climate change. This is due to inefficient land use, which leads to massive deforestation. The urban spatial growth shows the urban development sustainability, which includes

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Assessing the impacts of human interventions and climate change on fluvial flooding using CMIP6 data and GIS-based hydrologic and hydraulic models

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ABSTRACT

This study presents an approach for modelling and mapping fluvial flooding, considering both land use/land cover (LULC) change and climate change, and applies it to the Brahmani River Basin in eastern India. Climate change projections were obtained from the Coupled Model Intercomparison Project Phase 6 (CMIP6), and their impacts on the hydrology of the catchment were investigated using HEC-HMS and HEC-RAS software. Results reveal that changes in LULC types, specifically an increase in proportions of agricultural and built-up areas and a decrease in forest cover, as undergone between years 1985 and 2018, have increased peak discharge following a storm, thereby causing an increase in spatial extent of floods of different return periods. Moreover, downscaled climate change scenarios from two General Circulation Models were used to determine potential changes in river discharge according to two GHG emission scenarios from the latest IPCC: SSP245 and SSP585. The projections indicate that peak discharge and the spatial extent of flooded areas will increase for floods with return periods ranging from two to 100 years. This study demonstrates the important influence that changes in LULC have had on the susceptibility of the BRB to flooding, with climate change projected to further enhance the risk of flooding as the century progresses.

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Fluvial flooding, land use/land cover, GIS-based hydrologic and hydraulic models, climate change, Brahmani River Basin

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This article has been corrected with minor changes. These changes do not impact the academic content of the article.

1. Introduction

Extreme weather and climate-related disasters, for instance, storms, landslides, heatwaves, droughts, and flooding, including glacier lake outbursts, affect many countries worldwide (Wallemacq et al. 1995; Quirós and Gagnon 2020). Nonetheless, of all natural hazards, flooding is the most recurrent and widespread

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Quantifying surface soil organic carbon distribution globally during the COVID-19 pandemic using satellite data

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ABSTRACT

Soil organic carbon (SOC) is an important soil parameter of agricultural soils, ensuring food security and agricultural sustainability. It plays a critical role in the global carbon budget and carbon sequestration. Spatial mapping of SOC can help develop sustainable management approaches to enhance soil carbon sequestration and mitigate greenhouse gas emissions and adverse environmental effects. However, quantifying Spatio-temporal distributions of SOC at the global level is complex because of high land heterogeneity and several climatic and hydrologic influential parameters. The main goal of this study was to quantify the annual global SOC change focusing on cropland using daily soil moisture active passive (SMAP) satellite SOC data. The specific objectives of this study were to assess annual SOC change globally, quantify the annual SOC distribution before and during the COVID-19 pandemic, and evaluate change in SOC on cropland during the study period. Results showed an increase of annual SOC on cropland in several countries in 2020 compared to 2019, which can be attributed to the direct and indirect impact of partial and complete lockdowns due to the COVID-19 pandemic. The change in SOC between 2015 and 2019 was considerably different from the SOC change between 2019 and 2020. For example, between 2019 and 2015, 45.6% of the global area showed a decrease in SOC 0 to 25 g C m^{-2} and 30.4% area showed an increase in SOC 0 to 25 g C m^{-2}. However, between 2020 and 2019, 11.4% of the global area showed a decrease in SOC 0 to 25 g C $m^{-2,}$ and 55.4% area showed an increase in SOC 0 to 25 g C m^{-2}. There is a good relationship between lockdown measures and improvement in SOC, as 48 out of 50 highly infected countries showed increased SOC in 2020 than in 2019. This study suggests better land use management practices can help enhance carbon sequestration and improve soil health.

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Remote sensing, SMAP, soil organic carbon, cropland, global, COVID-19, satellite

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1. Introduction