Analyzing Urbanization Dynamics and Land Use Efficiency in Philippine Cities Using Earth Observation Data

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Rapid urbanization is a global phenomenon that has led to various challenges related to land use, infrastructure development, and the well-being of urban populations. To address this, Sustainable Development Goal 11 (SDG 11) was established, aiming to enhance inclusive and sustainable urbanization. Achieving SDG 11.3, which focuses on improving land use efficiency and urban planning practices, requires understanding the patterns and dynamics of built-up area expansion, urbanization, and land use efficiency in cities and municipalities. In recent decades, the Philippines, like many other countries, has witnessed substantial urban growth and expansion. However, there needs to be more information concerning the decadal patterns and trends in built-up area expansion, urbanization characteristics, and land use efficiency within Philippine cities. The archipelagic nature of the Philippines poses challenges in collecting consistent data on land use/land cover and population across multiple islands. This complexity hinders data availability, potentially resulting in gaps and variations in quality. Fortunately, advancements in remote sensing and geospatial technologies offer solutions. Using satellite imagery and modeling techniques, the Global Human Settlement Layers (GHSL) dataset provides valuable data on built-up surfaces, population distribution, and urban/rural land classification. GHSL enables a standardized assessment of built-up areas, facilitating efficient analysis of urbanization dynamics and land use patterns. This study conducted a spatiotemporal analysis of the GHSL to examine decadal patterns and trends in built-up area expansion, urbanization dynamics, and land use efficiency in 149 Philippines cities from 1980-2020. Land use efficiency was measured using the SDG 11.3.1 indicator (LCRPGR), computed as the ratio of the land consumption rate (LCR) and population growth rate (PGR). Our analysis showed that the aggregated built-up area in Philippine cities increased at an average annual rate of 24% from 1980 to 2020. Despite covering a mere 12% of the country's total land area, their collective built-up area significantly contributes to over 40% of the nation's total built-up area. The most significant increase in city built-up area happened between 1980 and 1990, but this rapid expansion gradually decreased in the succeeding decades. The analysis also revealed a high level of urbanization in cities, with 89% of the population living in urban areas in 1980 and increased to 95% in 2020. However, the decadal urbanization rates declined, dropping from 33% during 1980-1990 to 18% during 2010-2020. A similar downward trend was observed for land consumption and population growth rates. The average LCR was highest at 4.09% during 1980-1990 but decreased to 1.34% during 2010-2020. The downward trend in the decadal LCR of cities indicates a potential reduction in the pace of land consumption for urban development and other human activities. The average PGR of cities was highest during 1980-1990 at 3.16% and gradually decreased to 1.52% from 2010 to 2020. This suggests that more cities experienced population growth rates that exceeded land consumption rates over time. Regarding land use efficiency, the analysis shows a progression towards more efficient land utilization in most cities over the studied periods, with the 2000-2010 period exhibiting the highest land use efficiency (average LCPRGR=0.60). These findings provide valuable guidance for urban planners, policymakers, and stakeholders in understanding the dynamics of urbanization and land use efficiency in Philippine cities. The observed trends of diminishing urbanization rates and improving land use efficiency highlight the potential for more sustainable urban development practices and strategic

planning to optimize land resources and accommodate population growth in the future.

Keywords: Built-up area expansion, Urbanization dynamics, Land use efficiency, Global Human Settlement Layers (GHSL), Sustainable Development, SDG 11.3