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INTEGRATED MAPPING TECHNOLOGIES TO PRODUCE AN ACCURATE LAND USE/ LAND COVER MAP FOR SUSTAINABLE LAND MANAGEMENT

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Highlights: This research establishes an integrated framework for producing an accurate land use/ land cover map (LULC). The map can be used for city and tourism planning, resource management, studying habitat fragmentation, and projecting dynamics of LULC. Methodologically, the cost of producing the maps is complimentary. The data were acquired from Landsat 8, USGS, and processed in the Geographic Information System application (GIS). In practice, this research may help the stakeholders, researchers, practitioners, and even the students to assess, monitor, organize and develop the land to achieve sustainable planning and design of a town or city.

Keywords: *LULC, framework, city planning, GIS, Landsat-8, sustainable land management*

Introduction

The studies of Earth's surface have been growing exponentially since the emergence of remote sensing technology. The studies of LULC have become a popular research trend, especially related to the issues of urbanization. Malaysia had suffered a substantial loss of forest cover since 1954, when forest cover was converted to agricultural land and accommodated for new residential, commercial, and industrial lands (JPBD, 2010). The change of LULC has precipitated various negative impacts, including degradation of the environment, increasing land surface temperature that exacerbates the urban heat island effect (UHI), flooding and soil erosion due to impermeable surfaces and unstable soil structure, to name a few (Yeo et al., 2017). Thus, the study proposes an integrated mapping method using the free-accessed computer and web-based programs such as Geographical Information System, Google Earth, Google Street View, and Earth Explorer (USGS).

Map Production Process based on Integrated Mapping Technologies

The integrated framework established in Figure 1 depicts the process of producing the LULC map by using the latest complimentary data of Landsat 8 from Earth Explorer-USGS and subsequently exercising interactive supervised classification (ISC) and Iso cluster unsupervised classification (ICUC) in the Geographic Information System application (ArcGIS 10.8). Next, the maps produced using ISC and ICUC methods were tested with actual site images from Google Earth and Google Street View. The statistical test result shows that the ISC method has an overall accuracy of 87.7%, while the ICUC method has an accuracy rate of 67.7% (refer to Yeo et al., 2022 for a detailed explanation of the integrated framework). It implies that the map produced with ISC method has a higher accuracy rate. Thus, it is more recommended to use it in producing the map. Nevertheless, the ICUC method is much easier to execute and requires a shorter time to process the data. Consequently, the accuracy rate is lower.

Impacts on Education and Communities

Remote sensing and GIS-related studies are essential for town and city planning. It is widely used in the courses of *Earth Science*, *Environmental Science*, *Town and Country Planning*, *Tourism Planning,* and *Landscape Architecture*. With this integrated framework that we proposed, researchers or students can produce the up-to-date LULC map without acquiring it from Jabatan Ukur dan Pemetaan Malaysia (JUPEM) or PLANmalaysia (previously known as Jabatan Perancangan Bandar Dan Desa, JPBD). The data acquisition from the authorities is often time-consuming, and the data could be outdated. As a result, the project cannot initiate on time. This innovative pedagogical method is introduced in the module of Geographic Information System (GIS) in the Bachelor of Landscape Architectural course with the hope that students have more time to study and analyze the map instead of data acquisition. This research may also be relevant to other courses in higher education and industrial practices, especially in town and city planning.

Advantages of Mapping Technologies and Its Commercial Values

An accurate map is crucial for understanding what is happening on the site and promoting sustainable land management. The advantages of the proposed framework include no additional cost involved during the entire process of producing the LULC map, except the software itself needs to be purchased (ArcGIS). Alternatively, a free

version of the software can be utilized (e.g., QGIS). Secondly, we demonstrated the accuracy rate of using ISC and ICUC methods so that the researcher can opt for whichever method to the best of their research interest. Thirdly, the maps we produced have the potential to explore the LULC change for a certain period, study habitat fragmentation, record the current land use type, identify urban sprawl and monitor natural resources and the depletion of forest cover. So, the stakeholder can draw a more coordinated decision making in their local planning plan (Rancangan Tempatan). Based on the rate reported by Jabatan Pertanian (n.d), a digital land use map in JPEG format costs RM 50.00 per sheet, while in shapefile costs rm 900 per megabyte (MB). The maps we have produced using ISC method are around 110MB, and ICUC is around 80MB, which will cost RM 99,000 and RM 72,000, respectively. Note that we are unsure how detailed the Jabatan Pertanian prepared the attributes and sub-attributes information of the shapefile. Generally, the more detailed and complex the shapefile, the higher the cost.

It is also worth noting that we only managed to identify the LULC but not the specific classifications or sub-attributes. For instance, in agriculture alone, there are paddy fields, grazing land, oil palm estate, rubber plantation, and various fruit plantation as well. Future research can seek to improve this aspect. In conclusion, this research provides an innovative method to produce the LULC maps, which will benefit the stakeholders, practitioners, researchers, and students. Researchers or students can use the LULC map for various post-analysis projects in academia. Meanwhile, stakeholders can use the LULC map to monitor land-use changes. Lastly, the practitioners can adopt such a method in their actual industry projects.

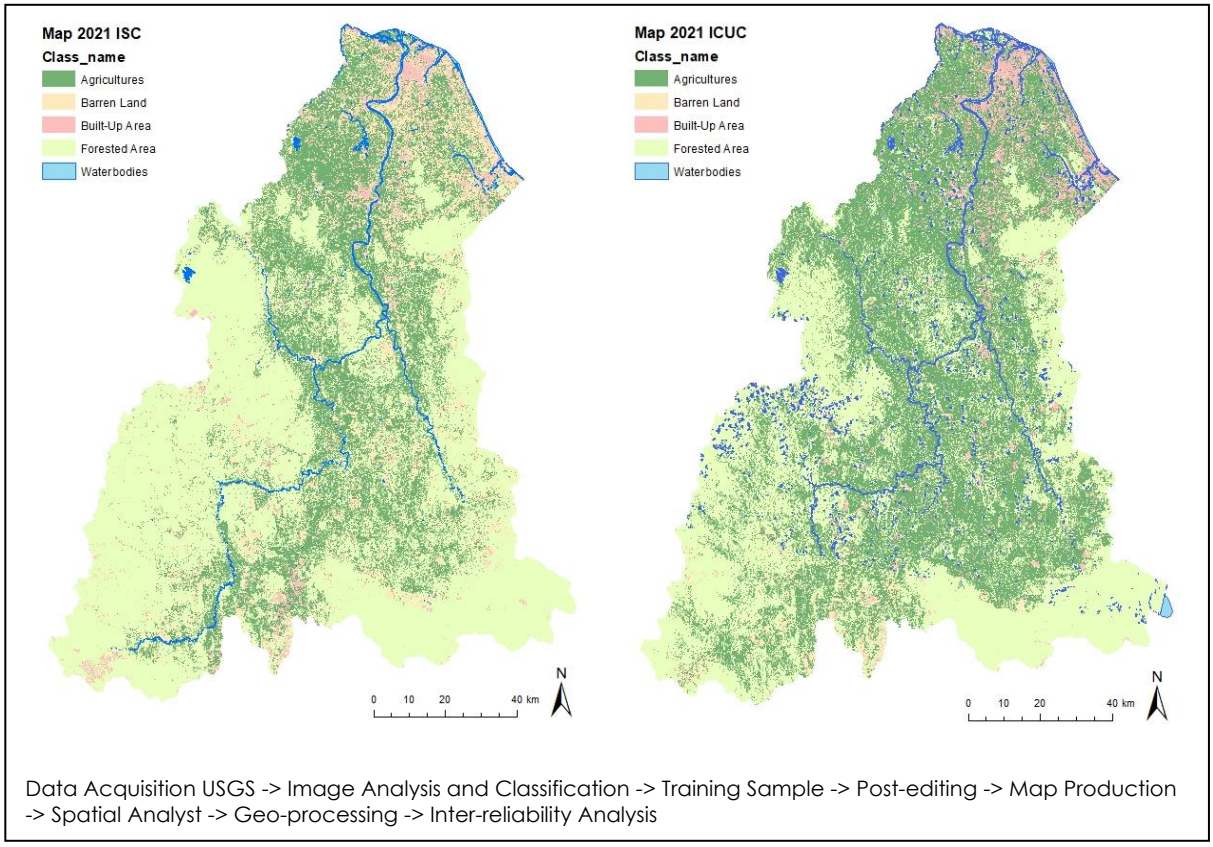

Figure 1: LULC maps based on supervised (left) and unsupervised (right) classifications

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