Chapter 33
Mapping Regional Landscape by Using OpenstreetMap (OSM): A Case Study to Understand Forest Patterns in Maya Zone, Mexico

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ABSTRACT

A forest patterns map over a large extent at high spatial resolution is a heavily computation task but is critical to most regions. There are two major difficulties in generating the classification maps at regional scale: large training points sets and expensive computation cost in classifier modelling. As one of the most well-known Volunteered Geographic Information (VGI) initiatives, OpenstreetMap contributes not only on road network distributions, but the potential of justify land cover and land use. Google Earth Engine is a platform designed for cloud-based mapping with a strong computing power. In this study, we proposed a new approach to generating forest cover map and quantifying road-caused forest fragmentations by using OpenstreetMap in conjunction with remote sensing dataset stored in Google Earth Engine. Additionally, the landscape metrics produced after incorporating OpenStreetMap (OSM) with the forest spatial pattern layers from our output indicated significant levels of forest fragmentation in Yucatan peninsula.

INTRODUCTION

Incorporating Road Networks Into Forest Landscape Mapping

Forest ecosystems are one of the most important ecosystems. Forests cover one-third of the surface land and contain nearly 80% of terrestrial biodiversity. Forests also provide a broad range of ecosystem goods and services for human well-being (Aerts & Honnay 2011; Costanza et al., 2006). Forests contribute significantly to the terrestrial carbon cycle and sequester massive amounts of anthropogenic CO_2 emissions. In landscape ecology perspective, forest landscape is defined as a spatial mosaic of arbitrary

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boundaries containing forest patches that are able to interact functionally (Turner 1989). Also, forests are amongst the most biologically rich terrestrial systems and provide broad ranges of goods and services for human well-being (Costanza et al., 2006). However, human activities are negatively transforming and altering the global forest patterns and structures. Human activities, such as road-building and resource extraction (e.g., timber harvesting and timber production), alter forest patterns and landscapes, thereby fragmenting continuous forests into smaller and more isolated patches (Jaeger et al., 2007). Understanding forest landscape patterns is critical in ecological research and forest land management. Remote sensing and GIS science are powerful tools that make monitoring forest dynamics over decades at regional scale possible. However, interpreting remote-sensing-derived images is not a new technology since the first aerial photographs (Carls, 1947) and satellite images (Estes et al., 1980 and Landsat 1). The recent increase of satellite sensing prompts the rapid development of open geoscience and helps us see the world in a more complete way.

Moreover, the updates for most land cover map projects are far from frequent, particularly at regional scale due to the uneven distribution of data resources. Most developed countries have a well-established infrastructure to provide high quality, large scale and comprehensive dataset on land cover/land-use for a variety of purposes. North America and Europe have well-done QA/QC assessments, such as COoRdination of Information on the Environment (CORINE), National Land Cover Database (NLCD) and Coast Change Analysis Program (C-CAP). Although land cover mapping techniques are well studied and have been applied to map most of the developed areas; however, there are still difficulties mapping land cover and land changes at a large scale with high in spatial and temporal resolution, especially for areas with high heterogeneity. In the developing world, such high-quality datasets are limited, and most developing countries lack the resources to collect extensive ground data.

Mapping forest fragmentation by incorporating road network is a fundamental basis of forest landscape ecological analysis (Haddad et al., 2015, Abdullah et al., 2007). A variety of forest fragmentation results have been characterized from the regional to global scale (Espírito et al., 2014, Haddad et al., 2015). McGarigal et al., investigated the landscape structure changes of the San Juan Mountains from 1950-1993 and found that roads had a more significant impact on landscape structure than logging (McGarigal et al. 2001). Wickham examined forest changes in cumulative distribution based on patch sizes for the Chesapeake Bay, Virginia (Wickham et al. 2007). However, there is persistent difficulty in delineating ecologically relevant patches based only on remote sensing images. In landscape ecology perspective, the significant impacts of road networks are continuously disregarded, not to mention the ignorance of small roads. In other cases, the systematic mapping of roads excludes small roads (e.g. logging roads and trails). Moreover, the effects of small secondary roads remain largely unknown. We therefore urgently need a more comprehensive road network database to evaluate the effects of road-caused fragmentation. As human activities make forestland more accessible, road building itself becomes a domino effect increasing secondary roads.

Roads inherently cut the existing forest patches into pieces, which is one of the most obvious reasons for forest fragmentations. Road networks are also treated as one of the most important human factors that cause forest fragmentation (add more citations here). Roads and the adjacent area contribute upwards of 20% of American total geographical land, as Forman et al., analyzed in 2000 (Forman et al. 2000). In some heavily forested areas, road and water features are hiding under canopy, so we have difficulty discovering and mapping them using regular classification techniques, especially when we want to explore the forest patterns. Also, there is persistent difficulty in delineating ecologically relevant patches based only on remote sensing images. Besides, road networks have significant secondary impacts on

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