Human Economic Activity and Material Stock Analysis Based on Nighttime Lights Imagery in Java Island

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1. Introduction

The estimation of current material stock as well as material and energy flow became important keys to gain the knowledge of entire world economic activity and environmental impact. However, the estimation is difficult in a city or country where statistical data are not sufficiently available.

Artificial lighting is one indicator of human activity that can be measured from space. Remote sensing data in the form of nighttime lights can provide a uniform, consistent and independent estimate of economic activity as a part of human activity [1]. It was reported that nighttime lights imagery offers a strong correlation with some form of human activity such us electricity consumption, gross domestic product (GDP), the material stock in infrastructures or settlements [2]. The nighttime light imagery covers the entire world. Hence, a method utilizing nighttime lights could be a powerful appliance for environmental resource accounting (ERA).

The primary objective of this paper is to clarify the economic activity and correlation between the values obtained from radiance calibrated DMSP/OLS nighttime lights imagery with material stock in Java island of Indonesia for the year 2006.

2. Datasets and Methods

2.1 Nighttime lights Imagery

The nighttime lights image was used to calculate the sum of light intensity for each administrative unit. A merged stable lights and radiance-calibrated nighttime image of 2006 was used to estimate economic activity and material stock in each administrative unit. The NGDC of NOAA has been archiving and processing DMSP/OLS nighttime lights data since 1994.

The 2006 stable lights data were composited from a set of cloud-free orbits for the year 2006, with the ephemeral light sources, such us fires and lightning removed [3]. The spatial resolution of the original nighttime lights data is 2.7 km. The images are geolocated to 30 arc-second grids, equivalent to approximately 1 km^2 at the equator.

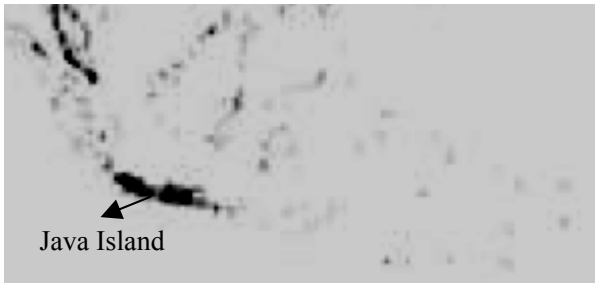

Fig.(1) A negative of merged stable lights and radiance-calibrated image of 2006 for Indonesia.

2.2 Official Gross Regional Domestic Product (GRDP)

Official GRDP data were obtained from the National Bureau of Statistics of Indonesia for each province. The official GRDP was expressed in Indonesian Rupiah (Rp).

2.3 Digital Geographical Information System (GIS) data

The GIS data were obtained from National Agency for Surveys and Mapping of Indonesia (Bakosurtanal).

2.4 Methods

First the correlation between the sum of nighttime light brightness (SL) values in each province with official GRDP was evaluated. Secondly, the building stock of each province was estimated by following equation generated in our previous study:

$$B = 1653L + a \quad (1)$$

where, L is the intensity of the nighttime lights, B is the building stock, and a is estimated unique coefficient for each province.

Keywords: Nighttime lights imagery, gross regional domestic product, material stock

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The last part, the correlation between GRDP and building stock based on nighttime light imagery was evaluated.

3. Results and Discussion

The relation between sum of lights and official GRDP is shown in Fig. (2). As is seen in Fig.(2), Jakarta Province is much wealthier relative to its sum of lights value. On the other hand, Central Java Province is much poorer relative to its sum of lights value.

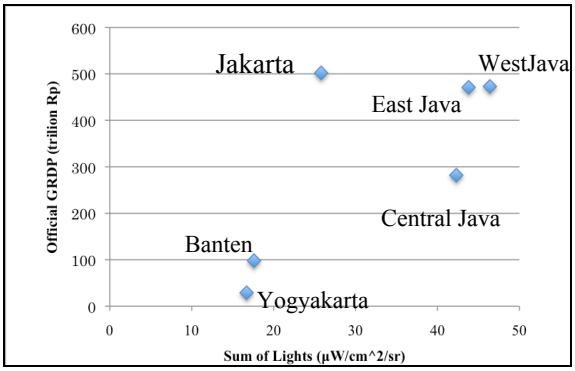

Fig.2 Relation between sum of lights and official GRDP of 6 provinces in Java Island of Indonesia

This observation indicated that better relationships between the sum of lights (SL) and GRDP could be obtained if province administrative unit having similar ratios between SL and GRDP are grouped together. The ratio (R) was calculated as follows:

R = SL/GRDP/area

After calculating the ratio the provinces were sorted in ascending. We found inconsistency within the ratio. Based on the ratio, Yogyakarta has the highest ratio among the provinces in Java Island, followed by Jakarta, Banten, Central Java, West Java and East Java.

The relation of estimated building stock and official GRDP of each province is shown in **Fig. (3)**. The linear relation was obtained by excluding Jakarta. Jakarta has the narrowest area among the province in Java Island but it has the highest GRDP. The ratio if each province area is divided by its GRDP was calculated. It is found that Jakarta has approximately 80 times higher value than the others. The target area is likely need to be divided by some categories for better analysis.

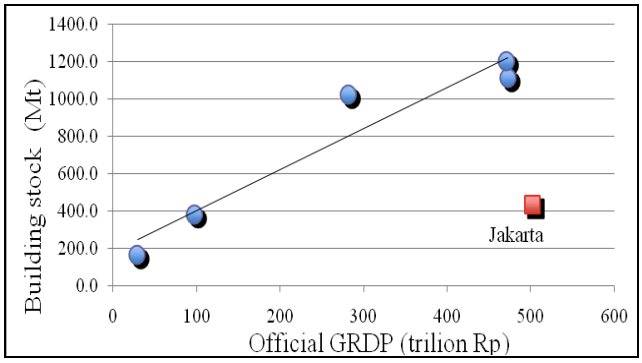

Fig.3 Relation between official GRDP and estimated building stock of 6 provinces in Java Island of Indonesia

In many developing countries, including Indonesia, a greater percentage of economic activity is conducted within informal sectors than the formal sectors, and informal sectors productivity is often excluded from the formal statistics [4,5]. Also, maps based only on lights do not consider the distribution of agricultural activity. Further study, including the consideration of agriculture and informal economy data is needed tom order to gain more reliable result.

Acknowledgement

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