（千葉大学審査学位論文）

A STUDY ON RELATIONSHIP OF DENGUE DISEASE WITH ENVIRONMENTAL FACTORS USING SATELLITE DATA

--- Analysis in Bandung City, Indonesia ---

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（千葉大学審査学位論文）

衛星データを用いた
デング熱と環境要因との関係に関する研究
--- インドネシア・バンドン市における分析 ---

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ABSTRACT

Cleaning roof areas is still uncommon regulation. An excellent means of controlling dengue disease pandemics is to monitor and intervene in environmental factors such as roofs surface size, population, vegetation, precipitation, temperature, and elevations. The ultimate objective of this study was to identify spatiotemporal patterns of dengue disease and their relationship with the environmental factors.

Analysis procedure was in 3 steps: dengue disease patterns (DDPs), environmental factors and their geographical relationships. To obtain DDPs, incidence of dengue was measured as rate in grid population and then analysed with combination of life expectancy of *Aedes* mosquito, estimated mosquito flight range, number of patients, onset date of symptoms, and point address location factors using Getis–Ord method that defined DDPs in statistical properties as standard deviations (Z score) which identifies local patterns. Higher positive Z score shows a hotspot or higher risk; lower negative reflects a spatial repelling/dispersed pattern or lower risk; whereas a Z score near zero indicates independent/random pattern or moderate risk. Initially, it was applied to a test area locating in north-western of the study area then performed to the whole study area.

About environmental factors, we used pitch and flat roofs surface size, population, Normalized Difference Vegetation Index (NDVI), precipitation, temperature and elevation. A supervised minimum distance classifier for roof classifications was applied to training data from image object segmentations. Ground validation was done using global positioning system tools and object photos. Ethical clearance, and informed consent of each house owner were done prior to ground validation.

For relationship model analysis of environmental and DDPs, we used ordinary least squares (OLS) which generally measure a regression, and continued with

geographically weighted regression (GWR) that allowing geographical analysis identifying local patterns. We analysed the relationship using 17, 24 and 35 precipitation days before onset date of dengue disease symptoms, compared them and used one precipitation day with the highest relationship. Then, it was used for analysing the model relationship in hotspot, random and dispersed groups; analysing the relationship in days start with no rain, days with less rain and with more rain groups; and analysing the relationship in lower and higher NDVI groups.

Our findings showed that hotspot, random and dispersed DDPs were found in the study area; 35 days before the onset date of illness was found as the best day for prevention because it was the highest relationship in the model. Hotspot pattern area had higher risk than random and dispersed patterns; less rainy days was higher in risk than dry or more rainy days; lower NDVI had higher risk than higher NDVI.

In conclusions, this study reveals that *Aedes* mosquito characteristics: life expectancy and estimated flight range, numbers of covered patients, patients' onset date of symptoms and their addresses were important factors in identifying dengue disease patterns (DDPs) more detail into 3 types of area: (1) area with high risk by inter-related chain pattern of infected patients, (2) with middle risk by un-related infection of patients, as well as (3) with low risk without infection chain by intentional defence. Surface size of roof type is an important factor that can be used in remote sensing technique to measure risk of roofs to dengue disease. Roofs with stagnant water are the highest risk environmental factors because mosquito eggs can hatch and become adults on these areas. Blocked gutters by falling leaves, and abandoned elevated water tank are important factors on roofs. There is more risk of dengue disease on 35 days after the rain than on 24 and 17 days, where less rainy days are at higher risk than dry or more rainy days. Temperature in this study is also a risk factor in any places regardless their elevations.