The Use of Drone Photogrammetry and Multi-criteria Decision Making (MCDM) to Evaluate of Dengue Breeding Area in Khon Kaen City, Thailand

Thatsalak Phongsuriyachay(1), and Chattichai Waisurasingha(1)

[1]Sustainable Infrastructure Research and Development Center,
Faculty of Engineering, Khon Kaen University, 40002, Thailand
Email:bonussuriya@gmail.com; chattichai@gmail.com

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ABSTRACT
World Health Organization has reported that Thailand, especially in the northeastern part, is a risk zone to dengue. The risk areas are present in both urban and rural regions. Additionally, Khon Kaen City, where is the metropolitan area of northeastern Thailand, is now dealing with a burden of dengue. It is therefore essential to assess the dengue breeding zone. According to the advantage of drone photogrammetry, it is possible to produce a map with a super high resolution of less than 10 cm which is relatively robust to identify land use/ land cover detail accurately. Thus, this study aims to integrate the use of drone photogrammetry and multi-criteria decision making for detecting the dengue breeding zone. The result showed that digital orthophotos from dron photogrammetry has a potential to analysis the land use/ land cover map. It is possible to detect the dengue breeding zone using orthophoto from drone photogrammetry by combining with the other factors such as terrain, rainfall and season.

1. INTRODUCTION

The World Health Organization (WHO) releases a list of the top health threats facing the global population. The 2019 list includes things like infectious disease epidemics, air pollution problems, NCDs, influenza and one of those problems is dengue fever. The burden of Mosquito-Borne Diseases (MBDs) is estimated to be higher in tropical and subtropical areas, affecting disproportionately the poorest populations. Despite the fact that there have been global campaigns to eradicate MBDs. (WHO, 2016) Although medical innovations and technology are continuously developing, but there are still a large number of people in many areas around the world facing health problems and low quality healthcare. Each year, as many as 390 million people are infected with the dengue virus and more than 40 % of the world's population is at risk of getting infected. The countries with the most deaths are Bangladesh and India. (WHO, 2019) in the aforementioned situations, ministry of Public Health (Thailand) focus on dengue fever due to it is health problem for the population. Thailand is located in a tropical area which is a breeding for Aedes mosquitoes. Including global warming shortening the mosquito's life cycle and increasing the rate of transmission. Dengue is a mosquito-borne viral infection and is endemic in many tropical and subtropical regions in the world. (Jamie, 2011) Nowadays, the world is faced with global warming, these environments suitable for the spread of mosquitoes. Climate change is impacting many tropical diseases such as dengue it’s generally assumed that the distribution is determined by climate and rainfall is also one of the most important environmental factors that affects the vector’s reproduction cycle. Many processes that are associated with mosquitoes are strongly influenced by temperature, as the rate of development of the virus inside the vector is linked to warmer temperatures. (David, 2002) Survival, interaction between vectors and pathogens, temperature distribution indicates a higher spread trend of Aedes mosquitoes, resulting in a high spread potential reducing the time to establish the rate of growth it indicates that mosquitoes can multiply more base on the same period the current environment has reduced the incubation period and the increase in the spread of disease. Air temperature estimates were either indirectly linked to the remotely sensed Land Surface Temperature (LST), which is widely used as a proxy, or by collection of in situ observations. LST is the radiative skin temperature of the land surface and is an important climate variable that is estimated from Top-of-Atmosphere brightness temperatures from the infrared bands of the satellite’s sensors. (Sandra, 2013) Vegetation indices are another important parameter that showed strong correlations with the vectors’ behavior and their biological cycle. Most of the studies used the Normalized Difference Vegetation Index (NDVI), which is a proxy index of vegetation density and distribution due to the fact that is chlorophyll sensitive. NDVI is not only restricted to studies of plants; various studies have coupled vegetation dynamics with biodiversity, animal species distributions. (Nathalie, 2011) NDWI is an indirect proxy for precipitation and humidity, and it was associated in many studies conducted in subtropical climates with dengue occurrences. (Juan, 2018) The land type was significantly correlated with the dengue fever outbreak (Yujuan, 2018) variables that proved to be significant were various LU/LC classes as well as socioeconomic factors and human population density was one of the most significant predictors. Mosquito-borne dengue affecting quality of life and from past news it clearly indicates that the northeast region of Thailand is another region that has had an expansion of the epidemic of Aedes mosquito therefore, surveillance of Aedes is another event that must be monitored and closely monitored. Various environmental factors are analyzed suitable area is a breeding place for mosquitoes.

There are many researches dealing with mosquitoes, which carry disease. Most of the research in Thailand will focus on specific studies based on various diseases caused by mosquitoes. The researcher has focused on eliminating mosquito repellents that are found to be a disease and must be aware of the top surveillance in Thailand extermination of Aedes mosquito species is to conquest the life cycle to reduce the number of Aedes mosquitoes that carry disease, to solve the problem that naturally causes. In this paper analyze risk areas of mosquito breeding site using Unmanned Aaerial vehicle (UAV) imagery to analyze factors together with satellite image data from Remote Sensing (RS) techniques and Geographic Information System (GIS). Use multi-criteria decision-making techniques for evaluating the importance of each factor using the multi-criteria decision process using the Analytic Hierarchy Process (AHP) to be able to analyze mosquito breeding sites. Therefore, the techniques and methods obtained as data sources for analysis are suitable factors for mosquito breeding sites. Must be an effective tool for assessing the situation of mosquito breeding and controlling the spread of mosquito-borne diseases

2. MATERIALS AND METHODS

2.1 Study Area

Samliam Community is situated in Nai Mueang, Mueang Khon Kaen District, Khon Kaen. Samliam Community is one of the major cities under the National Economic and Social Plan of the country regionally centers development in terms of education, financial institutions, government offices and transportation. Most areas are residential, commercial buildings, townhouses, rental homes, apartments and apartments. Until it became a dense community of houses

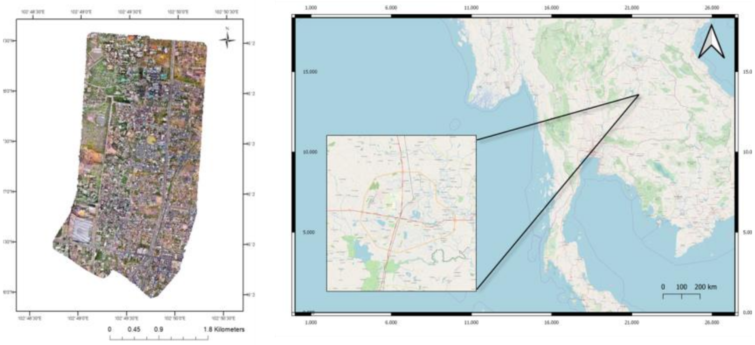

Figure 1 Study area

2.2 Explanatory Variable

Sentinel-2 level 1-C data that covered the study area was acquired on January 2016 to detect mosquito breeding site in winter. The image was freely downloaded through the Copernicus Scientific Data Hub website. Image corrected using the Sentinel Application Platform (SNAP) software. Sentinel-2 is a multispectral high-resolution imaging mission. The sensor has 13 spectral channels, incorporating four visible and near-infrared bands at 10 m resolution, six red-edge/shortwave-infrared bands at 20 m and three atmospheric correction bands at 60 m. (Gomez, 2017). The environmental factors considered were: NDVI, NDWI, LST and Land cover obtained from drone photogrammetry. Thus, this studied were to use Drone photogrammetry, Remote Sensing and Analytic Hierarchy Process (AHP) to identify mosquito breeding site. Determine the preferable predictor of mosquito breeding habitats NDVI analyzed with two bands, RED and NIR using by QGIS program expressed as follows:

$$NDVI = (NIR - RED)/(NIR + RED)$$

NDVI values range from -1 to +1, in areas where NDVI values are less than 0 or approaching -1 indicate water areas. In areas where the value of NDVI approaches 0, it indicates the areas that have plants. Less green vegetation, and if the value of NDVI is close to +1, it is an indication of the area covered by vegetation. The NDVI has a variety of benefits, such as the study of plant distribution and soil density. Used to classify plants including changes according to Time period of vegetation quantity used to study drought conditions and the integrity of vegetation. Second, studied index is NDWI analyzed with two bands, NIR and SWIR using by QGIS program expressed as follows:

$$NDWI = (NIR - SWIR)/(NIR + SWIR)$$

The NDWI product is dimensionless and varies from -1 to +1, depending on the hardwood content, as well as the type of vegetation and cover. The high NDWI values (in blue) correspond to high plant water content and coating of high plant fraction. Low NDWI values (in red) correspond to low vegetation content and cover with low vegetation. During periods of water stress the NDWI rate will decrease. Next, LST is an important factor used for analysis to study physics of earth surface by Sentinel -3 SLSTR. It freely downloaded from Copernicus Scientific Data Hub website. It's was acquired on January 2016 using the Sentinel Application Platform (SNAP) software. Drone photogrammetry it is possible to produce a map with a super high resolution of less than 10 cm which is relatively robust to identify land cover detail accurately. Thus, this study aims to integrate the use of drone photogrammetry and multi-criteria decision making method for detecting the dengue breeding zone.

2.3 Data Preprocessing

Factors affecting as a mosquito breeding, select Analytic Hierarchy Process (AHP) method is for factor analysis to assess risk areas and create geographic factors. Considering the importance of factors, use the priority values of the factors to overlap with the map to assess the risk areas as mosquito breeding site.

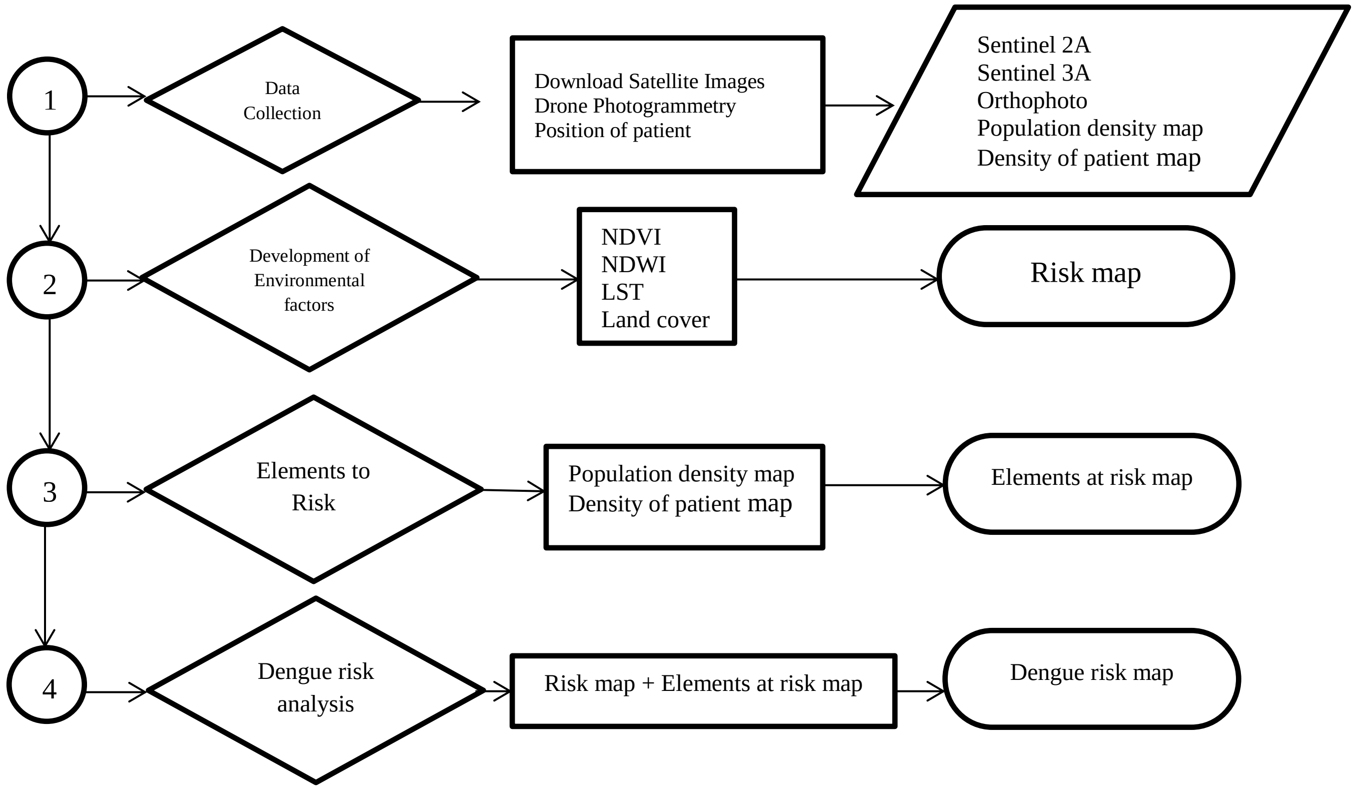

Figure 2 Flow chart of this study

UAV: Unmanned Aerial Vehicle, aerial data acquisition technology, study area for analysis Land use such as agricultural land, forestry, specify water source (distance, community source and water source), miscellaneous area The density of the roof is the house, school building, office, dormitory, etc.

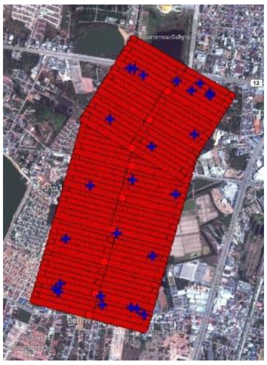

Figure3 shows the flight direction and the number of ground control points of a 3D model that uses GCP points from the survey using GNSS.

This research is to plan the plane of photography with unmanned aircraft. Surveying the coordinates of various areas in the study area, all 2 blocks, 1C 1W. Therefore, the research plan, which has the tools and tools as follows; DJI Phantom 3 professional, Tablet Galaxy Tab S2, GPS Sokkia total station, GPS GARMIN, model GPS map 62s, Target point signal through ground imagery, Pix4D program and ArcGIS 9.4 software. Due to study areas are in Khon Kaen, data entry fields must be planned in each step so as not to affect traffic.

Figure 4 Orthopho

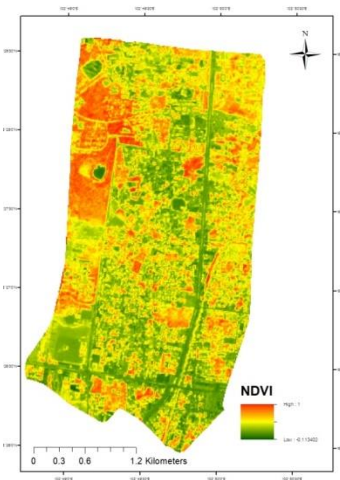

Figure 5 Vegetaton Factor

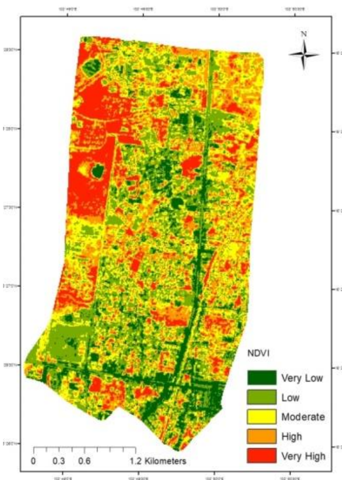

Figure 7 vegetation factor reclassify

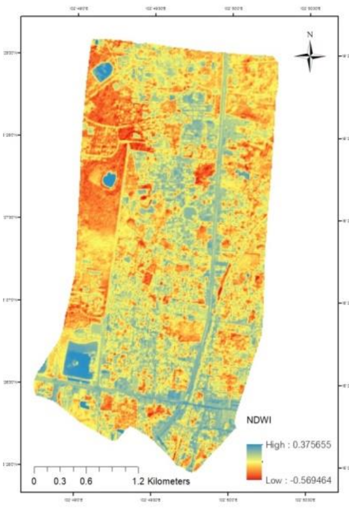

Figure 8 NDWI Factor

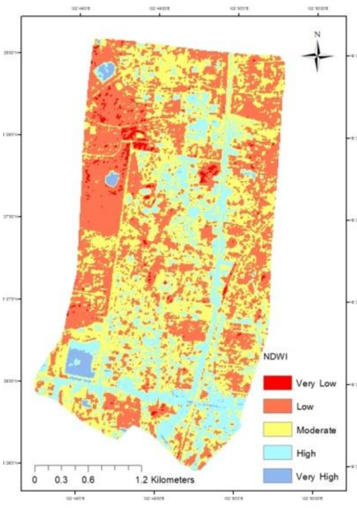

Figure 9 NDWI factor reclassify

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