# STUDIE ON DETECING FOREST DECLINE USING MODIS TIME SERIES COMPOSITE DATA

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**KEY WORDS:** MODIS, Time Series Composite Data, NDVI, Oak Disease, *Raffaelea quercuvora*

**ABSTRACT:** This study discusses an assessment of analysis method using Moderate Resolution Spectroradiometer (MODIS) time series data for detecting forest decline. This decline in forest is called oak wilt disease, caused by a fungus (*Raffaelea quercuvora*) carried by oak borer (*Platypus quercivorus).* In this study, 250 meter meshed MODIS time series data for 2005-2010 were processed for Kinki district of Japan, where oak wilt disease has broken out in recent years. Analysis was processed using maxima value of normalized difference vegetation index (NDVI) for each year, a given period and entire period. Time series datasets were divided into seasonal change, trend, and random change to estimate forest vegetation activation using liner regression with trend ingredient. In all datasets, meshes which were more distant than 3σ were estimated as showing excessive land cover change.

## 1. INTRODUCTION

The activities of human beings in the world can affect environment including forest ecosystem. Native and non-native insects and diseases which were affected and brought by such activities have been deeply and collectively damaging forest in resent years. For instance, gypsy moth (*Lymatria dipar*) native to Europe has caused sever damage in the forest of the United States, and chestnut blight disease in the U.S. caused by *Endothia parasitica* and pine wilt disease in Japan were also brought from abroad and have damaged forest while spreading out.

On the other hand, there is sever forest damage caused by native insects and diseases. In Japan, one of the diseases called "Oak wilt disease" is spreading. Its pests are oak borer (*Platypus quercivorus*) and a fungus (*Raffaelea quercuvora*) the borer carries. The oak wilt disease was reported to exist from 1750's in Japan although its damage has become obvious recently. Because the borer prefers larger trees, and they used oak woods as fuel before oak trees grew up in the past. But they seldom cut oak trees down today, and many oaks are growing up largely. That is the reason the disease and its damage are obviously spreading now. And one of the obvious declining sign of the disease is that leaves turn into red in summer.

Then, many scientists have been trying to detect such changes and damage of the forest by many surveys for monitoring and reducing the expansion of those diseases in forest. For grasping the current status and the change of land cover including in forest, it is important to analyze vegetation by remote sensing. In remote sensing for wide area to use satellite data is effective. Monitoring by optical sensors has been used for a long, and many indices and analyzing methods have been proposed. One of the most familiar indices with vegetation is Normalized Difference Vegetation Index (NDVI). However, satellite survey is easily affected by the weather and limited only during daytime because optical sensors utilize reflected light of sunshine.

To complement data of the areas or seasons where it is difficult to monitor due to such weak points of the survey, composite data using maximum value in a period of time exist. The composite data product of NDVI based on monitoring data by NOAA satellite or Terra has been published. Those products can be used as time series data, and the changes of land cover or the damage of forests can be known to analyze the data.

So, we are trying to detect the change and the damage of the forest with oak wilt disease using NDVI composite data product. For this time, we report the method and the results of our study.

## 2. OBJECTIVES

This study described the method and the results using Moderate Resolution Spectroradiometer (MODIS) composite data for detecting oak wilt. MODIS data are provided by National Aeronautics and Space Administration (NASA) and can be easily and freely downloaded. With the following objectives, the study was conducted: 1) Analyze using MODIS composite time series data products; and 2) Detect spot where Oak wilt disease is occurring. Moreover, assess the agreement of the result of the method with practice.

## 3. METHODS

### 3.1. Study Area

Kinki district including Fukui prefecture, Shiga prefecture and Kyoto prefecture in Japan were selected for the study area (Fig.1.) because oak wilt disease has been spreading recently in the area and there are cities, fields, forests, lakes and others. In particular, Higashiyama area in Kyoto was focused on because of plenty of data related with oak wilt.

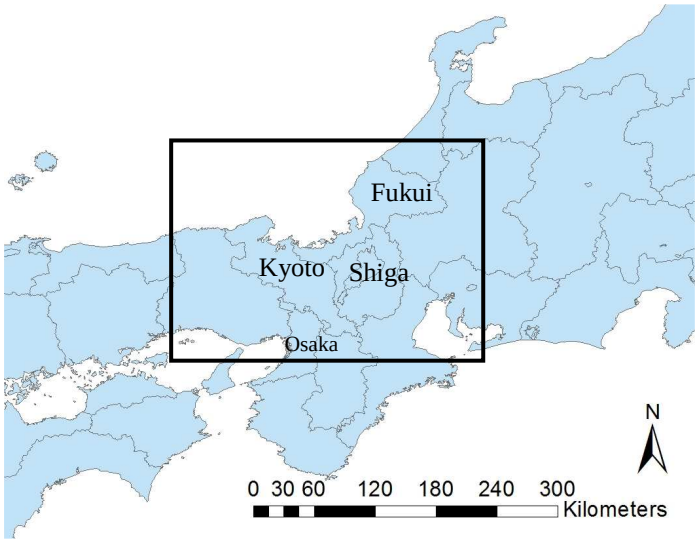


Fig.1. Location of study area in Western Japan (study area extent is outlined in a quadrilateral with black line).

### 3.2. Satellite data acquisition and preprocessing

The data used in this study are MODIS 250 meter meshed daily and composite monthly NDVI data products which were computed and composed to use maximum NDVI value in each mesh for a month from daily data. MODIS data products were acquired over the study area for all available dates 2005 January thorough 2010 December. Some of data are the achievement of collaborative research of Tokai University and Geospatial information Authority of Japan.

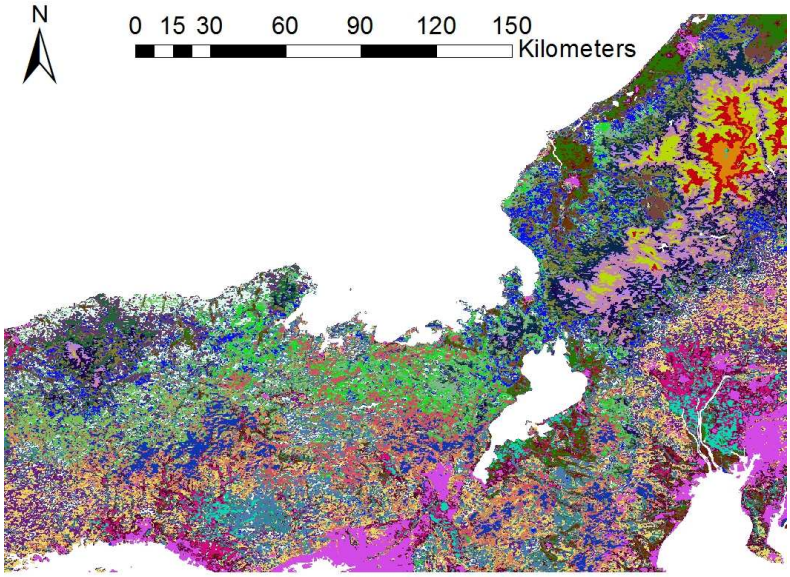


Fig.2. The result of Clustering into 30 classes.

### 3.3. Detection of forest decline caused by oak wilt disease from composite data

In each mesh, NDVI values obtained from composite data of the six years were as time series dataset, analyzed with unsupervised classification into 30 classes, and classified with K-means method of cluster analysis. And the time series datasets were divided into seasonal change, trend and random change for detecting land cover change in

each mesh. Then the degree of leaning of straight line of trend was calculated and normalized for extracting meshes which have abnormal value more than distant $3\sigma$.

## 4. RESULTS AND DISCUSSION

Because of containing information of seasonal change of a year, the result of clustering was shown in Fig.2. And some time series NDVI changes of the classes were in Fig.3.And the meshes declining or inclining vegetation vitalization are shown in Fig.4. Red meshes indicate declining and locations where oak trees are damaged in practice are with small purple circles.

Compared with locations of the damaged trees in practice, the results of this analysis seem good agreement. However, there are many subjects left undone. For instance, one of them is the subject of comparison between classes. It was seen that some of red meshes partially overlapped the spots in Fig.3. And others of red meshes did not. It may depend on differences between classes. And other of them is the subject of yearly change. The change is different in each year and can affect NDVI value. The difference may depend on climate change or precipitations.

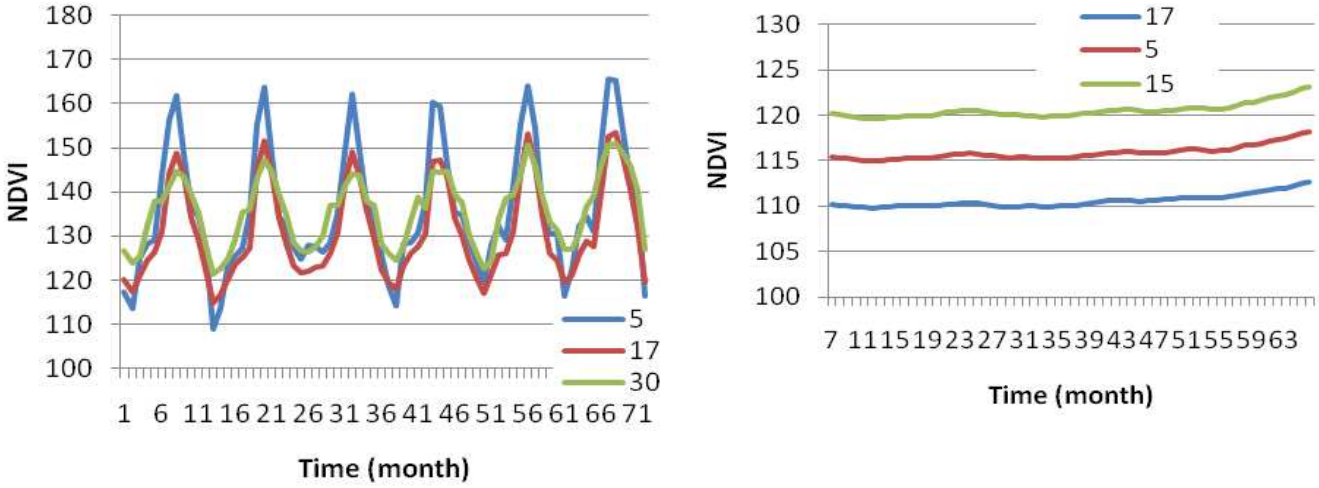


Fig.3. NDVI changes of some classes for 6 years (left) and the change of some trend ingredient (right).

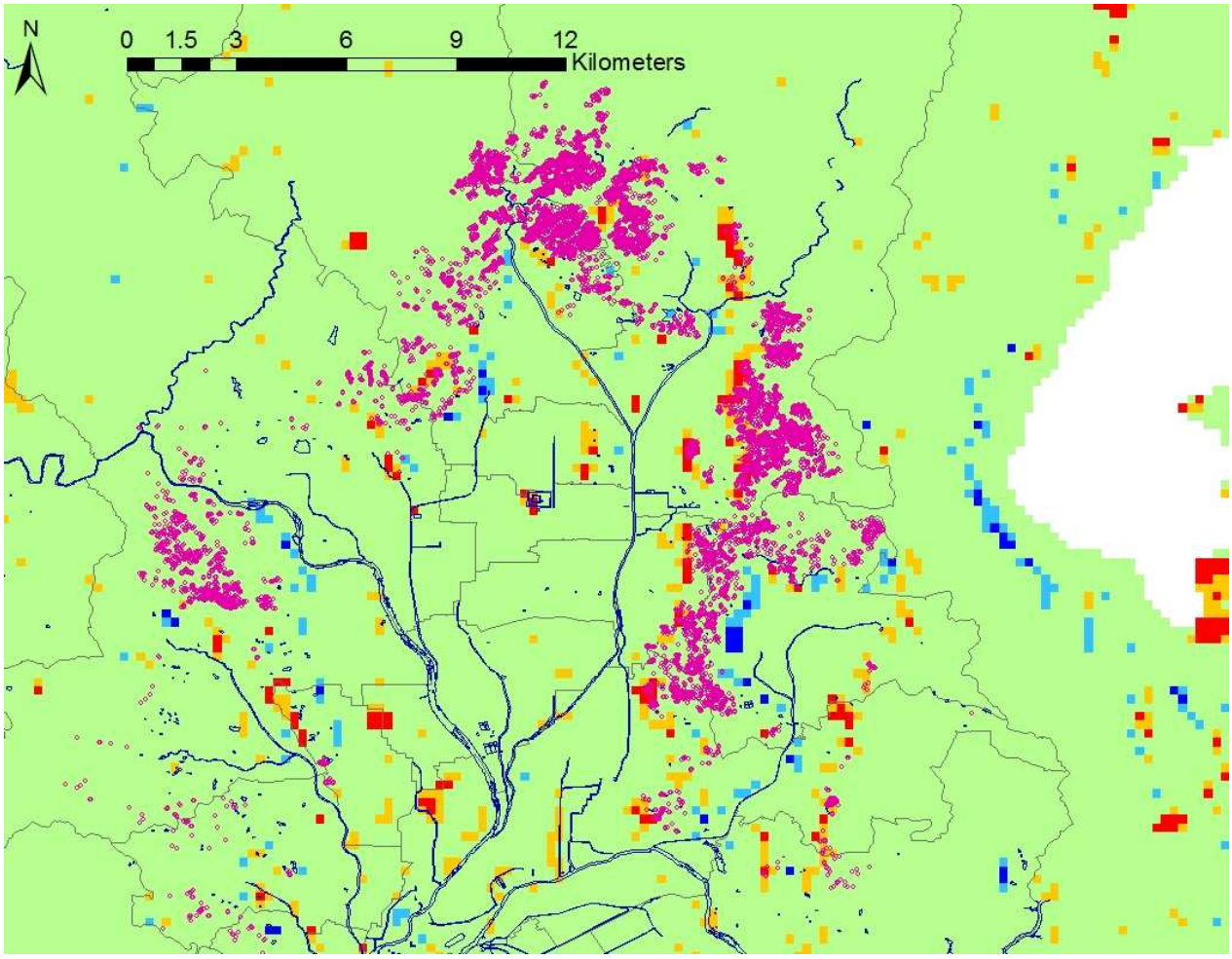


Fig.4. Overlay of a layer showing meshes more than $3\sigma$ and another showing points of each trees of oak wilt disease in Higashiyama area of Kyoto (Meshes less than $-3\sigma$ are showed at red squares, $-3\sigma$ to $-2\sigma$ at yellow, 2 to $3\sigma$ at light blue and more than $3\sigma$ at blue. The each location of oak wilt damaged trees is at a purple circle).

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