Paper presented at the 22nd Asian Conference on Remote Sensing, 5 - 9 November 2001, Singapore.

EXTRACTION METHOD OF DAMAGED AREA BY PINE WILT DISEASE(*BURSAPHELENCHUS XYLOPHILUS*) USING REMOTELY SENSED DATA AND GIS

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KEY WORDS: ***Bursaphelenchus Xylophilus,*** **Pine Wilt Disease, Remotely Sensed Data, GIS, Supervised Classification**

ABSTRACT:- The aim of this study is to select the most effective method for extraction and detection of *Bursaphelenchus Xylophilus* damaged area in Chubong-Do and Goje-city which is located in southern part of Korea using Multi-temporal Landsat TM images, 1m IKONOS images and GIS. The results of this study were that MHC(Mahalanobis Distance Classification), one of supervised classification method, was available for extracting spatial range of damaged area by *Bursaphelenchus Xylophilus* and MLC(Maximum Likelihood Classification) was effective classification method for extraction of damaged area depending on landcover classification after lumbering. IKONOS 1m image was significant available for detecting and identifying the front of damaged area by using spectral histogram analysis method than any other image processing methodology. Furthermore, this study could clarify spatial distribution characteristic of damaged area after constructing GIS Database. The result of GIS spatial analysis was showed that 120-160m elevation, 21°-40°slope and west direction aspect were the most serious within damaged area.

I. Introduction

A pinetree is one of typical Korean species of trees. It took more than 50% of the whole forest areas of the country in the 1960s, but the area of pinetree forest has been gradually reduced into 30% because of the recent changes of forest ecosystem and of every kind of damages by disease and insect pests. Especially, *Bursaphelenchus Xylophilus* has currently spreaded over Haman, Jinju, and Tongyoung around Busan region. The outbreak areas of the pest reaches to about 2,000ha, and it needs to be cautious because 100% of the trees attacked by *B. Xylophilus* must be blighted to death. However, since it is difficult to figure out the damaged areas and to predict the spreading ways just to partially control and exterminate it has not effective enough so far now. The damaged areas by it have continuously spreaded out at present.

Thus the introduction of spatial information technology such as GIS and satellite images is highly demanded. It is very effective to examine the spatial distribution characteristics that can establish timely proper strategies for control against *B. Xylophilus* by periodically figuring out the damaged situations as soon as possible and by predicting the spreading ways of the damage.

Since satellite image data have a great deal of advantages such as wideness, rapidity, simultaneity, and economy, the needs and the interests of remote senses among professionals as well as general persons have greatly increased these days. Even in the field of forest damages by disease and insect pests it was proved to possibly use various analysis methods by satellite image data and GIS, and studies on this field are actively working. Seo, Du-cheon(1998) extracted the damaged areas by *Matsucoccus thunbergianae* in terms of supervised classification method using Landsat TM image over the coniferous forest areas around Namhae-gun Kyungnam. Oh, Dong-ha(1998) classified the damaged areas by pine needle gall midge and analyzed their spatial changes around Hongcheon Kangwon in terms of non-operation among bands, cosine correction and Minnarert correction using Landsat TM image and digital map data. Yang, Kyung-lak(1999) extracted the damaged areas by pine needle gall midge in Youngyang-gun Kyungbuk in terms of ratio and spatial filtering method using Landsat TM image.

This study extracted the damaged areas by *B. Xylophilus* and compared each extractable range according to the characteristics of Landsat TM image of 30m resolution, which is usually used for vegetation classification, and IKONOS image of 1m high resolution, which is known to have high accuracy and resolution. Then we tried to present the effectivity and applicability according to each characteristic of images.

? . Materials and Methods

The study areas were Chubong-do located in Hanryo national sea park and Yeoncho-myon Goje-si Kyungnam in Figure1. This study worked on Landsat TM image and IKONOS image, which have different characteristics each other, and the study processing was as the following

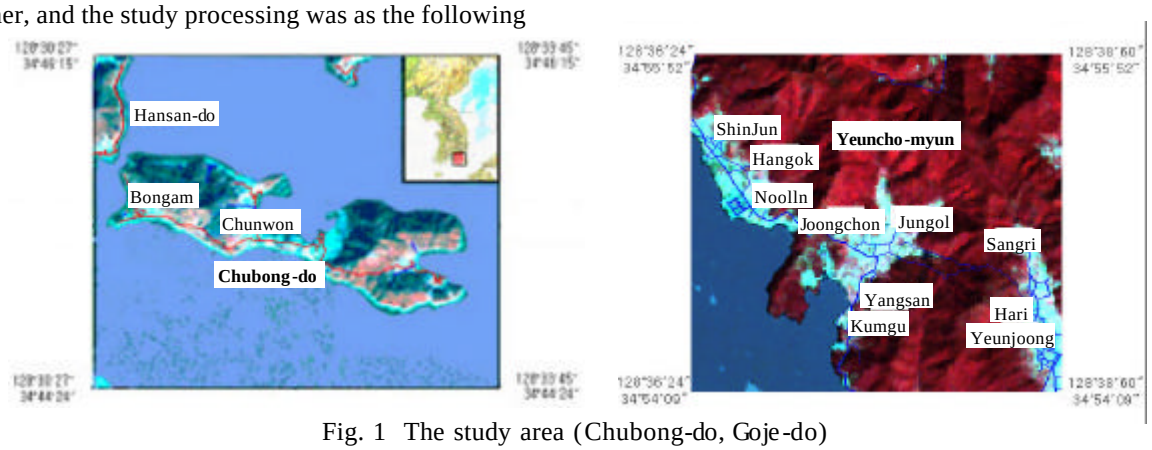

Fig. 1 The study area (Chubong-do, Goje-do)

In the areas of Chubong-do, the damages by *B. Xylophilus* had developed since spring in 1998, and became greatly serious in the following autumn. After all the dead timber in the damaged areas had been lumbered since spring in 1999. Thus this study analyzed the image before the damage (Octorber ,8 1997) and the images after it

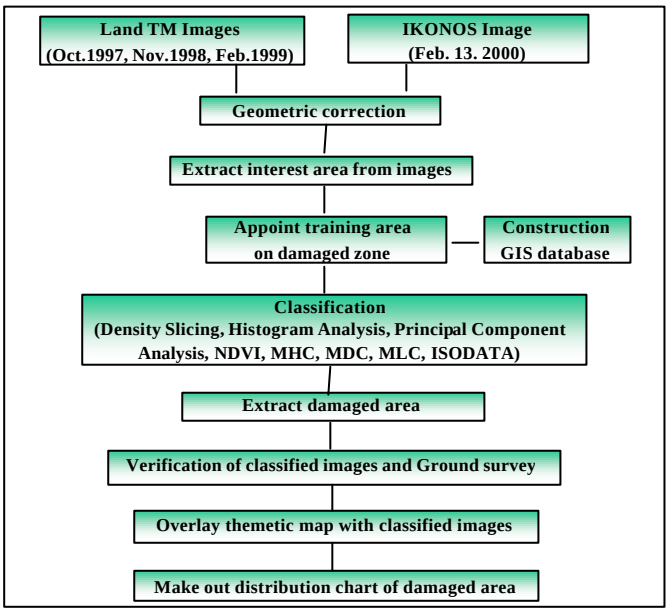

Fig.2 The study flow

(February, May, 1999) based on the autumn images (November, December, 1998) during the periods of the most serious damages by *Bursaphelenchus Xylophilus*. These analyses were to effectively extract the forest damaged areas by pine wilt disease in Chubong-do areas and to exactly identify the spatial distribution characteristic of the area. In addition, this study used Landsat TM image, because it has infrared detecting area in wide wavelength areas of multi channel and effectively reflects vegetation classification as well as spectrum characteristic.

For the areas of Goje-do, we analyzed IKONOS image in 2000 (February 13, 2000) when *B. Xylophilus* developed to more effectively extract the fronts of forest damages. We created thematic maps per layer of the study areas and constructed DB of them by using Arc/Info GIS Tool on 1/2,5000 forest type map and 1/5,000 digital map as well as on statistic data by ground survey.

Then we extracted GCP(Ground Control Point) from 1:5000 digital maps of all IKONOS satellite images of high resolution and Landsat TM images with multi-spectral band. Then we worked geometric correction on it in terms of Unix ERDAS Imagine 8.3, and extracted the damaged areas from each image in terms of various image-processing methods.

? . Extraction of the damaged areas by *Bursaphelenchus Xylophilus* using satellite image

1. Spatial ecological characteristics of *Bursaphelenchus Xylophilus*

Bursaphelenchus Xylophilus is so strongly pathogenic and such a powerfully disease and insect pests that can make dead all the pinetrees within the damaged forest in the 5~6years, if being left without any step, and attack new areas to bring out great damages, which might never happen before in other cases of damages by insect pests.

In Korea it was discovered for the first time in pinetree forest of Mt. Kumjung in Oncheon-dong Dongrae-gu Busan-si in 1988, and since then, the damaged areas by it have spreaded over Haman, Jinju, and Chubong-do, Tongyoung, Kyungnam. In the case of Japan, it developed for the first time in 1905, and so far now it has dead most of pinetree forests. In the case of China, it developed in 1982, and so far now the damaged forests have reached over 4 million ha. In Taiwan, pinetrees has been almost in crisis of extinction at present since the outbreaks of the pine wilt disease were identified in 1985. However in Japan, China, and Taiwan, most of the damaged forests have been left without any step because proper method of control and extermination of it in the case of large forests has not yet been developed.

The types of pinetrees infected with *B. Xylophilus* so rapidly wilt that 80% of them may be dead in the infected year, and that about 100% of them may be dead in the following spring. Pinetrees are finally dead by going through the course which their xylem become dry and their needle leaves turn yellow or brown to be dead because their effusion of resin should be reduced or stop and their moisture content becomes low. Since *B. Xylophilus* cannot move by itself it is disseminated by a carrier insect, *Monochamus alternatus.*

2. Extraction of the damaged areas using Landsat TM image

The damaged areas by *B. Xylophilus* in Chubong-do were extracted by Landsat TM image. Figure 3 indicates that the whole areas of Chubong-do were consisted of pinetree forests and mixed forest according to the result of unsupervised classification on the image before the damage (October 8,1997). For verification we analyzed the result by using NDVI image and supervised classification (MLC).

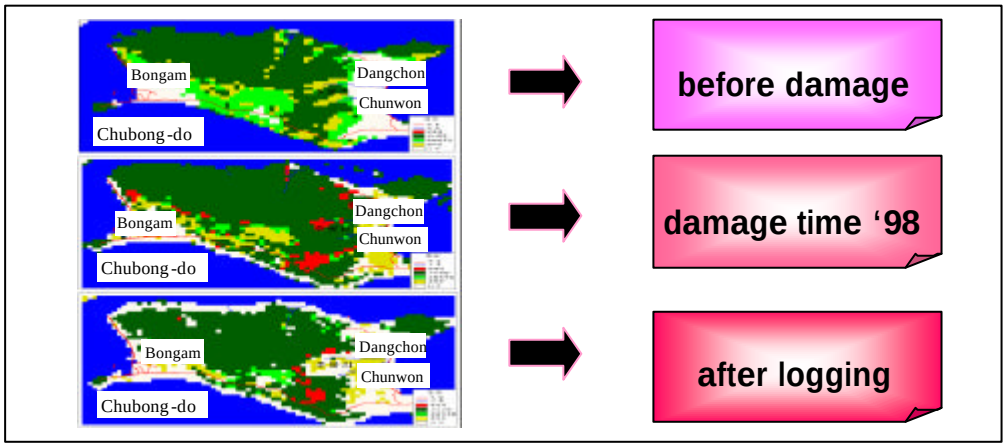

Fig. 3 Extraction of the damaged areas using Landsat TM image

We firstly processed the image of November 12, 1998 when the damage was the most serious with Tasseled Cap and NDVI, and then did supervised classification such as MLC(Maximum Likelihood Classification), MHC(Mahalanobis Distance Classification), MDC(Minimum Distance Classification). Figure 4 is NDVI histogram of multi temporal Landsat TM images. The image of 1997 when there was no damage by *B. Xylophilus* obviously shows the distribution of high normalised difference vegetation indexes, whereas the image of 1998 because of the damages by pine wilt disease generally shows the distribution of low NDVI. The image of 1999 after the damaged trees were lumbered indicates a big difference in the distribution of NDVI.

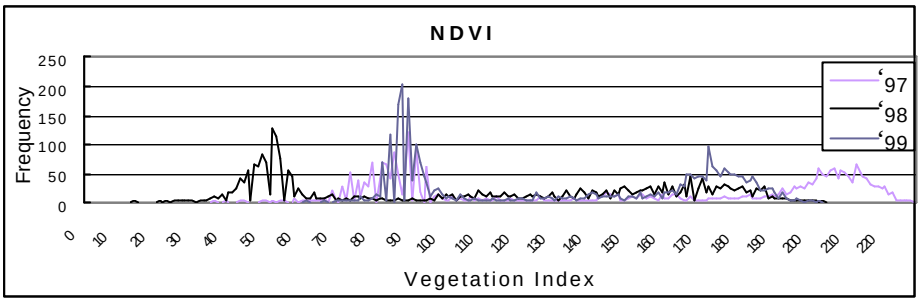

Fig. 4 NDVI histogram of Landsat TM images

As the above processing result, for extraction of the damaged areas by *B. Xylophilus*, the image processing by MHC(Mahalanobis Distance Classification) method was more effective than by other supervised classifications, and for extraction of the areas with no vegetation where the damaged trees were cut down, MLC(Maximum Likelihood Classification) method was more effective.

3. Extraction of the front damaged areas by IKONOS image

Brusaphelenchus Xylophilus form a front per a pinetree at the early stage, and gradually infect wide range of areas. For this reason it is very important to discover the front areas of them at the early stage and to control and exterminate them. However Landsat TM image of 30m resolutions was not suitable for extraction of the front damaged areas of *B. Xylophilus*. Thus we suggest that the images of high resolution should be more desirable for extraction of the front areas.

This study extracted the front areas of *B. Xylophilus* by using 1m spatial resolution, 4m red(0.63-0.69) band, and NIR(0.76-0.90) band. These bands are the same wavelength area as Landsat TM band 3, band 4. Moreover since they have higher spatial resolutions than Landsat TM, they have been used for lots of studies in the field of forest and vegetation. We analyzed only the stock areas of pinetrees, that is the focus areas of this study, after we separated them from other areas by masking just the forest areas by means of vector coverage. We figured out NDVI of the study areas and at the same time performed principal component analysis on them. In addition, we interpreted the distribution characteristic of pixel values of NIR band by histogram analysis with the above processed results.

The result derived from figure 5 shows areas ? to be front damaged areas, and the locations of their spatial distribution of the damaged trees were identified by ground survey data. However areas ? and ? indicated that there should be some errors in the course of process as they were analytically compared with the practical damaged trees. These areas were orchards and scrub forests on hillsides that indicated similar spectrum characteristic to the damaged trees by *B. Xylophilus*.

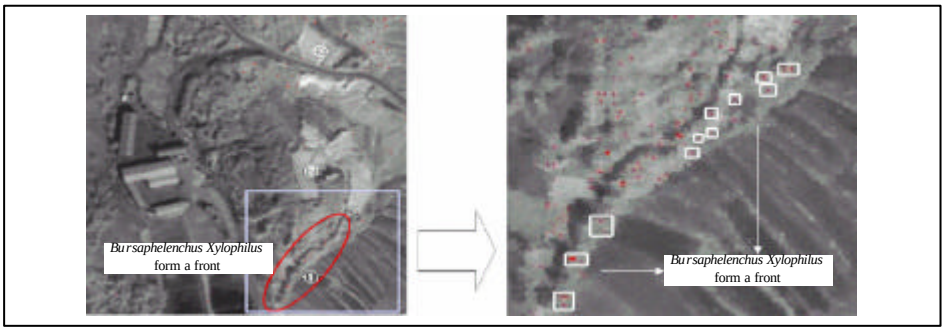

Fig. 5 the extraction images of the front areas of *Bursaphelenchus Xylophilus* by IKONOS

4. Spatial distribution characteristic of the damaged areas by *Bursaphelenchus Xylophilus* using GIS

Satellite image can more effectively and economically analyze the characteristics of the damaged areas by disease and insect pests by being integrated with GIS. Moreover, it is expected that the integrated analysis would predict the spreading ways.

This study could identify the spatial distributions characteristics of the damaged areas by *B. Xylophilus* by extracting the damaged areas from Landsat TM image of Chubong-do areas in terms of various image classification methods, and then by overlaying them with GIS thematic map. The characteristics of the spatial distributions of the

damaged areas after the damaged trees were lumbered in 1999 indicated that *B. Xylophilus* most actively worked at elevations of 120m-160m, on west aspects of slopes, and with slope of 21°-40°.

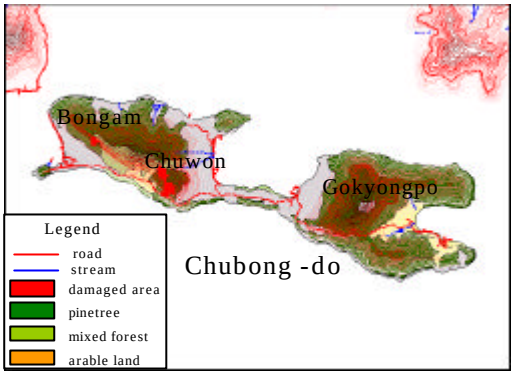

Fig. 6 Overlay of GIS thematic maps of the damaged areas

? . Conclusion

This study applied various image analysis methods such as Landsat TM and IKONOS image of high resolution to the extraction of the damaged areas by *Bursaphelenchus Xylophilus*. Thus we not only extracted the damaged trees by *B. Xylophilus*, but also suggested the possibility of using Landsat TM and IKONOS images for the study on the forest damages by any disease and insect pests. For Landsat TM the damaged areas were extracted by NDVI and Tasseled Cap analyses as well as various classification methods such as MLC, MHC, and MDC by means of its characteristic of wide wavelength area. Thus it was identified that the expected results respectively were different according to each classification method. In addition, wide ranges of the damaged areas were effectively detected, and as well their front areas were not accurately extracted. Meanwhile, for IKONOS image the digital map for general spatial analysis as well as GIS DB overlay were not necessary for processing. At the same time, as it could synthesize color images by overlaying white and black images of high resolution with near infrared of Multi band, it could easily make the spatial image map concerning ground phenomena. Thus it was indicated that IKONOS image was effective in selection of GCP and training area. Meanwhile pixel values of the image were much too accurate to be effective in classification of wide range of areas and general land cover classification. The capacity of the image was so huge that it may accompany image analysis with limits of time and hardware. In the near future it is expected that more accurate extraction of the damaged areas will be derived from using more detailed tools of spatial analysis like GPS.

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