

ASSESSMENT OF ENVI FOREST HEALTH TOOL IN DETECTION OF DUST AND SEEPAGE CONTAMINATED FOREST AREAS

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ABSTRACT

Stress in forests displays a variety of symptoms, some of which may be detected by remote sensing. Conventionally, change in canopy spectral reflectance has been the symptom studied. Increases in red reflectance due to reduced chlorophyll absorption, decreases in near infrared reflectance from reduced cell vigor and shifts in the red edge between these to spectral regions have been commonly used as indicators of forest stress. ENVI software package is widely used in hyperspectral data analysis. ENVI features a forest health tool, which creates a spatial map showing the overall health and vigor of a forested region. Forest health tool uses three different vegetation indices in the evaluation process. These indices are greenness, leaf pigment concentration and canopy water content or light use efficiency. Each of these indices can be calculated with several different methods. The main objective of this study is to assess forest health tools capability to detect dust and seepage contaminated forest areas. The test site is boreal forest area around Lahnaslampi talc mine in North-East Finland. Mineral dust composed predominantly of talc and carbonates is disseminated to the surrounding environment by wind from this open-pit mine. Some minerals are diluted by surface waters from the ore material.

The study utilized imagery from the HyMap airborne hyperspectral scanner recorded at 28th of July 2000. The imagery comprised of 126 bands from 420-2480nm. The ground resolution of one pixel was 5*5 meters. The Atmospheric correction was done to the HyMap data with ATCOR software and six noisy channels were removed. During MINEO project Geological Survey of Finland made extensive field study in this test area, which produced verified vegetation map of contaminated forest areas. This map was used as a ground truth in assessment of ENVI forest health tool. The ground truth comprised of 4 different contaminated forest classes. These classes were dusts contaminated pine, dust contaminated coniferous, dust contaminated birch and seepage contaminated birch. In addition to contaminated areas one area with healthy forest was used as a ground truth.

First it was necessary to determine which vegetation indices should be used with forest health tool. All possible VI combinations were tested and the amount of stressed pixels were calculated in contaminated and healthy areas. The combination which produced best separation of healthy and stressed areas was chosen. Combination of Normalized Difference Vegetation Index, Cartenoid Reflectance Index 1 and Water Band Index produced best separation of stressed and healthy forest areas. The forest health tool classifies input image to nine classes, from least healthy forest to healthiest forest. In this study best three classes were accounted as healthy forest and worst three classes as stressed forest. All five ground truth classes were classified with forest health tool. The percentage of healthy and stressed pixels is shown in Table 1.

Table 1. The percentage of healthy and stressed pixels

Area	Stressed	Healthy
Dust contaminated Pine	26.61	14.36
Dust contaminated Coniferous	37.02	18.55
Dust contaminated Birch	20.46	39.63
Seepage contaminated Birch	56.06	4.48
Healthy forest	2.84	70.42

The classification results of healthy forest area were quite good, only 2.84% was classified to stressed class. Classification results of seepage contaminated birch area were also rather good, only 4.48% was classified to healthy class. Classification of dust contaminated birch produced only poor results. The most likely reason of poor result is the location of this test area. The average distance from mine centre is 1 845 m for dust contaminated birch area when average distance is 915 m for seepage contaminated birch area. Measurements with field spectrometer in this test area have showed that there is strong correlation between distance from mine and change in canopy reflectance due to contamination. In order to study the relationship between forest tools classification result and targets average distance from the mine centre average distance for each of the nine classes were calculated for dust contaminated birch area. Class 1 represents most healthy area and class 9 least healthy area. Results is shown in Table 2.

Table 2. The relationship between forest health tool class and average distance from mine centre

Class	1	2	3	4	5	6	7	8	9
Distance(m)	1870	1880	1780	1475	1580	1690	1425	1235	1265

Results indicate that there is clear correlation between classification result and targets distance from mine centre. Poor classification result for dust contaminated birch area can be explained with the fact that average distance from the mine centre is so high. Overall results of this study shows that ENVI forest health tool can provide valuable information when detecting dust and seepage contaminated forest areas. When the stress level is low and distance from contamination source is higher classification results degrade.