Detecting Pine Sawfly Defoliation by Means of Remote Sensing and GIS

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Abstract

Insect outbreaks and climate change are two of the components comprising the greatest environmental challenges. Efficient remote sensing methods are needed for monitoring and predicting insect outbreaks. In this study an approach is outlined to map the distribution and intensity of defoliation by the Common pine sawfly with an EO-1 Hyperion imagery and digital aerial photography. Defoliation classification was compared using data from the Hyperion and digital aerial photographs without any seasonal differences.

Keywords: Defoliation, digital aerial photography, *Diprion pini*, outbreak, hyperspectral remote sensing

Kurzfassung

Erfassung der durch die Kiefernbuschhornblattwespe verursachten Entnadelung mittels Fernerkundung und GIS

Insektenkalamitäten und Klimaänderung sind zwei der größten Herausforderungen für die Umwelt. Effiziente Fernerkundungsmethoden sind für die Überwachung und Prognose von Kalamitäten erforderlich. In dieser Studie wird ein Ansatz skizziert, um Verbreitung und Intensität des Nadelverlustes durch die Gemeine Kiefernbuschhornblattwespe mittels EO-1 Hyperion-Aufnahmen und digitaler Luftfotographie katographisch darzustellen. Die Nadelverlust-Klassifikation wurde anhand von Daten vom Hyperion und von digitalen Luftbildern unter Ausschluss jahreszeitlicher Unterschiede verglichen.

Schlüsselworte: Entnadelung, digitale Luftfotographie, *Diprion pini*, Kalamität, hyperspektrale Fernerkundung

Introduction

The present warming trend in temperatures has already resulted in numerous effects on distribution and phenology of insect species. The increase of damages and invasions by forest insects has been seen to be related to the global changes in the climate (Peterson et al. 2004). Insect outbreaks and climate change are two of the components comprising the greatest environmental challenges.

Remote sensing and Geographical Information System (GIS) provide efficient tools for mapping actual insect distribution and damage (Ranson et al. 2003). The multi-date nature of satellite imagery permits monitoring dynamic features of landscape and thus provides a means to detect major land cover changes and quantify the rates of change. Rapid development in techniques has opened new ways in forest protection.

Figure 1: Defoliation by *Diprion pini* in Palokangas study area
Abbildung 1: Entnadelung durch *Diprion pini* im Untersuchungsgebiet Palokangas

During the latest outbreak of the Common pine sawfly (*Diprion pini* L.) in 1998-2001, approx. 500000 ha of pine forests were defoliated in mid Finland (Lyytikäinen-Saarenmaa & Tomppo 2002). The outbreak is still active in Ilomantsi district (E Finland), where approx. 13000 ha of forest is suffering from defoliation (Figure 1). In this paper, we outline an approach to map the distribution and intensity of defoliation with EO-1 Hyperion imagery and digital aerial photography.

Study area and field data

The Palokangas study area is located in the eastern parts of Ilomantsi, where mature Scots pine stands are mainly in a commercial use. Due to dry sandy soils the understorey is largely open. Some clear-cuts are located within the study area.

We measured 18 clusters of field plots in June 2007. The clusters represented different defoliation categories: low, moderate and heavy defoliation. Each of the clusters consisted of four circular plots, one of which being a permanent one. Plot location was georeferenced using a Trimble Pro XT GPS. Tree height, $D_{1.3}$, distance and angle from a plot centre were measured from trees within a 13 m radius. Tree-wise defoliation was estimated by naked eye in 10 %-classes.

Image data and classification

We employed one Hyperion image (30 m pixels), collected on October 11th, 2007 (Figure 2) and digital aerial photographs, acquired near the same date. Using data from the two sensors without any seasonal differences facilitates the comparison of the classification. The spectral resolution of the Hyperion image is high. Hyperion data has been earlier utilized e.g. in mapping of forest composition (Townsend & Foster 2002).

Digital aerial photography and other geographical information for monitoring forest health have already been used for assessing drought damages (Holopainen et al. 2006). The present interpretation is based on reference field plots and changes in image features caused by defoliation. The spectral features of Hyperion image and spectral and textural features of aerial photographs are used to classify the field plots with several methods such as maximum likelihood and nearest neighbours. The interpretation accuracy on plot and stand levels will be validated using the leave-one-out method.

Conclusion

Our study is the first attempt to analyze and classify insect defoliation with hyperspectral imagery. At the moment, we are working on the classification of the data. We also aim to compare accuracy, achieved with different spectral resolutions, i.e. comparing Hyperion and Landsat ETM data. Remote sensing will bring several advantages for monitoring forest damages and adapting forest management to climatic change.

Figure 2: EO-1 Hyperion image on the Palokangas area, showing location of the clusters of field plots

Abbildung 2: Aufnahme von EO-1 Hyperion vom Gebiet Palokangas mit Lagedarstellung der Erhebungspunkte

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