HYPERSPECTRAL REMOTE SENSING DATA – EFFECTIVE TOOL FOR LARGE-SCALE MONITORING OF EARLY STAGES OF SPRUCE DAMAGE: INTERPRETATION WITH THE USE OF BIOCHEMICAL, HISTOCHEMICAL, STRUCTURAL, AND MACROSCOPIC MARKERS OF DAMAGE IN THE KRUŠNÉ HORY MTS.

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The massive forest decline phenomenon in the Krušné hory Mountains, Czech Republic has been described since the early 1950s and is attributed to the combination of severe atmospheric pollution and climatic conditions. The Krušné hory trends southwest-to-northeast, along a gradient of atmospheric deposition which leads from heavy (to the east) to light (to the west) related to the distance from pollution sources. Current field evaluation methods of assigning damage classes to individual trees or forest stands are mainly based on visual assessment of macroscopic characteristics, e.g. foliar loss or altered tree architecture. Although this assessment can be precise, it is often observer-biased. Moreover, this approach does not reveal the early previsual stages of damage to conifers. Before macroscopic changes and needle loss occur, alterations in metabolic pathways lead to changes exhibited at the cellular level. Foliar damage related to anatomical structure and chemical composition of the vegetation can be also assessed from plant spectral reflectance data (Rock et al. 1986, Rock et al., 1992) at certain wavelengths or by use of different spectral indexes (Entcheva, 2000). Moreover, spectral reflectance of leaves can be also used as an estimate of the concentration of photosynthetic pigments, water content, and chemical composition of plants (Martin & Aber, 1997). Thus, markers of damage on structural and metabolic levels can serve for efficient interpretation of hyperspectral remote sensing data.

The study area (Přebuz, Boží dar, Kovářská) along a gradient of increasing atmospheric pollution in the Krušné hory Mts. was chosen exhibiting the whole range of forest stand damage. In August 1997 and 1998, fifty-one stands of Norway spruce were observed and characterized by common field methods. Sunlit branches from the middle third of the crown (from about 300 trees) were sampled for different analyses. Needle samples were processed by laboratory analyses in different ways for determination of photosynthetic pigment content, needle structure, and needle phenolic compound accumulation using histochemical and biochemical methods. Spectral reflectance measurements of age classes of branch segments and needles were acquired with a portable GER 2600 spectroradiometer. Additionally, the Near-Infrared (NIR) Spectrometer laboratory instrument was used to obtain reflectance features used for further predictions of lignin, nitrogen and cellulose concentrations in needles (Entcheva 2000). Airborne hyperspectral
data were acquired by the Advanced Solid-state Array Spectroradiometer (ASAS) developed at
the NASA Goddard Space Flight Center (Irons et al. 1991). The spectral range of ASAS covers
410-1,032 nm in 62 spectral bands. It was flown on an Antanov AN-2 single engine biplane at
2500 m above terrain, producing an approximately 820m swath width, with a 1.5m by 2.00m
nominal spatial resolution. Overflight occurred on August 17 and September 1, 1998.

Remote sensing methods have the potential to provide low-cost, long-term and large-scale
monitoring of forest health. The NASA project presented focused on the development of
advanced remote sensing methods for monitoring Norway spruce forest health, specifically on
separation of initial damage classes (DC0 and DC1) of forest decline (Albrechtová et al., in
press). The data on the previsual markers of damage (Soukupová et al. 2000) served as
background for interpretation of hyperspectral remote sensing data in order to detect initial stages
of damage. Based on this effort and previous research (1991-1998) the above analyses indicate a
trend of forest recovery particularly in the northeastern part of the Krušné hory Mts. based on
spectral properties, pigment content, foliar chemistry and anatomy. However, the forest
ecosystems in the Krušné hory Mts. are still endangered and have been on the edge of ecological
stability for decades.

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