Remote Sensing of the environmental impact of industrial and mining activities

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In this summary we present the partial results obtained for the "Information service from hyperspectral techniques for Environmental Impact Assessment of Mining and Industrial Activities" (MINPACT project) sustained by the "Services Fédéraux des Affaires Scientifiques, Techniques et Culturelles" (SSTC) inside Stereo program. The principal objective is to take into account the know-how of the work made by the MINEO project, to study the industrial impact in the Meuse valley near Liège (Belgium) and around the mine of Rosia Poieni (Romania) with hyperspectral images (AHS-160 sensor) and multispectral images (ASTER sensor) respectively. In this abstract we present the results obtained in the Meuse valley.

The Meuse valley is characterized by a complex industrial history of chemical and metallurgical industries. We choose several sites along the Meuse valley that reflect two types of contamination, a historic pollution ("Chimeuse" and "cokerie de Flémalle" sites) and the industrial modern activity (Arcelor steel-making activities). The Chimeuse site was initially a coking plant, onto which a chemical industry (which has given its name to the site) was subsequently developed. It presents areas of extremely high pollution of heavy metals (Pb and As essentially, Hg in less critical concentrations), very high pollution of chrysene (PAH) and high pollution of cyanides, BTEX (volatile organic compounds such as benzene, toluene, ethylbenzene, xzylene), mineral oils and other PAH. Flémalle site also hosted coking plants, it presents areas of extremely high pollution of PAH (PolyAromatic Hydrocarbides), cyanides and BTEX. It presents also a high pollution of heavy metals and mineral oils. The Chimeuse and Flémalle sites are characterized by the presence of invasive vegetation (birch, oak, ash tree, bramble...) in a perfect health (determined from the field analysis). The stress of the vegetation is manifested by the trees morphology (small leaves and small branches), but not by the important change in chlorophyll content (chlorosis).
Active industrial sites owned us to evaluate the regions potentially suffering from an industrial dusts plume covering the vegetation. However, the accumulation of industrial dusts is subject to the meteorological conditions (In Belgium, there is huge quantity of rain in the whole year) and to the quantity of dust disseminated from the industries (quite small i.e. < 500 mg/m²/day in the vicinity of the factories).

The hyperspectral images are acquired with AHS-160 sensor operated by INTAS, obtained the 20/06/05, corrected atmospherically (WATCOR software) and orthorectified (PARGE software) by VITO (www.vito.be). Regrettably the images are affected by severe banding generated during image acquisition and this periodic noise is present in orthorectified images.
We evaluate several destriping methods on orthorectified images and raw images (only atmospherically corrected). The best results are obtained using the algorithm proposed by Datt et al, (2003) using raw images. We also have analyzed in detail the spectral behaviour in the SWIR area (2.03 – 2.49 μm). In this spectral domain the number of pixels with value near or equal to 0 increases in exponential way and reach 50% of the image at bands 60 - 63. Due to the uncertainty of the spectral behaviour in this area, we decide not to use the bands ranging from number 22 to 63. The only acceptable spectral domains for data analysis cover the first 21 bands of the sensor. The thermal bands were neither taken into account.

Hyperspectral techniques assessing vegetation health were calculated, namely, Vegetation Indices, Red Edge position and Leaf Area Index. Field measurements with a portable spectrometer and a chlorophyll fluorometer were carried out to validate the results. Unfortunately, no reliable correlations were found between pollutant concentrations and hyperspectral calculations. The test sites seem to be too complex compared with the quality of data available. However, promising results were obtained in detection of the industrial dusts plume in the Meuse valley and research in this field might be valuable.

Bibliography
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