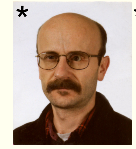
RELATIONSHIPS BETWEEN SOIL PROPERTIES OF THE ABANDONED FIELDS AND SPECTRAL DATA DERIVED FROM ASTER IMAGE



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Introduction

Remote sensing techniques offer fast access to information about soil conditions and have been applied over a number of regions worldwide for mapping physical and chemical properties of bare ground. However, in case of surfaces covered with vegetation it is also possible to estimate of soil conditions using remote sensing data since vegetation patterns often reflect underlying soil properties. The pixel value on the satellite imagery is proportional to the amount of reflected radiation from a vegetated surface. Abundant, non-stressed plants reflect more near-infrared energy and less visible light than a sparser vegetation cover. Since there are strong relationships between soil conditions, plant biomass and their spectral response thus green vegetation can serve as an indirect measure of underlying soils.

The objective of the research described here was to investigate the relationship between the soil physical-chemical characteristics and the vegetation indices derived from ASTER satellite imagery.

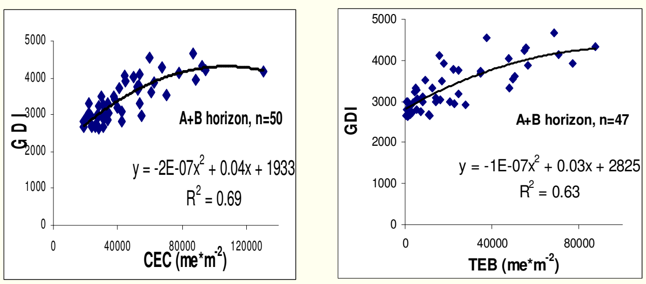

Fig 2. Relationship between the GDI vegetation index and two soil characteristics from B and A+B horizons

Methods

The study was conducted in the Lubuskie voivodship in western part of Poland where annual precipitation is around 528 mm and average temperature is 8°C. An Aster scene acquired on 18 May 2002 was used for this study, in order to derive the remote sensing attributes of the abandoned fields. Three Aster's bands were used to calculate vegetation indices (VI): G (green), R (red) and NIR (near-infrared). The original brightness values - DN were transformed to SRFI – Standarized Reflectance Factor Index (its values changes from 0 to 10000). This transformation is based on Paris concept and it enclosed Chavez atmospheric correction model. The VIs were calculated using the following formulas: GDI=NIR-R+G, SR=NIR/R and NDVI=(NIR-R)/(NIR+R). VIs data were extracted from corresponding soil sample locations for each study site using GPS coordinates obtained in the field.

Field work was conducted in June and July 2005 at six abandoned fields which have not been ploughed since 2000 (K1, K2, K3, S, B, ZS). Vegetation on these fields was in the secondary stage of succession. Soil profiles were dug at the locations which were selected by visual inspection of the satellite image. Soil samples were taken at 0-25 cm (top horizon) and 25-50 cm (sub-surface horizons) depth intervals. The soil samples were analysed to determine their physical and chemical properties: organic carbon content (Corg), pH, cation exchange capacity (CEC), total exchangeable bases (TEB), and particle size distribution (sand, silt and clay). Water retention characteristics (RAWC) were estimated by pedo transfer function.

For the statistic analysis the value of the soil variables from the top horizon (0-25cm), sub-surface horizon (25-50 cm) and total horizon (0-50 cm) were taken.

Results

Fig. 1 shows the spatial variation in the GDI at six abandoned fields resulting from the different soil conditions. Pixels having a larger value of this index correspond to the denser vegetation cover and greater biomass what is connected with more favourable soil conditions for plants.

Results of correlation analysis showed a significant relationships between soil physical and chemical parameters and all VIs counted for pixels corresponding to the sampling points. Stronger correlation exists between VIs and values of soil variables from the total horizon than from the top or sub-surface horizons (Table 1).

Table 1. Correlation coefficients between soil variables from total horizon and three vegetation indices derived from ASTER image.

	sand (%)	silt (%)	clay (%)	C_{org} (%)	TEB ($me*m^{-2}$)	CEC ($me*m^{-2}$)	RAWC (mm)	pH_{KCl}
NDVI	-0.66	0.58	0.60	0.57	0.61	0.65	0.68	0.23
SR	-0.68	0.57	0.67	0.66	0.74	0.76	0.71	0.38
GDI	-0.61	0.50	0.66	0.69	0.78	0.78	0.69	0.48

The Aster VIs were regressed against the soil variables using stepwise regression. The variation of NDVI on the Aster image is explained in 72% by pH_{top}, $Corg_{top}$, $RAWC_{sub}$, $sand_{sub}$ and TEB_{tot}. For the GDI index the same level of explanation of its variation is obtained for CEC_{tot} and $Corg_{tot}$. These two soil variables explained also 67% of SR variation.

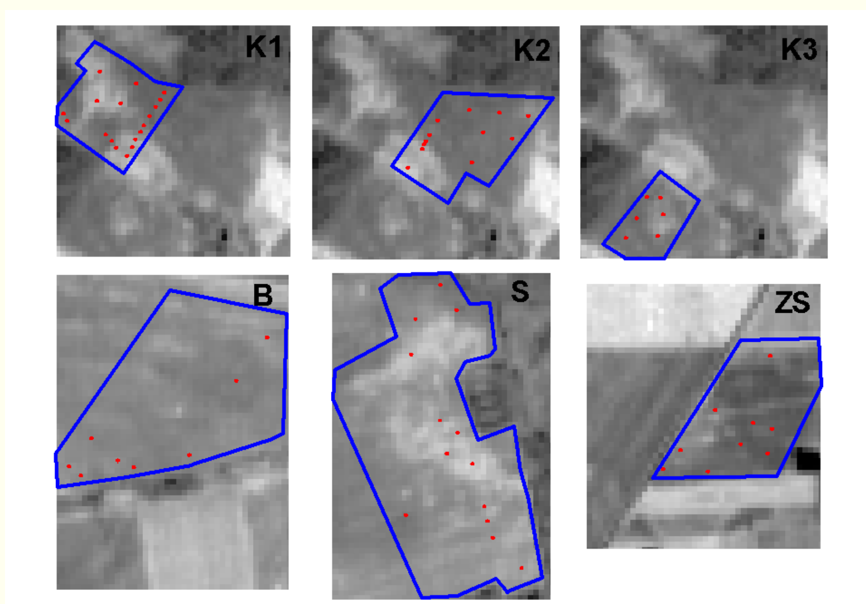

Fig 1. Six parts of the GDI index calculated from ASTER imagery on which the abandoned fields are outlined

Conclusions

Our results show that ASTER data can be used to identify relationships between soil physico-chemical data and remotely sensed measures derived from this sensor. The remote sensing methods can be used to assess the soil conditions on abandoned fields. In Poland in 2006 the acreage of the fallowed fields amounted to about 1 mln hectares. Big part of the abandoned grounds (about 30%) lies on the good quality soils and these fields should be treated as the set aside agricultural fields. The rest of the fallowed grounds, lying on poor, sandy soils, should be permanently taken out from the agricultural production and afforested.