IDENTIFICATION OF HISTORICAL LAND USE BY THE HELP OF AERIAL PHOTOGRAPHY.

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ABSTRACT:

Southern Moravia region (Czech Republic) belongs to old development areas settled by a man from of old. A man had influenced it since primeval ages and up to the present days we have been finding here survivals from his activity both out of this time. To recognize a certain place thoroughly, it is necessary to use all accessible resources and to synthesize them in a suitable way. One of the information sources about a local countryside are aerial photographs. Human intervention into the landscape in the past led to overlay of mould and to the change of soil rates of a particular place and thus to a change of the soil plants surroundings. This is one of the reasons why the land cover on this place is different from the one in the suroundings. And just for this diversity, monitoring the aerial photography in spectral channels NIR and RED is very suitable, just for differential reflectivity of green matter in these channels. For information highlighting we can use so called vegetation indexes that declare the relation between reflectivity of NIR and RED channels. Land use in the past was watched on the fields of University agriculture enterprise in Zabcice near the village Prisnotice (ninety kilometres to the north of Vienna). In the monitored area, which is presently agriculturally exploited, five hundred-hectare plot, there was identified and by other surveys designated the region settlement in the past and its destruction, the gas conduit location and the place after sand mining.

1. INTRODUCTION

Southern Moravia in the Czech Republic has been the site of settlements stretching back to the dawn of man. The landscape has been under human influence since people first arrived on the scene, with individual eras leaving their mark in the form of layers which may be read almost like a palimpsest. A single location may show evidence of human activity from the eneolithic period, the age of the Romans, the medieval era and contemporary times. Human activity during these periods has been of varied intensity, with the greatest influence on the structure of the landscape being attributable to agriculture. Deforestation took place initially, followed soon after by use of the land for farming. Every intrusion on the land in times past, whether it involve relocation, the addition of new layers, excavation or topsoil, has changed its structure to varying degrees, with results still visible today. All of these intrusions on the soil have left their mark on the vegetation. These allow past human activities to be observed. They are easily seen from above and therefore amenable to monitoring by aerial photography using various spectral bands. The use of remote sensing has been described by various authors.

Spectral characteristics of plants are influenced by the size of leaf surface per unit of area (leaf area index LAI). The difference in the amount of chlorophyll in leafs has a great influence on the determination of LAI. An influence of the amount of chlorophyll on the LAI determination was studied by Haboudane et al. (2004). Convenience of used spectral bands is often discussed question. Primary, standard red (RED, 630-690 nm) and near infrared (NIR, 750-900 nm) bands are used. Zhang et al. (2006) used these spectral bands and NDVI, respectively, for the determination of the amount of nitrogen in rice and Reyniers et al. (2006) observed dependence between the amount of nitrogen and NDVI in plants. Additionally, studies that evaluate convenience of various spectral bands in different plant growth phases or conditions are also made. Ferwerda, Skidmore a Mutanga (2005) observed that the most convenient spectral region for the monitoring of the nitrogen amount lies between 1770 and 693 nm. Lee et al. was then comparing hyperspectral and multispectral data.

Large-scale aerial photography in the infrared band has been taking place in the Czech Republic since last year. (Figure 1.)

Figure 1. Aerial photography in the infrared band (© GEODIS)

2. METHODS

2.1 Study site

Past land use was monitored on parcels belonging to the Zabcice UAE at Prisnotice, 90 km from Vienna. (Figure 2.) The project took place in the same location as that used for a precision agriculture project. The project was solved on the land of University agriculture enterprise (Mendel University in Brno), placed in Žabčice, which is working mainly in the maize area. Field production is focused on the production of cereals and fodder crops and livestock production is focused on beef and pig-rising. Additional activities are focused first of all on the practical aspects of the student education. ŠZP Žabčice controls 1602 ha of the farmland (1353 ha of arable land). The chosen locality has an area of 61 ha (Czech Republic, 48°59´11" N 16°37´40" E, 175 m above sea-level).

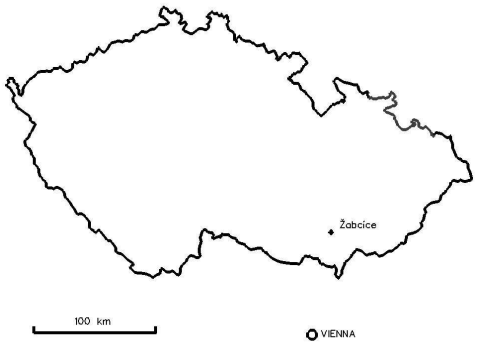

Figure 2. Study site

2.2 Digital aerial imagery

The first step was aerial photo. Based on our experience, and for the reason of data comparison with other research studies in the area, the monitoring was done in two spectral bands (RED, 630-690 nm and NIR, 750-900 nm). Aerial images was done by GEODIS BRNO Ltd. using Z-37A Čmelák airplane equipped with digital medium-format camera Hasselblad H1 with lens of 50.4 mm focal length and Phaseone P25 digital back. Hasselblad H1 is a medium format SLR camera with a number of unique features that support digital backs and provides a similar handling and functionality as an integrated digital camera. The image format is 6 x 4,5 cm (actual size 56 x 41.5 mm). A Phaseone P25 digital back incorporates a 22 megapixel CCD chip with a size of 48.9 x 36.7 mm, 9 x 9 µm pixel pitch, ratio 4:3 ratio and 16 bits per pixel ADC. The images were sensed using custom-made optical filters to obtain two bands (RED and NIR) with spectral properties similar to Landsat TM bands. Each single exposition was directed using GPS according to in advance planed snapshot program using the pin-point method (according to pre-determined centers of projection). For the precise determination of the corrected center of projection and of tilt-angle against normal line to index display plane, the camera was connected with Aparature POS AV 310 (GPS/INS) from Applanix Ltd. The resulting orthophotomaps of the corresponding spectral bands are prepared by orthogonalization of the aerial digital images to the pre-prepared digital model of the corresponding landscape. The interpretation bases are then obtained by the correct synthesis of the resulting orthophotomaps. The accuracy of position of the orthophotomap corresponds approximately to 2.5 times the size of the ground element. For the standard aerial monitoring, where the size of the ground element is 25 cm, the resulting possible root-mean-square error of position in the orthophotomap generated according to the above given procedure is approx. 65 cm.

2.3 Data processing

The history of the landscape is specific to particular locations. Thorough knowledge requires that all available resources be used and an appropriate synthesis made. Aerial photography provides one source of information about the local landscape, which may be integrated using a geographic information system. Interpretive signs were used for manmade shapes. Regular lines and shapes were sought for structures which had been built and disappeared in past times, along with evidence of the former course of waterways which have currently been regulated and the appearance of crops which do not correspond to the presumed condition of soils which differ from their surroundings. Observed differences were supplemented by land surveys and the study of archival materials, primarily maps, and with the collection of information from witnesses.

3. RESULTS AND DISCUSSION

Changes in the spectrum characteristic of agricultural fields with past human activity were identified in a 500 ha area at this location, arranged in chronological order by era of origin.
An archaeological site (Gojda, 2000) includes remains from the eneolithic era – circular trenches with a burial pit at center – as well as traces of Roman earth dwellings and the outlines of a medieval village. This 50 ha area is part of the cultural heritage and may be used for agricultural purposes but other uses are limited. (Figure 3.)

Figure 3. Archaeological site

At the start of the 1970s, wells for potable water were constructed at the location of interest. The fence around them increased from 50 ha in 1976 to 100 ha in 2000. The Level 1 Hygienic Protection Zone encompasses 50 fenced hectares and the entire area is included in a Level 2 Hygienic Protection Zone. Two gas pipelines were run through the area in 1974 and 1984 which are still visible on aerial images. Including a 50-meter protected zone, they occupy 50 ha. (Figure 4.)

Specific to the area are locations at which sand has been has been excavated. Sand was first removed from the location, where farming had earlier taken place, and subsequently the remaining pit was filled with sludge from the nearby sugar refinery in Zidlochovice, with the land then forested via volunteer seeding. When the area of arable land was increased in the 1970s, this land came under cultivation and was not reclaimed. Although it is used for agricultural purposes today, under adverse moisture conditions cultivation is not possible. Any other use is therefore practically impossible. The entire process has taken place without clear ownership relations. The area at which sand was excavated is not large – it consumes 10 ha – but its history is most interesting. (Figure 5.)

Figure 4. Two gas pipelines

Figure 5. Sand excavation

4. CONCLUSIONS

Human intrusions on the landscape during the past have resulted in new layers of soil and changes in soil conditions at particular locations, thereby modifying the soil environment for plants. This is one reason why vegetation at this location differs from its surroundings. Aerial photography using the NIR and RED bands is thus particularly well-suited to observing these differences because of the varied reflectivity of green materials in these bands. This method allows the use of remote sensing in archaeology. Archaeological sites may be identified in this way, along with pipelines, water wells and the traces of sand excavation. This type of management is limited of past activities and must be taken into account for the future.

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