Deliverable TN2:

Theoretical base of mapping an abandoned agricultural land

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Advanced Techniques for Biomass Mapping in Abandoned Agriculture Land using Novel Combination of Optical and Radar Remote Sensing Sensors
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Contents

1. Introduction

Abandonment of agricultural land in Slovakia is a gradual process which manifests in physiognomic changes such as heterogeneous groupings of vegetation, variability of its height and by accruing of new species like wind-borne weeds, shrubs and trees (these diversify or replace the annual or perpetual agricultural crops, vineyards and orchards). Tab. 1 brings the generalisation of this process.

Table 1. Sample of modification of agricultural land use classes in favour of abandonment (example of Slovakia)

Agricultural land use	Overgrowing by
Arable land	herbaceous formations
	shrub and herbaceous formations
	tree, shrub and herbaceous formations
Permanent crops	herbaceous formations
	shrub and herbaceous formations
Pastures and meadows	shrub formations
	tree and shrub formations

Coppin et al. (2004) refer to the change of land cover (LC) by the gradual disappearance of its original content as “modification”. The opposite to this type of land cover change is “conversion” which is a radical change of one LC class to another (for instance, change of meadow into arable land) (Feranec et al. 2016).

As far as the change of arable land in the all-European context political changes that took place in 17 countries of Central and Eastern Europe[1] after 1989 must be taken into account. These changes led to transformation of the structure of agriculture (Feranec et al. 2017). Abandonment of farmland followed by overgrowing by wood species demonstrated by Taff et al. (Taff et al 2009) in Latvia, Angelstam et al. (2003) and Kozak et al. (2007) in Poland, Bičík et al. (2012) in Czechia, and Gabrovec and Kladnik (1997) in Slovenia prove it. Pazúr et al. (2014) identified more intensive abandonment of low-quality farmland in less accessible locations and in neighbourhood of other than farmland plots; further on the authors also found out that abandonment of farmland was highly affected by migration and changes of population structure in rural regions.

The aim of the Technical Note 2 is to set definitions of abandoned agricultural land (AAL) classes whose occurrence dominates in conditions of Slovakia. Another aim is documenting their dominant physiognomic characteristics as recorded by field research and the possibilities of identification of these characteristics by Sentinel-2 satellite data taken in the optical part of spectre. Obtained information about physiognomic and spectral characteristics of AAL constitutes the input into the process of their identification by application of the quoted satellite data.

[1]Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Kosovo, Latvia, Lithuania, Macedonia, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia

2. Definitions of Abandoned Agricultural Land (AAL)

Abandoned cropland is defined by Löw et al. (2018) as "cropland permanently without management", i.e. the land that has not been used (sown but not cropped) for a period longer than the fallow periods practiced under the typical crop rotations in the region (usually four or more years). Due to the abandonment process agricultural land remains untilled (in case of abandonment of land with annual crops it is untilled and unsown, in case of meadows it is uncut or not grazed and in case of orchards and vineyards it is agro-technically unkempt) and gradually replaced by unmanaged grasslands and weeds and the successional shrubland (Kuemmerle et al., 2008). Other definitions interpret abandonment as a common land use change making the accurate mapping of both location and timing when agricultural abandonment occurred important to understand its environmental and social outcomes (Yin et al., 2018). Alcantara et al. (2012) specify this process as a result of a land owner's decision to reduce the intensity of land use for agriculture (including grazing) for an undetermined period of time based on either natural, socioeconomic, or personal constrains. Pointereau et al. (2008) analyzed different definitions of farmland abandonment. These definitions depend on the type of their approach – administrative, economic, social, landscape-ecological or agronomic and are adaptable to the context of different countries. For example, some countries use the qualitative definition of abandoned land (such as the description of the land conditions) whereas others use a quantitative definition (e.g. number of years without cultivation or grazing). In all cases, agricultural land is considered to be abandoned when there are no more farming functions.

The ATBIOMAP project contains definitions of three basic classes of abandonment of farmland identified according to overgrowing by various species of vegetation, its tallness, density and clustering:

AAL: General definition

Abandoned agricultural land (AAL) is land void of any activities associated with agricultural production until this land becomes overgrown by other than agricultural vegetation.

AAL1

Abandoned agricultural land overgrown by low vegetation ***(herbaceous formations)***: originally agricultural land (arable land, vineyards and orchards) overgrown by low to tall grasses and broad-leaved herbs. It develops without human interventions during more than three years, while it is not part of a fallow. Overgrowing of land by herbaceous formations > 90%; their tallness oscillates between 0.5-1.5 m.

AAL2

Abandoned agricultural land overgrown by medium sized vegetation ***(shrub formations)***: originally agricultural land (arable land, meadows and pastures, vineyards, and orchards) fully overgrown by grasses and broad-leaved herbs and shrubs with the canopy closure > 20%, tallness of which is max. 1.6-3 m. Sporadic trees are not identifiable on the Sentinel images (picture element 10 × 10 m).

AAL3

Abandoned agricultural land overgrown by tall vegetation ***(tree formations)***: originally agricultural land (arable land, meadows, and pastures) fully overgrown by grasses and broad-leaved herbs and shrubs with a varied canopy closure and > 20% trees canopy taller than 3 m.

Based on the field research of these three basic classes it was possible to identify six subclasses of AAL (see Tab. 2) according to the species overgrowing farmland represented by arable land, meadows and pastures, orchards, and vineyards).

Table 2. Nomenclature for the graphic record of classes AAL1, AAL2, AAL3 and additional objects, that is, parts of training and test sites in the landscape (m=1 indicates appurtenance to study area 1, m=2 indicates appurtenance to study area 2; n – number of training and test sites indicated in the orthophotomosaic)

AAL1	AAL11 – Abandoned Agricultural Land – **arable land** with herbaceous formations	**AAL11-m-n**
	AAL12 – Abandoned Agricultural Land – **vineyards=V** with herbaceous formations	**AAL12V-m-n**
AAL2	AAL21 – Abandoned Agricultural Land – **arable land** with herbaceous/shrub formations	**AAL21-m-n**
	AAL22 – Abandoned Agricultural Land – **meadows and pastures** with shrub formations	**AAL22-m-n**
	AAL23 – Abandoned Agricultural Land – **orchards=S** and **vineyards=V** with shrub formations	**AAL23S-m-n** **AAL23V-m-n**
AAL3	AAL32 – Abandoned Agricultural Land – **meadows and pastures** with tree formations	**AAL32-m-n**

3. Characteristics of natural conditions in selected parts of study area 1 – Podunajská nížina lowland (PN) and study area 2 – Zvolenská kotlina Basin (ZK)

Study area 1 (PN) is situated north-east of Bratislava (see Fig. 1) and it is part of the Podunajská nížina Lowland (geomorphological region), which is vertically differentiated by units of the Podunajská Plain with research sites 1, 2, 10, 11 and the Podunajská Hilly Land (sites 4, 6, 9) while a narrow strip of the territory is in the foothills of the Malé Karpaty Mts. (site 8) (see Fig. 2). The plain is on the Quaternary gravel sediments with fertile Chernozems and Chernitsas exploited prevailingly as arable land. Waterlogged depressions are covered by Alder fen woods (locality NATURA 2000 – Šúr). Hilly lands on the Neogene and loess sediments with fertile Chernozems and Orthic Luvisols are exploited as arable land and vineyards with of oak woods refuges. Vineyards in a warm and moderately humid climate (with mean yearly temperature of 9 ^{o}C and mean yearly atmospheric precipitation of 550-600 mm) prevail on the granite and granite-diorite slopes of the Malé Karpaty Mts. on Cambisols.

Study area 2 (ZK) is situated in the eastern part of the Slovenské stredohorie (geomorphological region), in the units of Zvolenská kotlina Basin and the Javorie Mts (see Fig. 1). The basin research sites are situated in the dissected hilly land (site 2) or a much dissected upland (site 7) (see Fig. 3). Research sites 4, 10 and 11 are located on the slopes of the Javorie upland. Floodplains and hilly lands of the basin with compact urban and rural settlements are mostly used as a large-block arable land. Dissected hilly lands and uplands on the Neogene volcanic andesite rocks with medium fertile Cambisols have a moderately warm and moderately humid climate (with mean yearly temperature of 6 ^{o}C and mean yearly atmospheric precipitation of 700-800 mm). Much dissected and inclined upland was traditionally agriculturally exploited on small plots of arable land, meadows, pastures and orchards especially around the dispersed settlements (Detvianske lazy). Elevated parts of upland are covered by oak-hornbeam or sub-mountainous beech woods.

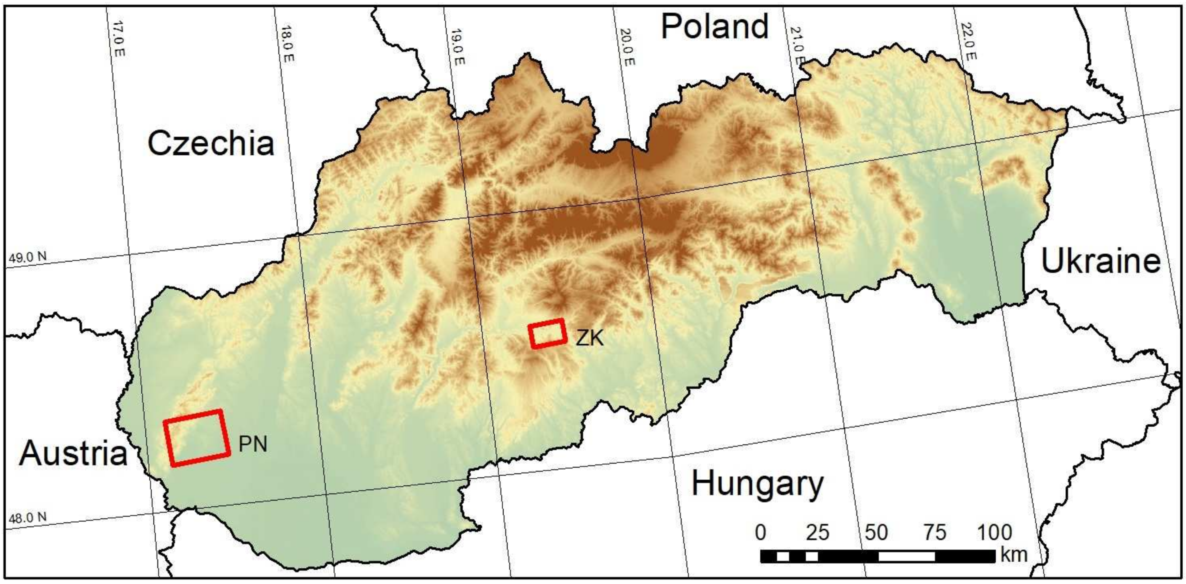


Figure 1: Location of the study areas PN and ZK (marked by red squares).

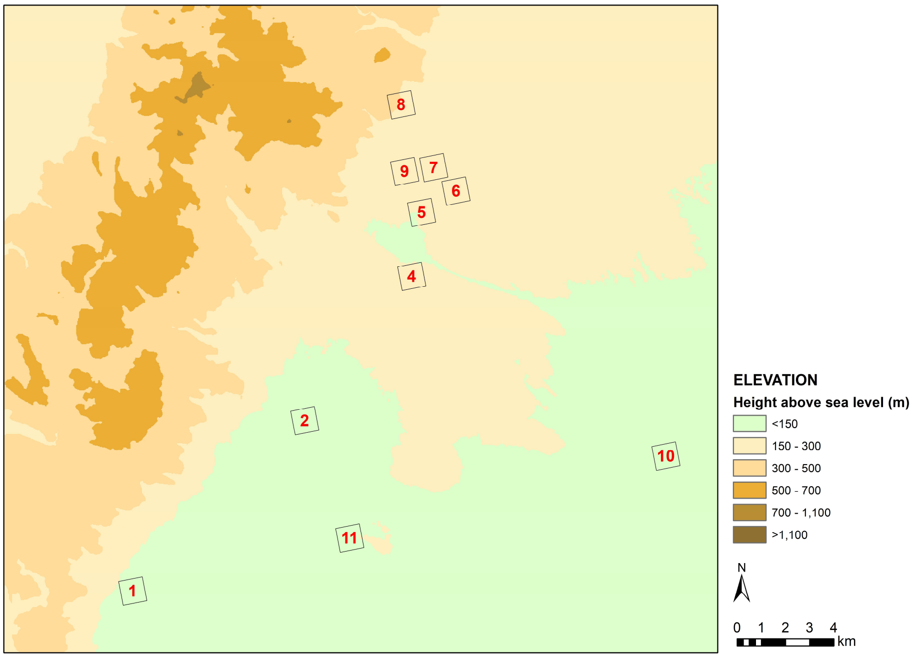


Figure 2: Location of the training and test sites in PN (marked by numbers 1-11).

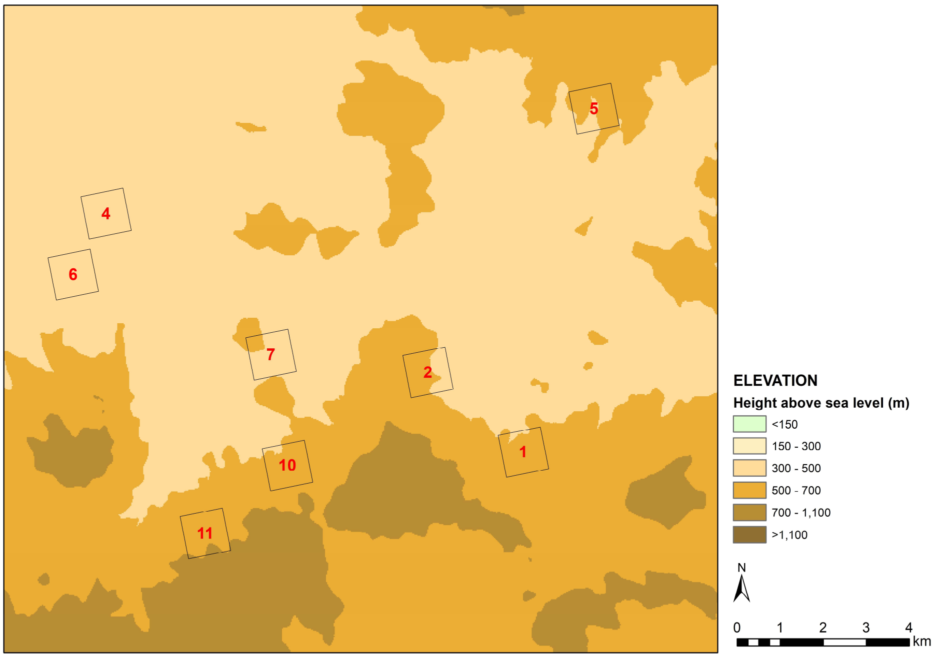


Figure 3: Location of the training and test sites in ZK (marked by numbers 1-11).

4. Results of field survey and their assessment with the aim to determine significant physiognomic characteristics of AAL classes

Field research has been carried out during the vegetation period in the Podunajská nížina Lowland (study area PN) on 24 May 2018, 14 June 2018, 27 June 2018, and 12 July 2018 (10 training and test sites) and in the Zvolenská kotlina Basin (study area ZK) on 20 to 21 June 2018 (8 training and test sites). Recorded characteristics of 8 sites (study area PN) and 5 sites (study area ZK) were used for the purpose of this Technical Note.

Applying the criteria of the AAL class definitions (see Part 2) AAL classes and LC/LU classes (see Tab. 2 and Tab. 3) with the minimum area of 0.3 ha were identified in the training and test sites sized 1 × 1 km. Results of the field survey were inserted into the orthophotomosaic at scale 1:5,000 (see the sample in Fig. 4). Physiognomic characteristics of AAL classes, namely the species composition of vegetation, its tallness, overall cover and clustering into forms i.e. pattern were put into tables (see Tab. 4 and Tabs. 5-16 in the supplements). Overview of these characteristics for all these 13 training and test sites is in Tab. 17. Their relationship to the computed value of the normalised difference vegetation index (NDVI) is analyzed and assessed in Part 7.

Results: Arable land overgrown by herb formations in sites: PN2, PN10, and PN11; arable land overgrown by herb formation and shrubs in PN1, PN4, PN11, and ZK2; vineyards overgrown by herb formations in PN8; vineyards overgrown by shrubs in PN6, PN8, PN9, and PN10; meadows and pastures overgrown by shrubs in: PN6, ZK2, ZK4, ZK7, ZK10, and ZK11; orchards overgrown by shrubs in ZK7; meadows and pastures overgrown by trees in ZK10 and ZK11.

It must be mentioned that the physiognomic characteristics of the overgrowing vegetation are changing during the vegetation period. Characteristics quoted in Tab. 17 are precisely from the culminating vegetation period (May-July) in accord with the contract schedule, WP3, Task 3.1.

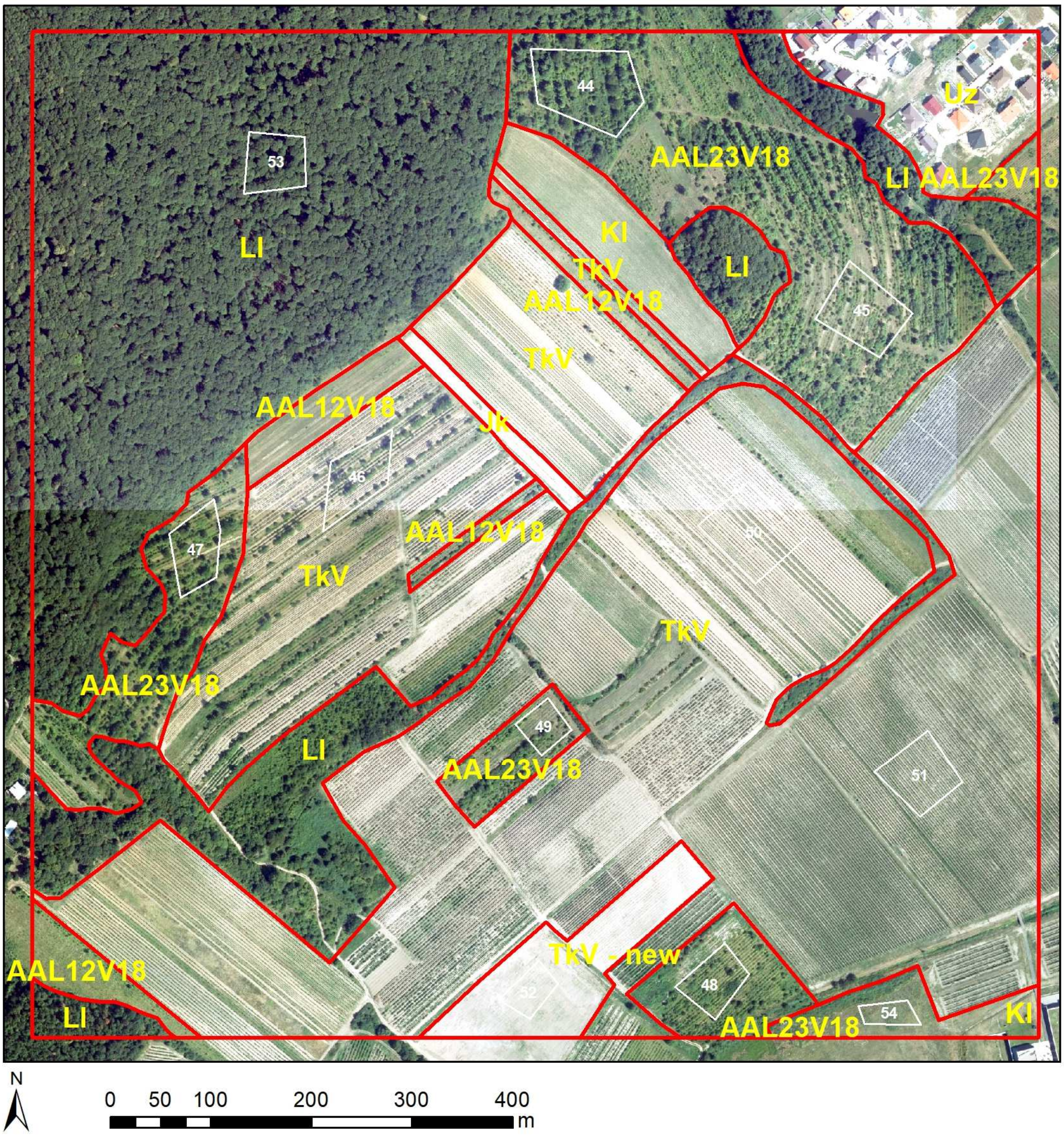


Figure 4: AAL and LC/LU classes recorded by the field research into the orthophotomosaic in site PN8 – Dubová.

Table 3. Nomenclature of identified land cover/land use (LC/LU) classes in training and test sites

Urban fabric	**Uz**
Industrial and commercial units	**Pz**
Road network	**Ck**
Rail network	**Zk**
Mineral extraction site	**At**
Dump site	**As**
Annual crop	**Jk**
Fodder crops (alfalfa=d, meadow=l, pasture=p)	**Kd, Kl, Kp**

Heterogeneous agricultural areas	**24**
Fallow land	**U-Jk**
Permanent crop (vineyard=v, orchard=s)	**Tkv, Tks**
Broad-leaved forest	**Ll**
Coniferous forest	**Li**
Mixed forest	**Lz**
Shrubs	**Kr**
Wetland	**Mo**
Water course	**Vt**
Water body	**Vp**

Table 4. Significant physiognomic characteristics of overgrowing vegetation in site PN8 – Dubová

Trieda/Class:	**AAL23V18, AAL12V18**		
Dátum záznamu činnosti/Date of actvity record:	12.7.2018		
Poloha/Location:	Dubová		
Nadmorská výška stredu areálu/Sea level altitude of the area:	288 m		
Tvar georeliéfu/Form of terrain:	○ rovina/flatland; ◉ svah/slope	orientácia/orientation: ☑ J/S ☐ S/N ☐ V/E ☑ Z/W ☑ kombinovaná/combined	
Pôdny typ/Soil type:	74, 80		
Pôdny druh/Soil texture:	hlinitá/loamy soil		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: Festuca, Calamagrostis, Poa, Tanacetum, Jacea /23V18,12V18		
	E_2 – krovinovej/shrubby: Rosa, Acer campestre, Rubus /23V18,12V18		
	E_3 – stromovej/tree: Acer, Fraxinus, Prunus avium /23V18		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: do/up to 1,2 m	E_2: do/up to 1,5 m	E_3: above 3 m
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *nepravidelná mozaika/ irregular mosaic*	E_3: *nepravidelná mozaika/ irregular mosaic*
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☑ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: 20-60 %	E_3: 20 %
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular; ☐ nepravidelný/irregular	☑ ostrý/distinct	☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Table 17. Overview of physiognomic characteristics of overgrowing vegetation in 13 sites (study areas 1 and 2) – E_1 – grass-herbs, E_2 – shrubby, E_3 – tree

Training and test sites		Significant physiognomic features of AAL classes (characterising of vegetation)			
Site	AAL class	Species composition	Tallness	Overall cover	Clustering into forms (pattern)
PN1	AAL2111	E_1, E_2	E_1: 0.7-0.9 m E_2: 1-2 m	E_1: 100% E_2: 10-40%	E_1: fully overgrown E_2: mosaic of small groups
PN2	AAL1112	E_1	E_1: 0.6-0.7 m	E_1: 100%	E_1: fully overgrown
PN4	AAL2114	E_1, E_2	E_1: up to 1.2 m E_2: up to 3 m	E_1: 100% E_2: 20-60%	E_1: fully overgrown E_2: irregular mosaic
PN6	AAL2216	E_1, E_2	E_1: 0.6-0.8 m E_2: up to 1 m	E_1: 100% E_2: 20-50%	E_1: fully overgrown E_2: irregular mosaic
	AAL23V16	E_1, E_2	E_1: 0.6-0.8 m E_2: up to 3 m	E_1: 100% E_2: 60-80%	E_1: fully overgrown E_2: irregular mosaic
PN8	AAL23V18	E_1, E_2, E_3	E_1: up to 1.2 m E_2: up to 1.5 m E_3: above 3 m	E_1: 100% E_2: 20-60% E_3: up to 20%	E_1: fully overgrown E_2: irregular mosaic E_3: irregular mosaic
	AAL12V18	E_1, E_2	E_1: up to 1.2 m E_2: up to 1.5 m	E_1: 100% E_2: 20-60%	E_1: fully overgrown E_2: irregular mosaic
PN9	AAL23V19	E_1, E_2, E_3	E_1: up to 0.6 m E_2: up to 2.5 m E_3: above 3 m	E_1: 100% E_2: 40-80% E_3: up to 10%	E_1: fully overgrown E_2: irregular mosaic E_3: sporadic appearance
PN10	AAL11110	E_1	E_1: up to 0.6 m	E_1: 100%	E_1: fully overgrown
	AAL23V110	E_1, E_2	E_1: up to 0.6 m E_2: app. 1.5 m	E_1: 100% E_2: 20-30%	E_1: fully overgrown E_2: sparse mosaic
PN11	AAL11111	E_1	E_1: 0.7-1.3 m	E_1: 100%	E_1: fully overgrown
	AAL21111	E_1, E_2, E_3	E_1: up to 0.5 m E_2: up to 3 m E_3: above 3 m	E_1: 100% E_2: 20-30% E_3: 10-20%	E_1: fully overgrown E_2: sparse mosaic E_3: continual stripe
ZK2	AAL2122	E_1, E_2	E_1: up to 0.3 m E_2: 1-2.5 m	E_1: 100% E_2: 40-50%	E_1: fully overgrown E_2: mosaic stripes
	AAL2222	E_1, E_2	E_1: up to 0.3 m E_2: 1-2.5 m	E_1: 100% E_2: 20%	E_1: fully overgrown E_2: mosaic
ZK4	AAL2224	E_1, E_2	E_1: up to 1.2 m E_2: app. 2 m	E_1: 100% E_2: 15-30%	E_1: fully overgrown E_2: circles
ZK7	AAL23S27	E_1, E_2, E_3	E_1: up to 0.3 m E_2: 0,5-1,5 m E_3: above 3 m	E_1: 100% E_2: 20-100% E_3: up to 10%	E_1: fully overgrown E_2: irregular mosaic E_3: sporadic appearance
	AAL2227	E_1, E_2, E_3	E_1: up to 0.3 m E_2: 0.5-1.5 m E_3: above 3 m	E_1: 100% E_2: 20% E_3: up to 10%	E_1: fully overgrown E_2: irregular mosaic E_3: sporadic appearance
ZK10	AAL22210	E_1, E_2	E_1: up to 0.6 m E_2: up to 2 m	E_1: 100% E_2: 30-40%	E_1: fully overgrown E_2: mosaic, circles
	AAL32210	E_1, E_2, E_3	E_1: up to 0.6 m E_2: up to 2 m E_3: above 3 m	E_1: 100% E_2: 60% E_3: up to 20%	E_1: fully overgrown E_2: mosaic, circles E_3: mosaic
ZK11	AAL22211	E_1, E_2	E_1: up to 1.2 m E_2: up to 1.5 m	E_1: 100% E_2: 20-40%	E_1: fully overgrown E_2: mosaic
	AAL32211	E_1, E_2, E_3	E_1: up to 1.2 m E_2: up to 1.5 m E_3: above 3 m	E_1: 100% E_2: 20-40% E_3: 20-30%	E_1: fully overgrown E_2: mosaic E_3: mosaic – solitaires

5. Contribution of imaging by the UAV to the precision of results obtained in field research (stress on identification of vegetation type, its tallness, coverage, pattern, and construction of a 3D model of the area)

The aim of imaging by means of the Unmanned Aerial Vehicle (UAV) was to document the possibility to specify the results of field survey in training and test sites with stress on determination of tallness of overgrowing vegetation in AAL, its coverage, and appearance clustering i.e. pattern. DJI Phantom system was used for imaging in two sites: PN8 and ZK4. Spatial referencing was performed with 12 control points (GCP – Ground Control Point) targeted by RTK GPS with 20 mm accuracy for each site. Flight altitude was set at 70-100 m and combination of nadir and oblique was used to achieve the precision and model texture quality. The data were processed in Agisoft PhotoScan software. Colorized dense point clouds, 3D models and orthophotomosaic were generated for analyzing the significant physiognomic features of AAL classes (see Fig. 5a, b). Total geometry error was less than 100 mm for the site PN8 and the site ZK4 dataset and ground resolution was 3.32 cm/pixel and 2.82 cm/pixel, respectively with 3D points cloud density 227 points per m^2 and 314 points per m^2.

The site PN8 represents the vineyard landscape. The UAV dataset covers an area of 0.3 km^2 on the edge of forest, a newly established vineyard, a production vineyard, and abandoned vineyards (Fig. 6a, b). High resolution UAV-orthophoto points out spatial differences between the Sentinel-2A 10 m pixel representation and the real pattern and structure of vegetation cover. The class AAL23V18 is situated in ground plots (see Fig. 4 in the Part 4) without agricultural management and the vegetation is composited mainly from grass-herbaceous species with 10-70 cm tall and shrubs with abundance of 20-60% and from 1 to 3 m tall. Proportion of the tree cover is up to 20% with solitaries or small clusters in the former vineyard lines (Fig. 7a, b, c).

The site ZK4 is situated in a hilly area with traditional farming, that is, cultivation of arable land and exploitation of pastures or meadows. UAV dataset covers area of 0.2 km^2 and captures the area of abandoned meadow above the Vígľaš village. The area of meadows is overgrown by shrubs dominantly consisting of *Prunus sp*. on the edge of the forest, where they form a semicircular continuous cover with evident circular shape of the former separate shrub formations (Fig. 8a, b). Grass-herbaceous species (mainly *Calamagrostis sp., Festuca sp.*) create a circular clustering of shrubs with average tallness of 2.7 m and average diameter 13.8 m (from 5.49 m to 28.2 m) on the meadow.

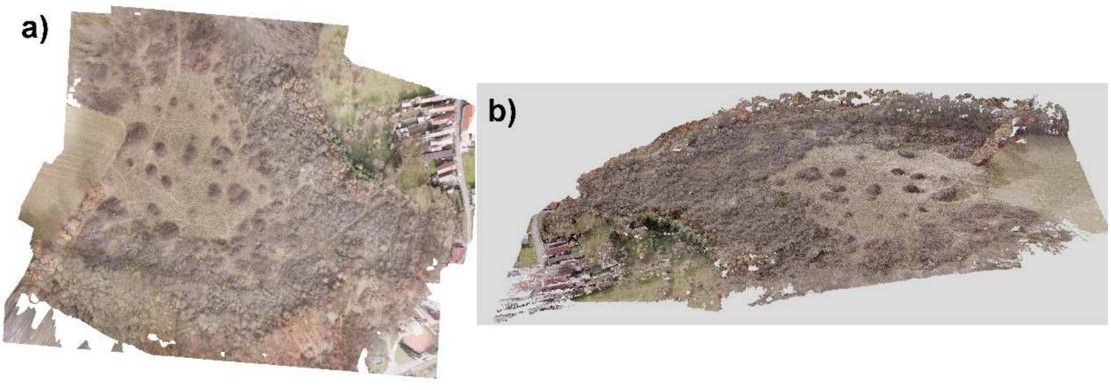


Figure 5: Example of UAV dataset for the site ZK4: (a) orthophotomosaic, (b) photorealistic colorized point cloud landscape model.

Figure 6: Differences between (a) detailed UAV-orthophotomosaic of the site PN8 – Dubová with the class AAL23V18 with 10 m pixel fishnet and (b) Sentinel-2A representation of the identical area.

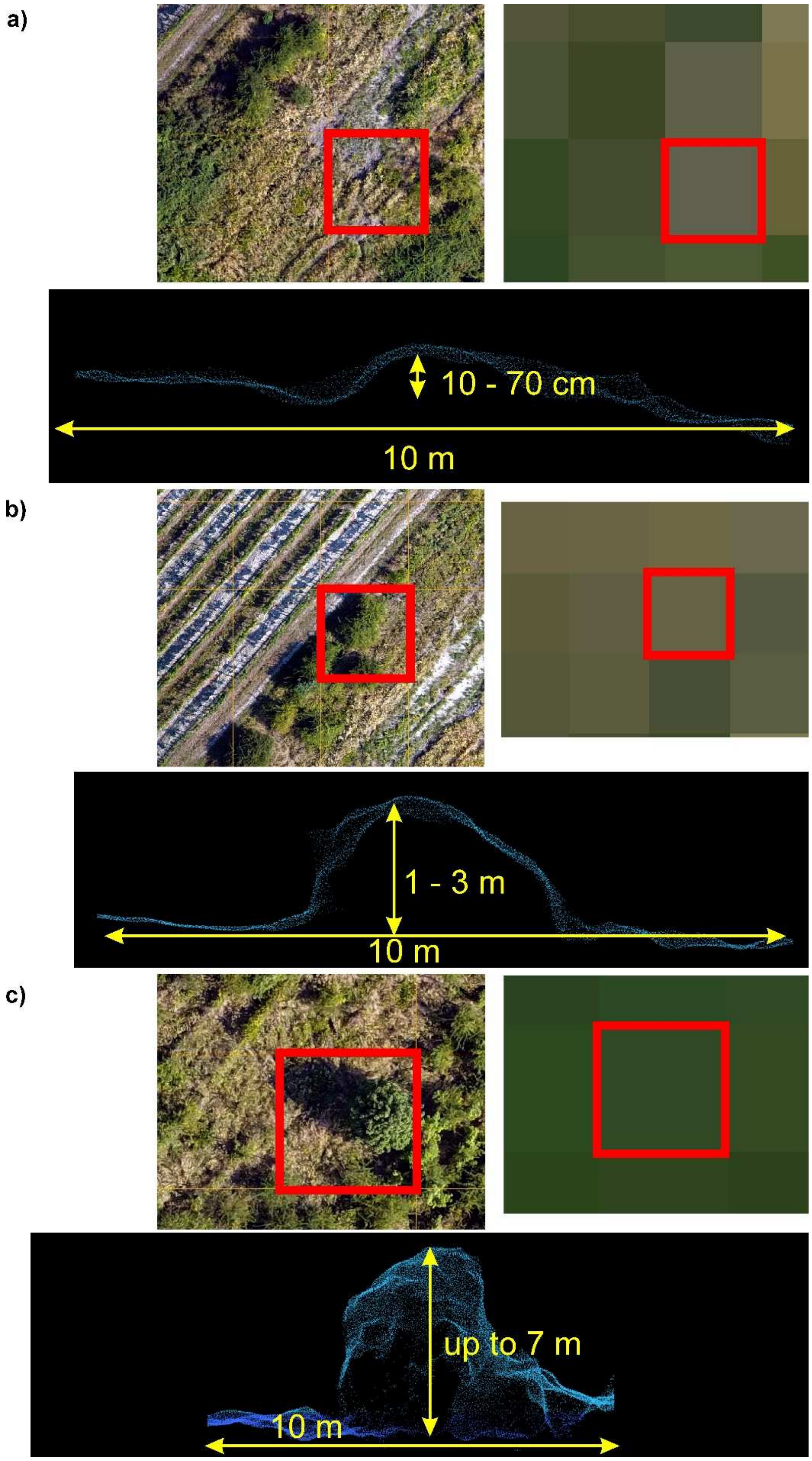


Figure 7: Three main species composition in abandoned agricultural land in the site PN8: (a) grass-herbs species on detailed UAV – orthophotomosaic compared with the Sentinel-2A true colour image and 3D point cloud profile; (b) shrubby species; and (c) tree species.

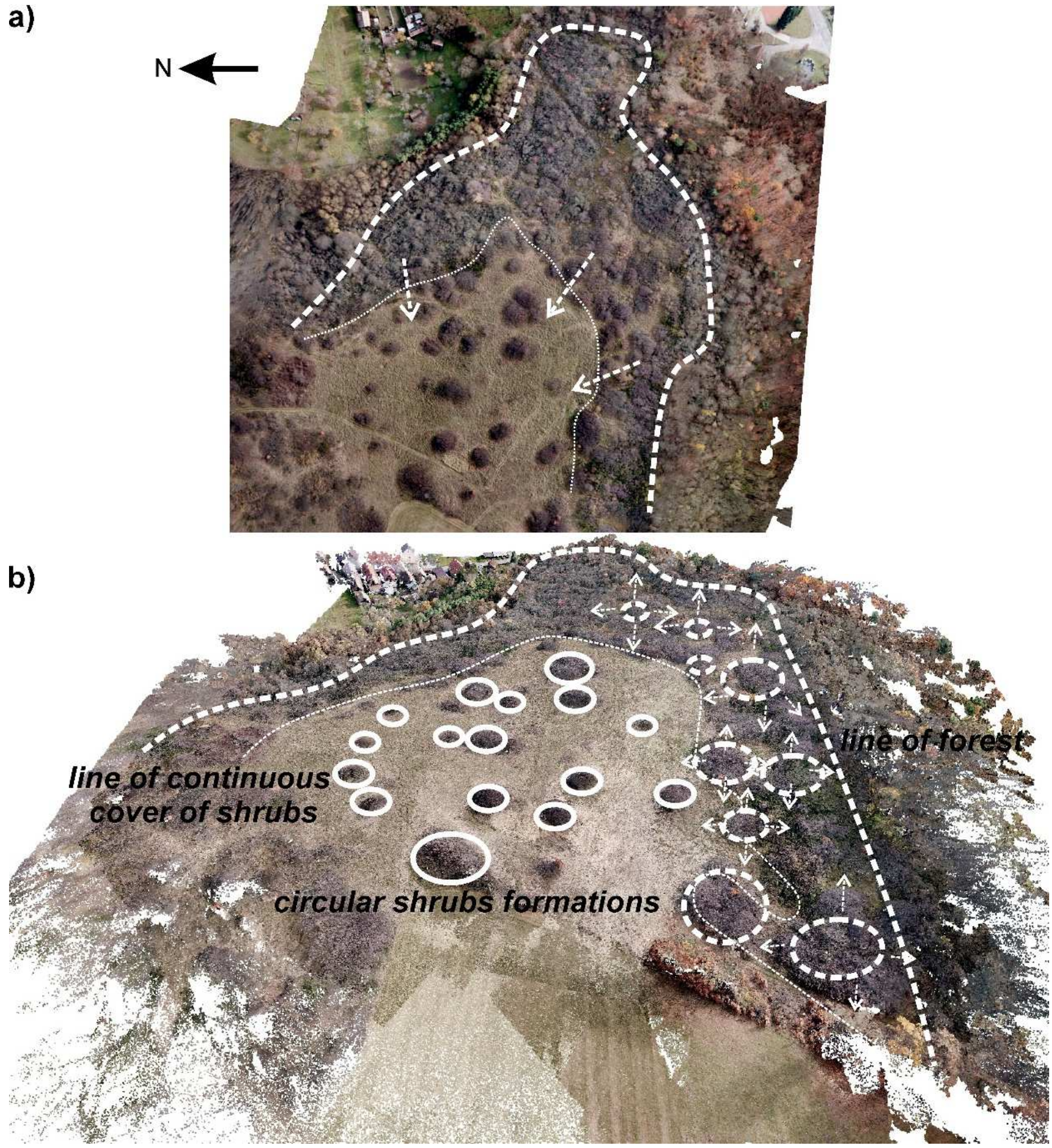


Figure 8: The site ZK4 with the class AAL2224 where meadows are overgrown by shrubs formation creating a continuous semicircular cover near the forest edge and a solitaire circular clustering formation on the meadow.

6. Selection of satellite images for training and test sites

The used data were gained by the Copernicus Open Access Hub. Total number of downloaded satellite images was 308 (163 images for PN, 145 images for ZK). Data were obtained from 12/2015 to 09/2018 (see Fig. 9) and 01/2016 to 10/2018 respectively (see Fig. 10). Pre-processing was performed by the Sen2Cor algorithm (ESA release 2.5.5) which also computes different categories including a cloud-mask (Sen2Cor - L2A_SceneClass). Using this classification, we masked out all areas of potential clouds, cloud shadows or water surfaces (L2A_SceneClasses 1:3, 6,8:11). This process removed most of the pixels containing those categories. To remove additional pixel of likely presence of cloud and cloud shadows we used blue band-based and near-infrared (NIR) band-based mask, respectively. This additional masking was found as a useful procedure of cloud masking in previous research, as cloud and snow reflectances are highly reported in the blue spectrum (Hagolle et al. 2015; Kolecka et al. 2018) and dark and water objects in NIR spectrum (Zhong et al. 2017).

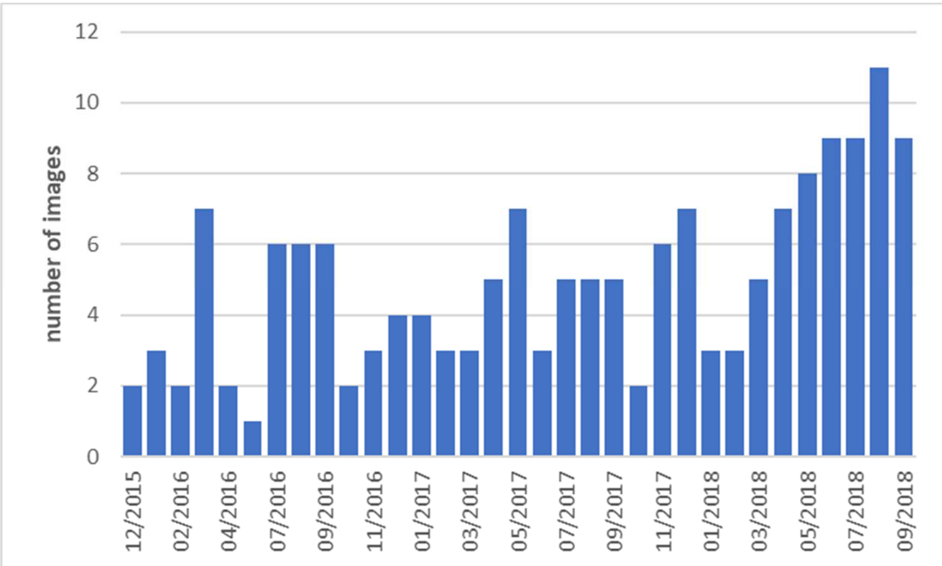


Figure 9: Downloaded satellite images for the locality PN.

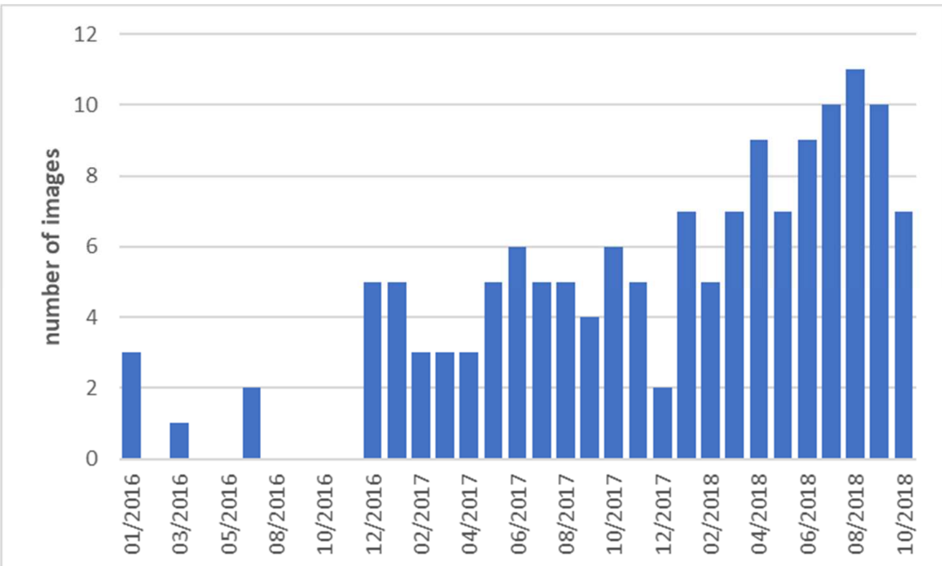


Figure 10: Downloaded satellite images for the locality ZK.

7. Computation of time series i.e. NDVI profiles; Pearson correlation coefficient of the Sentinel-2A data

Vegetation indices are parameters sensitive to photo-synthetically active radiation. They have been computed from spectral reflectance recorded by two or more spectral channels of the scanning device (Bannari et al. 1995). They are frequently used as variables for distinction of vegetation. In the ATBIOMAP project the NDVI index was applied with the aim to point to the options of distinction of vegetation in AAL and the vegetation in tilled farmland represented by the annual and perennial cultures. The basis for the use of phonological NDVI profiles in agricultural areas is an assumption of their difference in the use of the area. Phenological profiles in the AAL sites were expected to directly reflect the phenological condition of plants (depending on the stage of the growing season) without any pronounced instability or distinct apices. On the contrary, vegetation profiles representing the actively tilled land (for instance, mowed meadows, arable land with annual crops, worked vineyards, etc.) should have had one or more narrow apices in the consequence of alternation of the green biomass (its amount) in the assessed agricultural area (Estel et al. 2015). Moreover, a considerably abrupt decrease of phenological index characterizing human activity (mowing or harvesting) in certain phonological vegetation stages is typical.

Sentinel-2A and Sentinel-2B data were the input into the computation of NDVI index in the ATBIOMAP project. We pre-processed the Sentinel-2 scenes applying the Sen2Cor algorithm (ESA release 2.5.5) which also calculates a cloud-mask with the sufficient accuracy and is able to remove most of the clouds including haze.

To insure the robustness of the calculated NDVI profiles we manually selected 104 homogenous areas and calculated for each polygon the median of all NDVI values for particular Sentinel-2 scene. In addition, we calculated the Pearson correlation coefficient which represents the rate of statistical dependence between two variables, in our case, data about spectral characteristic of AAL and LC/LU classes (this coefficient may gain values from the interval -1 to +1, while the value close to +1 means that the assessed dependence is more intensive, the value close to 0 indicates scarce similarity of classes and the negative value means that the manifestations of classes are contrary).

8. Comparison and assessment of the NDVI values and correlation coefficients with the significant physiognomic features of AAL areas

Explanation of the NDVI data concentrated upon documenting of differences between the AAL classes and the not abandoned agricultural lands by means of:

- Orthophotomosaics and tables with recorded results of field research (identified AAL and LC/LU classes including their physiognomic characteristics: species of overgrowing vegetation, their tallness, coverage, and pattern),
- Images of the characteristic parts of AAL classes recorded by field research,
- Selected NDVI profiles of abandoned and tilled farmland (the input for computation of NDVI were the Sentinel-2 data from the vegetation season of 1 April to 30 September 2018),
- Pearson correlation coefficient.

AAL11 class was identified in three sites (PN2, PN10 and PN11). The originally arable land is overgrown by grasses (first of all Lolium sp., Arrhenatherum sp.) and weeds (for example Anthemis sp., Daucus sp., Papaver sp., Artemisia sp.) below 1.3 m tall (see Supp. 1 – Tabs. 6, 10, 11 and Supp. 2 – Figs. 12a,b, 17a,b, 18a,b). Overall cover in time of field research amounted to 100 %. Grasses and weeds did not form any distinguished clusters (Tab. 17, see also Supp. 1 – Tabs. 6, 10, 11). NDVI values were computed for seven sites of the selection of pixels representing relatively homogenous manifestations of overgrowing vegetation (the selection was not arbitrary; it was based on graphic records obtained by field research and analysis of the 2017 orthophotomosaic. Such procedure was applied to the selection of all 104 sites). Number of NDVI profiles in one graph was reduced for the sake of improved transparency (spectral manifestations of the most characteristic parts of AAL vs. LC/LU classes are represented). The course of profiles of NDVI of AAL11 classes in graphs is similar (see Supp. 2, Figs. 12c,d, 17c,d, 18c,d). It is attributable to the natural development of vegetation in areas free from human interventions in recent years. Correlation coefficient between them (for instance, for PN2 the correlation coefficient between sites 9 and 10 is 0.84, but between sites 8 and 9 it is only 0.60) confirm it. For PN2, NDVI profiles of AAL classes and classes of tilled farmland (LC/LU) on the graphs are distinctly different (see Fig. 12c,d), as confirms the correlation coefficient 0.06 for site 9 (abandoned arable land) vs. site 11 (tilled arable land with sunflower growth) (see Tab. 19). Similar conclusion has been drawn for PN10: correlation coefficient between sites 60 (AAL11) and 59 (wheat) is only 0.27 (see Supp. 2 – Tab. 24) where the wheat field was mown in July and without vegetation in difference from the abandoned field with abundant weed vegetation which means a good discernibility of abandoned arable land from the tilled arable land.

AAL21 class was found in four localities (PN1, PN4, PN11 and ZK2). What was originally arable land is in an advanced stage of overgrowing not only by herbs (for instance, Festuca sp., Poa sp., Calamagrostis sp., Anthemis sp., Melitus sp. a pod.), but also by shrubs (for instance, Rosa sp., Prunus sp., Corylus sp., Crataegus sp.) (see Supp. 1 – Tabs. 5, 7, 11, 12 and Supp. 2 – Figs. 11a,b, 13a,b, 18a,b, 19a,b). Tallness of herbs is between 0.5 m and 1.2 m and that of shrubs is between 1 m to 3 m. Overall coverage by herbs was 100 % and that of shrubs was 10-60 %. Patterns of shrubs formed varied mosaics (see Tab. 17). NDVI values were computed for 12 sites of selection of pixels with the stress on determination of the varying density of overgrowing by shrubs. The course of NDVI profiles in graphs characterising the vegetation season is also comparatively uniform (for instance for ZK2: sites 95 and 96 NDVI profiles are shifted regarding each other in the direction of the axis *y* which is confirmed by the thicker representation of shrubs in site 95 and the value of correlation coefficient is 0.77 (see Supp. 2 – Figs. 19c, d, Tab. 26). For example, for PN4: NDVI profiles sites 21 and 22 are very similar, their correlation coefficient is 0.98 (see Supp. 2 – Figs. 13c,d, Tab. 20); For PN1: profiles NDVI of sites 3 and 5 are also very similar due to about the same representation of shrubs as confirms the NDVI correlation coefficient 0.85; NDVI profiles for sites pre 1 and 2 are, as expected, shifted lower in the direction of axis *y* compared to sites 3 and 5 due to scarcer shrubs; correlation coefficient between 1 and 2 is 0.93 and between 1 and 5 it is only 0.53 and between 2 and 3 it is only 0.25 (see Supp. 2 – Figs. 11c,d, Tab. 18). In PN11 sites 17 and 18 have similar spectral manifestations as confirm the NDVI profiles (see Supp. 2 – Figs.

18c,d) and the correlation coefficient 0.94 (see Supp. 2 – Tab. 25). Regarding the theme treated in the project, stress is laid on distinction of the tilled arable land from the abandoned land. In this context comparison between sites 17 and 18 (AAL21) with tilled arable land growing maize (site 11) can be taken into account. Part of NDVI profiles for the period May-July is very similar (the biomass of the maize approximates that of herbs and shrubs). The course of NDVI profiles is different outside this period. Correlation coefficient between sites 18 and 19 is 0.65. It confirms a comparatively good discernibility of abandoned arable land overgrown by herbs and shrubs from the tilled arable land.

AAL22 class appears in six localities (PN6, ZK2, ZK4, ZK7, ZK10 and ZK11). The original meadows and pastures are overgrown by about 2.5 m tall shrub formations (see Tab. 17) of Rosa sp., Prunus sp., Juniperus sp., Cornus sp., Crataegus sp., Corylus sp., Rubus sp. and grasses Feastuca sp., Calamagrostis sp., Poa sp., Antoxantum sp., Dactylis sp., Lolium sp., Briza sp. (see Supp. 1 – Tabs. 8, 12, 13, 14, 15, 16) 0.3-2.5 m tall dominate in meadows and pastures. The estimated overall coverage by shrubs is between 15% and 50%. They mostly form patterns of irregular mosaic and circles. PN6 is not a statistically significant set as it is not typical for this class (small area overgrown by herb formations and shrubs neighbouring on vineyards). NDVI values were computed for 14 sites of the selection of pixels with stress on inclusion of shrubs alternating with grass associations only in the ZK study area. The course of NDVI profiles for ZK2 part of which are sites 97, 98, 99 and 101 of the same AAL22 class is very similar. Correlation coefficients (0.75-0.94) confirm it. Comparison of NDVI profiles and correlation coefficients of these sites with mown meadows (sites 100, 102 and 103) points to great similarity (for instance, coefficient of place 100 vs. place 98 is 0.79). It means that it is difficult to discern the overgrown meadows from mown meadows. It is probably given by the spectral similarity of mown meadows (certain period with less green biomass) with overgrown meadows which dry up in July-August and also contain less green biomass (see Supp. 2 – Figs. 19c,d, Tab. 26). ZK4: site 61 (AAL22) vs. site 64 (mown meadow) has a similar NDVI profile (June-August) profile in certain section with coefficient 0.63 (see Supp. 2 – Figs. 20c,d, Tab. 27). It also confirms that the distinction of mown meadows from overgrown meadows is ambiguous. ZK11: sites 88, 89, 90, 91, 94 (AAL22) show a very similar course of NDVI profiles and great similarity (values of correlation coefficients are 0.94-0.99). The overgrown meadow vs. mown meadow (93) discerns by NDVI profiles only in June (mowing time); correlation coefficients 0.63-0.72 confirm the ambiguity of their distinction, (see Supp. 2 – Figs. 23c,d, Tab. 30). Results of the NDVI and correlation coefficients assessment in the ZK study area have shown that it is difficult to discern the overgrowing meadows and pastures from mown meadows.

AAL23S class is represented only in one locality (ZK7). It is an abandoned orchard (after it was removed) with the sporadic occurrence of Prunus sp. cherry trees (below 10 %). Grasses (up to 0.3 m tall) particularly Poa sp., Festuca sp. and Lolium sp. dominate in the herb growth. Shrubs are represented by Prunus spinosa, Rosa sp. and Crataegus sp. They are up to 1.5 m tall and their overall coverage is in a wide interval of 20-100 % (see Tab. 17). NDVI values were computed for five sites of the selection of pixels (68, 69, 70, 71, 74), located in a manner that encompasses combination of grass formations with the density of shrubs from 20% (site 74) to 100% (site 69). Course of NDVI profiles confirms the differentiating density of overgrowing by shrubs (see Figs. 21c,d); it manifests by a shift in the direction of *y* axis (especially May-August) and by a low correlation coefficient (0.25) confirming the different overgrowing (abandonment) stages of meadows and pastures. In case the density of overgrowing by shrubs in abandoned orchards is low their distinction from mown meadows and overgrown meadows is ambiguous (for instance, correlation coefficient of sites 70 vs. 72, 73 is 0.90-0.96, see Supp. 2 – Tab. 28).

AAL12V class was identified in one locality only (PN8, see Figs. 15a,b), it contains vineyards overgrown by herb formations in their initial stage. Its representation is marginal and statistically insignificant. Its physiognomy is similar to the maintained vineyards with counter-erosion strips of grass between the grape vine rows. Moreover, the grape vine did not have to be necessarily attended in time of field research.

AAL23V class is represented in four sites (PN6, PN8, PN9, and PN10). It covers vineyards overgrown by herb and shrub formations. The coverage by overgrowing shrubs moves between 20% and 80%. Apart from herbs there are various grasses (Festuca sp., Calamagrosti sp. and Lolium sp.) and also Galium sp., Tanacetum sp., Jacea sp. and Carduus sp.; Rosa sp., Prunus sp., Crataegus sp., Cornus sp., Rubus sp. dominate among shrubs. Their pattern forms an irregular mosaic. Sporadic representation (below 20%) is also that of trees (especially Acer sp. and Fraxinus sp.) (see Tab. 17 and field Supp. 1 – Tabs. 8, 4, 9, 10). The NDVI values were computed for 18 sites of the selection of pixels. In this type of abandonment of vineyards too, the sites were selected in a manner that represents examples of different densities. The course of NDVI profiles for PN6 (sites 28, 29, 30, 31 and 32) is very similar. Correlation coefficients in case of comparable overgrowing density (sites 28, 29, 30, and 31 see Figs. 14c,d, Tab. 21) are high (0.92-0.97), with the exception of site 32 where the correlation coefficient vs. sites 29, 30 and 31 is considerably lower (0.50-0.60). The course NDVI profiles for PN8, sites 44, 45, 47, 48 and 49 is similar including the shift in the direction of axis y as caused by the amount of herb and shrub vegetation biomass (as the NDVI for site 44 proves). The same goes for correlation coefficients between sites 44, 45, 47 and 48 (values of coefficient are 0.80-0.88) with a slight difference of site 49 (less overgrown) compared to site 44 (where it is 0.58, see Supp. 2 – Figs. 15c,d, Tab. 22). Correlation coefficients point to good discernibility of abandoned vineyards (correlation coefficient of, for instance, 51 vs. 48 is -0.21; that of 50 vs. 48 is 0.34). In PN9 sites 36, 37, 38, 39, 40 are very similar concerning the overgrowing by shrub formations where correlation coefficients move between 0.90 and 0.98. Managed vineyards (sites 41 and 42) clearly differ from the abandoned ones with correlation coefficients 0.41-0.65 (see Supp. 2 – Figs. 16c,d, Tab. 23). Relatively homogenous are also sites 55, 56 and 57 (site PN10); course of their NDVI profiles is very similar (see Supp. 2 – Figs. 17c,d, Tab. 24), as are their correlation coefficients (0.92-0.98) confirming this similarity.

AAL32 class was indentified in two sites (ZK10, ZK11) of meadows and pastures overgrown by shrubs and trees. Among the overgrowing herbs Festuca sp., Poa sp., Antoxantum sp., Dactylis sp. and Galium sp. dominate while the prevailing shrub species are Rosa sp., Prunus sp., Juniperus sp. and Cornus sp.; trees are represented above all by Pinus sp., Betula sp., prunus sp. and Malus sp. (see Supp. 1 – Tabs. 15, 16), They form mosaic patterns or circles. NDVI profiles were computed for four sites of the selection of pixels (ZK10: sites 77 and 81, ZK11: sites 86 and 87). NDVI profiles represented in graphs are very similar.

They take into account the amount of biomass (NDVI profile of site 87 is slightly vertically shifted due to a pronounced overgrowing by trees; the proximity of abandoned meadow is also confirmed by the correlation coefficient between sites 77 and 81 (0.90), or sites 86 and 87 (0.91). The AAL32 class is comparatively well distinguishable from a mown meadow (correlation coefficient for instance in 77 vs. 83 is 0.48; and for 81 vs. 82 it is 0.29). Distinction of AAL32 from AAL22 is more difficult (correlation coefficient for 78 vs. 77 is 0.72, or for 81 vs. 79 is 0.92) (see Supp. 2 – Figs. 22c,d, 23c,d, Tabs. 29, 30).

9. Conclusions

Tab. 31 contains the generalized comparison of results obtained by field research with the NDVI profiles and the Pearson correlation coefficients. By means of correlation coefficients the similarity of AAL classes, their inner consistency (in one or several areas of the same class) and the discernibility of these classes from the LC/LU classes was assessed. This comparison revealed that it is possible to identify unambiguously the defined AAL classes by means of field research and particularly by means of four physiognomic features of overgrowing vegetation: **species composition, tallness, overall cover, clustering into forms – patterns**. NDVI profiles are well comparable within the AAL22 and AAL32 classes (it is possible to assume that the biomass content was approximately the same in the particular time interval) and well comparable in the rest of classes (profile shifts in graph suggest differences in the biomass content). Consistency of the assessed classes was very good for AAL32; very good to good for AAL21, AAL22 and AAL23V; good for AAL11 and problematic for AAL23S. AAL11 and AAL23V classes are the best distinguished from the analogical LC/LU classes while the AA22 and AAL23S classes are difficult to distinguish.

Table 31. Overview of AAL class identifiability (**++** very good, **+** good, **–** problematic)

AAL classes	**Identifiability of AAL classes by means of physiognomic characteristics of vegetation identified by the field research and application of UAV**	**Comparability of NDVI profiles of the same AAL class**	**Pearson correlation index applied to:**	
			Consistency of AAL class (in one or in more areas of the same class)	**Discernability of AAL class from the analogical LC/LU class (not abandoned)**
AAL11	**++**	**+**	**+**	**++**
AAL21	**++**	**+**	**++** also **+** (depending on density of overgrowing)	**+**
AAL22	**++**	**++**	**++** also **+** (depending on density of overgrowing)	**+** also **–** (prevailingly)
AAL23S	**++**	**+**	**–**	**–**
AAL23V	**++**	**+**	**++** also **+** (depending on density of overgrowing)	**++**
AAL32	**++**	**++**	**++**	**+** (depending on density of overgrowing)

10. References

Alcantara, C., Kuemmerle, T., Prishchepov, A. V., Radeloff, V. C. (2012). Mapping abandoned agriculture with multi-temporal MODIS satellite data. *Remote Sensing of Environment*, 124, 334-347.

Angelstam, P., Boresjö-Bronge, L., Mikusiński, G., Sporrong, U., Wästfelt, A. (2003). Assessing village authenticity with satellite images: a method to identify intact cultural landscapes in Europe, *Ambio*, 32, 594-604.

Bannari, A., Mori, D., Huete, A. R., Bonn, F. (1995). A review of vegetation indices. *Remote Sensing Reviews*, 13, 95-120.

Bičík, I., Jeleček, L., Kabrda, J., Kupková, L., Lipský, Z., Mareš, P., Šefrna, L., Štych, P., Winklerová, J. (2012). *Vývoj využití ploch v Česku*. Praha: Edice Geographica.

Coppin, P., Jonckheere, I., Nackaerts, K., Muys, B., Lambin, E. (2004). Digital change detection methods in ecosystem monitoring: a review. *International Journal of Remote Sensing,* 25, 1565-1596.

Estel, S., Kuemmerle, T., Alcantara C., Levers, Ch., Prishchepov, A., Hostert, P. (2015). Mapping farmland abandonment and recultivation across Europe using MODIS NDVI time series. *Remote sensing of Environment*, 163, 312-325.

Feranec, J., Hazeu, G., Soukup, T (2016). Interpretation of Satellite Images. In Feranec, J., Soukup, T., Hazeu G., Jaffrain G., Eds. *European landscape dynamics: CORINE land cover data*. Boca Raton: CRC Press.

Feranec, J., Kopecká, M., Štych, P., Bičík, I., Soukup, T., Jindrová, M., Jupová, K. (2017). Changes of agricultural landscape in Central and Eastern Europe in 1990-2012. In Bičík, I., Himiyama, Y., Eds. *Land Use/Cover Changes in Selected Regions in the World - Volume XII*. Asahikava: IGU LUCC.

Gabrovec, M., Kladnik, D. (1997). Some new aspects of land use in Slovenia. *Geografski Zbornik – Acta Geographica,* 37, 7-64.

Hagolle, O., Huc, M., Villa Pascual, D., Dedieu, G. (2015). A Multi-Temporal and Multi-Spectral Method to Estimate Aerosol Optical Thickness over Land, for the Atmospheric Correction of FormoSat-2, LandSat, VENµS and Sentinel-2 Images. Remote Sensing, 7, 2668-2691.

Kolecka, N., Ginzler, C., Pazur R., et al. (2018). Regional Scale Mapping of Grassland Mowing Frequency with Sentinel-2 Time Series. *Remote Sensing*, 10, 1221. doi: 10.3390/rs10081221

Kozak, J., Estreguil, C., Troll, M. (2007). Forest cover changes in the northern Carpathians in the 20th century: a slow transition. *Journal of Land Use Science,* 2, 127-146.

Kuemmerle, T., Hostert, P., Radeloff, V. C., van der Linden, S., Perzanowski, K., Kruhlov, I. (2008). Cross-border Comparison of Post-socialist Farmland Abandonment in the Carpathians. *Ecosystems*, 11, 614-628.

Löw, F., Prishchepov, A., Waldner, F., Dubovyk, O., Akramkhanov, A., Biradar, C., Lamers, J. (2018). Mapping Cropland Abandonment in the Aral Sea Basin with MODIS Time Series. *Remote Sensing,* 10, 159.

Pazúr, R., Lieskovský, J., Feranec, J., Oťaheľ, J. (2014). Spatial determinants of abandonment of large-scale arable lands and managed grasslands in Slovakia during the periods of post-socialist transition and European Union accession. *Applied Geography,* 54, 118-128.

Pointereau, P., Coulon, F., Girard, P., Lambotte, M., Stuczynski, T., Sanchez Ortega, T. et al. (2008). Analysis of farmland abandonment and the extent and location of agricultural areas that are actually abandoned or are in risk to be abandoned. In Anguiano, E., Bamps, C., Terres M. J.,l Eds., *JRC Scientific and Technical Reports* (EUR 23411 EN).

Taff, G. N., Müller, D., Kuemmerle, T., Ozdeneral, E., Walsh, S. J. (2009). Reforestation in Central and Eastern Europe After the Breakdown of Socialism. In Nagendra, H., Southworth J. Eds. *Reforesting landscape: linking pattern and process*. Dordrecht: Springer Landscape series.

Yin, H., Prishchepov, A. V., Kuemmerle, T., Bleyhl, B., Buchner, J., Radeloff, V. C. (2018). Mapping agricultural land abandonment from spatial and temporal segmentation of Landsat time series. *Remote Sensing of. Environment,* 210, 12-24.

Zhong, B., Chen, W., Wu, S. et al. (2017). A Cloud Detection Method Based on Relationship Between Objects of Cloud and Cloud-Shadow for Chinese Moderate to High Resolution Satellite Imagery. *IEEE J Sel Top Applied Earth Observation Remote Sensing,* 10, 4898–4908. doi: 10.1109/JSTARS.2017.2734912

Supplement 1: PN1 – Table 5

Trieda/Class:	**AAL2111**		
Dátum záznamu činnosti/Date of actvity record:		14.6.2018	
Poloha/Location:	Rača		
Nadmorská výška stredu areálu/Sea level altitude of the area:			138 m
Tvar georeliéfu/Form of terrain:	◉ rovina/flatland ○ svah/slope ☐ S	orientácia/orientation: ☐ N ☐ E	☐ W ☐ combined
Pôdny typ/Soil type:	11, 14		
Pôdny druh/Soil texture:	hlinitá/loamy soil		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: *Festuca, Calamagrostis, Lolium, Senecio, Anthemis, Carduus*		
	E_2 – krovinovej/shrubby: Rosa, Populus, Rubus		
	E_3 – stromovej/tree: -		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: 0,7-0,9 m	E_2: 1-2 m	E_3: -
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *mozaika malých skupín krov/ mosaic of small groups*	E_3: -
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☐ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: 10-40 %	E_3: -
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular	☐ nepravidelný/irregular ☑ ostrý/distinct	☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: PN2 – Table 6

Trieda/Class:	**AAL1112**		
Dátum záznamu činnosti/Date of actvity record:	14.6.2018		
Poloha/Location:	Svätý Jur		
Nadmorská výška stredu areálu/Sea level altitude of the area:	130 m		
Tvar georeliéfu/Form of terrain:	◉ rovina/flatland ○ svah/slope ☐ S	orientácia/orientation: ☐ N ☐ E ☐ W ☐ combined	
Pôdny typ/Soil type:	11, 22, 27, 95		
Pôdny druh/Soil texture:	*hlinitá/loamy soil, ílovitohlinitá/clay-loamy, piesočnatohlinitá/sand-loamy*		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: Lolium, Anthemis		
	E_2 – krovinovej/shrubby: -		
	E_3 – stromovej/tree: -		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: 0,6-0,7 m	E_2: -	E_3: -
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: -	E_3: -
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☐ iné/other	☐ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: -	E_3: -
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular	☐ nepravidelný/irregular ☑ ostrý/distinct	☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: PN4 – Table 7

Trieda/Class:	**AAL2114**		
Dátum záznamu činnosti/Date of actvity record:		27.6.2018	
Poloha/Location:	Šenkvice		
Nadmorská výška stredu areálu/Sea level altitude of the area:			168 m
Tvar georeliéfu/Form of terrain:	◉ rovina/flatland	orientácia/orientation:	
	○ svah/slope	☐ J/S ☐ S/N ☐ V/E	☐ Z/W ☐ kombinovaná/combined
Pôdny typ/Soil type:	50		
Pôdny druh/Soil texture:	hlinitá/loamy soil		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: Calamagrostis, Festuca, Conyza		
	E_2 – krovinovej/shrubby: Rosa, Prunus, Crataegus		
	E_3 – stromovej/tree: -		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: do/up to 1,2 m	E_2: do/up to 3 m	E_3: -
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *nepravidelná mozaika/ irregular mosaic*	E_3: -
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☐ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: 20-60 %	E_3: -
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular	☐ nepravidelný/irregular	☑ ostrý/distinct ☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: PN6 – Table 8

Trieda/Class:	**AAL23V16, AAL2216**		
Dátum záznamu činnosti/Date of actvity record:	12.7.2018		
Poloha/Location:	Modra		
Nadmorská výška stredu areálu/Sea level altitude of the area:	192 m		
Tvar georeliéfu/Form of terrain:	◉ rovina/flatland ○ svah/slope ☐ S	orientácia/orientation: ☐ N ☐ E	☐ W ☐ kombinovaná/combined
Pôdny typ/Soil type:	51, 71		
Pôdny druh/Soil texture:	hlinitá/loamy soil, ílovitohlinitá/clay-loamy		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
E_1 – travinno-bylinnej/grass-herbs: *Festuca, Calamagrostis, Galium, Tanacetum / 23V16* *Calamagrostis, Festuca, Tanacetum, Achillea / 2216*			
E_2 – krovinovej/shrubby: *Rosa, Prunus, Crataegus, Cornus / 23V16* *Rosa, Prunus, Crataegus, Rubus / 2216*			
E_3 – stromovej/tree: -			
Vertikálna štruktúra vegetácie – prevládajúca výška: **Vertical vegetation structures – prevailing tallness:**			
	E_1: 0,6-0,8 m	E_2: *do/up to 3 m/23V16, 1 m / 2216*	E3: -
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *nepravidelný sporadický výskyt/ sporadic appearance*	E_3: -
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☐ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: *60-80 % /23V16, 20-50%/ 2216*	E_3: -
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular	☐ nepravidelný/irregular ☑ ostrý/distinct	☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: PN9 – Table 9

Trieda/Class:	**AAL23V19**		
Dátum záznamu činnosti/Date of actvity record:	12.7.2018		
Poloha/Location:	Modra		
Nadmorská výška stredu areálu/Sea level altitude of the area:	219 m		
Tvar georeliéfu/Form of terrain:	○ rovina/flatland	orientácia/orientation:	
	◉ svah/slope	☐ J/S ☐ S/N ☐ V/E ☐ Z/W ☑ kombinovaná/combined	
Pôdny typ/Soil type:	26, 51, 60, 71		
Pôdny druh/Soil texture:	hlinitá/loamy soil, ílovitohlinitá/clay-loamy		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: Festuca, Calamagrostis		
	E_2 – krovinovej/shrubby: Rosa, Prunus, Crataegus, Cornus		
	E_3 – stromovej/tree: Prunus avium, Acer, Fraxinus		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: do/up to 0,6 m	E_2: do/up to 2,5 m	E_3: above 3 m
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *nepravidelná mozaika/ irregular mosaic*	E_3: *sporadic appearance*
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☑ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: 40-80 %	E_3: up to 10%
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular ☐ nepravidelný/irregular	☑ ostrý/distinct	☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: PN10 – Table 10

Trieda/Class:	**AAL11110, AAL23V110**		
Dátum záznamu činnosti/Date of actvity record:		14.6.2018	
Poloha/Location:	Reca		
Nadmorská výška stredu areálu/Sea level altitude of the area:			123 m
Tvar georeliéfu/Form of terrain:	◉ rovina/flatland ○ svah/slope ☐ S	orientácia/orientation: ☐ N ☐ E	☐ W ☐ kombinovaná/combined
Pôdny typ/Soil type:	32, 34, 35		
Pôdny druh/Soil texture:	piesočnatohlinitá/sand-loamy, hlinitá/loamy soil		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: *Arrhenatherum, Anthemis, Daucus,Carduus / 11110* *Lolium, Carduus / 23V110*		
	E_2 – krovinovej/shrubby: *Rosa, Vitis (remainders) / 23V110*		
	E_3 – stromovej/tree: -		
Vertikálna štruktúra vegetácie – prevládajúca výška: **Vertical vegetation structures – prevailing tallness:**			
	E_1: do/up to 0,6 m	E_2: app. 1,5 m / 23V110	E_3: -
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *riedka mozaika/ sparse mosaic*	E_3: -
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☐ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: 20-30 %	E_3: -
Tvar hraníc AAL/Shape of AAL borders:	☐ pravidelný/regular ☐ nepravidelný/irregular	☑ ostrý/distinct	☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: PN11 – Table 11

Trieda/Class:	**AAL11111, AAL21111**		
Dátum záznamu činnosti/Date of actvity record:		14.6.2018	
Poloha/Location:	Bernolákovo		
Nadmorská výška stredu areálu/Sea level altitude of the area:		134 m	
Tvar georeliéfu/Form of terrain:	◉ rovina/flatland	orientácia/orientation:	
	○ svah/slope ☐ S	☐ N ☐ E	☐ W ☐ combined
Pôdny typ/Soil type:	17, 34		
Pôdny druh/Soil texture:	hlinitá/loamy soil, piesočnatohlinitá/ sand-loamy		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: *Anthemis, Conyza, Artemisia, Papaver, Carduus /11111*		
	Calamagrostis,Melilotus, Lathyrus / 21111		
	E_2 – krovinovej/shrubby: *Robinia (shrub form), Rosa / 21111*		
	E_3 – stromovej/tree: *Ailanthus / 21111*		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: *0,7-1,3 m / 11111* *do/up to 0,5 m / 21111*	E_2: *do/up to 3 m /21111*	E_3: *above 3 m / 21111*
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *nepravidelná mozaika/ irregular mosaic*	E_3: *kontinuálny pás/ continual stripe*
	☐ pásov/stripes	☐ pásov/stripes	☑ pásov/stripes 21111
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☐ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: 20-30 %	E_3: 10-20 %
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular	☐ nepravidelný/irregular ☑ ostrý/distinct	☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: ZK2 – Table 12

Trieda/Class:	**AAL2122, AAL2222**		
Dátum záznamu činnosti/Date of actvity record:	21.6.2018		
Poloha/Location:	Plešť II		
Nadmorská výška stredu areálu/Sea level altitude of the area:	522 m		
Tvar georeliéfu/Form of terrain:	○ rovina/flatland	orientácia/orientation:	
	◉ svah/slope	☐ J/S ☑ S/N ☑ V/E	☐ Z/W ☑ kombinovaná/combined
Pôdny typ/Soil type:	71, 77, 81		
Pôdny druh/Soil texture:	hlinitá/loamy soil		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: Festuca, Poa, Briza, Eryngium, Galium		
	E_2 – krovinovej/shrubby: Rosa, Prunus, Corylus, Crategus		
	E_3 – stromovej/tree: -		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: do/up to 0,3 m	E_2: 1-2,5 m	E_3: -
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *mozaika / mosasaic*	E_3: -
	☐ pásov/stripes	☑ pásov/stripes 2122	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other 2222	☐ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: *40-50 % / 2122, 20% / 2222*	E_3: -
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular	☐ nepravidelný/irregular ☐ ostrý/distinct	☑ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: ZK4 – Table 13

Trieda/Class:	**AAL2224**		
Dátum záznamu činnosti/Date of actvity record:		20.6.2018	
Poloha/Location:	Vígľaš		
Nadmorská výška stredu areálu/Sea level altitude of the area:			363 m
Tvar georeliéfu/Form of terrain:	○ rovina/flatland	orientácia/orientation:	
	◉ svah/slope ☐ J/S	☐ S/N ☐ V/E	☐ Z/ ☑ kombinovaná/combined
Pôdny typ/Soil type:			
Pôdny druh/Soil texture:	hlinitá/loamy soil		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: Calamagrostis, Festuca, Conyza		
	E_2 – krovinovej/shrubby: Rosa, Prunus, Crataegus		
	E_3 – stromovej/tree: -		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: do/up to 1,2 m	E_2: ca 2 m	E_3: -
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *kruhy rôznej veľkosti/ circles of different sizes*	E_3: -
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☑ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☐ iné/other	☐ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: 15-20 %	E_3: -
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular	☐ nepravidelný/irregular ☑ ostrý/distinct	☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: ZK7 – Table 14

Trieda/Class:	**AAL23S27, AAL2227**		
Dátum záznamu činnosti/Date of actvity record:	20.6.2018		
Poloha/Location:	Stožok		
Nadmorská výška stredu areálu/Sea level altitude of the area:	457 m		
Tvar georeliéfu/Form of terrain:	○ rovina/flatland; ◉ svah/slope	orientácia/orientation: ☐ J/S ☐ S/N ☐ V/E ☐ Z/W ☑ kombinovaná/combined	
Pôdny typ/Soil type:	77, 81, 94		
Pôdny druh/Soil texture:	hlinitá/loamy soil, piesočnatohlinitá/sand-loamy		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: Poa, Festuca, Lolium		
	E_2 – krovinovej/shrubby: Prunus, Rosa, Crataegus		
	E_3 – stromovej/tree: Prunus avium		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: do/up to 0,3 m	E_2: 0,5-1,5 m	E_3: above 3 m
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *nepravidelná mozaika/ irregular mosaic*	E_3: *sporadický výskyt/ sporadic appearance*
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☑ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: *takmer 100 % / 23S27xx*	E_3: do/up to 10 %
		E_2: *20 % / 23S27x*	
		E_2: *20 % / 2227*	
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular	☐ nepravidelný/irregular; ☑ ostrý/distinct	☐ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

Supplement 1: ZK10 – Table 15

Trieda/Class:	**AAL22210, AL32210**		
Dátum záznamu činnosti/Date of actvity record:		20.6.2018	
Poloha/Location:	Klokoč		
Nadmorská výška stredu areálu/Sea level altitude of the area:			556 m
Tvar georeliéfu/Form of terrain:	○ rovina/flatland	orientácia/orientation:	
	◉ svah/slope ☐ S	☑ N ☐ E	☑ W ☑ kombinovaná/combined
Pôdny typ/Soil type:	71, 81		
Pôdny druh/Soil texture:	hlinitá/loamy soil, piesočnatohlinitá/sand-loamy		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: Festuca, Poa, Anthoxanthum, Galium /32210, 22210		
	E_2 – krovinovej/shrubby: Rosa, Prunus, Juniperus, Cornus /32210, 22210		
	E_3 – stromovej/tree: Pinus, Betula /32210		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: do/up to 0,6 m	E_2: do/up to 2 m	E_3: above 3 m
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *skupiny - mozaika/ groups - mosaic*	E_3: *mozaika/ mosaic*
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☑ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☑ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: *30-40 % / 22210, 60 % / 32210*	E_3: *20 % / 32210*
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular ☐ nepravidelný/irregular	☐ ostrý/distinct	☑ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

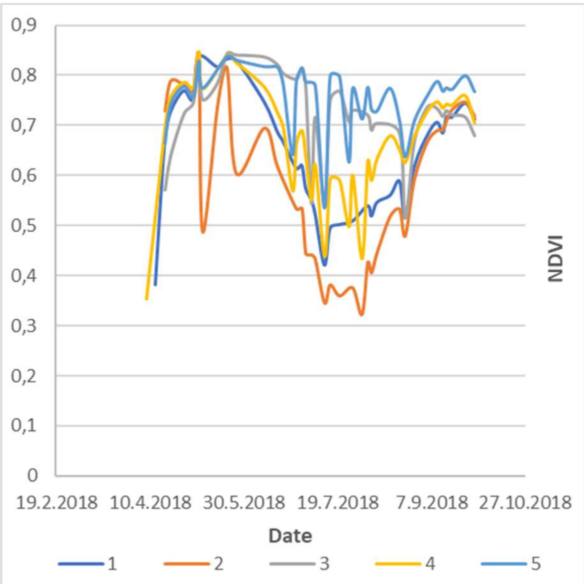
Supplement 1: ZK11 – Table 16

Trieda/Class:	**AAL22211, AAL32211**		
Dátum záznamu činnosti/Date of actvity record:	20.6.2018		
Poloha/Location:	Slatinské Lazy		
Nadmorská výška stredu areálu/Sea level altitude of the area:	631 m		
Tvar georeliéfu/Form of terrain:	○ rovina/flatland ◉ svah/slope	orientácia/orientation: ☐ J/S ☑ S/N ☐ V/E ☑ Z/W ☑ kombinovaná/combined	
Pôdny typ/Soil type:	77, 81		
Pôdny druh/Soil texture:	hlinitá/loamy soil, ilovitohlinitá/clay-loamy, piesočnatohlinitá/sand-loamy		
Vegetácia/Vegetation:			
Základné druhové zloženie/Basic species composition			
	E_1 – travinno-bylinnej/grass-herbs: Festuca, Anthoxanthum, Poa, Dactylis, Galium /32211, 22211		
	E_2 – krovinovej/shrubby: Rosa, Prunus /32211, 22211		
	E_3 – stromovej/tree: Prunus avium, Malus, Betula / 32211		
Vertikálna štruktúra vegetácie – prevládajúca výška:			
Vertical vegetation structures – prevailing tallness:			
	E_1: do/up to 1,2 m	E_2: do/up to 1,5 m	E_3: above 3 m
Jej vzhľadové zoskupenie do tvarov/Apparent clustering into forms:			
	E_1: *kontinuálne zarastenie/ fully overgrown*	E_2: *mozaika / mosaic*	E_3: *mozaika - solitéry/ mosaic - solitaires*
	☐ pásov/stripes	☐ pásov/stripes	☐ pásov/stripes
	☐ kruhov/circles	☐ kruhov/circles	☐ kruhov/circles
	☑ iné/other	☑ iné/other	☑ iné/other
Celková pokryvnosť vegetácie/Overall vegetation cover:			
	E_1: 100 %	E_2: 20-40 %	E_3: 20-30 % /32211
Tvar hraníc AAL/Shape of AAL borders:			
	☐ pravidelný/regular ☐ nepravidelný/irregular	☐ ostrý/distinct	☑ neostrý/indistinct
Ďalšie charakteristiky/Additional characteristics:			

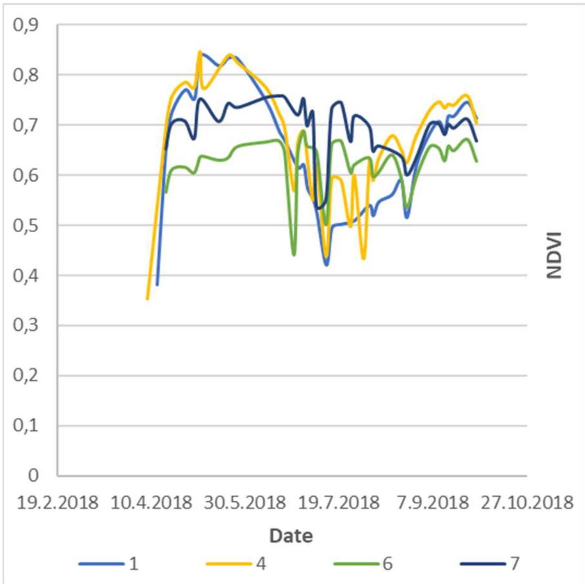
a

Supplement 2: PN1 – Fig. 11	
a	AAL & LC/LU classes
1-7	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

b



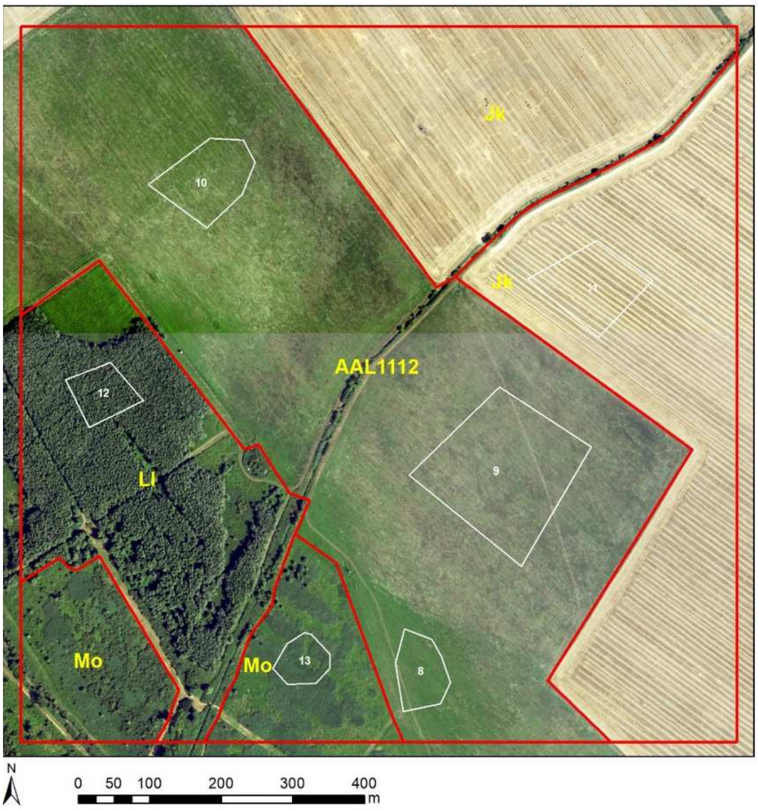
c



d

Table 18: Pearson correlation coefficient

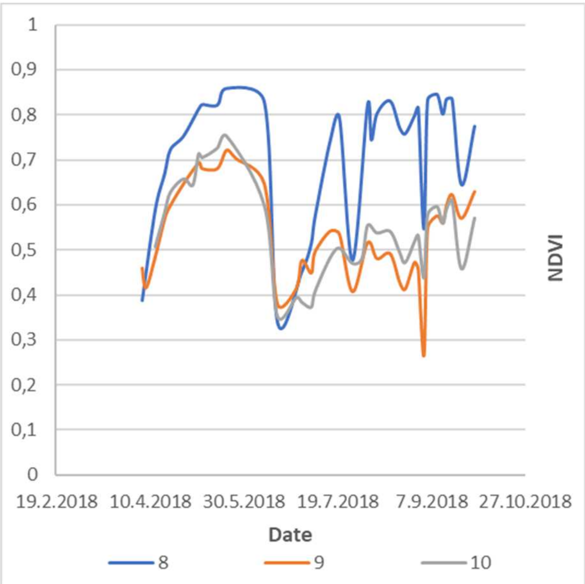
ID	*TEXT-ID*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
1	AAL2111-a	-						
2	AAL2111-b	0,93	-					
3	AAL2111-c	0,50	0,25	-				
4	AAL2111-d	0,96	0,86	0,53	-			
5	AAL2111-e	0,53	0,33	0,85	0,67	-		
6	Uz-1	0,34	0,16	0,82	0,47	0,84	-	
7	Uz-2	0,48	0,32	0,67	0,49	0,74	0,71	-



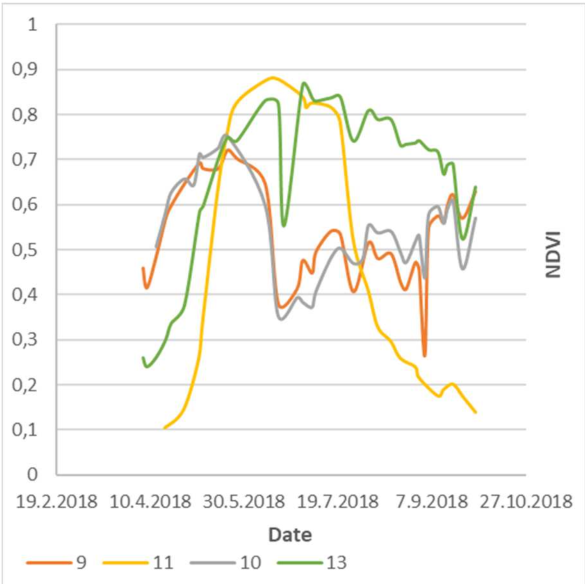
a

Supplement 2: PN2 – Fig. 12	
a	AAL & LC/LU classes
8-13	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

b



c



d

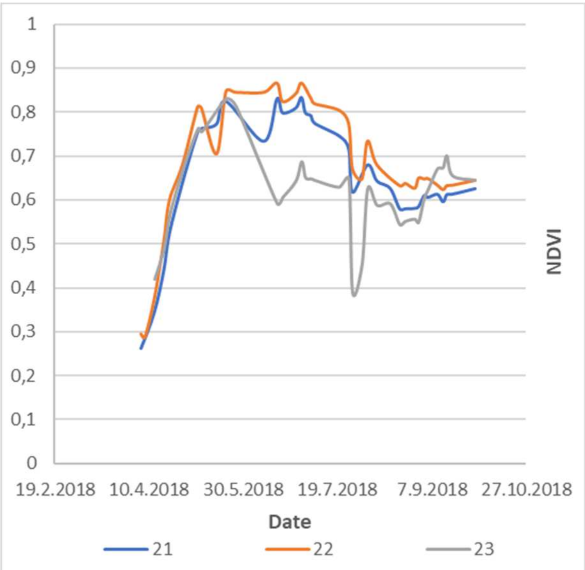
Table 19: Pearson correlation coefficient

ID	*TEXT-ID*	*8*	*9*	*10*	*11*	*12*	*13*
8	AAL1112-a	-					
9	AAL1112-b	0,60	-				
10	AAL1112-c	0,75	0,84	-			
11	Jk-1	-0,43	-0,06	-0,32	-		
12	Ll-2	0,25	0,39	0,34	0,35	-	
13	Mo-3	0,15	-0,07	-0,37	0,66	0,57	-

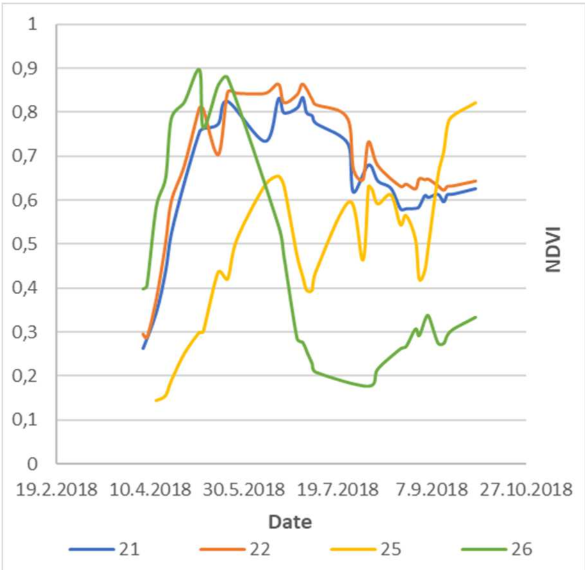
Supplement 2: PN4 – Fig. 13	
a	AAL & LC/LU classes
21-27	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

b

a



c

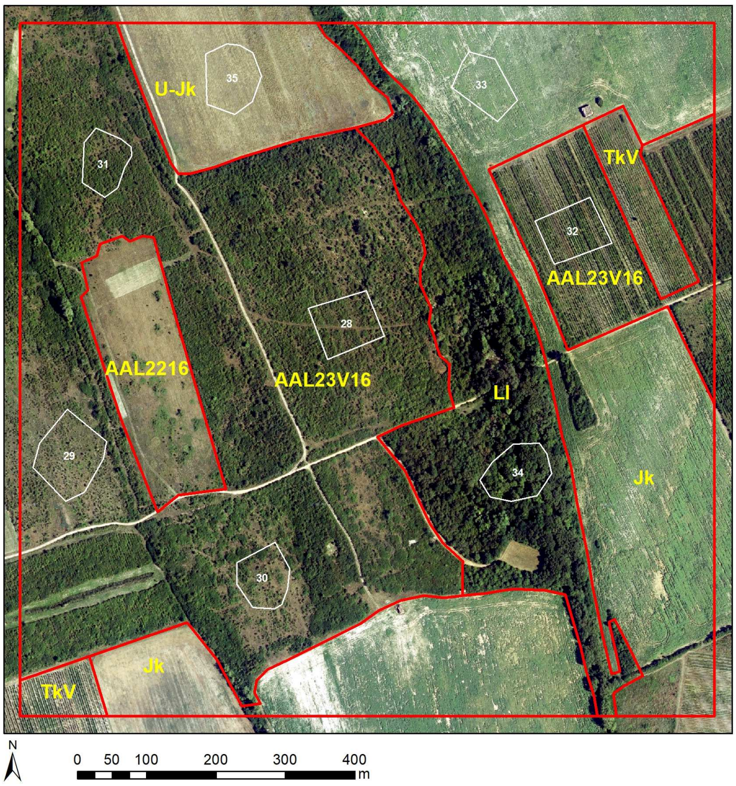


d

Table 20: Pearson correlation coefficient

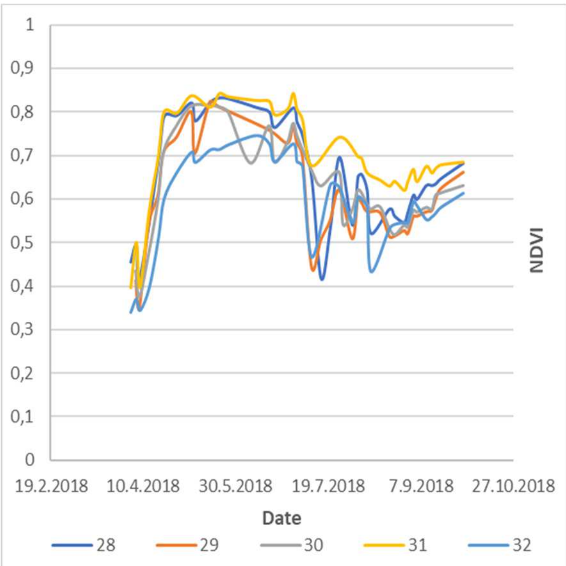
ID	*TEXT-ID*	*21*	*22*	*23*	*24*	*25*	*26*	*27*
21	AAL2114-a	-						
22	AAL2114-b	0,98	-					
23	AAL2114-c	0,64	0,62	-				
24	Kl-1	0,91	0,92	0,68	-			
25	Kl-2	0,19	0,19	0,19	-0,09	-		
26	Jk-3	0,05	0,06	0,26	0,26	-0,57	-	
27	Jk-4	0,72	0,68	0,07	0,60	0,13	-0,36	-

Supplement 2: PN6 – Fig. 14	
a	AAL & LC/LU classes
28-35	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

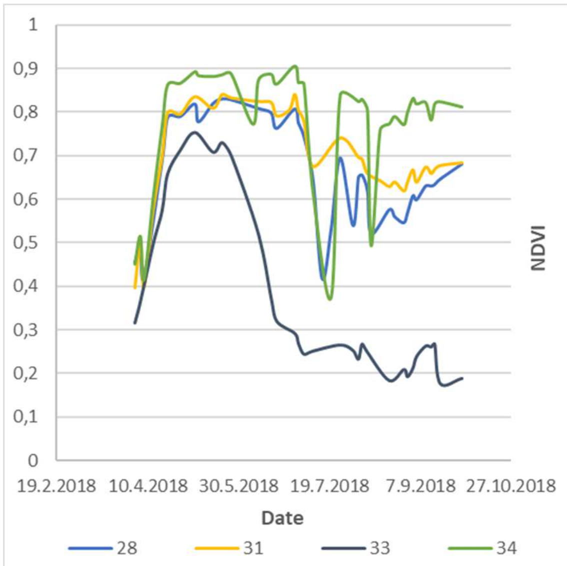


a

b



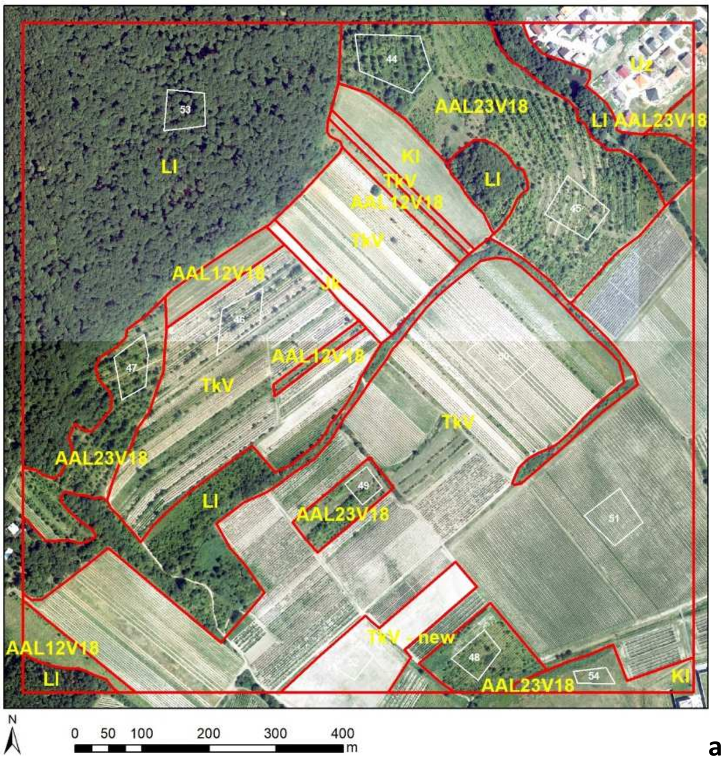
c



d

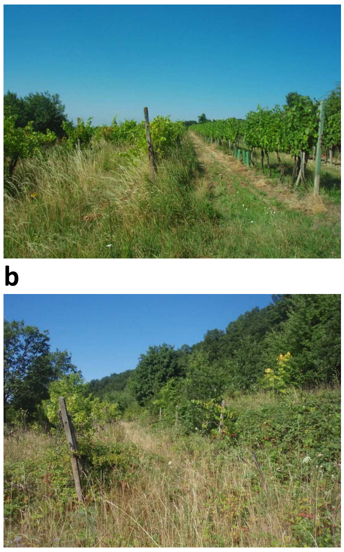
Table 21: Pearson correlation coefficient

ID	*TEXT-ID*	*28*	*29*	*30*	*31*	*32*	*33*	*34*
28	AAL23V16-a	-						
29	AAL23V16-b	0,93	-					
30	AAL23V16-c	0,90	0,92	-				
31	AAL23V16-d	0,97	0,94	0,97	-			
32	AAL23V16-e	0,88	0,50	0,54	0,60	-		
33	Jk-1	0,66	0,61	0,59	0,49	0,34	-	
34	Ll-2	0,80	0,74	0,73	0,90	0,79	0,22	-
35	U-Jk-3	*OUT*						

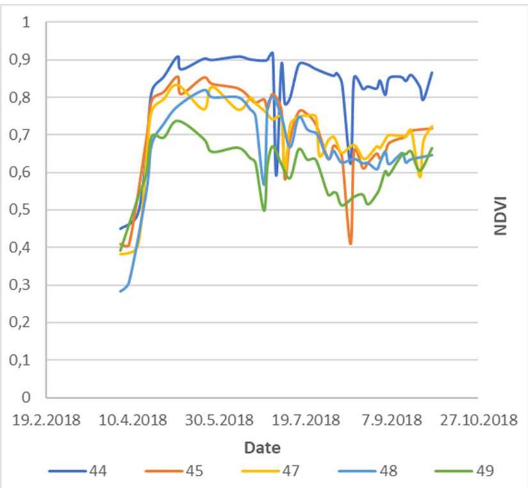


a

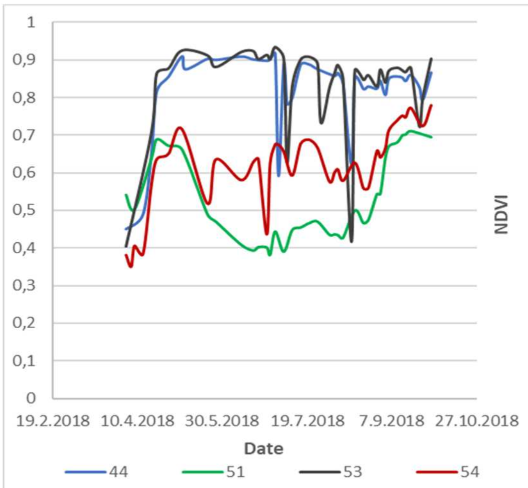
Supplement 2: PN8 – Fig. 15	
a	AAL & LC/LU classes
44-54	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes



b



c

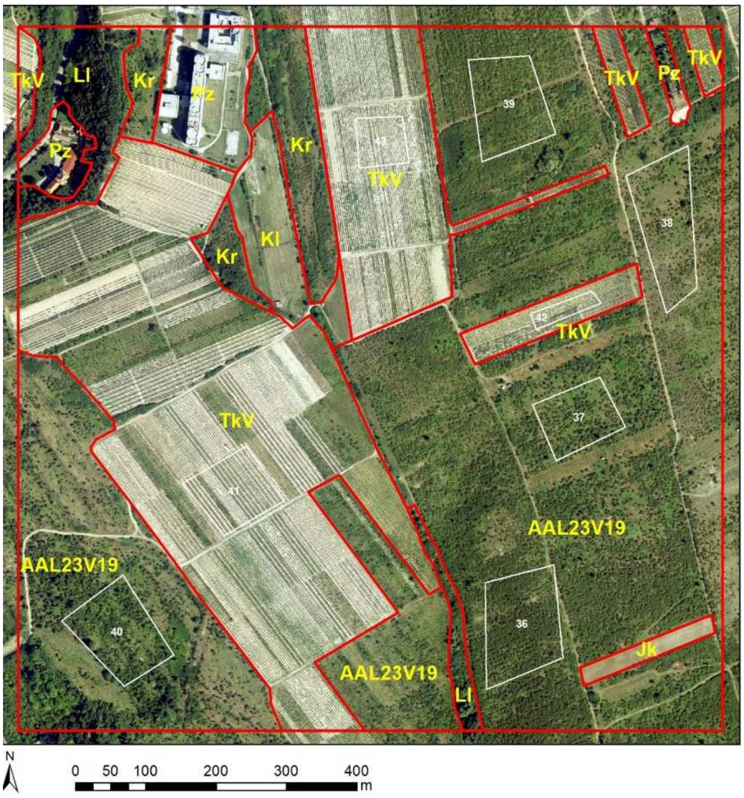


d

Table 22: Pearson correlation coefficient

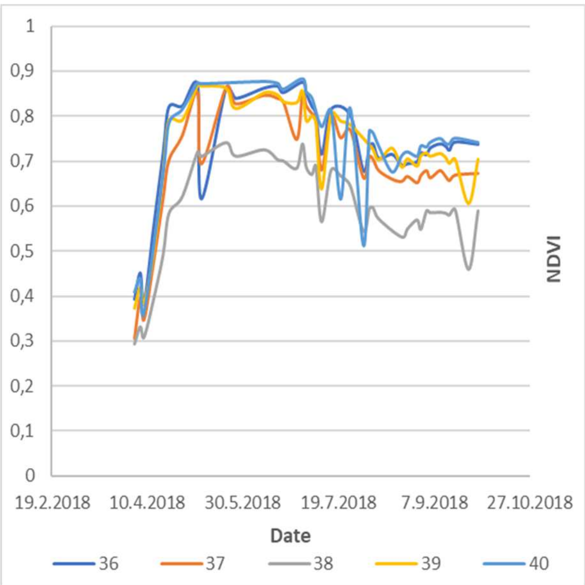
ID	*TEXT-ID*	*44*	*45*	*46*	*47*	*48*	*49*	*50*	*51*	*53*	*54*
44	AAL23V18-a	-									
45	AAL23V18-b	0,80	-								
46	Tkv-1	0,43	0,59	-							
47	AAL23V18-c	0,88	0,95	0,60	-						
48	AAL23V18-d	0,85	0,90	0,38	0,87	-					
49	AAL23V18-e	0,58	0,82	0,78	0,72	0,77	-				
50	Tkv-2	0,58	0,31	0,67	0,52	0,34	0,54	-			
51	Tkv-4	-0,22	-0,07	0,65	-0,08	-0,21	0,33	0,53	-		
53	Ll-4	0,92	0,83	0,42	0,87	0,80	0,60	0,55	-0,14	-	
54	Kl-5	0,52	0,44	0,66	0,55	0,52	0,66	0,81	0,50	0,49	-
52	Tkv-3	*OUT*									

Supplement 2: PN9 – Fig. 16	
a	AAL & LC/LU classes
36-43	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

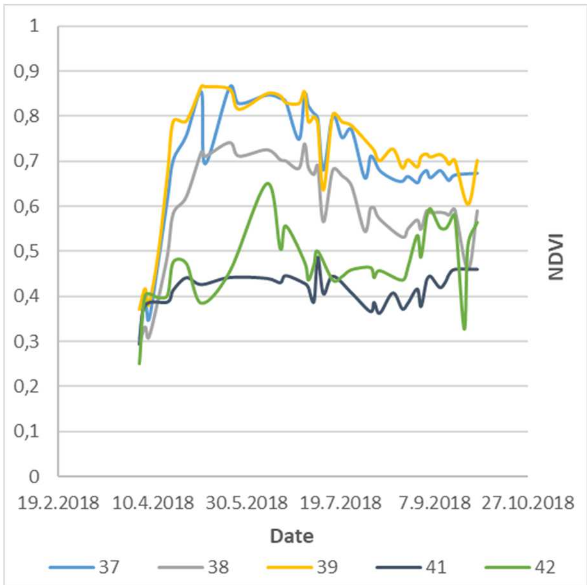


a

b



c

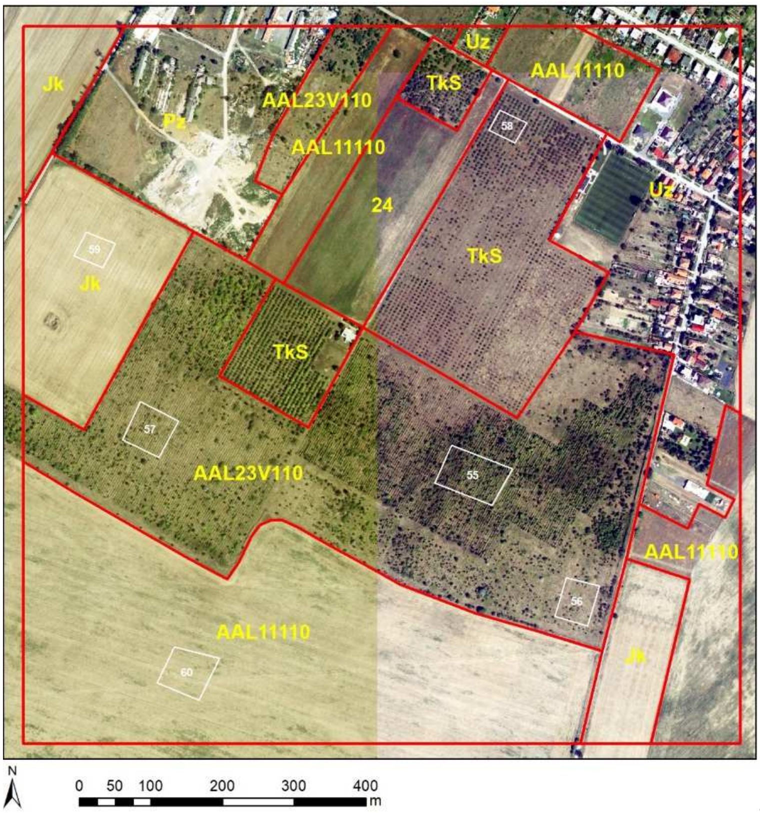


d

Table 23: Pearson correlation coefficient

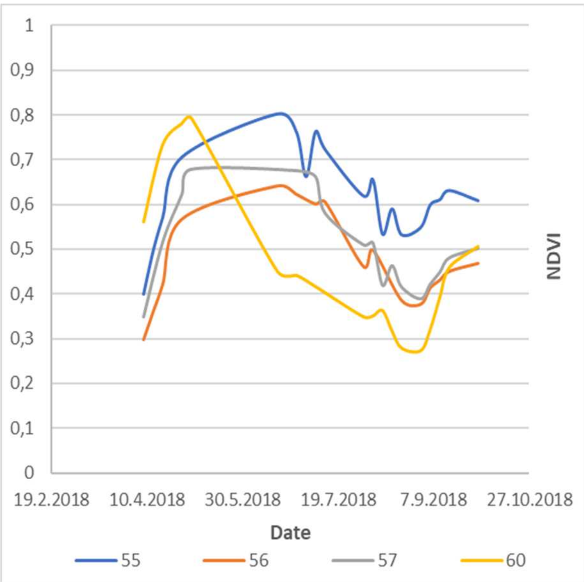
ID	*TEXT-ID*	*36*	*37*	*38*	*39*	*40*	*41*	*42*
36	AAL23V19-a	-						
37	AAL23V19-b	0,97	-					
38	AAL23V19-c	0,92	0,97	-				
39	AAL23V19-d	0,92	0,96	0,98	-			
40	AAL23V19-e	0,90	0,90	0,91	0,93	-		
41	Tkv-1	0,65	0,61	0,67	0,61	0,61	-	
42	Tkv-2	0,45	0,41	0,43	0,42	0,48	0,69	-
43	TkV-3				*OUT*			

Supplement 2: PN10 – Fig. 17	
a	AAL & LC/LU classes
55-60	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

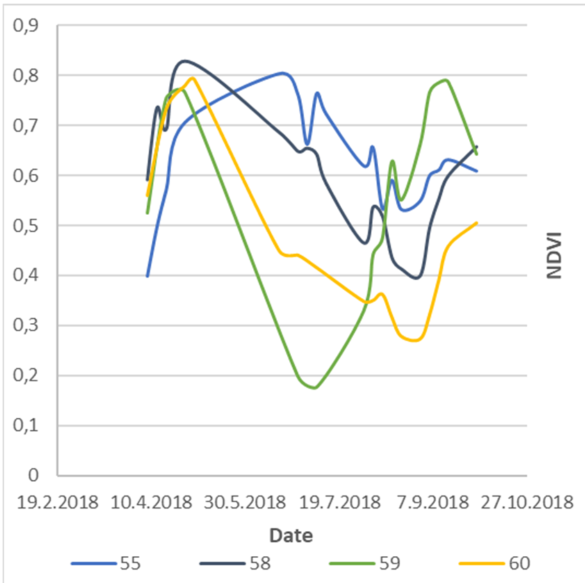


a

b



c



d

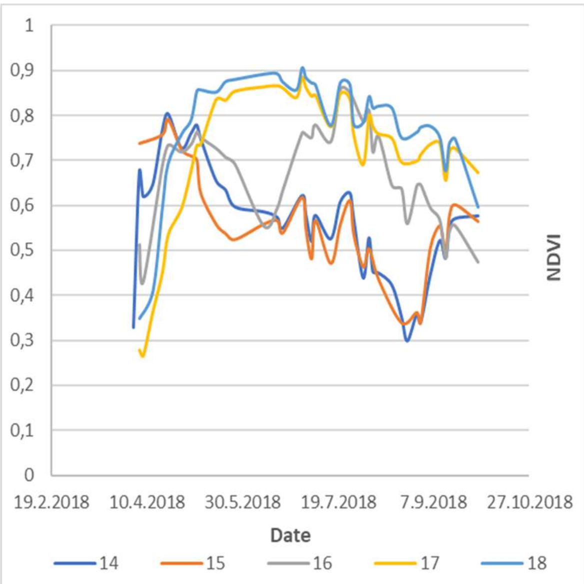
Table 24: Pearson correlation coefficient

ID	*TEXT-ID*	*55*	*56*	*57*	*58*	*59*	*60*
55	AAL23V110-a	-					
56	AAL23V110-b	0,98	-				
57	AAL23V110-c	0,92	0,96	-			
58	Tks-1	0,35	0,39	0,63	-		
59	Jk-2	-0,37	-0,50	-0,48	0,07	-	
60	AAL11110	0,10	0,16	0,51	0,88	0,27	-

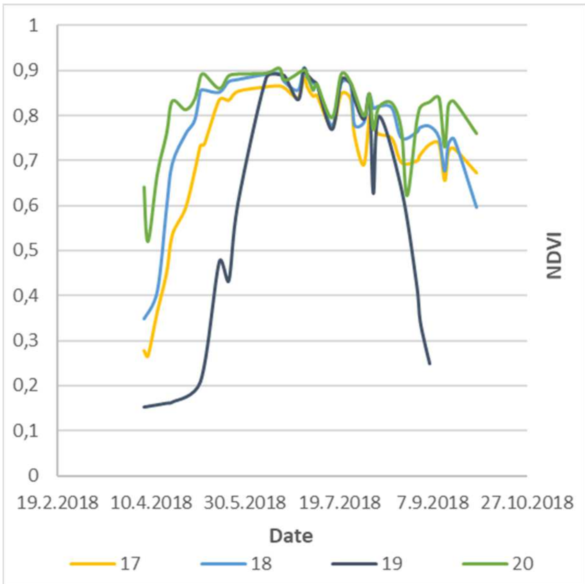
Supplement 2: PN11 – Fig. 18	
a	AAL & LC/LU classes
14-20	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

b

a



c

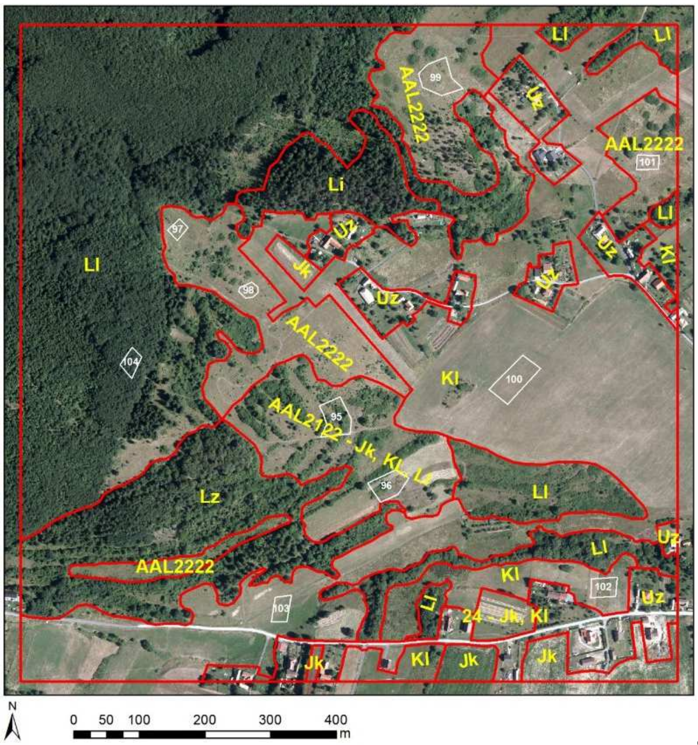


d

Table 25: Pearson correlation coefficient

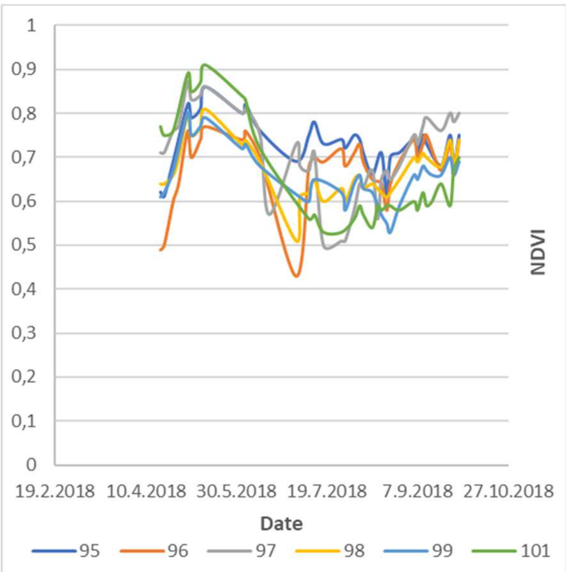
ID	*TEXT-ID*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
14	AAL11111/1-a	-						
15	AAL11111/1-b	0,94	-					
16	AAL11111/1-c	0,23	0,07	-				
17	AAL21111/2-a	-0,26	-0,43	0,48	-			
18	AAL21111/2-b	-0,13	-0,29	0,55	0,94	-		
19	Jk-1	-0,28	-0,35	0,38	0,74	0,65	-	
20	Ll-2	0,20	0,01	0,60	0,88	0,91	0,51	-

Supplement 2: ZK2 – Fig. 19	
a	AAL & LC/LU classes
95-104	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

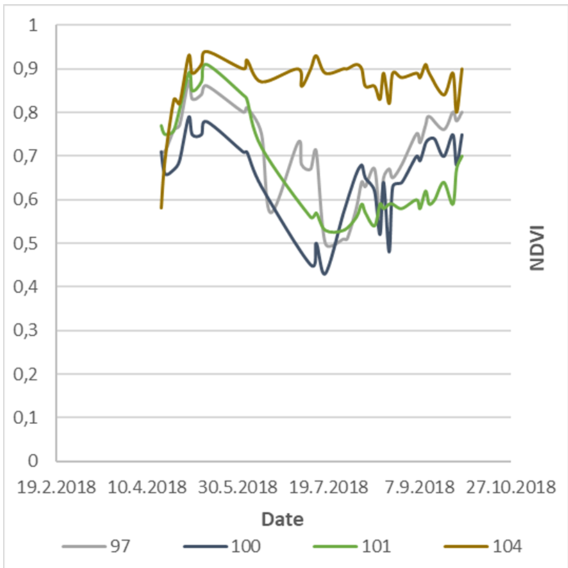


a

b



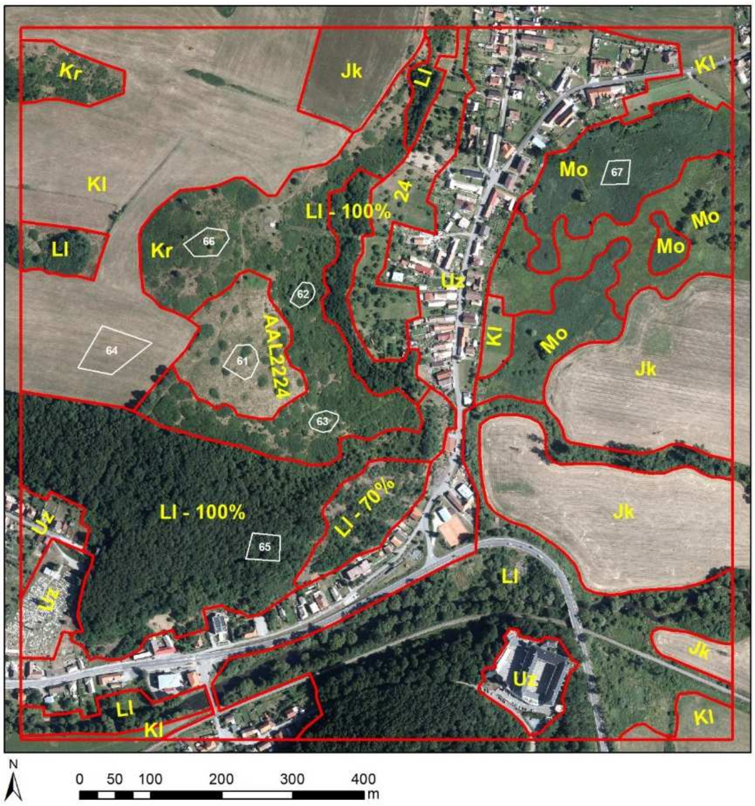
c



d

Table 26: Pearson correlation coefficient

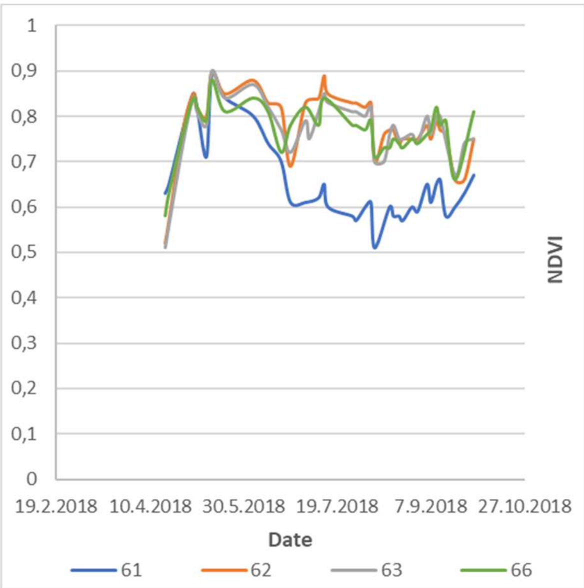
ID	*TEXT-ID*	*95*	*96*	*97*	*98*	*99*	*100*	*101*	*102*	*103*	*104*
95	AAL2122-a	-									
96	AAL2122-b	0,77	-								
97	AAL2222-c	0,40	0,20	-							
98	AAL2222-d	0,68	0,68	0,75	-						
99	AAL2222-e	0,75	0,59	0,79	0,94	-					
100	Kl-1	0,34	0,30	0,76	0,79	0,69	-				
101	AAL2222-f	0,45	0,10	0,75	0,75	0,75	0,59	-			
102	Kl-3	0,57	0,56	0,71	0,87	0,80	0,88	0,58	-		
103	Kl-4	0,55	0,53	0,63	0,81	0,80	0,85	0,53	0,83	-	
104	Ll-5	0,74	0,68	0,07	0,25	0,33	0,04	-0,06	0,25	0,17	-



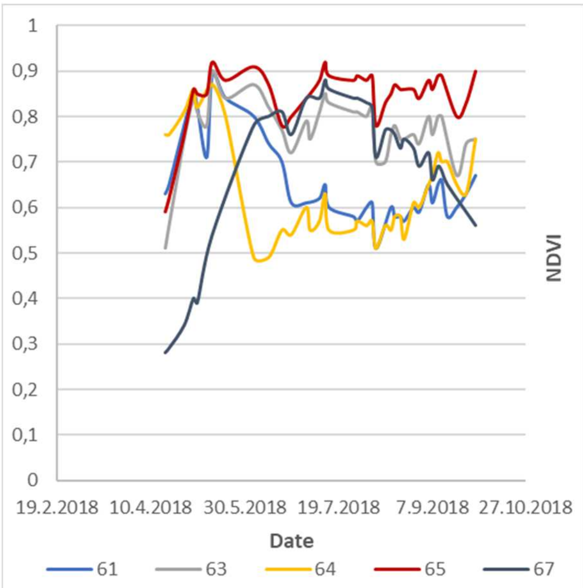
a

Supplement 2: ZK4 – Fig. 20	
a	AAL & LC/LU classes
61-67	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

b



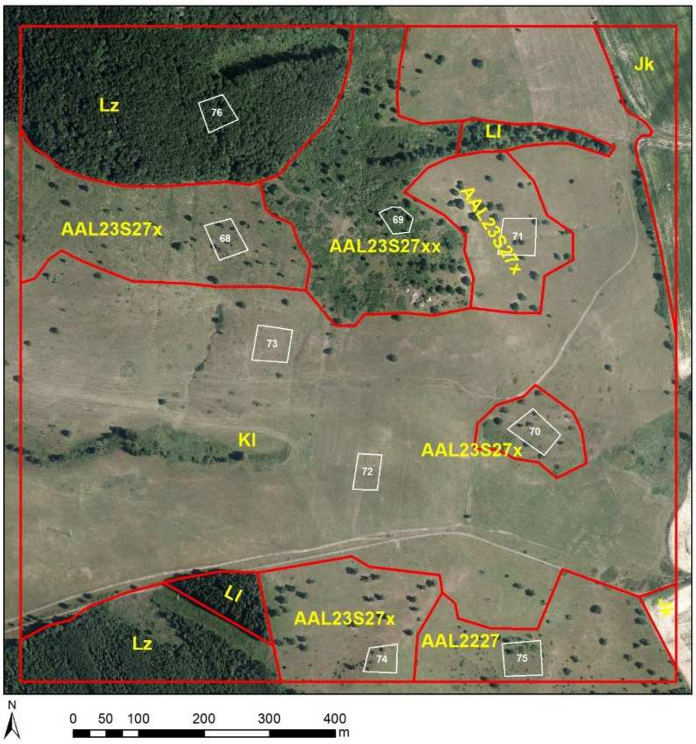
c



d

Table 27: Pearson correlation coefficient

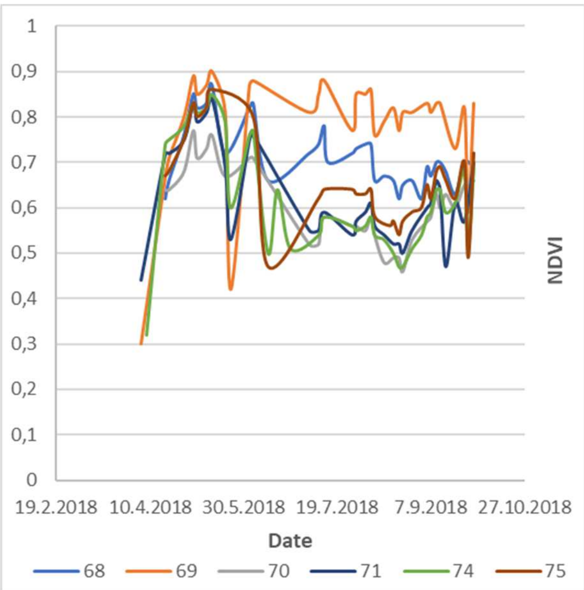
ID	*TEXT-ID*	*61*	*62*	*63*	*64*	*65*	*66*	*67*
61	AAL2224	-						
62	Kr-1	0,41	-					
63	Kr-2	0,41	0,95	-				
64	Kl-3	0,63	-0,08	-0,05	-			
65	Ll-4	0,13	0,82	0,90	-0,19	-		
66	Kr-5	0,50	0,88	0,92	0,14	0,82	-	
67	Mo-6	-0,48	0,53	0,50	-0,83	0,63	0,31	-



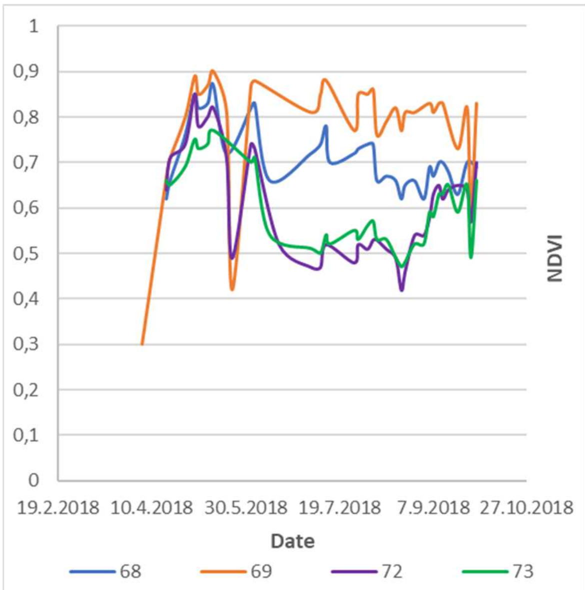
a

Supplement 2: ZK7 – Fig. 21	
a	AAL & LC/LU classes
68-76	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

b



c

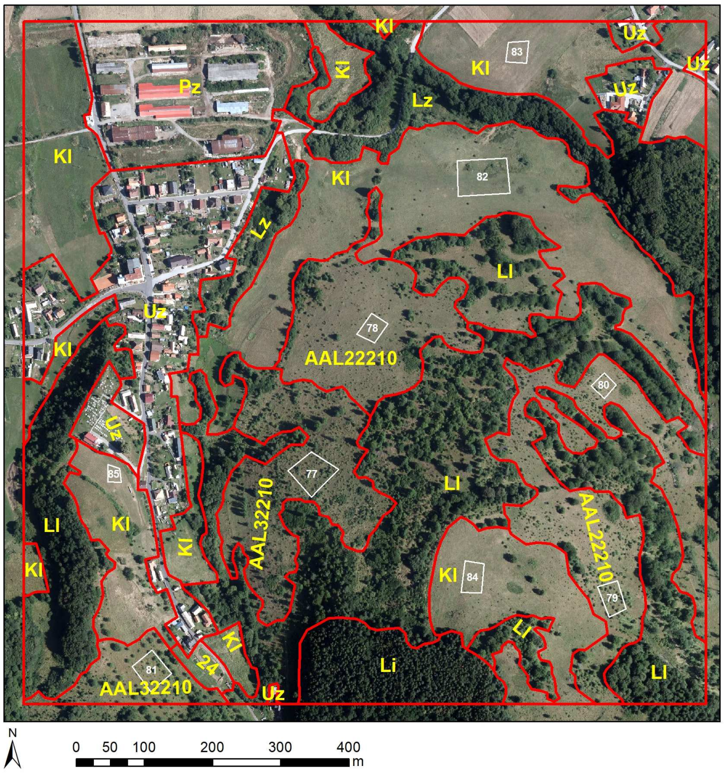


d

Table 28: Pearson correlation coefficient

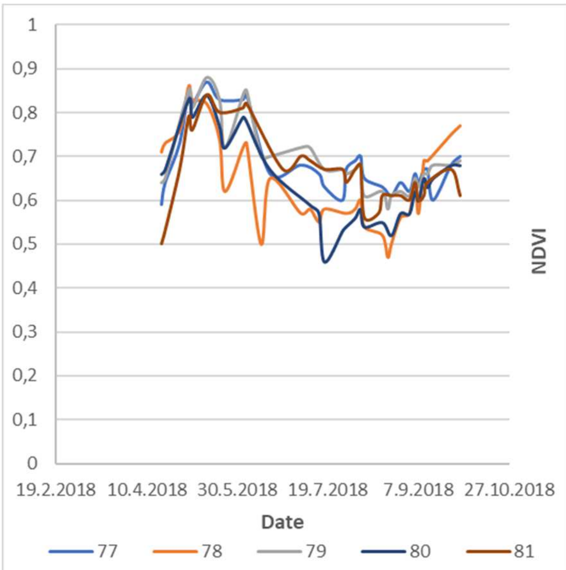
ID	*TEXT-ID*	*68*	*69*	*70*	*71*	*72*	*73*	*74*	*75*	*76*
68	AAL23S27-a	-								
69	AAL23S27-b	0,80	-							
70	AAL23S27-c	0,70	0,34	-						
71	AAL23S27-d	0,69	0,45	0,89	-					
72	Kl-1	0,61	0,30	0,96	0,90	-				
73	Kl-2	0,67	0,37	0,98	0,89	0,95	-			
74	AAL23S27-e	0,68	0,25	0,96	0,93	0,93	0,97	-		
75	AAL2227	0,81	0,57	0,96	0,90	0,87	0,92	0,93	-	
76	Lz-3	0,57	0,73	0,13	0,11	0,14	0,11	0,03	0,25	-

Supplement 2: ZK10 – Fig. 22	
a	AAL & LC/LU classes
77-85	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

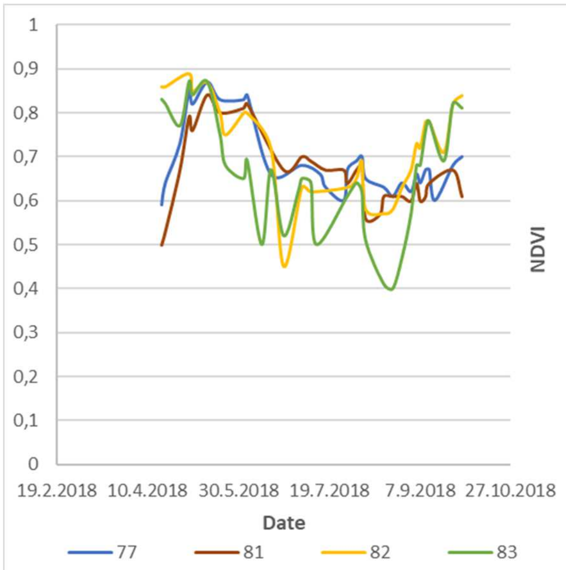


a

b



c

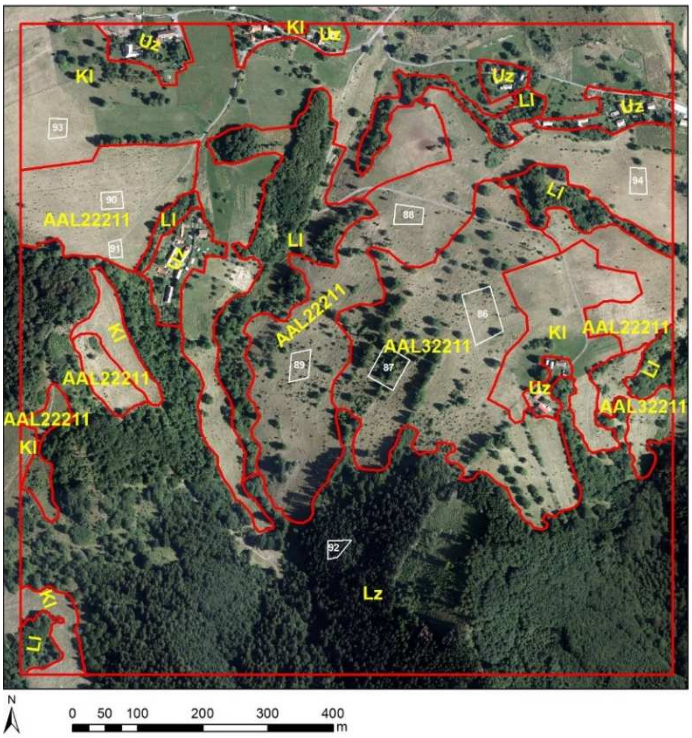


d

Table 29: Pearson correlation coefficient

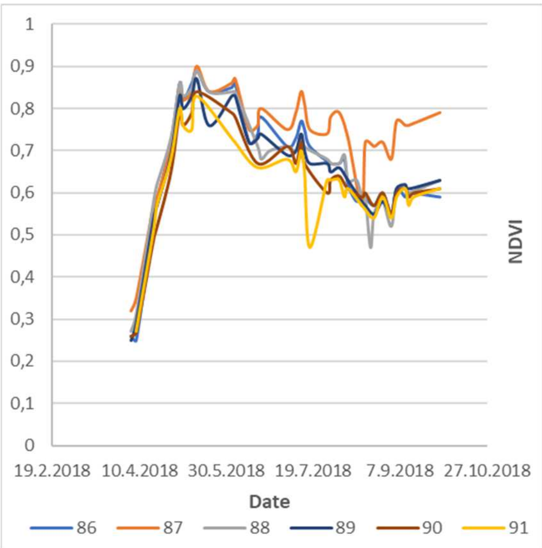
ID	*TEXT-ID*	*77*	*78*	*79*	*80*	*81*	*82*	*83*	*84*
77	AAL32210-a	-							
78	AAL22210-a	0,72	-						
79	AAL22210-b	0,94	0,72	-					
80	AAL22210-c	0,84	0,88	0,86	-				
81	AAL32210-b	0,90	0,49	0,92	0,67	-			
82	Kl-1	0,55	0,95	0,59	0,85	0,29	-		
83	Kl-2	0,48	0,90	0,51	0,73	0,28	0,89	-	
84	Kl-3	0,72	0,91	0,75	0,96	0,52	0,89	0,74	-
85	Kl-4	OUT							

Supplement 2: ZK11 – Fig. 23	
a	AAL & LC/LU classes
86-94	IDs of NDVI computation sites
b	Field photo(s)
c	NDVI for AAL classes
d	NDVI for LC/LU classes

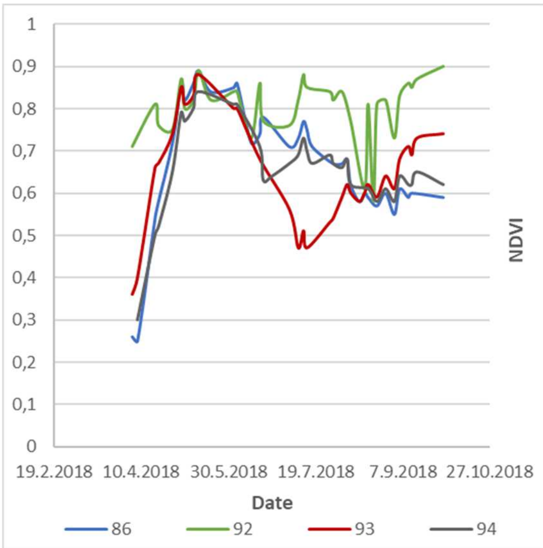


a

b



c



d

Table 30: Pearson correlation coefficient

ID	*TEXT-ID*	*86*	*87*	*88*	*89*	*90*	*91*	*92*	*93*	94
86	AAL32211-a	-								
87	AAL32211-b	0,91	-							
88	AAL22211-c	0,98	0,89	-						
89	AAL22211-d	0,99	0,92	0,98	-					
90	AAL22211-e	0,98	0,94	0,97	0,99	-				
91	AAL22211-f	0,92	0,85	0,97	0,94	0,98	-			
92	Lz-1	0,41	0,65	0,53	0,45	0,46	0,35	-		
93	Kl-2	0,68	0,62	0,72	0,71	0,69	0,63	0,35	-	
94	AAL22211-g	0,96	0,94	0,95	0,97	0,98	0,91	0,44	0,57	-