Actual vegetation of cultural landscape in northern Slovakia  
(study area in the Poprad basin)

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ABSTRACT

This paper reviews actual vegetation of a cultural landscape in northern Slovakia, under High Tatra Mountains National Park – UNESCO Biosphere Reserve. We identified amount of types of actual vegetation units based on CORINE Biotopes methodology supplemented with geobotanical research. We noticed many abandoned biotopes in agricultural landscape before used as mown meadows, pastures or arable land. Forest zones on borders of the study area - parts of bigger nature areas appear highly fragmented and their species composition is far from potential natural vegetation. Chosen area should also fill a function of national park’s buffer zone, therefore there should be paid more attention for proposals for agricultural landscape structure optimization in the central part of the study area and biodiversity restoration in peripheral forests.

Keywords: actual vegetation, CORINE Biotopes, cultural landscape, High Tatra National Park, Slovakia

1 INTRODUCTION

The agriculture in Central Europe underwent significant transformation during the second half of the 20th century (Halada et al., 2008). The intensification, otherwise typical for the whole Europe, was here connected with the breakdown of traditional farming and the replacement of small- and medium-sized private farms with large state or collective farms. The intensification of agriculture was accompanied by broad land use changes leading to homogenisation of landscape and fragmentation of natural and semi-natural habitats (Jongman, 2002), elsewhere followed by agricultural abandonment of less productive or remote areas (MacDonald et al., 2000) attended by spontaneous succession and reforestation. Both intensification and abandonment bring environmental consequences as: change in landscape character, loss of traditional landscape features and reduction of both biodiversity and conservation value. Since these processes are important forces driving Central Europe’s landscape change (Hunziker and Kienast, 1999), the issue is of great concern for landscape planners and conservationists.

This paper briefly describes vegetation mapping method and characterizes current state of actual vegetation on study area in Slovakia. The study area has a character of a cultural landscape, which fills a function of buffer zone of nearby national park. Obtained results are planned to be used as an input for scenario analysis of possible future development of the study area with focus on its spatial landscape structure optimization.

2 MATERIAL AND METHODS

2.1 Study area

The study area is located in the northern part of Slovakia (Fig.1), in the Poprad basin between
the High Tatra Mountains National Park – UNESCO Biosphere Reserve and the Levočské vrchy Mountains, and includes 33.9 square kilometers. Studied eastern part of a basin belongs to the region of the moderately cool climate. The bed of the basin is built by flysch layers covered by Quaternary sediments mainly glacio-fluvial and fluvial sediments. The area belongs to the region of Western-Carpathian flora (*Carpaticum occidentale*). Fir and fir-spruce forests (*Abietion, Vaccinio-Abietenion*) and submontane alder forests along the watercourses (*Alnetum glutinosae*) represent potential natural vegetation.

Only few studies have dealt with vegetation of the study area. Špániková and Zaliberová (1985) realized phytocenological mapping of communities of meadows, pastures and riverine vegetation along the river Poprad and its floodplain. Valuable species were found in locality called Medvedisko - the former peat bog which was mined out in the period of 1959–1967, only remnant remained and surrounded area overgrew with pioneer communities. In this area Novák (2003) recorded current occurrence of critically endangered species *Viola epipsila* in a fragment of alder carr and Šoltés and Novák (2001) ascertained occurrence of endangered moss species *Helodium blandowii* in present peat bog.

2.2 Methods

Our research was realized according to CORINE Biotopes methodology (Ružičková et al., 1996). The procedure was set up within international project CORINE Biotopes and was given to vegetation mapping throughout Slovakia. Before fieldwork mapping, accessible relevant data were analysed, such as: forest management plans (National Forest Centre, 2009) and chosen phytosociological records stored in Slovak National Vegetation Database (www.ibot.sav.sk/cdf).
Aerial images and ortophotomaps provide information about boundaries, physiognomy, structure of communities and dominant features of tree layer within forest communities (Falt'an, 2005), therefore we processed ortophotomaps to delimitate preliminary physiognomical-ecological vegetation units before fieldwork. For this purpose we used ortophotomaps available at Google Earth (http://earth.google.com/).

The field research was focused on large-scale mapping of plant communities and their actual state. We specified boundaries of particular biotopes, recorded their horizontal and vertical structure, distribution and defined preliminary classification of biotopes according to methodology (Ružičková et al., 1996). The fieldwork was realized during the vegetation period in 2009 and was geared to record the species composition of mapping units and to specify their boundaries. The nomenclature of the plants follows Marhold (1998) and names of described vegetation units (syntaxa) are given according to a list of vegetation units of Slovakia (Jarolímek et al., 2008). Vegetation records were taken using standard phytosociological methods (Braun-Blanquet, 1951) and the 7-degree Braun-Blanquet scale. At large-scale vegetation mapping, e.g. in project CORINE Biotopes (Ružičková et al., 1996), there are considered vegetation units as syntaxa of alliance.

The study area has a character of agricultural landscape, therefore biotopes of cultural landscape were mapped with special effort to record natural and valuable biotopes. We did not deal with plant communities of surrounded settlements and along the roads, railway and tall-herb communities along the riverbanks. The representative vegetation units were defined and their actual boundaries were charted in map of scale 1:10 000. The final map of actual vegetation was processed by ArcGIS 9.3 software and was generalized into scale 1:25 000.

3 RESULTS AND DISCUSSION

In the following section we characterize species composition of plant communities peculiar to mapping units of actual vegetation in study area (Fig.2).

A Forests

A1 Spruce-fir forests

Spruce-fir forests occur on the edges of the study area. The forest stands represent forests of High Tatra Mountains National Park and its buffer zone in the western part and forests of Levočské vrchy Mountains in the eastern part. The vegetation unit is characterized with mosaic of fragments of natural spruce forests (Eu-Vacciniou-Piceenion Oberd. 1957), spruce and pine monocultures. Picea abies and Pinus sylvestris dominate in the tree layer, also occur: Larix decidua, Sorbus aucuparia, sporadically Abies alba. In the shrub layer grow: Corylus avellana, Betula pendula, Acer pseudoplatanus, Sambucus racemosa, Lonicera xylosteum, Rubus idaeus. The herb layer is characteristic with species of association Abietion albae Březina et Hadač ex Hadač 1965: Calamagrostis arundinacea, Oxalis acetosella, Vaccinium myrtillus, V. vitis-idaea, Maianthemum bifolium, Dryopteris filix-mas, Senecio ovatus, Hieracium murorum, Mycelis muralis, Fragaria vesca and others: Chamerion angustifolium, Gentiana asclepiadea, Avenella flexuosa, Luzula sylvatica, Equisetum sylvaticum.

A2 Pine woods

Pine woods remained notably on sites of former meadows and grasslands, where Pinus sylvestris diffused spontaneously as light-loving wood, non-demanding for moisture and soil depth. Plant community dominated by Pinus sylvestris in the tree layer. The shrub layer is sparse: Sorbus aucuparia, Sambucus racemosa, Rosa canina. In the herb layer grow species such as Rubus idaeus, Brachypodium pinnatum, Fragaria vesca and species coming from forest fringes: Dactylis glomerata, Hypericum maculatum, Picris hieracioides, Galium verum, Anthyllis vulneraria, Alchemilla spp.
A3 Mixed woods
Natural pioneer communities composed of light-loving woods and shrubs spread around the abandoned pastures and near the forests. Mixed woods are distinguished by non-regular canopies and different age composition.

Locality called Medvedisko represents special case, where organic sediments and humic peaty clays caused rapid spread of pioneer species. Besides the vegetation unit of mixed woods, locality Medvedisko is also characterized by presence of alder carr fragments (Novák, 2003), reed beds and peat bogs of different degrees of transformation.

Betula pendula, Pinus sylvestris, Populus tremula, Sorbus aucuparia, Alnus glutinosa occur in the tree layer. The shrub layer consists of: Padus avium, Corylus avellana, Sambucus nigra, Lonicera nigra, Lonicera xylosteum, Salix caprea, Rubus spp. The herb layer is covered chiefly by shade-loving species: Dryopteris filix-mas, Filipendula ulmaria, Urtica dioica, Polygonatum multiflorum, Paris quadrifolia, Maianthemum bifolium, Oxalis acetosella, also: Brachypodium sylvaticum, Anhrriscus sylvestris, Chaerophyllum hirsutum, Daphne mezerum, Melampyrum nemorosum, Fragaria vesca. Chamerion angustofolium and Calamagrostis epigeios grow at open spaces and borders of vegetation unit. Viola epipsila occurs locally on peaty soils.

A4 Spruce monocultures (Piceetum culti)
Spruce monoculture area artificially restored and used as a tree nursery. The species diversity is small, with lesser species abundance than in spruce-pine forests. Picea abies predominates in the tree layer, shrub layer is missing. The poor cover of herb layer is caused by lack of solar radiation and needles fall. On the light places grow grass and herbal species of neighbouring pastures of association Lolio perennis-Cynosuretum cristati Tüxen 1937.

A5 Poplar monocultures (Populetum culti)
In the north-western part of the study area, two poplar lines are situated between grasslands and arable land. The monotonous species composition proves, that in the past it was planted by man. Populus tremula supplemented with Betula pendula dominates in the tree layer. Padus avium and wild species of fruit trees, e.g. Malus sylvestris, occur in the shrub layer. The herb layer comprise: Anhrriscus sylvestris, Poa nemoralis, Dactylis glomerata, Urtica dioica, Geum urbanum and Serratula tinctoria.

B Shrub vegetation
B1 Shrubby clearings (Sambuco-Salicion caprae R. Tx. et Neumann ex Oberd. 1957)

B2 Blackthorn shrubs (Ligustro-Prunetum R. Tx. 1952)
Thick growths of mesophile shrubs arise along the back roads, on the edges of meadows and pastures in open agricultural landscape. Blackthorn shrubs create 2-6 metres wide belts or plane and mosaic shrub formations with Prunus spinosa, Padus avium, Rosa canina, Corylus avellana, Viburnum opulus, Rubus caesius in wider shrubs together with trees Betula pendula and Salix caprea. The herb layer is made of: Urtica dioica, Geranium robertianum, Anhrriscus sylvestris, Origanum vulgare, Galium aparine.

C Grasslands
C1 Mesophile meadows (Arrhenatheretalia R. Tx. 1931)
Mesophile meadows represent tall-grass one or twice mown meadows, occasionally grazed, growing on mesophile sites. Mainly species of alliance Arrhenatherion elatioris Koch 1926 occur in the herb layer: Arrhenatherum elatius, Festuca pratensis, Dactylis glomerata, Trifolium pratense, Geranium pratense, Campanula patula, Ranunculus acris, Crepis biennis, Daucus carota, Achillea millefolium, Potentilla erecta, Knautia arvensis, Anthyllis vulneraria, Lotus corniculatus, Veronica chamaedrys.

C2 Wet meadows (Molinietalia Koch 1926)
Tall-herb permanently or periodically wet eutrophic meadows cover sites influenced by groundwater. Mainly hydrophilic species of subassociation Junco inflexi-Menthetum longifoliae Lohmeyer ex Oberd. 1957 occur in the herb layer: Juncus conglomeratus, J. articulatus, J. inflexus, Alopecurus pratensis, A. geniculatus, Mentha longifolia, Lychnis floscuculi, Sanquisorba officinalis, Myosotis palustris, also: Scirpus sylvaticus, Filipendula ulmari, Cirsium rivulare, C. oleraceum, Epilobium hirsutum, Rumex acetosa, Rumex obtusifolius, Galium aparine, Mentha arvensis.

C3 Abandoned meadows
Abandoned meadows arise from not utilized meadows in remote and badly accessible parts of cadaster areas. In study area they occur under the forests of High Tatra Mts. National Park, where create mosaic with forest communities. The growth consists mainly of species of association Anthoxantho odorati-Agrostietum tenuis Sillinger 1933: Agrostis capillaris, Arrhenatherum elatius, Anthoxantum odoratum, Calamagrostis villosa, Festuca rubra, Hypericum maculatum, Trifolium montanum, Anthyllis vulneraria, and others: Geranium pratense, Carum carvi, Ranunculus polyanthemos, Centaurea jacea, C. montana, Lotus corniculatus, Securigera varia, Alchemilla sp., Vicia cracca.
Actual vegetation of cultural landscape of study area in Slovakia

Fig. 2 - Actual vegetation of cultural landscape of study area in Slovakia
C4 Mesophile pastures (Cynosurion cristati R. Tx. 1947)

The alliance includes semi-intensive and intensive grass mesophile pastures. The stands are dominated by short-grasses or by herbs resistant against trampling and grazing particularly of association Lolio perennis-Cynosuretum cristati Tüxen 1937, within two variants have been recognized on sites utilized by distinct grazing intensity (Janišová et al., 2007).

Variant with Thymus pulegioides occurs in remote areas near to forest edges with lower intensity of grazing, we can find species: Festuca rubra, Agrostis capillaris, Anthoxantum odoratum, Ranunculus acris, Achillea millefolium agg., Hypericum maculatum, Trifolium repens, Trifolium pratense, Thymus pulegioides, Alechemilla spp. These stands represent transition to association Anthoxantho odorati-Agrostietum tenuis Sillinger 1933.

Variant with Plantago major influenced by strong grazing and trampling is located in adjacency of settlements and along the watercourses with such a species composition: Lolium perenne, Cynosurus cristatus, Leontodon autumnalis, Trifolium repens, T. pratense, Prunella vulgaris, Plantago major, Potentilla anserina, Taraxacum sect. Ruderalia, Alechemilla spp.

D Riverine vegetation

D1 Riparian willow formations (Salicion triandrae Th. Müller et Görs 1958)

Only few fragments of original communities of willow formations on inundated banks of watercourses in lowlands and uplands persisted on floodplain of river Poprad. The tree layer is dominated by Salix triandra, we can find also S. fragilis, S. caprea, Alnus glutinosa. The shrubs are less abundant: Sambucus nigra and Rubus caesius occur there. In the herb layer grow: Urtica dioica, Aegopodium podagraria, Arctium lappa, Mentha longifolia, Angelica sylvestris, Filipendula ulmaria, Lysimachia vulgaris, Galium aparine, Geum rivale, Glechoma hederacea, Calystegia sepium.

D2 Submontane willow shrubs (Salicion incanae Aichinger 1933)

The pioneer communities of willow shrubs substitute alder carrs on submontane waterstreams alluviums. In the shrub layer dominate Salix purpurea and S. fragilis, also Alnus incanae, Padus avium, at edges mixed with Corylus avellana, Viburnum opulus, Frangula alnus, in higher altitude with Picea abies and Pinus sylvestris. The herb layer is floristically rich: Urtica dioica, Aegopodium podagraria, Chaerophyllum hirsutum, Cirsiurn oleraceum, Scrophularia umbrosa, Anthriscus sylvestris, Synthytm officinale, Geranium palustre, Lysimachia vulgaris, Filipendula ulmaria, Staechys sylvatica, Campanula trachelium, Galium aparine, Melampery nemorosum, Stellaria holostea, Vicia sepium.

E Vegetation of still waters

E1 Reed beds (Phragmitetum australis Koch 1926)

The tall-herb reed beds are situated on the pondsides and stands with shallow eutrophic still waters. Phragmites australis predominates in the growth, afterwards Typha angustifolia, T. latifolia. The lower layer consists of hygro- and hydrophilic species: Mentha longifolia, Veronica beccabunga, Calystegia sepium and Equisetum palustre.

E2 Willow carrs (Salicetum cinerae Zólyomi 1931)

The sparsely varied, loaf-shaped willow shrubs are situated on wet sites and alluvial meadows along waterstreams. Salix cinerea fully predominates in the shrub layer. The herb layer comprises mostly hydrophilic species: Urtica dioica, Phalaroides arundinacea, Lysimachia vulgaris, Filipendula ulmaria.

F Anthropogenic biotopes

F1 Weed communities of intensive crops (Stellarietea mediae R. Tx. et al. ex von Rochow 1951)
The large-sized intensively used agricultural fields cover less varied weed communities. In the herbal layer grow: *Tripleurospermum inductorium*, *Anthemis arvensis*, *Raphanus raphanistrum*, *Sinapis arvensis*, *Sonchus arvensis*, *Capsella bursa-pastoris*, *Papaver rhoeas*, *Convolvus arvensis*, *Polygonum aviculare*.

F2 Weed communities of extensive cultivation (*Stellarietea mediae* R. Tx. et al. ex von Rochow 1951)

In the small- and medium-sized private fields used tradionally and gardens, weed communities consist of species such a: *Galinsoga parviflora*, *Anagalis arvensis*, *Taraxacum sect. Ruderalia*, *Chenopodium album*, *Acetosella vulgaris*, *Stellaria media*, *Convolvus arvensis*, *Veronica persica*.

F3 Herbaceous edges

The herbaceous edges represent not utilized belts with herbal vegetation between the particular fields. The species composition of such a colourful edges is formed of: *Tripleurospermum perforatum*, *Artemisia vulgaris*, *Arctium tomentosum*, *Cirsium arvense*, *Achillea millefolium*, *Rumex acetosa*, *Elytrigia repens*.

F4 Abandoned agricultural land

In the past by man used arable land and pastures, recently abondoned with gradual spontaneous secundary succession. The herb layer comprises many ruderal species: *Tanacetum vulgare*, *Tripleurospermum perforatum*, *Armoracia rusticana*, *Tussilago farfara*, and also: *Aegopodium podagraria*, *Geranium pratense*, *Festuca rubra*, *Dactylis glomerata*, *Carum carvi*, *Hypericum maculatum*, *Urtica dioica*, *Pastinaca sativa*, *Leucanthemum vulgare*, *Cychorium intybus*, *Galium verum*, *Galium aparine*, *Cirsium arvense*. The growth is locally covered by shrubs: *Rubus caesius*, *Rosa canina*, *Prunus spinosa* and *Corylus avellana*.

F5 Park communities

Park communities occur in park near chateau Strážky – National Cultural Monument. Park was maintained as english park before, today its attractivity resides in a varied species composition of woods and their age range – from 30 to 150 years. *Acer platanoides*, *Tilia Platypyllos*, *T. cordata* predominate in the tree layer, also occur: *Aesculus hippocastanum*, *Fraxinus excelsior*, *Pseudotsuga menziesii*, *Picea omorika*, *P. pungens*, *P. abies*, *Pinus sylvestris*, *Larix decidua*, *Abies alba*, *Fagus sylvatica*, *Quercus robur*, *Sorbus aucuparia*, *Alnus glutinosa*, *A. incana*, *Salix caprea*. The herb layer consists mainly of: *Taraxacum sect. Ruderalia*, *Bellis perennis*, *Plantago media*, *P. lanceolata*.

Observed results of vegetation mapping indicate that state of studied biotopes is not satisfactory. Our expectations that forest biotopes inside the agricultural landscape are less stable than forest biotopes on periphery of the study area were not fulfilled. Surrounding forests are highly fragmented and species composition is far from potential natural vegetation, though e.g. forests in High Tatra Mts. are part of national park. The reason of forests bad condition is the windstorm in 2004, which destroyed substantial part of forests of High Tatra Mts. National Park and caused vast forest fragmentation (Kopecká and Nováček, 2009). Forest fragmentation in forests of Levočské vrchy Mts. was also observed (Kopecká and Nováček, 2008), but in smaller extent than in High Tatra Mts., brought by non-coordinate logging (Feranec et al., 2009). Forest fragmentation as one of the serious threats to biodiversity, not only reduces the amount of available habitat but also may isolate populations and increase edge effects (Faaborg et al., 1995). As a consequense, the originally present abundance and diversity of species often decline.

Forest woods and riverine vegetation in central part of the study area appear more stable, what seems favourably for design of ecological corridor and providing of landscape connectivity between two large nature areas – High Tatra Mts. and Levočské vrchy Mts.
In agricultural landscape we registered many abandoned biotopes before used as mown meadows, pastures or as a mosaic with small private fields, today without any possible use. Such a changes in intensity of utilization of semi-natural grasslands may cause changes in species composition, in dominance and constancy of species, simplification of community structure and finally some species may disappear and never come back (Halada et al., 2008). In the mountain zones where abandonment is taking place, the environmental processes usually involved encroachment of vegetation onto old field sites, loss of grassland areas to shrub and forest and loss of woodland clearings (MacDonald et al., 2000). Taking into account the vast areas of land that might be abandoned in Europe during the next decades (Hunziker and Kienast, 1999), landscape planners need rapid, simple assessment procedures for evaluating these changes and proposals for quick arrangements to maintain existing environmental value of cultural landscape, landscape character and biodiversity.

4 CONCLUSIONS

We identified 20 unit types of actual vegetation on study area, based on methodology CORINE Biotopes supplemented with geobotanical research. During fieldwork we processed 80 vegetation records. As ecologically most stable biotopes are considered forest woods making local biocentres and riverine vegetation with biocorridor function. Anthropogenic stands (mainly intensively used agricultural fields and abandoned agricultural land) are less stable. The predominant part of vegetation communities on study area represent secondary vegetation. In the past, there was not payed enough attention to research of such a vegetation, currently its significance increased. The results obtained are applicable in landscape planning process, in particular at spatial landscape structure analysis and proposals for its optimization.

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