University of West Hungary
Faculty of Forestry

Thesis of doctoral (PhD.) dissertation

EXAMINATION OF THE WOODLANDS OF VÉRTESALJA, INTERRELATION BETWEEN LAND USE AND VEGETATION

Written by:

Norbert Riezing

Sopron

2010

Doctoral School: Roth Gyula Forestry and Wildlife Management Doctoral School

Program: Ecology and diversity of forest ecosystems

Advisor: Dr. Gergely Király

1. Premises, aims

The author started to examine the barely known vegetation of Vértesalja more than 10 years ago. This region is particular in that the habitats formed on the sandy base of this low hilly landscape give home to many different communities from beech woodlands to open forests reminiscent of steppe woodlands. A few decades ago one could find lush beech woodlands contrastingly bordered by open sand steppes. It is remarkable that totally different botanical communities may sometimes appear at similar habitat types. Clearcut borders between different vegetation units often cannot be explained on the base of habitat types either. Besides vegetation examination the author's interest therefore also turned to land use.

As it was explained earlier by others, past events greatly influence the present condition of vegetation (ZÓLYOMI 1958, MOLNÁR 1997). Landscape changes are influenced by natural rocesses and human activities. We have to know the past as well as possible to be able to understand present vegetation interrelations, changes occured and dynamics of processes. Vegetation patterns have a partly anthropogenic origin and they are directed by anthropogenic influences (FRISNYÁK 1999). Actual environmental impacts or competitional relations are often not reflected in the composition of vegetation, as influences originating from greater time scale processes (MOLNÁR 1996).

The majority of land use investigations examins the past 2-3 centuries, which are better documented (written sources, maps, botanical data) (MOLNÁR 1997). This thesis tries to gather as many data as possible from the earlier centuries, which could be used to estimate influences of early stages of land use to current vegetation.

The thesis tries to find an answer to the following most important questions:

- How far can the influences of grazing done until the middle of the last century be seen in the present vegetation?
- How far effects the earlier grazing the current status of woodlands (structure, associations, species)?
- Are there any differentiating species relating to earlier grazing or mowing in the case of alder woods?
- Are there any traces of the former settlements in today's vegetation (occasional differences in species composition)?
- What conclusions can be made about former land use and woodlands by examining remnant trees?
- What is the correlation between the distribution pattern of certain plant species and the former grazing practices?

The aim of the investigations therefore is to examine the interrelations of former land use and present vegetation. Given the knowledge of present vegetation and former land use the thesis searches for indicators, pointing towards certain practices of former forest use. It examines on what time scale different indicators can be used, respectively how far recent events may conceal appearances of past processes. It also examines the nature of interrelations between anthropogenic and natural effects of various intensity and their influences on different processes and on vegetation patterns.

2. Research area, methods applied

2.1. The region examined

The examined area is found in the region of the Transdanubian Hills, at the northern fothills of the Vértes, between the Által rivulet and the hills of the Vértes. Administratively it belongs to Oroszlány, Bokod and Pusztavám settlements. The area is characterized by gently rolling low hills inclined towards the Által rivulet, dissected by narrow valleys of small streams. The average height of the hills is 220-270 metres above sea level, even the highest ones do not reach 300 metres. The height of the examined area in the valley of Által rivulet reaches between 200 and 170 metres.

The geological structure of the landscape is rather uniform. Most of it is covered by pleistocene riverine sediments, mostly sand but also gravel, which is covered by a layer of drift sand of various thickness (mostly 1-2 metres, but also from a few dozen centimetres to 6-8 metres). Soils are also fairly monotone: primarily rostbrown forest soil was formed on the sandy ice age sediments covering most of the surface. Other soil types occur only uncommonly and in smaller areas.

The thesis describes climate based on weather station data of the region and on available literature. In contrary to the well-known submediterranean climate of the southern Vértes the northern foothills are strongly characterized by a continental climate, which is increasingly influenced by atlantic elements closer to the Vértes Hills.

The surface water network of Vértesalja can be described as medium rich with low capacity or temporary streams. Most of the woodlands (99%) of the examined area are independent of surface water with the exception of narrow, ribbon like, deeply indented floodlands and a few low depressions.

2.2. Methods

2.2.1. Landscape history research

The thesis emphasizes the importance of landscape history research using several types of sources and trying to investigate in many ways. Analysis of data was done with the help of archeologists and historians.

In order to gain knowledge of **former anthropogenic influences** many sources were gathered: historical data, literature of archelogical findings, historical bibliography, books on landscape and economical history, period publications on farming, statistical data, period geological and botanical publications and travel diaries.

For the **description of associations** and their changes old and new forestry plans were used, but old paintings as well as photographs depicting the landscape or the woodlands were also considered.

Various maps and aerial photographs were used to **analyse vegetation patterns**. The first maps (manorial and military maps) that could be used for the analyses were made in the second half of the 18th century, while the first extensive series of aerial photographs was taken in 1951. The collected data was complemented by accounts of old foresters, who know the area well.

2.2.2. Botanical field examinations

Field sampling of vegetation was done with the help of coenological examinations and population descriptions, parallel to vegetation mapping.

Coenological surveys were made in the selected middle aged, closed forests, in the possibly most characteristic patches of forest based on the methods suggested by LÁJER et al. (2002) and KUN – MOLNÁR (1999). Vegetation was documented on the forms elaborated by the authors. Such quadrants were chosen (with photographic documentation) that could be assessed later as well. Their positions were marked on a 1: 10 000 EOV map. The sample territory was 400 m². Density (A-D) was estimated on a 6 scale level (+, 1, 2, 3, 4, 5). Species seen outside the quadrants, but characteristic for the habitat were also noted (marked with k in the tables). There were at least 2 surveys (during spring and summer) in each quadrant, but occasionally more if identification of plants required it. If a taxon occurred at both occasions, the greater density was considered. During the survey trees and shrubs lower than 50 cm were counted to the herb stratum.

Vegetation mapping was done according to the 1: 10 000 EOV map. Patches were marked in the field with subsequent marking on the EOV map. Each patch has its own description: species of tree, shrub and herb stratum, their approximate coverage, differentiation of common and uncommon species, age of trees, height of shrub stratum and other notes on e.g. supposed dynamics, traces of former and present land use (grazing, removal of sporadic trees, rooting up of tree trunks, complete ground clearance). During evaluation the patches were grouped into habitat categories. Because associations could not always be identified higher level vegetation units were separated (e.g. hornbeam-oak forest). Description of habitat categories was done according to coenological surveys, (species composition, frequency, density), field notes and maps.

2.2.3. Examination of interrelation between land use and vegetation

There were several types of examinations conducted on the interrelation of former land use and present vegetation.

Tracking vegetation changes involved the comparison of former and present vegetation of an area (e.g. the environment of coenological surveys, clearings with open sand steppe vegetation or other important areas), as well as recording the changes of distribution of different tree species. During the examinations historical maps, former and recent aerial photographs (open and closed forest), old and recent forestry management plans, botanical data (old and recent) and oral information from foresters were used.

Comparison of vegetation patterns in different time periods was done primarily by comparing and analysing the 1951 aerial photographs (the first available ones) and the actual vegetation pattern, as well as analysing maps (first, second etc. army maps).

The **survey of old remnant trees** was conducted to assess former distribution of some tree species (e.g. pedunculate oak) and also to find out how the foliage of these trees can indicate former foliage structure of the forest.

When examining **the effects of former grazing** the actual vegetation of forests used for grazing until the middle of the last century was compared to forests used for timber production (based on coenological surveys). In the case of alder woodlands the former land use and base of comparison was the usage for hay cutting. The formerly permanently grazed forests were identified using old and contemporary literature (e.g. HÁRVICH 1870, LÁNG 1870, SZERÉMI 1877, BARTHA 2002) and the 1951 aerial photographs assessing the opening up of tree stratum. The thesis lists the possible mistakes and ways to avoid them, as well as the limits of the used methods. The thesis identifies three categories based on the closing of forests: closed forest (above 70%), grazed woodlands (20-70%), wooded pastures (below 20%). Differentiating species were chosen based on occurrence (K) or density (AD).

Assessment of medieval anthropogenic effects was possible in areas, which were depopulated during the Turkish occupation and remained abandoned giving place to natural like forests. Forests (alder woodlands) growing on the place of medieval artifical ponds could also be examined. Further criteria of sample areas were that the forest had to be utilized continuously since repopulation of the area (marked as closed forest on military, manorial, etc. maps between the 18th century and today, closed forest on 1951 aerial photographs), and the forest is closed and at least middle aged today. These patches of forests were compared using coenological surveys of their vegetation to forests, which according to our current knowledge were not established on the place of medieval settlements or ponds and which all other criteria could be applied to.

During the examination of the interrelation of land use and vegetation the thesis compares **actual distribution patterns of certain plant species** to the patterns of open and closed forests in the middle of the last century (using the 1951 aerial photographs) and to the actual vegetation map. The aim of research here was to determine what the correlation is between the actual occurrence of species rich mesophilic forests containing more sensitive species and the former grazing, as well as the correlation between distribution patterns of certain species and the actual forests used for forestry purposes. The selected, mapped plant species were the following: *Asarum europaeum, Corydalis cava, Corydalis intermedia, Galanthus nivalis, Galeobdolon luteum s.l., Geranium phaeum, Isopyrum thalictroides, Knautia drymeia, Lilium martagon, Maianthemum bifolium, Mercurialis perennis, Fagus sylvatica.*

3. Results of the research

3.1. Land history research

Land history research reveals that anthropogenic effects on the vegetation have been fluctuating throughout the centuries showing different ways and intensity of influence. Thus four different periods can be differentiated.

From the ancient age to the 10th century the Vértesalja experienced anthropogenic impacts varying in intensity with regards to time and space. These impacts were most obvious during the age of Roman villa-farms. The decrease of forest cover was supposedly only locally significant and it hardly affected the examined area. Temporary forest clearing began considerably intensively during the bronze age, but the forests could have regenerated supposedly since. Farming resulting in the restructuring of forests could be the most intensive during the Romans. We have no detailed knowledge about the territory it affected and about the procedures. This period was concluded by a longer, locally sometimes interrupted regeneration phase (the period of great invasions). During this era the more common large ruminants might have had a larger influence on vegetation.

Landscape transformations before the 10th century at the Vértesalja, which can be accurately localized cannot be used for analysing the relation of land use and vegetation. On one hand archeological sites are mostly located within the limits of present settlements, while others are found on agricultural lands or other types of areas (containing no natural like forests), on the other hand there are no such areas that were not used during a later time period.

Vértesalja and the treated area was populated more lastingly during the Arpad dinasty. **From the period between the 10th century and the Turkish occupation** there are much more historical sources available and farming practices are also better known. By the 13th-14th century there was a dense settlement structure created also on the areas, which are nowadays uninhabited. There were abbeys, fortresses and castles built besides the villages. According to available sources the most important usage of the forests was hunting, followed by woodland grazing and masting. Timber usage for local consumption was not significant, its effects were only locally important. Different sources depict a variable status of the forests. There were young secondary growth forests, more open, older grazed forests and dense primary forests in the region. The period was concluded by depopulation due to the Turkish rule and the regeneration of the vegetation. We do not have detailed knowledge on the actual anthropogenic effects on the vegetation, especially on its composition.

From the middle age we know such settlements or artificial ponds that were since abandoned and were occupied by natural like forests, and their forest coverage can be considered continuous during the last few centuries. These places are suitable for the assessment of the relation between former land use and present vegetation.

Modern age repopulation began with deforestation at the end of the 17th and the beginning of the 18th century. This was especially significant in the territory of Oroszlány. Deforestation has been controlled however already by the middle of the 18th century or it was often prohibited, moreover permission was also needed for timber usage. Both the Eszterházy family owning the lands of Oroszlány and Bokod and the

Lamberg family owning the forests of Pusztavám and Mór tried to establish modern farming practices. Therefore they tried to introduce up to date German forestry methods. There was a special forestry organization created that controlled forest usage and enforced rules. There are no data available on the proportion of secondary forests, but according to old descriptions the proportion of 200 (oak) and 120-150 (beech) year old forests was significant. There were even designated reservations. Logging was primarily done for organized firewood production. Regrowth was mainly natural, but seedlings were also planted. By the end of the 19th century alien tree species were often planted on areas with less favourable conditions. Woodland grazing and masting significantly affected the forests as it became very significant by the middle of the 18th century and which was an important income source until the 19th century being the most significant forest use. With the decrease of its economic importance and realising the damage caused by it there was a tendency to regulate it more and more. Following the growing need for grazing lands however more and more forests were permitted to be grazed. Gradually the difference between grazed woodlands and woodlands kept under closure became significant and it can still be traced nowadays. Due to grazing on the sandy soil open sand oak woodlands or even open sand steppes might as well be formed inside beech woodlands. Following the arrangement of socage many pasture woodlands were turned into treeless pastures, although the ratio of deforestation was far from the country average.

The status of forests in the modern age can be retraced from descriptions, documents and other sources and their extent from maps. At the end of the period aerial photography appears. Comparing the aerial photographs to detailed forestry management plans gives detailed information about the vegetation of certain forests or forest patches, as well as the effects of various land uses.

From the middle of the 20th century until today forests have undergone significant changes. The most significant changes happened during the 1950s. Grazing was practically finished, forests were managed by uniform principles. The transformation of 150-200 year old forests, which were considered damaged (former pasture woodlands, secondary forests) was started along with the large scale planting of adventive tree species. The forests became closed and clearings were reforested. At the same time surface mining became widespread, which transformed the landscape and the water regulation conditions dramatically.

3.2. Changes in the distribution and occurrence of tree species

The former distribution of tree species is documented in literature, travel diaries and forestry management plans. This information was supplemented by the examination of old remnant trees (distribution maps, age of specimens). The changes in the distribution of certain tree species during the previous periods, from which there are no localised data available, can only be estimated based on the applied farming practices, their occurrence can be traced according to the known habitats. During the examination former distribution data was compared to actual distribution patterns. Only the most important tree species are assessed here.

3.2.1. Pedunculate oak

According to old forestry management plans it was found in the whole territory: it is a frequent tree in wooded pastures, dry oak woodlands, hornbeam-oak woodlands, beech woodlands, sometimes it is the dominant tree. The examination of remnant trees proves its former wide distribution as well as habitat relations and literature data from similar sandy areas. Its proportion was well below turkey oak already in the middle of the last century. Former forestry management (Eszterházy lands) suggests that its decrease to the benefit of turkey oak began before the middle of the last century, but unfortunately there was no documentation about it found during the surveys. (In the sandy territories of the Gödöllő Hills this was already proven, the substitution of tree species was done within a surprisingly short period, see BIRÓ 2003.) Based on the investigations the dominant tree in the Vértesalja was pedunculate oak during the former times.

3.2.2. Sessile oak

According to the management plans of the 1950s it was much scarcer than pedunculate oak, mosty it occurred uncommonly. It occurred mostly close to the Vértes Hills and on the top of gravelly riverine deposits (where it could have been dominant too). Based on the available data it substituted pedunculate oak on drier hilltops, gravelly riverine deposits independent of ground water, but the two species also occurred together.

3.2.3. Pubescent oak

It is now rare in the examined area, but according to former management plans it was fairly common in dry, open pasture woodlands, wooded pastures (especially close to the Vértes Hills), moreover it was sometimes the dominant tree. Its former distribution was probably related to grazing.

3.2.4. Turkey oak

Now the most common oak species. Many forestry and land use data suggest its expansion, but up to now there are no detailed records available about its spreading (from when on, how quickly, in which areas etc.).

3.2.5. Beech

Management plans, literature sources, remnant trees, its present uncommon occurrence, moreover the experiences of the past decade all warrant the continuous decrease of its former distribution. Relation between its present distribution and the former grazing forest use can be established (it is absent from the former wooded pastures, although the habitat is favourable). The investigations suggest that formerly it was more widely distributed.

3.2.6. Hornbeam

The former grazing land use and forestry management influenced its distribution significantly, mostly negatively. In the past half century its expansion and its decrease can also be noted in various forests. It could be present to a much larger extent potentially (in the canopy), thus the proportion of hornbeam-oak woodlands could also be larger.

3.3. The origin of sand steppe vegetation

The land history examination was conducted to determin the origin and age of open sand steppe vegetation found inside the forest or along the edges that was already mentioned by Ádám Boros in the first half of the last century. According to the investigations these areas were covered by forest during the period of repopulation and they were formed following forest clearance (e.g. Községi-legelő) or with the opening of former woodland pastures. The Homok-tisztás, richest in sandy steppe species, which was researched by Boros in 1933 was for example a forest during the first military mapping in 1783-84. It is possible that it was already a more open grazed woodland, but trees were still dominating. The second military mapping of 1847 describes it as wooded pasture, i.e. latest by the middle of the century the forest opened up. The sand steppe examined by Boros therefore was not older than 150 years. It is interesting that inside the forest a species rich sand steppe vegetation could have been formed so quickly. From the flora list of Boros only a few plant species are missing, which are rare in the nearby areas of the Kisalföld (e.g. around Császár) as well. Compared to the Kiskunság however it is markedly poor in species. It is therefore more appropriate to compare these areas to the Kisalföld, as their origin also suggests.

3.4. Examination of the effects of grazing and hay cutting done until the middle of the last century

3.4.1. Alder woodlands

According to the comparative surveys there are small differences between the understorey vegetation of alder forests used for hay cutting until the middle of the last century and alder forests formerly used for forestry purposes. The surveys showed *Valeriana dioica* to be the best differentiating species for alder forests used for hay cutting formerly, but there are a few other species suggesting previously open forests:

Galium palustre, Phragmites communis, Agrostis stolonifera, Veratrum album, etc. Certain species can be found in both types of alder woodlands, but they are more common in former hay meadows. Such are *Filipendula ulmaria* or *Cirsium oleraceum*. The most obvious difference between the two differing land use types is the massive occurrence of sedges (here *Carex acutiformis*) on the territory of former hay meadows.

3.4.2. Beech woodlands

According to the first aerial photographs all beech woodlands were closed forests half a century ago too, therefore they remained where the forest was not used for grazing.

3.4.3. Hornbeam-oak woodlands

It is difficult to find „good" differentiating species in hornbeam-oak woodlands because of the transformation (regeneration) of forests, the variability of anthropogenic or related influences and their tendency to conceal the former conditions. Only poor relations could be detected during the surveys: some mesophilic species are missing or are less frequent in the forests, which had previously been grazed, while some weed species seem to be/are more common.

3.4.5. Turkey oak woodlands

Most of the differences originating from differing land use were abolished by the disturbance of modern forestry management (full, deep ploughing, rooting, use of herbicides, etc.) and the increased number of wild animals. Plus turkey oak woodlands are often found under unfavourable habitat conditions, therefore they are under transition. Still certain differences can be detected between populations with different former land use history. The richness of light-loving plants indicate former steppe woodland like habitats and wooded pastures. For example *Teucrium chamaedrys* or *Genista tinctoria*, which do not occur in other forests, or *Clinopodium vulgare* and *Hypericum perfoliatum*, which are rarer in other types of forests. A few species are more common in the closed forests not used formerly for grazing (*Astragalus glycyphyllos*) or they only occur in these forests (e.g. *Scrophularia nodosa*). A few species are characteristic for former grazed woodlands. These species do not occur in the former wooded pastures turned into present closed forest and they are rare in the forests that have been always closed: *Convallaria majalis, Melittis melissophyllum*. There are many species, which primarily occur in the areas continuously covered by forests (open or closed), while they are absent or uncommon in the closed forests replacing former grazed woodlands. Such species are for example *Corydalis pumila, Adoxa moschatellina* or *Galium schultesii*. There are further scarcer plant species (accidental in the surveys) in the surveyed area, which only occur in the formerly open or in the always closed forests. The best is however if we estimate the former land use by the detailed analysis of species.

3.5. Examination of traces of medieval anthropogenic effects

Only a few areas were suitable for the examination criteria, therefore sampling was limited. Besides further archeological research (exact localisation of former settlements) investigations working with larger sampling could be conducted in the future. Based on the informatory results there are no significant differences found between the natural forests and neither in the present beech woodlands used during the middle age, nor in the present alder forests. Plant species rare in the Vértesalja may occur in the sites of former forest clearance.

3.6. Relations between distribution of plant species and land use

The present distribution of some of the surveyed plant species does not indicate former land use (*Galeobdolon luteum s.l., Knautia drymeia*), while others are characteristic for closed forests (e.g.. *Galanthus nivalis*). Some species are mostly distributed in forests that were closed according to old maps and aerial photographs, but at some places they occur in woodland formerly used for grazing but becoming closed since (*Corydalis intermedia, Geranium phaeum, Isopyrum thalictroides, Mercurialis perennis*). If distribution maps are compared to actual vegetation maps it reveals that early spring geophytones are less sensitive to the transformation of hornbeam-oak and beech forests into turkey oak woodlands. Comparing the localities of species, patches with a high number of mesophytic species can be detected. In these areas other species characteristic for the mesophytic forests of the Vértesalja occur in large numbers, some of them only occur here (e.g. *Ornithogalum sphaerocarpum*). These patches considered as refuges are without exception sites that were not grazed formerly according to historical land use sources.

4. Publications connected to the thesis

Publications in revised journals

RIEZING N. (2001): *Ophrys apifera* Huds. és *Apium repens* (Jacq.) Lagasca előfordulása a Vértesben – Kitaibelia **6**(2): 371-375.

RIEZING N. (2002): Adatok a Dunántúl északi részének flórájához – Kitaibelia **7**(2): 163-167.

RIEZING N. & ÓVÁRI M. (2004): A *Sisyrinchium bermudiana* agg. újabb előfordulásai Magyarországon.– Kitaibelia **9**(1): 57-65.

VÖRÖSVÁRY, G., HOLLY, L., RIEZING, N. (2005): Distribution of creeping marshwort (*Apium repens* (Jacq.) Lag.) populations in Hungary. – Crop wild relative, Issue 3 April 2005: 11-12.

RIEZING N. (2005): Adatok a Gönyű-Neszmély közötti Duna-szakasz flórájához és vegetációjához. – Botanikai Közlemények **92**(1-2): 57-67.

RIEZING N. (2006): Adatok az Által-ér-völgy flórájához. – Kitaibelia **10**(1): 128-134.

RIEZING N. (2006): *Polystichum aculeatum* (L.) Roth a Kisalföldön. – Kitaibelia **10**(1): 198.

RIEZING N. (2006): *Salix elaeagnos* Scop. A Hortobágyon. – Kitaibelia **10**(1): 199.

RIEZING N. (2006): Égerligetek és láprétek a Vértes északi előterében. – Kitaibelia **11**(1): 75.

RIEZING N. (2007): Adatok a Vértes északi előterének flórájához. – Botanikai Közlemények **94**(1-2): 75-90.

RIEZING N. (2008): A hínárvegetáció változása az Által-ér vízgyűjtőjén a korábbi kutatások tükrében. – Természetvédelmi Közlemények **14**: 91-103.

RIEZING N. és SZOLLÁT GY. (2009): Kiszáradó nyírlápok a Vértesalján *Ophioglosso-Betuletum pubescentis* RIEZING, SZOLLÁT et SIMON ass. nova. – Kanitzia 16: 45-58.

Presentations at conferences

RIEZING N. (2004): Erdőssztyepek a Vértes északi előterében. – Poszter az „Aktuális flóra- és vegetációkutatás a Kárpát-medencében VI." konferencián. Abstract: Összefoglaló kötet: p. 92.

Manuscript papers

RIEZING N. (1997): Az Északi-Vértes és a Vértesalja éghajlata – Soproni Egyetem, Sopron. (mscr.)

RIEZING N. (1999): A Ferencmajori-rét, valamint a Pusztavámi-láprét és égerláp természeti értékei – „Nem védett természeti területek" KTM pályázat, Budapest. (mscr.)

RIEZING N. (2000): Az Észak-Vértes telepített fenyveseinek növénytani és természetvédelmi vizsgálata – TDK dolgozat, Nyugat-Magyarországi Egyetem, Sopron. (mscr.)
RIEZING N. (2000): Az Oroszlány-Bokod környéki gyepek növénytani érdekességei – „Nem védett természeti területek" KTM pályázat, Budapest. (mscr.)
RIEZING N. (2003): Emberi tevékenység hatása az erdő fajkészletére, emberi tevékenységet jelző fajok – Nyugat-Magyarországi Egyetem, Sopron. (mscr.)
RIEZING N. (2003): Pár mondat a Vértes északi előterének növényzetéről. I. MÉTA-túra, túrafüzet, Vácrátót.
RIEZING N. (2006): Homoki erdőssztyepp erdők Magyarországon – Szigorlati dolgozat, Nyugat-Magyarországi Egyetem, Sopron. (mscr.)