



System Report: Wood-pasture in Southern Transylvania

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Authors	Tibor Hartel, Popa Răzvan and László Rákossy – Sapientia University and Babes Bolyai University, Romania
Contact	hartel.tibor@gmail.com ; poparazvand@yahoo.com , laszlorakossy@hasdeu.ubbcluj.ro
Approved	Gerardo Moreno (13 April 2016); Paul Burgess (17 April 2016)

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1 Context

The AGFORWARD research project (January 2014-December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. The project has four objectives:

1. to understand the context and extent of agroforestry in Europe,
2. to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe,
3. to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
4. to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

This report contributes to Objective 2, Deliverable 3.7: “Detailed system description of case study agroforestry systems”. The detailed system description includes the key inputs, flows, and outputs of the key ecosystem services of the studied system. It covers the agroecology of the site (climate, soil), the components (tree species, crop system, livestock, management system) and key ecosystem services (provisioning, regulating and cultural) and the associated economic values. The data included in this report will also inform the modelling activities which help to address Objective 3.

2 Background

The initial stakeholder report (Hartel 2014) and the research and development protocol (Hartel et al. 2015) provides important background information about the wood-pasture systems in southern Transylvania. Wood-pasturing has been widespread in this part of Europe since the middle ages. The current wood-pastures developed from woodland grazing which was common up to the nineteenth century. With the development of formal forestry institutions and the increased demand for timber and agricultural products in the nineteenth and twentieth centuries, woodland grazing was separated into forestry (i.e. managing woodlands as high forests with grazing prohibited) and pasturing (where the timber value of the trees decreased, the trees being maintained only scattered in the grazed landscape). The typical livestock used for grazing were cattle, buffalo, horse and pigs and only rarely sheep and goats. In the twentieth century with the communist regime and afterwards, the grazing management changed drastically, with increasing use of sheep and the sharp decline of cattle and buffalo. There were also changes in the period of grazing: the sheep being allowed to graze the pasture year round, causing erosion of the vegetation and even creating local conflicts due to the lack of clear, formal control and illegal grazing of the hay meadows.

The main challenges identified for the future sustainability of wood-pasture systems in southern Transylvania are related to sheep grazing, lack of tree regeneration, the disappearance of large, old trees, uncontrolled pasture burning which affects the pasture as well as the trees, and the shift from communal pasturing to individually-owned (rented) pasture parcels which often excludes the traditional access of the local community to wood-pastures (sometimes wood-pasture parcels being delineated with fences) (Hartel 2014).

3 Update on field measurements

Field measurements taken in 2009-2010, to understand the social-ecological values of the wood-pastures from southern Transylvania, included ecological and structural and social assessments.

3.1 Ecological and structural assessments

These assessments were based on surveys carried out in order to understand the broad characteristics and threats of the wood-pasture systems from Transylvania. These assessments included:

3.1.1. Identification and characterization of wood-pastures and their status. These surveys targeted specifically i) the understanding of the tree communities in the traditional wood-pastures compared with managed high forests (Hartel and Moga 2010; Hartel et al. 2013), ii) the understanding of the value of traditional wood-pastures for large, old trees (Moga et al. 2016), iii) the bird communities of traditional wood-pastures compared with managed high forests and pastures without trees (Hartel et al. 2014). These assessments started in 2009 and are still on-going. An on-line database containing over 1000 large, old trees (the site is permanently updated with the identification of new trees on almost weekly basis) was created in 2015: <http://arboriremarcabili.ro/en/>

3.1.2. Assessments of wetland types and characteristics (small sized temporary ponds are tightly connected with the grazing regime applied) (e.g. Hartel and von Wehrden 2013, Hartel et al. 2014). These surveys aimed to i) generate understanding related to the potential links between human activity (e.g. grazing) and the types and richness of wetlands in this region of Transylvania and ii) to assess the presence of amphibians in these various types of ponds. An important species in this respect was the yellow bellied toad (*Bombina variegata*), which is in decline in Europe and in the southern Transylvanian region is strongly dependent on the existence of small disturbances caused by human activity. These surveys were mainly carried out in 2010-2012.

3.1.3. Detailed floral and faunal surveys on an ancient wood-pasture near the town Sighisoara (e.g. Öllerer 2013, 2014 and the reports in Romanian are available from the web page <http://www.rezervatia-breite.ro/>). These surveys were mainly conducted in the period of 2004-2010, within a project aiming to develop a management plan for this wood-pasture. The main goals of these surveys were to understand the natural value of this wood-pasture and based on these to propose conservation management interventions.

3.1.4. Vegetation and spider community assessment in a moderately-intensively grazed wood-pasture. This study was carried out in 2015 and involved stratified sampling design, allowing for the comparison of the above mentioned communities according to the pasture parts without trees, under the canopy of scattered trees, scattered trees and shrubs and finally forest edge. The main goal of this survey was to determine the natural value provided by scattered trees and shrubs in a traditionally managed wood-pasture (the wood-pasture was grazed with about one livestock unit per hectare for the past four years). The data collected through this survey are still on analysis stage, but the results are promising (Galle et al. *unpublished data*).

3.2 Social values of wood-pastures from Transylvania

These studies started in 2013 and are still on-going. About 120 interviews were collected from farmers regarding the value of scattered trees (past and present), the management of the wood-pastures (past and present) and the value of large, old, hollowing trees for farmers. These studies are on the way to be analyzed and published.

3.2.1. Historical institutional development shaping woodland use

This study was carried out in order to better understand the historical background of the current traditional rural systems. The underlining assumption was that an initially tightly coupled social-ecological system governed by local, informal rules was decoupled by higher-level institutional development. The study specifically highlighted woodland management including wood-pasturing, as these were in the heart of the traditional social-ecological systems from this region of Transylvania and Romania (see Hartel et al. 2016 for an open access publication regarding these aspects).

3.2.2. Awareness raising with local communities on the multiple values of ancient wood-pastures

The idea of this project emerged in 2016, when field surveys on known wood-pastures revealed a sharp decline of large-old trees due to human cutting. In this respect, there was an urgent need to work with stakeholders to inform them of the value and unique nature of the region – tree cutting is largely a local option and it can be controlled by stakeholders (i.e. there is no law or formal rule which oblige local communities to remove old trees). In 2016 Tibor Hartel developed bespoke documents for 15 local communities with outstanding wood-pastures from southern Transylvania. These short documents detailed: i) the overall value of the wood-pasture systems, ii) wood-pastures in relation to the Common Agricultural Policy (CAP) (relevant for Romania), iii) the important value of southern Transylvania within Romania and Eastern Europe, iv) the important value of the specific community within southern Romania, in terms of ancient wood-pasture and finally vi) a set of recommendations for the local communities on how to capitalize on these ancient wood-pastures. The final document will include a CD with representative pictures of the wood-pastures as well as individual trees. In each community, the documents will be personally given to important local stakeholders such as: the mayor (local council), forestry authority, farmer association, priest, school teacher, and relevant NGOs. Tibor Hartel has also indicated that he is willing to further discuss these issues with stakeholders on their request. The project is on-going and is supported by the Remarkable Trees of Romania project.

4 Description of system

Table 1 provides a general description of the wood-pasture systems from southern Transylvania. Wood-pasture systems in this part of Romania are still common and they have typically evolved in similar biocultural and bioclimatic contexts.

Table 1. General description of wood-pastures in southern Transylvania

General description of system	
System	Wood-pastures from Transylvania
Associated WP	Use of livestock
Geographical extent	Continental region of southern Transylvania, Central Romania.
Estimated area	The total area of wood-pastures in this region of Transylvania is ca 7000 hectares
Typical soil types	Brown forest soils and podzolic clay, argilo-aluvial podzolic soils with clay and alluvial regosols. These soil types are typical for oak forests
Description	Wood-pastures from this region emerged from woodland grazing which was common up to the nineteenth century. Typically these systems are pastures with scattered trees. The tree density on these pastures is ca 4-7/ha and it shows a decreasing tendency.
Tree species	Typically oak (<i>Quercus robur</i> , <i>Q. petraea</i>), pear (<i>Pyrus communis</i> , <i>P. pyraster</i>), beech (<i>Fagus sylvatica</i>) and hornbeam (<i>Carpinus betulus</i>). Some wood-pastures contain almost 100% oak trees while others a mixture of the above mentioned tree species, with oak predominance.
Tree products	<p>Current use of the trees: largely as shadow for livestock and sporadically for fruits. For example we found that some persons still collect acorn from wood-pastures as food supply for sheep. This activity is very rare nowadays and in many villages it disappeared.</p> <p>Historically the tree products regularly used by the local communities include: acorns for pigs, tree hay to complement the shortage of grass hay in extreme hot summers, pear and apple as feed for livestock as well as for brandy (a locally made alcoholic drink). Much of these tree products have been abandoned in the past half century. Several villages for example do not produce any brandy (i.e. they completely abandoned the goods produced by pear trees) and these coincides with the removal of several hundreds of pear trees from pastures.</p> <p>Overall, the abandonment of the traditional tree products from Transylvanian wood-pastures and the lack of any clear initiative to revive the value of trees for the local community suggest a narrowing and more specialized valuation and use of these systems. The economic valuation of the current wood-pasture systems is now largely based on the herbaceous layer while the trees are in sharp decline. The CAP and national level policies also discourage the use of tree related products.</p>
Crop species	No crops used in these pastures.
Crop products	No crops used in these wood-pastures. The grass is typically grazed while the hay meadows are typically mowed.
Animal species	Currently sheep is the dominant animal species, especially after the fall of the communism in 1989. In the past, cattle and buffalo were the dominant species.

Animal products	Lamb and sheep (meat and milk)
Other provisioning services	As mentioned above, other traditionally important provisioning ecosystem services (e.g. tree hay, fruits) are largely abandoned.
Regulating services	<p>Services recognized by local stakeholders:</p> <ul style="list-style-type: none"> • Shade for livestock (primary role, recognized by the great majority of stakeholders) • Buffering the grassland against wind and dryness (recognized by some stakeholders) • Nutrient cycling (the hollowing, dried trees release minerals) is also recognized by few farmers. • Controlling soil erosion (recognized by few stakeholders, also recognized in historical records) <p>Regulating services are indicated from a scientific perspective but there are no experiments on this aspect from Transylvania.</p> <p>In conclusion, the assessment of ecosystem service type has largely been determined from local stakeholders; some of these have experience-based knowledge with the system.</p>
Habitat services and biodiversity	<p>Services recognized by stakeholders: only very few stakeholders mentioned about the natural value of scattered and especially old trees. These stakeholders are not typical for the farmer community (e.g. they have formal education and access to internet and international TV channels, and “love nature”).</p> <p>Scientific research highlighted the exceptional biodiversity value of wood-pastures.</p> <p><i>Biodiversity potential:</i> in an ancient oak wood-pasture from Romania of 133 hectares, there were 476 species of vascular plants, 121 species of macromycetes, 281 species of Lepidoptera, 40 species of xylophagous beetles, 27 species of nesting birds, and 38 species of mammals (Hartel et al. 2013). Wood-pastures contain more bird species and functional groups than high forests and open pastures (Hartel et al. 2014). More recent surveys carried out in a moderately intensively grazed wood-pasture (with 1.1 livestock units (LU) per hectare) revealed exceptionally diverse spider communities in such systems, with 140 species and four new species of spiders for Romania (Gallé, Szpisjak, Urák and Hartel <i>manuscript in preparation</i>). These findings reveal the outstanding, yet under studied biodiversity values of the traditional wood-pastures of Eastern Europe.</p> <p><i>Large, old trees:</i> research carried out in Transylvania showed that the largest old trees from a large region are concentrated in wood-pasture systems and not in high forests. The density of large, old oaks in 25 wood-pastures ranged between 0.0085 – 1.25 trees ha⁻¹ (Moga et al. 2016).</p> <p><i>Wetlands and wood-pastures:</i> research showed that wood-pastures grazed with buffalo and cattle contain significantly more small wetlands than those grazed by sheep. The reason of this is that the buffalo and cattle create those disturbances which removes native vegetation, allowing the maintenance of small wetlands. By contrast, sheep avoid wet areas resulting in vegetation enrichment in wetlands. The yellow bellied toad is highly abundant in buffalo grazed wood-pastures while less abundant in sheep grazed systems (Hartel and von Wehrden 2013).</p>

Cultural services	<p>When wood-pastures were communally managed in this region, they had the following important cultural services:</p> <ul style="list-style-type: none"> • Bringing together the local community each year e.g. for pasture clearance and maintenance activities. Every member of the community had an obligation to take part in these activities depending on their number and types of livestock. These activities are still remembered by old persons in the community. These activities could serve as good community organization model around pasture management. • Sets of rules existed regarding the use of the collapsed/fallen large old trees in the wood-pastures. These trees were used strictly on the community benefits, e.g. by local carpenters. • Ancient wood-pastures were arenas for cultural gatherings. We are aware about such gatherings in Sighisoara, Medias, Rupea and Sibiu towns. Most of these gatherings were cancelled in the communist regime. Some new initiatives exist to revive these gatherings, e.g. the 'Breite days' (Sighisoara, Mihai Eminescu Trust).
Key references	See end of report

5 Description of the tree communities

5.1 Tree species

As noted in the Table 1, tree communities in wood-pastures are significantly different than those of closed forests from the same cultural region. Light-demanding trees (oak, pear, apple) are better represented in the wood-pastures while forests contain a more balanced proportion of species including oak, hornbeam and beech (Figure 1).

5.2 Tree size

The largest trees from southern Transylvania tend to be located in wood-pastures and not in forests (Hartel et al. 2013). Recent surveys highlighted the existence of over 2000 old trees in wood-pastures of southern Transylvania, including oaks with circumference exceeding 700 cm, hornbeams with over 500 cm, birch with over 300 cm and pear trees with over 400 cm. These tree sizes are also outstanding at a European level. A recent study (Moga et al. 2016) and the subsequent surveys (Remarkable Trees of Romania, 2016: <http://arboriremarcabili.ro/en/trees/>) aimed to provide a comprehensive overview of the ancient trees from wood-pastures of southern Transylvania. The density of the old oaks is 0.14 ha^{-1} ($n = 25$ wood-pastures). Figure 2 provides examples of tree size distribution of large oaks from two ancient wood-pastures of Transylvania. We considered an oak 'remarkable' (i.e. old) when its trunk circumference was at least 400 cm. At this size the trees tend to have ca 200 years or more. A distribution map of large, old trees for an ancient wood-pasture is presented in Figure 3.

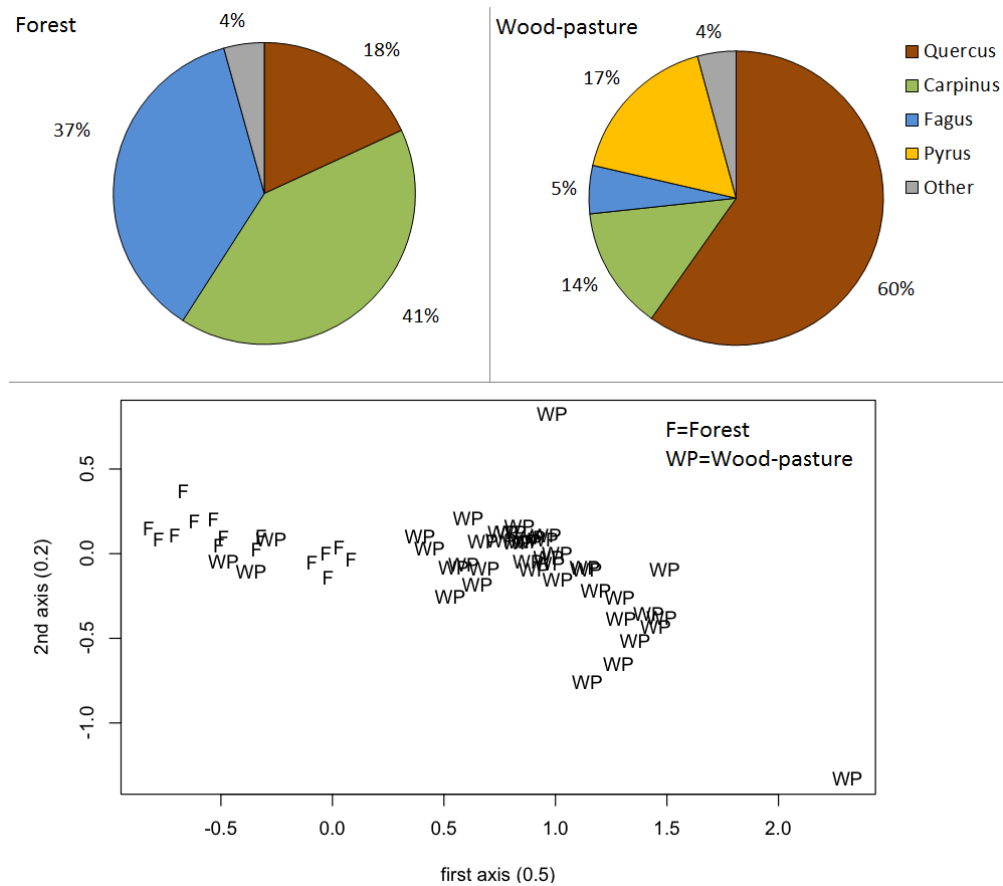


Figure 1. Comparison of the tree communities in high forests (n = 15) and wood-pastures (n = 41) from southern Transylvania (source of data: Hartel et al. 2013).

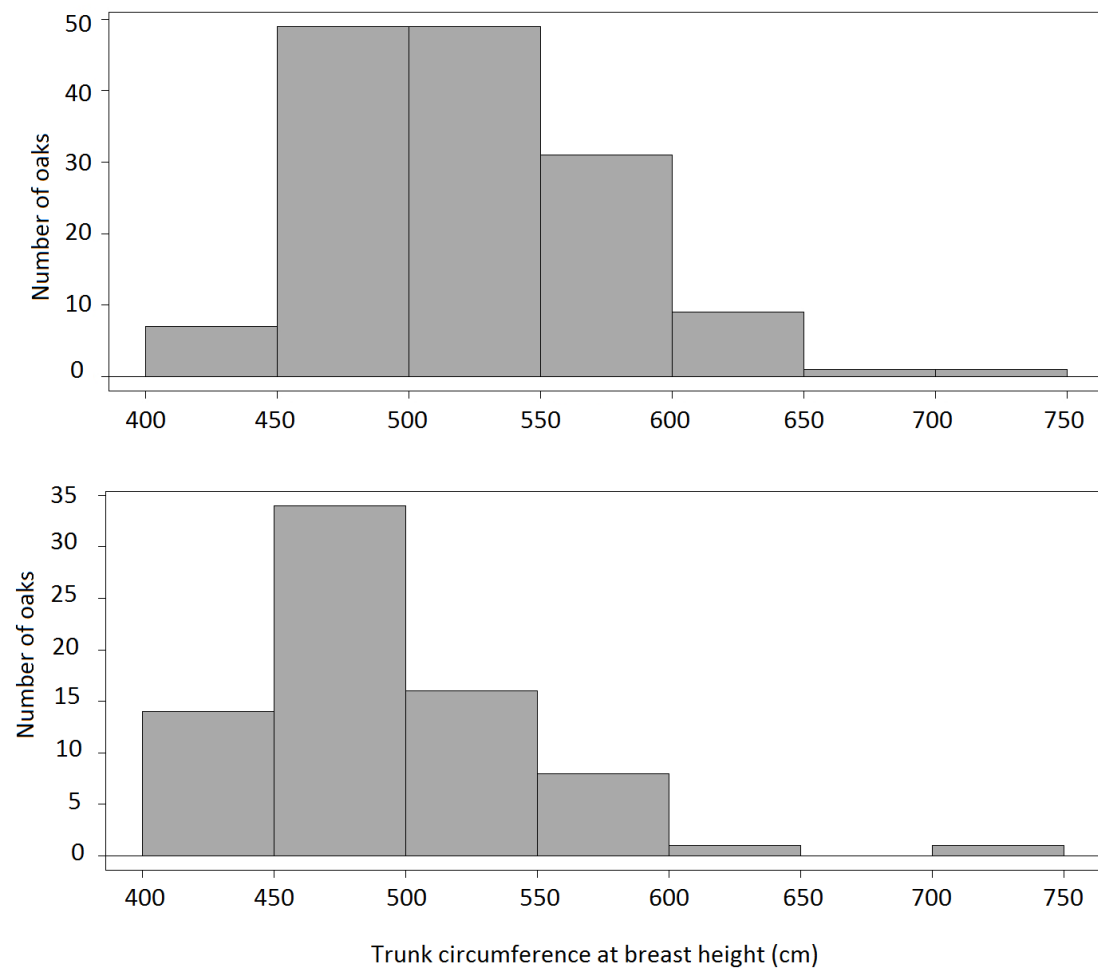


Figure 2. Distribution of the large oaks according to the trunk circumference in two ancient wood-pastures of Transylvania (Ticusu – upper graph and Rupea – lower graph). Note that we arbitrary set a minimal value of 400 cm trunk circumference to consider an oak tree ‘old’ and ‘large’.

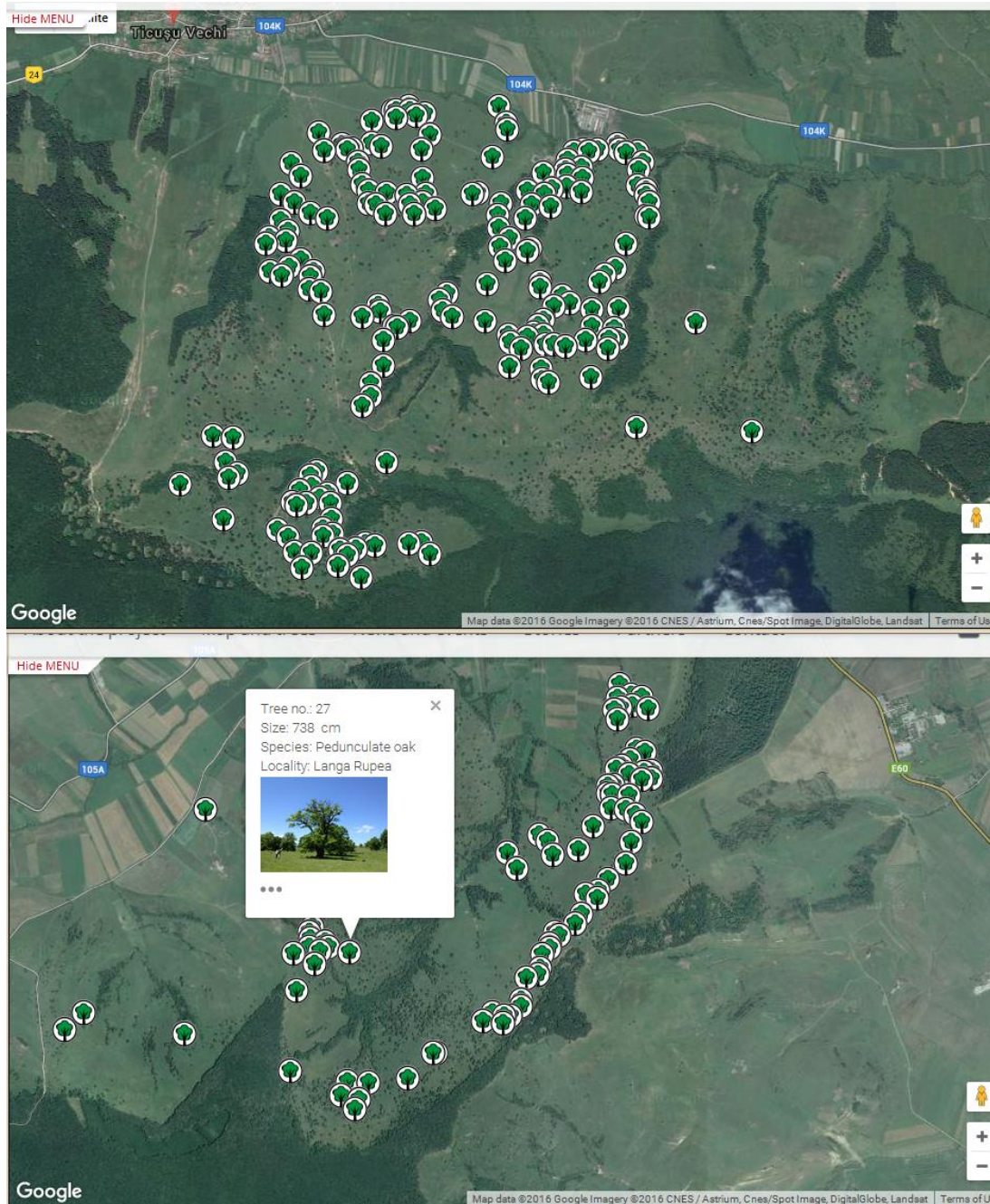


Figure 3. Mapping large, old trees in wood-pastures from Transylvania within the Remarkable Trees of Romania project. There are 180 trees in the upper map (ca 100 more to be uploaded – Ticusu wood-pasture) and 100 in the lower map (Rupea wood-pasture). The largest oak from the lower wood-pasture (738 cm trunk circumference) was highlighted. The data were collected by Árpád Szapanyos, Lucian Holban and Tibor Hartel.

5.3 Tree density

The tree density in the wood-pastures of southern Transylvania is difficult to estimate because i) the trees have (a natural) uneven distribution across the wood-pastures and ii) there is a strong tendency of ageing and reduction of the scattered trees while there is virtually no tree regeneration occurring. There are large areas of wood-pastures where the trees have been completely removed in recent decades. Although these areas are now pastures without trees, they historically were part of

woodland grazing systems. If we consider the historical state as baseline, then these treeless pasture parts should also be managed as wood-pastures e.g. by including tree regeneration (passively or actively) in the management strategy of these systems. Figure 4 shows four examples of wood-pastures with highly uneven distribution of trees across their surfaces. Two of these wood-pastures were drastically affected by tree removal in the communist times and afterwards (locals, personal communication) while two wood-pastures suffered less dramatic changes and they still contain scattered trees.



Figure 4. Wood-pastures where the trees were dramatically affected in the past decades (under communism and afterwards, upper figures) and wood-pastures where the human impact was relatively smaller (lower figures). The management of these wood-pastures should consider tree regeneration in order to assure the long term sustainability of these systems.

Estimations of the tree densities in 41 wood-pastures in the field resulted in an average value of 7.5 trees ha⁻¹ (SD = 4.8 trees ha⁻¹, reported in Hartel et al. 2013). The median of the tree density was 6 trees ha⁻¹ (lower quartile = 4.5 trees ha⁻¹, upper quartile = 11 trees ha⁻¹, min-max = 0.5-20.5 trees ha⁻¹). The majority of the wood-pastures had up to 10 trees per hectare (Figure 5). We advise against the bold application of our average and median values to qualify wood-pastures; rather, we believe that we have captured the general tree density spectrum for the wood-pasture types from our bioclimatic region and suggest the consideration of specific local contexts in establishing the tree density in any wood-pasture (or within its various parts). Specific contexts can include e.g. ruggedness of the terrain, likelihood of erosion, wetlands or other local important local variables, the large-old trees, tree species, historical, cultural contexts and preferences. As wood-pastures from our region evolved as strongly linked social-ecological systems, these context related factors will be important at local scale.

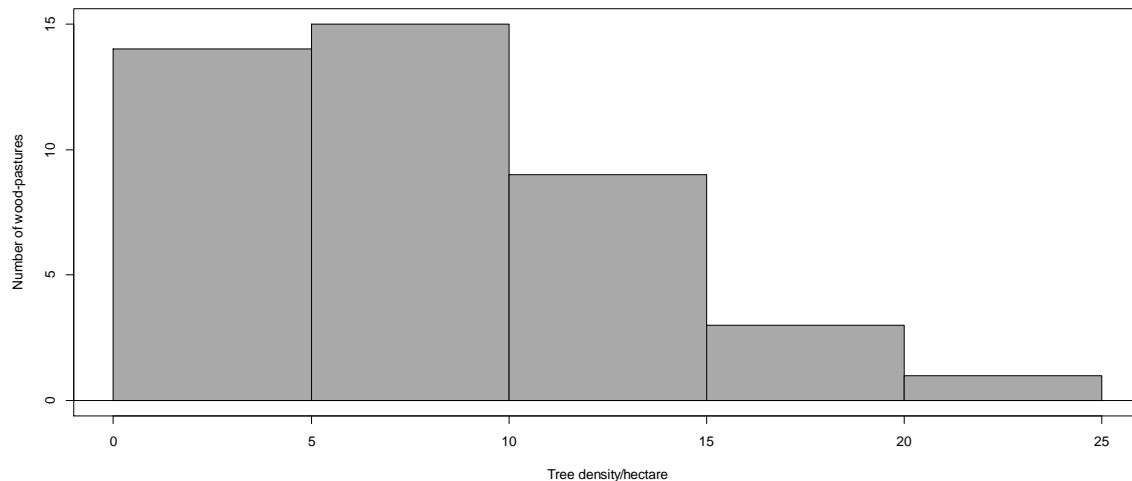


Figure 5. The distribution of the wood-pastures according to the tree density categories in southern Transylvania

5.4 Characterizing the oak trees

The oak trees were characterised in the Breite oak wood-pasture reserve near Sighisoara, for the management plan of this area. The following features of 69 oaks were measured: trunk circumference (m), height, crown projection (m^2), canopy destruction (%), acorn production (scale 1-4 for low and high), the number of juvenile oaks under the canopy and the average height of the juvenile oaks. The descriptive statistics of these variables are provided in Table 2.

Table 2. Descriptive statistics of 69 oak trees from the Breite wood-pasture

Oak tree feature	Average	Standard deviation
Girth (m)	4.28	1.14
Height (m)	23.0	4.4
Crown projection (m^2)	292	122
Canopy destruction (%)	27.2	20.9
Fructification (1-4 scale)	2.0	0.9
Number of oak saplings	30	34
Average height of saplings (cm)	35.9	22.8

The relationship between some of the above mentioned variables are explored with simple scatterplots (Figure 6). None of these relationships were statistically significant.

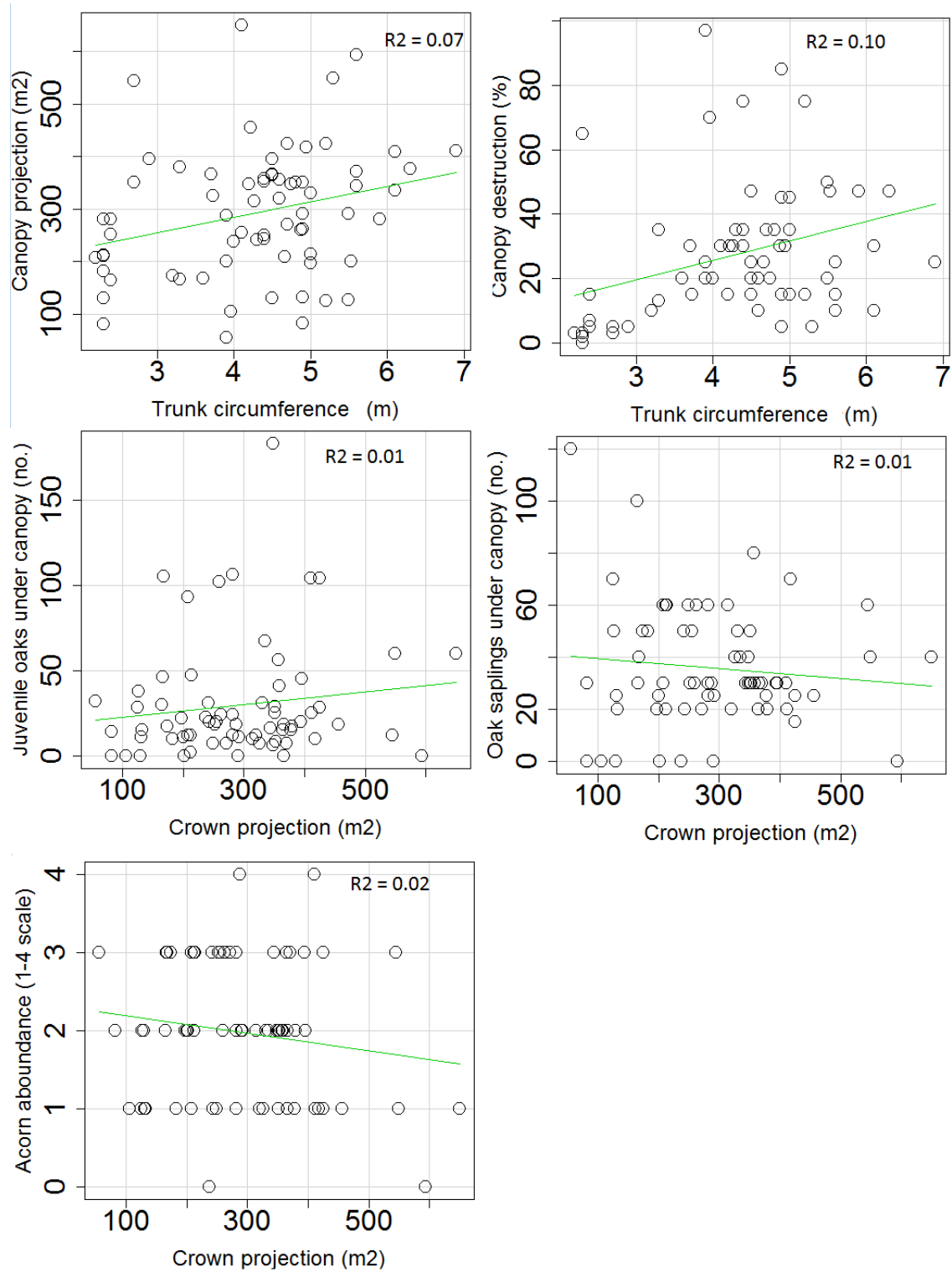


Figure 6. Relationships between the various features of 69 oak trees measured in the Breite ancient wood-pasture reserve. Note that these relationships are not statistically significant. Data source: Mihai Eminescu Trust.

6 Herbaceous vegetation

We lack comprehensive understanding of the vegetation of wood-pastures from southern Transylvania. Detailed vegetation records exist, however, for the Breite wood-pasture, where Kinga Öllerer recorded 476 species of vascular plants (Öllerer 2013, 2014). The Breite wood-pasture is atypical for the region with respect of its management: being a protected area, the grazing intensity was sharply reduced to about 0.1-0.5 livestock units (LU) per hectare. Furthermore, snapshot surveys carried out using stratified sampling design (to assess the effect of individual scattered trees, scattered trees *and* shrubs, and forest edge, compared to pasture parts without any woody vegetation) in a moderately intensively managed wood-pasture (ca 1.1 LU/ha) revealed a high overall richness of plant species (197 species), with the highest species richness / m² being 40. With this vegetation diversity, the studied wood-pasture has high natural value. Furthermore significant effects of scattered trees were identified on vegetation structure, highlighting the exceptional value of scattered trees at landscape level (Tölgyesi, Bátori, Gallé, Hartel *manuscript in prep.*).

7 Wetlands

The small sized wetlands (typically temporary ponds with surface area of *ca* 2-20 m²) are typical components of the wood-pastures from southern Transylvania. Typically, a wood-pasture will have about 10-50 temporary ponds. Their existence is a combined result of the natural pre-requisites and grazing management. Buffalo and cattle are typically attracted to wetlands (especially buffalo – see Figure 7) while sheep typically avoid wetlands. Buffalo and cattle contribute to the longevity of the wet periods for these temporary ponds because of trampling and by disrupting the presence and evapotranspiration from vegetation in the ponds. By contrast, these ponds are over-vegetated in the sheep grazed wood-pastures (typically with *Juncus* sp. and *Carex* sp.).

The occurrence of the yellow bellied toad (*Bombina variegata*) was much higher in the temporary ponds which were open than in vegetated ponds (Figure 7). Based on these surveys, we suggest that maintaining traditional grazing with buffalo would be a crucial element for maintaining sustainable yellow bellied toad populations in this region. The yellow bellied toad is an endangered amphibian (present also in the Habitats Directive and priority species).

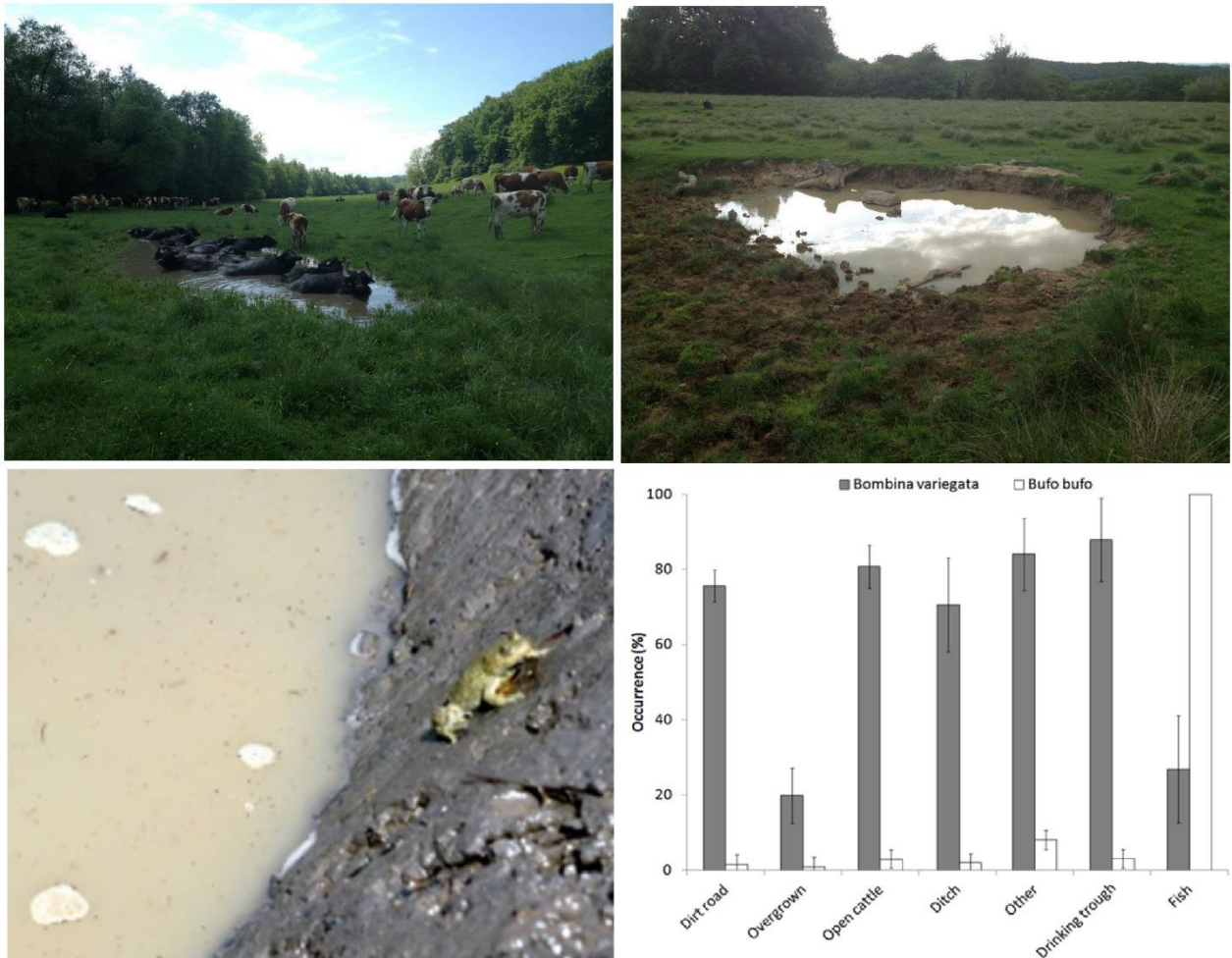


Figure 7. Temporary ponds maintained by buffalo and cattle in southern Transylvania. The graphic shows that the occurrence of the yellow bellied toad is high in the open cattle ponds and in the livestock drinking through from pastures, while is lowest in ponds with vegetation overgrown and fishponds. For comparison, another anuran with different habitat preference (the common toad which prefers permanent ponds) is presented (Hartel and von Wehrden, 2013).

8 Management

Wood-pastures in our study region were and still are typically managed by grazing. According to the surveys carried out in 2012, 60% of the surveyed wood-pastures were grazed exclusively by sheep while 5% showed no signs of grazing. The rest of the wood-pastures were grazed by mixed livestock type and 16% were grazed by cattle and buffalo in mixed way.

9 Developing conservation plans for wood-pastures in southern Transylvania

In this section we provide a brief overview of the various initiatives to promote (over the long-term) the social-ecological values of wood-pastures in southern Transylvania. These activities were summarized from work over the past 15 years (from Hartel et al. 2016).

- ‘Multi-secular oak reservation at Breite’ – a project aimed to promote the value of the Breite ancient wood-pasture near the town Sighisoara, to generate scientific understanding of this wood-pasture, and to protect it from a damaging governmental project (Sustainable

Sighisoara Association and Eco Breite Association, early 2000`s).

- Building milk collecting centres in villages and promoting markets for traditional products to help and motivate farmers to use their wood-pastures (ADEPT Foundation, 2010 and on-going).
- The project 'Conservation of biodiversity in the Breite ancient oak reserve, Sighisoara' targeted the in-depth scientific documentation of the Breite ancient wood-pasture, the development of its management plan and the implementation of several on-ground conservation actions, such as the removal of shrubs, closure of drainage ditches and regenerating young trees (Mihai Eminescu Trust, MET, <http://www.rezervatia-breite.ro/> (2006-2010)),
- The project 'The implication of the local communities in the conservation of the wood-pasture habitats from the Saxon villages of southern Transylvania' targeted a comprehensive inventory of wood-pastures from southern Transylvania, and also resulted in the measurement of over 400 ancient oaks (MET, 2009-2010)
- The projects 'Find the oldest tree' and 'One oak for every pupil' were first of all educational and awareness rising projects, targeting several schools and villages from southern Transylvania (2009-2010). This project resulted in the identification of the oldest and largest oak (*Quercus robur*) in southern Transylvania, and the second largest known living oak of Romania. The oak was formally protected as a natural monument, due to the initiative.
- 'The oak day' was a community event organized by MET in partnership together with over 50 institutions and important persons from Sighisoara. This event aimed to place back the Breite wood-pasture in the heart of the local community, by renewing a traditional cultural Saxon community event (i.e. the 'Skopationsfest') and adopting this to the current value systems of the society (2010).
- 'The Remarkable Trees of Romania' is a new, citizen-science based project targeting the large, old trees of Romania. The project was launched by His Royal Highness Prince of Wales (Pogány-Havas Association, WWF, MET, Eco Breite, Galeria Posibilă, Ancient Tree Forum, 2014, on going).
- Approaching the Minister of the Environment of Romania to discuss possibilities for social-ecological sustainability of Romanian wood-pastures. A press release following this meeting coming from the Romanian Government expressed the need for finding solutions for wood-pastures (Pogány-Havas Association, 2014).
- Highlighting wood-pastures as valuable landscapes needing protection in the management plan of a local Natura 2000 site of 85,000 ha (WWF, 2014).
- Initiation of a policy seminar in Brussels (European Commission) in order to recognize European wood-pastures within the Common Agricultural Policy (17 November, 2015). Materials (presentations, booklet and video) available at <http://arboriremarcabili.ro/en/news-and-events/>
- Initiation of artistic event 'Old Trees' in three major cities of Romania, to promote ancient trees (Galeria Posibilă organization, 2015)
- Eight peer-reviewed scientific papers addressing the ecological and socio-cultural values and threats for wood-pastures from southern Transylvania.

10 Conclusions

In conclusion this report shows that there is a relatively good understanding of the structural components and biodiversity value of the traditional wood-pastures of southern Transylvania and there is strong evidence of their large potential for serving as 'biodiversity reservoirs' at landscape scale. More studies in this respect need to explore the fine-scale relationship between the structural elements of the wood-pastures and biodiversity properties, and how these are related to management. However, we believe that there is already enough knowledge about these systems in order to start acting for the social-ecological sustainability of these wood-pastures.

We also highlighted that there are several good initiatives emerging which could facilitate re-connection of societies to their wood-pastures. This can be done with reviving old values and knowledge, as well as with promoting the development of new value systems. Section 9 outlines some important initiatives in this respect. There are also important policy initiatives inspired by Transylvanian wood-pastures. Together these initiatives provide optimism and motivation for future activities to assure the social-ecological sustainability of wood-pastures in Transylvania and their global cultural and ecological heritage values.

11 Acknowledgements

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