ECOSYSTEM SERVICES PROVIDED BY BLACK LOCUST (*ROBINIA PSEUDACACIA* L.) PLANTATIONS IN SOUTH-WESTERN ROMANIA

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Abstract: *This paper underlines how black locust plantations play an important part in ensuring forest specific ecosystem services in Oltenia region located in South-Western part of Romania. Forest area in Oltenia region has diminished considerably in the last two centuries, and by the year 2010 it dropped to 5.3% of region area. This phenomenon generated degraded lands (especially "flying" sands) and had a devastating effect on the environmental and social conditions in the region, being further amplified in the last two decades by global climate change. The only efficient measure to reclaim the sandy soil degraded lands was found to be the afforestation with an exotic fast growing species: Robinia pseudoacacia* L. *Forestry research and practice proved that black locust has the required adaptability to help in the ecological reconstruction of different degraded land types (e.g. "flying sands", ravines, polluted soils and surface mine-lands) as long as its invasive nature is acknowledged. Romanian local communities benefited from the black locust plantations through wood and non-wood products, enhanced agricultural crops protection and also from CO_2 sequestration. Considering that in Romania the total area of degraded lands exceeds 2 million hectares, extreme weather is increasing in the South of the country, and the general need for services provided by forests, black locust plantations represent a viable solution for these societal demands.*

Key words: black locust, ecosystem services, degraded lands.

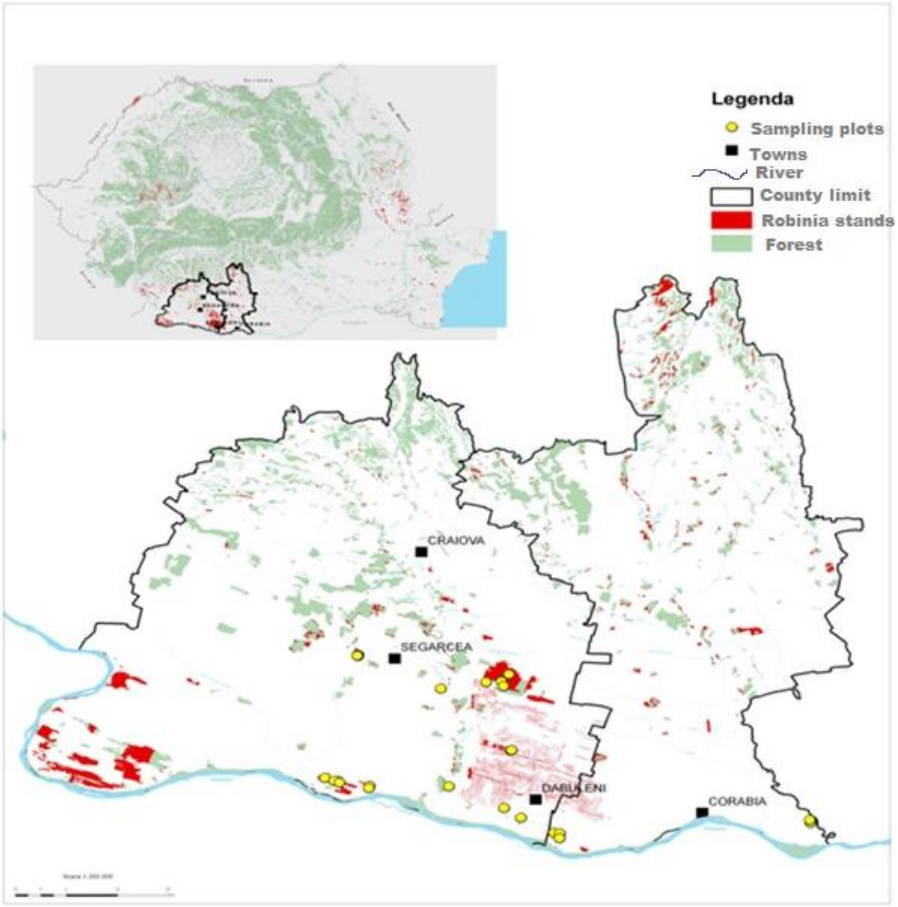
1. INTRODUCTION

Forest area in the south west of Romania and especially in Oltenia region has diminished considerably in the last two centuries (Popescu et al., 2004), reaching in 2010 a level of afforestation of about 5.3% (National Afforestation Programme, 2010). In Oltenia Plain, loss of forest vegetation triggered fluvial sand deflation, causing the formation and advancing of sand dunes (Nuță 2007). This phenomenon has a devastating effect on the economic, environmental and social conditions of the region, and was enhanced in the last two decades by global climate change effects, which create prerequisites to desertification in this part of the country (Pienaru et al . 2009).

The sustainable solution to stabilize *flying sands* was identified in the commune of Băileşti since 1885, namely afforestation of the sand dunes with black locust (*Robinia pseudoacacia* L.) (Dracea 1928). Proving it's efficiency in stabilizing the flying sands, this adaptable species has been used at national level, especially in order to reclaim degraded lands (e.g. ravines, waste dumps) but also as protective shelterbelts (e.g. for protection of crop or infrastructure). This has led to the artificial (and natural) spread of black locust (currently occupies approx. 250,000 ha), the largest and most valuable stands being located in southern Oltenia (Figure 1) and totalling about 25,000 ha with a wood volume of ca. 1641000 m^3 (NFI 2012), thus having a significant contribution to national and regional forest economy.

In recent decades the amplification of extreme weather phenomena (prolonged drought, floods and high temperatures) manifested worldwide and felt also in Romania, has drawn attention to the importance of sustainable management of forest ecosystems to mitigate and combat the negative effects of climate change (Ciuvăț 2013). This paper is based on the doctoral theses of the authors and the results of *Romania Afforestation of Degraded Agricultural Lands Project*, and aims to highlight ecosystem services provided by *R. pseudoacacia* L. stands, in the context of current socio-economic challenges.

Figure 1. **Location of study area**



2. MATERIAL AND METHODS

Research was carried out in black locust plantations established on degraded agricultural lands and adjacent areas (crops, villages) located in south of Dolj and Olt counties of Romania (Figure1).

Ecosystem services represent the benefits humanity obtains from ecosystems. These include *provisioning services* (e.g. products, food), *regulating services* (e.g. flood control), *cultural services* (e.g. recreational and cultural), and *supporting services* (e.g. nutrient cycling, soil formation) ().

The ecosystem services assessed in this paper are biomass/CO_2 accumulation, non-wood products, agricultural crops protection, biodiversity and social benefits due to black locust plantations.

The methods used in evaluating the ecosystem services provided by black locust plantations were: a) *destructive sampling* for provisioning and supporting services (e.g. biomass production, soil nutrient cycling); b) *field observations and measurements* for regulatory services (e.g. crops and biodiversity gain); c) *social questionnaires* for social/cultural services (e.g. benefits to local communities).

Biomass production and C pools stock change (biomass, soil and litter) were estimated by measurements made in 39 sample plots (200 m^2) located in black locust plantations, age 1 to 10 years.

Biomass samples were oven dried (80^0C), and allometric equations were developed for tree components (e.g. root, stem), based on diameters at collar and basal (1.3 m) heights (Figure 2) (Blujdea et al. 2012).

Figure 2. **Sampling and processing of biomass samples**

Biodiversity gain associated with the black locust plantations was assessed based on dynamics of bird populations, especially the raptor species as indicators of ecosystem health and diversity.

Socio-economic assessment was fulfilled by filing in questionnaires in the communities affected by the plantations. The *indicators* used for socioeconomic assessment were (Table 1):

Table1. **Socio-economic indicators**

Social indicators	**Economical indicators**
Individual/community benefits	Household income and income trend for local population
Individual/community level negative impact	Investment of gain from working for plantation
Availability and interest for further afforestations	Presumptive gain/loss of crop due to plantations

3. RESULTS

Biomass/CO2 accumulation. Majority of *Robinia* plantations are located on sandy or alluvial soils. Whether planted on degraded agricultural lands or as shelterbelts for crops/infrastructure protection, black locust growth and carbon accumulation capacity is surpassed only by that of native and hybrid poplars (Table 2). Mean value per ha of CO_2 sequestration is 63.3 tones at ages of 1 to 10.

Table 2. C accumulation in black locust and poplar plantations/shelterbelts

Age (years)	C stock in plantations on degraded agricultural lands (tC ha^{-1})				C stock in forest shelterbelts (tCO_2 ha^{-1})			
	Black locust		Native poplar sp.		Black locust		Poplar hybrids	
5	3.52	12.91	1.66	6.09	5.47	20.06	3.71	13.60
10	33.24	121.88	44.13	161.81	17.02	62.41	14.56	53.39

Wood products. Given the small age of the studied plantations (1 to 10 years), the only wood products are those resulted from tending operations (poles or firewood), which is used by local farmers.

Non-wood products. Black locust stands have a high melliferous potential, the total quantity estimated at country level being 697,000 tons per year. The honey obtained from black locust flowers is considered of highest quality (Mădaş 2013), making it the most expensive on the market.

Agriculture crops protection. Earlier research showed that the existence of black locust shelterbelts in the study area led to an increase in different crop productions (e.g. tobacco, wheat, watermelons) of up to 130 %, as opposed to unprotected crops (Nuta 2007).

Biodiversity. Assessment has shown the presence of numerous birds (e.g. *paseriformae* and *coraciiformes* - Figure 3) from different groups (e.g. granivores and raptors) compared to initial land use (abandoned agricultural land). The numbers of reported/observed bird nests were located in understory and tree holes between 1,5 to 4 m (Figure 4). No negative effects on species included in the IUCN Red List of threatened species were observed (or species on a nationally recognized list). The plantations also offer shelter for different mammal species as small rodents, deer, fox, jackal, wild cats etc.

Figure 3. ***Upupa epops* L. in black locust stand**

Figure 4. **Bird nest**

Socio-economic and cultural assessment. Land use change by afforestation brings about a change in land use pattern at local and regional level, as well as in the behaviour of the local people. The positive effects come from stopping land degradation and reducing soil erosion, improving of landscape, supply of construction wood and fuel-wood, fruits etc. Adverse impacts of establishing the forest plantations may include reduced area for crops or grazing, and delay in revenue to owners.

Based on the social questionnaires filled by 27 inhabitants from the villages adjacent to the plantations resulted that local people were informed on past and existing afforestation activities in their vicinity. More so, locals had financially benefited individually and collectively from participating (temporary employed) in the afforestation activities.

4. DISCUSSIONS

Black locust shows greater biomass accumulation both on sandy and alluvial soils compared to other species (e.g. oak, ash, linden) used for afforestation of degraded lands in the study area, while its nitrogen fixing capacity improves the soil properties. With plantations in their 10'th year, the tending operations performed (especially thinning) resulted in fuel and small construction wood for local farmers.

Comparing to the results of social assessment performed in 2003 in the same areas, it was noted that the enthusiasm diminished as employment benefits associated with planting have declined. This is mainly because fewer than expected benefits such as wood and non-wood products are available.

Although long term positive effects of afforesting degraded lands were also acknowledged, social impact is little known or not acknowledged by local people. There were locals reporting some negative effects in the form of diminishing grazing area due to afforestations, and that the community still does not benefit from the beekeeping potential of black locust stands.

5. CONCLUSIONS

Robinia pseudoacacia L. stands (plantations, shelterbelts and coppice) in southern Oltenia provide all types of forest ecosystem services in an area characterized by one of the lowest percentages of afforestation at national and European level.

The afforestation and stabilizing of *flying sands* in southern Oltenia had a double advantage: saving both agricultural crops and local villages exposed to desertification and providing wood and non-wood products, thus contributing to the sustainable development of the region by protecting its primary economic resources.

Black locust shelterbelts insure the protection of infrastructure and increase yield capacity of crops leading to substantial economic benefit for local administration by increasing agricultural production per hectare and relief costs caused by snow or sand blocking of roads.

Having in mind the millions of hectares of degraded lands in Romania, and the international efforts to support the use of renewable energy resources, black locust stands out as one of the most suitable species for the ecological reconstruction of degraded lands, as long as its limitations and invasive nature are acknowledged.

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