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ECOLOGICAL RECONSTRUCTION OF DEGRADED LANDS DUE TO WASTE ABANDOMENT IN A SOUTHERN AREA OF DOLJ COUNTY

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ABSTRACT

The study aims to present the possibilities of ecological reconstruction of degraded lands in the area of the Ostroveni commune, Dolj county, due to the abandonment of waste by implementing technical works to restore and improve the areas intended for habitats of community interest. Technical works were carried out to uncover the polluted soil layer and to remove the grassy/woody vegetation composed of invasive species, followed by the stage of land preparation for the reconstruction of habitats, the selective removal of woody vegetation or grassland composed of non-useful species, covering with fertile soil, manual or mechanized soil mobilization/scarification, installation of warning signs to limit access to the area of reconstructed habitats for the purpose of developing native species and methods of reconstruction by seeding/planting with native species, monitoring and evaluating the habitats on which quality improvement actions have been applied since the preparation of the land, to highlight the effects of habitat reconstruction.

INTRODUCTION

The origin of all living things on Earth is, more or less, directly or indirectly linked to the soil, as more than 90% of human and animal food is produced in/and on the soil (Lal & Stewart 1992).

The quality of soil, water, atmosphere and vegetation directly influences our way of life. Now the fundamental role of the soil and its functions in promoting sustainable agriculture, in preserving the quality of the environment, in intensifying global climate changes, in preserving biodiversity, in the quality of life on the Planet is recognized.

The soil fulfills social, ecological, economic and cultural functions (Dodocioiu & Mocanu 2009). It also functions as support, provision, regulation and cultural service in ecosystem services (Keesstra et al. 2016).

Soil pollution is the result of any action that causes the disruption of the normal functioning of the soil, as a living environment, within various natural or man-made ecosystems, disruption manifested by the physical, chemical, biological degradation of the soil, which negatively affects its fertility, respectively its

bioproductive capacity, from a quantitative and qualitative point of view (Gavrilescu & Buzatu 2014).

Further this pollution reaches the underground environment and hence the pollution of groundwater, which for the most part is an effect of anthropogenic pressure on the environment (Dodocioiu & Buzatu 2017, Dodocioiu et al. 2017).

One of the key drivers of human-induced global environmental changes is represented by invasive species, as they affect biodiversity, systems services and human well-being (Pejchar & Mooney 2009).

One of the sources of soil pollution is the uncontrolled storage of waste, especially in rural areas (Gavrilescu & Buzatu 2014). In the case of the biodiversity environmental factor, the current situation of waste management, especially the non-compliant storage or abandonment of waste, have a significant impact on wild species of community interest, pollution being by far the most severe threat to their state of conservation (***, 2021).

Biodiversity is one of the global priorities in the current context of the transition to a greener economy and a more sustainable world, its decline having significant consequences both at the level of people's health and at the economic level.

Knowing the soil is the necessary and indispensable basis for the exploitation and reconstruction of any type of land, but this knowledge must also be supplemented with environmental elements in their interaction and interconditioning. Both natural factors and human action contribute to land degradation. In general terms, soil degradation means the reduction or loss of their biological and economic productivity.

Land degradation has become one of the biggest challenges facing humanity in today's world (Velmourougane & Blaise 2017). Land and soil pollution can have significant impacts on human health as well as soil biodiversity and ecosystem health. These pollutants can affect soil organisms and possibly contaminate our food and drinking water. Remediating contaminated land is difficult and expensive, but necessary to clean up past pollution (***EEA 2020).

Through the ecological reconstruction of degraded lands, there are improved the damage caused by anthropogenic and natural degrading factors, soil quality, water retention capacity, biomass production, biodiversity, etc.

That is why it is necessary to know the stage and causes of land degradation, to restore and reconstruct the degraded lands so that they can be used sustainably. In these conditions, the sustainable use of land is sustainable, only if a certain spatial configuration of the different uses is achieved so as to guarantee biodiversity and preserve the eco-balance of the entire system.

MATERIAL AND METHODS

The study has been carried out on the territory of Ostroveni commune, in a series of points with areas where the habitats are impacted by various anthropogenic factors that affect the state of conservation of habitats and species of community importance. The activity of restoring the impacted habitats involves a specific intervention within the habitats intended for ecological restoration. The proposed activity aims to improve the surface quality of these habitats, as they support a number of important plant and animal species or of community interest.

In the area of the Ostroveni commune, 5 areas were identified in which the intervention on the habitats was carried out by performing the following technical works: uncovering the polluted soil layer from a minimum depth of 20 cm, removing

the grassy/woody vegetation composed of invasive species*: Amorpha fruticosa, Reynoutria japonica,* covering with fertile soil, sowing with grassy species, placement of warning and information indicators, for the poplar's habitat. The degree of shrub cover (% of the habitat area) must not exceed 25%, and the height of the grassy layer must be less than 20 cm, for the conservation of bird species, the removal of dry or drying trees will be avoided, they will be maintained as landscape elements, i.e. solitary trees and isolated mature shrubs in open areas, as well as alignments of trees and bushes.

The pressures and threats mentioned in the management plan and identified in the territory of this locality are: A03.03-abandonment/lack of mowing; H05.01-garbage and solid waste; H01-surface water pollution; J03.01-reduction or loss of habitat characteristics; K02.01-change in species composition (***, 2016).

For the ecological reconstruction, the first stage was represented by the inventory and collection of current data from the 5 areas under study, by traveling in the field to each area intended for ecological restoration in the perimeter of the locality. As a result of this stage of inventory and data collection from the field, an estimate of the existing situation was made.

Data related to the type of affected habitat, the current state of anthropogenic impact, the degree of coverage with waste, data related to local plant biodiversity, namely the spectrum of plant species in each marked area, a list of important plant species were collected on the field, especially those characteristic of that habitat, precise localization with GPS coordinates related to each location and a series of suggestive images. A series of invasive allogeneic plant species, were also inventoried, some considered of interest for the Union (https://invasive.ccmesi.ro/despre-speciile-invasive/lista-sai-romania) or of regional interest (***, 2020).

RESULTS AND DISCUSSIONS

Areas impacted by certain anthropogenic factors, such as illegal landfills, are an ideal place ("hot spots") for the establishment and subsequent distribution of invasive species in the surrounding habitats. They are considered a major threat to local indigenous biodiversity, they destabilize the structure of native plant associations, having a major impact on habitats. They also have repercussions on human health, agriculture, fisheries and food production. Being a major pressure factor on biodiversity, the inventory and monitoring of invasive species has become of interest for Romania as well. According to Regulation 1143/2014, Art 24(1), it is provided that from 2019, every six years, the member states update and transmit to the Commission data related to the distribution of invasive species of interest for the Union or of regional interest (***, 2020).

In the Ostroveni locality, 5 human-impacted areas were identified, on an area initially estimated at 46,400 sq m (4.64 ha) (Figure 1). The land areas intended for habitat restoration are located in 5 areas, all of them being distributed in the vicinity of the Jieț River. The most affected surfaces are those of permanent meadows with a sandier soil structure, some drier, determined to be a 6260* or wetter habitat included in the 6440 habitat, but also other habitats in the immediate vicinity of these meadows, belonging to Jiet river, 92A0 and 3150 (Figure 1).

The invasive plant species identified in the area, so far, are *Acer negundo, Erigeron canadensis, Erigeron annuus, Galinsoga parviflora, Galinsoga quadriradiata, Robinia pseudocacia, Ailanthus altissima, Ambrosia artemissifolia, Lycium barbarum, Elaeagnus angustifolia, Bidens frondosa, Datura stramonium, Abutilon theophrasti.*

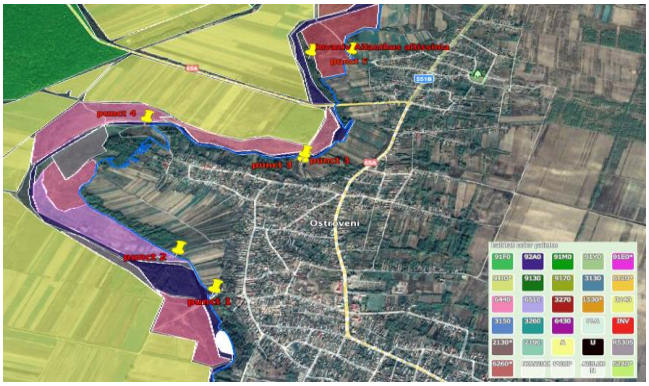

Figure 1. Location of the 5 areas studied, map generated in Google Earth Pro

The first area includes 2 habitats (GPS 43.807537-23.886955, altitude 76.8 m), at the time of field observations, extensive areas of meadows were covered in several places by a significant amount of waste, accumulated there over a long period of time, collected and superimposed in large heaps, so that they were compacted, stratified to a considerable height in certain areas, and covered with dense ruderal vegetation. In many areas this waste also reaches the neighboring wet habitats, 92A0 and 3150. The water quality of the Jieț River was very affected, with a pronounced eutrophication from a lot of decaying materials, with the reed vegetation infiltrated with waste. The wet habitat in this area, 3150 was very affected, eutrophicated, being devoid of the floating and submerged species characteristic of other well-preserved areas along the Jieț river.

A large area of these meadows, with a more humid character, is dominated by the native species *Conium maculatum* (poison hemlock), a toxic plant for both humans and animals. The presence of this species degrades the quality of the habitat, preventing the other native species from developing. Hemlock is a difficult species to eradicate, able to germinate quickly after rains, especially on disturbed sites or where there is little vegetation, where it acts as a pioneer species in the early stages of vegetation succession. Once firmly established in such conditions, hemlock can exclude most species that would contribute to the improvement of the grassland vegetation (***, 2017).

Related to the state of habitat 3150 on the Jieț river, it is important to mention that this is already a more eutrophic habitat, and any addition of nutrients, especially from waste from chemical sources, agricultural sources, leads to a higher enrichment of the water in nutrients, which produce an increase in eutrophication that affects and reduces floristic diversity. A high eutrophication, which usually comes from the decomposition of organic materials or phosphates, stimulates the formation of algae that end up forming dense floating layers, as well as the expansion of duckweeds species (*Lemna spp*.).

Habitat 6440, being a habitat with higher humidity, is more sensitive to invasion by invasive species, and if the place is anthropized by dumping waste, invasion of species such as *Conyza canadensis, Galinsoga parviflora*, *Ambrosia artemisiifolia, Datura stramonium* is encouraged, *Abutilon theophrasti, Amorpha fruticosa*, in very large numbers, being already present in the area. Another

invasive species identified is *Lycium barbarum* (buckthorn), which forms dense thickets in untended places and especially on fences in the area (GPS 43.807354, 23.887180).

Figure 2. Summary of the first stage represented by the inventory and collection of current data from the 5 studied areas: A- area 1, the image illustrates the degree of anthropogenic impact in habitat 3150, with the storage of waste covered by vegetation on the banks of the Jieț River. The appearance of the meadow with compacted waste deposits, trapped in the vegetation that has grown over them due to long storage, GPS 43.807537-23.886955, altitude 76.8 m.; B - area 2- The general, ruderal aspect of the permanent meadow vegetation, in many places dominated by *Conium maculatum*. C - area 3, the general aspect illustrates the degree of anthropogenic impact in the permanent grassland habitat, GPS: N43.816166-E23.891449, altitude 81.3 m.; D – General aspect of area 4, the image illustrates the degree of anthropogenic impact in the meadow habitat, GPS: 43.818748-23.880472, altitude 75.4 m.; E - area 5, the image illustrates the presence of the large number of specimens of the invasive species *Ailanthus altissima*, just started in vegetation, a species on the list of invasive species of interest for the European Union (GPS: N43.823833-E23.891056, altitude 72.0 m).

The second area (GPS 43.809864-23.884312, altitude 70.6 m) is a permanent meadow in the river Jieț meadow, mostly determined to be a 6440 habitat, currently highly anthropized, with various ruderal species uncharacteristic of the habitat. The substrate is sandier, more humid in the spring.

The zone intermingles with a more xeric habitat, which gradually leads to the 6260* habitat, especially in the higher and drier areas for a good part of the year. Certain areas have waste stored up to the neighboring habitats of 92A0, R5305 and 3150. Among the invasive species, *Acer negundo, Bidens frondosa, Ambrosia artemisiifolia, Datura stramonium, Abutilon theophrasti, Lycium barbarum* (N43.810083, E23.884265) were identified.

The third area studied (GPS: N43.816166-E23.891449, altitude 81.3 m) is located on a permanent meadow, bordering the Jieț River to the north, along which habitat 92A0 is located, and to the south with urban areas.

The area has waste deposits located on extensive areas of grassland, with a compacted appearance, due to their storage over a long period of time, waste arranged in layers, on a considerable height and covered by a dense ruderal vegetation. In many areas this waste also ends up in the neighboring wet habitats 92A0 and 3150. The wet habitat in this area 3150 was very affected, eutrophicated, lacking the characteristic floating and submerged species, with a lot of floating or decaying material.

The original permanent meadow probably had a more sandy substrate, but nowadays the soil looks very compacted, impregnated with many organic materials from the stored waste, so an altered substrate, with a mesophytic character in the spring period (when the water supply is still supported), similar to habitat 6440. It is a highly anthropized habitat, with various ruderal, nitrophilous species. The area overlaps with a more xeric habitat, especially on the other side of the Jieț River, with higher and drier areas for a good part of the year, which gradually leads to the 6260* habitat.

Invasive species identified *Ambrosia artemisiifolia, Acer negundo* (Boxelder maple; GPS: 43.818911, 23.880465), *Elaeagnus angustifolia* (Russian olive or oleaster; GPS: 43.818306, 23.881751), *Lycium barbarum* (Hedge buckthorn).

The fourth area (GPS 43.818748-23.880472, altitude 75.4 m) is, like the previous zone, a permanent meadow with a highly anthropized habitat, with various ruderal, nitrophilous species, with a sandy but compacted soil, with an altered substrate, impregnated with many organic materials from the stored waste, the plant species present indicate that it was originally an area that could be included in habitat 6440. Habitat 3150 of the Jieț River, located near the area, was not affected at the time of the field trip.

The fifth area (GPS: N43.823803-E23.893780, altitude 70.6 m) is located in a meadow that is mostly more sandy and drier, with certain areas where species characteristic of habitat 6260* (priority habitat) can be identified. On a large zone, areas with waste deposits gathered in piles or scattered at various points on the surface of the meadow were identified. Towards habitat area 92A0, close to the Jieț river, a large number of specimens of the invasive species *Ailanthus altissima*, a species on the list of invasive species of interest for the European Union, was identified (GPS: N43.823833-E23.891056, altitude 72.0 m).

Land preparation stage and the installation of warning signs for the delimitation of access in the area of reconstructed habitats for the purpose of the

development of native species (Figure 2). This activity consisted of the following actions:

1. Land preparation for habitat reconstruction:

- removal of waste/household scraps and their transport to authorized warehouses or specially arranged places;

- the uncovering of the polluted soil layer was carried out after analyzing the existing plant layer, the quality and thickness of this layer at a depth of at least 20 cm;

- the selective removal of woody vegetation with the objective of maintaining the land use category; However, the trees/trunks important for biodiversity were preserved;

- depending on the ecological characteristics of the sites that require intervention, it was decided which of these actions is applied;

The tree species characteristic of the habitats are maintained in the location, the alien species of the habitat type are used as dead wood or are turned into compost.

- removal (manual/mechanical) of grassy vegetation composed of useless, ruderal or invasive species or with low nutritional value, which occupied the land, inadequate to the assigned role;

- depending on the ecological characteristics of the sites that require intervention, it was decided which of these actions is applied. The herbaceous species characteristic of the habitats are maintained in the location, the alien species of the habitat type are transformed into compost;

- covering with fertile soil - is a necessary action, as a solution to combat the effect of stripping. Covering with fertile soil creates the necessary substrate for the development of the species characteristic of the habitat type;

- manual mobilization/scarification of the soil and, as the case may be, mechanized when manual mobilization was not possible - the action is necessary in order to loosen the soil and achieve an easy access of the seeds of plants specific to the habitats to the nutritious substrate.

2. Seeding/planting with native species:

- Collecting/threshing seeds from natural meadows in the area (*Agrostis stolonifera; Alopecurus pratensis; Poa pratensis, Poa trivialis; Daucus carota; Medicago lupulina; Trifolium repens; Potentilla reptans; Lotus corniculatus; Ranunculus repens; Lysimachia nummularia; Rorippa sylvestris; Eleocharis palustris; Sanguisorba officinalis; Carex arenaria; Carex praecox; Allium schoenoprasum; Festuca beckeri*, etc.), purchased from the locals/economic agents, to restore the herbaceous blanket; if they are not available in situ, they will be purchased;

- sowing the selected areas with seeds resulting from the collection/threshing previously done, the completion of the quantity will be done with the specific species and quantities purchased from the economic agents;

- planting the selected areas with saplings specific to the reconstructed habitats and specific to the ecological needs of the targeted species - this action involves the planting of some herbaceous saplings to improve the characteristics of the wet vernal and summer habitats;

- maintenance of the sub-tree and the usable arboretum in order to arrange the shelter habitat for *Lutra lutra*, a species that requires the presence of old trees, with well-developed roots and hollows in which it finds shelter, in its distribution

area. The maintenance of the arboretum, in the sense of preserving the woody vegetation on the banks of the waters, represents an important action in order to preserve the characteristics of the habitats for *Lutra lutra*.

3. Installation of warning signs to limit access to the area of reconstructed habitats for the purpose of developing native species.

4. Evaluation of the habitats on which qualitative improvement actions have been applied will be carried out already from the preparation of the lands.

The activity responds to the pressures/threats identified in the management plan: K02- Burning of meadows; I01- Allochthonous invasive species; A03.03- Abandonment/lack of mowing; H05.01-Garbage and solid waste; H 01-Surface water pollution; J03.01 - Reduction or loss of habitat characteristics; K02.01 - Change in species composition.

After the inventory stage of all the areas proposed for the ecological restoration of the habitats, the cleaning stage began, which involved a series of waste release activities from all areas where this impact was found. The clearing stage consisted of two stages, a mechanized clearing where large machinery was used and 20 cm of soil was removed, and a manual clearing.

The cleaning actions took place in the perimeter of Ostroveni, which has very extensive areas of habitats affected by waste deposits. A series of machines, machines of high capacity and a unit for sorting the collected waste were brought One problem that arose was that villagers continued to illegally dump waste in the area.

At the completion of this stage, a warning sign with "waste storage strictly prohibited" was installed, but it was destroyed by the villagers shortly after. Even with the warning board installed villagers continue to dump waste.

Seeding stage and habitat assessment on which actions for qualitative improvement were applied. In the seeding stage, the pressures and threats mentioned in the management plan and identified in the studied areas were taken into account.

Collecting a seed base from neighboring areas proved unfeasible, due to the fact that the surrounding permanent grasslands occupy relatively small areas due to the large extension of agricultural areas.

Another aspect is that the permanent grasslands in the area are heavily anthropized, overgrazed, with low seed production, but also difficult to harvest because the seeds shake off quickly.

Another aspect is the spectrum of species identified in the bordering meadows is limited, like grasses being mostly dominated by the *Bromus* genus, the meadows having an altered species composition (hence the impact mentioned in the management plan: K02.01 - change in composition of species; J03.01-reduction or loss of habitat characteristics).

Figure 3. Summary of the activities carried out: A- Area 1, the stages of the mechanized cleaning activity of the impacted habitats, with the loading of waste in the machines. B- Aspects with the progressive stage of the mechanized release of waste from area 1, cleaning the banks and the water surface of the river Jieț. C - Installation of a waste sorting unit to collect the remaining waste on the leveled surface, near which villagers continue to illegally deposit waste. D - Area 1, manual sorting and cleaning of waste remains on the ground and storing them in bags. E- Area 2, manual sorting and cleaning of waste remains on the ground and storing them in bags, GPS: 43.809864-23.884312. F - Area 3, aspects with the stage of mechanized release of waste, GPS: N43.816166-E23.891449. G- General appearance of the seed mixture applied at sowing. H- Seeding stage in area 5. I, L- Observation of invasive species installation in the vegetal carpet in zone 1. J- Observation of vegetal carpet evolution in zone 1. K- Restored area after being affected by the invasive species in area 5.

Practically harvesting seeds from these areas could have had a negative impact, leading to a decrease in the soil seed genetic base of native species, therefore it was preferred that the seeds be procured from other sources and an experienced producer from country, in the production of seeds for meadows.

In order to solve the problems on the surfaces proposed for ecological reconstruction, species were chosen that favor the installation of a vegetal carpet made up of valuable species, which are based on certain rules regarding the composition of perennial grass and leguminous species and the quantitative ratio between them.

When choosing the optimal version of the mixture of species, the stationary ecological conditions in the field and the local floristic spectrum were mainly taken into account. As it is a protected area and located on sands, where the ecological conditions are more special, it was considered appropriate to refer to the discussions and recommendations offered by those from the Grassland Institute in Vaslui, who came up with proposals for mixtures of plant species, but also with stocks available to be seeded.

It is important to note that the area proposed for seeding is located in and adjacent to a protected area, thus not indicating the addition of fertilizers and no chemical treatment of weeds that usually settle after seeding. In addition, most of the areas proposed for seeding are located in the immediate vicinity of the wetland (habitat 92A0 - Gallery forests of *Salix alba* and *Populus alba* and 3150 - Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* vegetation) and any leakage of pesticides or chemicals that could adversely affect water quality must be avoided.

Therefore, in the seeding stage, it was necessary to take into account the fact that areas impacted by certain anthropogenic factors, such as waste dumps, are an ideal place for the installation and subsequent distribution of invasive alien plant species, but also other native species that have invasive behavior, not allowing the other native species to develop.

From observations in the field, the biggest problem, especially in the seeding phase, is mainly caused by the native species *Conium maculatum*, because it is one of the species that, in the Ostroveni area, occupies appreciable areas, having a consistent seed base, distributed in all areas proposed for seeding. It is a difficult species to eradicate mainly due to a large seed bank and viable over a long period, being able to germinate quickly after rains, especially on disturbed sites or where there is little vegetation, where it acts as a pioneer species in the first phases of vegetation succession.

Once firmly established in such conditions, hemlock can exclude most species that would contribute to the improvement of the grassland vegetation. Therefore, it is necessary to control this species, but also other species (*Abutilon theophrasti* and *Datura stramonium*, *Ambrosia artemisiifolia*, especially in the first phase after the development of the new seeded vegetal carpet.

The proposed optimal species mix took into account the fact that permanent grassland can have mixed use, which includes mowing and grazing. The mix and percentage of species proposed for sowing was with the intention of laying the foundations of a balanced vegetal carpet, especially in terms of the ratio of species and the composition of species within it.

This base of the proposed plant mixture consists of three species of grasses (*Festuca pratensis, Lolium perenne* and *Bromus inermis*), which should give a good cohesion and stability over time to the plant carpet, a base also completed by a species of legumes (*Onobrychis viciifolia*). All these species are suitable for seeding on the difficult, sandy lands as they are in the Ostroveni area. In order to be able to install a proper vegetable carpet, the quantity of seeds per hectare was proposed to be increased by up to 30%.

Seeding was done after mechanized soil preparation, in all the proposed areas. Due to the weather conditions this year (2023), with very low air and soil temperatures and a lot of rain, which lasted a good part of March, seeding was done at the end of March in the Ostroveni area. The process of spreading the seeds on the soil was done by hand.

Assessment of habitat evolution. After seeding the lands that were the subject of the ecological restoration process, the evolution of the expected vegetal carpet was followed, and the result is promising. Part of the vegetal carpet has established itself and is developing, but there are extensive areas where an invasive species *Conium maculatum* has developed, much more than would normally be the case. This species was present in the surroundings, but not in this extensive form.

In this situation, additional intervention was needed to remove this invasive species. From several sources of information it appears that by repeated mowing (over a growing season) it is possible that the species *Conium maculatum* can be controlled or at least reduced in density. It is recommended to alternate with the application of herbicides, but it is very possible that insisting on mowing will give quite good results (***, 2017).

The intervention process is continued, so as to ensure a degree of restoration corresponding to the setting in the landscape and flora of the area. However, it is noted that the degree of damage was high, and the interventions must be adapted gradually, dynamically, depending on the periodic observations.

CONCLUSIONS

The ecological reconstruction of the lands meant the seeding with native species, the collection/threshing of seeds from the natural meadows in the area, the sowing of selected areas with seeds resulting from the collection/threshing previously done, the completion of the quantity was done with the specific species and quantities purchased from economic agents, the planting of selected areas with saplings specific to the reconstructed habitats and specific to the ecological needs of the targeted species, the maintenance of the sub-tree and the arboretum, the installation of warning signs to delimit access to the area of the reconstructed habitats in order to develop the native species.

Throwing waste at random is still a serious problem in Romania, especially in rural areas, as a result the actions to identify problem areas were carried out easily.

The monitoring and evaluation of the effects of habitat reconstruction works can be achieved by installing monitoring video cameras, placing warning panels that prohibit harmful/destructive practices on the territory of protected areas and present the impact of waste on the population and the environment, collaboration with the Police or the local Gendarmerie through patrol actions, as well as carrying out actions that lead to the awareness of the local and regional population regarding the importance of biodiversity and the need to keep it in the best possible state of conservation.

We must realize that human health and that of the ecosystem are inextricably linked, and protecting nature means ensuring health and well-being for ourselves.

The education and awareness of local communities regarding the importance of protecting the species and habitats within the sites are vital elements

in order to keep the natural heritage of this area as intact as possible, waste dumps being generators of impact and risk for the environment and public health.

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