APECTS REGARDING TO ECOLOGICAL RECONSTRUCTION AT COPŞA MICĂ, SIBIU COUNTY

ASPECTE PRIVIND RECONSTRUCȚIA EOLOGICĂ ÎN COPŞA MICĂ, JUDEȚUL SIBIU

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Abstract: *The aim of this research was the reinstallation of forest vegetation on very high polluted grounds - pollution caused by heavy-metals, the stabilization of high eroded soils caused by ashes. The actual research level: the ecological reconstruction started in 1988, with a surface of 168 ha in the first 10 years, now the reconstructed surface is about 644 ha. Many tree species were used, all of them, species with good resistance on pollution. Their resistance level was also investigated. After 20 years we are able to recommend the most resistant species. Methods and materials: the careful selection of the introduced species, the land preparation in order to plant the seedlings, the administration of fertilizer and amendments. The newness of the research: the ecological reconstruction on high heavy-metals polluted land in Copsa Mica is a premier in our country. Only ICAS Bucharest and the Forest Administration Sibiu researched this kind of ecological reconstruction. The achievement level in the domain: the over 20 years experiments continues on new land and on very polluted enclaves, where the used species did not achieve good results. The research limits: the insufficient assets for the ecological reconstruction. Now this researches are supported by the state budget and very few by the principal polluting agent. The practical implication of the research: the installation of forest vegetation on this polluted land, the identification of the most resistant species recommended to be used in conditions of high pollution and degradation of soil. The originality of the study: is represented by the experiment by itself. The importance of the study: the practical implication of the experiment and the dimensions of surfaces.*

Rezumat: *Scopul cercetărilor: reinstalarea vegetației forestiere pe terenurile intens poluate cu metale grele şi stabilizarea solurilor intens erodate. Stadiul cercetărilor actuale: lucrările de reconstrucție ecologică au început după anul 1988, pornind de la o suprafață de 168 ha în primii 10 ani şi ajungând la 644 de ha în prezent.S-a utilizat o mare diversitate de specii despre care se ştia că sunt rezistente la poluare şi s-a dorit stabilirea gradului în care acestea se adaptează la condițiile de mediu din Copşa Mică. Se pot recomanda cele mai rezistente specii. Metode şi materiale utilizate: alegerea speciilor introduse în cultură, pregătirea în vederea plantării, administrarea de amendamente şi îngrăşăminte chimice. Gradul de noutate: experimente de acest fel au fost efectuate doar de către ICAS Bucureşti şi Direcția Silvică Sibiu. Stadiul realizărilor: experimentele au o vechime de peste 20 de ani şi continuă pe terenuri noi şi pe enclave intens poluate în care speciile testate au dat rezultate nesatisfăcătoare. Limitele cercetării: insuficiența fondurilor destinate reconstrucției ecologice, care în prezent este susținută din bani de la bugetul de stat, ameliorare şi în mică măsură, de la principalul agent economic poluant din zonă. Implicațiile practice ale cercetării: instalarea vegetației forestiere pe aceste terenuri degradate şi stabilirea celor mai rezistente specii, recomandate a fi utilizate în condiții de poluare şi degradare pedologică similare.Originalitatea lucrării: este dată de experimentul în sine.Importanța lucării: este dată de implicațiile practice ale experimentului şi de dimensiunea suprafețelor pe care acesta se aplică.*

Key words: *pollution, ecological recosntruction, forest vegetations*
***Cuvinte cheie*:** *poluare, reconstrucție ecologică, vegetație forestieră*

INTRODUCTION

The town of Copşa Mică is situated in the Northwestern part of Sibiu County, at the crossing of the Tarnava Mare and Visa Rivers. The town is located 43 km from the county capital on the National Road DN14, 12 km from Medias and 33 km from Blaj on the DN14B. With an area of 2,590 hectares, out of which 278 hectares represents the actual size of the urban location, the town is placed within the valley of the Tarnava Mare River.

The Copsa Mica plant initially produced zinc for industrial purposes and was modernized on various occasions over the years (1950, 1960, 1967, 1975, 1984), including the addition of a lead production unit. From this point forward, the fate of the town was sealed, eventually becoming Europe's most polluted location until the nuclear accident of Chernobyl.

In 1993, following lengthy negotiations, the lead factory was closed and 5 years later, in 1998, SC SOMETRA SA was privatized with the majority ownership going to the Greek holding company, MYTILINEOS. Concurrently with the plant's privatization, a Conforming Program was adopted. Under the Program, the plant would subsequently function in accordance with the Environment Protection Law no. 137/1995 that contained 14 measures aimed at diminishing the plant's environmental impact through the reduction of gas and toxic powder emissions by the end of 2002. Article 11 of the Program stipulated that the SOMETRA plant should finance the "stabilization of the right branch of the Tarnava Mare River through the planting of trees on an area of 40 to 50 hectares and the rehabilitation of the destroyed forest ecosystem." Indeed, between 2002 and 2003, 35 hectares were planted using company funds in the areas of Copsa – Baraj, Gruisoare, and Puru. The Conforming Program continues through the Integrated Environment Authorization, which covers the period from 2006 through 2011, and which contains an action plan targeting both reduction of pollution and ecological reconstruction within the area.

Pollution of the forests in the Medias (1) Forest Range directly results from the activities of two companies located in Copsa Mica: SC SOMETRASA, producer of non-ferrous metallurgical products which, prior to 1990, was considered the largest plant of its kind in the country; and SC CARBOSINSA, a chemical plant.

Due to the long duration (over 60 years) of significant pollution, the area surrounding Copsa Mica is a severely affected zone, characterized by low air quality, tainted surface water, soil, and vegetation as well as the degraded health of the local human and animal populations. Usually, control measures for air quality focus on limiting emissions so that the concentration of pollutants in the environment do not rise above standard limits considered as not having any impact on general health.

MATHERIAL AND METHODS:

Effects of pollutionon forests

Beginning in the 1960's, as the local government became aware of the effects of industrial pollution on forests, areas containing affected arboricultural zones increased continuously. The rhythmic expansion of polluted areas and associated intensity of the pollution proceeded slowly at first, but then grew more and more aggressive. Beginning in 1961 the pollution phenomenon had barely begun, covering approximately 100 hectares located only in the tree-covered area surrounding the pollution sources (BUJA, 1994). By 1973 over 1650 hectares were polluted and only five years later (1978) the affected area had grown to cover 8,000 hectares. The last two inspections of the forest range show that almost the entire forest of the Medias Forest Range (20,110 hectares in 1998 and 17,247 hectares in 1999, following the ceding of two units to the Dumbraveni Forest Range) was affected by pollution. Moreover, beginning in 1988, evidence surfaced showing that the effects had spread to cover larger or smaller portions of the neighboring forest ranges as follows: Dumbraveni Forest

Range (UPV partial): 947 hectares; Agnita Forest (IInitial): 60 hectares, and; Blag Forest Range from DS Alba Iulia (entire): 8900 hectares. Therefore, by 1988, the entire forest zone around Copsa Mica exposed to pollution was larger than 30,000 hectares, an area similar in size to that determined by the 1999 analysis.

Equally spectacular was the growth in pollution intensity, registering, from one level to the next, a higher degree of damage to the local forested areas. The forested area included in the first degree, having the most visible damage, was the Forest Range Medias, estimated as 120 hectares in 1973, 900 hectares in 1978, almost 2,600 hectares in 1988, and over 4,500 hectares by 1999. The most affected forests are found in UPII Micasasa and III Tarnava, followed by ISeica Mica and IV Boian. The least damaged are the forested areas of V Darlos.

Both natural forest regeneration and manmade plantings suffered greatly from pollution. In the forested areas of the 3rd area of pollution forest regeneration has suffered moderately and natural tree offspring have seen growth difficulties in the forested areas of the 1st and 2nd areas of pollution, however, the natural forest regeneration process has stagnated completely or almost completely.

As far as the effect of heavy soil pollution on plantings is concerned, such endeavors have a very small chance for growth, if any, without the assistance of special measures such as mending, fertilizers, etc., which, in turn, increase costs substantially. One very clear example of the difficulties is reflected in the reforestation efforts of 1994 to 1998. Even when all assistance measures were applied, the success percentage varied from 12% and 95% with not one portion resulting in a complete success. The effort, necessary for success, and respectively, the risks of failure, are even larger if soil erosion or landslides are included in the picture.

As a result of pollution, the forested areas have almost entirely lost their protective functions: climatic, hydrological and anti – erosion, hygienic, recreational and even anti-polluting.

Under the influence of certain factors – steep slopes, fragile petrographic under layers, alternating layers of various rock types, a lack of water in the soil etc. – strong damage to, or total disappearance of, the forest is the final link in the chain reaction of degradation.(2) In addition to pollution, forest fires and agricultural malpractice have sped up the process of forest degradation.

All forms of degradation shown above are associated with a process of acidification, debasification and soil decomposition resulting from toxic environmental factors.

Ecological reconstruction

The ecological reconstruction through reforestation covered an area of intense pollution in the surroundings of Copşa Mică totaling 644 hectares, from which 470 hectares are within the forest range and 174 hectares represent reconstructive efforts outside the forest range.

Ecological reconstruction took place on degraded forested areas as well as areas owned by various landowners where assembled reconstruction occurred in precisely outlined plots according to current legislation in force.

Ecological reconstruction in the Medias Forest Range between 1988 -2008

Types of works	UM	Within the forest range			In perimeter outside the forest range			Total
		1988-1998	1999-2008	Total	1993-1996	1997-2008	Total	
Whole plantings	ha	168	302	470	68	106	174	644

The situationof obtained andoutlinedplots

1. Degraded plots obtained from the State Land Agency

a) The plot of Curmatura 1 – Axente Sever 16.72 hectares

2. Degraded plots obtained from the Local Councils of the affected area

a) The plot of Curmatura II– Axente 34.41 hectares

b) The plot of Şeica Mică – Şoroştin 71.20 hectares

3. Plots obtained from various landowners

a) The plot of Rupturile Copşei 98.10 hectares

Financing sources for reconstructive works:

- The fund for forest land amelioration
- Government funds allocated for these purposes
- Local funds from the forest ranges in the name of the forest conservation and regeneration fund

The Sibiu Forestry Department continues the process of ecological reconstruction of the heavily polluted state-owned forested areas through a project of ecological reconstruction, financed through the state budget, which stipulates reforestation of 30.8 hectares combined with the careful tending of the same land area.

RESULTS AND DISSCUSIONS:

Recommendations for planting various species

Of all species of trees used, acacia has, generally speaking, the highest potential for maintenance and development. Due to this fact, it remains the main tree species for reforestation on most plots, especially those under threat of all degrees of water erosion or landslides with or without land rupture. (3) It is also one of the few species that succeed in self-regeneration in the early stages of life stage following forest fires.

Of all species associated with the buckthorn, silverberry has shown the best results under the above-mentioned conditions; therefore, we continue to support maintaining use of this species in the reforestation program.

Additionally, while the acacia impoverishes the soil, the silverberry enriches it with nitrogen due to the nitrogen-generating bacteria with which the silverberry has a symbiotic relationship. The silverberry can be used, and has been used together with, the common sea-hawthorn, or, in the absence of the latter, to anchor surfaces predisposed to sliding, as long as these are not very steep.

The black cherry and the ash tree, both able to reproduce through vegetation and resistant to smoke and industrial gases, can be used, along with the acacia, though with more modest results. Additionally, the black cherry has a wider canopy and does behave better at levels lower than the acacia. The manna ash may also be added to this combination, especially when used on sunny slopes that are in danger of strong and excessive erosion.

Among saplings, the bastard indigo bush and the common hawthorn have had satisfactory results, both alone and in combination with the acacia and the other above-mentioned tree species on slopes and landslide ruptures. Together with these 2 sapling species, the common ash, which can be found naturally in various land conditions, as vigorous bushes with a tendency towards expansion, also proves greatly resistant to pollution (like the acacia, it seemingly can reinvigorate following forest fires). The common dogwood is another spontaneous presence that has been found to be very resistant to the toxic emanations of SOMETRA Company.

Despite some failure, continued use of the common sea-hawthorn is recommended as this most rustic of species is best for the anchoring of land in extreme conditions such as deep erosions, ravines, and landslides with deep rupturing. Key to their use is for the tree seedlings to produced, maintained, and transported under proper conditions.

Other species of trees which, when utilized from pure cultures, have proven resistant to pollution should be planted as follows: the common oak should be planted in flatter areas with enriched soils even if they are located on massive landslides with minor ruptures; the hybrid black poplar should be planted in river valleys with good drainage, but may also be used along stabilized landslides, given sufficient humidity; the black alder may be introduced in low valleys and micro depressions created behind massive post-landslide land accumulations with stagnant water for a longer period of time; finally, the white willow produces positive results, in the form of shade along ravines and in towns with a higher degree of humidity, and willow twigs may be used as a base for fences constructed for terrace consolidation.

CONCLUSIONS:

Based on three decades of experience in the fight for reforestation within the industrial pollution zone and the planting of new forests in the Copsa Mica area, we can state that, through constant reduction of toxic emanations from their source, mainly sulfur dioxide, as has occurred since 1990, there are viable solutions for reintroducing vegetation in the majority of the perimeters which, in the past, faced long and intense pollution. It must be kept in mind, however, that the respective solutions result from both high effort and costs.

The tree species that have obtained the best results, in stationary conditions approximately meeting ecological requirements, are the acacia (*Robinia pseudacacia* L.), the silverberry (*Eleagnus angustifolia* L.), the hybrid black poplar (*Populus x canadensis* Moench), the black cherry (*Prunus Serotina* Ehrh.), the European ash (*Fraxinus excelsior* L.), and, among saplings, the bastard indigo bush (*Amorpha fruticosa* L.), the common hawthorn (*Crataegus monogyna* Jack.), and, under certain circumstances, the common sea-hawthorn (*Hippophae rhamnoides* L.), etc.

As pollution levels diminish, it is possible to introduce valuable species such as the sessile oak (*Quercus petraea* Liebl.), the sycamore maple (*Acer pseudoplatanus* Liebl.), the sweet cherry (*Prunus avium* Liebl.), the oak (*Q. Robur* L.) and so on, which have already disappeared as species in the local vegetation, or are to be found only in isolated groups, unhealthy and carrying the marks of frequent fires. Besides seedlings of the black cherry already mentioned above, some naturally regenerated feeble and sparse sessile oak seedlings have been spotted.

In the case of new perimeters, technical solutions (choice of species, soil and land preparation, fertilizer and amendment management, etc.) must be based on rigorous mapping of the reforestation area and laboratory-conducted soil analysis.

The construction of little fences and dams plays a vital role in the success of plantings in heavily eroded perimeters.

Mending and fertilizing the soil are mandatory where applicable (areas with strong acid reactions and the lack of nutritious elements). Such actions must be completed every two to three years, if not more often. Mending the perimeter should be done a year before actual planting (while also fertilizing the soil). Both operations could extend to the old trees that are heavily affected by pollution but not completely dry in an attempt to reinvigorate them and push natural regeneration.

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It is worth mentioning that, more than anywhere else under different conditions, it is highly important for the success of the process, to work according to technical specifications that range from preparation of the planting material up until the last stage: seedling quality, the means of transportation, manipulation and deposit of the seedlings, preparing the perimeter, maintenance work and completion of the number of seedling, if necessary, managing the amendments and fertilizers, and, not in the least, preventing devastating fires.

Success in the process of ecological reconstruction ultimately depends on the application of all the requirements for environment protection through rehabilitation of production lines and the installation of nonpolluting equipment at SC SOMETRA SA in order to reduce the toxic emanations to levels below the imposed limit (4). This should be followed with the correcting of soil toxicity levels (even if the soil will continue to be toxic for years to come) through calcium-based amendments and fertilizers. Even under these circumstances, the newly created forests will have an essential protective role, mainly to combat and prevent degradation processes as well as plot regeneration without consideration for the end use of the resultant timber.

In order to find the optimal solutions, it is necessary to monitor all activities, to rely on experimentation to determine the best tree species for planting under various conditions, examine the reforestation strategies to be adopted, and to judge the effect of amendments and fertilizers, etc.

In order to continue the ecological reconstruction of the polluted area of Copsa Mica it is very important for everybody involved in this grand action to collaborate in order to obtain local, national and community funds.

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