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RESEARCHES ABOUT DOWNGRADED LANDS IMPROVEMENT BY SILVO-IMPROVED TREES AND SHRUBS CULTURE FROM BAIA MARE AREA

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Abstract

The purpose of this study is forestry ecological reconstruction on downgraded lands from Baia Mare area, Maramureş county. This land is unsuitable for forestry and other uses because of the downgraded land from surface erosion and also because the average slope of the land is 15 g. The technical solution of improvement includes land and soil preparation technology, afforestation formulas, afforestation technique, planting scheme, and also sustentation needed until canopy closure for every site class. To establish the necessary of seedlings was taken into account planting schemes and percentage of completion for every afforestation composition, as well echeloning the surfaces covered by the project. By establishing the value of proposed works were calculated the costs of basic operations composed by fencing, terminals construction and placement, guarding the perimeter and afforestation works pending final success.

Key words: *ecological reconstruction, downgraded land, surface erosion, afforestation formulas*

INTRODUCTION

It can be shown that the analyzed perimeter is classified as part of the land area characterized by strong to very strong erosion.

The basic reality in the field finds its justification in the way that the forest has been exploited, on one hand, and, on the other hand, in the maintenance of the land lacking of protective forest vegetation. The identified triggers are the following: precipitous slope correlated with the middle friable substrates; sunny exposition; relatively large lengths of slopes; large amount of precipitation; lack of vegetation within the perimeter; irrational exploitation of the land. (Ciortuz, I., 1981)

As a result of the cumulative action of all these factors, it has been noticed mainly the occurrence of soil erosion, namely gully erosion and especially superficial erosion, with profound negative effects on both production and protection potential of soil.

The onset as well as the intensification of soil erosion processes within the studied perimeter lead to the appearance of some negative consequences which affect the entire environment.

The erosion processes taking place within the area were the study was carried out are mainly caused by climate rich in precipitations which constitutes the vector that moves soil particles; plus the relatively precipitous slope which amplifies the effect of raindrops. These modifications determined by the change of both hydrological and soil aeration regime cause soil compaction, making it losing its structure and unable to maintain vegetation – the only natural element capable of ensuring soil stability.

Changes also occur at the level of soil and, respectively, vegetation, as well as at the microclimatic level for a number of climatic parameter are also affected: temperature, surface albedo, radiative capacity, etc. Also, another effect is visible from the aesthetic and social point of view, if taking into account the tourism potential of the area and the unpleasant appearance of the land as a result of the soil degradation processes.

The consequences of these torrential phenomena are more than negative for the environment, because all the mechanisms and

biological cycles that maintain the production potential, protection, aesthetic and social role of soil and vegetal cover are disrupted.
It can thus be said that there are sufficient reasons that justify the execution of engineering measures able to restore the land to its optimum operating conditions; these measures should be implemented as quickly as possible and accordingly with the actual real needs of the studied perimeter, also taking into account the fact that degradation processes are very dynamic, and nature does not have the means to stop them a rapid and safe manner. (Chiriţă, C., 1977)
The perimeter taken into study is directly influenced by the soil erosion processes, as it follows: soil erosion hazard (R) – medium; morphological slope (I) – 11-30% for basins and 21-60% for slopes; rainfall factor (P) – precipitations 945mm; soil texture (T) – light; vegetable factor (V) – pastures. Having in view the above mentioned characteristics, one can notice a predisposition to moderate erosion and a strong erosion hazard.
The soil texture is medium, soil thickness 25-75 cm, pavement < 10%, therefore soil erosion hazard is strong.

The *Fournie* index ($F_i = \sum_{i=1}^{12} \frac{p_i^2}{p}$) has a value equal to 90, and the *Bagnouls- Gaussen* index is below 50 (humide climat), so the climate erosivity is medium.
By correlating the soil erosion hazard with the climate erosivity and the medium slope of 33%, it results that the potential risk of erosion is strong and, as the land is incompletely covered with vegetation, the actual risk of erosion is also strong.
In conclusion, it is men's moral and social obligation to intervene promptly, by applying concise and effective measures in an attempt to restore the ecological balance within the improvement perimeter which was so severely disrupted by human activities.

MATERIALS AND METHODS

In order to take into account the multiple objectives pursued and the diversity of the existing situations in the improvement perimeter, the adoption of a complex set of works was required

Also, the adoption of this set of measures and improvement works is determined by the principle of full and sustainable land improvement (the second principle of Forest Improvement). The list of ameliorative complex assembly works is represented by: gathering stones and boulders; execution of simple terraces and / or supported terraces; belt planting system; brush head plug; works of retention or diversion upstream the detachment ravine; soil preparation works; fertilization works using topsoil and fertilizers; works of amending the acidic soils; afforestation works; security measures and fencing works. It is also necessary to adopt some ameliorative measures so as to stop the intensification and development of negative processes that manifest in the analyzed perimeter; these refer to both the land assembly within the improvement perimeter and the surrounding lands and consist of: restriction of use, exploitation rules, security measures and other measures. Restriction of use – the improved perimeter should not be exploited so that the degradation processes reactivate. Exploitation rules – it is forbidden to: operation of stands by clear cutting, grazing, tourism activities, etc. Security measures – it will apply in order to preserve the works made so as to achieve their goal. The improvement works are technical interventions which are executed exclusively on the improvement perimeter, and are divided into four categories: phyto-ameliorative works; site preparation and soil improvement; land development project; fencing works. Within the perimeter to be improved the effective area of woodland is 81,25 ha (96% of the perimeter). The role of the forest cultures is double - first of protection and subsequent, after reaching the equilibrium, of production, which occurs primarily on the soil, but also and the waters. Forest crops regulate leaking rainwater, stabilize, restore and recover the degraded land unsuitable for other uses.

As for their productive role, this is to obtain some products like: firewood, poles, resin, berries, etc., and later even wood for industrial uses (construction, pulp, etc.).
Social, climate and productive consequences of the improvement measures to be applied in perimeter are also taken into account.

By comparing the stationary conditions existing within the improvement perimeter with the ecological requirements of the species (the two factors underlying the choice of forest species for afforestation), for the improvement perimeter studied the following tree species were chosen: European black pine (*Pinus nigra Arn.*), Scots pine (*Pinus sylvestris L.*), maple (*Acer pseudoplatanus L.*), larch (*Larix decidua Mill.*), alder (*Alnus sp. L.*); shrub species will not be used, with the exception of the seadbucktorn (*Hippophaë rhamnoides L.*).

The extreme work conditions determine the elimination of sensitive or demanding species and only allow the installation of cultures composed of resistant and modest species, with high ecological amplitude; the heavier the conditions, the lower the number of species that can successfully be used.

The afforestation formula reveals the assortment and species' proportion and it is established depending on the intensity of degradation through erosion. Thus, on the moderately eroded land, one will introduce a high proportion of tree species, and, in extreme cases of very highly eroded and gully land, pine and, respectively, alder stands will be cultivated.

The planting method used for most of the surfaces is planting in normal pits of 30 x 30 x 30 cm. Within the ravine area the belt planting system is applied. The list quantities of the proposed works contains all the quantities of works proposed for execution in the improvement perimeter; for these works were mentioned the following: the specific code of the work, the unit of measure and the amount of work. The list serves for planning and evaluation of works, to determine the cost of the necessary work and labour (see table below).

For the proposed works to be executed to become operation as quickly as possible, the works started in 2004; they were carried out for 8 years and they were came to completion in 2011. Due to the large volume of work, was chosen to scheduling the deployment of forest cultures in the first two years: 2004, 2005.

The works were executed by direct labour by the Baia Mare OSM; the necessary workforce will be recruited from the nearby villages.

Table 1 Proposed works within the improvement perimeter

Category of work	Code of work	Name of work	UM	Quantity
1	*2*	*3*	*4*	*5*
A Afforestation works	A1	**Installation of forest cultures**	*1000 pieces*	**591,7**
	A2	**Completions of forest cultures**	*1000 pieces*	**177,16**
	A3	**Maintenance of forest cultures**	*Hectar*	**814,4**
B Soil preparation and improvement works	B1	**Preparation in patches**	*Aries*	**1408,79**
	B2	**Fertilization with topsoil**	m^3	**3691,75**
	B3	**Fertilization with organic fertilizers**	*t*	**0250**
	B4	**Amending with limestone powder**	*t*	**277,5**
C Territory management works	C1	**Gathering stones and boulders**	*Stere m*	**735**
	C2	**Simple/ continuous terraces**	*m*	**222 000**
	C3	**Terraces with fences**	*m*	**40 781,25**
	C4	**Terrace with banquette**	*m*	**7343,75**
	C5	**Brush head plug**	m^2	**1900**
D Fence/ enclosure works	D1	**Wire fences**	*m*	**3420**
	D2	**Perimetral quickset hedges**	*1000 pieces*	**17,784**

The necessary seedlings are taken from the Baia Mare O.S.M. nursery except alder, which will come from natural regeneration. The posts and stakes are ensured by Baia Mare O.S.M. as well, as a result of the cultural works performed within the forest district. The topsoil comes from borrow pits and the organic fertilizers from local farms. The stone designed for the terraces with banquettes comes entirely from the improvement perimeter. The other materials will be purchased from specialized

distributors (nails, wire, etc.)
The workers will be organized into teams, each team comprising three workers. Within the perimeter, it will be build barracks for workers, housing materials, glaciers to protect seedlings, paths etc. The working site will be equipped with medical kits.
It will not be lost sight the safety issues of the working site and it will consist of making the necessary briefing before starting work.

RESULTS AND DISCUSSIONS

In the analyzed area, there were identified 12 soil classes and 22 types with numerous subtypes and soil units, which differ distinctly concerning their properties, productive capacity and measures to preserve and enhance fertility.
The main classes of soils in the studied area are: protisoils with 30,25% of the total surface, out of which: aluviosoils represent 29,5%, lithosoils are extended on 0,69%, regosois cover 0,06%. Cambisoils with 24,49% of the total surface, out of which: acid bown soils cover 18,2%, bown forest soils cover 6,29%. Luvisoils with 23,43% of the total surface, out of which: brown podzolic soils cover 16,41%, reddish brown forest soils cover 7,02%. Chernozemic soils with 6,34% of the total surface, out of which: phaeozems cover 5,58%, rendzines cover 0,47%, chernozemlike soils are extended on 0,28%, kastanoziomurile cover 0,01%. Andosoils with 5,99% of the surface, out of which: andosoils ocver 5,99%. Spodisoils with 5,92% of the surface, out of which: prepodzols cover 5,60%, podzols cover 0,32%. Also, on specific small areas there are antrisoils, histisoils, salsodisoils and umbrisoils.
The associations of plants that live and characterize the hilly area of Transylvania are ones of the most diverse: herbaceous vegetation: *Agrostis tenuis, Festuca rubra, Festuca pseudovina, Agropyron repens, Pirus piraster, Medicago falcata,Crisium arvense* etc.; forest-improving shrubs: *Crataegus monogyna, Ligustrum vulgare, Cornus sanguinea, Hippophae rhamnoides* etc.; medium and large forest trees: *Pinus silvestris, Pinus nigra, Fagus sylvatica, genul Quercus, Carpinus betulu*s etc.

The analysis of eroded land, in different degrees of intensity, shows the following situation: strong and excessive erosion which affects: Maramureş area - affected areas count a total of 77 395 ha, representing about 6% of the territory; the moderate or severe erosion affects 70 000 ha in the Mures county, 125 000 ha in Bistrita-Nasaud and Cluj etc.
Regarding the forest-improving shrubs and their culture on the degraded hilly area of Transylvania, one can mention that a culture of forest- improvement trees and shrubs is the best option that should be considered for an ecological restoration.
If referring to some several properties that recommends the of silvo-improved shrubs, one can say the following: common privet - *Ligustrum vulgare* – contributes at the forest ecosystems, degraded, in the course of degradation and even for the non-degraded ones, by improving the physical and chemical properties of soil. It also covers the soil, by reducing the risk of soil erosion processes. It is an unpretentious species, very resistant to frost, drought and pollution, with reduced claims for soil properties, covering even the rough, flooded or skeletal soils and supports well both direct sunlight and shading. Since no outstanding claims are demanded, as well as a consequence of the fact that is sprouts, sends out suckers, layers and propagates by shoot cuttings, the common privet knows a great ecological amplitude.
The red dogwood - *Cornus sanguinea* – gives good results on: moderate to highly eroded soils, moderate rain-denudated lands, land fugitive lands on intact soils sites, has good results in terms of improving the forest-productive qualities of the soil
The seadbucktorn - *Hippophae rhamnoides* - by its rapidly expanding capacity on large areas is a good solution for the majority of degraded hilly land of Transylvania. Its ability to live in symbiosis with nitrogen-fixing bacteria give this shrub a plus in terms of its importance to degraded lands. Valorification of seadbuckthorn can have a positive impact on the areas where it is implemented.
Depending on the identified topo-climate within the improvement perimeter and on the type and intensity of the degradation processes, one selected the species used for afforestation:

silvo-improved bushes *Cornus sanguinea*, *Ligustrum vulgare* and *Hyppophae rhammnoides* , and large forest trees: *Pinus nigra* and *Quercus petraea*, as main base species, *Acer platanoides*, *Fraxinus excelsior*, *Alnus glutinosa* as main mix species.

On slightly eroded soils, the afforestation formulas were 50Go 25 Pa 25Sâ, preparation of soil was made in patches of 60x80 cm, planting was made accordingly to the scheme 2,0x1,0 m, using seedling with naked roots, 5000 buc/ha, in holes of 30x30x30 cm.

On the weakly to moderately eroded soils(e1-e2), the afforestion formulas were 25Go 50 Pa 25Sâ, the preparation of soil was made in patches of 60x80 cm, planting was made after the scheme 2,0x1,0 m, using seedlings with naked roots, 5000 buc/ha, in holes of 30x30x30 cm.

On soils with precipitous slope the management was using made unsupported terraces arranged accordingly to the contour lines at 2,0m distance between them and 0,75m width, following the planting scheme 2,0mx1,0m, resulting a density of 5000 buc/ha.

On strong and very strong eroded soils (e2-e3), the afforestation formulas used were 50 Pin 25Pa(Fr) 25Sâ, or 50Pin 50Ct; in the case of 50Pin 50Ct formula, the forest management was made on the basis of terraces supported by fences, places on the contour line at a distance of 3,0m and 0,6-0,7 m width. Planting was made using seedlings with naked roots, in the case of supported terraces for the seadbucktorn, in belt system, between terraces (13300 buc/ha, schema 3,0m x 0,22m) or in normal holes of 30x30x30 cm (3300 buc/ha, schema 3,0m x1,0 m), (perimeter Tonciu, u.a. 83 A, D, H, L, R).

In the case of 50 Pin 25Pa 25Sâ formula, preparation of soil was made in patches of 60x80 cm, planting was made using the schema 2,0x1,0 m, using seedlings with naked roots, 5000 buc/ha, in holes of 30x30x30 cm.

On sliding soils, with slid mass low to moderate fragmented with humus horizon remained at surface, without water excess, the afforestation formula was 25Go 50 Pa(Fr) 25Sâ(Lc), preparation of soil was made in patches of 60x80 cm, planting was made by the accordingly to the schema 2,0x1,0 m, using seedlings with naked roots, 5000 buc/ha, in holes of 30x30x30 cm. On the sliding slope, with mother-rock at day, the afforestation formula was 100Ct, being planted on belt system, by the schema 3,0m x 0,25 m, resulting a density of 13300 buc/ha.

The observations on the evolution of crops installed within the improvement perimeters were made in the perimeter of Coasta Mare, Teaca and Tonciu. As a result of the comments made regarding the maintenance of seedlings after a year or two after planting, it can be concluded the following: on weak to moderately eroded soils (degraded land station group 8), a very good maintenance on soil arranged on simple terraces, *Ligustrum vulgare* (92%), planted in patches in normal holes, *Cornus sanguinea* (75% on simple terraces, 89% in patches in normal holes.

Preparation of soil in simple terraces, where it is possible, influences positively the maintenance of seedlings. On strong eroded soils (degraded land station group 9), a very good maintenance registered *Cornus sanguinea* (90%-Teaca), good maintenance *Ligustrum vulgare* (67%) when preparing in patches and planting in normal holes by the schema 2,0 x 1,0, composition based on *Pinus nigra*, *Acer platanoides*, *Fraxinus excelsior* and *Cornus sanguinea* resulting the best records.

On strong an very strong eroded soils, a very good maintenance registered *Cornus sanguinea* (84% on strong eroded soils with preparation of soil in patches and planting in normal holes using the scheme 2,0 x 1,0m), very good maintenance *Hyppophae rhammnoides* (83% on very strong to excessive eroded soils, when planting in belt system using the scheme 3,0 x 0,25m).

On sliding soils, with slid mass low to moderate fragmented (degraded land station group 54), the maintenance was: *Ligustrum vulgare* 87%, planted in patches in normal holes, scheme 2,0x 1,0; *Cornus sanguinea* 83%, planted in patches in normal holes, scheme 2,0 x 1,0.

On sliding soils, with slid mass strong to very strong fragmented (degraded land station group 55), the maintenance was very good for the seadbucktorn -88%.

After analyzing the results it appears that, the compositions based on large forest species in combination with shrubs silvo-improved shrubs *Hyppophae rhamnoides*, *Cornus sanguinea*

and *Ligustrum vulgare*, suite best to stationary conditions of the stationary group of degraded land 54 of the studied area. Within the degraded land station group 8, only one experimental lot was set-up, where seedlings of *Quercus petraea*, *Fraxinus excelsior* and *Cornus sanguinea* were used.

Regarding the maintenance of seedlings at the end of the vegetation season 2009, although the highest values of maintaining the seedlings were obtained for the variants mobilized (84%), as compared to 79% in the control, a clear conclusion cannot be expressed if soil mobilization significantly influences the maintenance of seedlings. Experimental area will be further pursued.

Within the degraded land station group 11, 4 experimental lots were set-up, the species used being *Pinus nigra, Fraxinus excelsior* and *Cornus sanguinea.*

CONCLUSIONS

In conclusion, in the case of the soils by low to moderate erosion, the land management on simple terraces and planting on terraces leads to better results than planting in patches. On strong eroded soils, the *Cornus sanguinea* seedlings, planted in patches, in normal holes, using the scheme 2,0 x1,0, maintained the best.

On very strong and excessive eroded soils, the preparation of land on terraces supported by fences and planting seadbucktorn in bet system between terraces leaded to good results.

On sliding soils, the *Ligustrum vulgare* seedlings recorded the best maintenance. Mulching on terrace or in patches using cardboard, straw, litter, has a positive and significant influence on seedlings' maintenance.

The use of compost mixed with local soil to plant seedlings, in the context of lack of rainfall in the period after planting the seedlings, have a negative influence on seedlings' maintenance.

Nitrogen fertilization positively influences vegetation state of seedlings. But, it cannot be confirmed yet whether the mobilization of soil and nitrogen fertilization on the patches really influences the maintenance of the planted seedlings; further experiments must be pursued.

The most recommended species of silvo-improved shrubs for the Transylvanian hilly area are represented by: *Cornus sanguinea, Ligustrum vulgare, Hippophae rhamnoides,* due to the fact that they registered a very good rooting percentage, although the planting was made using naked roots, which proves their adaptability to rough soil conditions.

It is to be noted that restoring the downgraded land in this area takes time and can be achieved only by combining both species of shrubs and forest trees, as well as by grassing with species that cover the soil.

The ecological reconstruction process and procedures vary from case to case, but they are necessary to ensure the restriction of phenomena adversely affecting soil and their reintegration into forestry and agricultural circuits at optimal levels of production

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