PHD THESIS SUMMARY

Evolution of vegetation on degraded lands in the context of various risk factors in Transylvania area

Doctorand: **Mircea Cristian MOLDOVAN**

Conducător de doctorat: **Prof.dr. Marcel DÎRJA**

INTRODUCTION

The naturally present erosion phenomenon has been active throughout the grological eras, shaping the surface of the land until now. Within the doctoral thesis, the evolution of some stands installed in order to stop the surface erosion was followed. Experimental surfaces were placed in the field in which dendrometric measurements were performed to determine the growth of the stands. Also, runoffplots were placed to determine the erosion and implicitly to determine the anti-erosion capacity of the stands studied, in the recent climatic context.

OBJECTIVES PURSUED

The general objective, which can be deduced from the title of the thesis, is to follow the evolution over time of stands located on degraded lands, in the context of disturbing climatic and pedological factors and the development of locally technical solutions, in the future proposed project on regional plan.

The following specific objectives were identified in the study:

1. Determination of the main risk factors that lead to disruption of stands development
2. The evolution of vegetation in the analyzed perimeters
3. Location of experimental surfaces regarding the determination of erosion
4. Analysis of diseases and pests in the stands studied
5. Stands management

PHD THESIS STRUCTURE

The thesis is structured in two main parts:

FIRST PART: CURRENT STAGE OF KNOWLEDGE - it is structured in 4 chapters:

Chapter 1 contains six subchapters in which information is presented on: research on erosion phenomena, the main causes of land degradation, eroded land areas both globally and nationally. Information is also provided on research to combat erosion, both globally and nationally.

Chapter 2 refers to the research carried out in Romania regarding the afforestation of degraded lands.

Chapter 3 contains three subchapters, which highlight aspects of the health of stands established on degraded land. These aspects are presented in accordance with the main risk factors that lead to the weakening of trees, such as drought and windfalls.

Chapter 4 contains two subchapters, which present the new technologies that have emerged in the civilian area, such as drones, and their impact on the future of forestry research.

PART TWO: PERSONAL CONTRIBUTION - it is structured in 8 chapters.

Chapter 5: Phd thesis objectives

Chapter 6: Elements regarding the natural environment from the Gherla Forest District, Management Unit I Ţaga

In this chapter, we studied the natural environment where some of the experimental areas were located, respectively compartments 49 and 73.

The two perimeters are found in the Someşan Plain, on Sarmatian sedimentary deposits, on a lithological substrate made up of clays, marls and easily erodable sands. The dominant relief consists of gentle peaks separated by wide valleys with an average altitude of 450 meters. The main valley that crosses the production unit is Fizeş Valley.

From the climatic point of view, the studied territory is found in the area of hilly topoclimates with a moderate continental climate, with an average annual temperature of 8.2 degrees Celsius, and the average temperature in the vegetation season of 14.9 degrees Celsius. The annual average rainfall is 715 mm, and that in the vegetation period is 417 mm.

Regarding the soils, within UP I Ţaga there are the following classes of soils: luvisols, cambisols and undeveloped soils, the last class of soils being present in the perimeters studied, with the types of soils typical, respectively molic regosol. These types of soils are made up of two horizons, Ao and C, the main difference being the thickness of the Ao horizon, in the case of the molic regosol being much larger than in the case of the typical one.

Chapter 7: Elements regarding the natural environment from the Cluj Forest District, Management Unit I Vaida Mociu

In this chapter, the natural environment was studied, in which the improvement perimeters Frata 1 and Frata 2 were located. The territory belongs to the Mureş Plain, the southern subdivision of the Transylvanian Plain and consists of alternations of hard layers (conglomerates, sandstones, tuffs) with soft layers (marls, clays), and the main forms of relief being the

slopes and plateaus with altitudes between 290 and 510 meters. The main watercourse is Frata Stream and Plain Stream.

From a climatic point of view, UP I is located in the climate of the Transylvanian Plateau, with a climate characterized by relative humidity, constantly higher than in the continental sector of the country, the average annual temperature being 8.2 degrees Celsius, and in the vegetation period of 15.3 degrees Celsius. The annual average rainfall is 613 mm, and in the vegetation period is 433.7 mm.

From the perspective of soils, in the production unit, there are the following classes of soils: cernisols, luvisols and undeveloped soils, with the erodic anthrosol type, soil present in the perimeters of Frata 1 and 2. This type of soil is eroded during agricultural activities, especially to be overgrazed.

Chapter 8: Material and method

This chapter describes the main methods used to achieve the specific objectives.

Thus, in order to identify the risk factors, the specialized literature was consulted, on the basis of which the determination methods were established. In case of droughts, some of the data were taken from the National Meteorological Agency (ANM) and some were determined using a rain gauge. In the case of determining the windfalls and windbreaks, images taken with the drone were analyzed, and to determine the pedostational conditions, the main and control soil profiles were executed, on which the present soil types were determined.

In order to determine the evolution of the stands, they were placed on test surfaces where measurements of diameters and heights were made, using equipment specific to these operations.

In order to determine the erosion and the anti-erosion efficiency of the stands, experimental runoffplots were placed, according to the methodology used in the agricultural field. Each plot covers an area of 200 square meters, after each rain being measured the amount of water drained, then collecting water with alluvium, for laboratory determinations.

Also, determinations were made of the diseases and pests present in the perimeters studied, according to the methodology described and adapted to the Romanian forestry by Georgescu C. (1957) supplemented by Chira D. et al. (2003).

Chapter 9: Results and discussions

The research carried out, respectively the results obtained in order to achieve each objective, led, in the end, to the achievement of the general objective of the thesis.

1. Determining the main risk factors that lead to disruption of tree development

The main risk factors determined were droughts, windfalls, windbreaks and pedological conditions.

The disturbing factor identified in all the improvement perimeters studied is drought. This was felt quite strongly during the three years of study, being recorded fluctuations of precipitation in the vegetation season (March-September) quite large. Thus, in 2018, a maximum of 191 l / sqm was registered in June and a minimum of 5 l / sqm in August. In 2019, a maximum of 146.8 l / sqm was registered in May and a minimum of 0.7 l / sqm in September, and in 2020 a maximum of 160.4 l / sqm and a minimum of 3.8 l / sqm in April, a tiny amount, this trend being found in August and September.

Another identified risk factor is represented by the action of the winds, respectively the downfall and ruptures caused by them.

Windfalls and windruptures are present in subcompartments 49A and B respectivly in compartment 73.

In subcompartment 49A the percentage of trees affected by windfall is about 10%, and those with crowns affected by 15%. In subcompartment 49B, the percentages are lower, 5% downfall trees and 5% trees with damaged crowns. Within compartment 73, the percentage of downfall trees is about 15%, those with ruptures 15%, and those curved, which are on the verge of drying, about 10%.

In addition to climatic factors, soil is considered a risk factor in the perimeters studied. Within ua 49, the molic regosol was identified, in ua 73 the typical regosol, and in the perimeters Frata 1 and 2 the erodic anthroposol.

Regosols, by the nature of their formation, are a risk factor on the installed forests because they are sensitive to erosion phenomena, they appear very easily, washing the upper horizonts of the soils, depositing them at the base of the slopes.

Erodic anthrosol is a risk factor for installed trees due to the removal of the top layer in which organic matter is accumulated, the low humus content, clay and compaction.

2. The evolution of vegetation in the analyzed perimeters

The results obtained from the measurements reflect the vegetation status of the stands studied. The number of trees identified in each sample area from compartments 49 and 73 is quite varied.

Regarding the diameters, after the application of the unifactorial anova test, no variability was identified between them, only in the case of increases in diameter, calculated by the difference from one measurement to another, variability was recorded in ua 49A. Also, the variability of the increases was observed in the case of copmartment 73, between the same years.

Compared to diameters, respectively increases in diameter, in the case of heights and their increases, variability was observed, with significant differences within ua 49A, 49B and in compartment 73.

The lack of variability in diameters and their increases in the case of ua 49B, combined with the variability of heights and height increases, indicates that these stands suffer both from pedo-climatic disturbances and from non-execution of tending operations.

In the perimeters Frata 1 and frata 2 following the unifactorial anova test applied on diameters, it was found that there is variability, only in the case of false acacia in Frata 1, and in the case of increases in diameter, applying the t test for paired samples, it was found that variability in both the Frata 1 and Frata 2 perimeters.

In the case of their heights and increases, variability was observed with significant differences in both perimeters.

Within the Frata 1 and 2 perimeters, the variability of false acacia diameters, diameter increases, their heights and growths, indicates that these plantations have reached the phase of active growth.

3. Location of experimental surfaces for erosion determination

In order to determine the erosion and implicitly the anti-erosion efficiency of the stands, the surface drainge were analyzed, during June 16, 2019-5 July 2020, from the runoffplots located within compartment 49 and 73. In order to obtain the most conclusive results, the amounts of precipitation and the intensities of the rains were determined, both in the forest and outside the forest.

Following the laboratory processing, it resulted that the erosion differences in the forest are by 0.134 t / ha (24.54%) lower in the case of ua 49, compared to the plot outside the forest, and in ua 73 they are by 0.119 t / ha (21.83%) lower, compared to the plot outside the forest.

4. Analysis of diseases and pests in the stands studied

The stands studied were subjected to analyzes aimed at identifying diseases and pests, which intensify the process of weakening, caused by pedo-climatic factors.

In these studies, in addition to the classical monitoring techniques, in subcompartments 49A and 49B, experimentally, drone flights were performed, with the aim of obtaining photographs of tree crowns. Analyzing the orthophotomaps, trees were identified that showed reddish crowns. Analyzing these trees from the ground and comparing them with the descriptions in the literature, a preliminary identification of the disease "reddening of pine needles" caused by *Lophodermium pinastri* was made.

In order to confirm the observations made in the field, samples were taken which were analyzed in the forest protection laboratory within INCDS “Marin Drăcea” Cluj, where the above mentioned disease was confirmed.

5. Stands management

In order to achieve this objective, observations were made on the perimeters studied, on the management method, on other species that have appeared in the meantime and on the installed seedling.

Thus, in plots 49 and 73, in addition to the introduced species by planting, species such as walnut, false acacia, hornbeam, sessile oak were naturally installed, and in terms of seedlings, in subcompartment 49A the species that make up the seedlings are in proportion of about 40-50% sessile oak, 35% walnut and 30% false acacia, subcompartment 49B approximately 25% beech, 15% sessile oak, 5% walnut and 1% false acacia, and in compartment 73 the spieces that make up the seedling are in proportion of about 40 % sessile oak, 50% Turkey oak, 30% ash, 40% downy oak.

The Frata 1 and Frata 2 perimeters were set up strictly in order to stop the surface erosion of agricultural lands, the species and afforestation formulas being chosen according to the current norms, reaching the state of massif.

Chapter 10: The effect of climatic factors and management on vegetation evolution

In this chapter, the results obtained previously were correlated, in order to highlight the effects of climatic factors on the evolution of the located vegetation. Following these correlations, it turned out that the effect of climatic factors and the management of stands, directly influence their evolution, but they also directly influence the evolution as a soil risk factor.

Chapter 11: Conclusions and recommendations

Conclusions

1. The main disturbing factors identified in the improvement perimeters studied are of climatic and pedological origin.
2. Climatic factors that negatively affect trees are droughts, windfalls and winduptures.
3. Windfalls and ruptures are present, being isolated, in particular in the stands in plots 49A and 73, which are located along the main valley.
4. The factors of pedological origin are the types of soil on which the stands are found, respectively molic and typical regosols, in the case of compartments 49 and 73, and in the case of the perimeters Frata 1 and Frata 2 being the erodic anthroposol.
5. The evolution of vegetation in the analyzed perimeters was determined on the basis of annual measurements of diameters at 1.3 meters, in the case of stands and at the collar, in the case of plantations in both situations height measurements were performed, using specific methods.

6. The increases in diameter were analized, which were obtained by the difference from one measurement to another, for which graphs were drawn up, respectively they were subjected to anova testing, within subcompartments 49A, 49B and compartment 73, and in the case of perimeters Frata 1 and 2, the T test for paired samples was used.
7. As a result of these tests, there were statistically insured differences, resulting in significant differences between 2020 compared to 2018 and 2019 compared to 2018 in ua 49A and ua 73. There were no statistically insured differences in ua 49B.
8. The lack of variability in growth and the downfalls on a very small areas within 49B reinforce the fact that the development of stands is seriously endangered by the lack of cultural operations.
9. Within the perimeters frata 1 and 2, according to the results of the T test applied on each component species, respectively false acacia and flowering ash, there are statistically assured differences.
10. The variability of the increases of the diameters within the plantations, demonstrates that, despite the limiting factors present in the area (drought, eroded soil, slope), the stands are on an increasing trend, being necessary to follow them and apply specific works in time.
11. With regard to heights, there is variability ensured statistically both in the case of heights and in the case of increases recorded from one year to another.
12. Associating the lack of variability in diameters with the variability in the case of heights, in compartments 49 and 73, it can be concluded that the non-performance of tending operations leads to the structural destabilization of the stands, over time reaching their decline.
13. Associating the variability of the increases in diameter with that of the increases in height, it can be stated that the vegetation installed within the perimeters of Frata 1 and 2 has adapted to the pedo-climatic conditions in the area, entering the phase of active growth.
14. Although it was not possible to directly correlate the increases with precipitation, based on the results it can be stated that they play a very important role in the development of stands, a fact observed from the growth differences between 2018 and 2020, due to precipitation in previous periods and in during the growing season.
15. The results obtained from the location of the 8 experimental runoffplots, six in the forest fund, respectively two outside it, refer to the determination of erosion within the forest and in the grassy land, adjacent to the forest fund.
16. The determined erosion, expressed in tones per hectare amounts to 0.412 t / ha within compartment 49, being 24.54% lower than in the limitrophe area. Within compartment 73, the value of erosion is 0.426 t / ha, 21.83% lower than in the area of open land limitrophe to it.

17. In order to be able to assess the anti-erosion efficiency of the forest, the influence of rainfall intensity and that of soil retention on surface runoff through simple linear regression was followed.
18. In compartment 49, the intensity of the rains affects the surface drainage by 39% and the ground retention by 28%. In the case of compartment 73, the intensity of the rains influences the surface drainage in proportion of 38%, and the ground retention in proportion of 28%.
19. The stands under study were analyzed for diseases and pests, which cause damage, especially in the long term.
20. To confirm the results obtained in the field, biological samples were collected, which were analyzed in the laboratory of Forest Protection within INCDS "Marin Drăcea" Cluj.
21. The results of the laboratory tests confirm the preliminary tests obtained in the field, namely the presence of the disease ”reddening of the pine needles”.
22. In the case of the Frata 1 and Frata 2 plantations, no diseases or pests were observed, the only damage being caused by droughts, which were insignificant.
23. The afforestation composition in the two perimeters involved 10000 seedlings per hectare, in the case of ua 49A being kept from the time of planting to the present time, respectively 10PiN, in the case of ua 49 B it underwent slight changes, respectively from 5PiN -2Pi-3Mo at 6 PiN 4 Mo, the Scots pine reaching disseminated, reaching the respective tel composition 6 PiN 4 Mo and in the case of ua 73, the composition underwent substantial changes, from 7PiN-2Pa (Fr) 1 Sea buckthorn to 8 PiN 2DT , DT = ash, maple, downy oak, moving away from reaching the target composition, respectively 5 PiN, 3 Pa, 2 Fr.
24. Under ua 49A, the species comprising the seed are approximately 40-50% sessile oak, 35% walnut and 30% false acacia. In ua 49B, the species that make up the seed are approximately 25% beech, 15% sessile oak, 5% walnut and 1% false acacia, and in plot 73 the pieces that make up the seed are approximately 40% sessile oak, 50% turkey oak, 30% ash, 40% downey oak.
25. The perimeters of Frata 1 and Frata 2 were set up strictly in order to stop surface erosion of agricultural land, the species and afforestation formulas being chosen according to the present rules. The afforestation composition adopted was 70 Sc (Gi) 15 Ul.t (Mj, Gi), 15 Vi.t (Cn, Gi), 4000 seedlings per hectare, the actual plantings being made with false acacia, flowering ash and Turkish sour cherry, the last having a very poor yield.

26. Other works that were carried out to stop erosion and help the plantation were terraces supported on coastal fences (approximately 15% of each area).

Recommendations

1. Analyzing the current risk factors present in the perimeters of improvement and drawing up maps by degrees of risk (climatic, pedological).

2. Extension of dendrometric research to improvement perimeters, especially in areas where landslide or flood risks are present for intervention with tending operations.

3. Location of drainage plots and their monitoring in the improvement perimeters in areas at high risk of landslides or floods.

4. Improving afforestation compositions and adapting them to new trends in climate change.

5. When applying silvotehnic operations, natural regeneration should be promoted, especially where appropriate, within the improvement perimeters.

Originality and innovative contributions of the thesis

The main notes of originality of the thesis, were detached from the adaptation and use of methodologies applied in other fields of research, which were adapted in the field of forestry, the main purpose being to obtain conclusive results, which can be used both in the field of research. as well as forestry practice.

The topic was adapted to new GIS technologies. Thus, the location of the surfaces was initially done at the office, on orthophotomaps, the coordinates thus established, being transferred to GPS, with the help of which they are located in the field.

Another technology, the UAV, was used to obtain information on windfalls. Also, information was obtained regarding the drying of some trees, which facilitated the detection of the present diseases.

In addition to GIS and UAV technologies, methodologies applied in the field of agricultural research have been used, namely the use of runoff plots to determine the effects of stands on erosion, compared to grassland.

The use of indicators, such as rainfall intensity and ground retention, to determine the anti-erosion efficiency of stands.