SILVER FIR STANDS INFECTED BY MISTLETOE (*VISCUM ALBUM* SSP. *ABIETIS*) DYNAMICS IN THE CONTEXT OF CLIMATE CHANGE

DINAMICA ARBORETELOR DE BRAD CU ATACURI DE VÂSC (*VISCUM ALBUM* SSP. *ABIETIS*) ÎN CONTEXTUL SCHIMBARILOR CLIMATICE

BARBU Cătălina
”Ştefan cel Mare” University of Suceava, Faculty of Forestry

Abstract. *In the expected climatic change questions are being raised concerning the migration of the potential range of forest species and the consequences on silviculture. To answer these questions, information about climatic changes is required. In this paper the dynamics of mistletoe infected silver fir stands in the context of climate change is examined. Silver fir stands from the border of natural vegetation area are the most vulnerable on climate changes and here mistletoe infection is highest. To simulate the effects of climatic change the aridity indices (IA) were calculated for the following hypotheses: i) hypothesis 1: temperature increase and precipitation decrease, ii) hypothesis 2: temperature increase and precipitation increase.*

Key words: climatic change, aridity index, mistletoe, silver fir

Rezumat. *Ecosisteme perene cu ciclu lung de producţie, pădurile suportă continuu efectele variaţiilor sezoniere, anuale şi periodice ale parametrilor climatici Creşterea prognozată a temperaturii va determin, în anumite zone instalarea unor deficite de umiditate în sol în timpul sezonului de vegetaţie cu efecte negative asupra stării de sănătate a arborilor sau vor predispune arborii la boli şi dăunători. În lucrarea de faţă este examinată dinamica arboretelor cu brad afectate de vâsc în contextul schimbărilor climatice. Bradul de la marginea arealului natural de vegetaţie este cel mai vulnerabil la schimbările climatice si parazitismul vâscului este cel mai virulent. Pentru simularea schimbărilor climatice în arealul actual al bradului din Carpaţi s-au calculat indicii de ariditate (IA) anuali în diferite ipoteze de prognoză: i) ipoteza 1- creşte temperatura, scad precipitaţiile, ii) ipoteza 2 – creşte temperatura, cresc precipitaţiile.*

Cuvinte cheie: schimbări climatice, indice de ariditate, vâscul bradului, brad

INTRODUCTION

To underline the prognoses climate changes for the next decades the mean values of temperature and precipitation can be obtained from maps published in different studies or using a simulation model of a regional climate in different prognoses hypothesis. In hypothesis that B1 scenario is the most probable (*the B1 scenarios are characterized by: rapid economic growth, reductions in material intensity and the introduction of clean and resource efficient technologies, an emphasis on global solutions to economic, social and environmental stability)* for

Romania the climate prediction pointed out a mean temperature increase of 0.5 - 2^0 C and also quantitative and qualitative changes of precipitations. The winters will be warmer (with + 1-3^0C) and wet (by comparison with 1961-1990 period) and summers with low precipitations and higher temperatures (IPCC, 2001).

The most recent access_of the site www.peseta.jrc.es underline higher increases of the mean annual temperatures that have been anticipated till now (figure 1). The same site reveals moderate increments of the mean precipitation for the mountainous area and for the northern part of the country and significant decreases of precipitations (-15-20%) in Câmpia Română (figure 2).

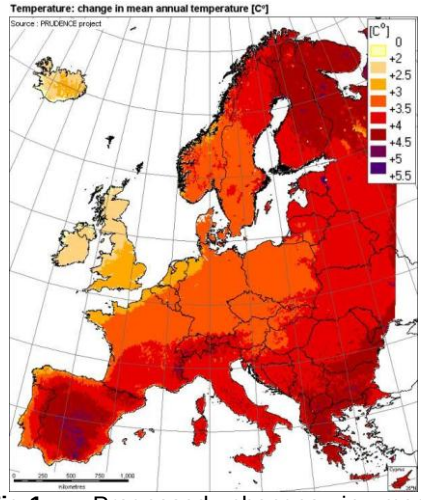

Fig.1 - Prognosed changes in mean annual temperature at the end of 21th century (2071-2100) related to mean values from 1961-1990 period (after www.peseta.jrc.es)

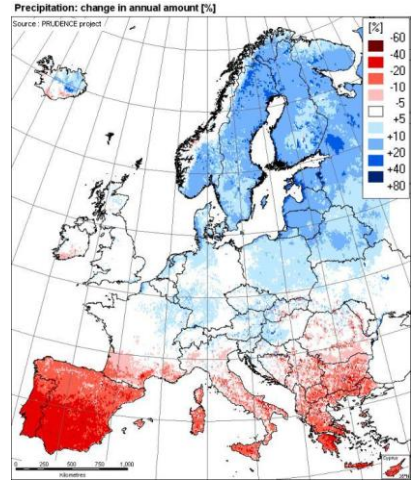

Fig. 2 - Prognosed changes in mean annual precipitation at the end of 21th century (2071-2100) related to mean values from 1961-1990 period

For the silver fir of Carpathians Mountains are prognosed increases of the mean annual temperatures with +2-3^0C in North and +3-3,5^0C in Curvure and Southern Carpathians. Concerning the precipitation the prognosed changes pointed out increases around 5% in North (+30-80 mm) and decreases around 10% (-50-100 mm) in South.

Plagnat (1950) showed in his studies that the distribution area of the silver fir is correlated with temperature and precipitation. The same author asserts that silver fir has optimal development in the areas with the aridity index above 40. After Perrin (1931), silver fir occurs in the areas with 50 and 60 aridity indices.

The aim of this paper is to analyze the dynamics of mistletoe infected silver fir stands in the context of climate change.

MATERIAL AND METHOD

To simulate the effects of climate changes in the present area of silver fir from Carpathians (figure 3) the aridity indices (IA) were calculated in different prognosis hypothesis.

Fig.3. Distribution of silver fir in Romania

IA=P/T+10, where:
P represents the mean annual precipitations,
T represents the mean annual temperatures.
The aridity indices calculus take into consideration the mean annual values of temperature and precipitation from the lower elevation boundary of silver fir ecosystems from Romania (Barbu and Barbu, 2005). The silver fir from the border of the natural area is the most vulnerable at climate changes and the mistletoe infection is the most virulent.

This very simple annual index, which does not take monthly variation in temperature and precipitation into account, only gives general information on the drought level at the considered sites. It simulates the climatic changes easily (Aussenac, 2001).

Table 1

Scenarios of temperature and precipitation evolution at the end of 21th century in silver fir stand from Carpathians Mountains

Hypothesis 1 increase temperature, decrease precipitation			**Hypothesis 2 increase temperature, decrease precipitation**		
Aridity index (IA)	**Prognosed temperatures (T^0C)**	**prognosed precipitations (P mm)**	**Aridity index (IA 0)**	**Prognosed temperatures (T^0C)**	**prognosed precipitations (P mm)**
IA 0	T	P	IA 1+50	T+1	P+50
IA 1	T+1	P	IA 3+50	T+3	P+50
IA 3	T+3	P	IA 3+100	T+3	P+100
IA 1-50	T+1	P-50			
IA 3-50	T+3	P-50			
IA 3-100	T+3	P-100			

IA 1 = P/T+11	**IA 1-100** = P-100/T+11	**IA 1+50** = P+50/T+11
IA 2 = P/T+12	**IA 2-50** = P-50/T+12	**IA 1+100** = P+100/T+11
IA 1-50 = P-50/T+11	**IA 2-100** = P-100/T+12	**IA 2+50** = P+50/T+12
		IA 2+100 = P+100/T+12

T and P represent the mean values of temperatures and precipitations in 1905-1961 period (after Atlasul Climatic al României, 1966).

RESULTS AND DISCUSSIONS

Figure 4 presents the values of aridity indices for the last century (1900-2000) for the piedmountains area of Obcinele Bucovinei (ecological region A2 – 621 meters a.s.l).

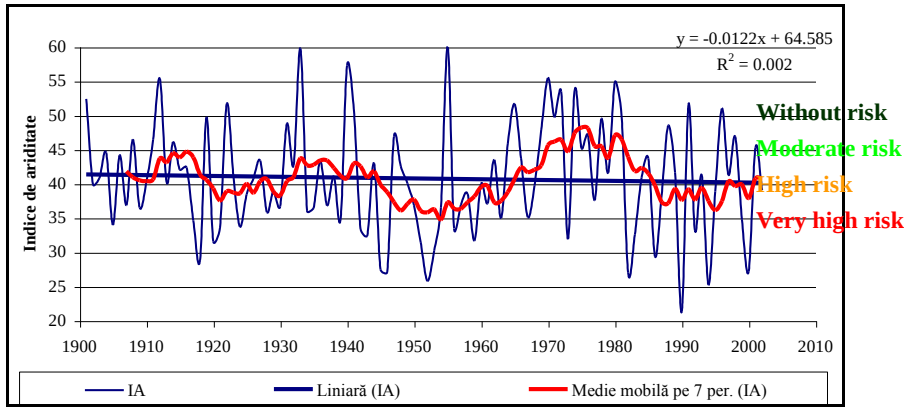

Fig. 4. Aridity index variation in 20th century in the ecologic subregion A2 – ecosystems with silver fir from Obcinele Bucovinei (621 m a.s.l.)

At the entire century, a variation tendency of aridity indices cannot be observed. The mean value of aridity index is around 40. Analyzing the moving average can be observed the alternation of periods with IA above and under 40 with a 40 years periodicity and amplitude of 10-15 units. Thus, in the last century there were registered three maximum values in 1905-1915, 1930-1940 and 1970-1980 and three minimum values in 1920-1930, 1945-1955 and 1985-1995. The periods with the aridity indices values under 35 can be associated with the period of maximal virulence of mistletoe.

On the bases of many observations in silver fir stands from the Eastern Carpathians we propose the following values of aridity indices (table 2) associated with risk classes on mistletoe infection.

Table 2

Risk classes on mistletoe infection related to aridity indices

Aridity index	Risk classes on mistletoe infection	Comments
50	very low	there is no risk for the reduction of the actual area of silver fir stands
45	moderate	moderate risk of the present area reduction
40	high	high risk of present area diminution
35	very high	very high risk of present area diminution

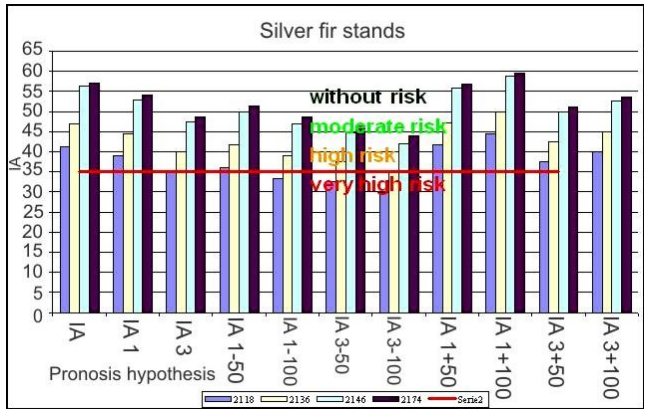

Fig. 5. Simulation of variations aridity indices (IA) relative to an increase in mean temperature and a reduction or increase in annual rainfall at the end of 21th century in silver fir stands

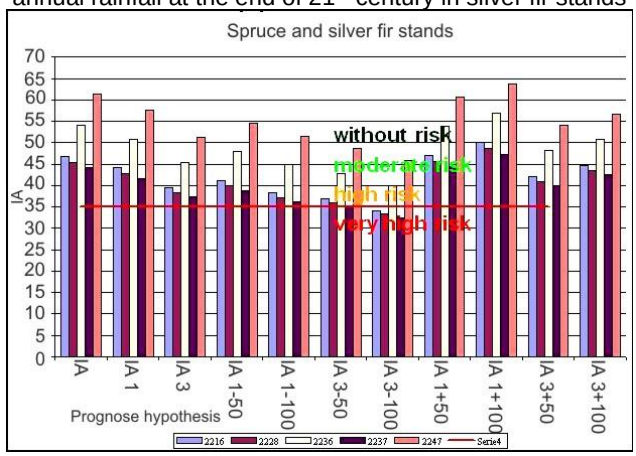

Fig. 6. Simulation of variations aridity indices (IA) relative to an increase in mean temperature and a reduction or increase in annual rainfall at the end of 21th century in spruce and silver fir stands

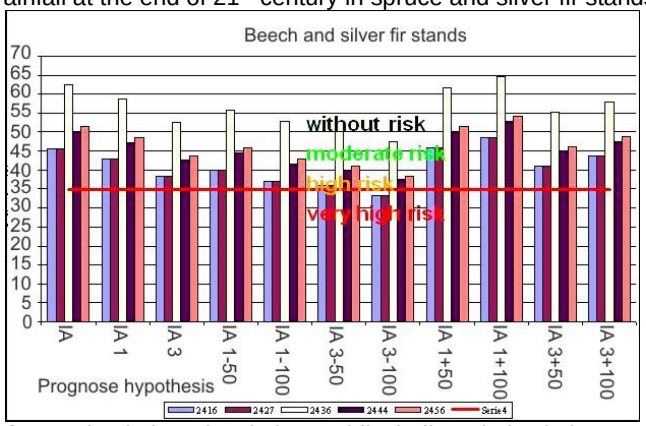

Fig. 7. Simulation of variations aridity indices (IA) relative to an increase in mean temperature and a reduction or increase in annual rainfall at the end of 21th century in beech and silver fir stands

In figures 5-7 there are presented the aridity indices simulation from different prognosis hypothesis for silver fir stands from Romania.

The main silver fir ecosystems in which the prognoses climate changes for the end of 21th century will amplify the infection with mistletoe of silver fir trees older than 80 years were synthesized on risk classes and forest formation (table 3). The actual areas of silver fir stands will diminish in the detriment of some competitive or with a wide ecological area species.

Table 3

Risk classes on mistletoe infection for silver fir ecosystems in different climate change hypothesis at the end of 21th century

Risk class	Stand		
	Silver fir stands	Spruce and silver fir stands	Beech and silver fir stands
Very high	2118*)	2237, 2228, 2216	2416, 2427
High	2136	2236	2444
Moderate	2146	2247	2456

Note: *) – represents the stand code

CONCLUSIONS

On the basis of the simulation results it seems that a possible temperatures increase without the increase of precipitation can generate a high risk of mistletoe infection in silver fir stands.

In the hypothesis of increases temperature and decreases precipitation the value of aridity index falls under 35 and the mistletoe infection risk is very high.

For aridity indices values above 50 there is no risk for mistletoe infection.

REFERENCES

1. **Aussenac G., 2001** - Ecology *and ecophysiology of circum-Mediterranean firs in the context of climate change*. Ann. For. Sci. 59: 823-832.
2. **Barbu I., Barbu Cătălina, 2005** - *Silver fir in Romania*. Editura Tehnică Silvică, Bucureşti
3. **Perrin H., 1931** - *Indices d'aridite et repartitiondes essences forestieres*. Congres de l'A.F.A.S. Nancy. 511-514.
4. **Plagnat F., 1950** - *Le gui du sapin*. Annales de l'École nationale des eaux et Forêts, tome XII, 155- 231.
5. **xxx, 2001 -** *Summary of Policymakers*. A report of Working Group I of the Intergovernmental Panel on Climate Change (IPCC), 20 p
6. **xxx, 1966 -** *Atlasul climtologic al României*. Editura CSA. Institutul Meteorologic Bucureşti.
7. **www.peseta.jrc.es**