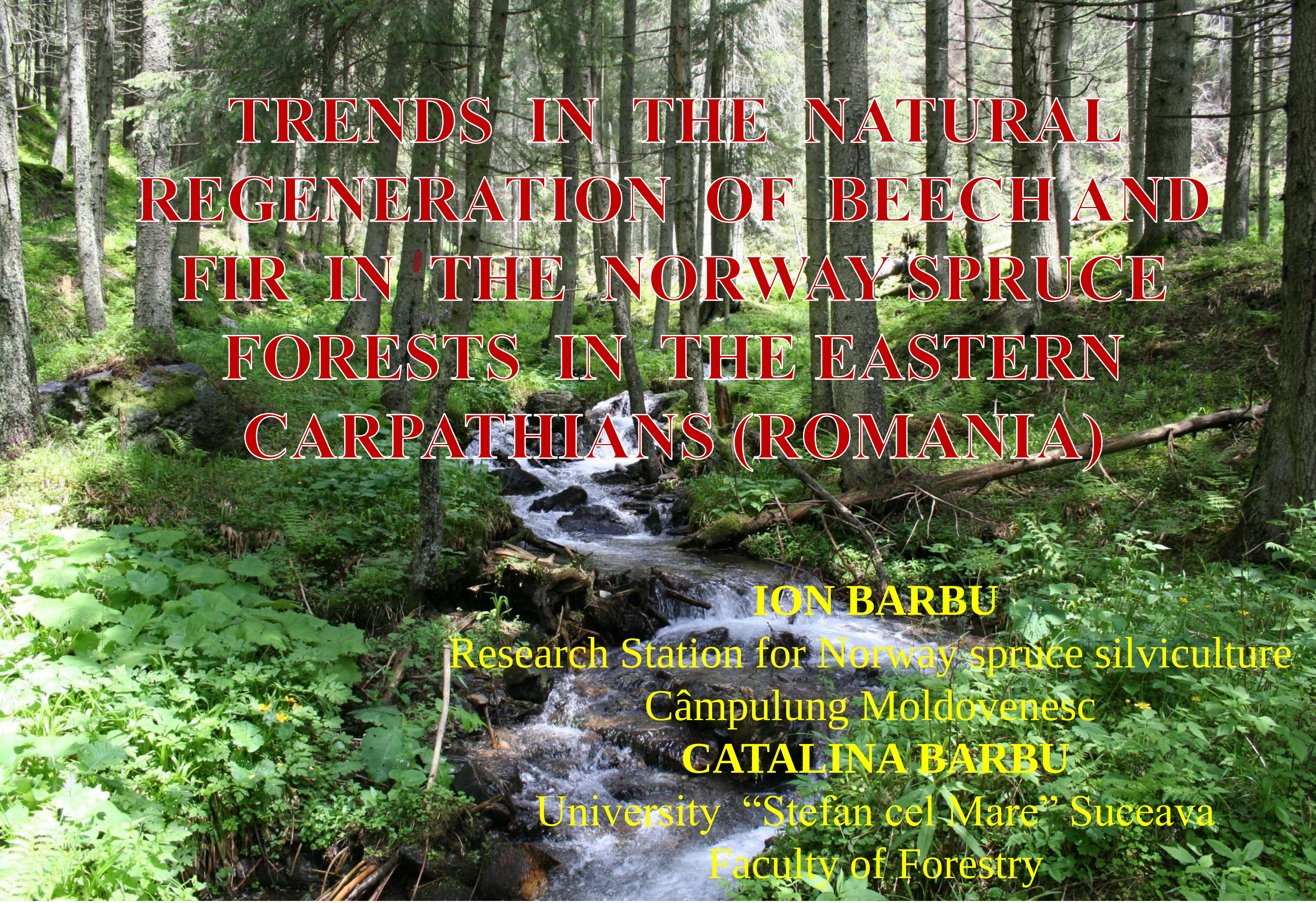

# TRENDS IN THE NATURAL REGENERATION OF BEECH AND FIR IN THE NORWAY SPRUCE FORESTS IN THE EASTERN CARPATHIANS (ROMANIA)

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# INTRODUCTION

**The research focuses on the relations between the natural regeneration processes and the environmental factors, including the structural characteristics of the mothers stands.**

**Regeneration processes refers to the physiological (seed productions dispersal and generation) and autecological (development of the plants in the environment) aspects, including the competition with other species in specific climatic and site condition.**

**The successful installation of the seedlings and their transformation into saplings of different heights (0.5 … 1 and 2 meters) is more complex and put in evidence the multitude of ecophysiological, environmental and adaptive capacity of tree species in the actual climatic conditions.**

**Analysis of the frequency of the species in number, basal area and regeneration capacity put in evidence some trends and permit forecasts concerning the composition and vigor of the stands natural regenerated.**

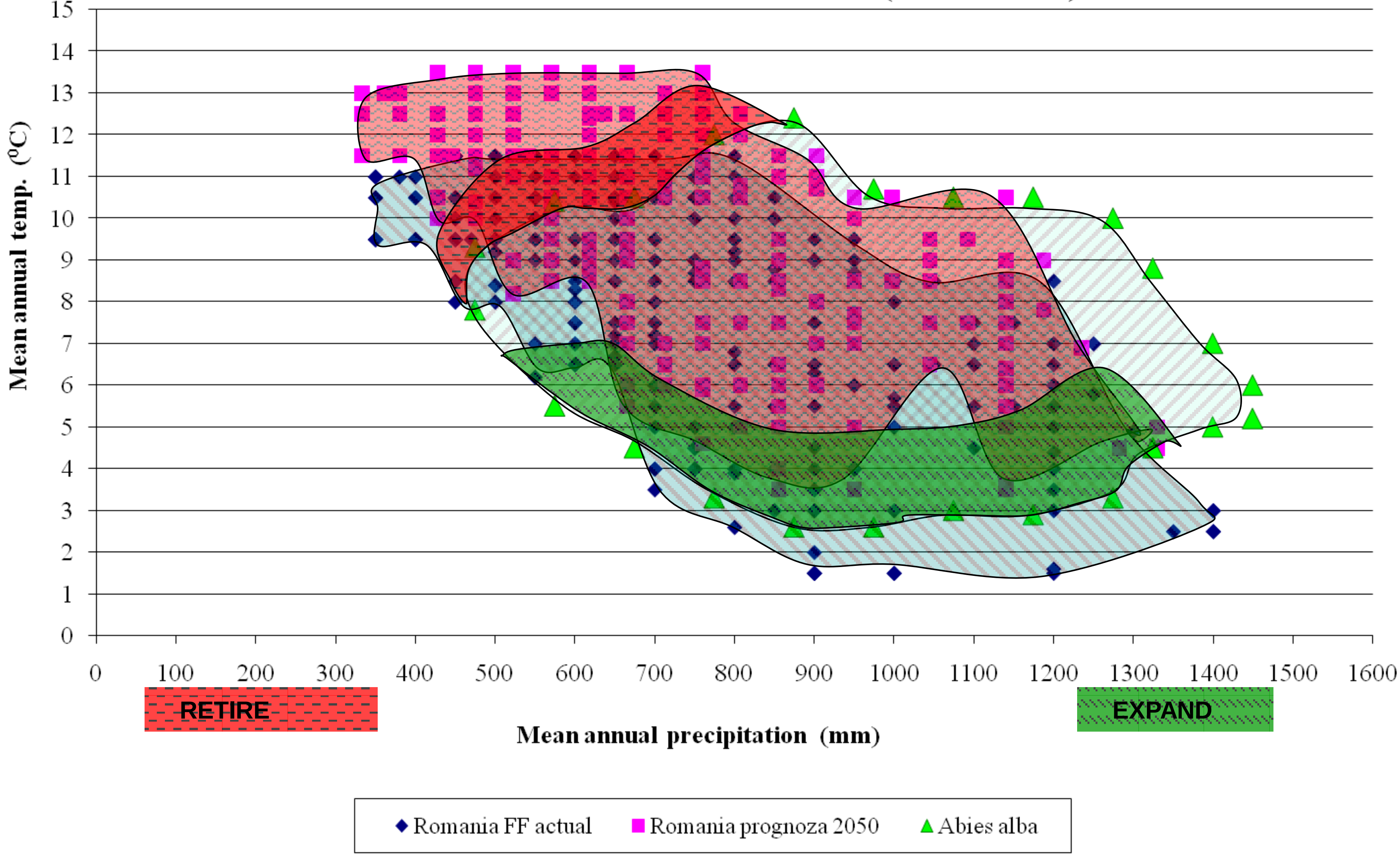
**The relations between the frequency of the trees species in the natural regenerated cohorts, represents an easy and useful way to study the trends in the composition of the forests, mainly at the border of natural area of the trees. The regeneration process is influenced by major factors:**

- **the light and the regeneration treatment**
- **the micro site, site and conditions**
- **the influence of the herbivores.**

**In the mountain regions, the dynamic of colonization in relation with micro sites and species abilities to produce seeds and seedlings conduct to a very large variability of speeds of colonization because of few suitable regeneration sites. The presence of "relict species" or of endemic species, adapted to the local ecological conditions is a measure of this variability.**

**One of the most widely held expectations of vegetation response to warming is that altitudinal belts of vegetation will move altitudinally. This changes appears to be occurring more evident in the spruce belt of the Carpathians.**

# Comparison between the actual ecological domain climatic envelope of Romanian Forests, the forecast domain for 2050 and the natural area of silver fir (*Abies alba*)



# Questions

1. Did the frequency of Silver fir, beech and Sycamore in the Northern Carpathians increase in the last decades?

2. Does the expansion of this species in the Norway spruce belt forests represent an invasion in areas were was eliminated by human activities, or is a true upward shift of the mixed forest (of conifers and beech) belt?

3. In which ecological niches occurs the sensitive species and what are the main drivers of mixed forest regeneration?

4. Climate change or management techniques are most significant factors?

# LOCATION OF THE RESEARCH:

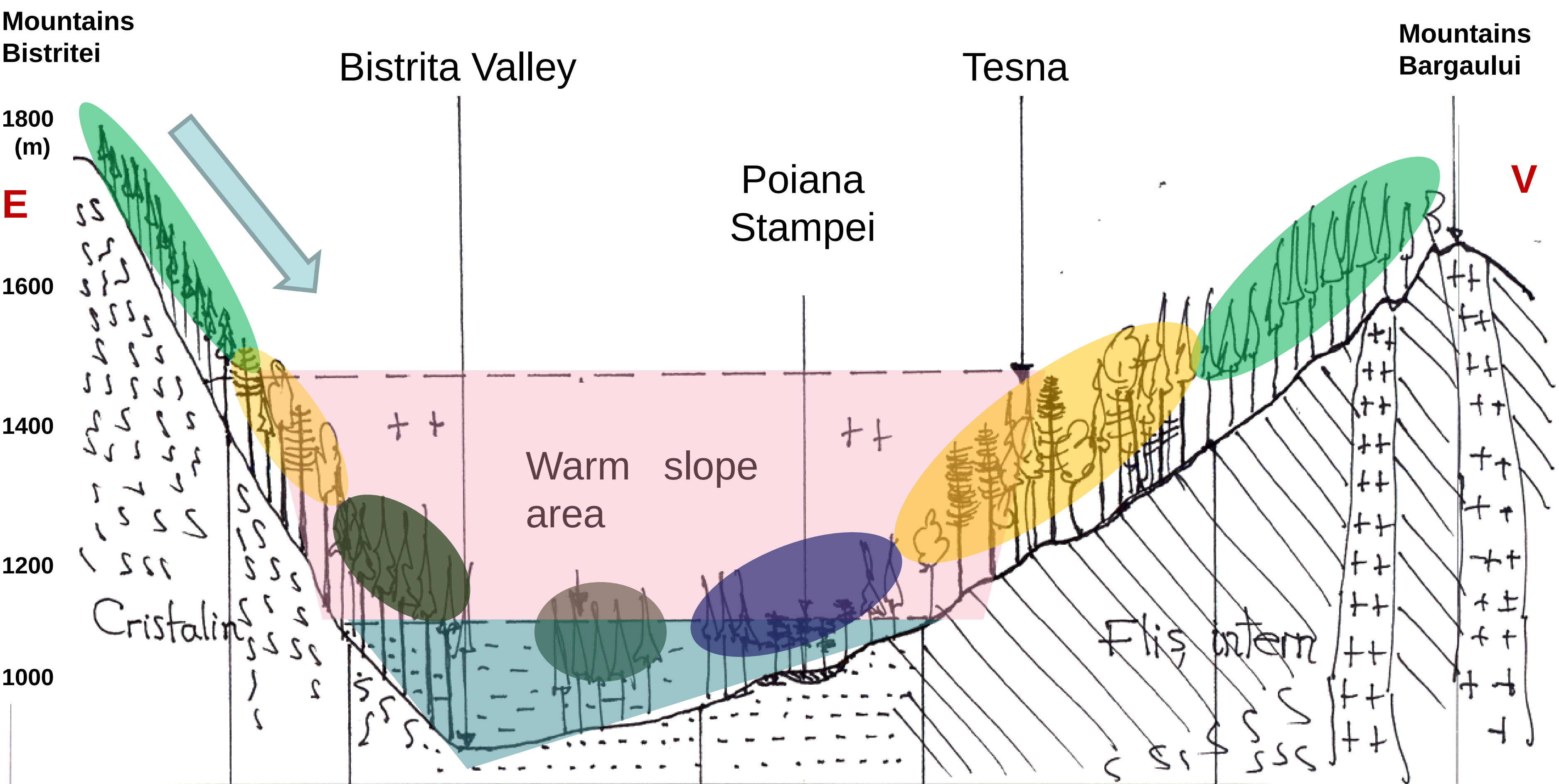
**Northern Carpathians. Dorna Basin : 800 – 1400 m**

***Design of transects and plots***

**A set of 17 transects of 500-1000m length with 5-8 plots of 500m$^2$ each was established in 2003 and 2004. Each transect comprises mature stands with different density and structures as result of wind damages in the past and management works. Inventories made in 11 transects with 416 plots were statistically analyzed**

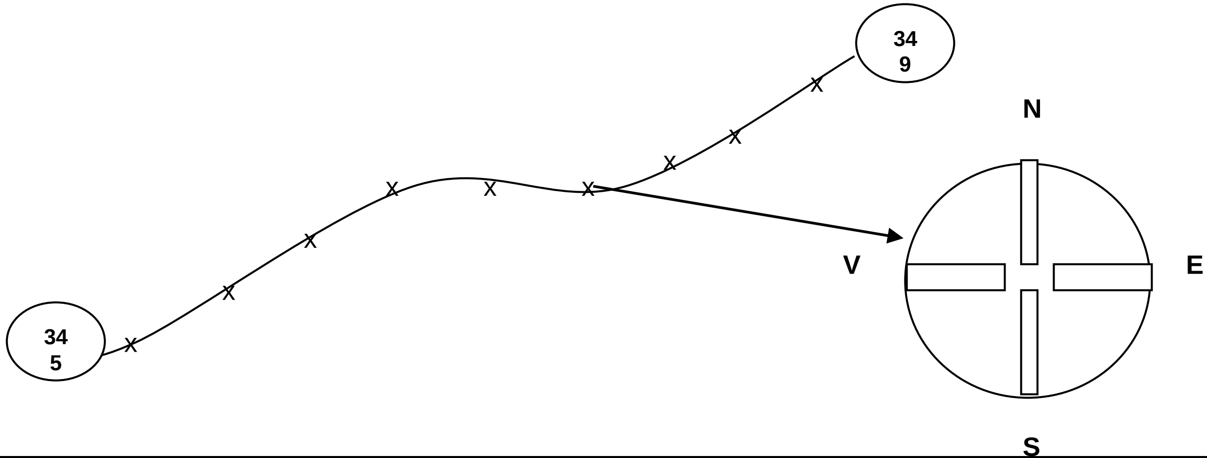

**Location of the research area in the Romanian Carpathians**

**Schematic section in Dorna basin oriented E – V (60 km), showing the distribution of the forest vegetation in relation with the thermal inversion zone. The warm slope zone favorise the presence of the senzitive species fir, beech, sycamore.**




| Spruce | Mixed forest conifers and beech | Spruce of inversion | Mire and bogs with Pinus torfosa …..and spruce | Mixed forest of conifers and beech | Spruce forest |
|---|---|---|---|---|---|

# Characterization of the transects and plots environment




| Sample plot | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Alt. (m) | | | | | | | | | |
| Slope orientation | | | | | | | | | |
| Inclination | | | | | | | | | |
| Substrate | | | | | | | | | |
| Soil type | | | | | | | | | |
| Structural type. | | | | | | | | | |
| Herbal flora type | | | | | | | | | |
| Herbal coverage | | | | | | | | | |

# METHODS:

Trees species presence and concurrence capacity were quantified using the index VID (Value of dendrologic index) calculated as sum of the percent frequency of an tree species in number (N), basal area (G) and regeneration strata (R )

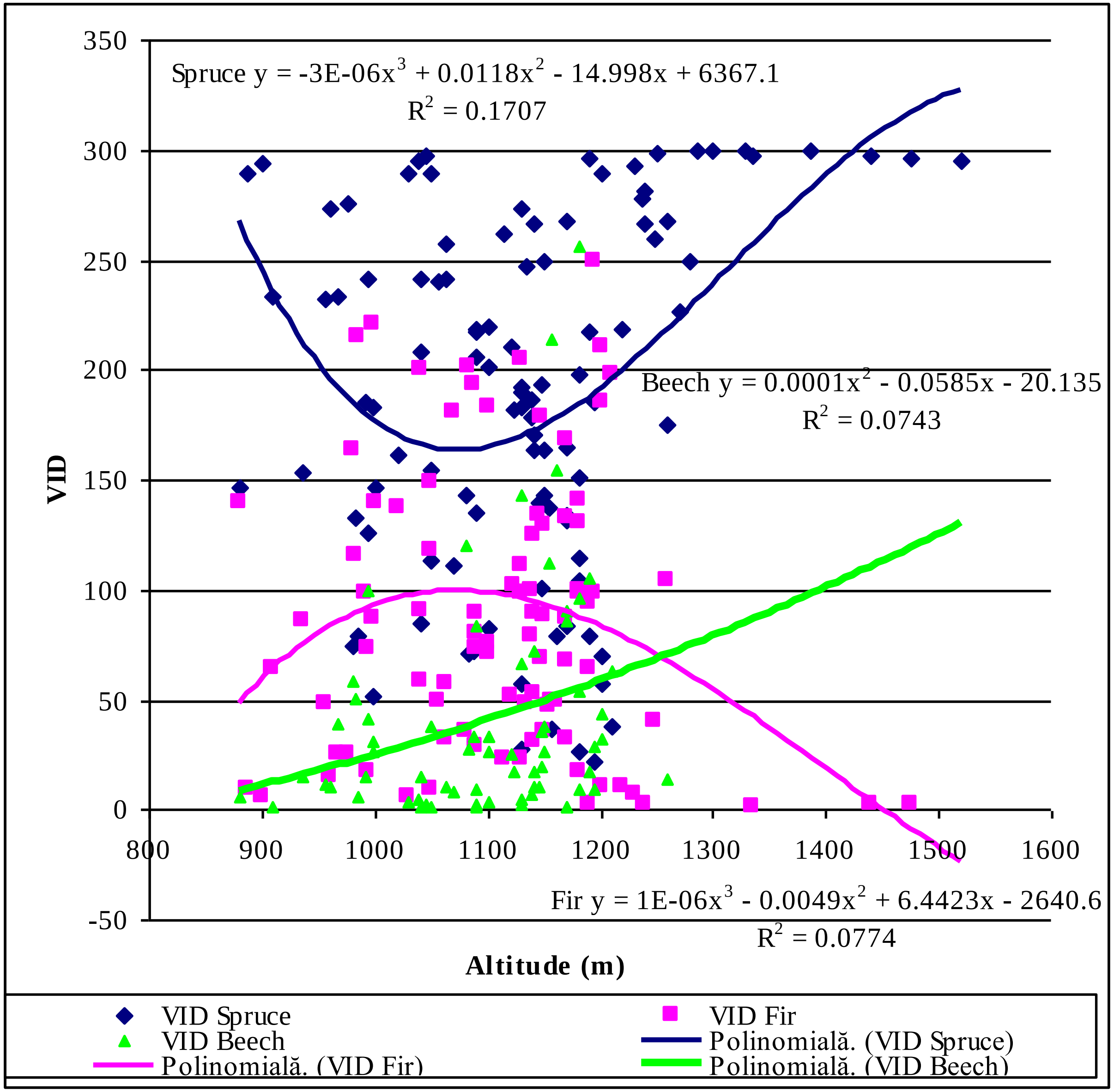
$$VID = N+G+R$$

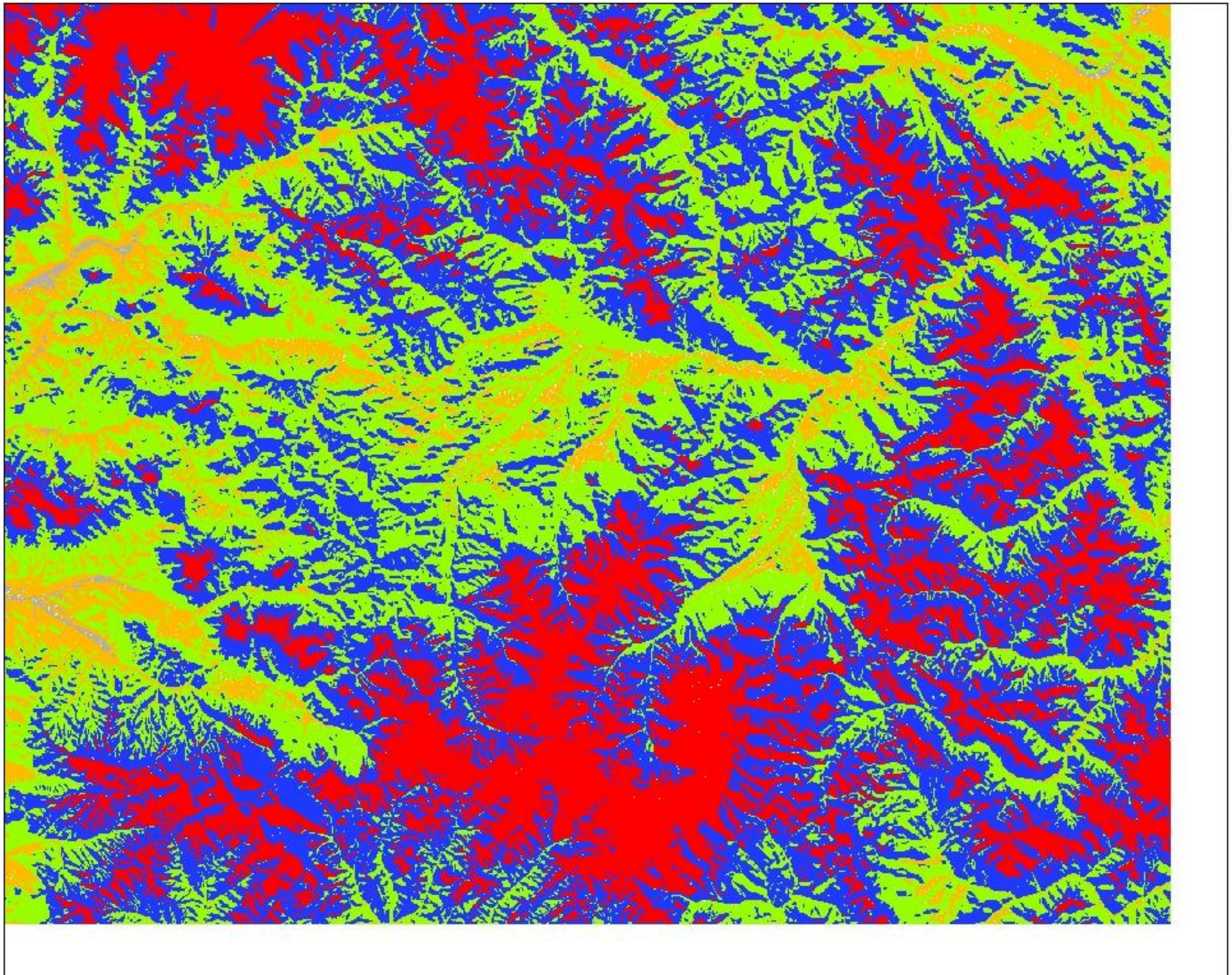
- **The inventories were made in mature stands with natural regeneration in gaps in 11 transects with 5-8 plots located at 30-50 altitudinal differences and 50-150m distance. For each plot were described and estimated following site parameters: altitude (m), slope orientation, slope inclination, soil substrate, soil types, stand structure types, herbaceous type flora and % of herb colonization.**

- **For the old stands, in each circular plot with 500m2 area were measured and described all the exemplars over 6 cm diameter. Tree species, BHD, height, and actual state of the crown, estimated in the following categories: living, uprooted, hanging, brakeage of the trunk, crown brakeage, dry.**

- **In each plot natural regeneration were estimated in 4 satellites of 10x1 $m^2$ oriented N, E, S, V. Each *seedling* (living young plants < 50cm) and *saplings* (>51cm) were evaluated in relation with the species and quality. Field data were recorded in adequate formulars.**

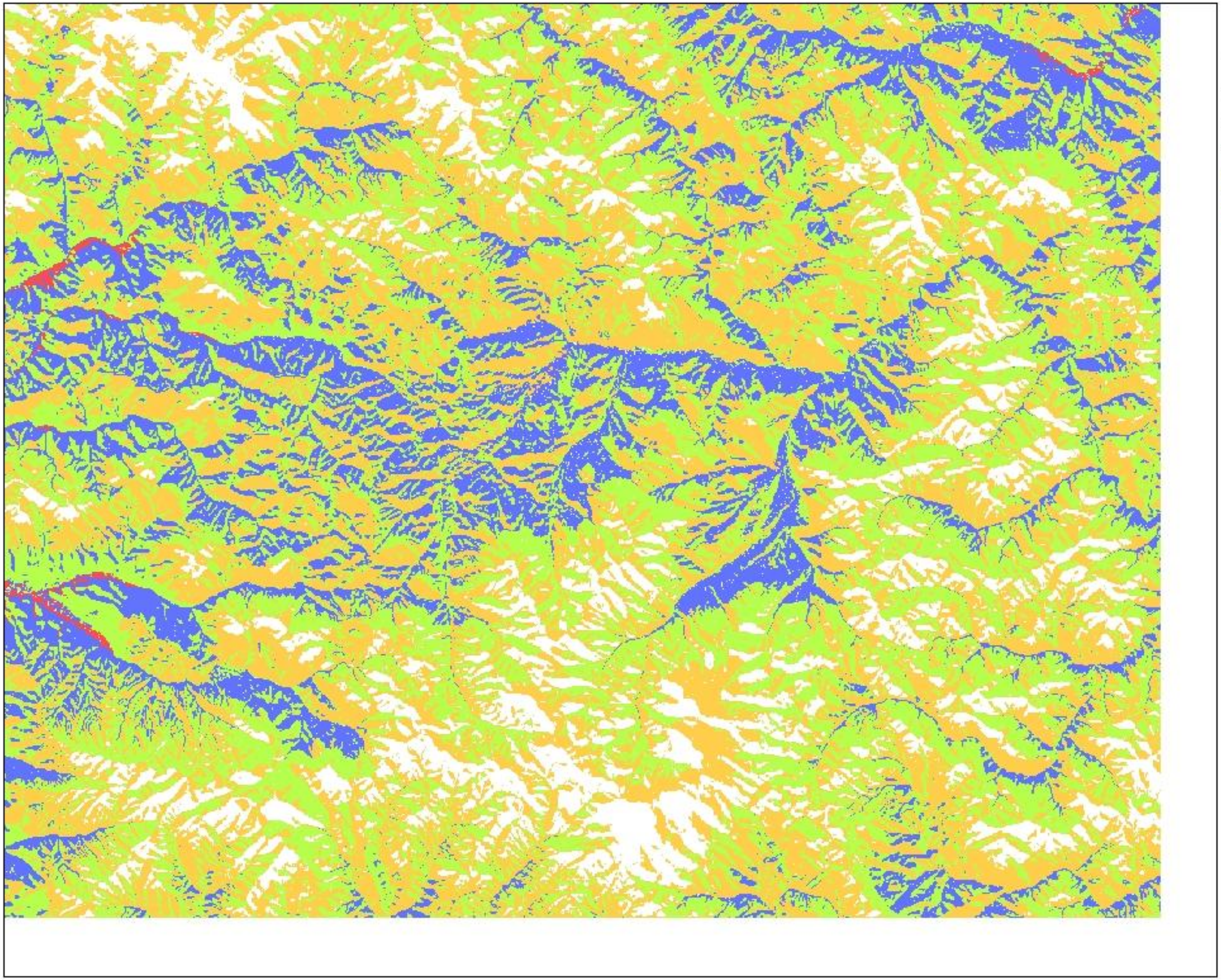
# Distribution of VID index for the main species in relation with altitude





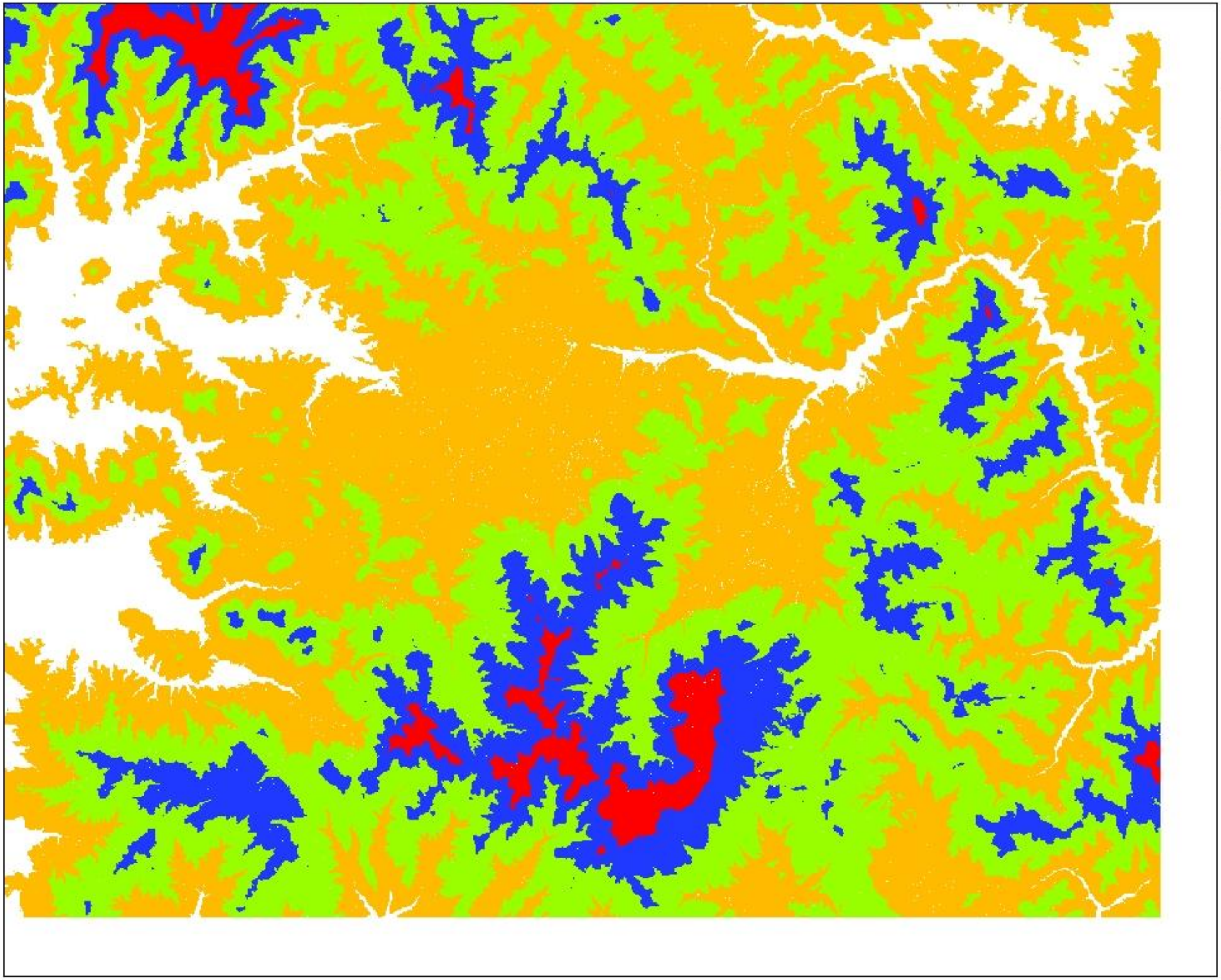

**NORWAY SPRUCE registered 2 maximum with VID over 250 at low altitudes in depressions at 800-1000m (termic inversions) and at high altitudes, over 1300m**

**VIDSpruce = 0,24+0,13Alt. + 18Exp. + 0,78Incl (Rm = 0,276)**



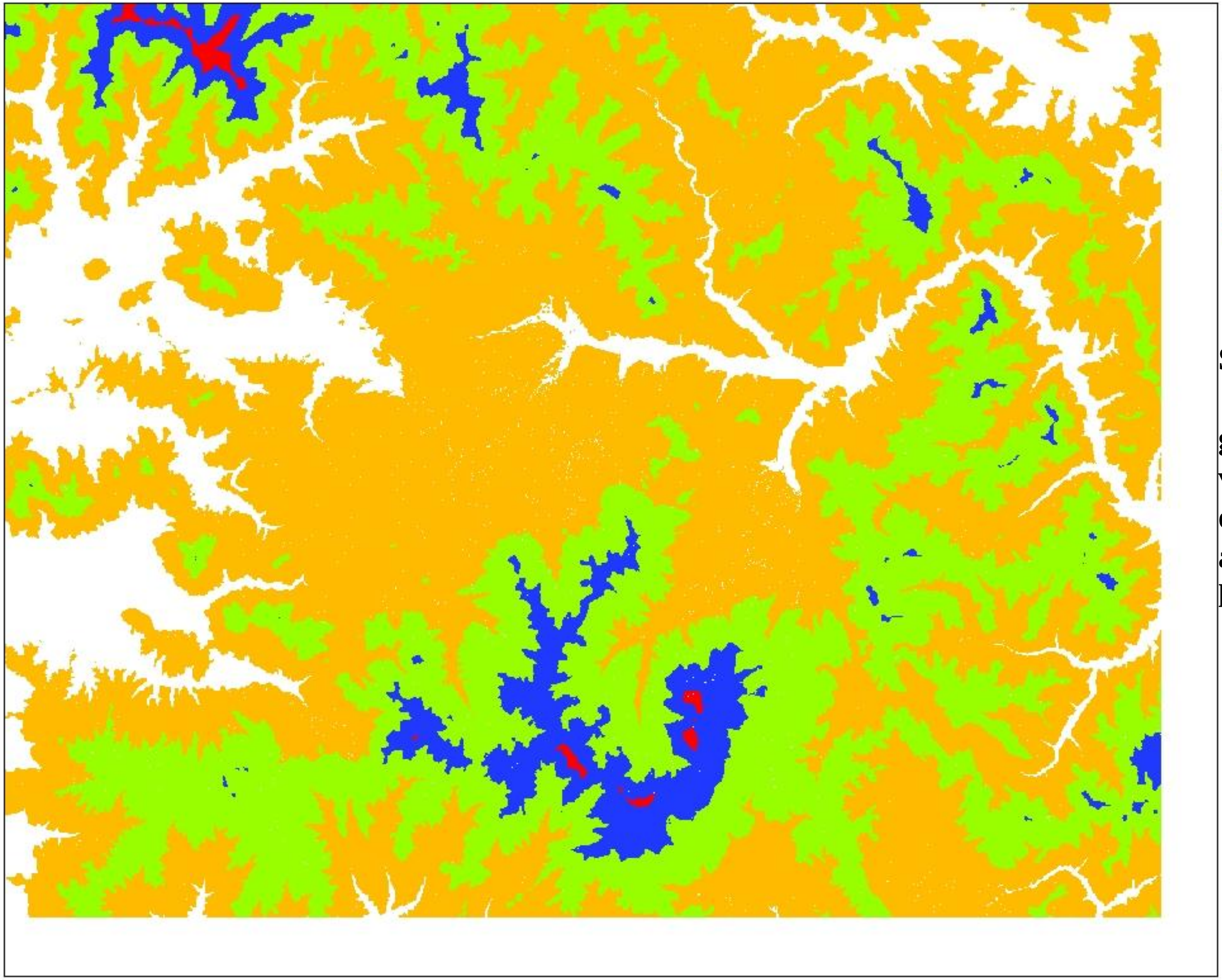

**SILVER FIR has maximum VID-index (150-200) at 1000-1200m altitudes. At lower than 1000m altitudes and over 1200m VID index drop to 50-75**

**VIDSilver fir = 231,8 – 0,08Alt. – 28Exp. – 0,54PIncl (Rm = 0,297)**



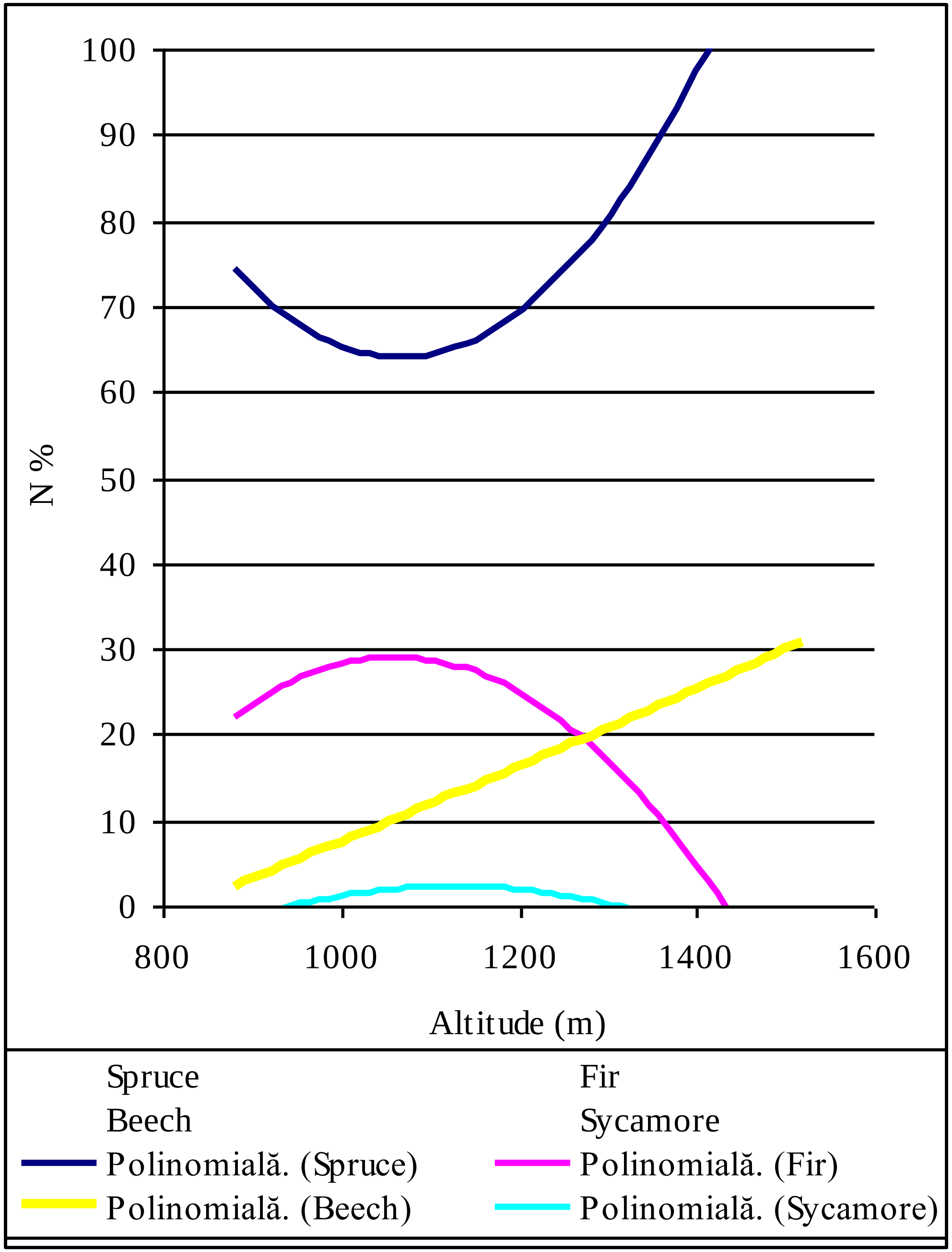

**BEECH**
**has VID indices lower than silver fir with maximum 100-150 at 1100-1200m altitudes**

**VID Beech = -147 + 0,167Alt. + 2,35Exp. + 0,09Incl (Rm = 0,274)**

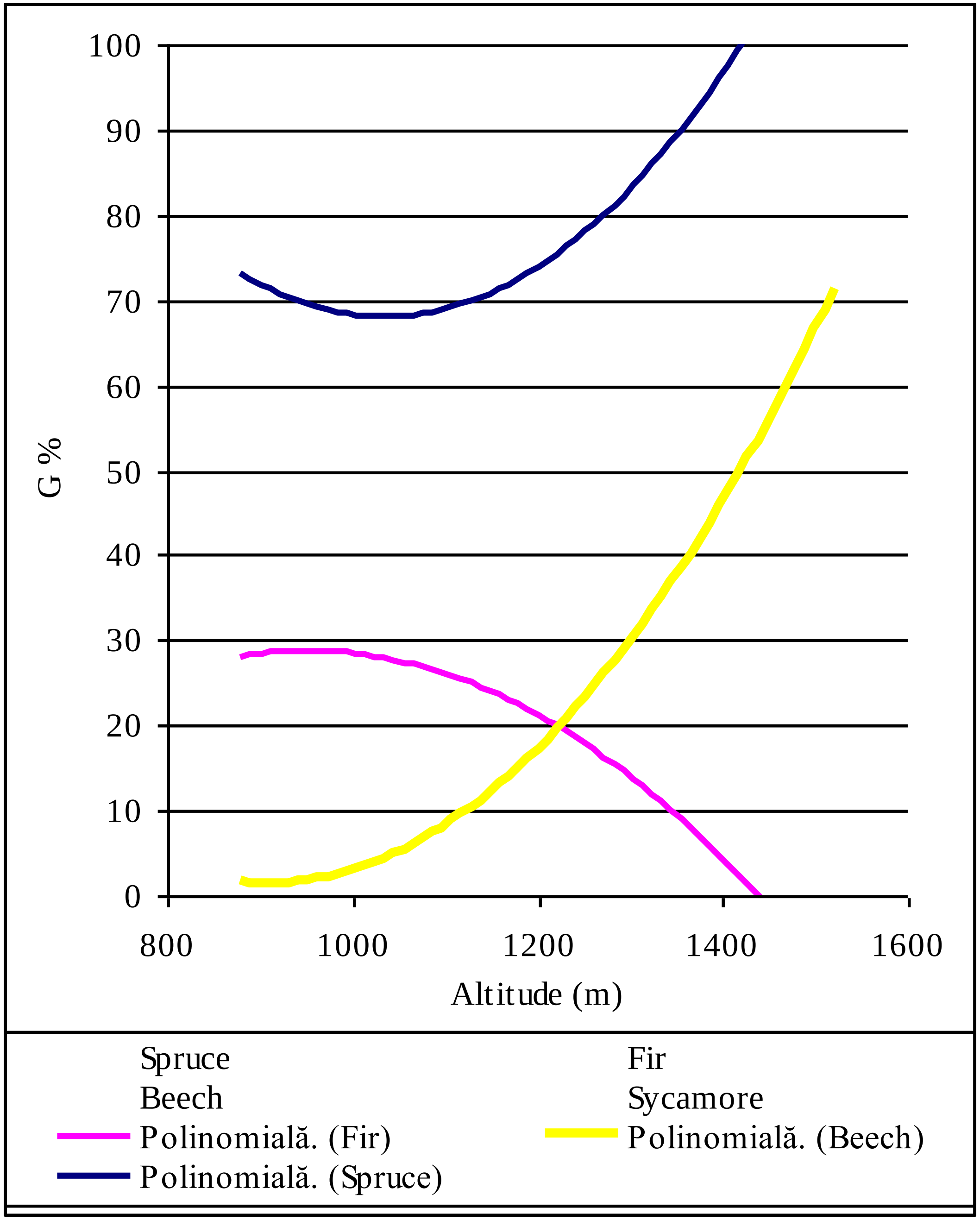



**SYCAMORE register generally low values (≤100) of VID index at 1100-1200m like the beech**

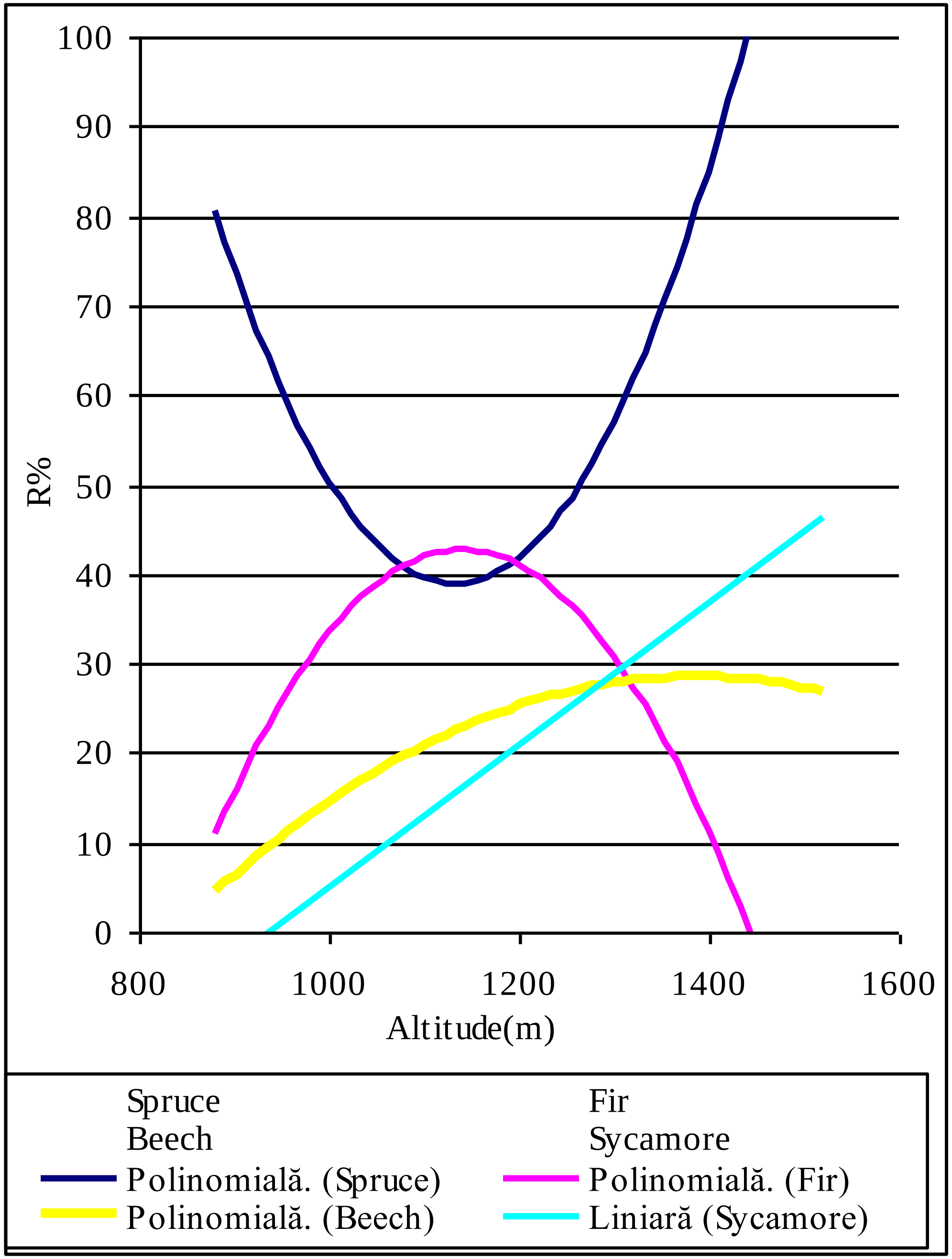
**VIDSycamore= -59,34 + 0,07Alt. – 0,40Exp. + 0,007Incl (Rm = 0, 165)**




# Frequency in relation with altitude of number (N) of Spruce, Fir, Beech and Sycamore in Dorna Basin

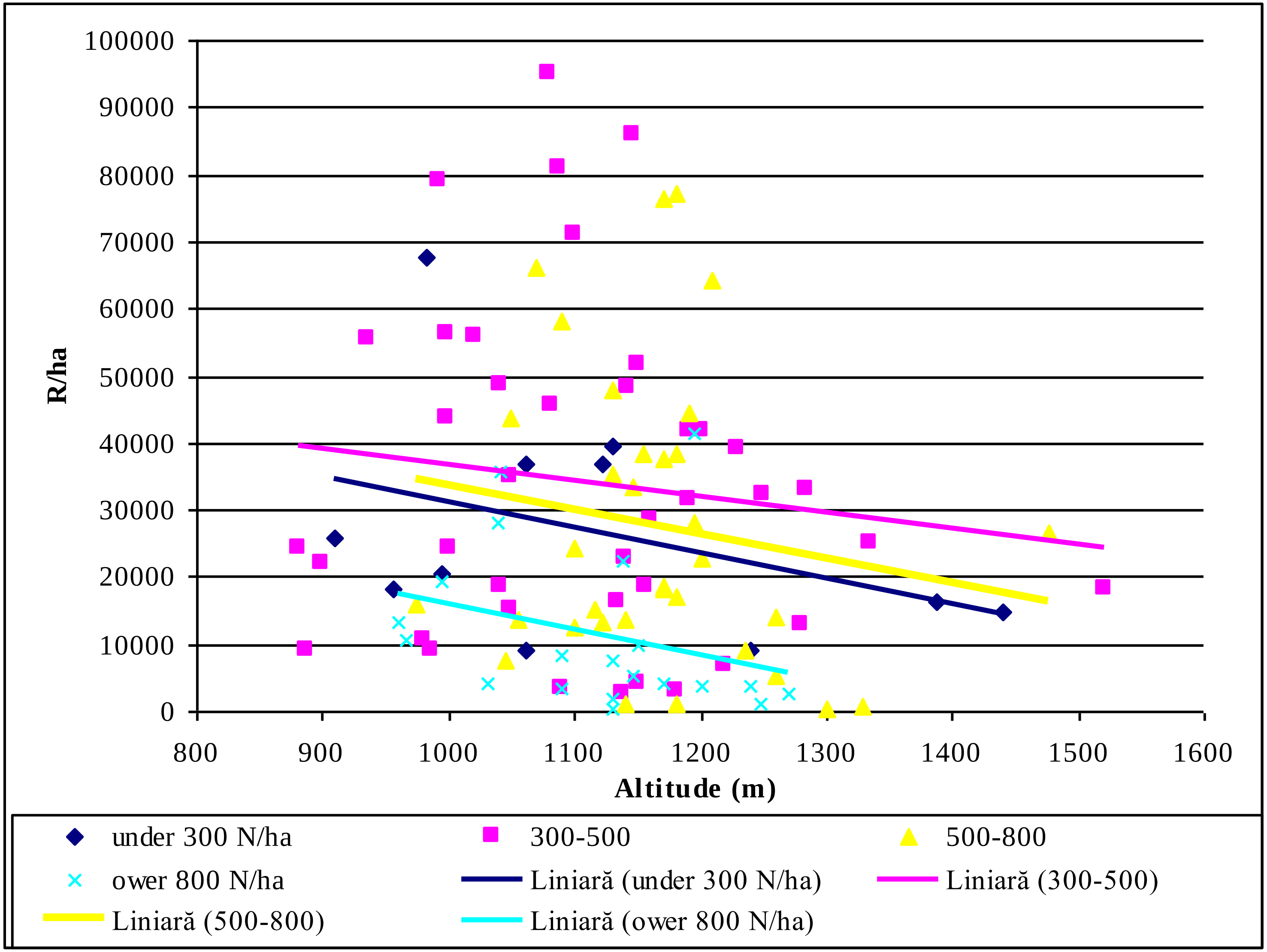



**Frequency in relation with altitude of basal area (G) of Spruce, Fir, Beech and Sycamore in Dorna Basin**

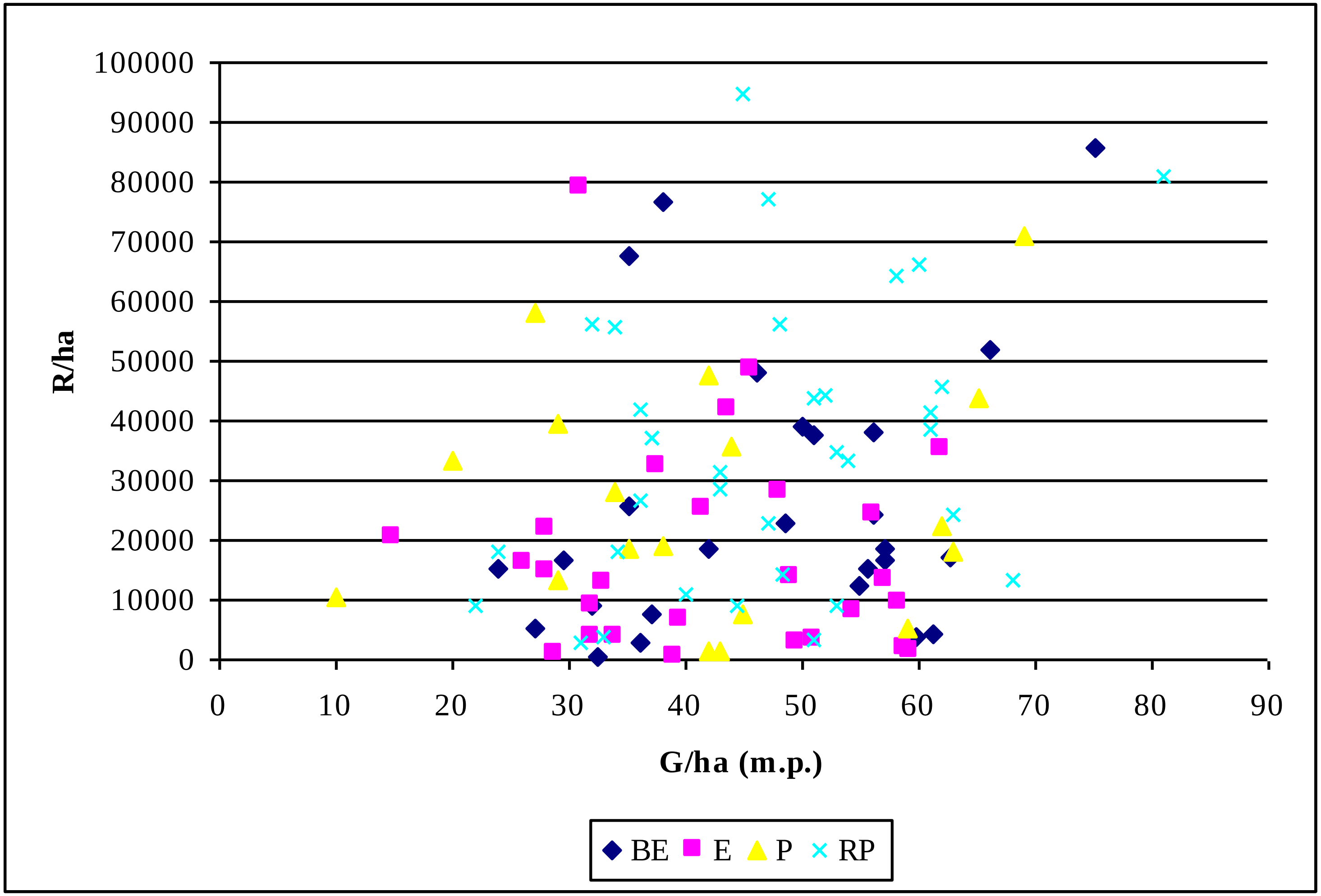



# Frequency in relation with altitude regeneration (R) of Spruce, Fir, Beech and Sycamore in Dorna Basin

# Distribution of the density of natural regeneration in relation with altitude and of the density classes old stand



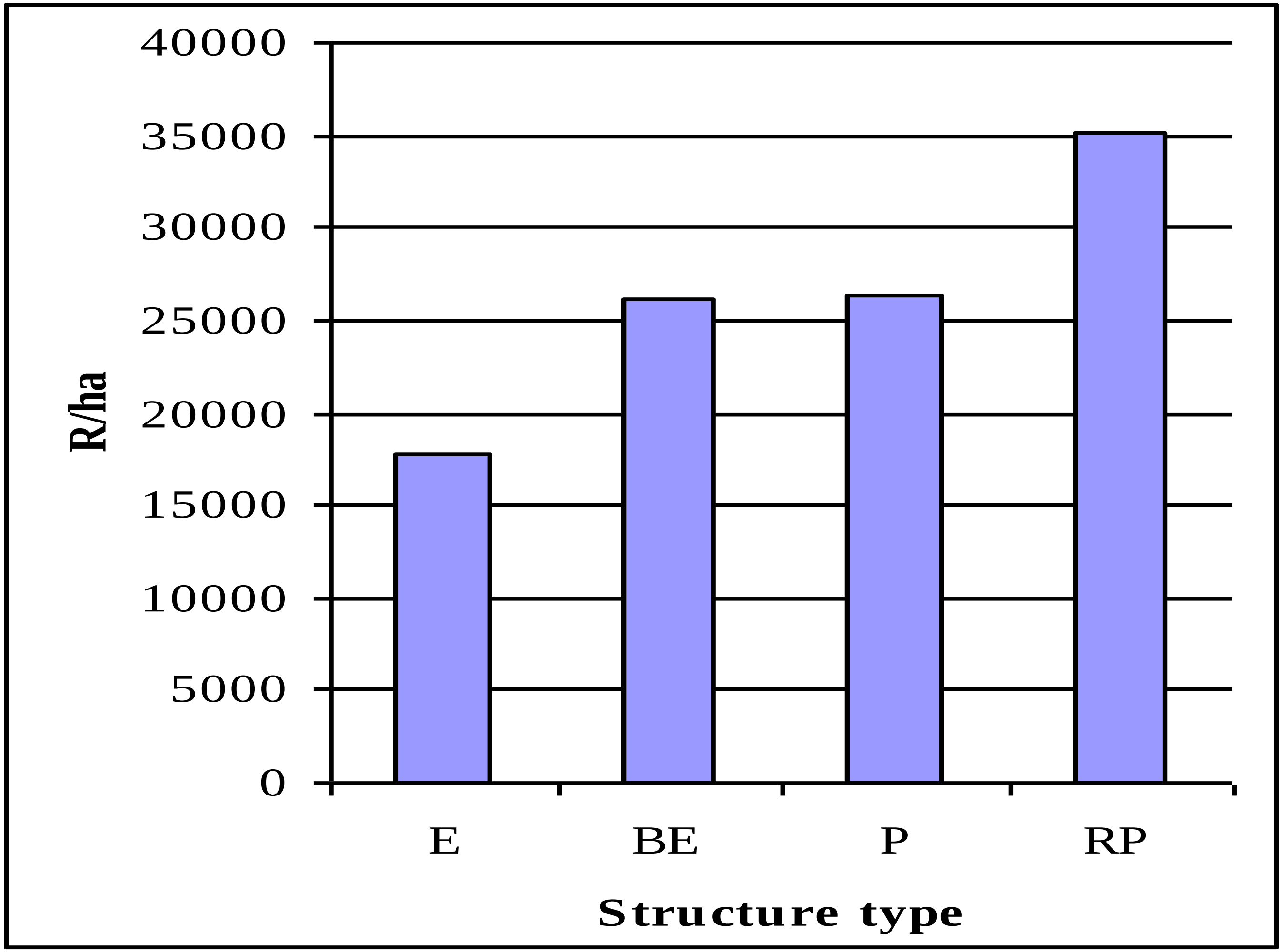
# Relations between basal area (G) of the mature stands, type of structure and the natural regeneration density




E – evenaged; RE – relatively evenaged

P – unevenaged; RP – relatively unevenaged

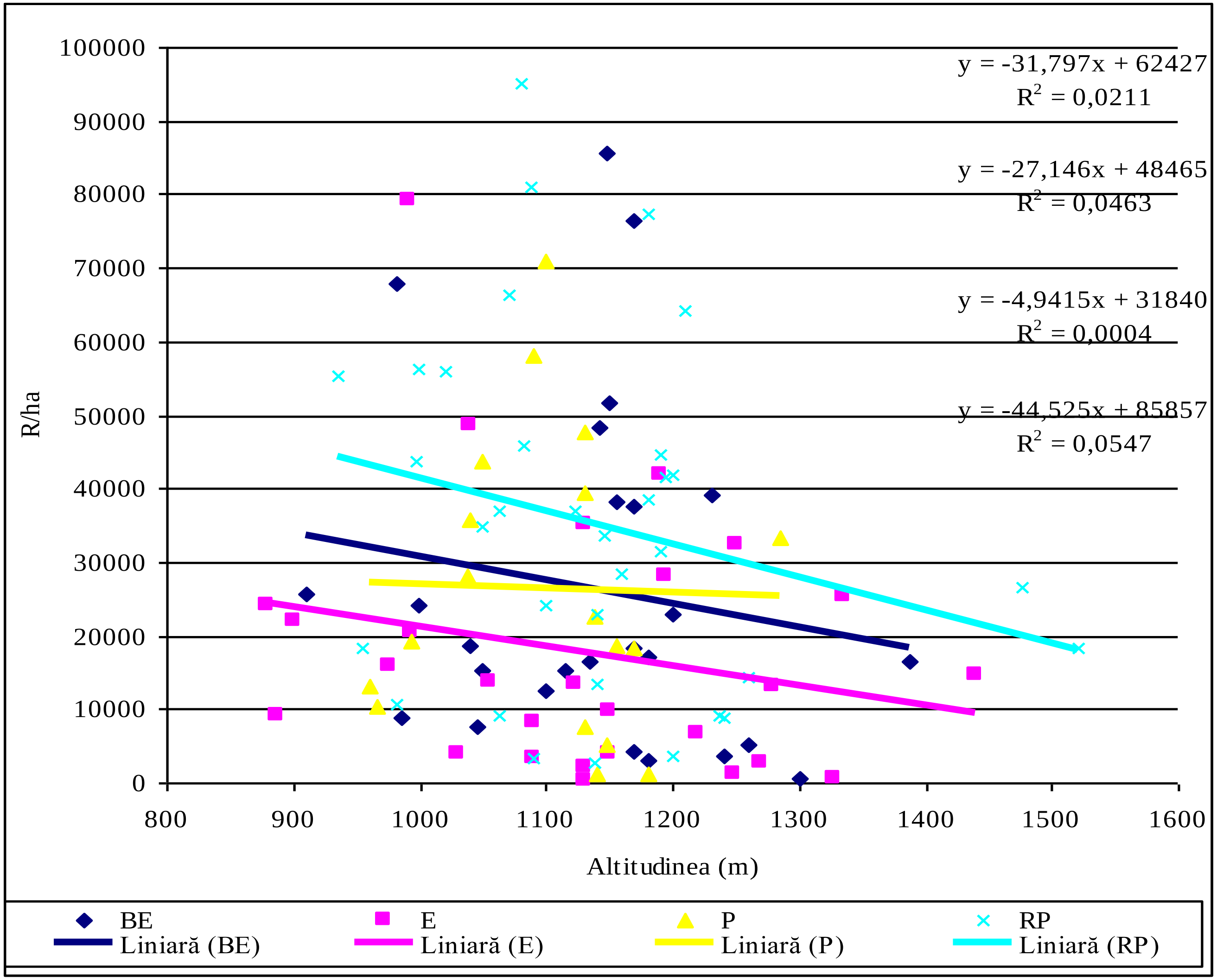
# Mean density of natural regeneration in mature stands with different structure type




E – evenaged; RE – relatively evenaged

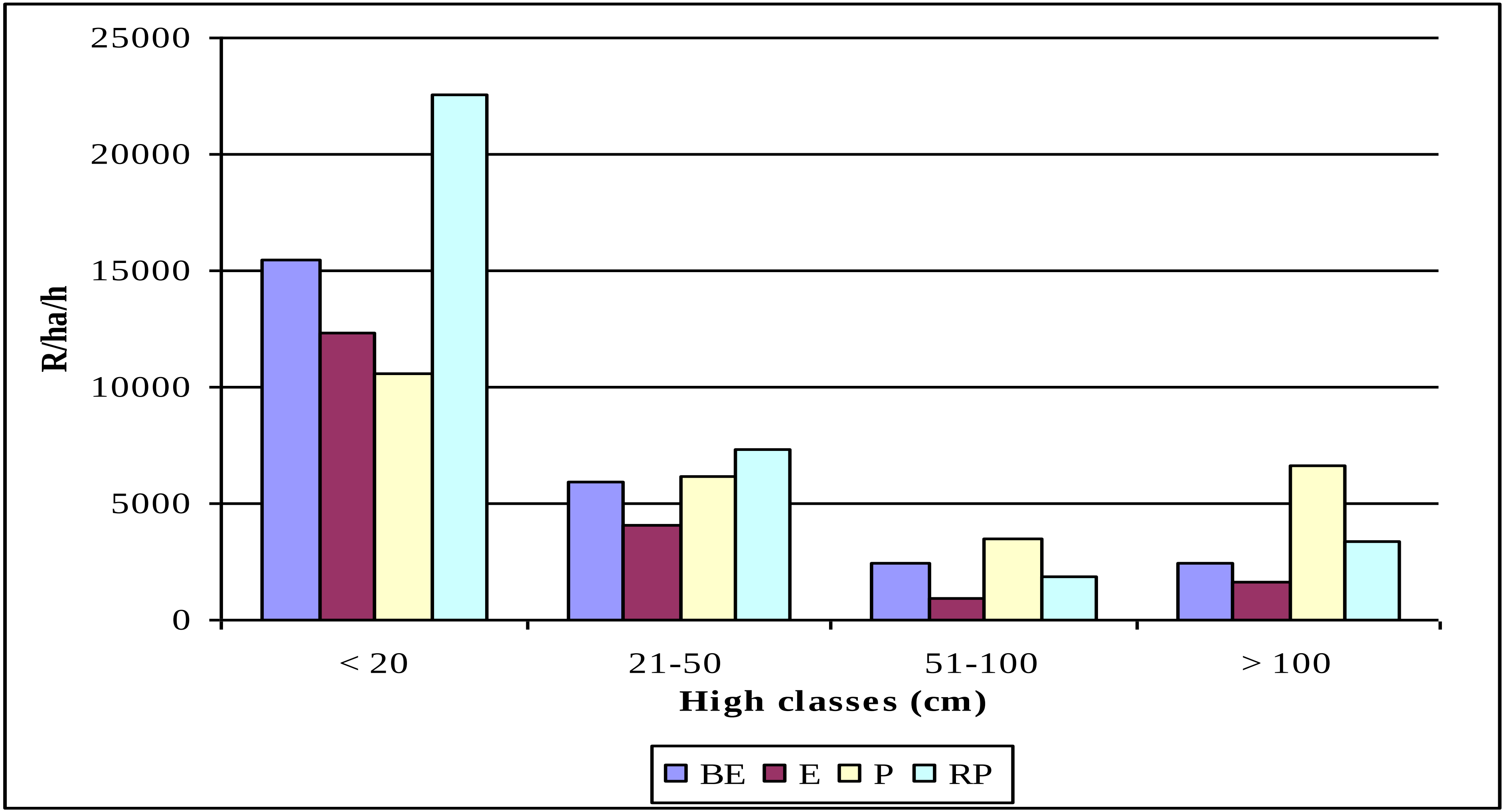
P – unevenaged; RP – relatively unevenaged

# Influence of the altitude and of the structural type of stand on the density of natural regeneration (R/ha) in the Dorna Basin



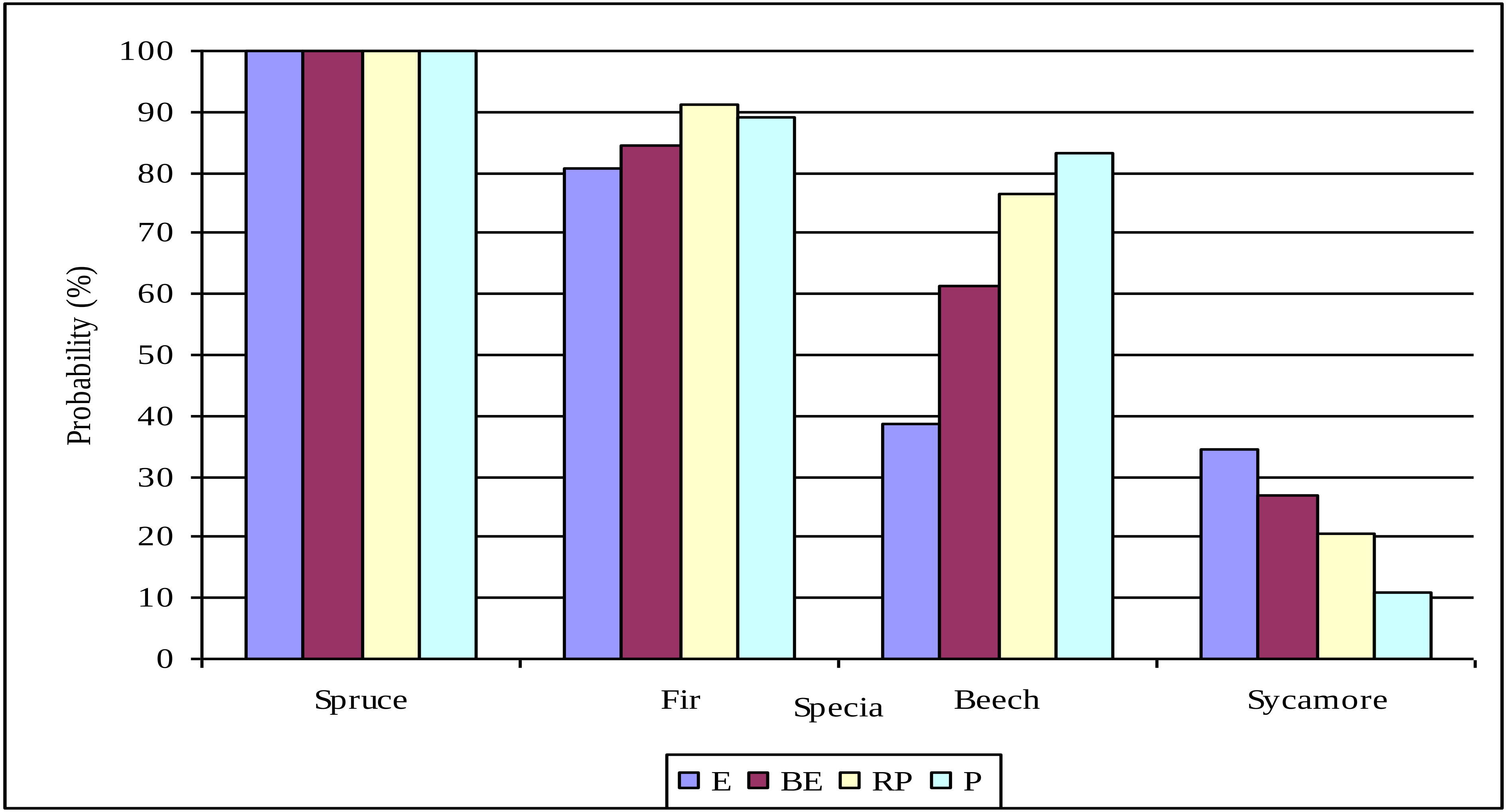

E – evenaged; RE – relatively evenaged; P – unevenaged; RP – relatively unevenaged

# Frequency of the natural regenerated seedlings on different high classes in relation with the structural types of the old stands



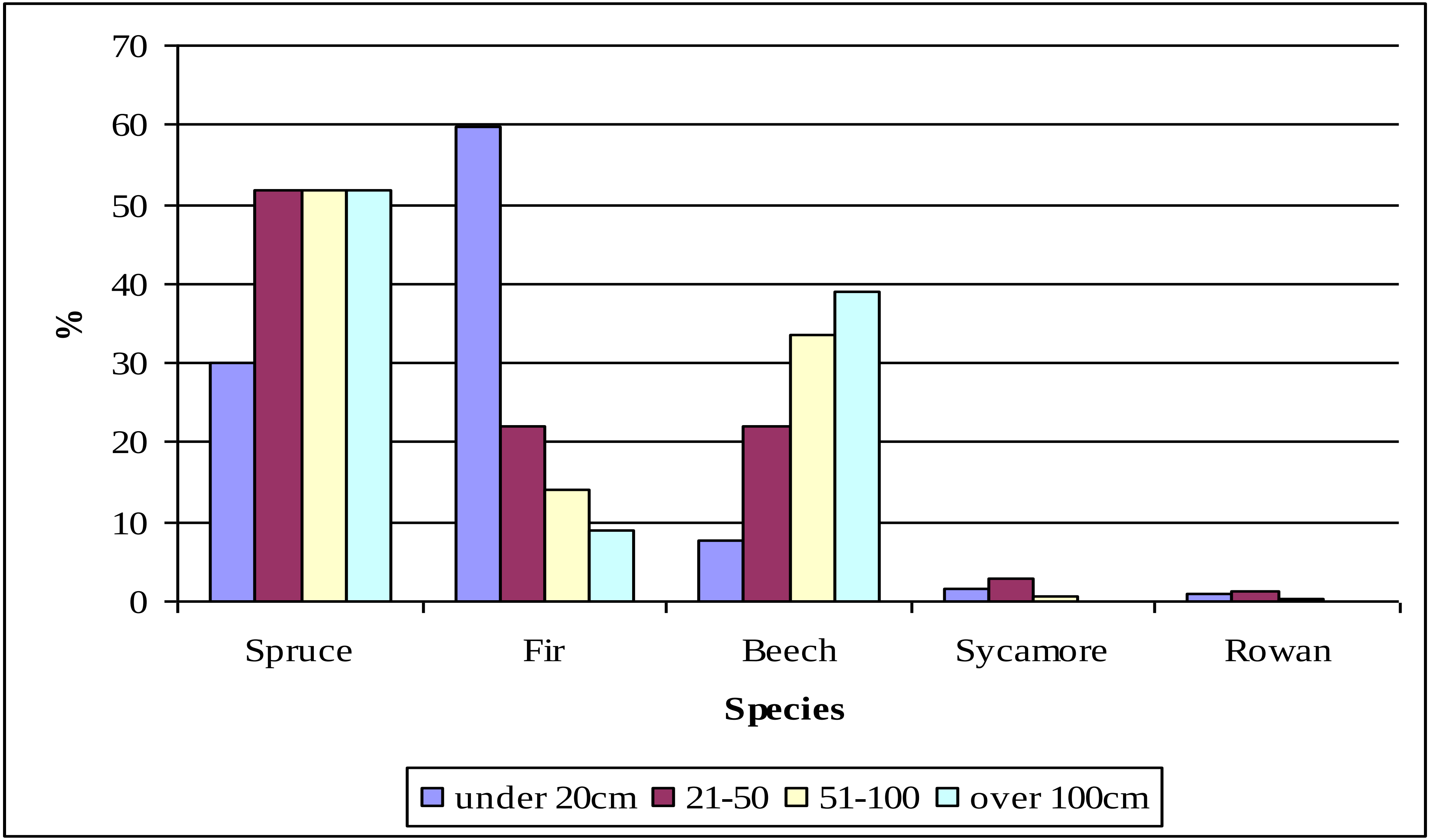

E – evenaged;  RE – relatively evenaged; P – unevenaged; RP – relatively unevenaged

# Probability of occurrence of the tree species in the natural regeneration cohorts in relation with the structural type of the stand




E – evenaged; RE – relatively evenaged; P – unevenaged; RP – relatively unevenaged

# Comparison between the relative proportion (%) of the species in the regenerations cohorts, according with height classes



**According with most of the scenarios of climate changes at the end of 21 century the temperature will increase with 2 …4 degree C, precipitations will change in their seasonal distribution. Consequently the storm damages and the forest fires and drought episodes will increase for the same periods.**

## Responses of the ecophysiological and autecological to some climatic parameters

| Processes | Temperature | Precipitations | | Storm frequency | Drought frequency |
|---|---|---|---|---|---|
| | + | + | - | + | + |
| Seed productions | ± | ± | - | - | - |
| Seed dispersal | 0 | ± | ± | + | - |
| Seed germination | + | + | - | ? | - |
| Seedling establishment | ± | + | - | + | - |
| Seedling growth | ± | + | - | + | - |

Possible response: + increase; 0 no change; - decrease

**The main meteo-climatic factors can have opposite action on different processes take into consideration. For the production of seeds temperature can be favorable but a high temperature and a drought can induce important losses in the seed production and survival of the seedlings. Precipitations and light (after storm damages) can favorise the growth and survival of the sapling.**

**For each tree species an detailed analysis can put in evidence advantages and disadvantages in relation with other competitive species. High variability of the climatic condition are difficult to be modeled in relation to the ecological exigencies of the trees.**

**Seedlings and saplings are sensitive to light (after disturbing factors which produce gaps in the old stand) and react rapidly, but also are very sensitive to drought and extreme temperatures. Seedlings are also concurrenced by herbaceous species and by browsing.**

**Analysis of the capacity of seedlings to achieve different heights to escape the concurrence of herbs (ex. 0.5…1m) or to browsing (1…2m) can offer other scales for the forecast of the future composition of stands. Only the survivors are candidates for the future stands, and can be take into consideration.**

The influence of the antropic activity on the actual composition of the forests were good documented in the lastdecades(Ichim, R., 1988, 1991;Geambasu, N., 1994, 1996; Barbu, I., Barbu, C., 2005).The actual shift at the broadleaves at high altitudes is in great part a recolonisation of the ecological niches in which this species were dominated by the planted spruce stands.

It is assumed that large spatial extents are associated with coarse data resolution and small extents with fine data resolutions.

# Scheme showing how different factors may affect the distribution of the species at various spatial scales

| | Scale | | | | | |
|---|---|---|---|---|---|---|
| Site parameters | Global >1000 km | Regional 10-1000km | Landscape 5-100km | Local 1000-5000m | Site 100-1000m | Microsite 100m |
| Climate | | | | | | |
| Topo-climate | | | | | | |
| Relief | | | | | | |
| Soil type | | | | | | |
| Biotic interactions | | | | | | |

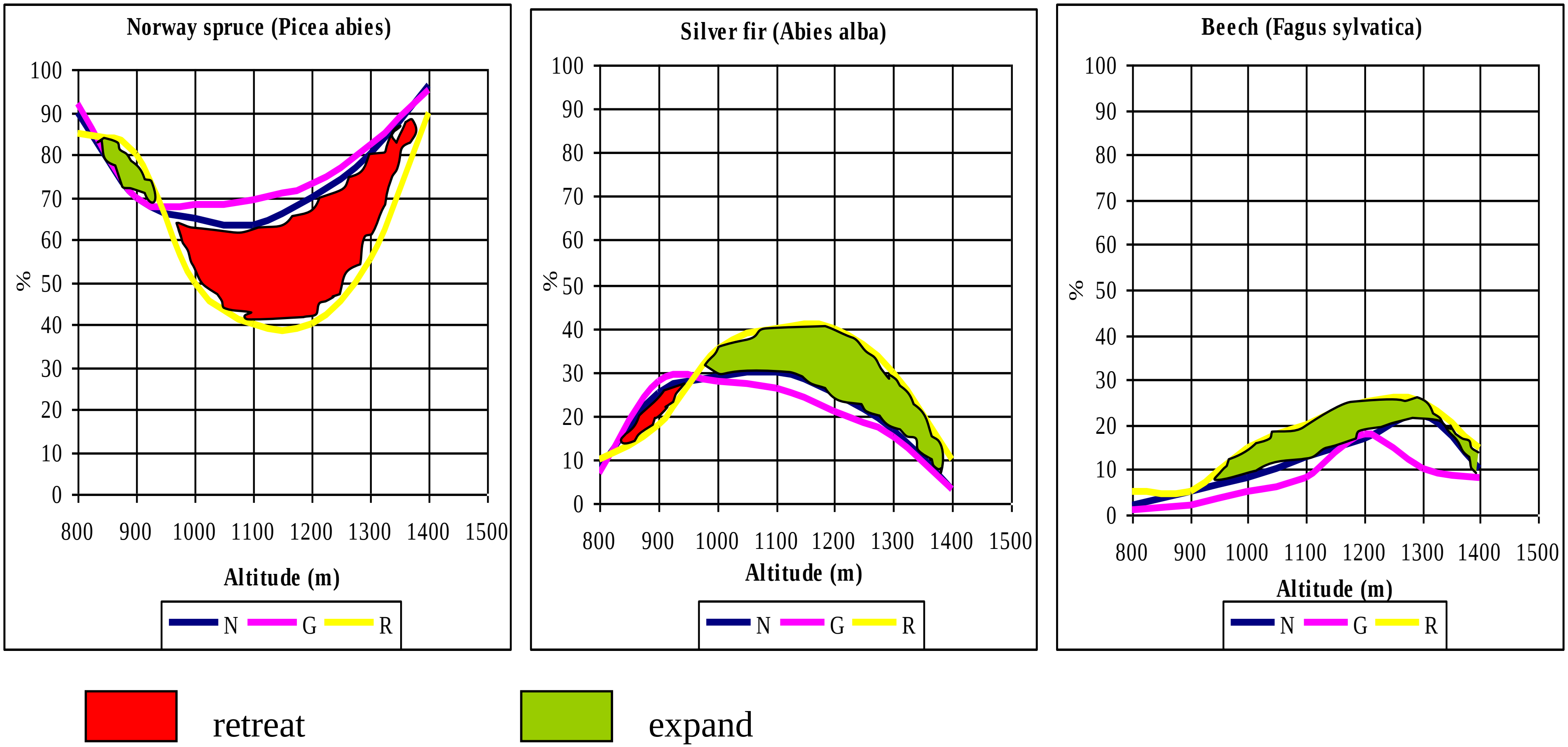
# CONCLUSIONS

- **The study investigated the change in the composition of the future forests in an area dominated by Norway spruce stands, on the ground of the trends observed in the natural regeneration, with consequent needs to adapt the management to climate change.**

- **Analysis put in evidence important changes in the composition of the natural regeneration in comparison with the old stands.**

- **The mean density of natural regeneration (over 3 years or over 20cm height) were 27300 plants/ha. Including also the seedlings of 1-3 years the number of individuals increase to 96200 plants/ha.**

# Trends in the frequency of tree species in regeneration strata in comparison with the frequency in the old stands in relation with altitude in Dorna Bassin




N - frequency in number - old stand
G - frequency in basal area - old stand
R - frequency in regeneration (new stand)

# CONCLUSIONS

- **Density of natural regeneration reach maximal values at basal area of the old stand 30-50m2/ha and a density of trees of 200-400 N/ha.**

- **With the openness of the canopy, the density of natural regeneration regress as result of the increased competition with herbaceous strata.**

- **Mean height of natural regeneration differ according with the species and the light availability.**

- **Browsing by dear was found an important factor for the elimination of  Silver fir and Sycamore from the natural regeneration cohorts over 1m height**

# CONCLUSIONS

- **Stand clearings by storms accelerate the installation and the development of natural regeneration and increase the nonhomogenous structures to a mosaic-like structures. Using the spots of regeneration after the wind damages can be a good chance for improving the structure of the future stands, mainly in the protected areas (National Parks etc.).**

- **In the last century the Norway spruce were artificial extended through plantations and  artificial seeding not only in the spruce type forests but also in the mixed forests.**

- **Reducing area of new planted stands favorised the gap regeneration of the pure spruce stands with sensitive species (*A. alba*, *Fagus sylvatica*, *Acer pseudoplatanus*).**

# CONCLUSIONS

- **Dominance of the Norway spruce remain in the large areas damaged by wind with succession through pioneers species.**

- **Observed changes can reduce the quantity of industrial wood but increase the stability of stands to wind and also improve the nutrient balance in the soils.**

- **For the studied region, the use of the natural regeneration in gaps can reduce with 25-70% the costs of regeneration.**


THANK YOU !