

## Introduction

- Romanian forests are situated mainly in the Carpathian Mountains (approx. 65%), while hills and especially plains are covered by much smaller areas of forests.

- Beech (*Fagus sylvatica* L.), spruce (*Picea abies* L. Karst) and oak species (*Quercus* sp.) constitute approximately 70% of Romanian forest habitats (of which 30% is beech), summing up around 4 mil. ha.

- The nutritional state of trees is often indicative of processes at the ecosystem level thus, sampling and analysis of needles and leaves is essential in monitoring forest health.

## Plots location and description

Plots area: 2500 m

Coordinates:

Fundata FAG: N 45° 25' 59" E 25° 16' 11"

Mihaesti GORUN: N 45° 01' 57" E 24° 59' 33"

Stefanesti STEJAR: N 44° 30' 34" E 26° 10' 38"

Predeal MOLID: N 43° 30' 25" E 25° 35' 21"

Altitude:

Fundata FAG: 1300 m

Mihaesti GORUN: 500 m

Stefanesti STEJAR: 86 m

Predeal MOLID: 1185 m

Main species:

Fundata FAG: European beech (*Fagus sylvatica*)

Mihaesti GORUN: sessile oak (*Quercus petraea*)

Stefanesti STEJAR: pedunculate oak (*Q. robur*)

Predeal MOLID: Norway spruce (*Picea abies*)

Age:

Fundata FAG: 57 years

Mihaesti GORUN: 69 years

Stefanesti STEJAR: 68 years

Predeal MOLID: 100 years

## Methodology

- Sampling was done every two years during the second half of the growing season (August - September).
- A composite sample was made by mixing (dried) equal quantities of each of the 5 samples per plot.
- Leaves and needles were dried at  $\leq 70^\circ\text{C}$ , then grinded.
- Powder for determining moisture content was dried at  $105^\circ\text{C}$ .
- Analytical determination methods used were ICP-AES for P, Ca, Mg and K (using Perkin Elmer Optima 2100), and element-analyzer (using Leco TRUSPEC) for C, N, S.
- Standard QA/QC was implemented and data was validated through inter-laboratory ring tests.
- Spearman's rank-order coefficient was used to correlate the mean annual temperature (T), precipitation (P), and De Martonne aridity index (Ia) with the foliar nutrition values.

## Conclusions

- The K deficit in both plots (2011 - 2013 period) highlights a disturbance in the assimilation process possibly due to decreased precipitations.
- The negative trend in the beech N nutrition is correlated with the increase of mean annual temperatures in the past 5 years.
- Climate change forecasts for Romania indicate an increase of the mean temperatures especially in the south of the country, affecting mostly oak stands, but also the lower altitude beech and spruce stands.

## Results

Chemical element concentrations and climate factors correlations

Spruce	Nutrition - Chemical elements (mg/g)						Climate factors		
	N	S	P	Ca	Mg	K	T (°C)	P (mm)	Ia
1993	12,74	0,99	1,48	4,66	1,35	6,06	4,3	776,08	54,27
1995	13,89	1,07	1,48	4,86	1,23	6,65	4,52	986,58	67,94
1997	13,19	0,93	1,48	4,42	1,3	5,72	3,92	994	71,40
2013	11,85	1	1,17	6,13	1,02	3,89	6,04	864,68	53,90
2015	12,58	1,06	0,89	5,68	0,83	6,03	6,69	874,3	52,38

  

Beech	Foliar nutrition - Chemical elements (mg/g)						Climate factors		
	N	S	P	Ca	Mg	K	T (°C)	P (mm)	Ia
1993	21,39	1,86	1,8	8,76	1,4	7,64	4,00	740,65	52,92
1995	20,81	2,02	1,36	11,34	1,8	8,35	4,31	538,22	37,62
1997	28,42	2,89	1,38	12,11	2,43	12,33	3,66	608,34	44,54
2011	26,58	0,244	2,16	1,14	2,91	1,81	5,33	543,3	35,44
2013	12,74	2,1	1,6	2,64	2,18	2,77	6,34	694,1	42,48
2015	28,6	2	1,2	14,45	1,39	9,48	6,54	833,30	50,38

BEECH	N	S	P	Ca	Mg	K	T (°C)	P (mm)	Ia
N	1,000000	-0,240952	-0,278926	0,452948	-0,224289	0,609504	-0,093407	0,371429	0,3142
S	-0,240952	1,000000	-0,029990	0,094720	0,138645	0,156153	0,024759	-0,085714	0,0857
P	-0,278926	-0,029990	1,000000	-0,600828	0,766925	-0,163223	0,082418	-0,200000	-0,2571
Ca	0,452948	0,094720	-0,600828	1,000000	-0,404553	0,562565	-0,107438	0,371429	0,5428
Mg	-0,224289	0,138645	0,766925	-0,404553	1,000000	-0,179845	0,038462	-0,657143	-0,7142
K	0,609504	0,156153	-0,163223	0,562565	-0,179845	1,000000	-0,263736	0,200000	0,4857
T (°C)	-0,093407	0,024759	0,082418	-0,107438	0,038462	-0,263736	1,000000	0,371429	-0,1428
P (mm)	0,371429	-0,085714	-0,200000	0,371429	-0,657143	0,200000	0,371429	1,000000	0,8285
Ia	0,314286	0,085714	-0,257143	0,542857	-0,714286	0,485714	-0,142857	0,828571	1,0000

  

SPRUCE	N	S	P	Ca	Mg	K	T (°C)	P (mm)	Ia
N	1,000000	-0,172085	0,645018	-0,522829	0,023256	0,509839	-0,313059	0,176944	0,1501
S	-0,172085	1,000000	0,054299	0,664489	-0,654818	0,087160	0,281594	-0,107156	-0,2053
P	0,645018	0,054299	1,000000	-0,458427	0,139122	0,520351	-0,601656	-0,068596	0,1028
Ca	-0,522829	0,664489	-0,458427	1,000000	-0,393912	-0,658908	0,531782	-0,135957	-0,1484
Mg	0,023256	-0,654818	0,139122	-0,393912	1,000000	0,191413	-0,373882	0,155496	0,3395
K	0,509839	0,087160	0,520351	-0,658908	0,191413	1,000000	-0,389982	0,148347	0,0893
T (°C)	-0,313059	0,281594	-0,601656	0,531782	-0,373882	-0,389982	1,000000	-0,092940	-0,4289
P (mm)	0,176944	-0,107156	-0,068596	-0,135957	0,155496	0,148347	-0,092940	1,000000	0,8642
Ia	0,150134	-0,205382	0,102894	-0,148480	0,339589	0,089366	-0,428955	0,864286	1,0000

