

# Trends of pollutants concentrations and fluxes in depositions and soil solution in Romania

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# Introduction

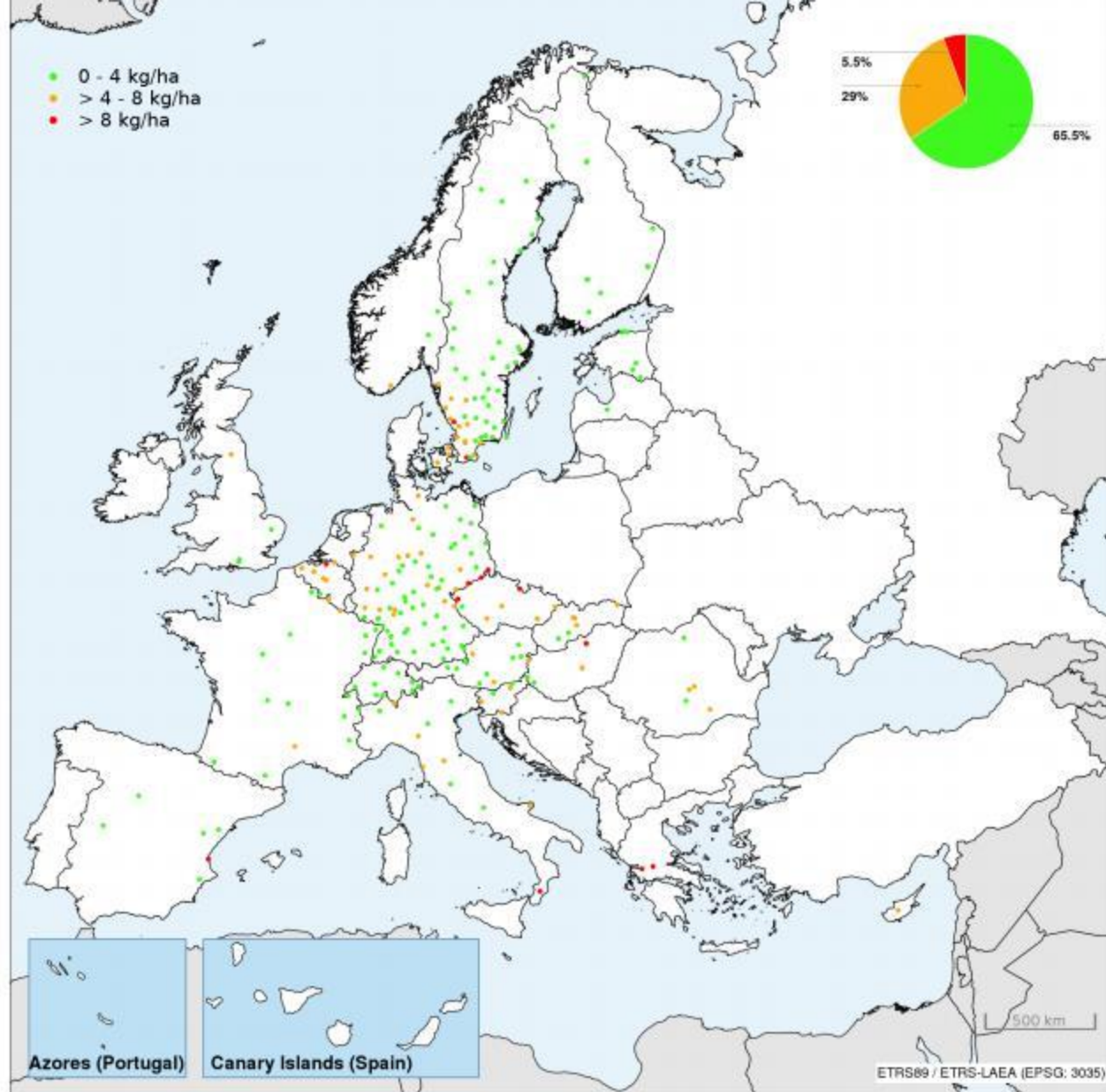
- In the framework of the ICP Forests, deposition and soil solution are monitored in Romania since 1998, at four level II plots, in order to establish the trends and correlation with other factors that can affect the forest health.

## Level II plots characteristics

<b>Nr.</b>	<b>Plot name</b>	<b>Longitude</b>	<b>Latitude</b>	<b>Altitude</b>	<b>Main forest species</b>
<b>1.</b>	<b>Rarau</b>	<b>25.32.11</b>	<b>47.28.34</b>	<b>1100</b>	<b>Spruce</b>
<b>2.</b>	<b>Fundata</b>	<b>25.16.11</b>	<b>45.25.59</b>	<b>1461</b>	<b>Beech</b>
<b>3.</b>	<b>Mihaiesti</b>	<b>24.59.33</b>	<b>45.01.47</b>	<b>573</b>	<b>Holm-oak</b>
<b>4.</b>	<b>Stefanesti</b>	<b>26.10.00</b>	<b>44.31.00</b>	<b>90</b>	<b>Oak</b>

# Processing data of deposition and soil solution

- In the present study, the SAS – Skript was used to select parallel sampling for the period 1998-2000 (when three type of collectors were used) and interpolate to monthly data. The Partial Mann-Kendall tests were applied to the monthly data using the R package ,rkt‘ written by Aldo Marchetto.



**Figure 5-4: Throughfall deposition of sulfate-sulfur ( $\text{kg SO}_4^{2-}\text{-S ha}^{-1} \text{yr}^{-1}$ ) measured in 2015 on the ICP Forests Level II plots and the Swedish Throughfall Monitoring Network**

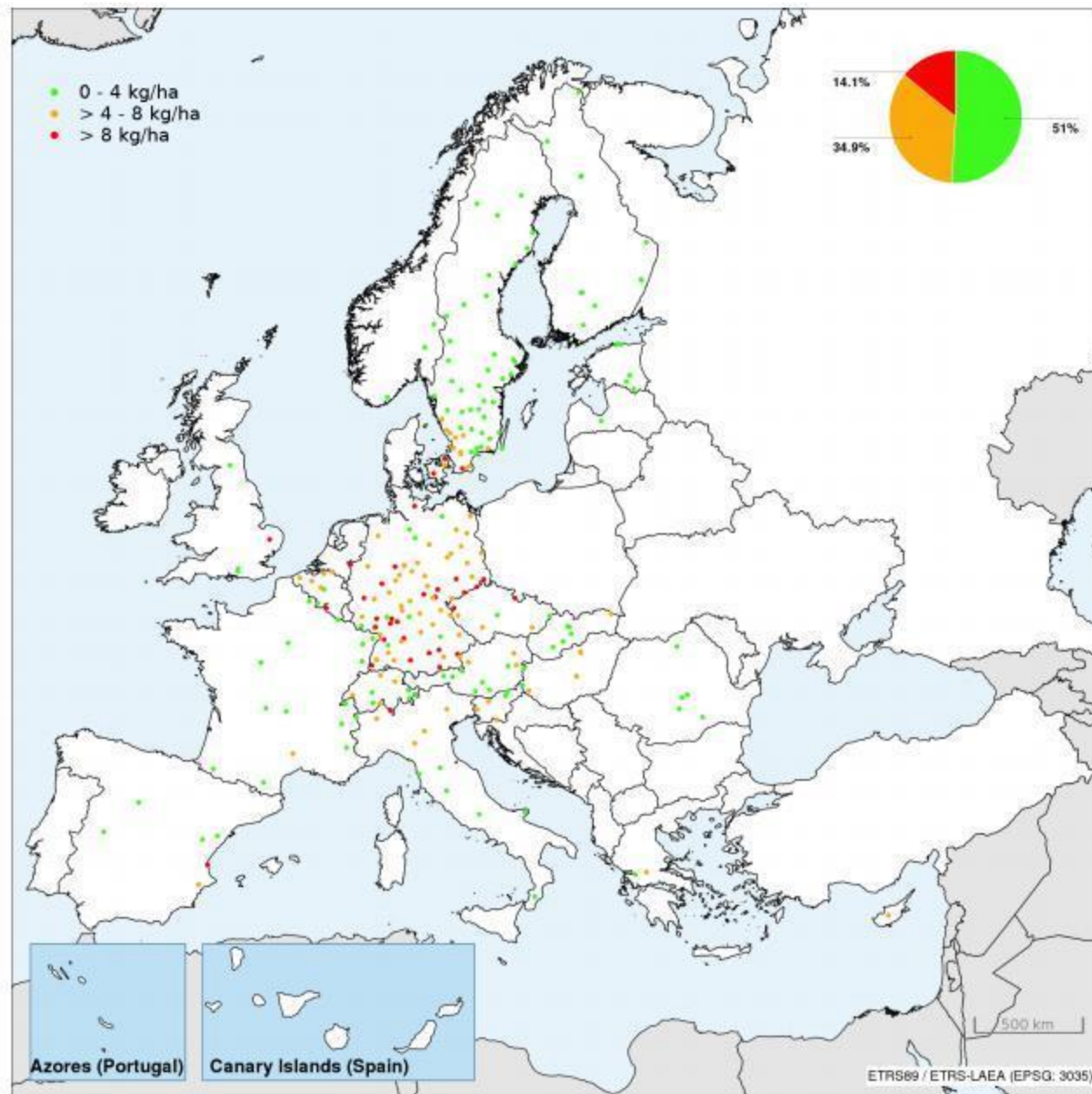


Figure 5-2: Throughfall deposition of nitrate-nitrogen ( $\text{kg NO}_3\text{-N ha}^{-1} \text{ yr}^{-1}$ ) measured in 2015 on the ICP Forests Level II plots and the Swedish Throughfall Monitoring Network

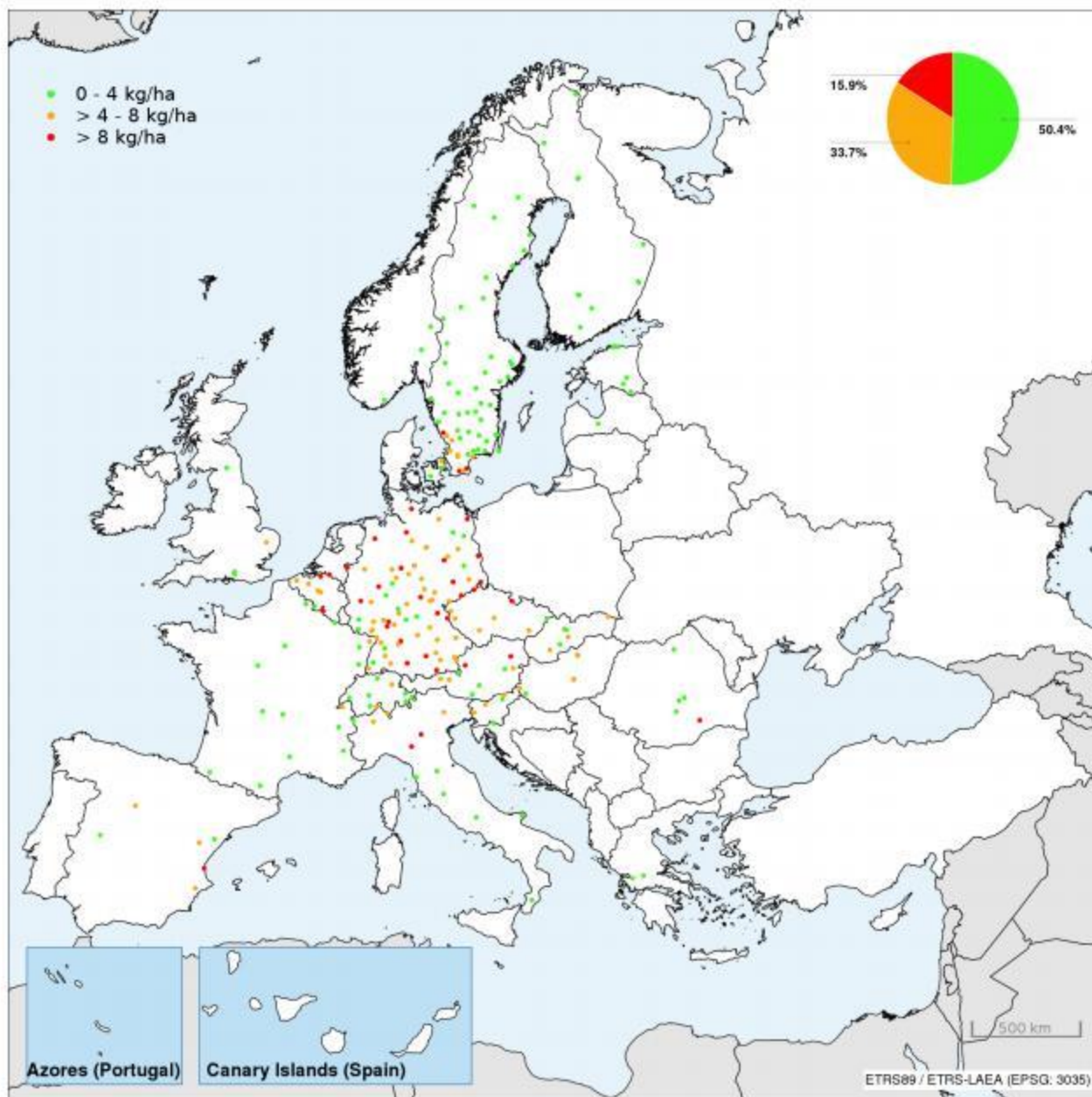


Figure 5-3: Throughfall deposition of ammonium-nitrogen ( $\text{kg NH}_4^+\text{-N ha}^{-1} \text{ yr}^{-1}$ ) measured in 2015 on the ICP

# Trends of sulphur and nitrogen compounds concentrations in bulk deposition for the period 1998-2016

Plot	Compound	Mean (monthly) mg/l	Trend	p	slope	rslope
Fundata	N_NH4	0,67	-2	0	- 0,0417	-0,0623
Mihaesti	N_NH4	1,11	-2	1,96E-12	- 0,0422	-0,0381
Rarau	N_NH4	0,53	-2	0	- 0,0360	-0,0677
Stefanesti	N_NH4	3,70	-2	7,58E-05	- 0,0627	-0,0169
Fundata	N_NO3	0,30	-2	5,14E-05	- 0,0084	-0,0284
Mihaesti	N_NO3	0,32	-2	0,048061	- 0,0052	-0,0163
Rarau	N_NO3	0,27	-1	0,101739	- 0,0026	-0,0097
Stefanesti	N_NO3	1,06	-2	3,21E-09	- 0,0360	-0,0338
Fundata	S_SO4	1,05	-2	0	- 0,0554	-0,0527
Mihaesti	S_SO4	1,86	-2	0	- 0,0950	-0,0511
Rarau	S_SO4	0,73	-2	0	- 0,0340	-0,0464
Stefanesti	S_SO4	2,73	-2	8,77E-14	- 0,1054	-0,0386

- 2: significant decreasing trend ( $p < 0,05$ ); negative slope
- 1: decreasing trend, not significant ( $p > 0,05$ ); negative slope
- 1: increasing trend, not significant ( $p < 0,05$ ); positive slope
- 2: significant increasing trend ( $p > 0,05$ ); positive slope



# Trends of sulphur and nitrogen compounds concentrations in throughfall for the period 1998-2016

Plot	Compound	Mean (monthly)(mg/l)	Trend	p	slope	rslope
Fundata	N_NH4	0,86	-2	4,04E-10	-0,0365	-0,0423
Mihaesti	N_NH4	2,35	-2	0	-0,1459	-0,0622
Rarau	N_NH4	1,04	-2	0	-0,0572	-0,0552
Stefanesti	N_NH4	2,69	-2	3,62E-06	-0,0739	-0,0274
Fundata	N_NO3	0,51	-1	0,621585	-0,0013	-0,0025
Mihaesti	N_NO3	0,77	-2	0,001498	-0,0115	-0,0151
Rarau	N_NO3	0,44	-2	0,003162	-0,0082	-0,0186
Stefanesti	N_NO3	1,58	-2	0,000359	-0,0266	-0,0168
Fundata	S_SO4	1,53	-2	0	-0,0693	-0,0454
Mihaesti	S_SO4	2,75	-2	0	-0,1370	-0,0498
Rarau	S_SO4	1,25	-2	1,42E-14	-0,0479	-0,0383
Stefanesti	S_SO4	4,46	-2	4,16E-10	-0,1149	-0,0258

## Trends of sulphur and nitrogen compounds fluxes in bulk deposition for the period 1998-2016

Plot	Compound	Mean (monthly) (kg/ha)	Trend	p	slope	rslope
Fundata	N_NH4	0,38	-2	0	-0,0194	-0,0504
Mihaesti	N_NH4	0,44	-2	6,91E-10	-0,0152	-0,0343
Rarau	N_NH4	0,34	-2	0	-0,0197	-0,0574
Stefanesti	N_NH4	0,90	-2	0,00194637	-0,0170	-0,0190
Fundata	N_NO3	0,16	-2	0,00120641	-0,0035	-0,0224
Mihaesti	N_NO3	0,14	-1	0,56919118	-0,0005	-0,0036
Rarau	N_NO3	0,16	-2	0,01065708	-0,0021	-0,0134
Stefanesti	N_NO3	0,37	-2	0,00110667	-0,0057	-0,0156
Fundata	S_SO4	0,61	-2	0	-0,0276	-0,0454
Mihaesti	S_SO4	0,85	-2	3,51E-11	-0,0334	-0,0391
Rarau	S_SO4	0,46	-2	0	-0,0194	-0,0421
Stefanesti	S_SO4	0,77	-2	1,18E-09	-0,0283	-0,0369

## Trends of sulphur and nitrogen compounds fluxes in throughfall for the period 1998-2016

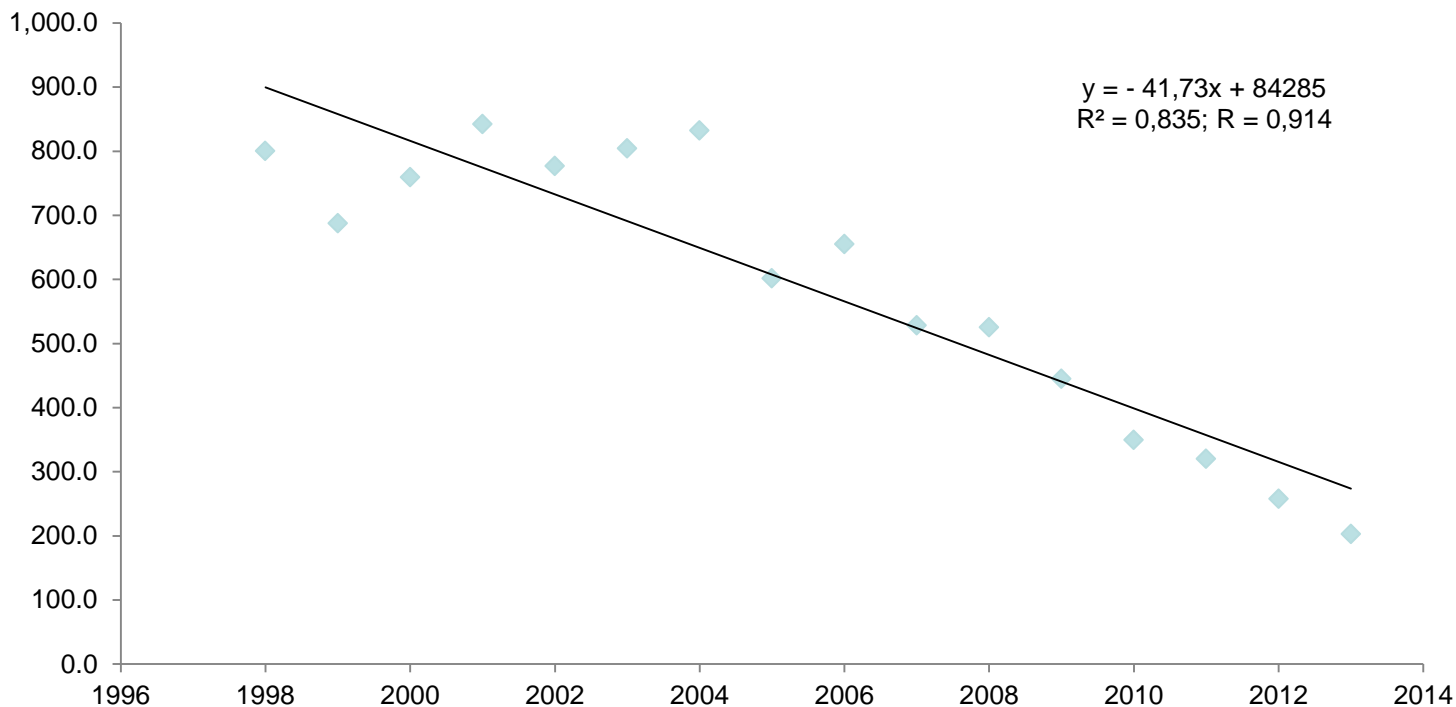
Plot	Compound	Mean (monthly) (kg/ha)	Trend	p	slope	rslope
Fundata	N_NH4	0,39	-2	3,07E-11	- 0,0128	-0,0327
Mihaesti	N_NH4	0,79	-2	2,49E-14	- 0,0408	-0,0516
Rarau	N_NH4	0,42	-2	0	- 0,0182	-0,0437
Stefanesti	N_NH4	0,65	-2	0,00127744	- 0,0126	-0,0194
Fundata	N_NO3	0,23	1	0,34410936	0,0012	0,0054
Mihaesti	N_NO3	0,30	-1	0,10442466	- 0,0023	-0,0077
Rarau	N_NO3	0,16	-2	0,00065638	- 0,0026	-0,0166
Stefanesti	N_NO3	0,40	-1	0,06419876	- 0,0041	-0,0102
Fundata	S_SO4	0,69	-2	2,22E-16	- 0,0297	-0,0431
Mihaesti	S_SO4	0,90	-2	1,39E-12	- 0,0461	-0,0510
Rarau	S_SO4	0,48	-2	3,33E-13	- 0,0181	-0,0376
Stefanesti	S_SO4	0,93	-2	7,07E-07	- 0,0273	-0,0293

# Trends of sulphur and nitrogen compounds concentrations in soil solution for the period 2000-2016

Plot	Compound	Depth	Trend	p
Fundata	N_NH4	0-10 cm	-2	0.008049304
		0-20 cm	-2	0.03564522
		0-40 cm	-2	2.614403e-07
		0-60 cm	-2	0.000201437
Fundata	N_NO3	0-10 cm	-2	0.02163806
		0-20 cm	-2	0.001197588
		0-40 cm	-2	0.008491817
		0-60 cm	-1	0.08074746
Fundata	S_SO4	0-10 cm	-2	1.931931e-08
		0-20 cm	-2	4.891711e-10
		0-40 cm	-2	6.251405e-07
		0-60 cm	-2	0.0001529874

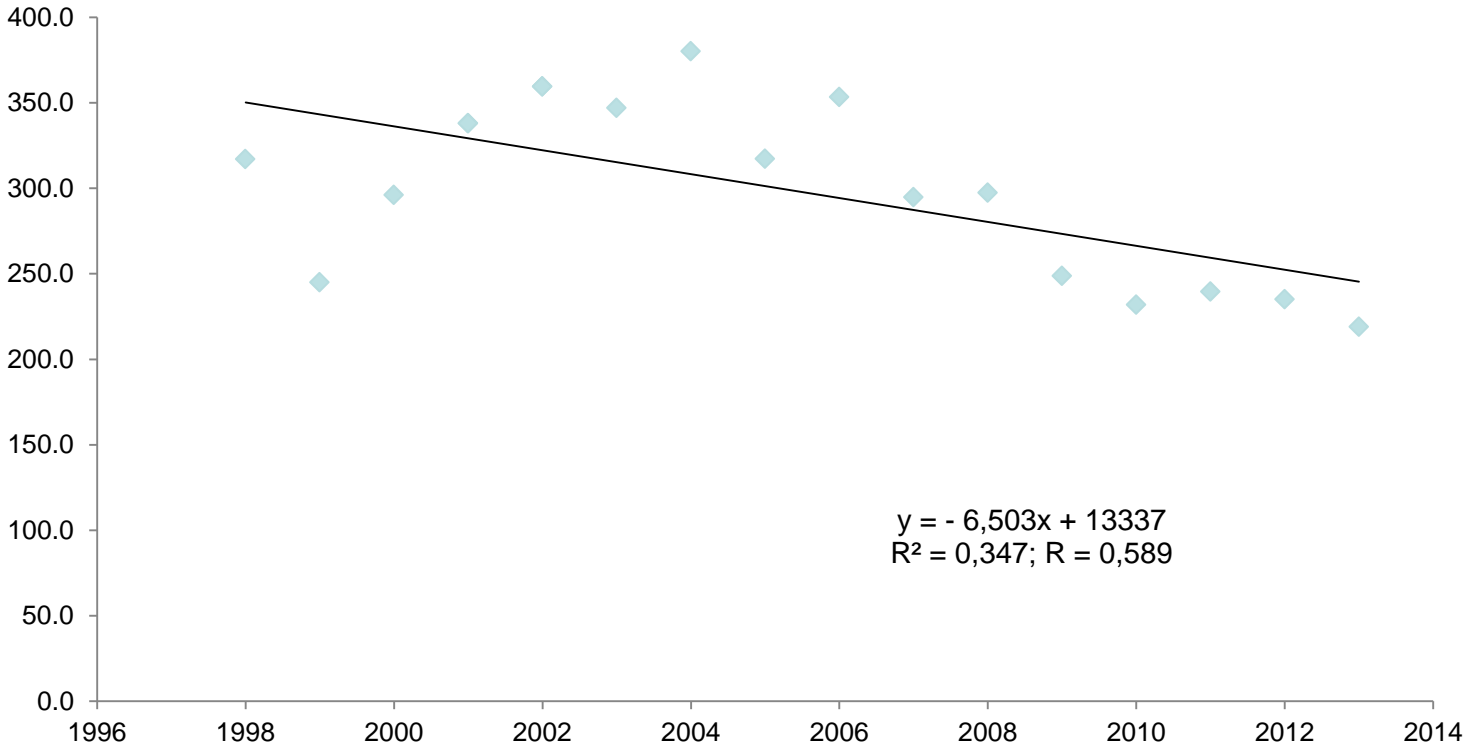
# EMEP National total emission SO<sub>x</sub> for Romania 1998-2013 (Gg)

(reported until 09.06.2015)



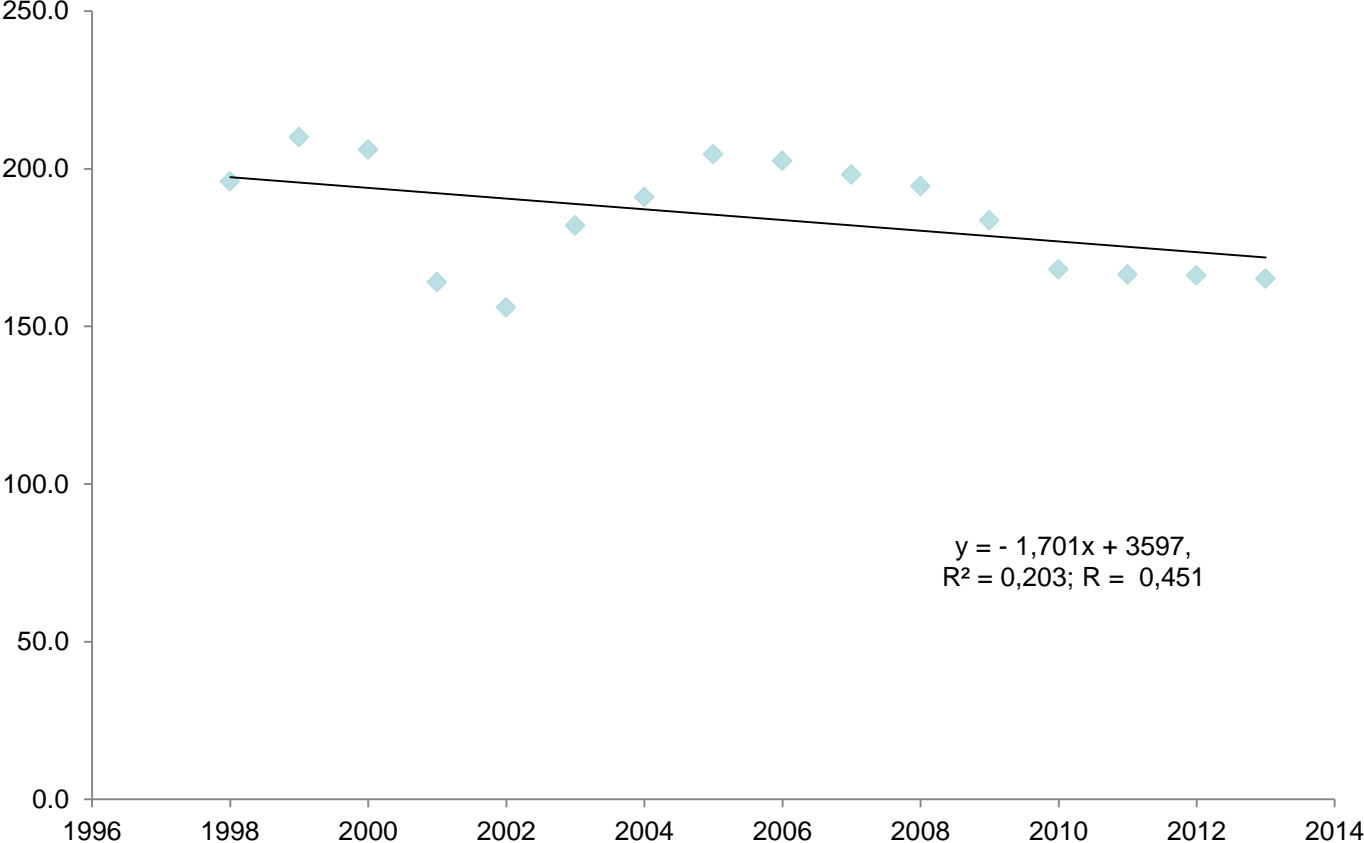
1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
800,0	687,0	759,0	842,0	776,5	804,0	832,0	601,5	654,8	528,2	524,8	444,5	349,5	320,1	257,7	202,7

# EMEP National total emission NOx for Romania 1998-2013 (Gg)



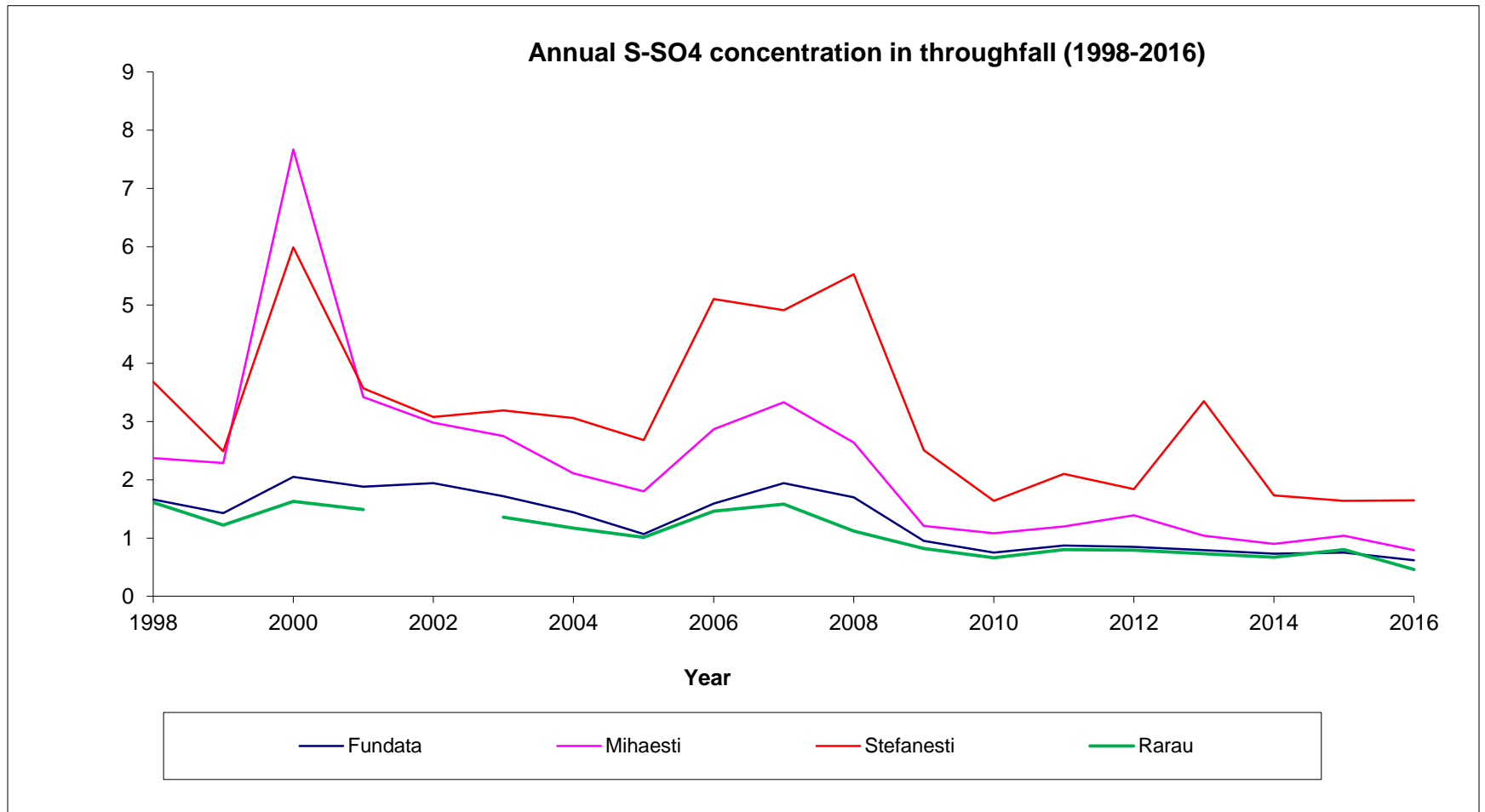
1998	1999	2000	2001	2002	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
317,0	245,0	296,0	338,0	359,5	338,0	359,5	347,0	380,0	317,2	353,4	294,7	297,4	248,7	231,9	239,5	235,0	218,8

# EMEP National total NH3 emission for Romania 1998-2013 (Gg)



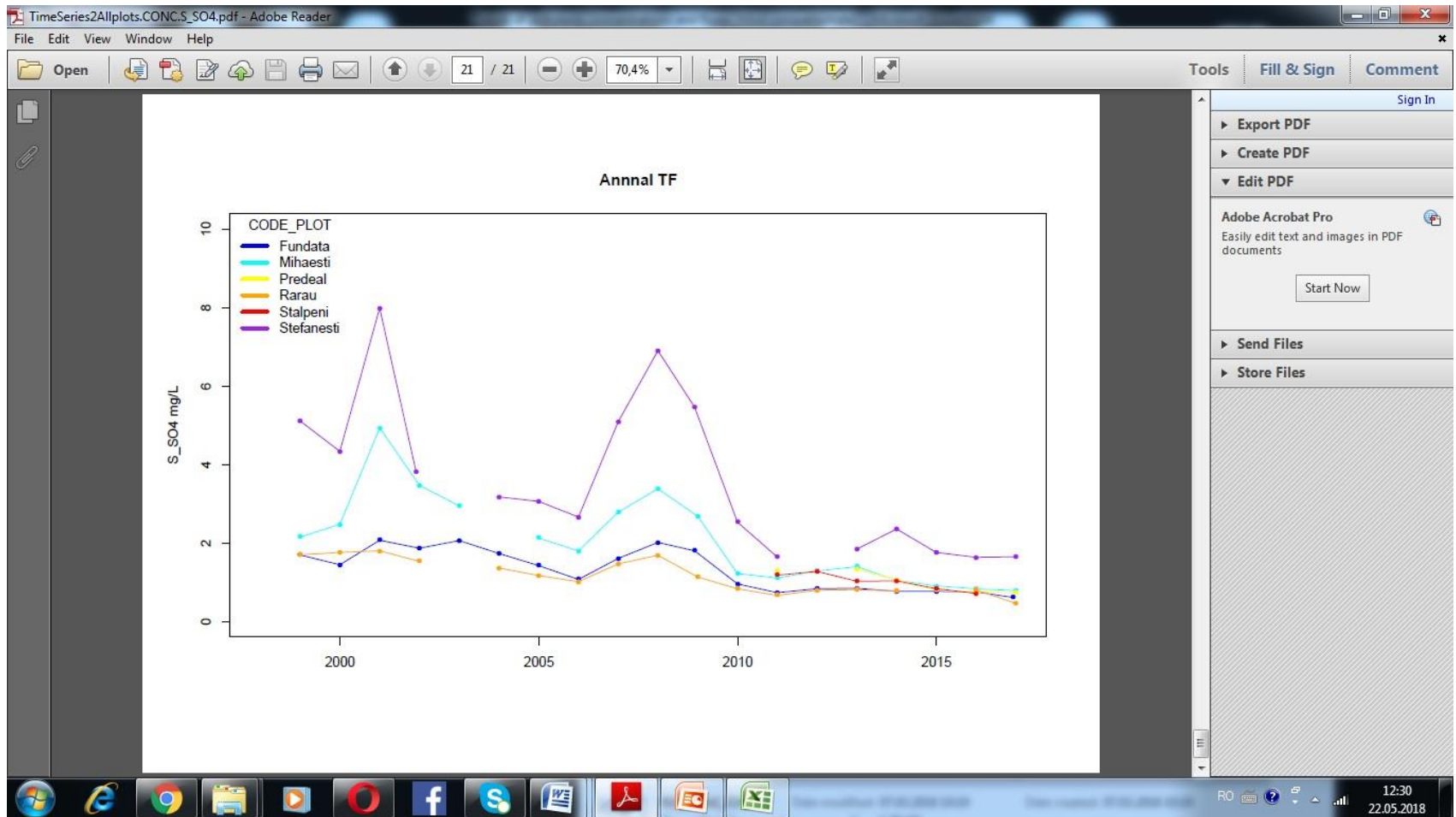
1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
196,0	210,0	206,0	164,0	156,0	182,0	191,0	204,6	202,4	198,1	194,5	183,6	168,1	166,4	166,1	165,1

# Concentrations of sulphate in throughfall between 1998-2016 (sampling periods)





# Concentrations of sulphate in throughfall between 1998-2016 (PMK)



# Conclusions

- Decreasing trends of sulphur and nitrogen compounds concentrations and fluxes, significant especially for sulphur. The trends were similar to that reported for the EMEP national total emissions.
- Increasing trends of chloride concentrations at Stefanesti, in BD and TH. Significant increase of chloride fluxes, in BD and TH (PMK).

Thank you for your attention!