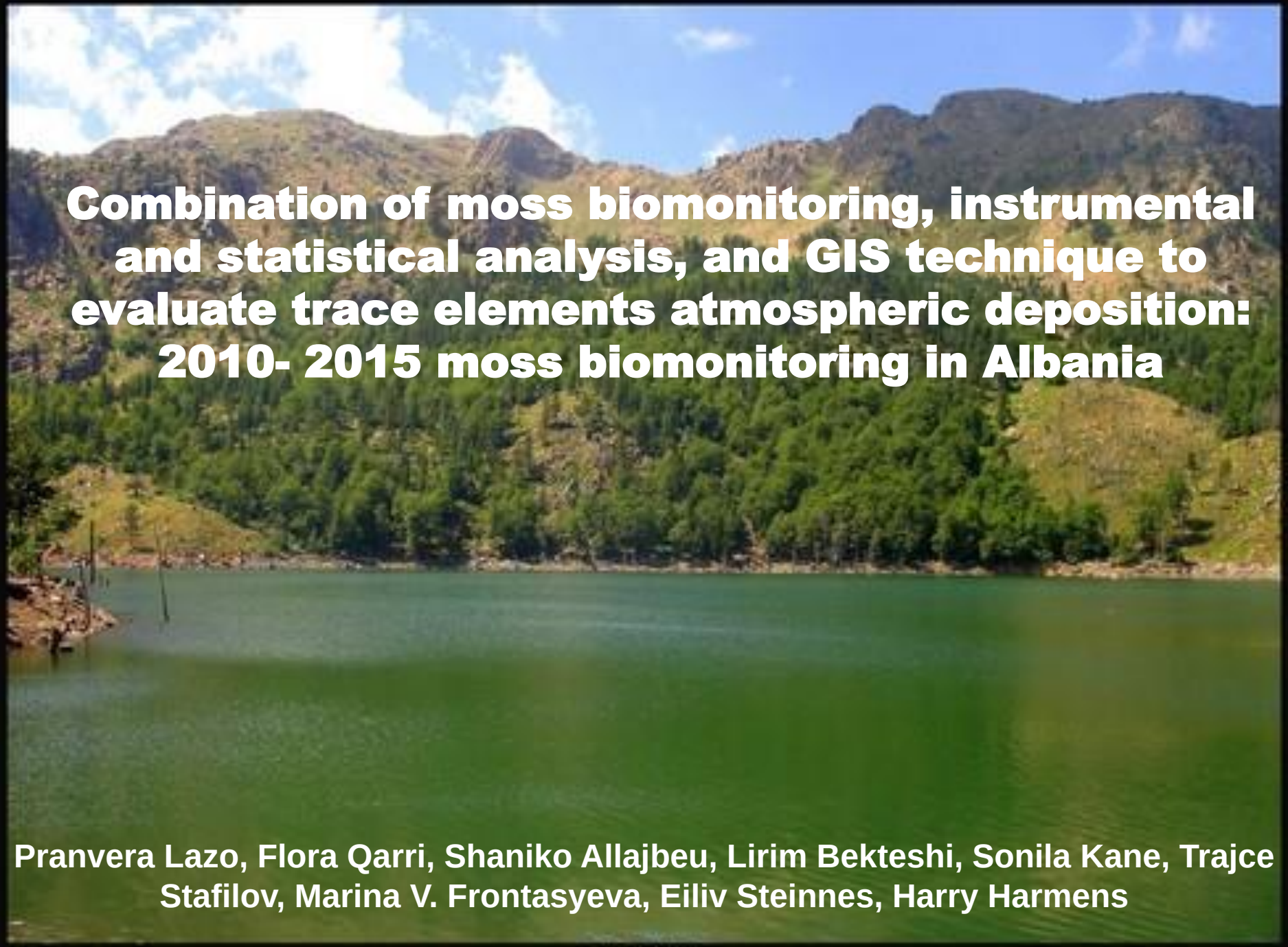
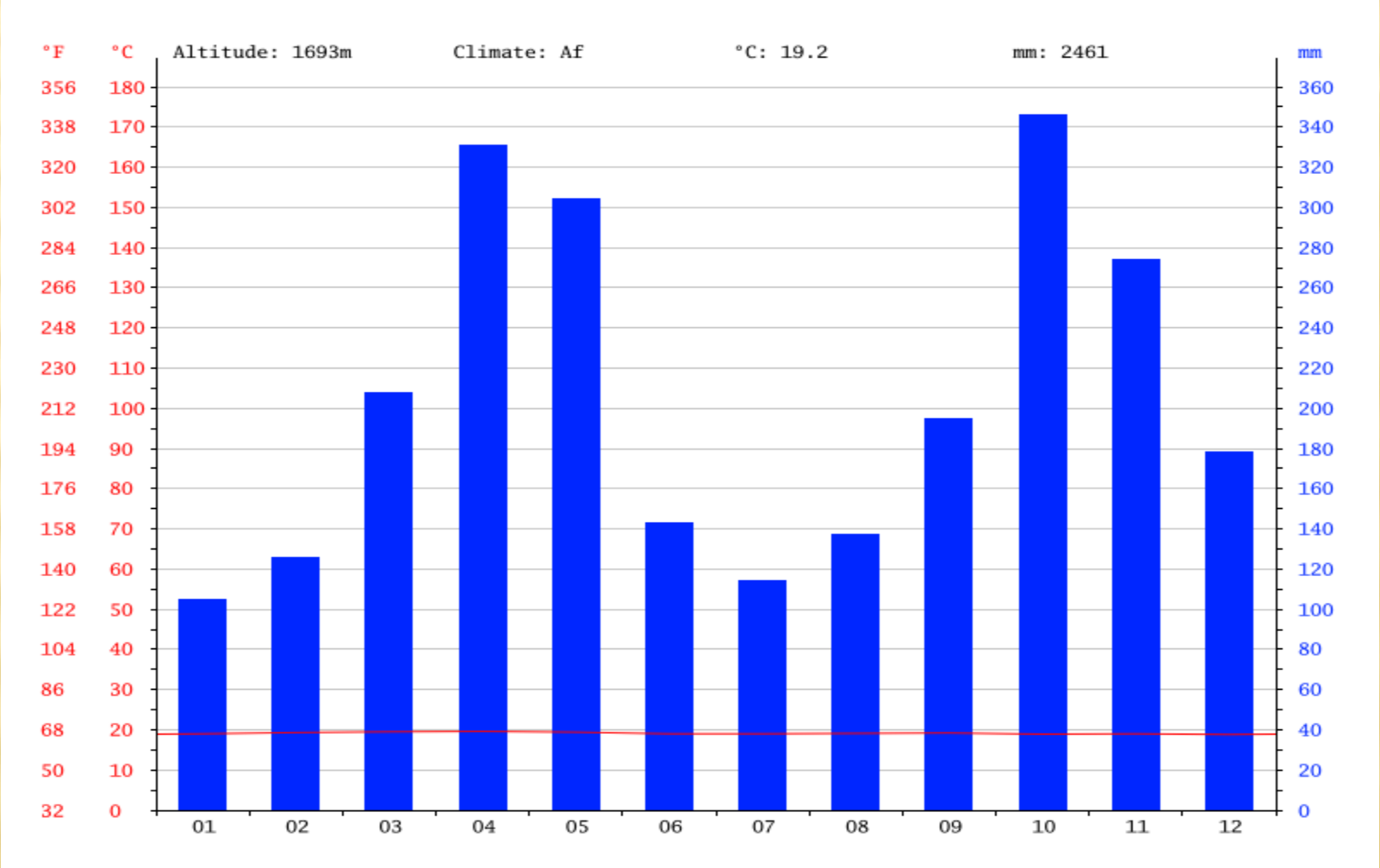


Combination of moss biomonitoring, instrumental and statistical analysis, and GIS technique to evaluate trace elements atmospheric deposition: 2010- 2015 moss biomonitoring in Albania

Pranvera Lazo, Flora Qarri, Shaniko Allajbeu, Lirim Bekteshi, Sonila Kane, Trajce Stafilov, Marina V. Frontasyeva, Eiliv Steinnes, Harry Harmens

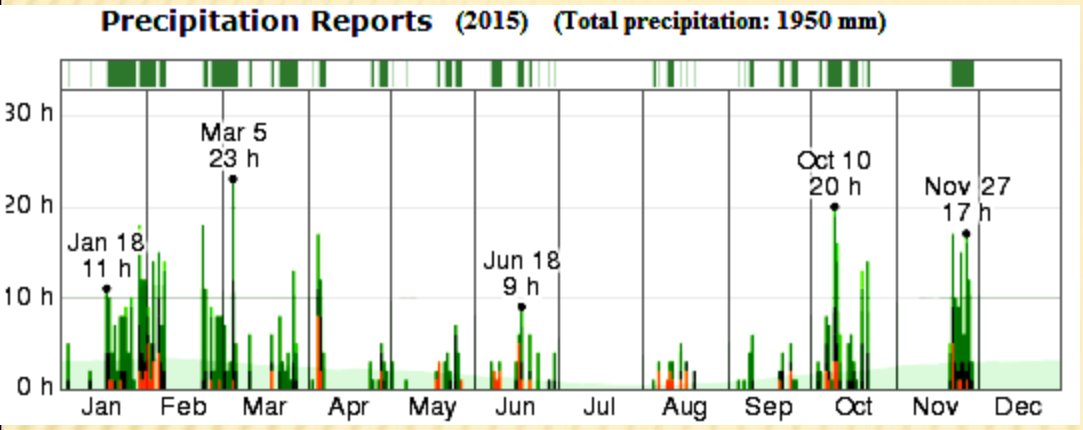
- **Geography**
- Location: Southeastern Europe.
- Area: 28,748 sq km (27,398 sq km land and 1,350 sq km water)
- Terrain: mostly mountains and hills; small plains along coast. The highest point: Korab 2,764 m; lowest point: Adriatic Sea: 0 m.

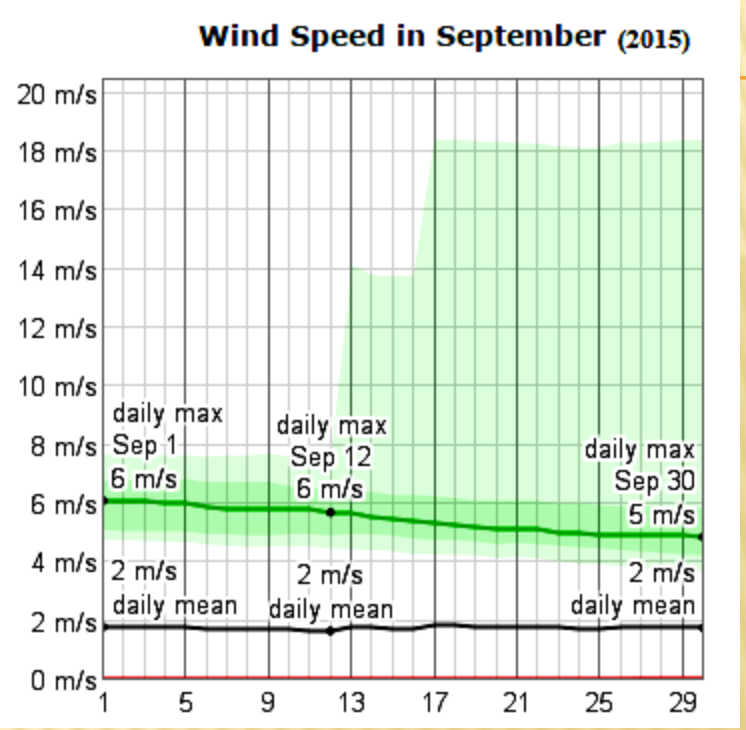
LOCAL FACTORS AFFECTING HM MOSS DISTRIBUTION

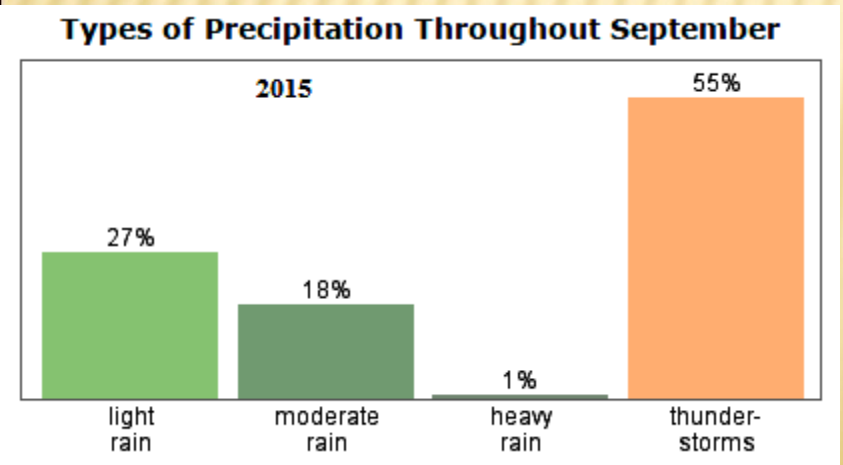


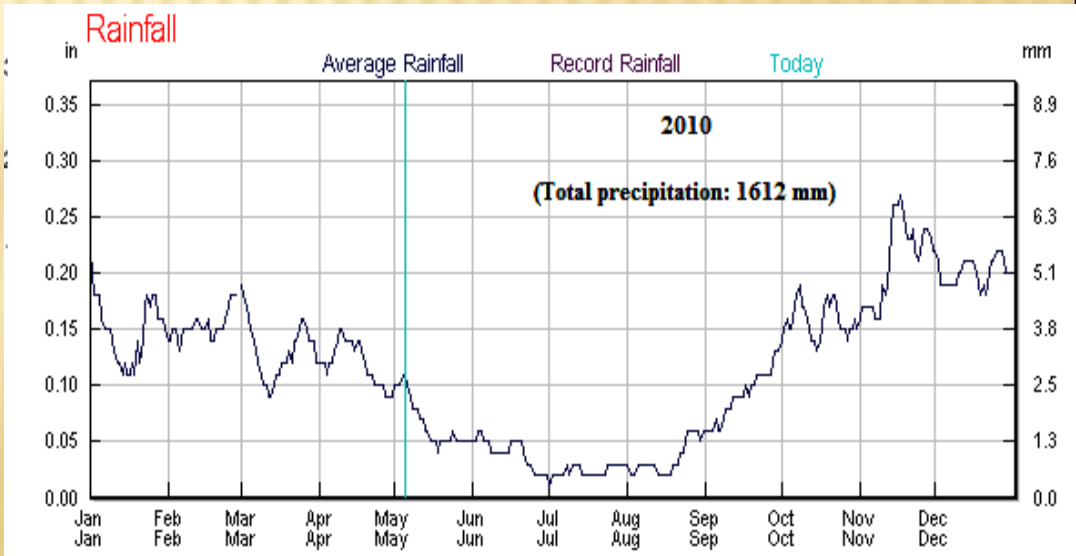
CLIMOGRAPH ALBANIA

Precipitation



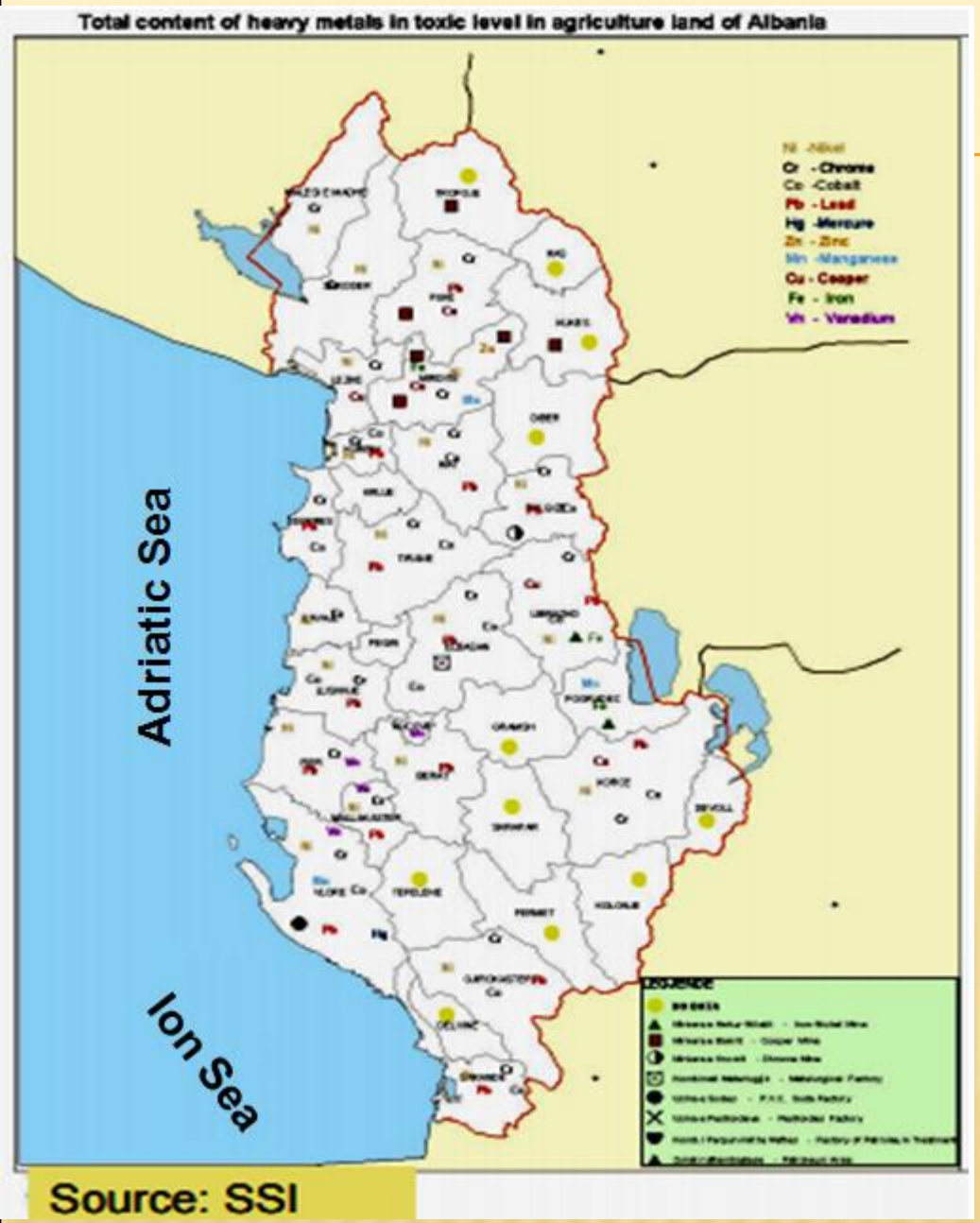






Territorial distributions of annual average wind speed (2-4.5 m/sec)

Territorial distributions of annual wind hours in Albania (1000-5000 h)

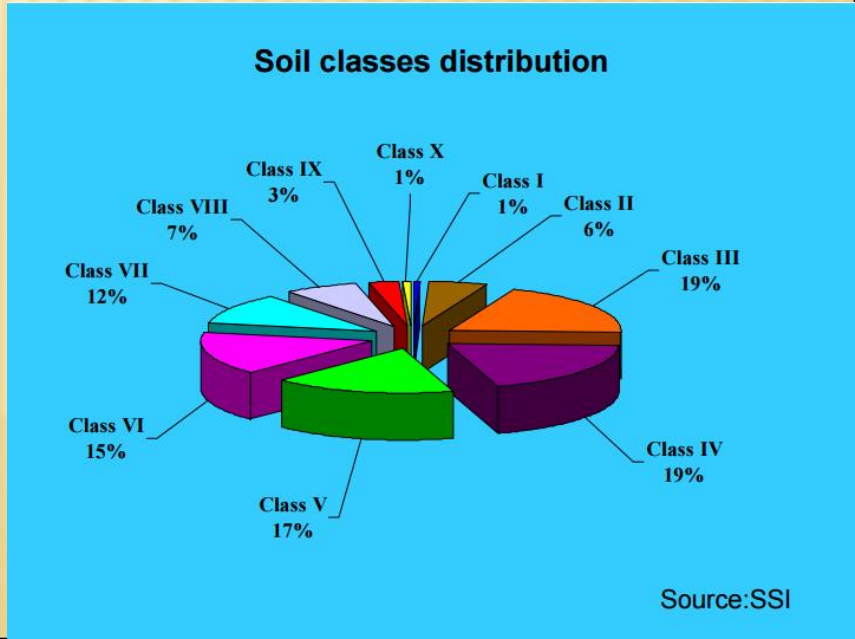


https://www1.ethz.ch/plantnutrition/research/Conf_pres/1_1_Lushaj.pdf

Soil Texture

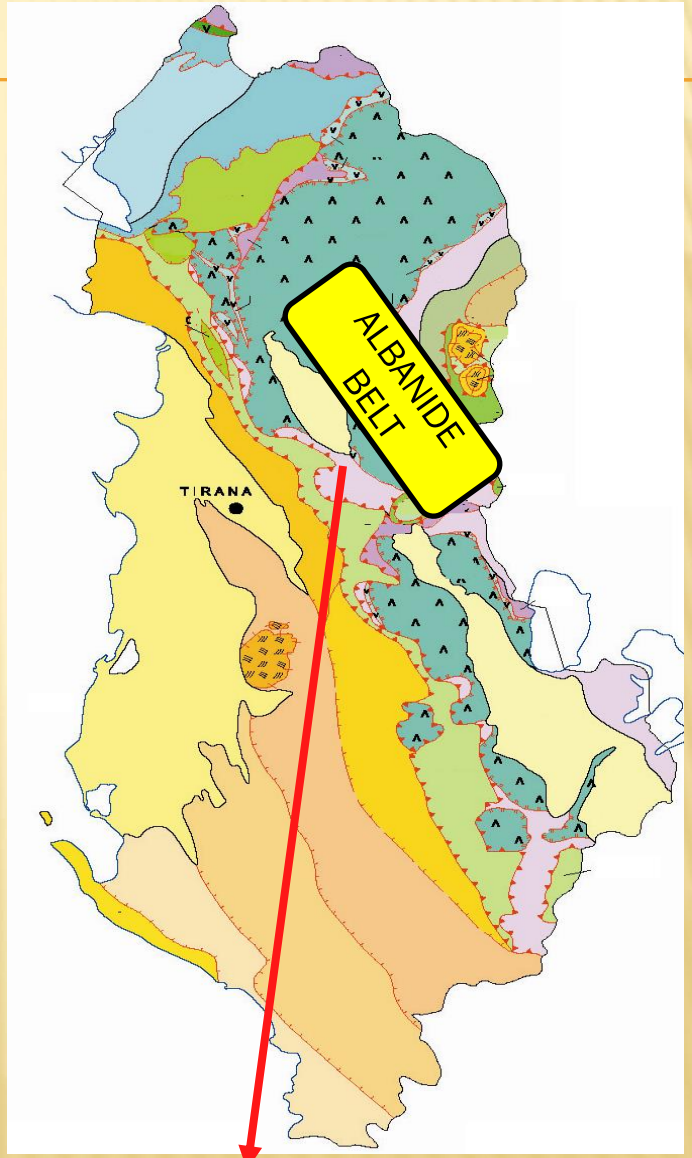
- Clay soil ~ 30%;
- Silty soil ~ 50%;
- Sandy soil ~ 20%.

The morphology of the Albanian soils is strongly related to geology of the area.



GEOCHEMICAL SETTINGS

Carbonate area with oil, gas and coal deposits



Mineral belt (metals)

Stationary Sources (power plants, factories) NO_2, SO_2, PM

Mobile Sources (vehicles) VOCs, NO_2, PM

Area Sources (waste incineration, gas stations) VOCs, NO2, SO2, PM

Natural Sources (forest fires) PM

Cr-Fe Metallurgycal plant

Traffic emission

Waste incineration

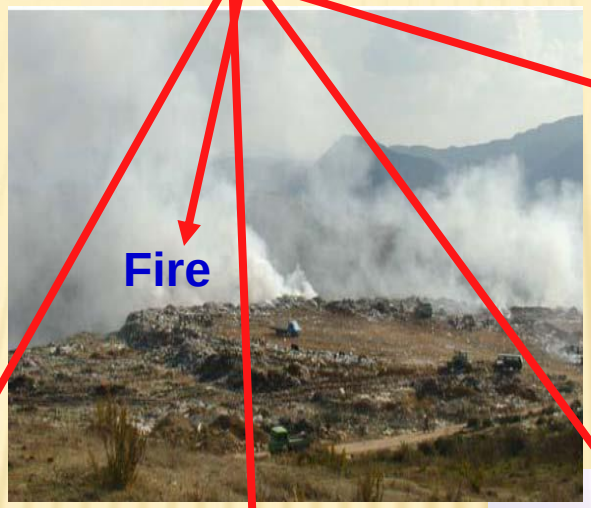
Forest fires in summer

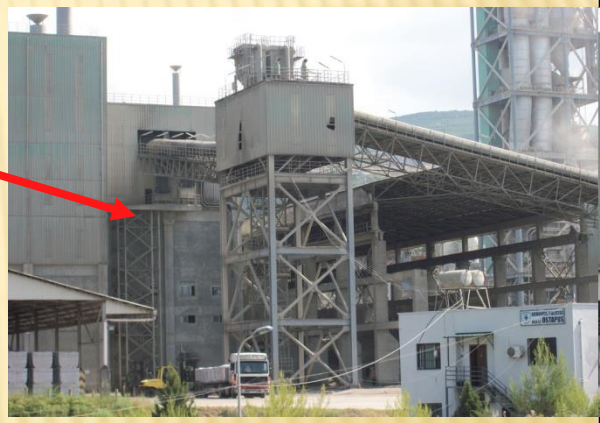
Main Sources of Air Pollution in Albania

PRIORITIES: ENVIRONMENTAL POLLUTION

DEFORESTATION; SOIL EROSION; WATER POLLUTION; WASTE MANAGEMENT; GAS EMISSION: INDUSTRIAL EMISSION, TRAFIC, WASTE INCINERATION;

Gas Emission





CEMENT INDUSTRY

OBLIGATED PARAMETERS ON AIR QUALITY IN ALBANIA

- The Albanian legislation decided six parameters (SSM, PM2.5 and PM10, SO_2, NO_2, O_3, Pb) - urban air quality.
- The standards and critical values was approved
- EMEP data for Hg, Cd and Pb

•Air Monitoring Instruments

Air pollution instruments could be grouped as:

Concentration Measurement

Continuous Emission Monitoring System

Deposition Monitoring

Meteorological Instruments

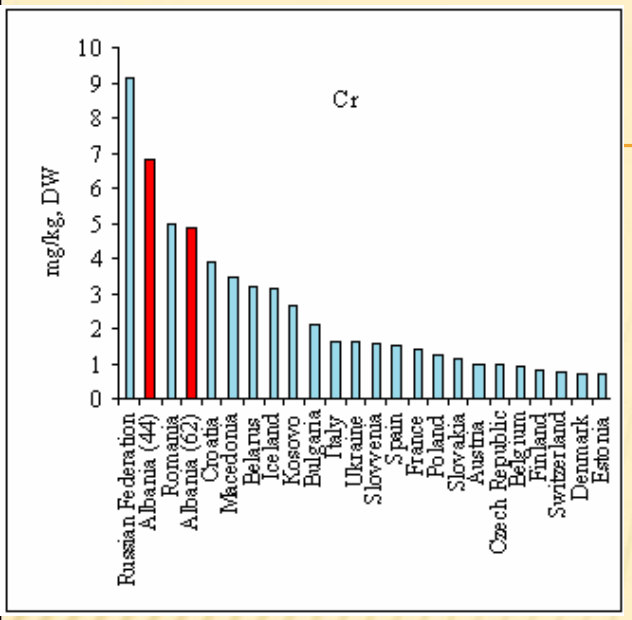
Ambient Monitoring

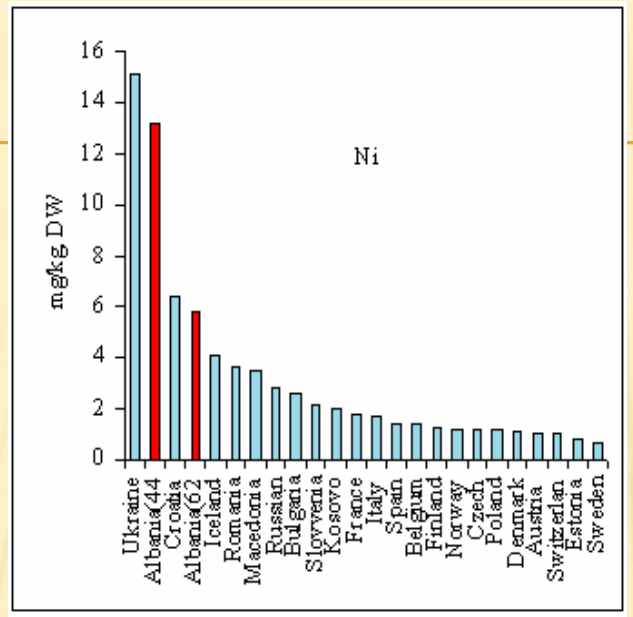
Air Measuring Device

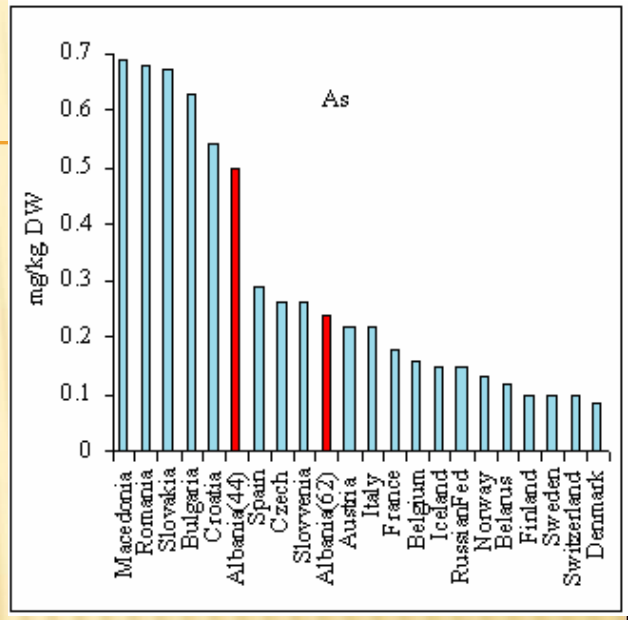
BIOMONITORING

MOSS BIOMONITORING IN ALBANIA

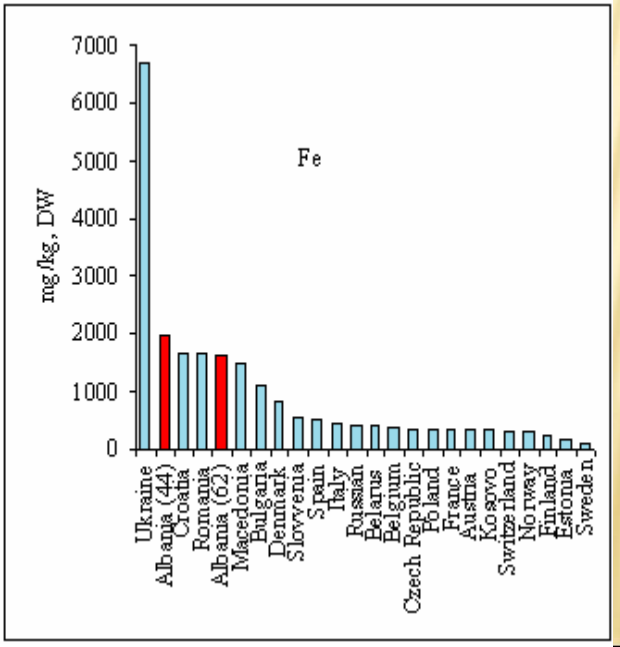
- Started on 2010, continued on 2015 – joined to ICP Vegetation Programme since 2010
- 2010 – 64 stations; reduced in 44. ICP-AES analysis for 20 elements in Skopje, Macedonia.
- ENAA analysis for 46 elements in JINR, Dubna.
- 2015 – 55 stations. Analyzed for 20 elements

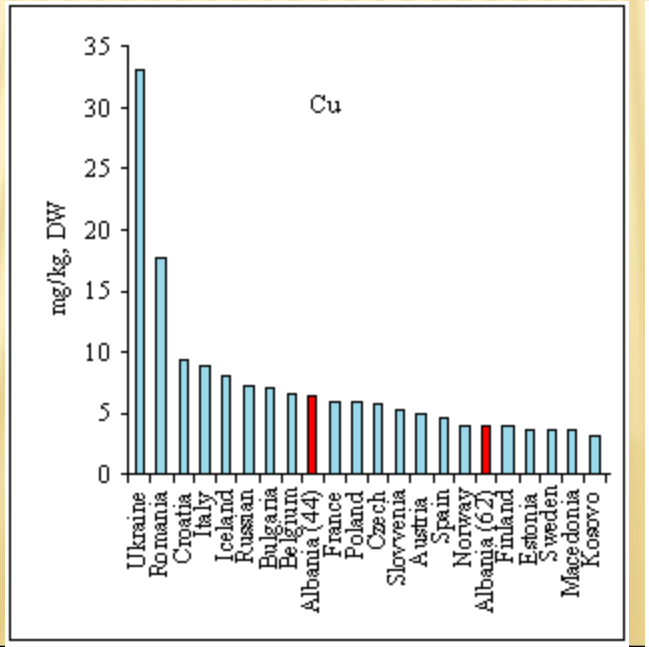

Cr
mg/kg, DW
0
1
2
3
4
5
6
7
8
9
10
Russian Federation
Albania (44)
Romania
Albania (62)
Croatia
Macedonia
Belarus
Iceland
Kosovo
Bulgaria
Italy
Ukraine
Slovvenia
Spain
France
Poland
Slovakia
Austria
Czech Republic
Belgium
Finland
Switzerland
Denmark
Estonia

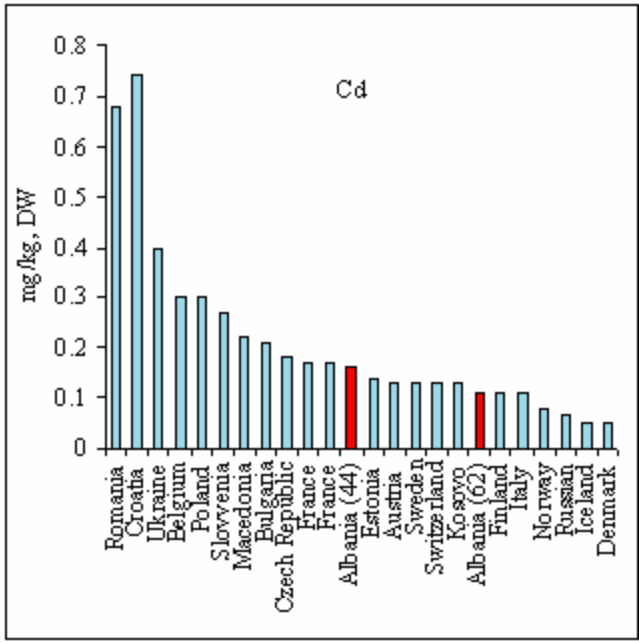

Ni
mg/kg DW
0
2
4
6
8
10
12
14
16
Ukraine
Albania(44
Croatia
Albania(62
Iceland
Romania
Macedonia
Russian
Bulgaria
Slovvenia
Kosovo
France
Italy
Spain
Belgium
Finland
Norway
Czech
Poland
Denmark
Austria
Switzerlan
Estonia
Sweden


As
mg/kg DW
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Macedonia
Romania
Slovakia
Bulgaria
Croatia
Albania(44)
Spain
Czech
Slovvenia
Albania(62)
Austria
Italy
France
Belgium
Iceland
RussianFed
Norway
Belarus
Finland
Sweden
Switzerland
Denmark

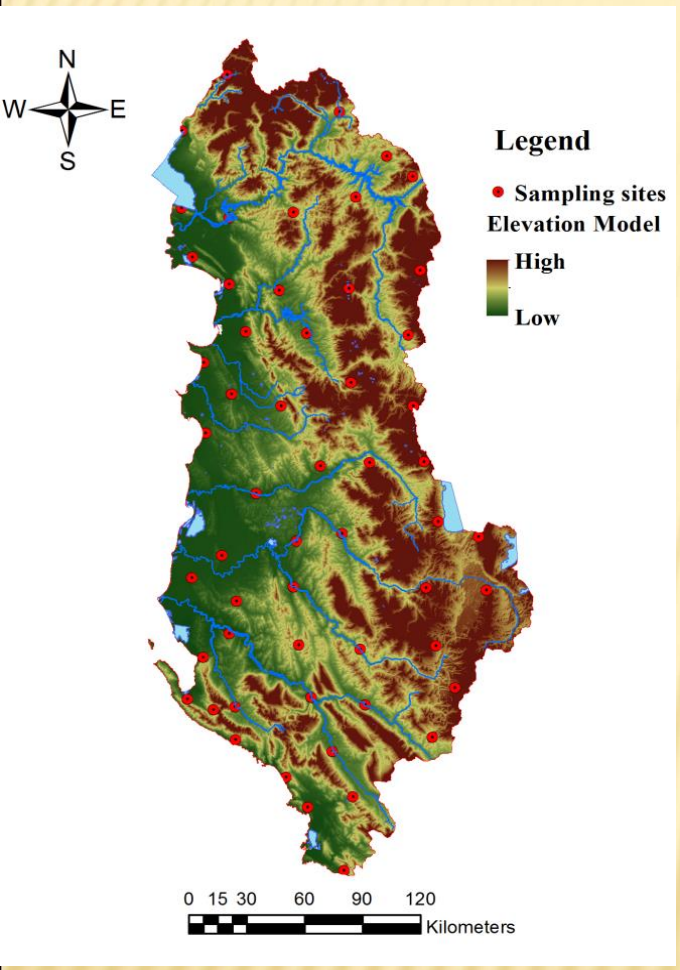
2010 data


Fe
mg/kg, DW
0
1000
2000
3000
4000
5000
6000
7000
Ukraine
Albania (44)
Croatia
Romania
Albania (62)
Macedonia
Bulgaria
Denmark
Slovvenia
Spain
Italy
Russian
Belarus
Belgium
Czech Republic
Poland
France
Austria
Kosovo
Switzerland
Norway
Finland
Estonia
Sweden


Cu
mg/kg, DW
0
5
10
15
20
25
30
35
Ukraine
Romania
Croatia
Italy
Iceland
Russian
Bulgaria
Belgium
Albania (44)
France
Poland
Czech
Slovvenia
Austria
Spain
Norway
Albania (62)
Finland
Estonia
Sweden
Macedonia
Kosovo


Cd
mg/kg, DW
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Romania
Croatia
Ukraine
Belgium
Poland
Slovvenia
Macedonia
Bulgaria
Czech Republic
France
France
Albania (44)
Estonia
Austria
Sweden
Switzerland
Kosovo
Albania (62)
Finland
Italy
Norway
Russian
Iceland
Denmark

2015 – MOSS SURVEY IN ALBANIA

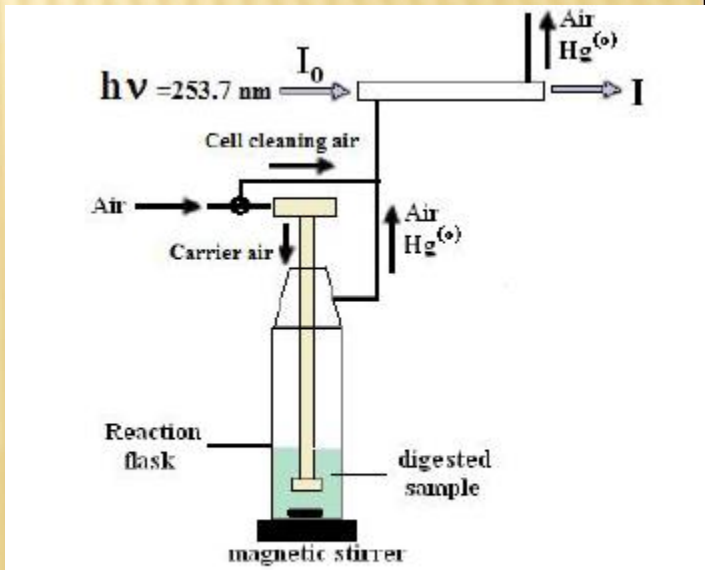


55 sampling sites (2 samples/1000 sq. km)
***20 elements* are included in this study**

17 metals (Li, Mg, K, Na, Ca, Mn, Sr, Ba, Cu, Fe, Cr, Co, Ni, Pb, V, Al and Zn -were determined by ICP-AES (Varian 715-ES) in Skopje, Macedonia).

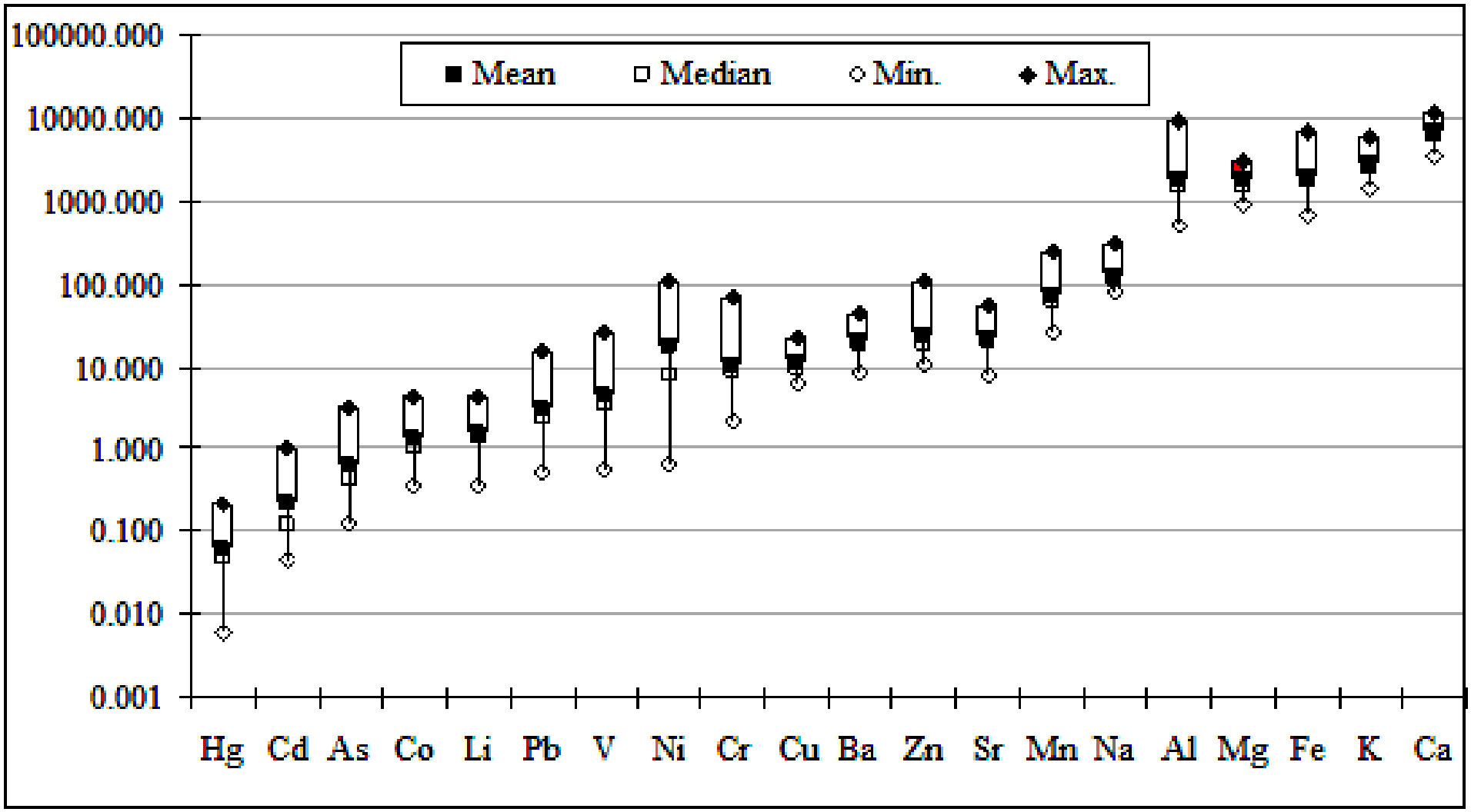
As and Cd - by ETAAS (Varian, SpectrAA 640Z).

Hg – by CVAAS (Varian 10+ and an home made cold vapor system).



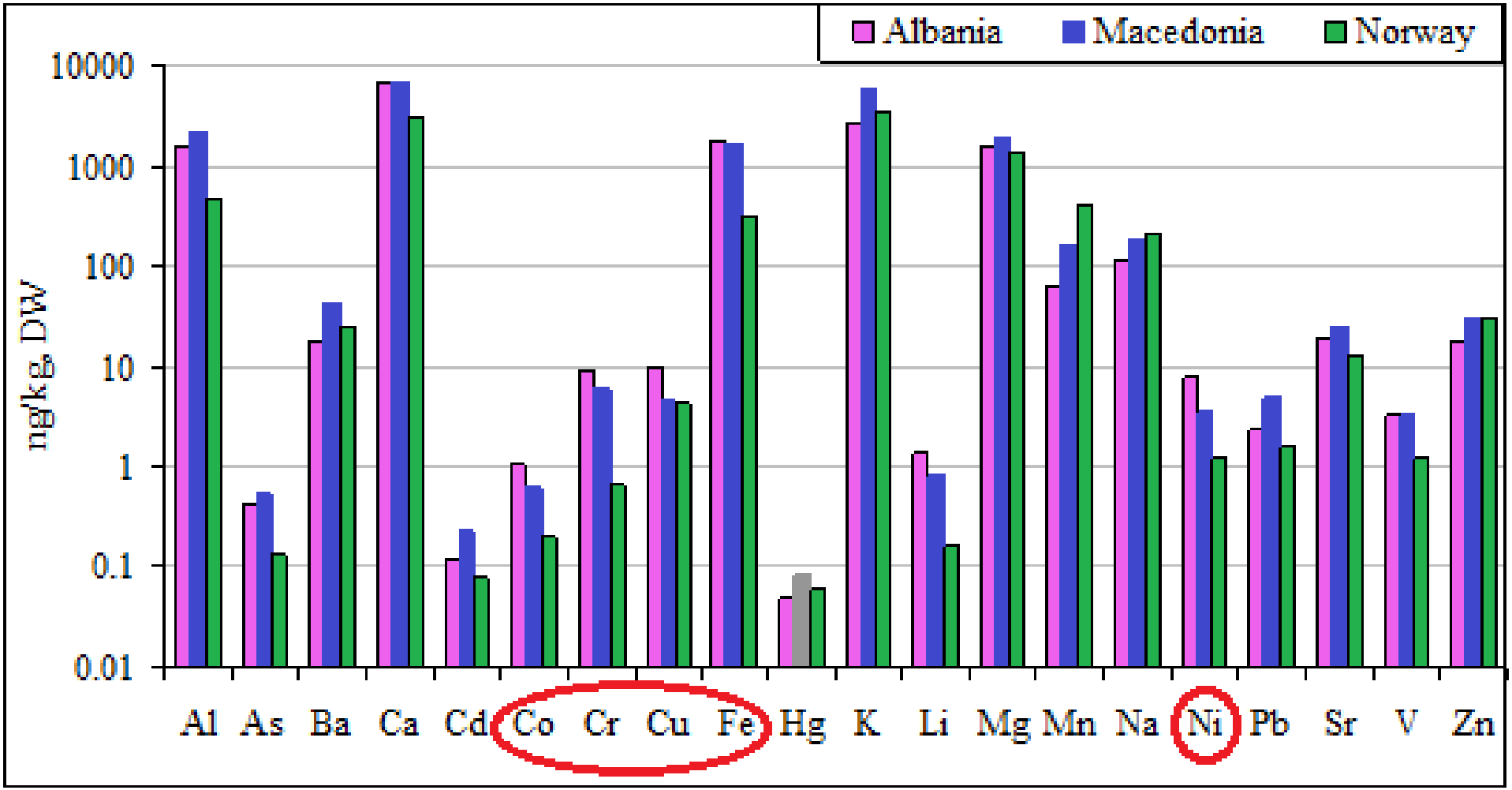
Schematic diagram of the "home-made cold-vapor system" used for atomization and volatilization of mercury

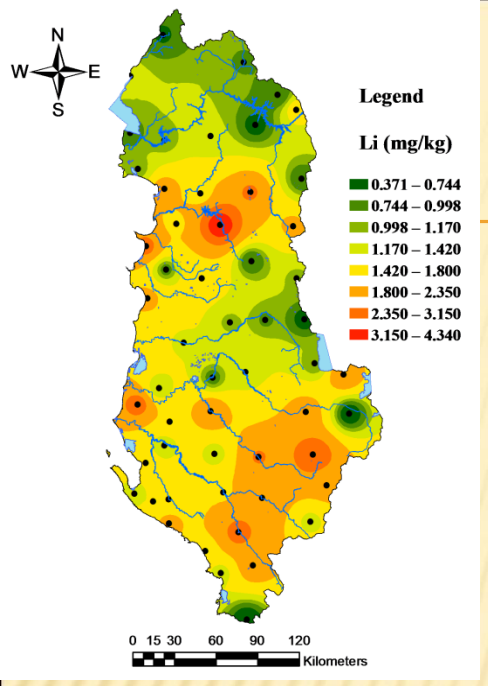
DISTRIBUTION TREND OF THE ELEMENTS

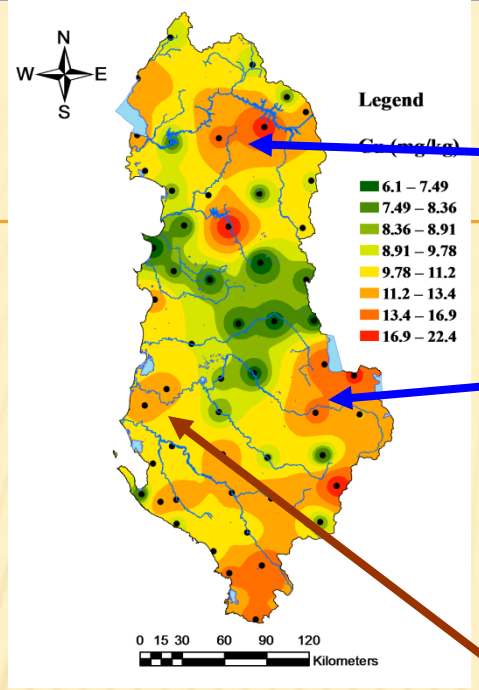


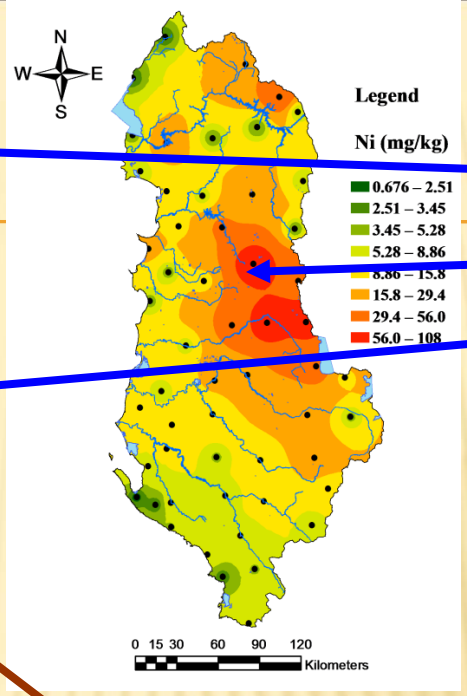
Concentration data

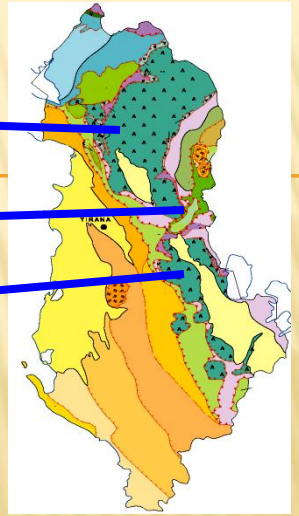
COMPARISON OF CONCENTRATION DATA



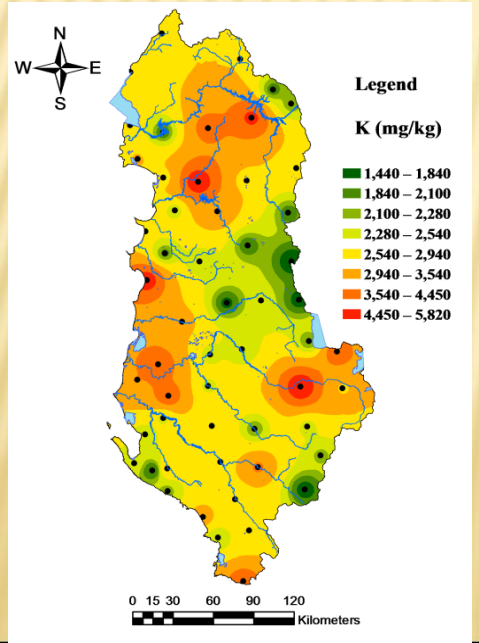


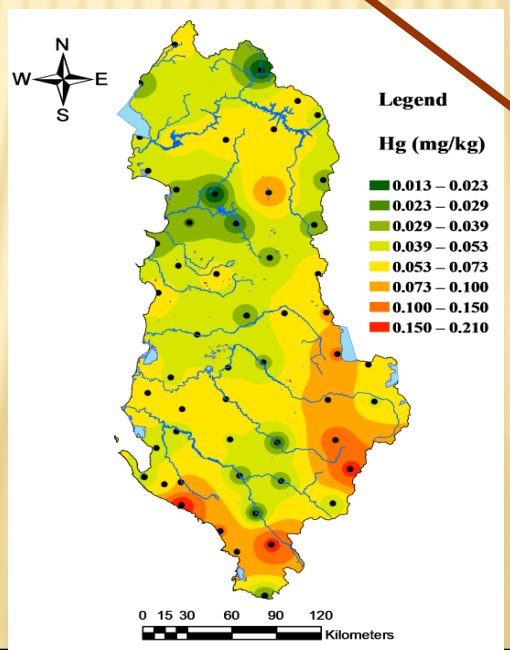




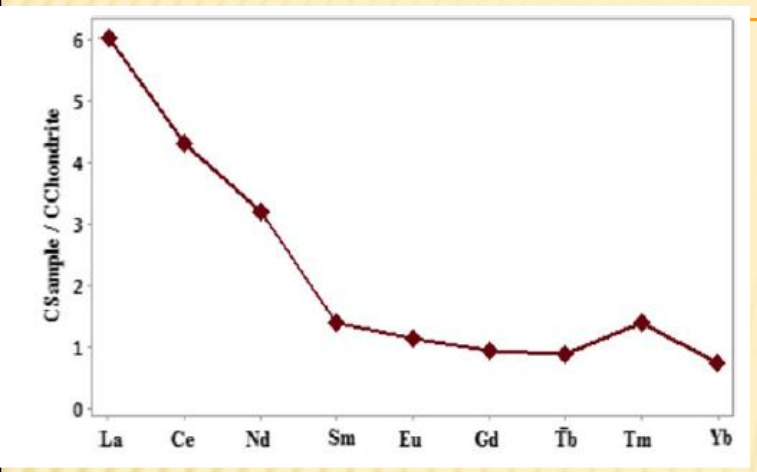


SPATIAL DISTRIBUTION OF THE ELEMENTS

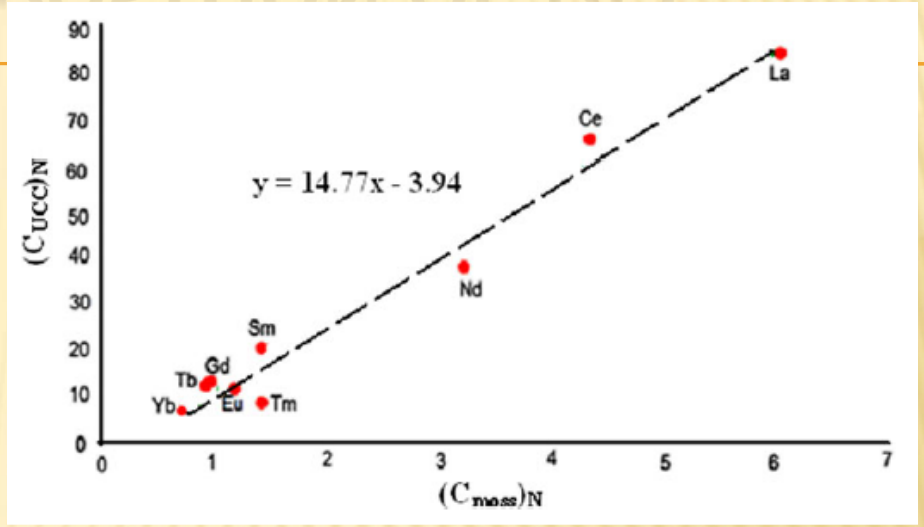




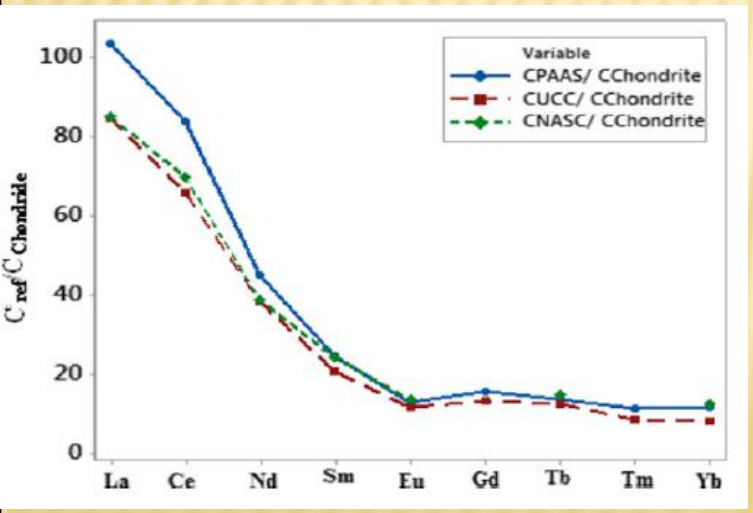
ATMOSPHERIC DEPOSITION OF REE

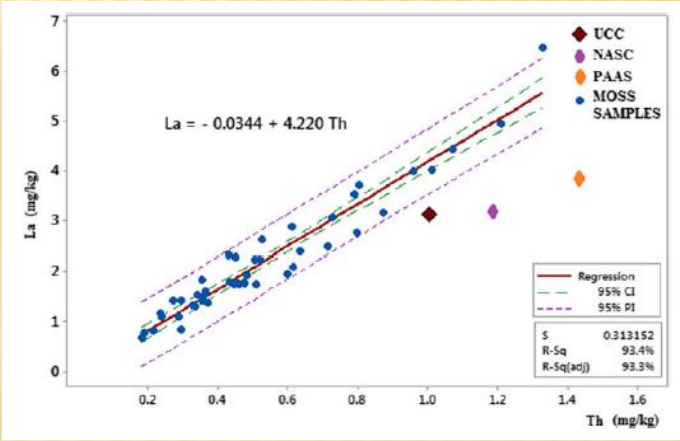


Spider diagrams of moss (REEs)N and(UCC), (NASC) and (PAAS)



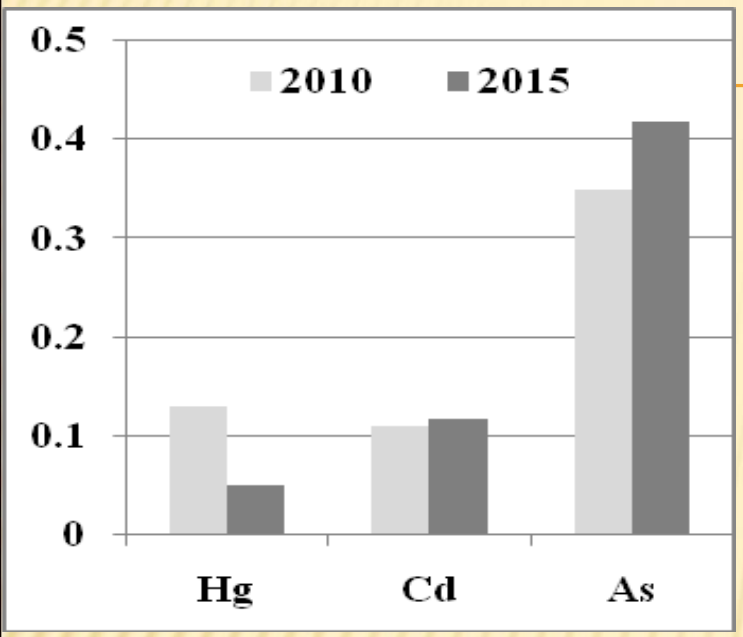
The linear regression of UCC/chondrite vs. sample/chondrite in moss samples

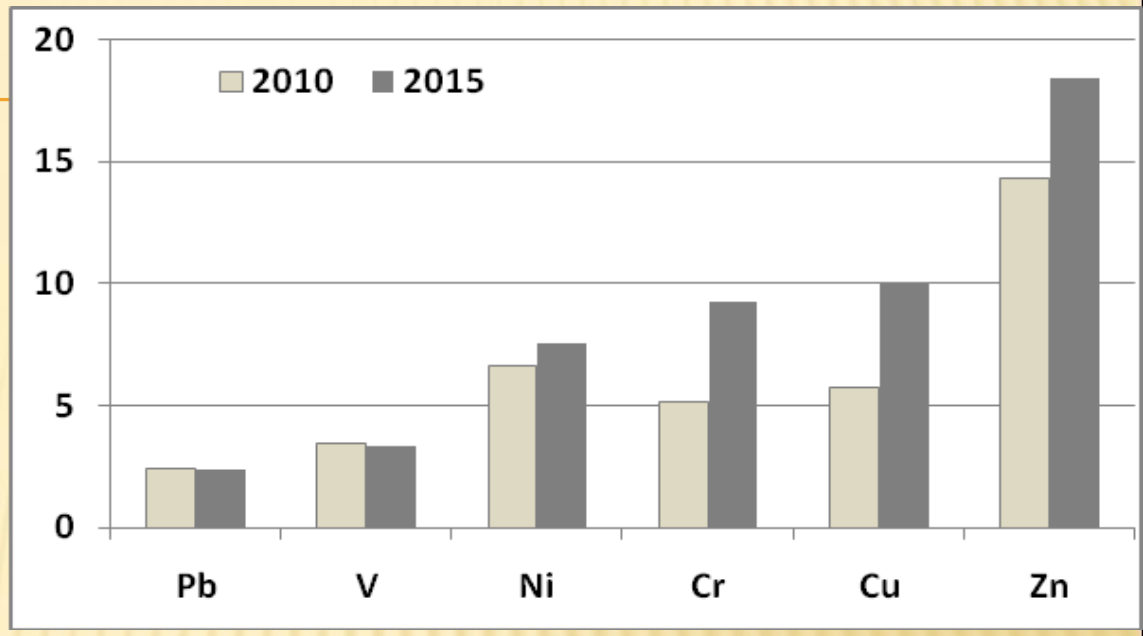


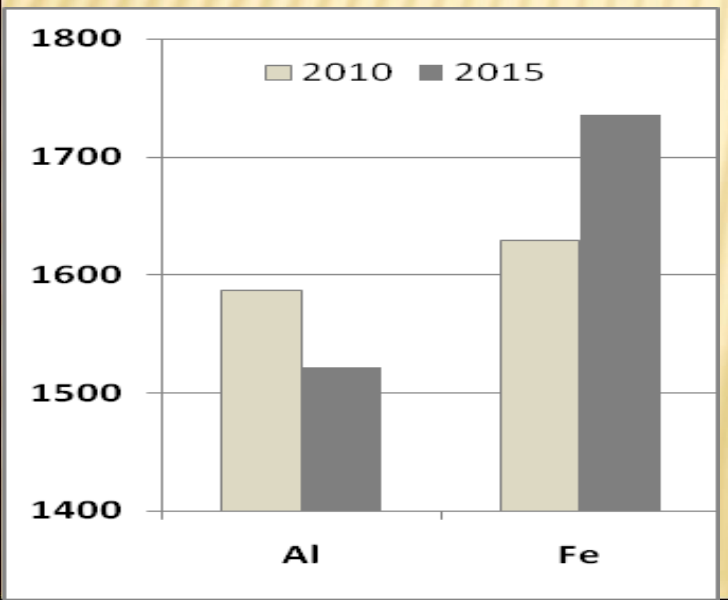


La vs. Th plot illustrating the differences between moss el. and UCC, NASC, and PAAS

TEMPORAL TREND OF THE ELEMENTS (2010-2015)



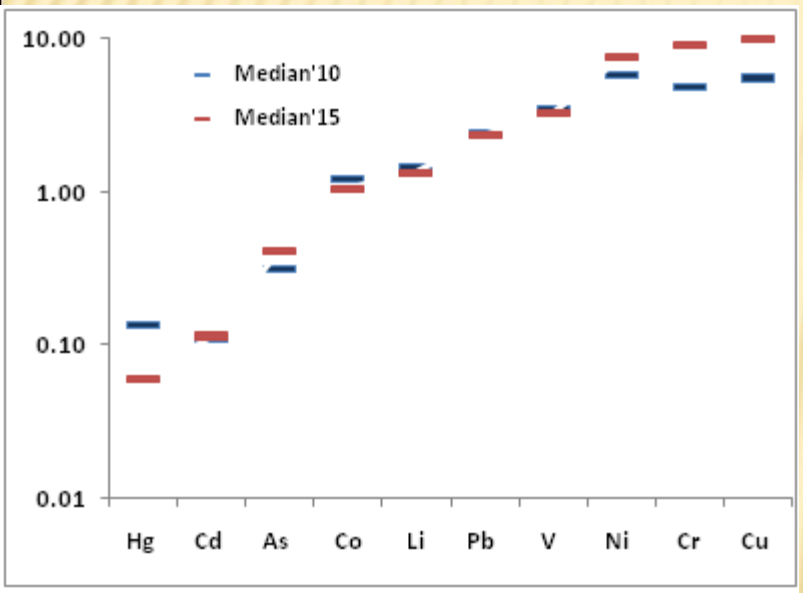


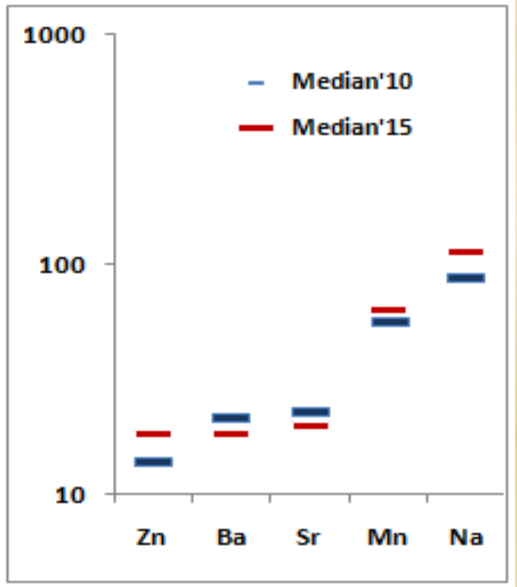


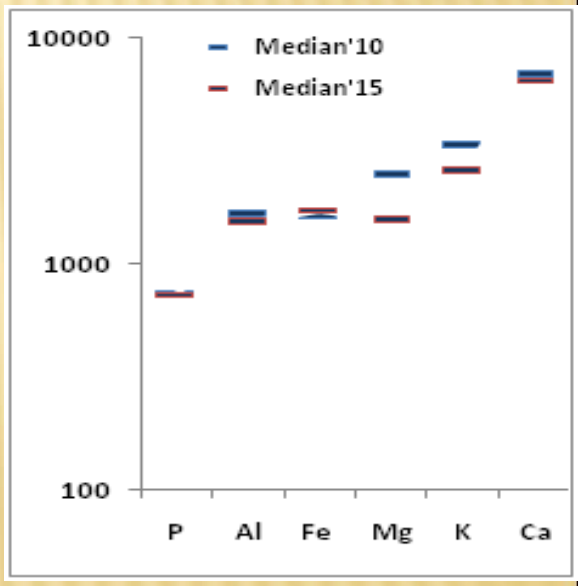
Hg, Mg, K, Ba, Sr are highly declined.
Li, Al, V show low decline.

Show high increase (Cr, Cu, As, Zn, Ni); low increase (Mn, Cd and Fe).
Na also show high increase on 2015 compared to 2010.

The comparison of 2010 and 2015 medians

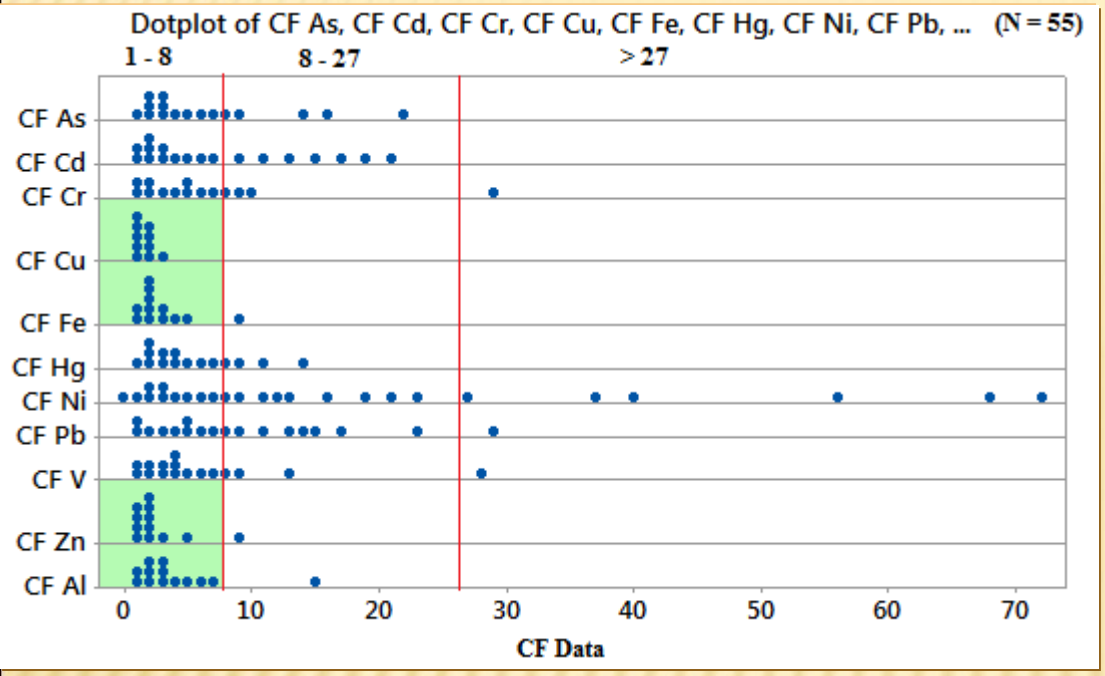


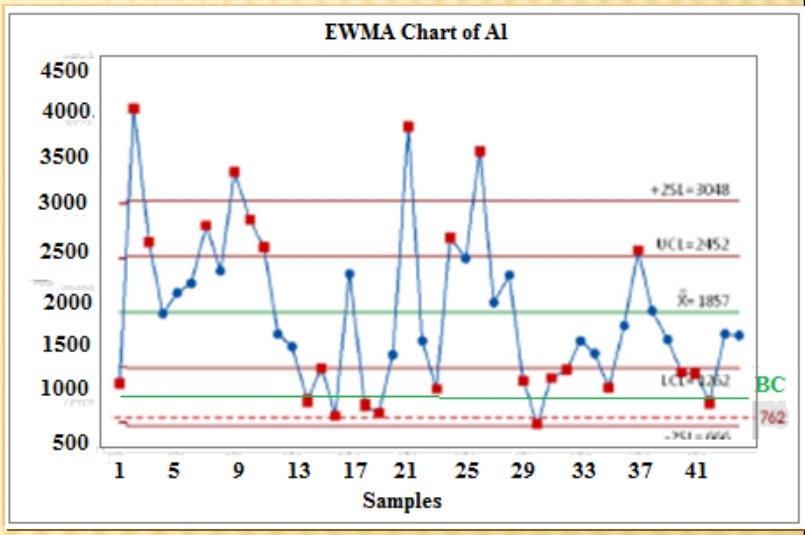


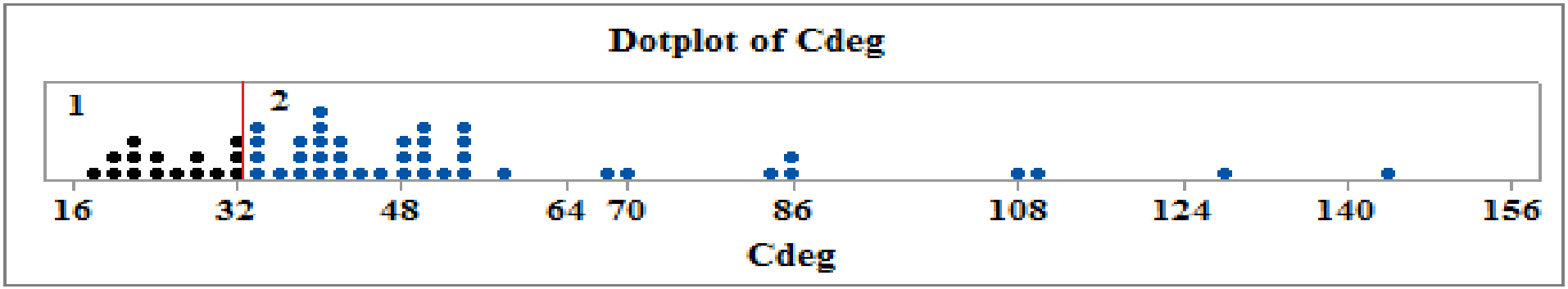


The contamination factors (CF) and degree of contamination (C_{deg}) for metal concentrations in current mosses

Overall CF=3.6; 3rd cont. scale, slightly cont. scale.



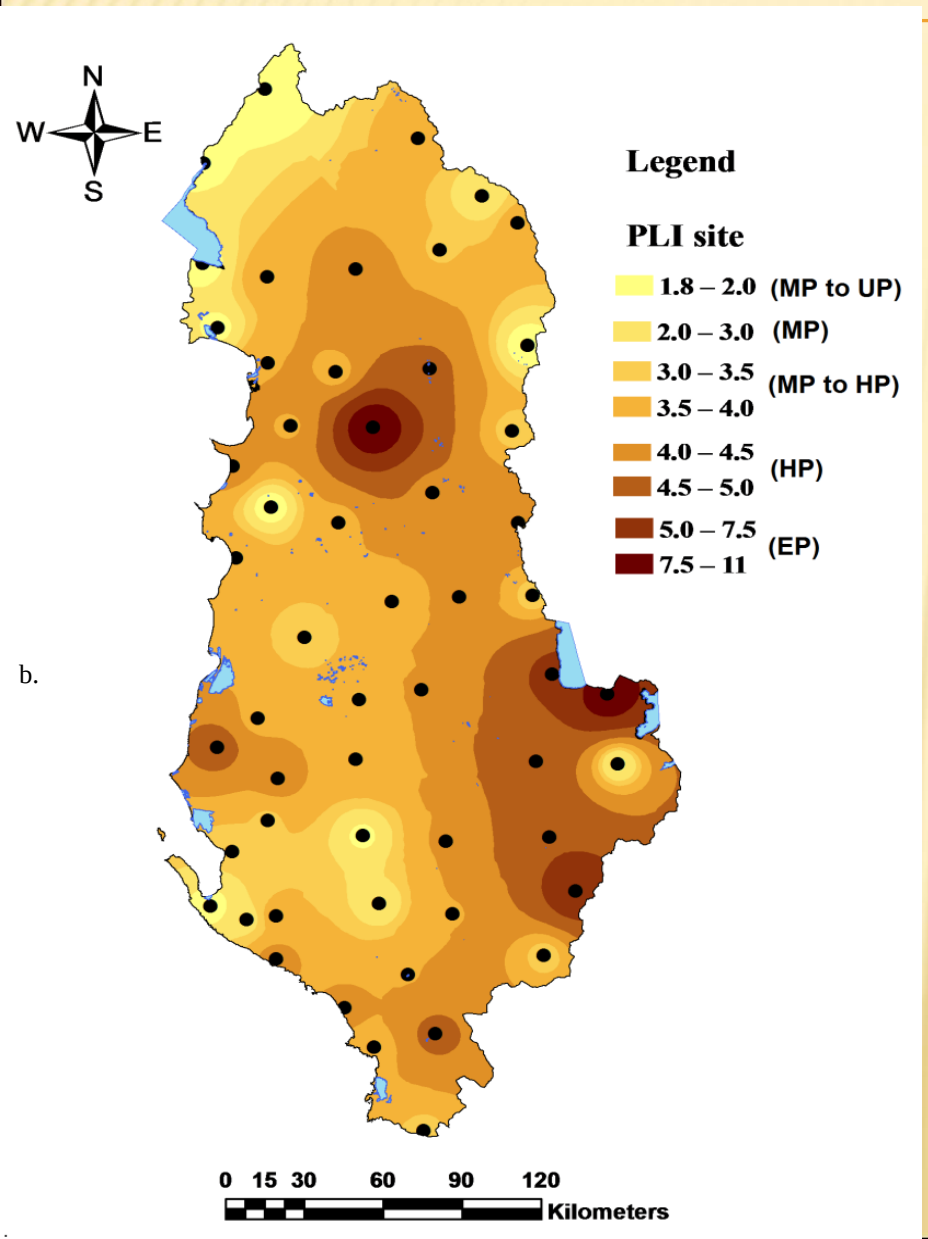


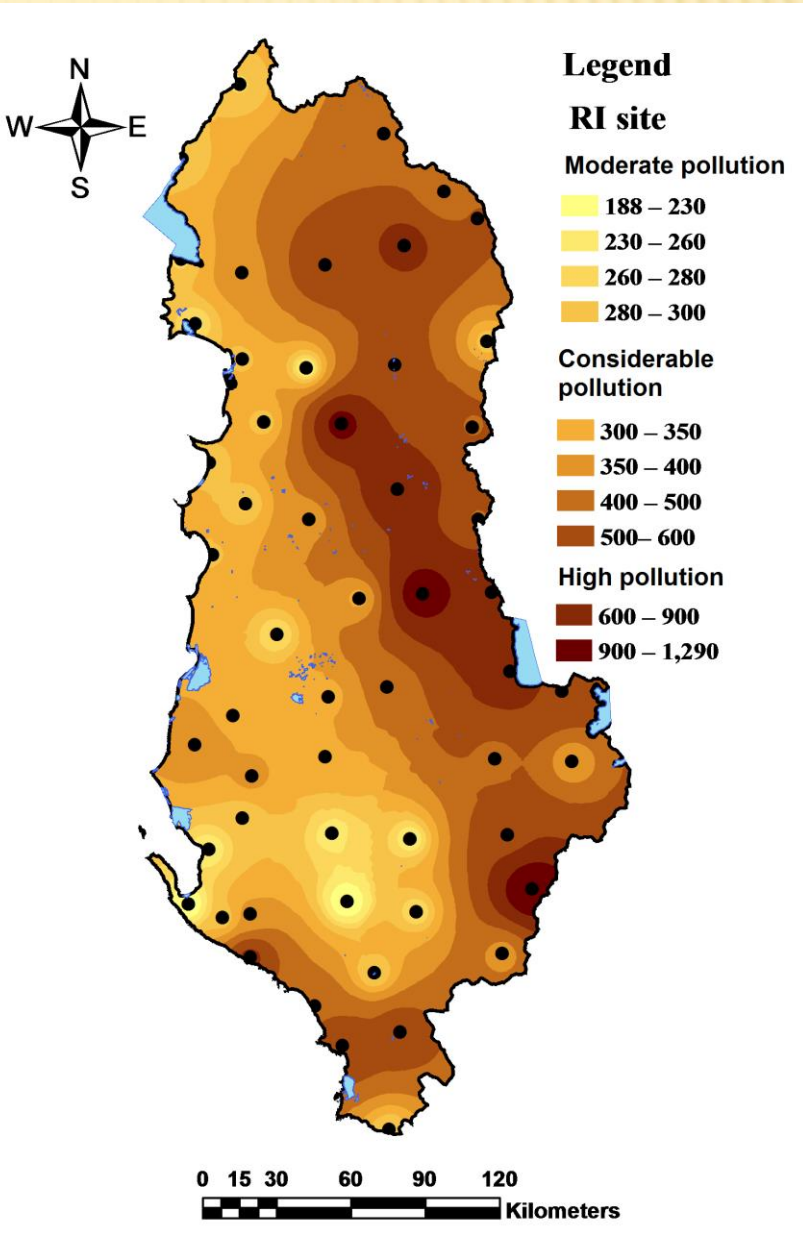


C_{deg} = 54.7- show serious anthropogenic input at all territory

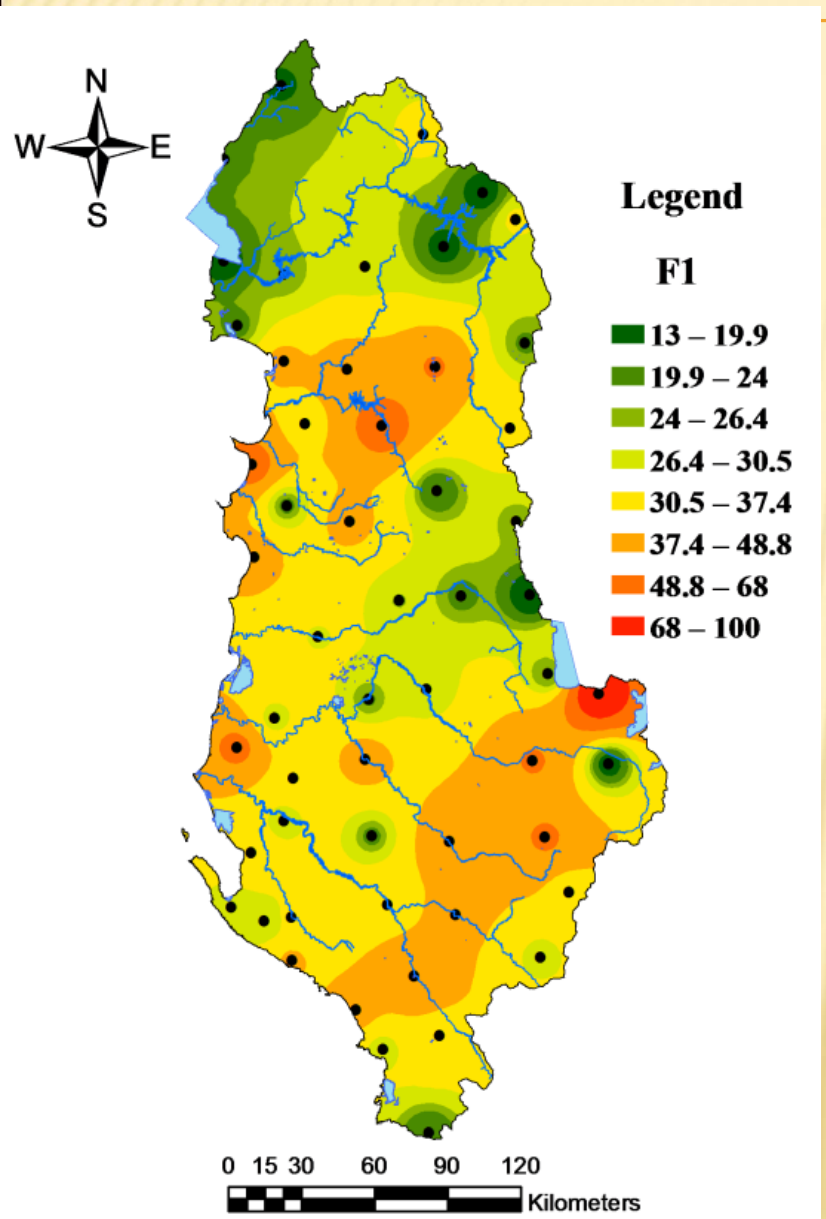
PLI and RI

b.

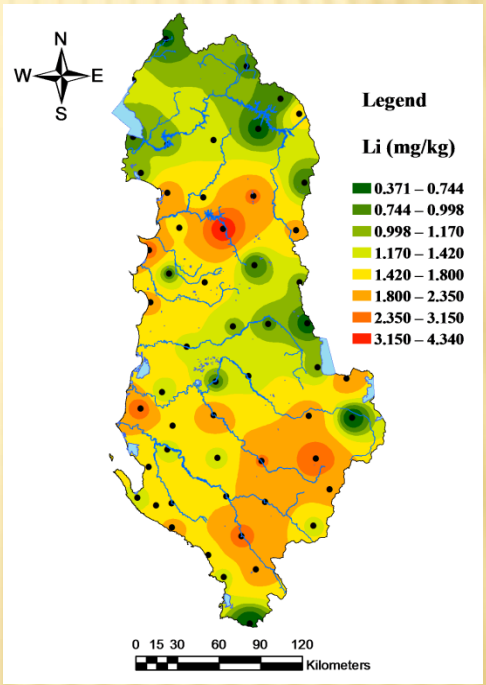

N
W
E
S
Legend
PLI site
1.8 – 2.0 (MP to UP)
2.0 – 3.0 (MP)
3.0 – 3.5
3.5 – 4.0
(MP to HP)
4.0 – 4.5
4.5 – 5.0
(HP)
5.0 – 7.5
7.5 – 11
(EP)
0 15 30 60 90 120
Kilometers


N
W
E
S
Legend
RI site
Moderate pollution
188 – 230
230 – 260
260 – 280
280 – 300
Considerable pollution
300 – 350
350 – 400
400 – 500
500– 600
High pollution
600 – 900
900 – 1,290
0 15 30 60 90 120
Kilometers

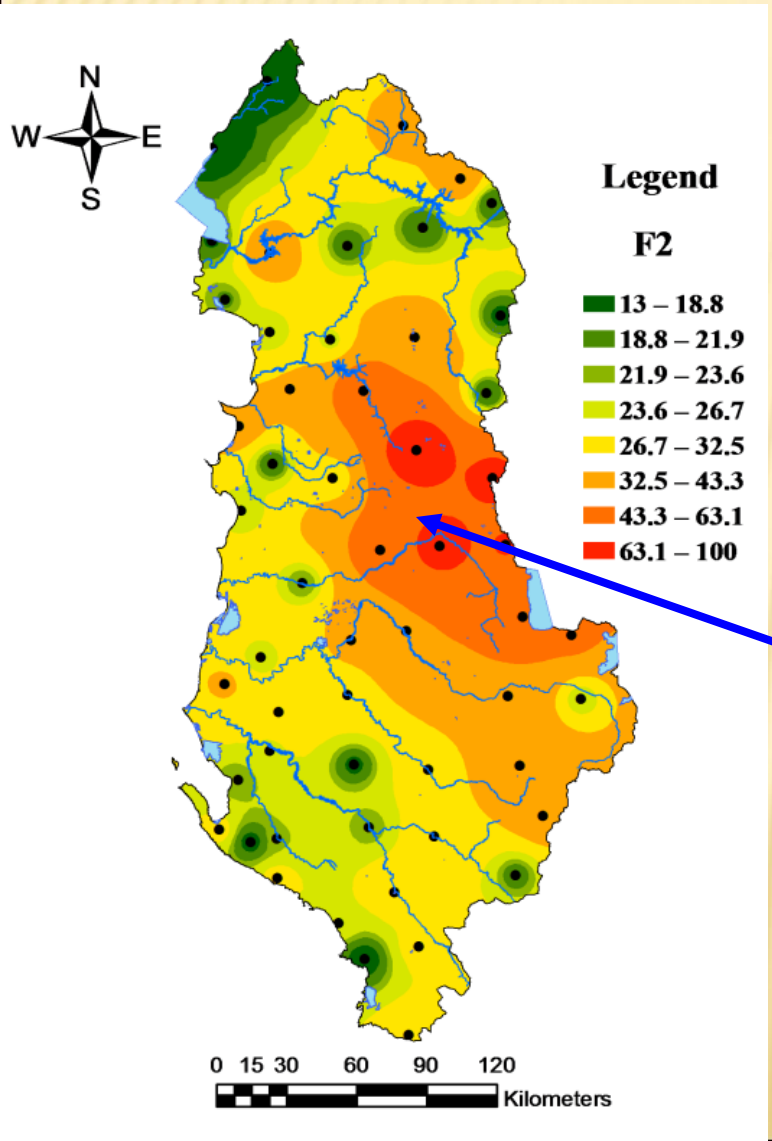
Factor analysis

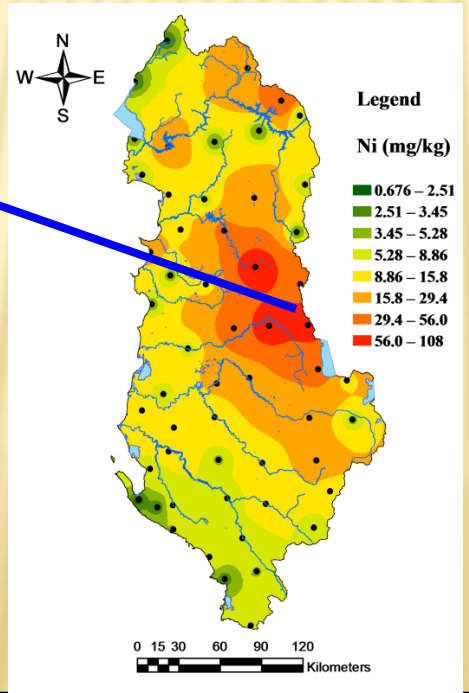


***F1* – Al, Mn, V, Fe, and Li**

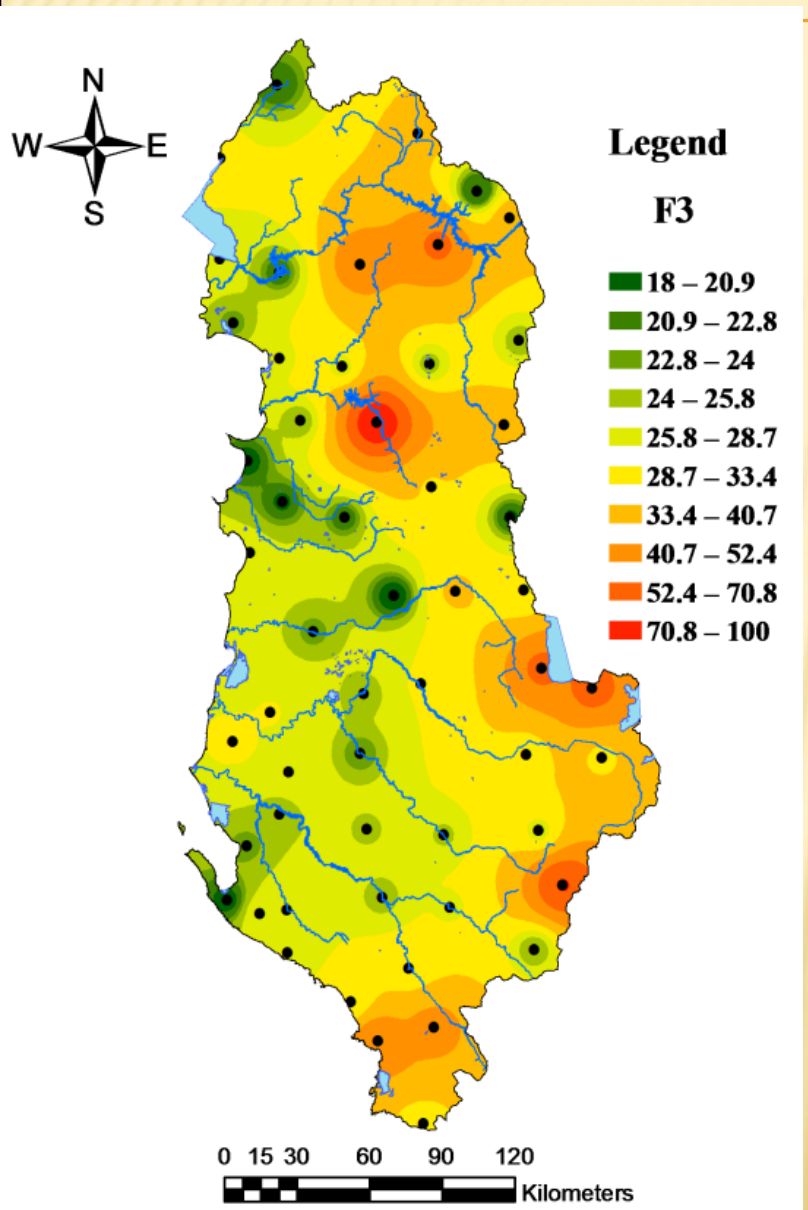


F2 – Cr, Ni, Co (and Pb)

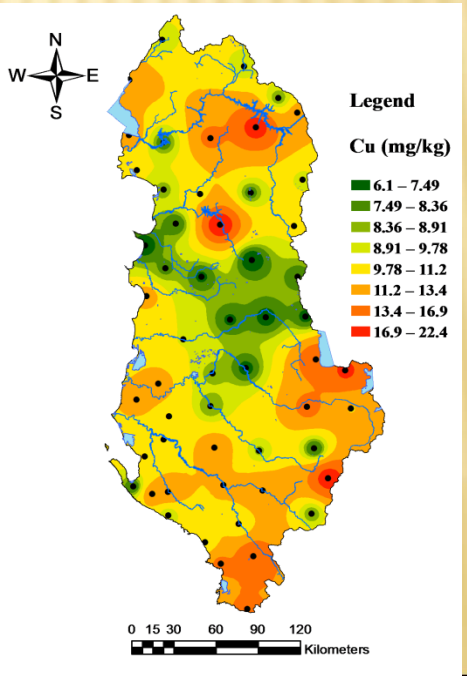




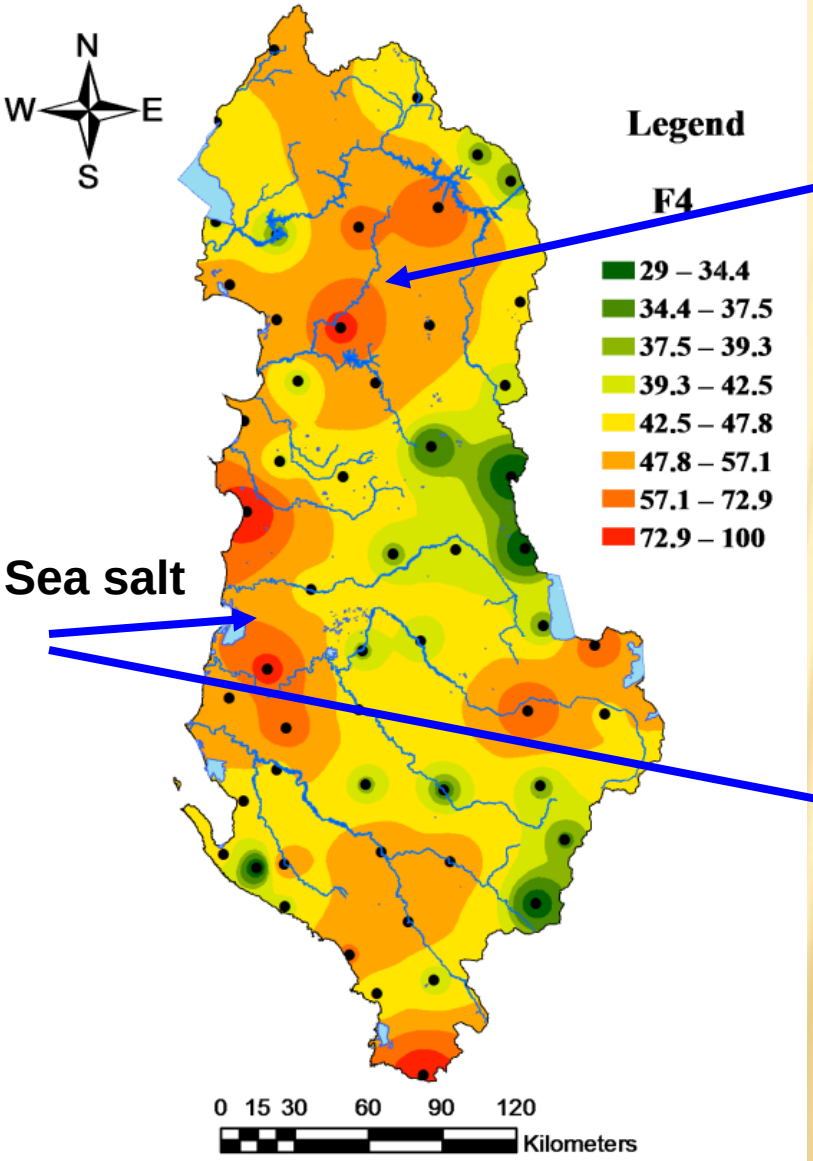
F3 – Cu, Pb, Zn, As, Cd and Pb

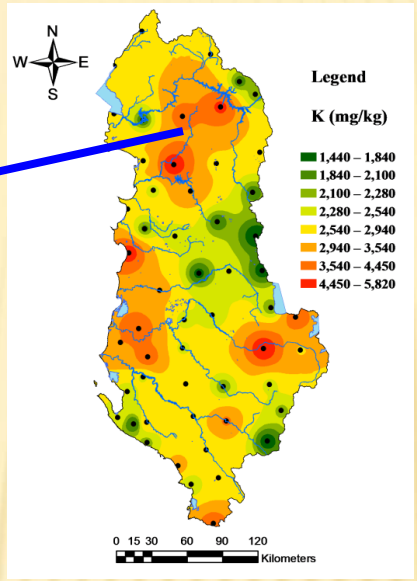


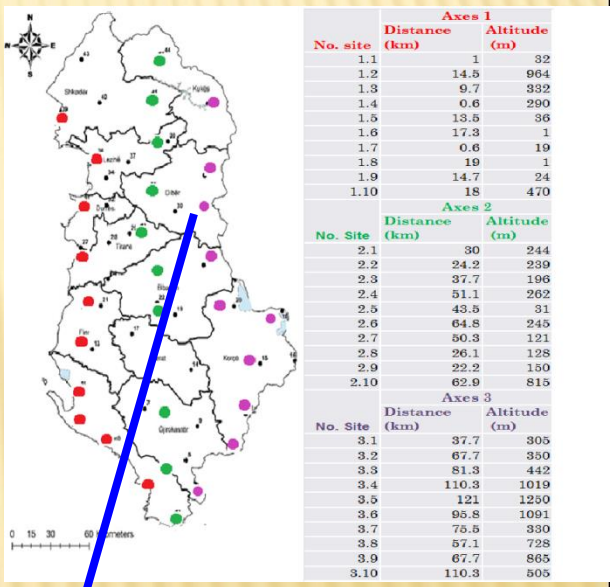
harmful substances (As, Cd, Pb, Zn, Cu, Ga, S, Se, Te) in the waste material of the dumps - copper industry



F4 – Na and K



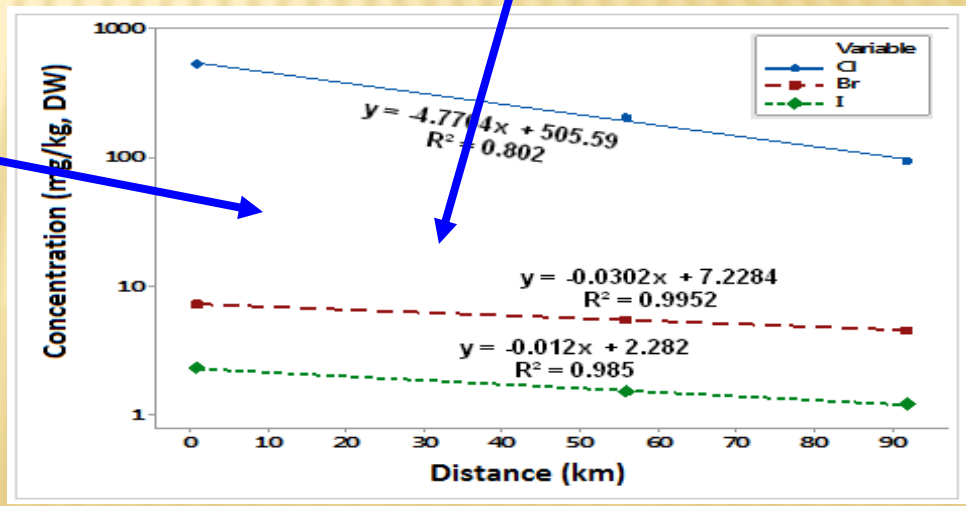




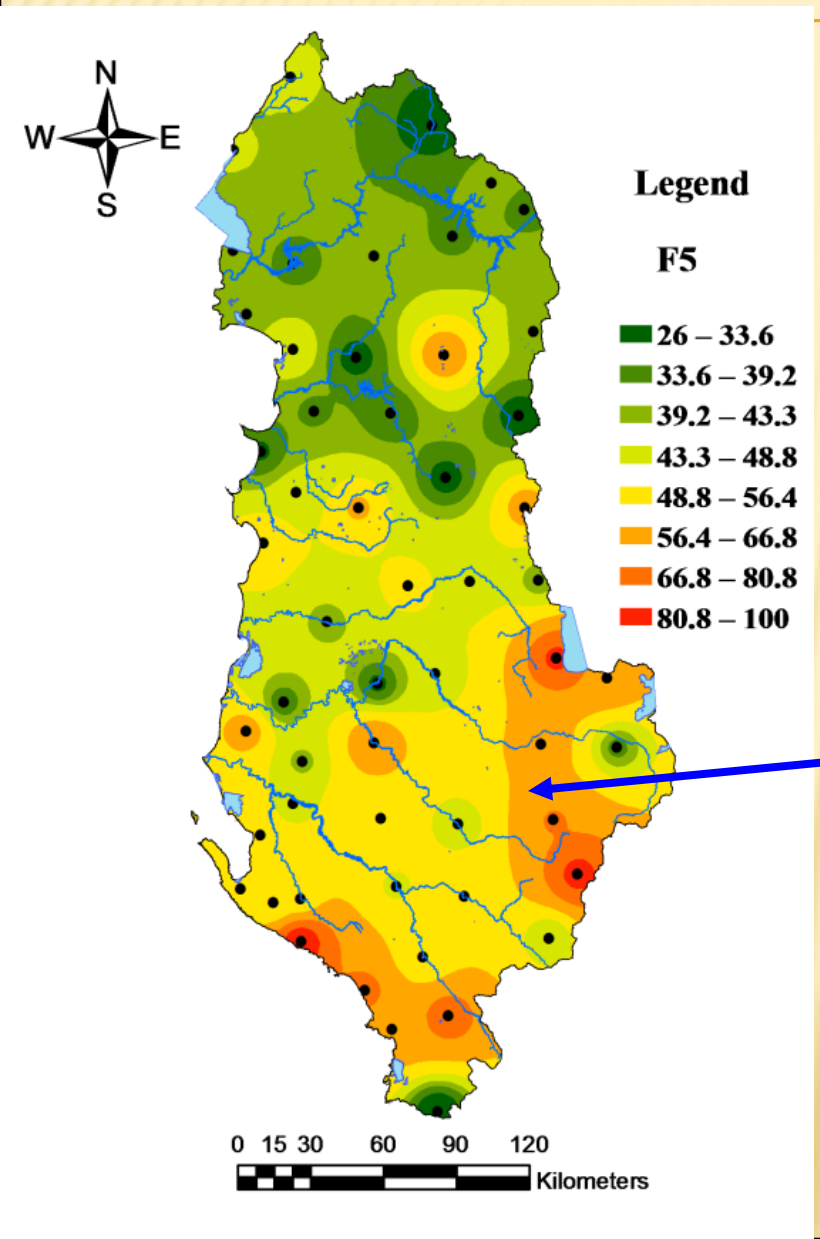
No. site	Axes 1 Distance (km)	Altitude (m)
1.1	1	32
1.2	14.5	964
1.3	9.7	332
1.4	0.6	290
1.5	13.5	36
1.6	17.3	1
1.7	0.6	19
1.8	19	1
1.9	14.7	24
1.10	18	470

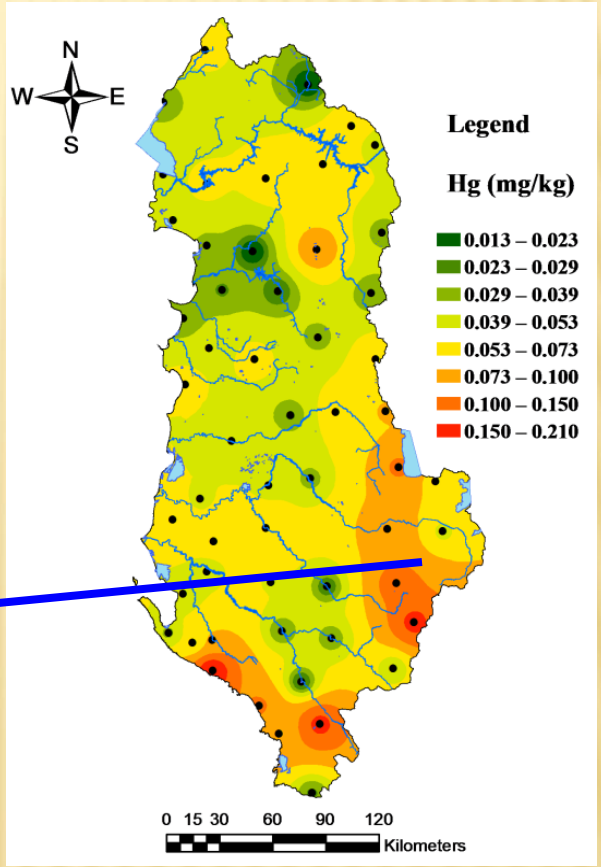
No. Site	Axes 2 Distance (km)	Altitude (m)
2.1	30	244
2.2	24.2	239
2.3	37.7	196
2.4	51.1	262
2.5	43.5	31
2.6	64.8	245
2.7	50.3	121
2.8	26.1	128
2.9	22.2	150
2.10	62.9	815

No. Site	Axes 3 Distance (km)	Altitude (m)
3.1	37.7	305
3.2	67.7	350
3.3	81.3	442
3.4	110.3	1019
3.5	121	1250
3.6	95.8	1091
3.7	75.5	330
3.8	57.1	728
3.9	67.7	865
3.10	110.3	505



F5 – Hg and Ca


N
W
E
S
Legend
F5
26 – 33.6
33.6 – 39.2
39.2 – 43.3
43.3 – 48.8
48.8 – 56.4
56.4 – 66.8
66.8 – 80.8
80.8 – 100
0 15 30 60 90 120
Kilometers


N
W
E
S
Legend
Hg (mg/kg)
0.013 – 0.023
0.023 – 0.029
0.029 – 0.039
0.039 – 0.053
0.053 – 0.073
0.073 – 0.100
0.100 – 0.150
0.150 – 0.210
0 15 30 60 90 120
Kilometers

Conclusions

The main conclusions are:

♦ Moss biomonitoring combined with trace metal analysis, statistical analysis, GIS technique and different contamination models are important tools for investigating the spatial distribution of heavy metal atmospheric deposition and assessing air quality.

♦ High variability of moss metal concentrations show the spatial distribution patterns of heavy metal concentrations on the moss that is site specific for each element.

♦ Contamination models used in this study indicate high pollution Level of HM atmospheric pollution, derived mostly from anthropogenic factors

♦ Current moss biomonitoring shows serious environmental problems in trace metal atmospheric deposition in Albania that require further attention and continuously monitory.

♦ The calibration of the method and the determination of critical limits are important for more correctly interpretation of the data.

THANK YOU!