

# Analyzing the Accumulation of Trace Elements in Moss Samples from Agricultural and Mountainous Environments

**Chaligava O.<sup>1,2,3</sup> Ziniovsciaia I.<sup>3</sup>, Peshkova A.<sup>2,3</sup>, Yushin N.<sup>2,3</sup>, Frontasyeva M.V.<sup>3</sup>,  
Vergel K.<sup>2,3</sup>, Grozdov D.<sup>3</sup>, Cepoi L.<sup>2</sup>**

*<sup>1</sup>Sector of Neutron Activation Analysis and Applied Research, Division of Nuclear Physics, FLNP, Joint Institute for Nuclear Research, Dubna, Moscow Region, Russian Federation*

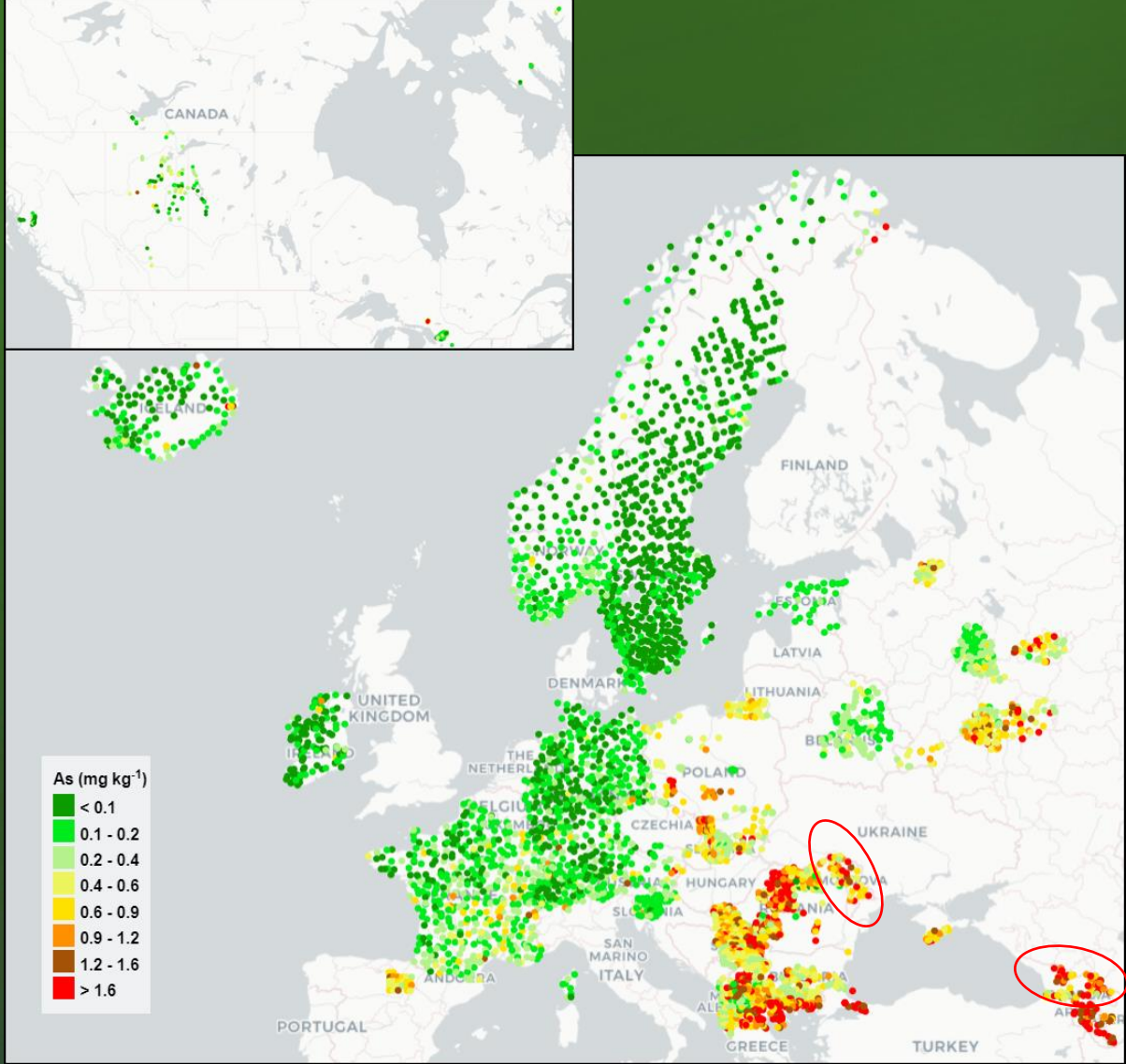
*<sup>2</sup>Doctoral School Biological, Geonomic, Chemical and Technological Science, Moldova State University, Chisinau, Republic of Moldova*

*<sup>3</sup>Faculty of Informatics and Control Systems, Georgian Technical University, Tbilisi, Georgia*

*\*e-mail: chaligava@jinr.ru*

# Moss Biomonitoring

Since 2014 Republic of Moldova, as well as Georgia participates in the moss biomonitoring programme of the UNECE ICP Vegetation.



According to 2015-2016 Moss Survey report the concentration of elements in moss samples from Georgia and Moldova were often higher compared to other countries participating in the program.



# Areas under investigation



Moldova's terrain is mostly lowland and hilly, with 74% of its land being agricultural. Georgia is predominantly mountainous with 43% of its land used for agriculture.



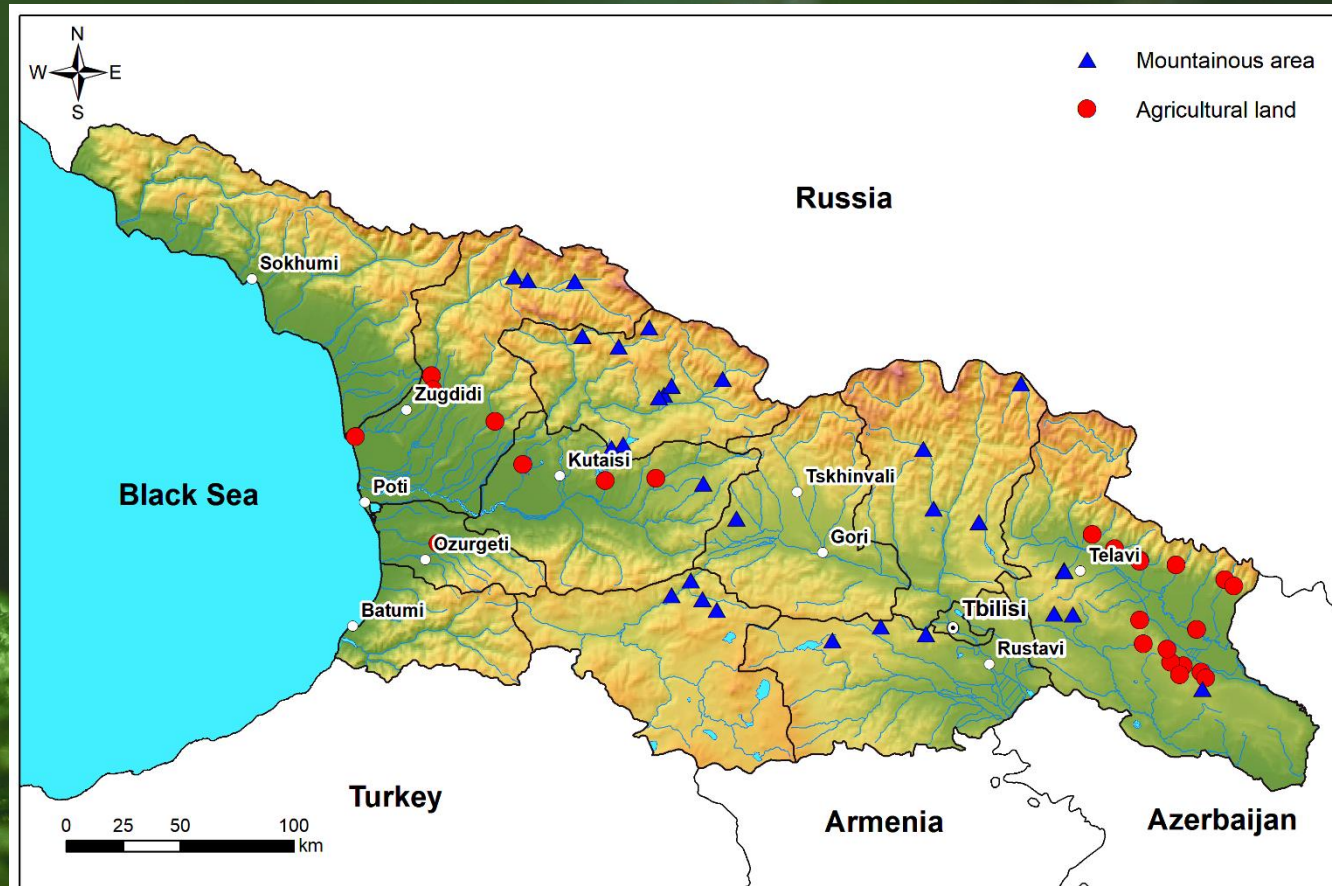
# Sampling maps

*Hypnum  
cupressiforme*  
Hedw.



Altitude range  
from 6m to 348m

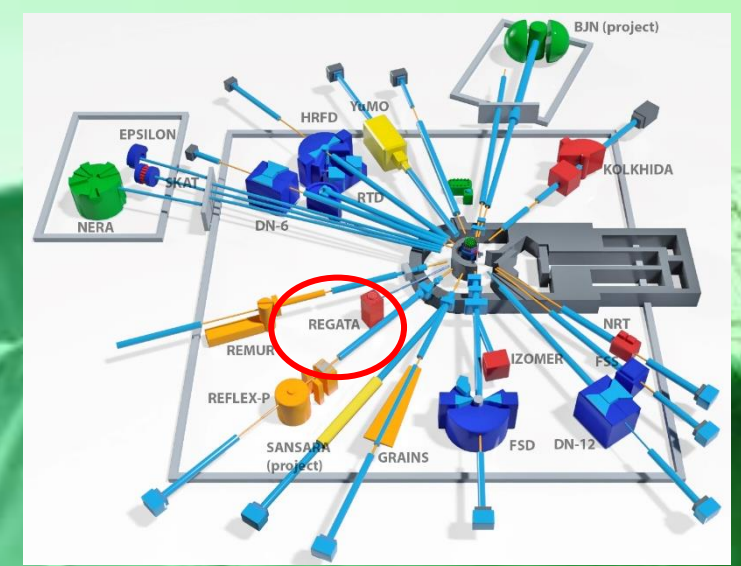
Altitude range  
from 3m to 1802m



# Analysis

## Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES)

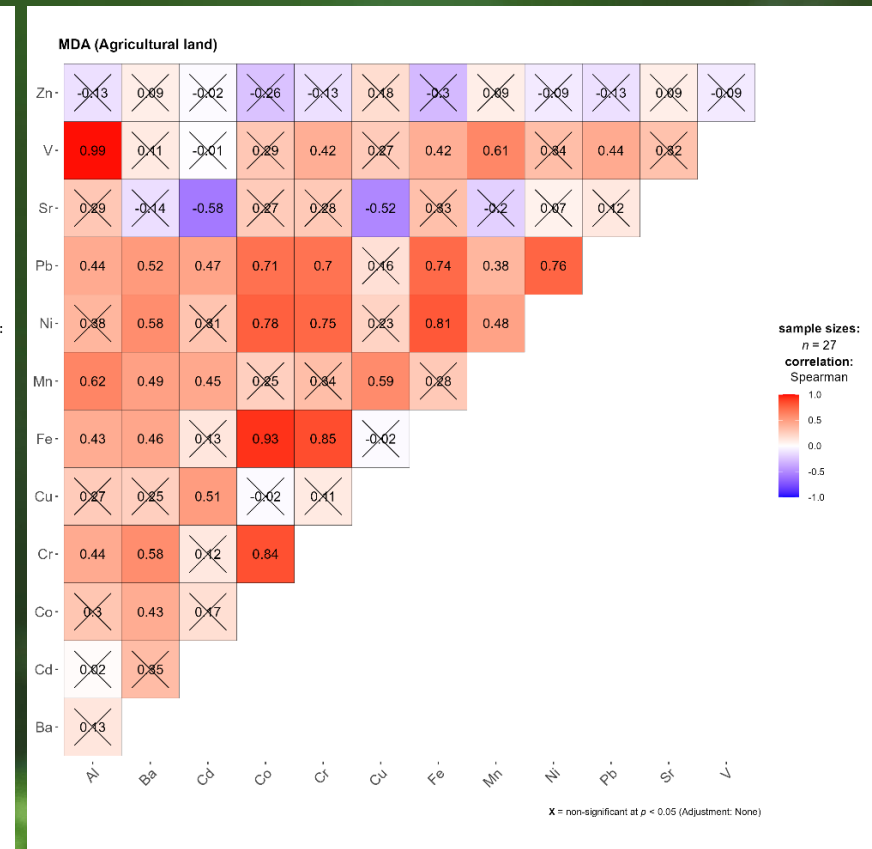
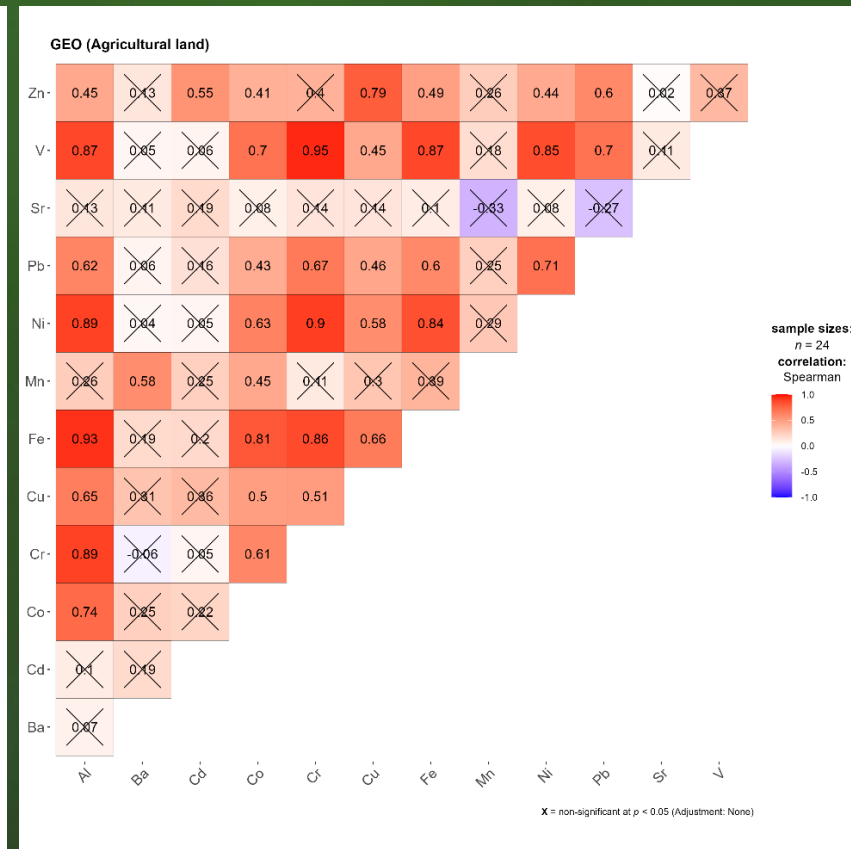
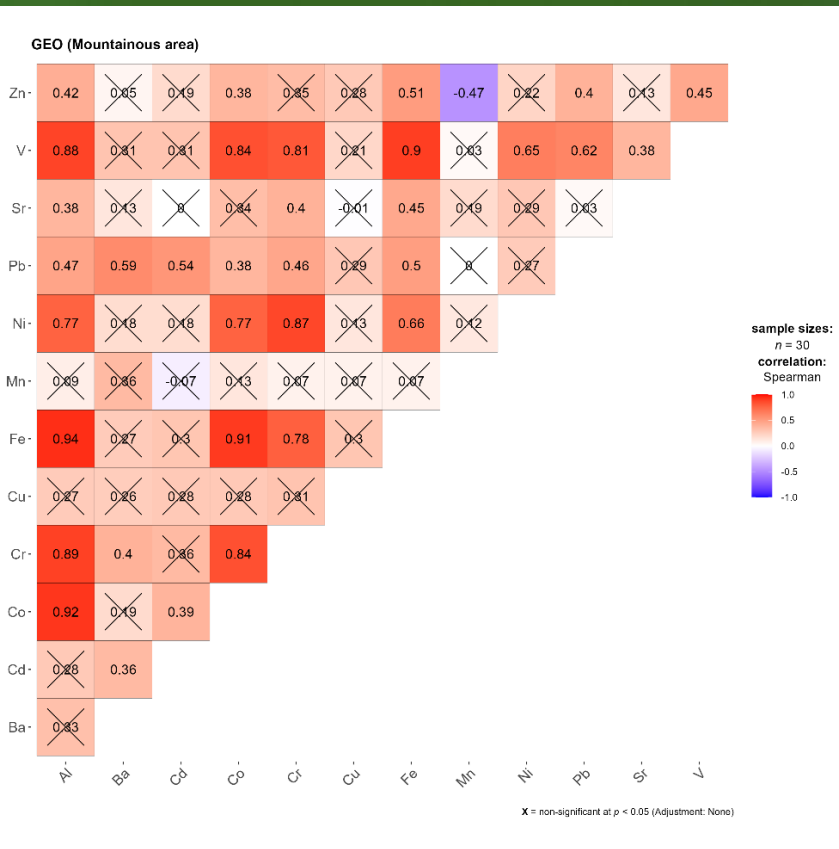
- **Sample Preparation:** 0.5g of moss was placed in a Teflon vessel and digested with 5 mL of nitric acid (HNO<sub>3</sub>) and 2 mL of Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) at a temperature of 180 °C in a microwave digestion system. The solutions were quantitatively transferred into 50 ml calibrated flasks and made up to volume with bidistilled water.
- The concentrations of 14 elements (Al, Ba, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, S, Sr, V and Zn) in moss samples were determined.



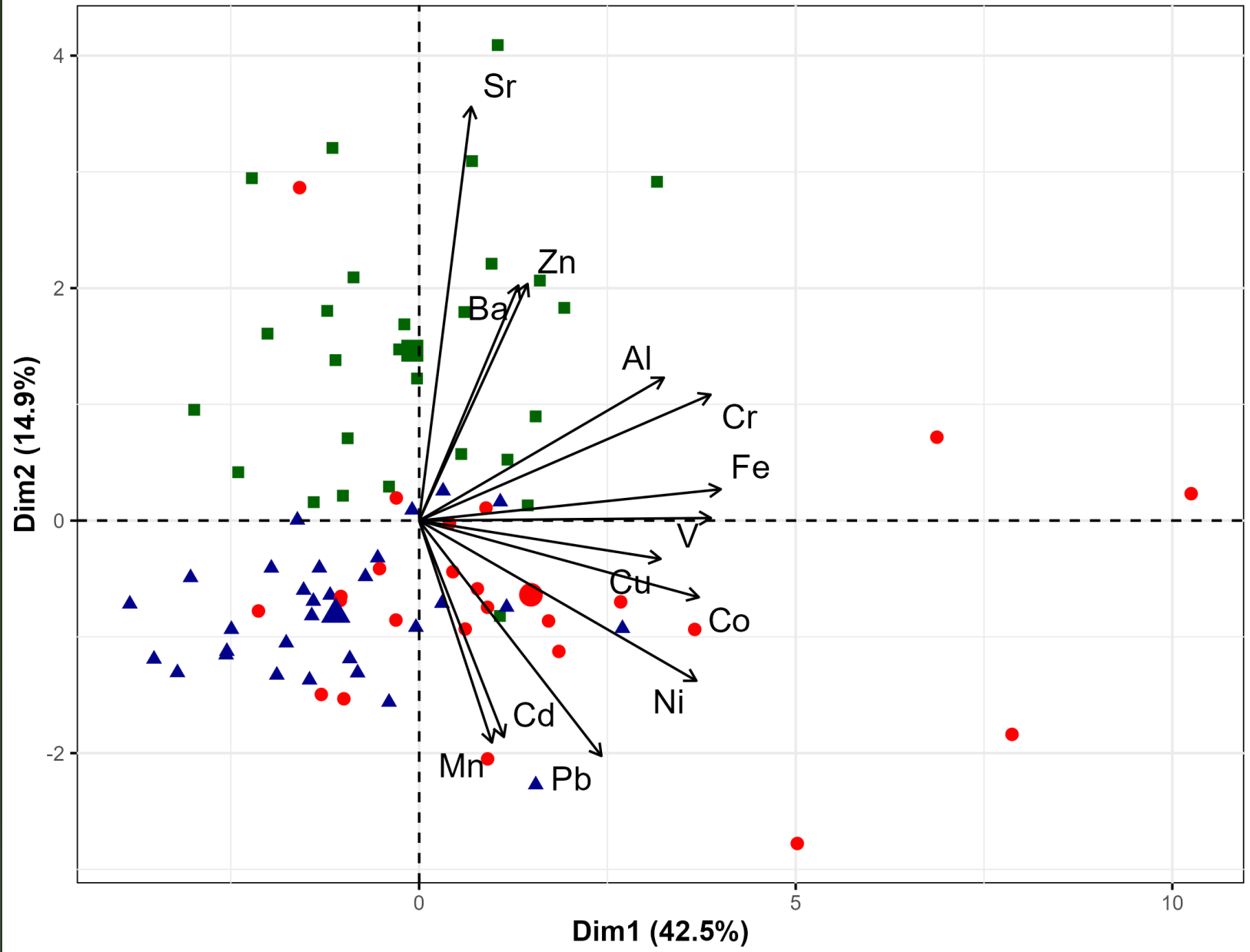
## Neutron Activation Analysis (NAA)

- **Sample Preparation:** About 0.3 g of moss was pelletized in press-form and packed for short-term and long-term irradiation.
- The concentrations of 39 (Na, Mg, Al, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, As, Se, Br, Sr, Zr, Mo, Pb, Sb, I, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Yb, Hf, Ta, W, Au, Th, U) elements in moss samples was determined using REGATA facility at the IBR-2 (JINR).

# Correlation

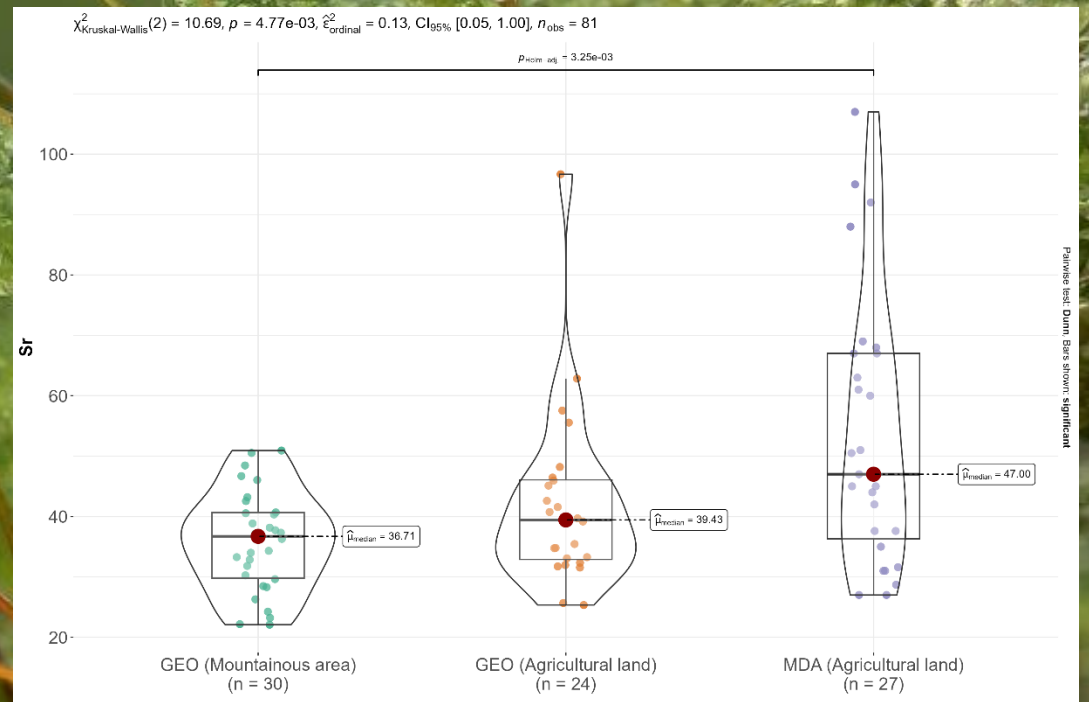
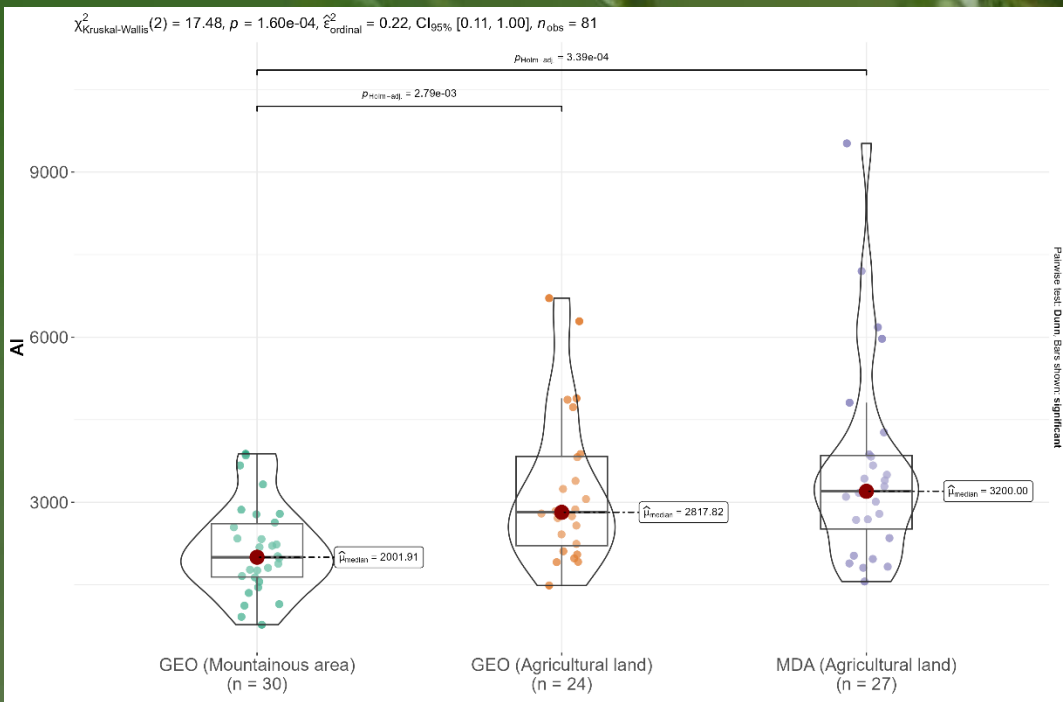
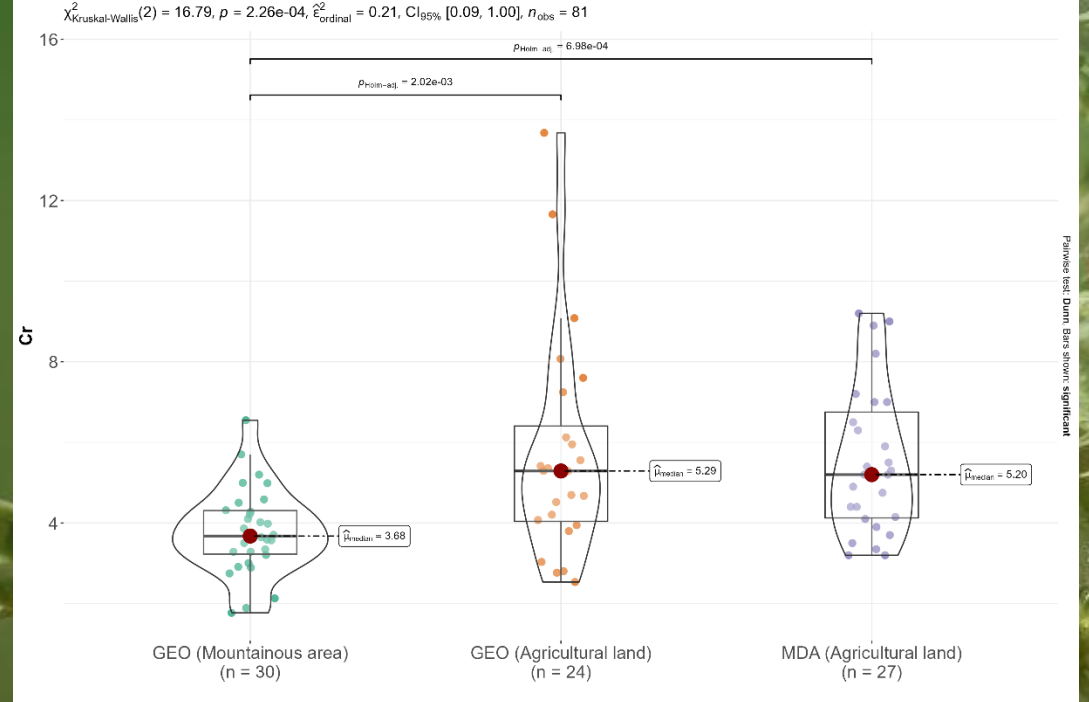
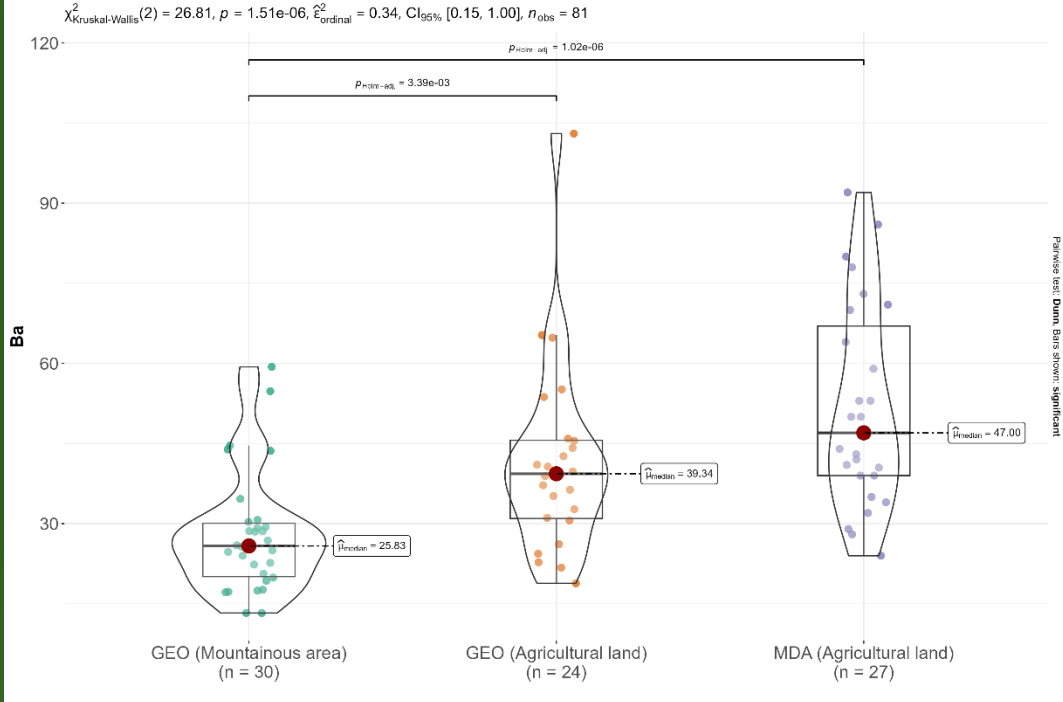


PCA - Biplot

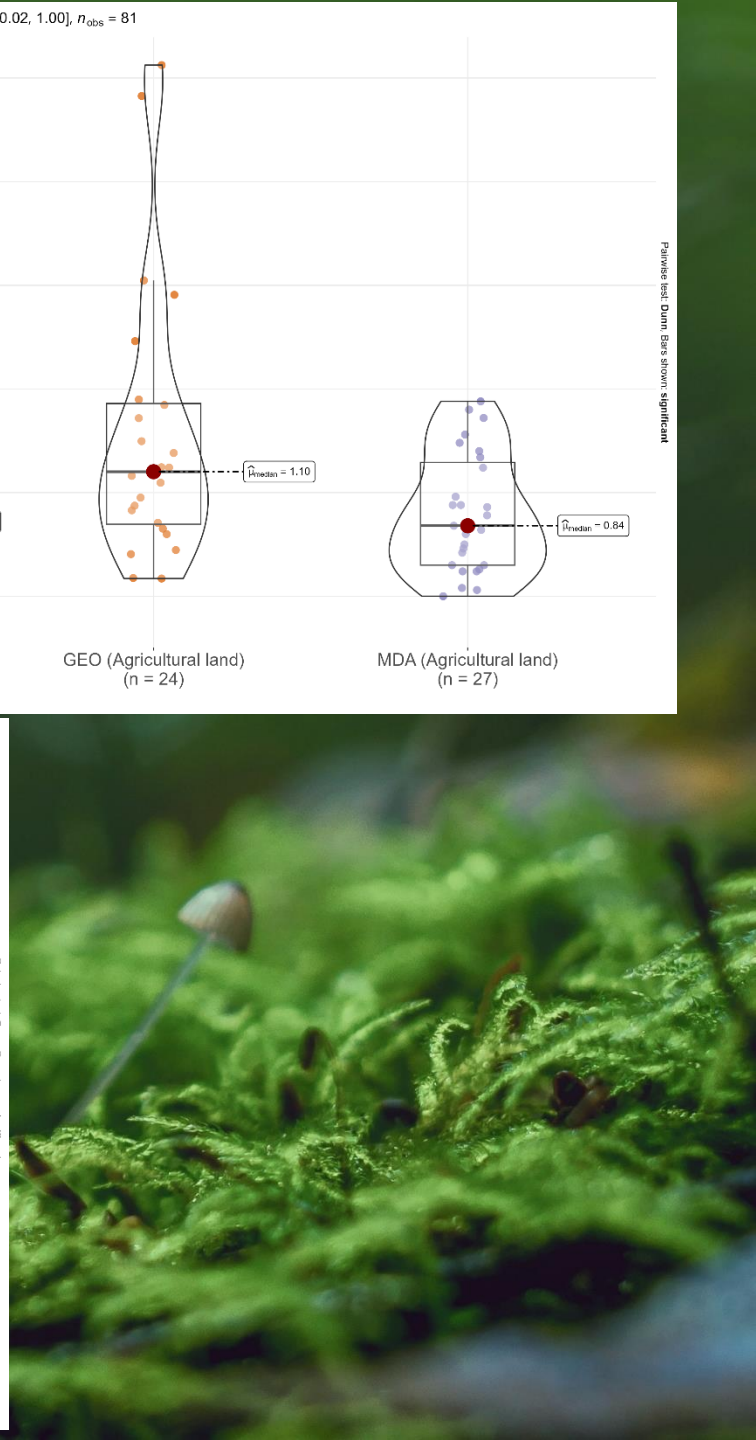
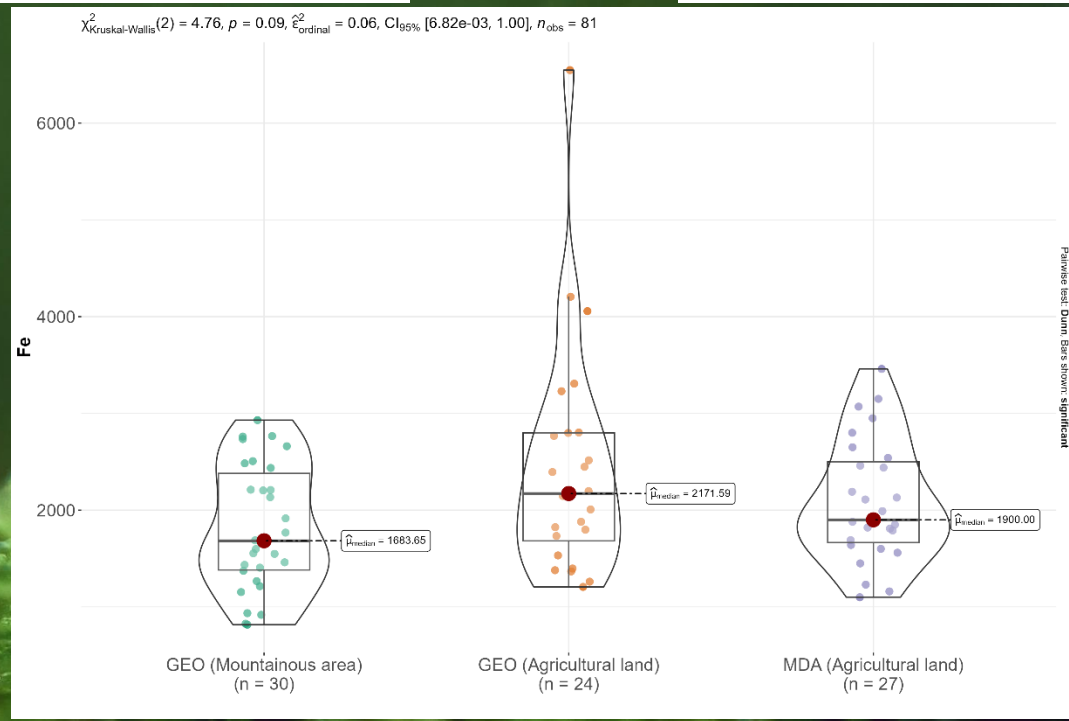
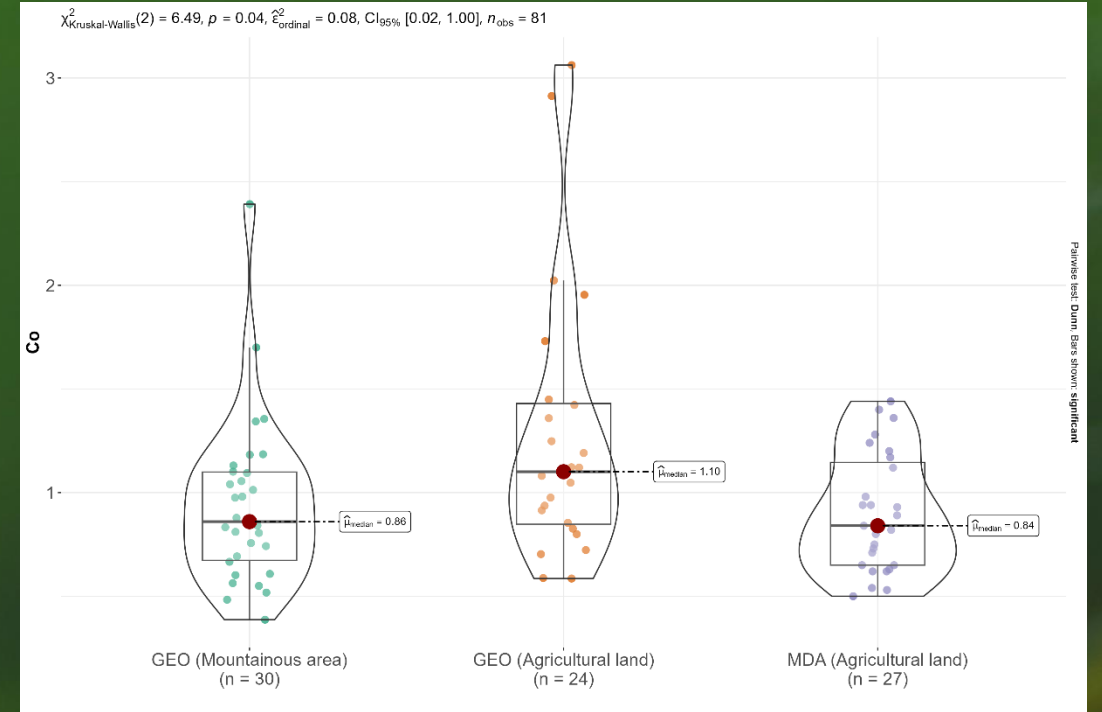
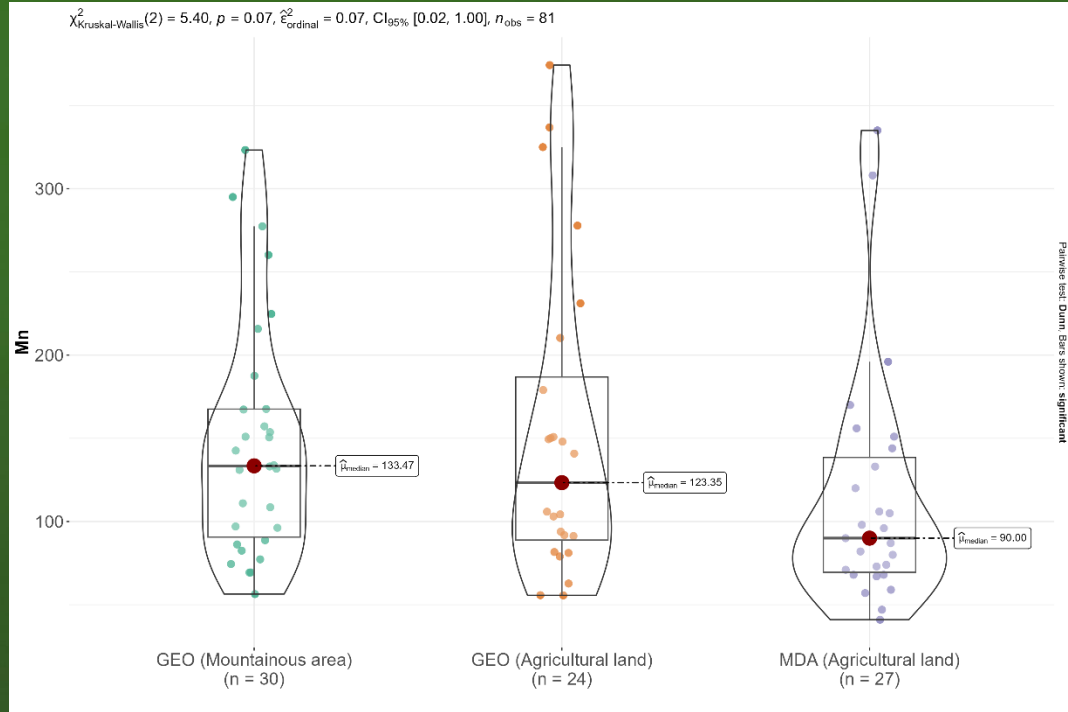


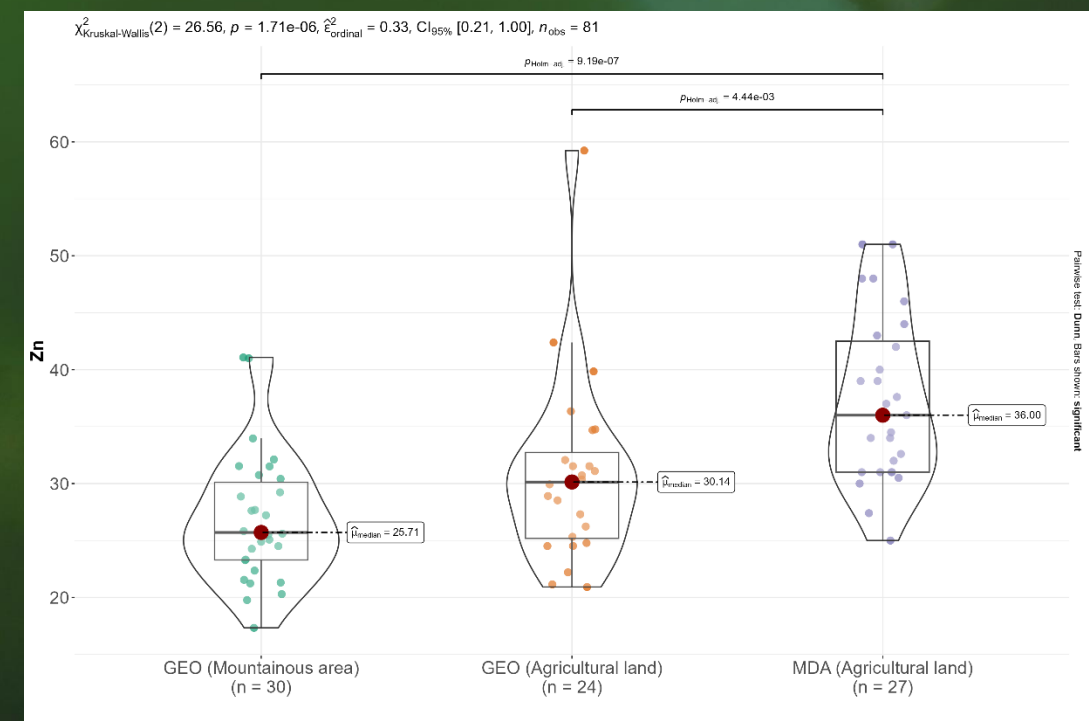
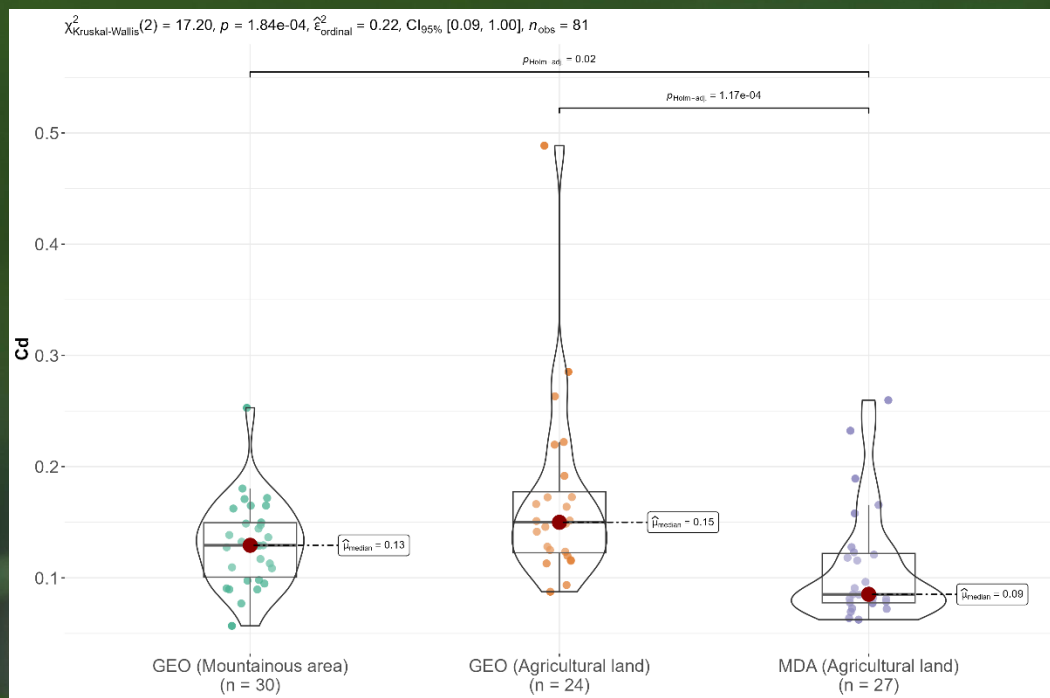
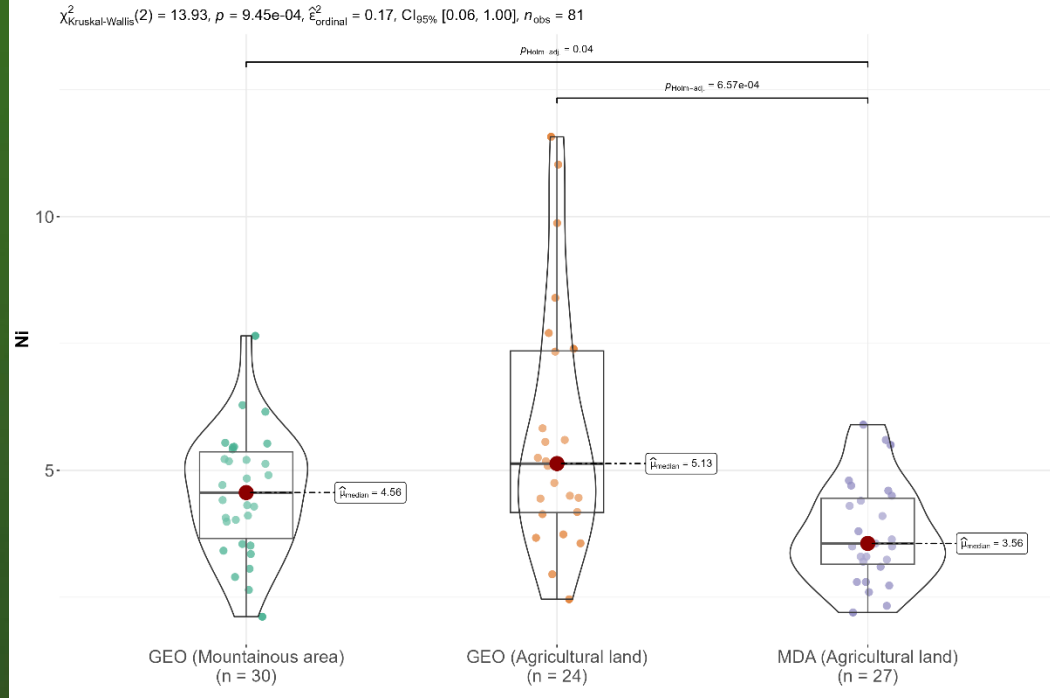
**Groups**

- ▲ GEO (Mountainous area)
- GEO (Agricultural land)
- MDA (Agricultural land)





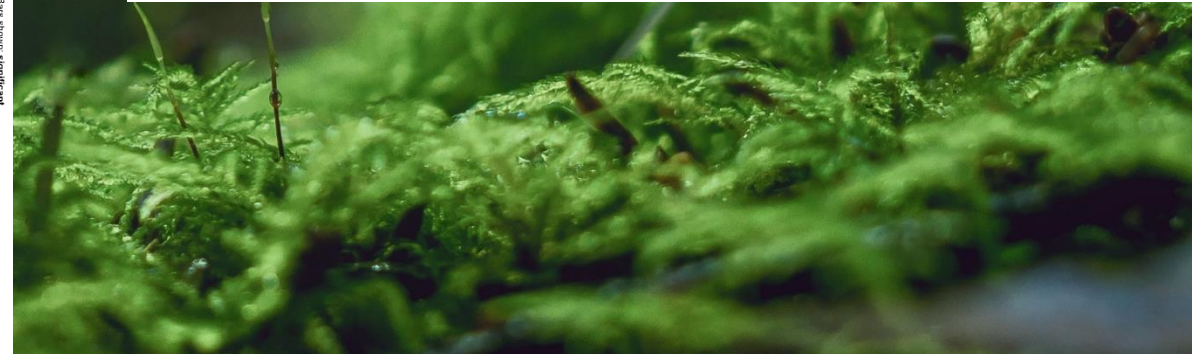


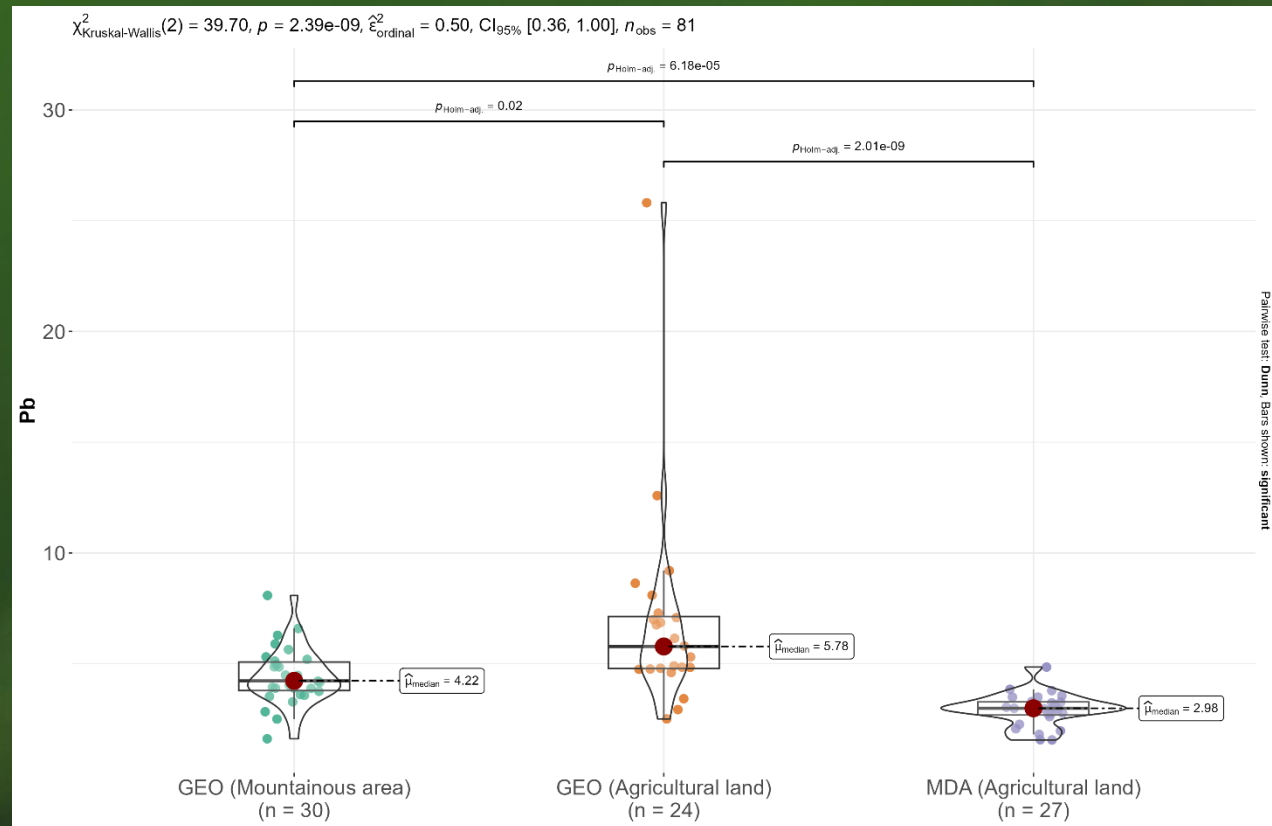
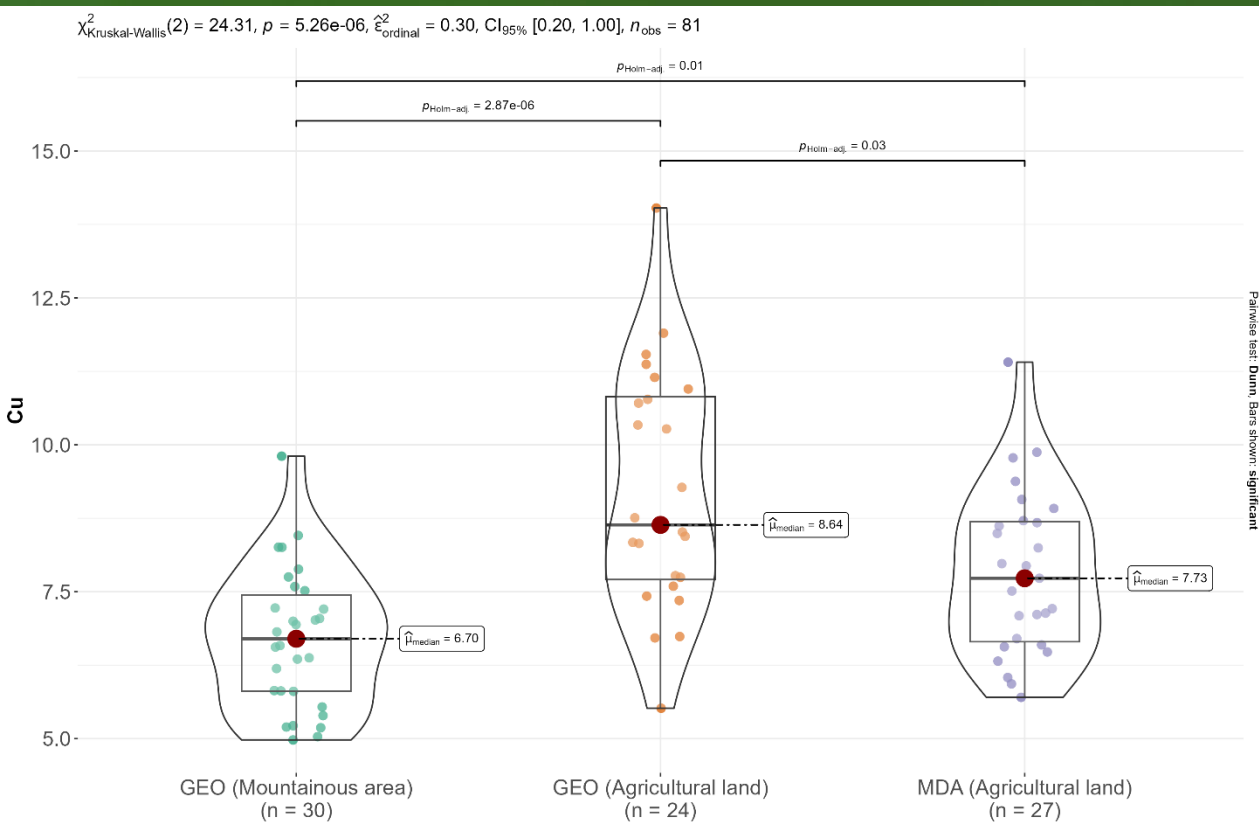


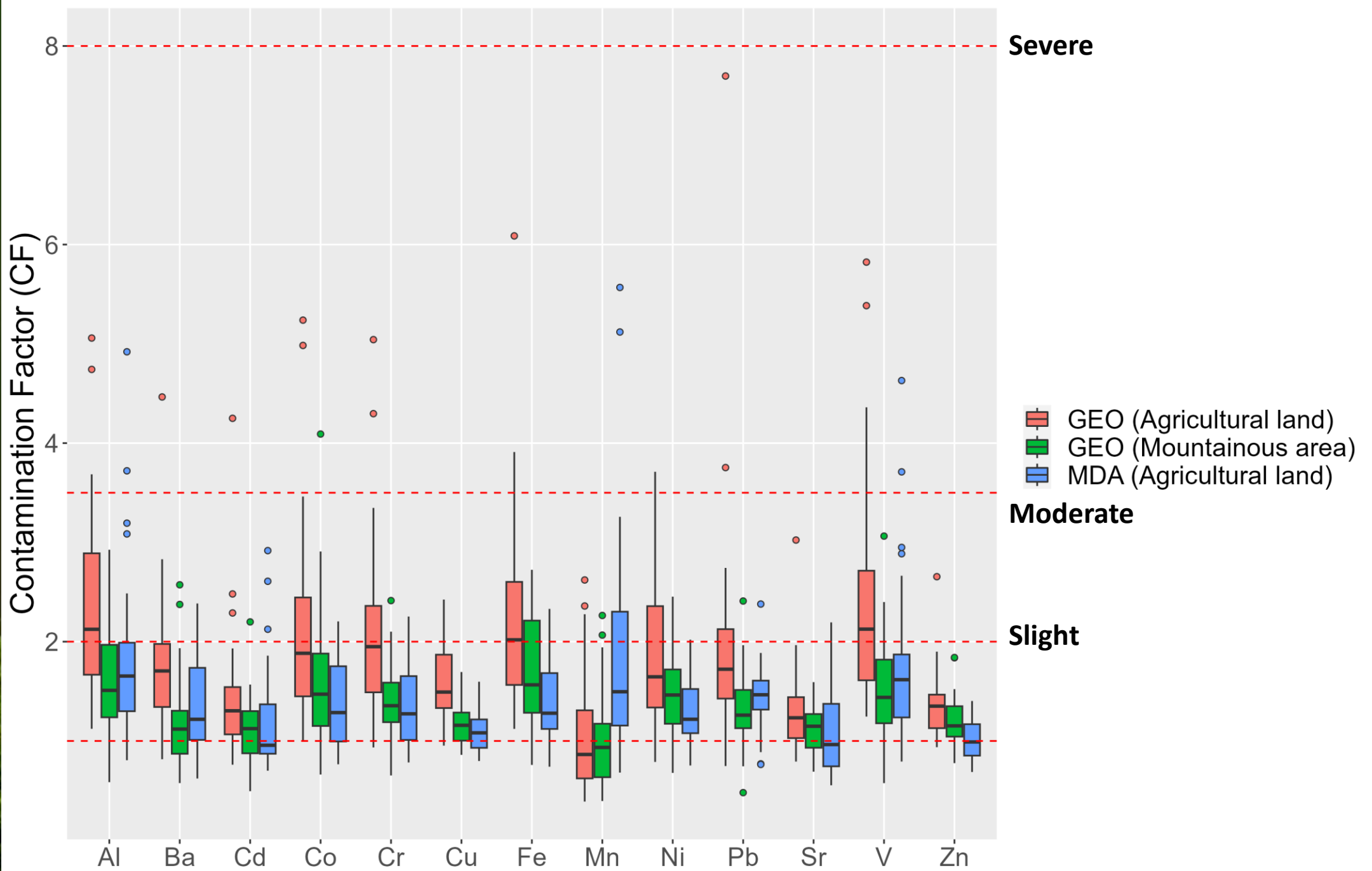
Pairwise test: Dunn. Bars shown: significant

Pairwise test: Dunn. Bars shown: significant

Pairwise test: Dunn. Bars shown: significant









Heretiskari

Tsitelgori

QAYSA

Alazani

87

Alazani

Alazani

4 km

Google Earth

Image © 2024 Maxar Technologies

Image © 2024 Airbus

Image © 2024 CNES / Airbus



87

Alazani

Alazani

Alazani

Alazani

N

1 km

Google Earth

Image © 2024 Maxar Technologies

Image © 2024 CNES / Airbus

Image © 2024 Airbus

# Conclusions

- It can be assumed that pollutants are spread more easily in open areas than in the mountains.
- Cr and Cu are often used as fertilizer components, so their concentrations are higher in agricultural areas.
- These two countries have a little different geochemical composition. The distribution of Ni, Cd and Zn differ slightly in agricultural and mountainous areas of Georgia, but differ significantly from Moldova.
- The impact of transport on the environment is traceable in Georgia.
- Research should be continued to discover other connections between the distribution of elements and environmental conditions.

Thank you for attention!

