

## BIOMONITORING LONG-TERM AND LARGE-SCALE DEPOSITION OF POLLUTANTS BASED ON MOSS ANALYSES

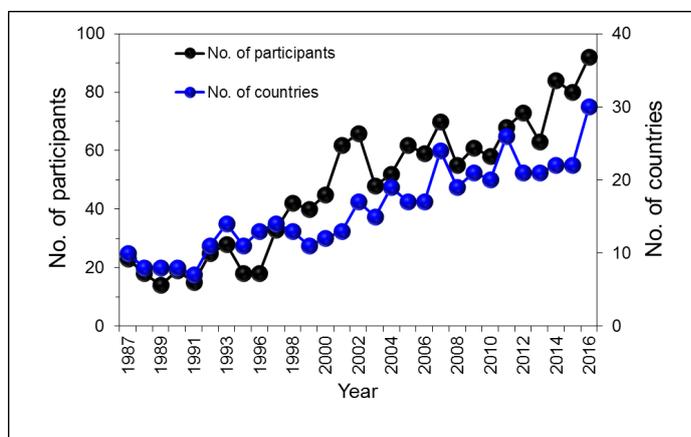
Marina Frontasyeva

*Joint Institute for Nuclear Research, Frank Laboratory of Neutron Physics, Division of Nuclear Physics, Department of Neutrino Activation Analysis and Applied Research, Dubna, Russian Federation*  
[marina@nf.jinr.ru](mailto:marina@nf.jinr.ru)

**Keywords:** UNECE ICP Vegetation; moss biomonitoring; trace elements; nitrogen, persistent organic compounds; radionuclides

### Introduction

A brief historical review is given on the development and milestones of the moss biomonitoring technique used to study atmospheric deposition of trace elements, nitrogen, organic persistent pollutants (PAHs, PCBs, PBDEs, dioxins, PFOS, *etc.*) and radionuclides of technogenic origin in Europe. The relevance of these studies to the UN Convention on long-range transboundary air pollution (LRTAP) is enlightened (<http://icpvegetation.ceh.ac.uk/>). Since 2014 coordination of this Programme moved to the JINR in Dubna, RF, and is conducted by the author of this presentation in the framework of the UNECE ICP Vegetation. In agreement with the long-term strategy of the LRTAP Convention to enhance participation and improve air quality in Eastern Europe, the Caucasus, Central Asia and South Eastern Europe, efforts to extend the moss survey for former republics of the USSR were successfully undertaken in countries such as Azerbaijan, Georgia, Kazakhstan, and Moldova. Armenia and Uzbekistan most probably will join the moss survey in summer of 2016. Around 15 teams are formed in Russia to cover with moss sampling in Northern and Central Russia, Western Siberia, and Far East of Russia (Kamchatka and Sakhalin).



**Figure 1.** Number of experts and countries participating in ICP Vegetation Task Force Meetings between 1987 and 2016.

JINR will continue support for the moss survey in some of its member states: Bulgaria, Czech Republic, Mongolia, Poland, Romania, Slovakia, Vietnam, as well as in some non-member states: Albania, Croatia, Hungary, Thailand, South Korea, and China. Up-to-date 36 countries participate in the present moss survey (Figure 1). In spite of the growing interest in assessment of the deposition of persistent organic pollutants (PAHs, PCBs, PBDEs, dioxins, PFOS, *etc.*), only a limited number of the Western European countries intend to determine POPs.

Radioecological laboratories in JINR (Dubna, Russia), Institute of Nuclear Physics (Almaty, Kazakhstan), University of Novi Sad (Serbia), Bratislava University (Slovakia) and Opole University (Poland) will be used to measure natural and man-made radionuclides ( $^{137}\text{Cs}$ ,  $^{210}\text{Pb}$ , *etc.*) under individual agreements with the interested countries. Some details are given on the newly established database for storage of information about the European and Asian moss survey. Potentialities of using moss planchettes for search of cosmic dust are also mentioned.

## Methods

For analytical purposes the following methods are used: FAAS, GFAA, INAA, ICP-MS, ICP-ES. Such elements As, Cd, Cr, Cu, Fe, Hg, Ni, Pb, V, Zn, Al, Sb, N (%) are reported to the Atlas of Atmospheric Deposition of Heavy Metals and Nitrogen edited under that auspices of the United Nations.

## Results

The results are presented in the form of the Table of results of descriptive statistics (number of sampling sites, min, max, mean and median of concentrations of the elements enlisted above for each country. [http://icpvegetation.ceh.ac.uk/major\\_results/documents/Final\\_moss\\_survey\\_report\\_2005-6.pdf](http://icpvegetation.ceh.ac.uk/major_results/documents/Final_moss_survey_report_2005-6.pdf)

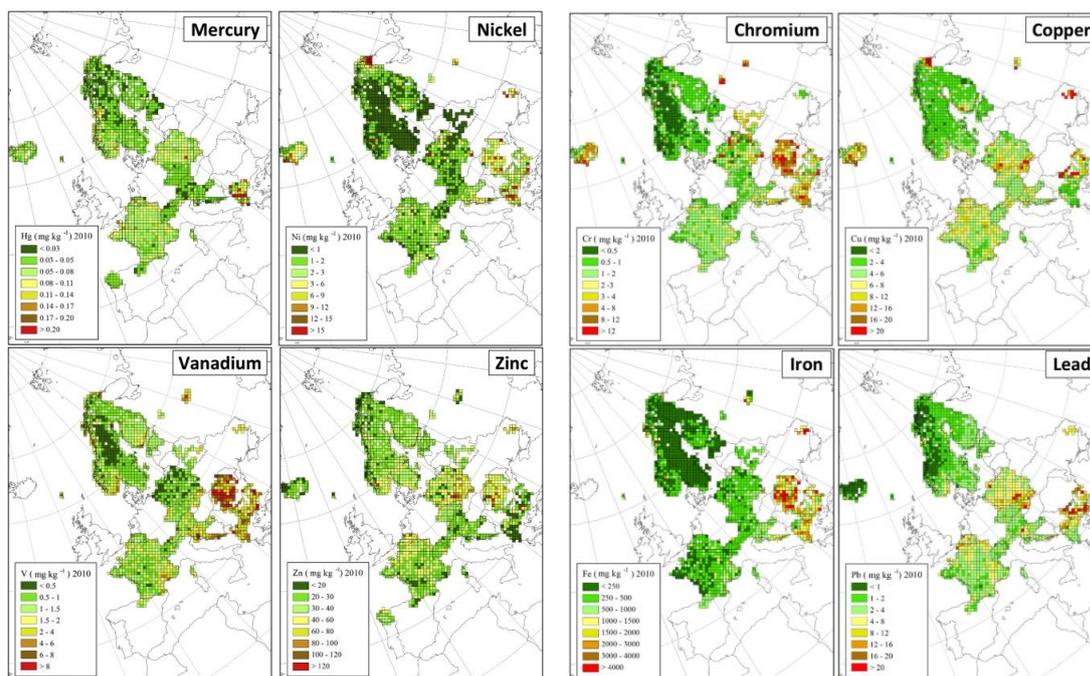


Figure 2. Distribution maps for moss survey 2010-2011 [1].

## Conclusion

The moss survey provides a cost effective method for monitoring heavy metal pollution across Europe at a high spatial resolution. Spatial trends of heavy metal concentrations in mosses are metal-specific. However, in general the lowest concentrations are observed in (north) Scandinavia, the Baltic States and northern parts of the United Kingdom and the higher concentrations in Belgium and eastern European countries. For cadmium and lead, concentration in mosses show the highest correlations with modelled depositions, followed by total emissions and the proportion of urban land use in a 100 km radius in Europe. For mercury, correlations between the concentration in mosses and modelled depositions or anthropogenic emissions are low. Between 1990 and 2005, the metal concentration in mosses has declined for arsenic (72%), cadmium (52%), copper (20%), iron (45%), nickel (20%), lead (72%), vanadium (60%) and zinc (29%), but not for chromium and mercury. Despite these general European trends, country and region-specific temporal trends were observed, including increases in metal

## Reference

- [1] Harmens, H., Norris, D.A., Sharps, K., Mills, G., ... Frontasyeva, M., ... Zechmeister, H. (2015) Heavy metal and nitrogen concentrations in mosses are declining across Europe whilst some “hotspots” remain in 2010. *Environmental Pollution*, Vol. 200, p. 93-104. <http://dx.doi.org/10.1016/j.envpol.2015.01.036>