

PLANT AND SOIL BIOMONITORING OF RADIONUCLIDE AND TRACE ELEMENT ATMOSPHERIC DEPOSITION OF SOUTH KOREA AND FAR EAST OF RUSSIA – SEQUENCES OF FUKUSHIMA DISASTER

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Introduction



Korea's current status of radionuclide exposure and air pollution -

- Increase of nuclear facilities
- Nuclear accidents : Fukushima
- Release of artificial radionuclides
- Yellow dust and fine dust delivered by China



**Necessity of radionuclide
and air pollution monitoring**



Introduction



Current monitoring -

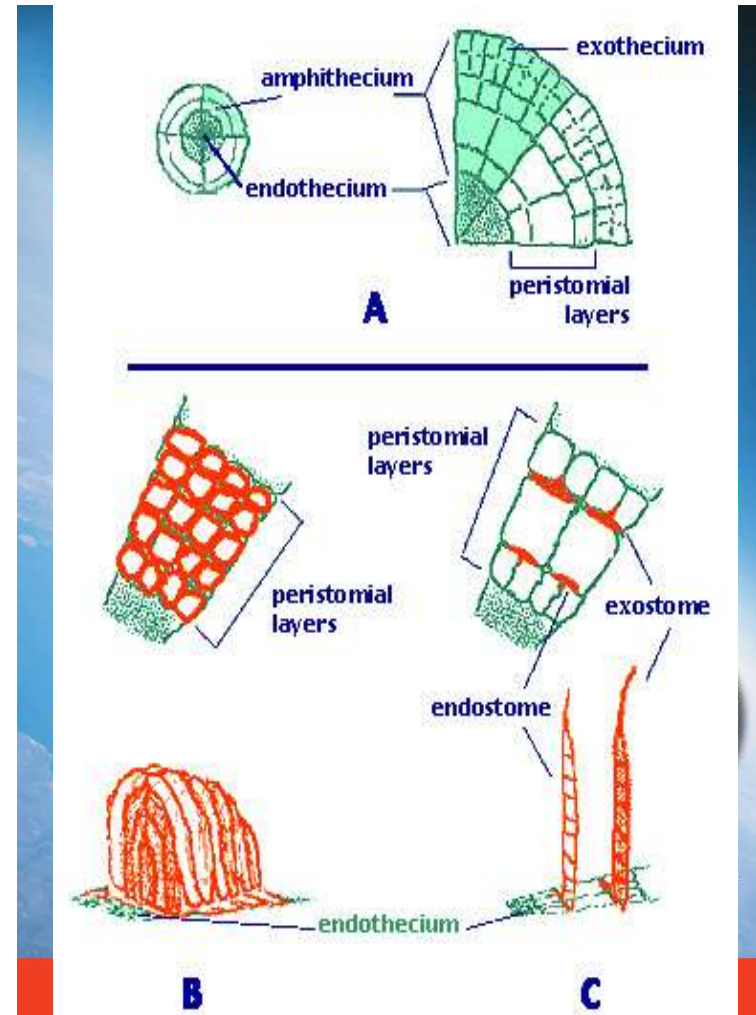
- Real-time monitoring for radionuclide (atmosphere, ocean) and dust (airborne)
- Not suitable for dose estimation
- Uncertainty of result
 - ✓ Natural radioactivity
 - ✓ Old-fashioned analyzed tools
- Difficulty in component analysis



Introduction

Moss and lichen biomonitoring -

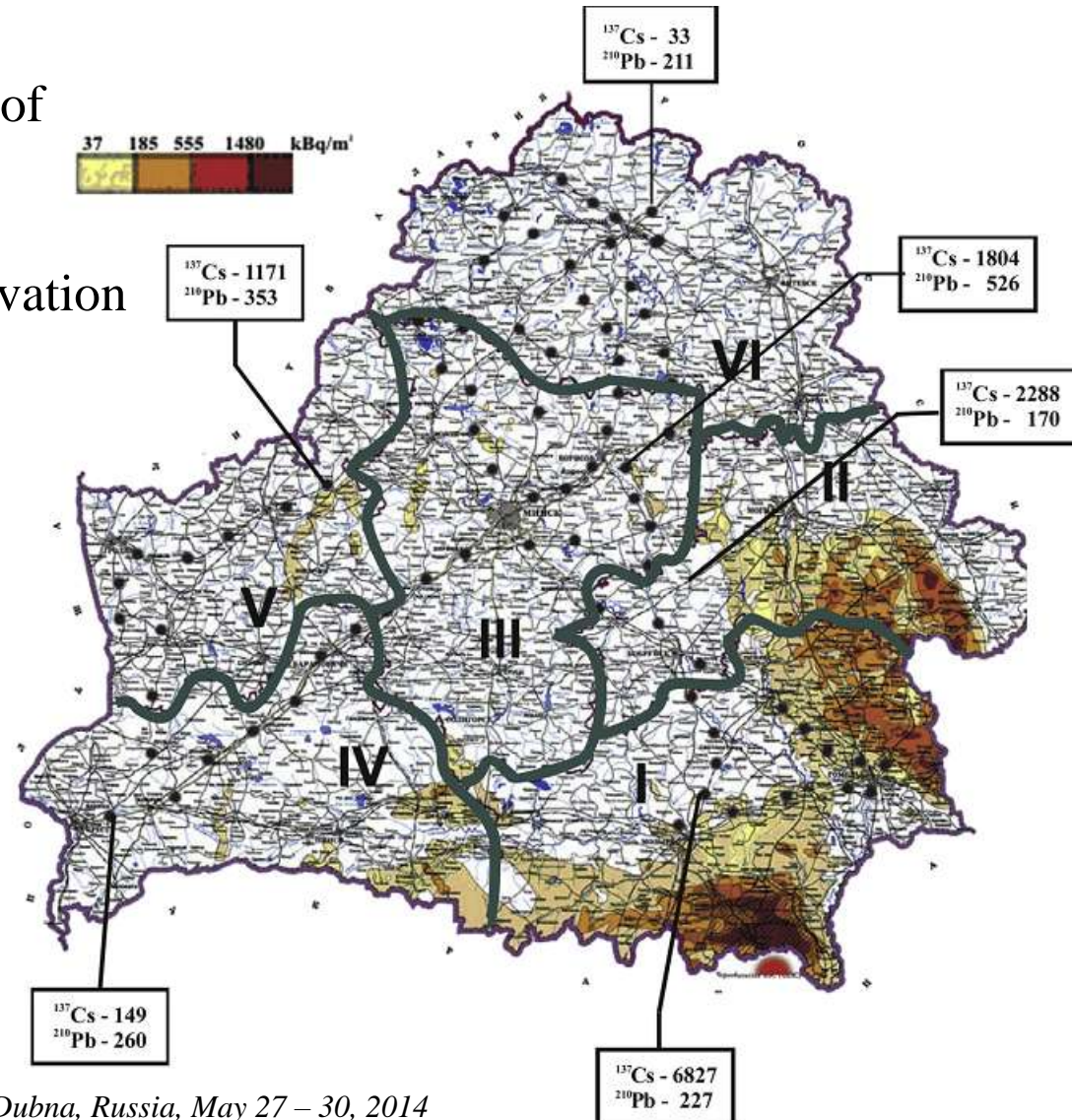
- Moss and lichen as a biomonitor for heavy metals and other pollutants
- Can afford and apply to radionuclides as well as heavy metals
- Moss and lichen have a **rudimentary root system**: Take up **heavy metals and radionuclides** from atmosphere
- Suitable for **spatial, temporal atmosphere monitoring**, and epidemiological study



Introduction

Moss and lichen biomonitoring -

- Used for measuring concentration of radionuclides near Chernobyl
- Using ICP-MS, NAA(neutron activation analysis) and other analysis tools
- Provision of accumulated data



ISINN-22, Dubna, Russia, May 27 – 30, 2014

Fig. 1. Map of ¹³⁷Cs contamination in Belarus 2004 with "our" sample points with maximum concentration (Bq/kg dry moss) in different regions.

Radionuclide and air pollution



Pollution sources -

- Long range atmospheric transport of pollutants from other nations
- Local point sources of air pollution within or closely outside borders
- Natural cycling processes, mainly atmospheric transport from the marine environment (marine factor)
- Root uptake in vascular plants from soil and subsequent transfer to mosses from living or dead plant tissue (vegetative factor)
- Mineral particles, **mainly windblown dust**, from local soil (soil factor)

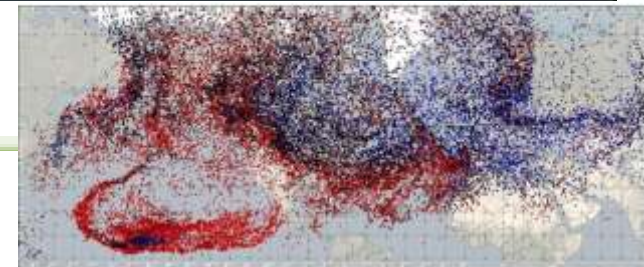


Can be absorbed by moss
and lichen

Radionuclide and air pollution

Radionuclide movement-

- Fukushima accident (2011)



Radionuclide and air pollution



Air pollution: yellow dust-



Radionuclide and air pollution biomonitoring



Biomonitoring using moss and lichen-

- **The possibility of making use of moss-lichen vegetation as biological indicator** of global radioactive fallout as well as for the purpose of long-term radioecological monitoring had been first reported in 1977
- **Mosses and lichens had been reported well-known for good bioaccumulators of radionuclides.** This application concerns an important part of research into the evaluation and the amount measuring of the fallout of radionuclides, above all after the Chernobyl incident and the Fukushima accident
- **Deposition of niobium, molybdenum, yttrium, lead, lanthanum, thorium, uranium, hafnium, and tungsten in mosses and lichens** with various circumstances has been reported.

Radionuclide and air pollution biomonitoring



Biomonitoring with different species-

- *Parmelia sulcata* has been used as a bioindicator for the presence of radionuclides in areas close to Chernobyl where I-129 and Cl-36 has been measured
- *Xanthoria parietina*, which has shown it to be the best bioindicator of radioactive fallout as against mosses
- Altitude is an important factor that is correlated with concentrations of Ra-226 and Ra-228 studied in lichens of the *Umbilicaria* species
- The moss species recommended for use in the European moss surveys are *Hylocomium splendens* and *Pleuroziurn schreberi*
- It had been reported that radionuclides such as Co, Se, Rb, Sr, Y, Zr, Nb, Mo, Cs, Ba, La, Ce, Eu, Yb, Lu, Hf, Ta, Pb, Th and U were found in *Hylocomium splendens* and *Pleurozium schreberi*

Radionuclide and air pollution biomonitoring

List of Biomonitoring with different species -

N.A. : Not available

Site	Species	Radionuclide	References
Black Sea Coast, Northern Turkey	<i>Xanthoria parietina</i> , <i>Leucodon immersus</i>	Cs-134, 137	Topcuoğlu, S., et al. (1995)
Rocky Flats, U.S.	<i>Xanthoria</i> spp.	N.A.	Thomas, R. S., et al. (1995)
Novozybkov, Bragin and Ovruc, near Chernobyl	<i>Parmelia sulcata</i>	I-129, Cl-36	L. A. Chant et al. (1996)
Norway	<i>Hylocomium splendens</i>	I, Se, La, Th, Co, Rb, Pb	E. steinnes et al. (1992)
Norway	<i>Hylocomium splendens</i> , <i>Pleurozium schreberi</i>	Co, Se, Rb, Sr, Y, Zr, Nb, Mo, Cs, Ba, La, Ce, Eu, Yb, Lu, Hf, Ta, Pb , Th, U	E. steinnes et al. (1997)
Southwestern Poland	<i>Umbilicaria</i> spp.	Ra-226, 228	J. Kwapuliński et al. (1985)
Northern Serbia, Bosnia-Herzegovina	<i>Hypnum cupressiforme</i>	Se, Co, Se, Rb, Sr, I, Cs, La, Ce, Eu, Hf, Th, U	Frontasyeva, M. V., et al. (2004)
Western Turkey	<i>Rhizoplaca melanophthalma</i> , <i>Cladonia convoluta</i> , <i>Cladonia pyxidata</i> , <i>Grimmia pulvinata</i> , <i>Hypnum cupressiforme</i>	Po-210, Pb-210	Uğur, A., et al. (2003)
Middle Urals, Russia	<i>Hypogymnia physodes</i>	Sr-90, Cs-134, 137	M.G. Nifontova et al. (1996)
Macedonia, Northern Greece	<i>Parmelia sulcata</i> , <i>Xanthoria parietina</i> , <i>Xanthoria calcicola</i> , <i>Xanthoparmelia somloensis</i>	Cs-137	Sawidis et al. (1997)

Conclusion

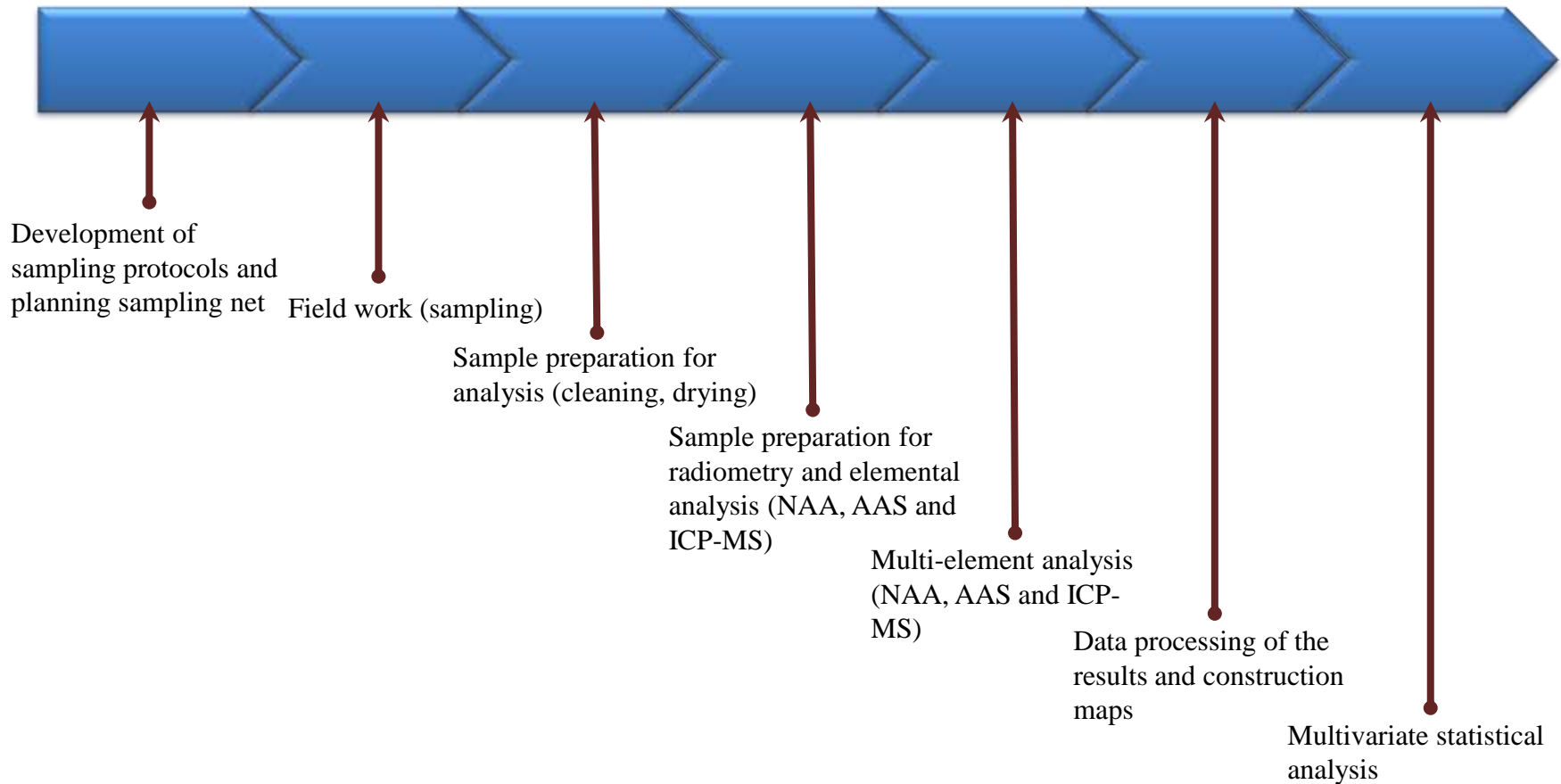


Proposed project-

- Focused on **tracing radionuclide deposition patterns** over the whole territory of South Korea and the far east of Russian Federation along with atmospheric deposition of trace elements in the sampled areas
- **Elemental analysis using complementary analytical techniques** such as NAA, AAS, HR γ -spectrometry, INAA and ICP-MS for concentrations of radionuclides in moss and lichen
- This study will provide the **atmospheric and oceanic deposition of radionuclides in the whole region in Korea and the far east of Russian Federation** by using moss and lichen biomonitoring

Conclusion

Working plan -



Conclusion

Proposed project-

- **Moss and lichen** that can be founded in **South Korea and Russian Federation** Boreal Forest



Hylocomium splendens



Pleurozium schreberi

Seashore

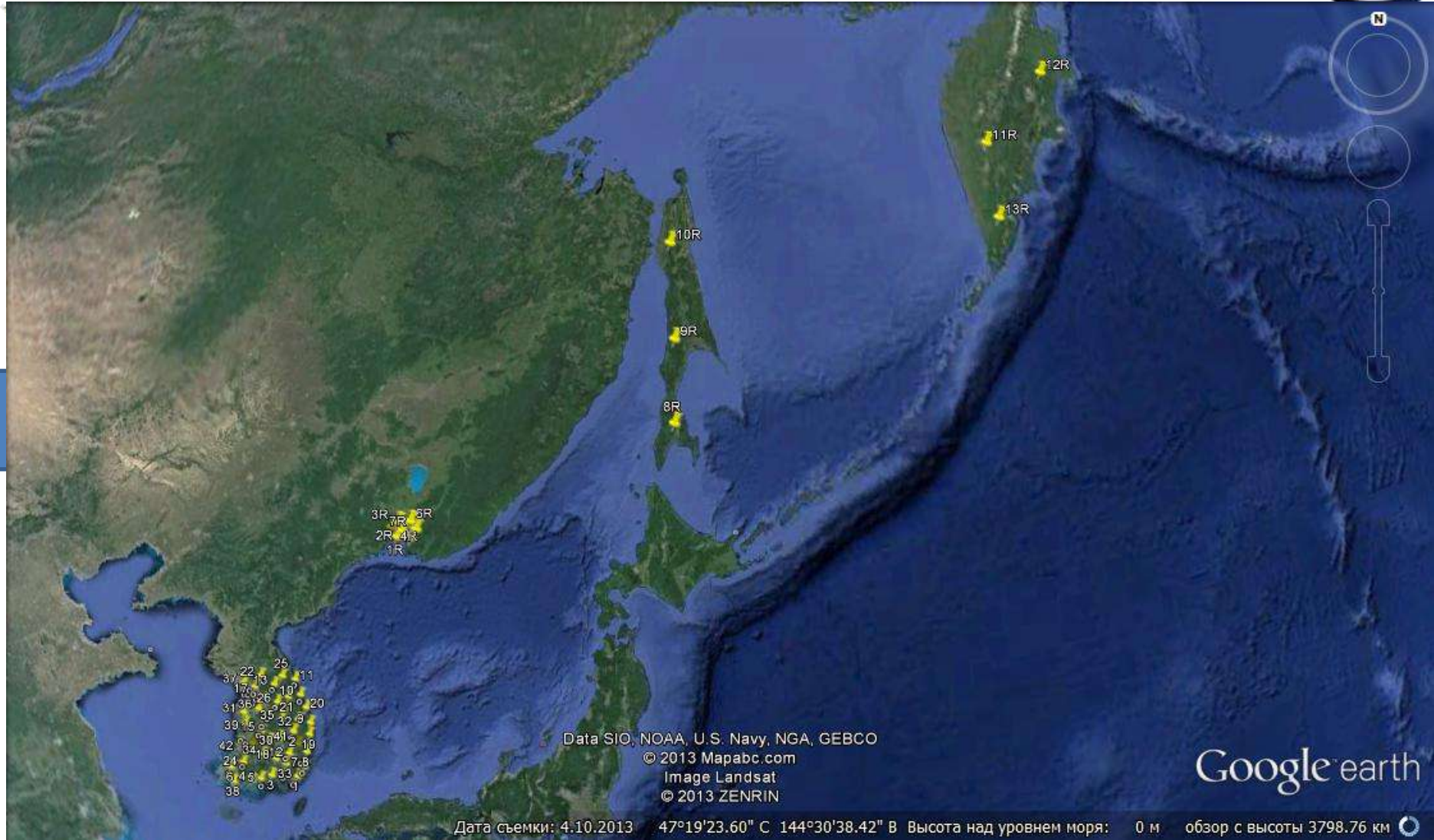


Xanthoria parietina



**Biomonitoring of Radionuclide
and Trace elements using Moss
and Lichen in Korea**

Conclusion



Conclusion

East region of South Korea -



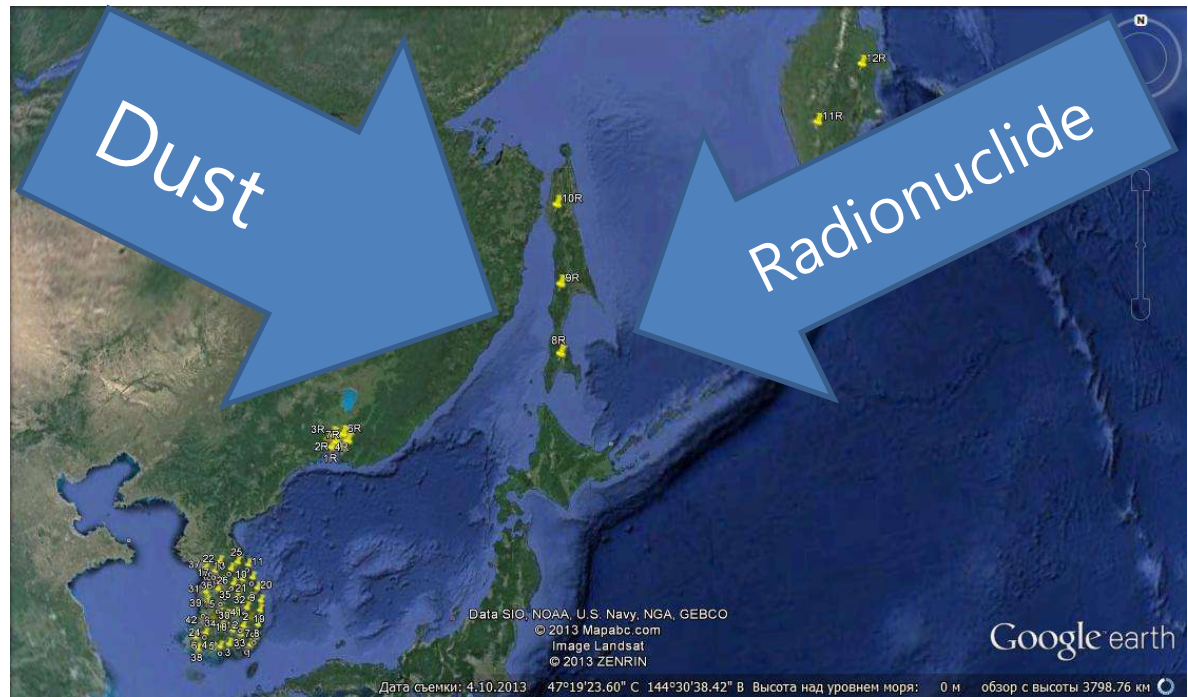
- Focused on tracing radionuclide deposition patterns over the east territory of South Korea along with oceanic deposition of trace elements in the sampled area
- Elemental analysis using complementary analytical techniques for concentrations of radionuclides in moss and lichen

Conclusion



Far east region of Russian Federation -

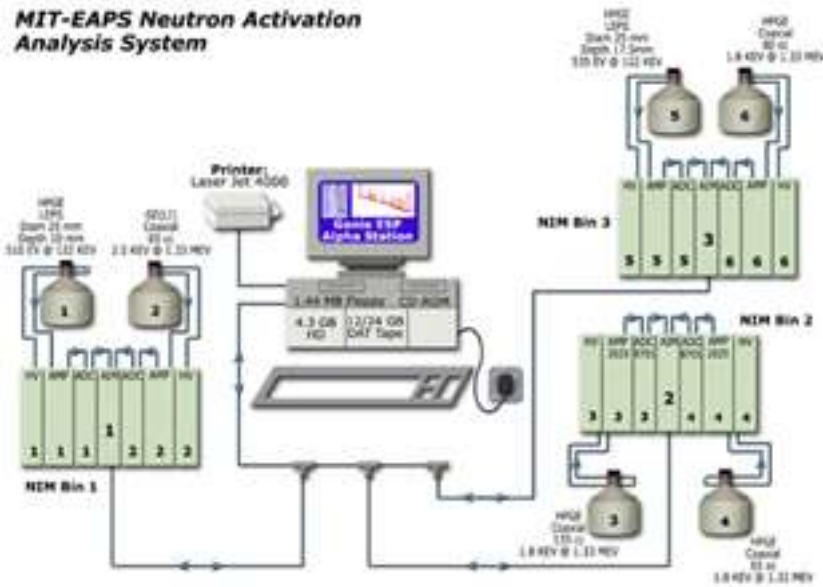
- Focused on tracing radionuclide deposition patterns over the far east region of Russian Federation along with atmospheric deposition of trace elements and oceanic deposition of trace elements in the sampled area
- Elemental analysis using complementary analytical techniques for concentrations of radionuclides and trace elements in moss and lichen



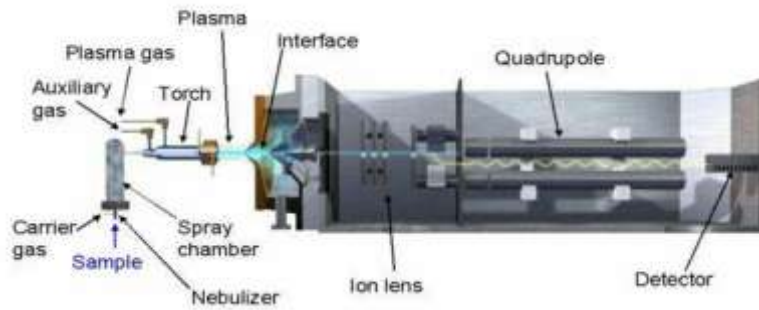
Conclusion

Analysis method-

MIT-EAPS Neutron Activation Analysis System

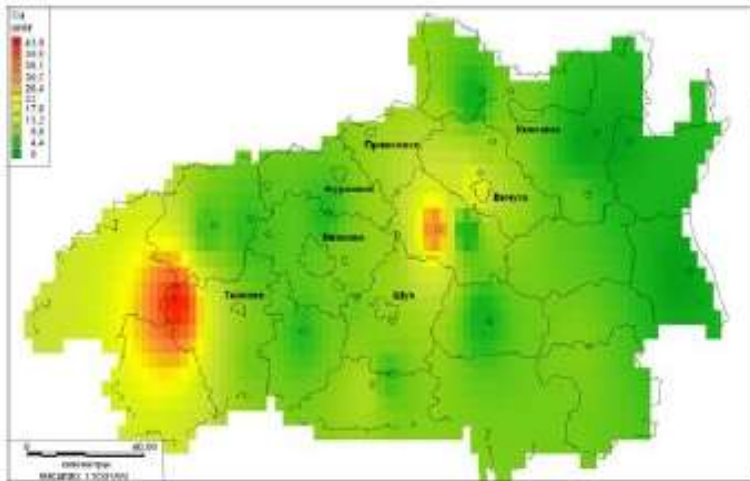
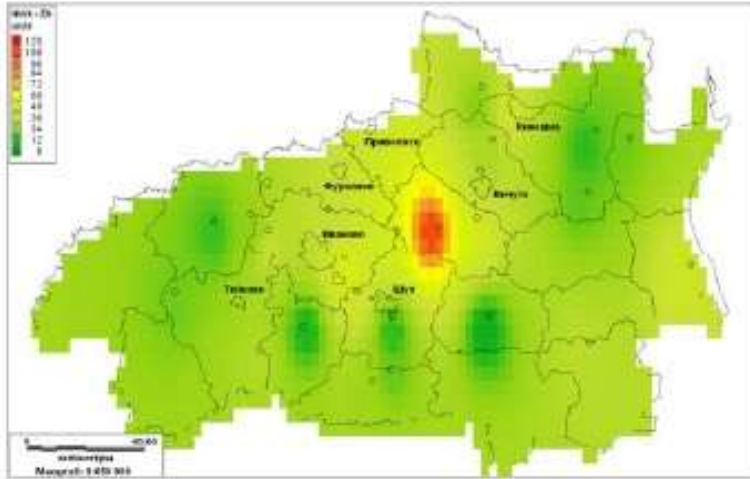


- **Radiometry** – High resolution gamma spectrometers and low-level background shielding facilities
- **Elemental analysis** – A combination of instrumental ENAA and AAS, or ICP-MS will provide data on concentrations of about 40 chemical elements (Al, As, Au, Ba, Br, Ca, Cd, Ce, Cl, Co, Cr, Cs, Cu, Dy, Eu, Fe, Hf, Hg, I, In, La, Lu, Mg, Mn, Na, Nd, Ni, Pb, Rb, Sb, S, Sc, Se, Sm, Ta, Tb, Ti, Th, V, W, Yb, Zn)



Conclusion

Analysis method-



- **Interpretation** – Application of selected statistical methods for the treatment of radionuclide and chemical data will allow estimation of current contribution from “Fukushima” and other different sources and sources categories (coal burning, metal smelting, etc.) as well as the relative importance of local versus more distant sources of heavy metal pollution in the study area
- **Mapping** – GIS (geographical information system) technologies for the purposes of environmental monitoring are widely used for interpretation of the distribution of heavy metals over examined territories. The program GRINVIEW from the geographical information system software package GIS-INTEGRO will be used to generate raster-based pollution contour maps for the elements of interest for the entire studied area

- This study is a principally **new attempt for assessing the environmental situation** in the South Korea and in the far east of Russian Federation using the well-approved European methodology based on moss analysis. There are no records of data that show the levels of atmospheric deposition of radionuclides and heavy metal pollution in the whole region by using the moss biomonitoring technique or any methods
- **Spatial deposition patterns of radionuclides and trace elements** could be revealed. They may show the local (domestic) and long-range atmospheric transport pollution from industrial enterprises, agricultural land-use, *etc.* in the continental China, Malaysia, North Korea and others
- **Scientific publications** in the international journals and presentation of results at the international conferences, electronic Atlases on radionuclides and trace element distribution of atmospheric deposition will be prepared.

Thank you for attention
