ATMOSPHERIC AIR CONTAMINATION ASSESSMENT IN IVANOVO REGION BY MEANS OF COMBINED ANALYSIS OF SNOW AND MOSSES

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An increase of anthropogenic impact causes environmental degradation, heavy metals (HM) being one of the most dangerous pollutants. They persist into the atmospheric air, move with it for a long distances and can deposit onto the earth. Air contamination by heavy metals is danger owing to ability of these metals migrate through the soil into the groundwater and poison it. This work is concerned with the study of HM air contamination level in Ivanovo region by combined analysis of snow and mosses.

The direct analysis of atmospheric air is very long and difficult. Different indirect methods are used instead of it. The analysis of snow is recommended by state air contamination control manual. It is a very simple way to analyze both gaseous and solid pollutants. However it gives the information about cold season only. Another method to assess air contamination is biomonitoring. Among different bioindicators mosses are most acceptable owing to their high accumulation ability. Sampling of moss usually carried out at summer. Combining these two methods it is possible to get total data on air quality.

Ivanovo region situated in the interfluve of the Volga and Klyaz'ma rivers with an area of 22 000 km^2 was the object of the investigation (Fig. 1). 25 squares were separated within the region with average area of 400 km^2. Samples of mosses and snow were taken from each square. Sample collection was done in 2010.

Fig. 1. Sampling map.

Sampling was made according to standard techniques. The analysis of HM content was carried out with the use of flame atomic absorption spectrometry and neutron activation analysis. Determination uncertainties were about 20-30% for ASS and 5-15% for NAA.

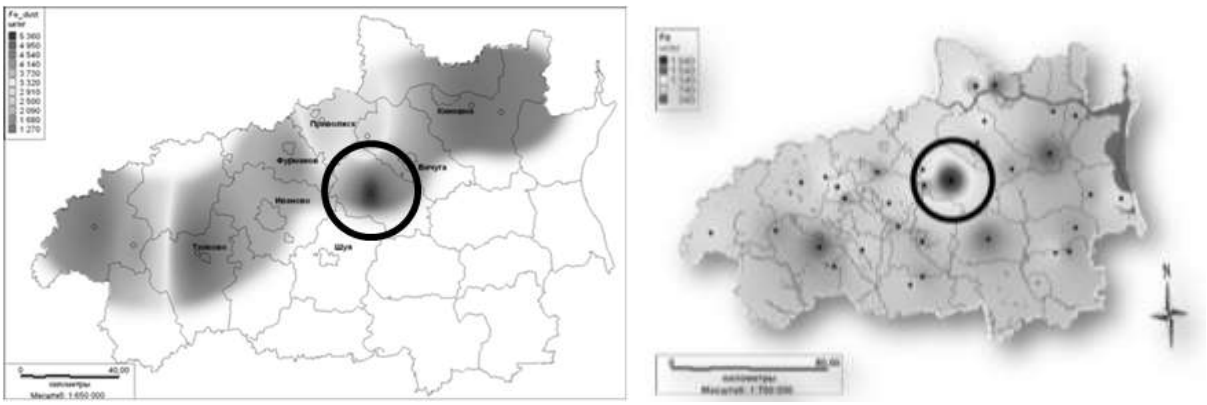
Values of HM content in moss were compared with the results of the research in Yaroslavl, Tver', Tula region and Udmurtia Republic. In fact, level of HM content in Ivanovo region was very close to neighbor regions for all observed elements.

Samples of snow were collected on March, 2011. HM content in bulk snow and solid fraction were measured. Composition of snow solid fraction (Zn, Mn, Fe) was an evidence of their soil origin. These metals were most common in soil and under wind transfer they could migrate in snow from roads. In bulk snow Cu, Zn, Mn and Fe were found. The concentrations of copper were the same as those of Nizniy Novgorod region, but zinc content in Ivanovo was less than in Nizniy Novgorod. Intensities of atmospheric deposition, which were calculated from the HM content in snow, were less than urban intensities of HM deposition.

Intensities of atmospheric HM depositions can be found by their concentrations in snow according to the following formula. Calculated values justified a significant level of HM presence in air. Background concentrations were exceeded for all samples. However, they didn't reach the level of HM deposition in urbanized areas. This situation successfully supplemented data of HM deposition calculated from concentrations into mosses.

Comparative analysis of copper content in moss and snow showed the coincidence of this element distribution in soluble part of snow and moss. However data by AAS and NAA are not agreed. It may be deal with big uncertainties of copper determination by NAA.

On the contrary the iron concentration in mosses coincide both NAA and AAS. It also agreed with iron content into solid phase of snow (Fig. 2). Iron in bulk snow has other distribution explaining by very low solubility of iron. The highest concentration of iron in moss and snow was fixed for the vicinity of Rodniki's asphalt plant.



a) b)

Fig. 2. Iron content (mg/kg) in solid part of snow measured by AAS (a) and moss measured by NAA.

This plant may be possible origin of zinc. Increasing zinc content was marked both NAA and AAS. However concentration of zinc in snow has a maximum not near Rodniki city, but Teikovo. Probably the main reason of it is activity of Teikovo power station worked on black oil.

The distribution of manganese in air derived from its content in moss and snow pointed out similar dependence near Kineshma city. The Ivanovo region soils are reached by manganese that is why wind transfer is most probable reason of its atmospheric arrival.

Summarizing it may postulate that anthropogenic impact form asphalt plant near Rodniki city is one of the largest sources of metal emission in Ivanovo region.

The factor analysis of the given data was done to detect potential origins of the intake. Processing was carried out by principal component method with the Varimax rotation.

The first factor is concerned with the biogenic elements as well as some heavy metals. Most of this factor loads concentrate near Rodniki city and may be explained by anthropogenic impact from its factories. Next two areas of high factor loads are situated near northern-west border of Ivanovo region (Fig. 3).

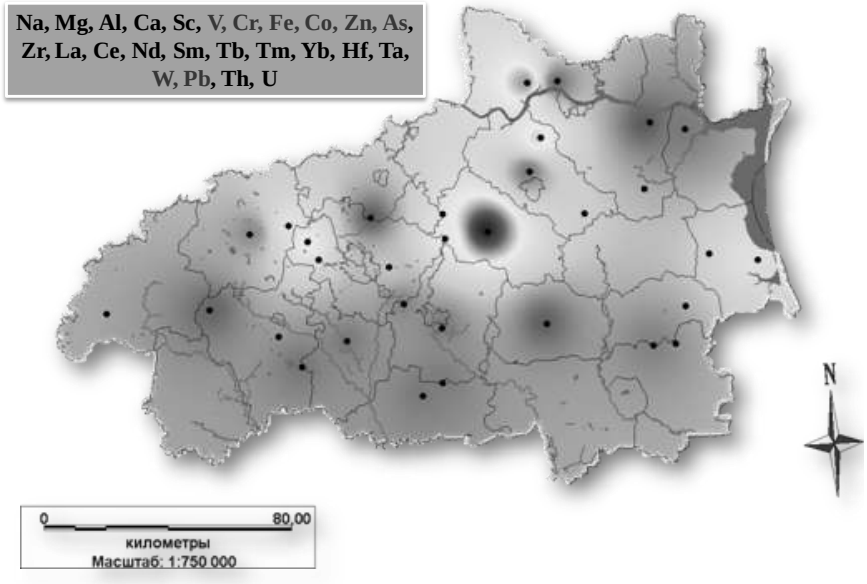


Fig. 3. Distribution of Factor 1.

Taking into account most frequent bearing of an apparent wind it may suppose that transboundary pollution from industries of Kostroma, Volgorechensk and Yaroslavl takes place (Fig. 4).

The calculation of contaminants scattering from Volgorechensk power station was made. It was established that the concentration of element inside the chimney reaches 10% level at 30 kilometers distance. It was sufficient to pollute the territory of Furmanov and Privolzsk districts.

There are a lot metal processing plants in Yaroslavl city. The oil refining factory is also situated there. The molybdenum content in moss is a marker of the influence of Yaroslavl industries.

Other factors may be dealt with anthropogenic impact from Ivanovo city and Rodniki city. The origin of factor 4 is not clear.

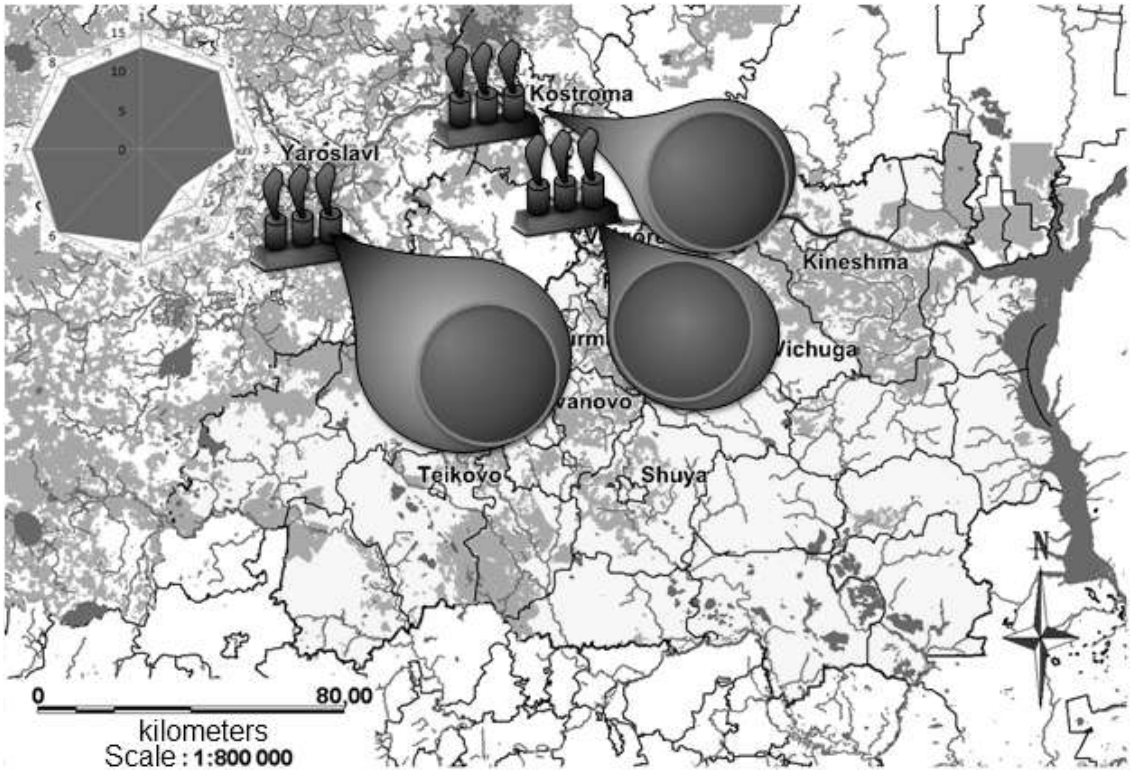


Fig. 4. Possible transboundary air pollution from Yaroslavl and Kostroma regions.

In conclusion it may postulate that air contamination level in Ivanovo region is acceptable and main internal source of air pollution is situated near Rodniki city (probably asphalt plant). Transboundary air pollution from Kostrona and Yaroslavl regions was found. Analysis of mosses and snow give similar results as well as AAS and NAA data.

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