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Immanuel Kant Baltic Federal University

Geoecological assessment of the Great Moss Swamp(Bolshoye Mokhovoye swamp), accumulation of heavy metals in bioindicates(peat and moss), transboundary transfer of heavy metals through precipitation.

Introduction

The research describes the characteristics of accumulation of trace elements - manganese (Mn), nickel (Ni), zinc (Zn), bromine (Br), strontium (Sr), rubidium (Rb), iron (Fe) and calcium (Ca) in mosses and peat in the Great Moss Swamp. The method employed to determine elemental composition of mosses and peat is X-ray fluorescence spectrometry. To explain the variations in the experimental data, the primary results were processed using descriptive statistics, correlation analysis and principal component analysis. The correlation and principal component analysis revealed three (in mosses) and four (in peat) factors. This may be owing to the effects of atmospheric deposition, water migration of chemical elements and leaching from plant residues.

Research question

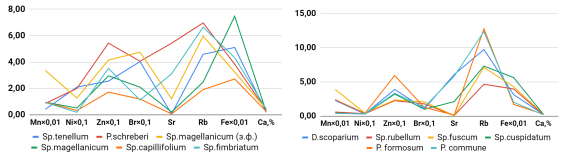
The relevance of the topic is determined by the need for applied research aimed at a comprehensive assessment of the geoecological state of one of the few well-preserved upland swamp, identification of the chemical composition of peat and mosses in the swamp, as well as prediction of the further geoecological situation of the Great Moss Swamp. The swamp is home to a large number of rare species of plants, insects and birds. 72 species of birds nest in the swamp, of which 17 species have special conservation status, including 4 included in the Red Book of the Russian Federation. Main purposes :

- assessment of landscapes through components of indicators of the geoecological state of the swamp;
- determination of the chemical composition of moss and peat samples (determination of the content of manganese, calcium, zinc, nickel, iron, strontium, rubidium, bromine);
- determination of the possible causes of the accumulation of chemical elements in samples of moss and peat;
- prediction of the geoecological situation in the territory of the Bolshoi Mokhovoe swamp.

Main method

A method for studying the composition of samples of moss and peat -
The elemental composition of the samples was determined using a Spectroscan-Max-G X-ray fluorescence spectrometer. The concentration of 8 elements was determined: Fe, Mn, Zn, Ni, Br, Sr, Rb, Ca. The content of the determined elements varies widely. The error in the determination of chemical elements did not exceed 5%. X-ray fluorescence spectrometry was carried out using "Spectroscan Max G" (Spectron, St. Petersburg, Russia) to determine elemental composition samples of moss and peat). Moss and peat samples were taken in June 2018. Moss samples were taken manually throughout the swamp territory, and the selected material was packaged in plastic bags. A total of 18 samples of moss were taken, and 12 species of mosses were identified. Peat samples were taken using a hand drill at two points in plastic zip-lock bags. A total of 36 peat samples were taken.

Graphs of the distribution of element concentrations in mosses



Mosses of various species have a pronounced affinity for certain elements: S. fuscum (brown) has a pronounced affinity for manganese, S.tenellum for nickel, P.formosum (beautiful polytrichum) for zinc and rubidium, S. magellanicum for bromine, D .scoparium - to strontium, S.magellanicum - to iron, S.fimbriatum - to calcium.

Keywords

Kaliningrad region, upland swamp, bioindication, accumulation of heavy metals, peat.

Main results

Using the SPSS Statistics 23 program, histograms of distribution frequencies were constructed, which made it possible to more clearly form an idea of the nature of the distribution. For most of the studied chemical elements, the nature of the distribution was defined as "close to normal." An exception was the distribution of nickel in samples of moss and peat, which is probably due to the anthropogenic origin of this element and its subsequent accumulation by vegetation, and then concentration in peat. To identify the possible causes of the accumulation of elements in the samples, a factor analysis was performed. In total, 3 factors were identified:
Factor 1 (Ni-Br) - 30.8% - presumably the effect of the aquatic environment.
The manifestation of factor 1 is mainly characteristic of species: Magellan sphagnum (green form), sclera pleurocium and tender sphagnum, leaching of the same elements was noted in cuckoo flax and genital sphagnum.
Factor 2 (Rb, Zn, Sr) - 24.6% - can be associated mainly with their mineral origin. It has a greater effect on the cuckoo flax, on the pointed sphagnum, pleurocium of the scraper and broom dicranum, to a lesser extent on the Magellan sphagnum and the hairy sphagnum.
Factor 3 (Mn, Ca) - 16.4% - the plant origin of these elements. The influence of this factor on the accumulation of manganese and calcium can be seen in the Magellan sphagnum (green form), brown sphagnum and beautiful polytrichum. A smaller accumulation of these elements is observed in the Magellan sphagnum, genus sphagnum and delicate sphagnum.

Table 2 - Pearson correlation coefficient for moss samples

	Mn	Ni	Zn	Br	Sr	Rb	Fe	Ca
Mn								
Ni	-0,105							
Zn	-0,097	-0,041						
Br	-0,243	0,541**	0,088					
Sr	0,092	0,201	-0,314	0,346*				
Rb	-0,028	-0,032	0,28	-0,21	0,179			
Fe	-0,007	0,148	0,836**	0,243	0,106	0,238		
Ca	0,247	-0,455**	0,186	-0,315	-0,259	-0,192	0,165	
** Correlation is significant at the level of 0.01 (two-way).								
* The correlation is significant at the level of 0.05 (two-way).								

Table 3 - Pearson correlation coefficient for peat samples

	Mn	Ni	Zn	Br	Sr	Rb	Fe	Ca
Mn								
Ni	-0,105							
Zn	-0,097	-0,041						
Br	-0,243	0,541**	0,088					
Sr	0,092	0,201	-0,314	0,346*				
Rb	-0,028	-0,032	0,28	-0,21	0,179			
Fe	-0,007	0,148	0,836**	0,243	0,106	0,238		
Ca	0,247	-0,455**	0,186	-0,315	-0,259	-0,192	0,165	
** Correlation is significant at the level of 0.01 (two-way).								
* The correlation is significant at the level of 0.05 (two-way).								

Main conclusion

Geoecological assessment of the Great Moss swamp:
The indicator components of the territory of the Great Mossy Swamp are slightly susceptible to anthropogenic impact, as evidenced by the concentration of chemicals in samples of moss and peat
Geoecological assessment of the state of the swamp is conditionally satisfactory.
Further changes in concentrations and the introduction of heavy metals are possible to a greater extent by atmospheric precipitation, which necessitates further forecasting and periodic geochemical analysis of indicator components, since the swamp territory is located in the protected areas - the Gromovsky integrated reserve and is hereinafter considered as a recreational zone of the region .

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