

Persistent organic pollutants in recent lake sediments of Poland

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Introduction: The study of bottom sediments of lakes in Poland, conducted by the Polish Geological Institute - National Research Institute, are performed in the frame of the State Environmental Monitoring. The aim of the research is to observe the changes in the content of potentially harmful metals and metalloids (Ag, As, Ba, Cr, Cd, Co, Cu, Hg, Ni, Pb, Sr, V and Zn) and persistent organic pollutants (PAHs, PCBs and organochlorine pesticides) of modern sediments. Tests are performed for lakes belonging to a monitoring regional network and 23 benchmark lakes. Studies of sediments of lakes belonging to the regional network are carried out every few years, usually every five years, while the benchmark lakes studies are made every two years.

Methods: In the years 2010 - 2012 sediment samples were collected from 280 lakes, and a total of 416 samples were tested (from lakes with an area greater than 250 ha two to five samples are taken according to the lake surface). Samples were taken at profundal zone from the surface layer of thickness about 5 cm. Contents of DDTs (p,p'-DDT, p,p'-DDE, p,p'-DDD), isomers HCH (α -HCH, β -HCH, γ -HCH, δ -HCH) and PCBs (congeners 28, 52, 101, 118, 153, 138, 180) were determined using GC-ECD and contents of 17 polycyclic aromatic hydrocarbons were determined using GC-MS. The samples were also analyzed for 22 elements (Al, Ag, As, Ba, Ca, Cd, Cr, Co, Cu, Fe, K, Mg, Mn, Na, Ni, P, Pb, S, Sn, Sr, V and Zn) using ICP-OES method, after digestion with aqua regia. In addition the samples were analyzed for Hg using TMA method and organic carbon (TOC) by coulometric titration method.

Results and Discussion: In the studied sediment PAHs content was found in the range of from less than 42 to 57 620 $\mu\text{g}/\text{kg}$. Their presence has been found in almost all the samples, the average content of PAHs was 4 610 $\mu\text{g}/\text{kg}$, and the geometric mean - 2830 $\mu\text{g}/\text{kg}$. The content of total HCH isomers studied ranged from less than 2 to 60.7 $\mu\text{g}/\text{kg}$. The presence of even one of the studied isomers of HCH was detected in 87% of samples tested, and the most frequently detected was α -isomer of HCH. The average content of total HCH was 7.6 $\mu\text{g}/\text{kg}$, and the geometric mean 4.4 $\mu\text{g}/\text{kg}$. DDTs content recorded in the range from less than 0.7 to 602.9 $\mu\text{g}/\text{kg}$, the

average was 17.2 $\mu\text{g}/\text{kg}$, and the geometric mean 8.1 $\mu\text{g}/\text{kg}$. Occurrence DDTs found in nearly all samples. Frequently was detected a metabolite p,p'-DDE (98.8% of analyzed samples), the presence of the metabolite p,p'-DDD in the contents above the limit of quantification was observed in 95.4% of samples, and p,p'-DDT in 87% of samples. The ratio of p,p'-DDT/(p,p'-DDD + p,p'-DDE) in 94% of samples were below 0.5. In the studied sediment PCBs content was found in low concentration in the range of from less than 0,72 to 50,7 $\mu\text{g}/\text{kg}$, the average content was 2,6 $\mu\text{g}/\text{kg}$, and the geometric mean - 1,6 $\mu\text{g}/\text{kg}$. The presence of even one of the studied PCB congeners was detected in 86,5% of samples tested. In sediments studies the content of HCH isomers are only weakly correlated with the content of organic carbon, phosphorus and sulfur, and with content of barium, copper, mercury, lead, zinc. DDT's content, as HCH, shows the correlation with the content of phosphorus, sulfur and organic carbon. Among the trace elements DDT's has a relatively high correlation with mercury, lead and zinc, and the lower correlation with the content of barium and copper. PCB content correlates with phosphorus, sulfur and organic carbon, and shows high correlation with mercury, lead and zinc. The correlation with copper, nickel and barium is week. PAH content, like other POP, correlates with the content of TOC, P and S, and also shows a high correlation with mercury, lead, and zinc.

Conclusions: In samples examined the content higher than the *PEC* (probable effect concentration) [1] was found in the case of PAHs (22 800 $\mu\text{g} / \text{kg}$) in 1.2% of the samples, for lindane (1.38 $\mu\text{g}/\text{kg}$) - 28.1% of the samples, p,p'-DDE (6.75 $\mu\text{g}/\text{kg}$) - 41.3% of the samples, p,p'-DDD (8.51 $\mu\text{g}/\text{kg}$) - in 20.9% of the samples, p,p'-DDT (4.77 $\mu\text{g}/\text{kg}$) - 1.9% of the samples. In none of the samples tested the PCB content higher than the *PEC* level (676 $\mu\text{g}/\text{kg}$) were detected.

References: [1] MacDonald D., Ingersoll C., Berger T. 2000. Development and evaluation of consensus-based sediment development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol., 39: 20-31.