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Phenomenon of organic carbon change in natural waters (system "catchment - Lake") of Russian Federation

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In the last two decades in the Russian Federation was found significant increase in the concentration of dissolved organic carbon in many aqueous systems. Most obviously, these changes may be related to global warming. It is known that increasing the temperature dominate during dry periods and increases the concentration of nutrients, primary production increases, leading to an increase of the dissolved organic matter. At the same time, it is known that some of the increase in DOC may be largely due to a decrease of anthropogenic sulfur deposition and increasing organic matter in the soil.
The European Russia (ER) is a region with substantial industrial emissions of sulphur. In the central part of ER are concentrated metallurgical productions. This has resulted in high concentrations of anthropogenic sulphate and an increase in the prevalence of acidification as well as a rise in metal concentrations in the lakes of North Kola. However, over the last 30 years, sulfur emissions in ola North have decreased substantially.
The aim of this work was to explain the mechanisms to improve the content of natural organic matter and to assess its role in the processes of acidification and recovery of water quality while reducing the deposition of technogenic acid.
The increasing of organic matter content in lake waters is being also observed for the totality of lakes in the Kola North. This conforms to the data reported by Skjelkvale et al. (2001a) which demonstrates the significant increase of DOC. Some authors explain the increased DOC levels by reduction in strong acid flow and return of water chemistry to its natural parameters of specifying organic matter concentrations in water.
It is known that DOC level has a direct relationship with water color. In analyzing long-term study data with regard to the group of 75 lakes (obtained during 1990-2010) DOC is increased year-over-year, but the color decreased. The following chemical processes developing in water can explain this phenomenon.
The water color is predominantly determined by large molecules of humus acids which molecular weight >1000 Da. Macromolecular organic substances of humus type can be dissociated in water with formation of a free proton, as well as enter into reactions of decomposition (hydrolysis) and disproportionation with formation of low-molecular weight fragments. Its fragments also are dissociated of proton (see the diagram below). Non-organic strong acids supplied from anthropogenic and natural sources may catalyze the above processes.
The diagram of the organic substances destruction of humus origin is given below, where R_i means non-symmetrical fragments of a natural polymer, X_iH - functional groups of organic substances of humus origin, and n - number of protons.

$$\begin{aligned} & \rightarrow R_1 - X_1H + R_2 - X_2H \quad + \quad R'_1X_{1^-} + R'_2X_{2^-} + nH^+ \\ HX_1 - R_1 - R_2 - X_2H \quad & \\ & \rightarrow HX_1 - R_1 - R_2X_2^- +^- X_1R_1 - R_2 - X_2H +^- X_1R_1 - R_2X_2^- + nH^+ \end{aligned}$$

When strong acids get into a water environment humus acids are degraded into fractions. It could be supposed that the organic matter structure undergoes changes in natural waters, as the fraction of high-molecular weight humus acids decrease. As a consequence of interaction between humus substances and protons the humic acids precipitate to form bottom sediments, whereas fulvic acids remain in water. Fulvic acids are characterized by lower molecular weights (from 500 to 2000 Da) and exert an insignificant effect on the water color.

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