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CLIMATIC FACTORS CONTRIBUTING TO WETLAND FORMATION IN THE NORTHERN PART OF EURASIA – STATISTICAL MODEL

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The process of wetland formation is a clear example of landscape self-development. This process, which started about 6000 years ago, demonstrates a high level of stability – wetlands slowly but surely conquer gently sloping surfaces. Despite the fact that there are a few doubts that climate plays a dominant role in the extension of highland (bogs) and forest wetlands, which are dominated by different species of sphagnum, there are a few successful attempts to describe their ecological niche. Meanwhile, comprehensive materials of the Russian regional peat fund, spatial climate models of Mark New [1] and 3-dimensional topological models create necessary preconditions for describing the ecological niche of wetlands. Peat fund data (peat fund of the Russia's European part; peat fund of Archangelsk region; peat fund of Komi Republic; peat fund of Western Siberia, which are available in open access from the NASA website [2] were combined in one GIS model with all climatic variables and 3-dimesional topographical model. The wetland area, carbon content, average and maximum depth of wetlands and mineral content of peat were estimated for the grid of 0.5º x 0.5º. The analysis showed non-linear relationship between wetland state in each cell with monthly temperatures, precipitation and hydrothermal coefficient. At the same time, mineral content grows linearly with temperature and decreases of precipitation. According to Figure 1, the optimum characterized by the maximum carbon content corresponds to the average may temperature of 2.5ºC. According to correlation values (R^2) hydrothermal regime in May, August and September also plays an important role in wetland formation. On average, main wetland features are determined by non-linear relationships with temperature and precipitation in spring and autumn months. Summer climate has smaller and independent impact on wetlands. The general statistical model describing wetland formation is developed from 2-factor regressions followed by step-wise regression analysis. It is clearly shown that wetlands are primarily developed around mid-altitudes. Overall the climate and topography statistical model describes about 62% of variation in the logarithm of carbon content per square meter with the standard error of 1.32. The percentage of wetlands and their depth is also subject to similar relationships with climate and topography but with different parameter values. The rate of carbon accumulation in wetlands (rate of wetland growth) reaches maximum at the following average values of temperature and precipitation: May - 2.5° and 36 mm; June - 11ºC and 40 mm, July - 15ºC with a wide range of precipitation levels; August - 12ºC and 54 mm; September 5ºC and 44 mm. In the North, wetlands are merging with tundra ecosystems at the average May temperature of 0˚C and precipitation of 13 mm. In the South, the wetland formation is limited by 15˚C and 44mm of precipitation. High wetlands (bogs) do not exist in Eurasia with May temperatures over 17ºC. In summary, the statistical analysis showed that wetland formation process is tightly linked with climatic regime in spring. Climatic regime in autumn also influences the rate of wetland growth but does not have much importance for its geographical extent. Considering the importance of spring climate for wetland formation, the beginning of active wetland growth in Holocene is likely caused by warmer and wetter springs. The developed statistical model of wetland formation could be linked with state-of-the-art spatially-explicit Global Circulation Models to project possible carbon fluxes in wetlands in conditions of changing climate.

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