ASSESSMENT OF ATMOSPHERIC POLLUTION LEVELS RESULTING FROM FOREST FIRES

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Every year, forest fires destroy tens to hundreds of thousands of hectares of vegetation, resulting not only in the loss of valuable timber (5–95% depending on fire type and intensity) but also causing long-term ecological damage affecting biocenoses locally and regionally. This ecological damage includes losses of natural, economic, and social resources due to environmental regulation violations, human activities, natural disasters, or catastrophes. These impacts manifest as resource depletion, socio-hygienic deterioration, and loss of economic potential.

Forest fires significantly influence climate change and intensify the greenhouse effect by releasing substantial carbon dioxide (CO_2) into the atmosphere. Annually, about one million fires occur worldwide, covering nearly 5% of the Earth's surface. Smoke from fires releases complex chemical compounds with high toxicity into the atmosphere, impacting regional climate modification.

Wood smoke is chemically diverse, containing over 100 substances, including carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), methane (CH_4), aldehydes, organic acids, phenols, and other volatile organic compounds (VOCs). Free radicals from wood smoke remain in biological systems approximately 40 times longer than those from tobacco smoke. Combustion of one ton of biomass releases about 125 kg of CO, 12 kg of hydrocarbons, 2 kg of NO_x, and 22 kg of particulate matter, mainly coal dust. Smoke consists of 50% gaseous substances, 25% soot, 20% ash, and 5% resinous compounds. Wood comprises carbon (C), hydrogen (H_2), oxygen (O_2), and nitrogen (N_2). The elemental composition of various wood species is nearly identical: 49.5% carbon, 44.2% oxygen (with nitrogen), and 6.3% hydrogen. Nitrogen content is about 0.12%. Wood also contains mineral compounds that form ash during combustion (0.2–1.7%). Ash primarily contains alkaline-earth metal salts, with pine, spruce, and birch wood ash consisting of over 40% calcium salts, more than 20% potassium and sodium salts, and up to 10% magnesium salts. During combustion, complex organic compounds are formed from these elements.

Laboratory studies analyzed VOCs emitted during peat combustion using samples from two national parks in North Carolina, USA. Experiments allowed continuous analysis of volatile compounds for 7 hours. The primary fraction (60%) comprised volatile organic aerosols, including acetaldehyde, formaldehyde, benzene, toluene, and chloromethane. Solid particles included alkanes, alkenes, organic acids, and polycyclic aromatic hydrocarbons (PAHs). The total PAH concentration (>12 mg/kg) was higher than biomass combustion values but comparable in toxicity.

Current pollution assessment methods in Ukraine focus primarily on anthropogenic sources, such as industrial facilities and vehicular emissions, limiting their applicability to forest fire emissions. Existing regulations are inadequate for assessing emissions from natural fires. Therefore, developing a unified methodology for evaluating fire emissions is crucial. This approach should be based on Ukraine's current regulatory framework for atmospheric pollutant assessment.