

THE IMPACT OF WILDFIRES ON ENVIRONMENTAL POLLUTION

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ABSTRACT

The analysis of literature sources has shown that the main impact of wildfires on environmental pollution is the pollution of atmospheric air by combustion products and contamination of the soil layer. The author has determined that to fully assess the impact of a wildfire on the environment, it is necessary to know the total amount of pollutants entering the surface layer of the atmosphere, as well as the concentrations of pollutants on the underlying surface in the area of the fire.

KEY WORDS : Atmospheric air, Climate change, Air pollution, Soil contamination, Microorganisms.

INTRODUCTION

Wildfires, occurring regularly in different regions of the world, have attracted attention as a natural disaster causing serious economic damage (Melnichuk *et al.*, 2020; Alpysbayev *et al.*, 2020). The problem has become even more acute with the increasing scale of global climate change. Wildfires are not only a blight on human populations but also an important factor in local, regional, and even global environmental dynamics, as manifested, for example, in fire-related emissions of greenhouse gases and aerosols into the atmosphere. It is estimated that around 30% of tropospheric ozone, carbon monoxide, and carbon dioxide in the atmosphere are contributed by wildfires. Wildfire-related atmospheric aerosol emissions can have a significant impact on optical characteristics of cloud cover and climate change.

The problem of wildfires has taken on considerable proportions. Wildfire statistics are kept in most countries. For example, nationwide data collected by the National Interagency Fire Center (NIFC), USA, show that in recent years (2011-2020), there have been an average of 62,693 wildfires annually and an average of 3.0 million hectares of land affected annually.

In 2020, over 58,250 wildfires burned 4.2 million hectares of land, which is the largest annual impact;

almost 40% of this area was in California (Congressional Research Service, 2021).

Hypothesis: Environmental pollution caused by wildfires leads to negative consequences for the atmospheric air and the soil cover of forests.

METHODS

The main research method was the analysis of the scientific literature on the research problem.

The keywords used in the literature search were “wildfires” and “environmental pollution” to provide a reference to the relevant article. The amount of literature was limited by publication time, from 2011 to the present for search engines to provide up-to-date references. Keyword search results showed the availability of some 4,200 scientific articles and books. However, based on the criterion of the limited research scope, only 11 articles were considered.

RESULTS

The literature analysis showed that the main impact of wildfires on environmental pollution is the pollution of atmospheric air with combustion products and contamination of the soil layer.

We shall take a closer look at certain aspects of environmental pollution caused by wildfires.

Table 1. Annual wildfires and burned areas (Congressional Research Service, 2021)

	2015	2016	2017	2018	2019
Number of fires (thousands)	68.2	67.7	71.5	58.1	50.5
Burned acres (million)	10.13	5.51	10.0	8.8	4.7

Air pollution : Wildfires are the main source of atmospheric gaseous and solid pollutants. Large quantities of gaseous and solid pollutant particles are emitted into the atmosphere during wildfires.

The consequences of air pollution due to wildfires are presented in Table 2.

Unlike other anthropogenic sources, wildfire

emissions from forest biomass are poorly quantified in the literature because of the difficulty in estimating their temporal and spatial distribution (Junquera *et al.*, 2005). The combustion process consists of many stages, each producing different compounds, and the burned material is heterogeneous and difficult to describe

Table 2. Consequences of air pollution caused by wildfires

No.	Consequences	Mechanism of impact
1	climate change	Wildfires can affect the physicochemical properties of the atmosphere through the emission of significant amounts of solid particles that interact with solar radiation (Trentmann <i>et al.</i> , 2005). For example, black carbon strongly absorbs solar radiation and biomass burning is responsible for 45% of black carbon emissions globally (Luterbacher <i>et al.</i> , 2004). Atmospheric solid particles also act as cloud condensation nuclei, which are important for the radiative balance and the hydrological cycle. Future climate warming could increase the occurrence and impact of wildfires on air quality in the region (Schar <i>et al.</i> , 2004).
2	increased local level of air pollution	Wildfires contribute 0.2% to nitrogen oxide emissions, 0.5% to non-methane volatile organic compounds, 0.2% to CH ₄ emissions, 1.9% to CO emissions, 1.2% to N ₂ O emissions, and 0.1% to NH ₃ emissions in Europe. As these emissions are limited to short periods and bounded areas, their impact is more severe on public health (e.g. respiratory symptoms and diseases including bronchitis, asthma, pneumonia and upper respiratory infections, impaired lung function, and heart disease (Bowman and Johnston, 2005).

Table 3. Consequences of soil contamination as a result of wildfires

No.	Consequences	Mechanism of impact
1	Changes in the physicochemical and morphological characteristics of soils	The concentration of heavy metals in the surface soil horizons increases several times and exceeds background values as a result of mineralization of forest floor from burning herbaceous vegetation; heavy metal pollution negatively affects the activity of soil enzymes and has a negative impact on the nitrification process, which, in turn, affects mineralization and reduces the nitrification process (Pan and Yu, 2011).
2	Negative impact on the flora	Biochemical, physiological, and metabolic processes are changed in plants that grow in regions with high levels of metal pollution (Nagajyoti <i>et al.</i> , 2010); cadmium accumulation in plants is of particular importance as it is subsided in high concentrations on leaves, which can be used for animal or human nutrition (Yanqun <i>et al.</i> , 2005).
3	Negative impact on microorganisms	Microorganisms play a key role in maintaining soil fertility through organic matter decomposition and nutrient cycling, and their numbers can be significantly reduced when exposed to stressors such as extreme temperatures, pH, salinity, and chemical pollution (Schimel <i>et al.</i> , 2007); soil contamination by heavy metals affects the microbial community structure, there are negative correlations between soil microbial biomass and heavy metal concentrations (Wang <i>et al.</i> , 2007); the presence of heavy metals entails a decrease in soil respiration rate and there is a negative correlation between microbial soil respiration and heavy metal content (Nwuche and Ugoji, 2008).

mathematically. This fact can lead to significant differences between predicted and observed levels of air pollution.

Contamination of the soil layer : Wildfires are also a source of soil contamination in forests. The consequences of soil contamination due to wildfires are presented in Table 3.

Thus, the state of the environment is generally characterized by a finite set of parameters, some of which change under the influence of fire, i.e. it is a function of the fire. According to the results of the study, to fully assess the impact of fire on the environment, it is necessary to know a whole set of parameters, the main of which can be considered:

- The total amount of pollutants (aerosol and other combustion products) entering the surface layer of the atmosphere as a result of the fire;
- Concentrations of pollutants (aerosol and other combustion products) on the underlying surface in the area of the fire.

The results of the study confirmed the hypothesis that environmental pollution due to wildfires leads to negative consequences for the atmospheric air and soil cover of forests.

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