

Impact of Extreme Weather on Human Mental Health from a Chemical Perspective and Mitigation Strategies

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Abstract:

In the context of global climate change, the frequent occurrence of extreme weather events not only threatens natural ecology and infrastructure, but also quietly poses a serious challenge to human mental health. This paper aims to explore how extreme weather (such as heavy rain, flood, heat wave, drought) exacerbates chemical pollution and further affects human mental health from a chemical perspective, and put forward corresponding mitigation strategies. Through a comprehensive analysis of existing literature, we found that extreme weather events promote the diffusion and accumulation of chemical pollutants, which in turn affect human health through air, water and food chains, increasing psychological stress and disease risk. The significance of this study is to reveal the complex relationship between extreme weather, chemical pollution and mental health, and provide scientific basis for formulating effective coping strategies.

Keywords: Extreme Weather; Human Mental Health.

1. Introduction

With the intensification of global warming, extreme weather events have become a global challenge that cannot be ignored. According to the International Meteorological Organization, the frequency and intensity of extreme weather events have increased significantly in recent years, bringing unprecedented impacts to human society. These extreme events not only directly damage ecosystems and infrastructure, but also have a profound impact on human health through a series of knock-on effects. In particular, the chemical pollution caused by extreme weather has become one of the important factors threatening human mental health. In recent years, scholars at

home and abroad have conducted extensive research on extreme weather and chemical pollution, chemical pollution and mental health [1]. The study found that heavy rains and floods often lead to industrial wastewater, pesticide residues and other chemical leakage, pollution of water and soil; Heat waves aggravate the concentration of atmospheric pollutants such as ozone and PM2.5, affecting air quality. Drought, on the other hand, can change soil chemistry and indirectly affect air quality. These chemical pollutants enter the human body through inhalation, ingestion or skin contact, and have adverse effects on human health, and then induce or aggravate anxiety, depression and other psychological problems. In view of the increasingly prominent potential threat of extreme

weather events to human mental health, this study aims to explore how extreme weather affects human mental health through chemical pollution and propose targeted mitigation strategies. The specific research framework includes: Firstly, the diffusion and accumulation of chemical pollutants under different extreme weather events are analyzed; Secondly, the mechanism of direct and indirect effects of chemical pollutants on human health was discussed. Finally, effective mitigation strategies and policy recommendations are proposed based on the above analysis [2] [3] [4].

2. Impacts of Extreme Weather on Chemical Pollutants

Extreme weather events have profound implications for the distribution, accumulation, and transformation of chemical pollutants in the environment. This section examines the effects of specific extreme weather conditions—storms and floods, heatwaves, and droughts—on the dispersion and accumulation of industrial chemicals, pesticides, heavy metals, and other contaminants, as well as their subsequent impacts on air and soil quality [5]. The impact of extreme weather on chemical pollutants has attracted much attention in recent years, especially in the context of increasing global climate change. Extreme weather events, such as heavy rainfall, floods, droughts, high temperatures and storms, not only have a direct impact on human living and production activities, but also have a significant effect on chemical pollutants in the environment.

Firstly, extreme precipitation events such as heavy rainfall and flooding can lead to significant transport and dispersion of pollutants. Surface runoff triggered by heavy rainfall can carry chemical pollutants, such as pesticides, heavy metals and industrial waste, from urban and agricultural areas into rivers, lakes and oceans, leading to increased pollution of water bodies. Floods can also cause toxic substances stored in industrial facilities, landfills and other sites to overflow, further contaminating soil and water bodies. When these pollutants enter the water environment, they not only threaten aquatic ecosystems, but also pose a potential threat to human health through drinking water or the food chain.

Secondly, the impact of hot weather on chemical pollutants is equally significant. High temperatures accelerate the evaporation of certain organic pollutants, increasing their concentration in the atmosphere and leading to deterioration of air quality. For example, volatile organic compounds (VOCs) evaporate more readily at high temperatures, and when they enter the atmosphere, they react

with nitrogen oxides to form ozone, thereby triggering photochemical smog events. In addition, high temperatures accelerate the chemical reaction rates of pollutants in soil and water bodies, leading to the transformation or decomposition of pollutants and the production of new hazardous substances, and these secondary pollutants may be more toxic and persistent than the original ones.

Dry weather, on the other hand, can cause the concentration of chemical pollutants in water bodies to rise because of reduced water flow and reduced dilution capacity, leading to the accumulation of pollutants in water bodies such as rivers and lakes. At the same time, drought also affects soil moisture, making pollutants adsorbed in the soil more likely to be dispersed by the wind and enter the atmosphere or migrate to other environmental media, further exacerbating the spread of pollution.

Finally, extreme storm events, such as typhoons or tornadoes, can disturb the environment and redistribute pollutants deposited on the bottom of water bodies, in the soil and in the atmosphere. Strong winds can lift deposited chemicals and carry them over greater distances, extending the reach of the pollution. These events can also damage pollution control facilities and lead to the release of stored hazardous chemicals, causing environmental contamination and harm.

Overall, the impacts of extreme weather on chemical pollutants are multifaceted and often result in the transport, dispersion and transformation of pollutants, increasing the risks to the environment and human health. Understanding and responding to the impacts of extreme weather on chemical pollutants is therefore essential for the protection of the ecosystem and public health.

2.1 Storms and Floods: Dispersion and Accumulation of Pollutants

Storms and floods, particularly in regions with intense industrial activities or agricultural practices, can lead to the widespread dispersion and accumulation of various chemical pollutants. Heavy rainfall can mobilize industrial chemicals stored in soil or sediment, causing them to be released into nearby water bodies. Similarly, floods can inundate agricultural fields, leading to the runoff of pesticides and fertilizers into rivers and lakes. The accumulation of these pollutants in aquatic ecosystems poses significant risks to aquatic life and can also affect human health through contaminated water supplies and food chains.

Moreover, storms and floods can cause the erosion of contaminated soils, leading to the redistribution of heavy metals and other toxic substances across landscapes. The sedimentation of these pollutants in floodplains and riverbanks can result in long-term contamination of soils and

groundwater, with potential consequences for ecosystem health and human well-being.

2.2 Heatwaves: Variations in Air Pollutant Concentrations and Health Risks

Heatwaves, characterized by periods of exceptionally high temperatures, can exacerbate the formation and accumulation of certain air pollutants. Ozone, a harmful air pollutant, is particularly sensitive to temperature changes, with hotter weather conditions favoring its formation through photochemical reactions involving volatile organic compounds (VOCs) and nitrogen oxides. Elevated ozone levels during heatwaves can pose significant health risks, particularly for individuals with respiratory sensitivities or chronic conditions.

Similarly, heatwaves can influence the concentration and dispersion of particulate matter (PM), including PM_{2.5}, which is associated with adverse health effects such as respiratory and cardiovascular diseases. The stagnation of air masses during heatwaves can lead to the accumulation of these pollutants near the surface, increasing exposure risks for populations in affected areas.

2.3 Drought: Impact on Soil Chemistry and Air Quality

Drought conditions can significantly alter soil chemistry, with implications for both soil health and air quality. Reduced precipitation leads to decreased soil moisture, which can enhance the mobilization and bioavailability of certain chemicals, including heavy metals and persistent organic pollutants. These changes can affect soil microbial communities and plant growth, with potential consequences for ecosystem functioning and services.

Furthermore, drought can contribute to the release of volatile organic compounds from stressed vegetation and soils, impacting local air quality. Wildfires, which are often more prevalent during drought periods, can also release large quantities of particulate matter, gases, and other pollutants into the atmosphere, further degrading air quality and posing health risks to nearby populations.

3. Mechanisms of Chemical Pollution's Impact on Mental Health

The relationship between chemical pollution and mental health is complex, involving both direct and indirect pathways. This section explores the mechanisms through which chemical pollutants can affect mental health, including neurotoxic effects, psychological stress responses, and broader socio-psychological impacts. The impact of chemical pollution on human mental health is a complex

and multifaceted process involving a number of mechanisms such as neurotoxicity, endocrine disruption, immune response, oxidative stress and genetic susceptibility. Together, these mechanisms may adversely affect brain development, function and neurotransmission processes, which in turn may have a negative impact on mental health.

3.1 Direct Impacts: Neurotoxic Effects of Chemical Pollutants

Certain chemical pollutants, such as heavy metals (e.g., lead, mercury) and volatile organic compounds, have been shown to exert neurotoxic effects, impacting the structure and function of the nervous system. These pollutants can cross the blood-brain barrier, disrupting neural signaling, altering neurotransmitter levels, and potentially causing long-term damage to cognitive and emotional processes. Exposure to these substances has been associated with a range of mental health outcomes, including cognitive deficits, anxiety, and depression.

3.2 Indirect Impacts: Psychological Stress Responses

Environmental pollution can also indirectly affect mental health by triggering psychological stress responses. The perception of environmental degradation, particularly when it threatens personal safety or the well-being of loved ones, can elicit feelings of anxiety, helplessness, and grief. Prolonged exposure to polluted environments or the aftermath of environmental disasters can lead to the development of post-traumatic stress disorder (PTSD) among affected individuals.

3.3 Socio-Psychological Impacts: The Role of Environmental Degradation

The socio-psychological impacts of environmental pollution should not be underestimated. Pollution-related environmental degradation can lead to the deterioration of living conditions, economic losses, and social disruptions, all of which can contribute to mental health challenges. Loss of income due to pollution-related job losses or decreased property values, for example, can lead to increased stress and anxiety. Similarly, the disruption of social networks and community cohesion in response to environmental crises can exacerbate feelings of isolation and despair, further compromising mental health outcomes.

4. Summary

The intricate interplay between extreme weather-induced chemical pollution and its profound impact on human

mental health underscores the urgency for comprehensive mitigation strategies. Our study, by examining chemical contaminant dispersion, direct and indirect psychological consequences, and proposing integrated solutions encompassing pollution control, psychological support, and policy-education, offers a roadmap for future preparedness. The findings emphasize the multidimensional harm caused by these pollutants and underscore the importance of concerted efforts across sectors to both mitigate pollution and bolster mental resilience. By advocating for proactive policies, enhanced public education, and robust mental health support systems, we aim to empower individuals and communities to navigate the complexities of climate change-related challenges.

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