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# A Comprehensive Study of Spread Models of Wildland Fires

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**Abstract :** These days, wildland fires, also known as forest fires, are more prevalent than ever. Wildfires have major repercussions that affect ecosystems, communities, and the environment in several ways. Wildfires lead to habitat destruction and biodiversity loss, affecting ecosystems and causing soil erosion. They also contribute to poor air quality by releasing smoke and pollutants that pose health risks, especially for individuals with respiratory conditions. Wildfires can damage infrastructure, disrupt communities, and cause economic losses. The economic impact of firefighting efforts, combined with their direct effects on forestry and agriculture, causes significant financial difficulties for the areas impacted. This research explores different forest fire spread models and presents a comprehensive review of various techniques and methodologies used in the field. A forest fire spread model is a computational or mathematical representation that is used to simulate and predict the behavior of a forest fire. By applying scientific concepts and data from empirical studies, these models attempt to capture the intricate dynamics of how a fire spreads, taking into consideration a variety of factors like weather patterns, topography, fuel types, and environmental conditions. These models assist authorities in understanding and forecasting the potential trajectory and intensity of a wildfire. Emphasizing the need for a comprehensive understanding of wildfire dynamics, this research explores the approaches, assumptions, and findings derived from various models. By using a comparison approach, a critical analysis is provided by identifying patterns, strengths, and weaknesses among these models. The purpose of the survey is to further wildfire research and management techniques. Decision-makers, researchers, and practitioners can benefit from the useful insights that are provided by synthesizing established information. Fire spread models provide insights into potential fire behavior, facilitating authorities to make informed decisions about evacuation activities, allocating resources for fire-fighting efforts, and planning for preventive actions. Wildfire spread models are also useful in post-wildfire mitigation strategies as they help in assessing the fire's severity, determining high-risk regions for post-fire dangers, and forecasting soil erosion trends. The analysis highlights the importance of customized modeling approaches for various circumstances and promotes our understanding of the way forest fires spread. Some of the known models in this field are Rothermel’s wildland fuel model, FARSITE, WRF-SFIRE, FIRETEC, FlamMap, FSPro, cellular automata model, and others. The key characteristics that these models consider include weather (includes factors such as wind speed and direction), topography (includes factors like landscape elevation), and fuel availability (includes factors like types of vegetation) among other factors. The models discussed are physics-based, data-driven, or hybrid models, also utilizing ML techniques like attention-based neural networks to enhance the performance of the model. In order to lessen the destructive effects of forest fires, this initiative aims to promote the development of more precise prediction tools and effective management techniques. The survey expands its scope to address the practical needs of numerous stakeholders. Access to enhanced early warning systems enables decision-makers to take prompt action. Emergency responders benefit from improved resource allocation strategies, strengthening the efficacy of firefighting efforts.

**Keywords :** artificial intelligence, deep learning, forest fire management, fire risk assessment, fire simulation, machine learning, remote sensing, wildfire modeling
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