

Navigating the Evolving Landscape of Wildfire Management: A Systematic Review of Decision Support Tools

By Tristan O'Mara, Andrew Sánchez Meador, Melanie Colavito, Amy Waltz, and Elvy Barton

Introduction

In recent decades, fire managers have been using decision support tools (DSTs) to inform their actions to address planning for and responding to wildfires. A wildfire management DST is a software application, framework, or system that assists managers in assessing, analyzing, and making informed decisions related to wildfire risks. In the response to the wildfire crisis and rapidly evolving field of wildfire management, the availability and number of DSTs has grown significantly, providing a breadth of options to assess wildfire risks; yet managers need more information and guidance on the strengths, limitations, and suitability of specific DSTs to determine what tool is appropriate for a given management action. We developed a framework to assess the usability and functionality of wildfire management DSTs, organizing them by functionality, intended use, and management objectives to help managers navigate overlaps and select the most suitable tool.

Methods

We conducted a systematic literature review of DSTs in the Western US and found a total of 56 articles that highlighted 24 unique DSTs. Our systematic review addressed the following questions: 1) *To what extent does peer-reviewed literature comprehensively represent the diverse array of wildfire DSTs used in the western US?* 2) *How do usability metrics vary across the wildfire DSTs available in the western US?* 3) *How can the categorization and classification of DSTs help managers navigate the decision support space?* For each tool, we extracted information about tool functions and capabilities and captured the number of times it appeared in the literature and its most common use.

To understand how the tools from our review align with a broader decision-making framework, we evaluated them based on their ease of application and created a classification system of eight different usability metrics (*Usability, User Support, Geospatial, Scalability, Accessibility, Time Investment for Output, Data Flexibility, and Collaborative Potential*). The resulting classification system was then used to distinguish different competency levels for each tool in each category.

Findings

To facilitate navigating the DST space, we grouped existing wildfire management DSTs into six categories (Figure 1, Table 1) that highlight their discrepancies and nested nature.

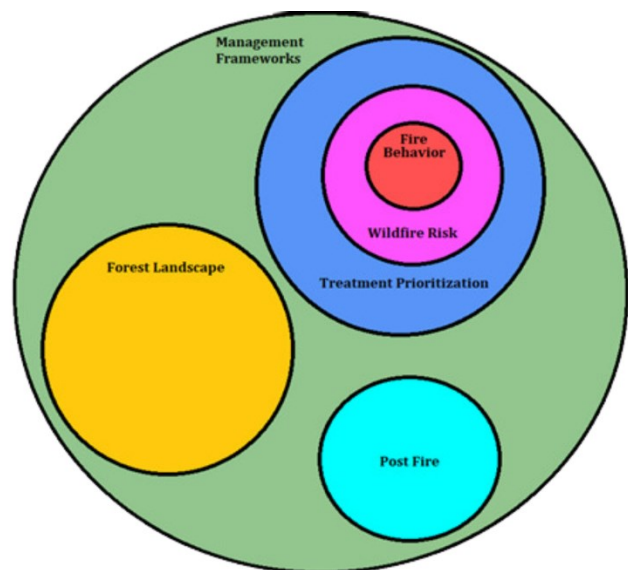


Figure 1. This diagram depicts the relationships of various decision support tools (DSTs) commonly used in wildfire management.

Table 1. Decision support tool category definitions used to categorize and classify tools found in this review.

Category	Description
Fire Behavior Models (FB)	Fire behavior models estimate fire behavior under various conditions. These tools utilize input data such as weather, fuel characteristics, and topography to predict the spread and intensity of wildfires.
Forest Landscape Models (FL)	Forest landscape models simulate changes in forest ecosystems over time, incorporating factors such as vegetation growth, succession, and disturbances on a variety of scales. These models are typically used in silviculture and enable the assessment of the temporal changes on forest landscapes, evaluate the effectiveness of different management strategies, and identify areas in need of treatment.
Management Frameworks (MF)	Management frameworks provide an overarching structured approach to wildfire management decision making. These tools offer guidelines for various aspects of fire management, including preparedness, response, and recovery. These frameworks may host dashboards that hold tools that often include risk assessment, collaboration, and other modeling.
Post Fire Models (PF)	Post-fire monitoring tools assist in assessing the ecological and environmental impacts of wildfires after they have occurred. These tools enable collecting and analyzing data related to vegetation recovery, soil erosion, water quality, flood risk, and wildlife habitat.
Wildfire Risk Models (WR)	Wildfire risk models assess the potential risk of wildfires in specific areas and the impacts on the wildland-urban interface (WUI) and other high-valued resources or assets (HVRAs). These models consider various factors such as historical treatment and fire data, fuel characteristics, weather patterns, and proximity to values at risk.
Treatment Prioritization Tools (TP)	Treatment prioritization tools assist in identifying areas where fuel treatments (e.g., prescribed burns, thinning) should be implemented to reduce high severity wildfire risks. These tools consider factors such as fuel loads, vegetation types, ecosystem resilience, cross-boundary collaboration, and values at risk.

- Most tools from the literature fell into the “Fire Behavior” or “Forest Landscape” models’ category, followed by “Management Frameworks,” “Post-Fire,” “Treatment Prioritization,” and “Wildfire Risk.”
- Notably, fire behavior models were the most frequently referenced in the case studies reviewed.
- The review also highlighted limitations of DSTs, particularly in usability and support for collaborative wildfire management.
- The variety of DSTs reflects the complex challenges of wildfire management, with both specialized tools for specific tasks and generalist tools offering overlapping functions.
- The review identified key gaps — particularly a need for post-fire tools.
- A gap exists between the academic focus on DSTs and their practical use in the field. Advancing applied social science is essential to bridge this divide, facilitating the adoption and effective use of these tools in real-world wildfire management.

Conclusions

Our review highlights the gap between the usage of DSTs in the literature and the practical field. While combining multiple tools can help address managerial needs that a single tool cannot, it may also complicate workflows for managers. “Wildfire Risk” and “Management Framework” tools stand out for their broad applicability in decision-making. Our research indicates that these tools cover the widest decision space, highlighting their adaptability and pivotal role in holistically addressing the complex challenges of wildfire management. Furthermore, our study highlights the lack of tools that effectively combine ease of use with collaborative functionality. This finding underscores a pressing need for tools that strike a balance between user-friendliness and fostering collaboration across various jurisdictions and departments.

This fact sheet summarizes information from the following publication

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