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Data-Driven Solutions For Forest Fire Management: A Case-Study Of Korea's Integrated Forest Disaster Management System

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Abstract:
This study adopts a data-driven approach to forest fire prediction and monitoring to examine the development, implementation, and outcomes of Korea's Integrated Forest Disaster Management System (FDMS). Against the backdrop of increasing wildfire risks exacerbated by climate change, as well as the unique forested landscape of South Korea, the Korea Forest Service (KFS) has initiated a multiphase project to enhance real-time fire response capabilities through technological integration and interagency collaboration. Using a qualitative case-study approach, data were collected through document analysis and semi-structured interviews with key stakeholders, including government officials and technical experts. The findings reveal significant challenges and strategies for addressing interdivisional resistance, enhancing data management systems, and promoting stakeholder engagement to optimize system usage. The FDMS development involved a series of task forces, progressive system upgrades, and extensive training efforts to build a platform integrating data from multiple agencies and supporting real-time decision-making through multiple tools, such as the "Smart Forest Disaster Management" application. This study highlights how the case study of Korea can be an example to other regions facing similar ecological and technological challenges in wildfire management, underscoring the importance of continuous system refinement, cross-sectoral coordination, and strategic use of ICT in environmental disaster response.

Keywords: *Forest fire, Data-driven prediction, Fire management, Interagency collaboration.*

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I. Introduction

Every year, wildfires devastate vast stretches of land, causing extensive environmental damage and severely affecting human communities. Climate change has exacerbated these effects by intensifying the frequency and scale of forest fires worldwide. In 2019 alone, more than 37.2 million hectares of land were scorched, inflicting unprecedented destruction in several countries (Care Our Earth, 2019). The urgent need for effective forest fire management is becoming increasingly clear as uncontrolled fires contribute significantly to biodiversity loss, habitat destruction, and the displacement of communities while amplifying carbon emissions that further contribute to global warming (Attri et al., 2020). Suppression is an essential component of forest fire management, and focusing primarily on prevention through accurate predictions is critical. Suppression, however, even with sophisticated ground and aerial firefighting equipment, is costly and can be insufficient to contain large-scale fires, such as those witnessed during Australia's 2019-2020 "Black Summer" crisis (Scholten et al., 2021). Thus, prioritizing predictive management offers a more sustainable and cost-effective approach to mitigating the impacts of fire.

Climate change has significant implications for forest fire management, as global warming has led to extreme fire weather, prolonging the fire season and contributing to larger and longer-lived fires (Scholten et al., 2021; Zhao et al., 2024). In regions, such as Canada, the United States, and Australia, the average forest fire size has doubled or even tripled in recent decades due to climate warming, altered fuel management practices, and rural depopulation (Hanes et al., 2019). Larger fires have been associated with more severe burns, as indicated by significant reductions in vegetation greenness post-fire (Cansler & McKenzie, 2014). Severe fires release high levels of carbon dioxide (CO) in the burned area, creating a negative loop that intensifies global warming. Forest fires influence climate systems by altering land–atmosphere exchanges of carbon, nitrogen, aerosols, energy, and water (Liu et al., 2019). Recent research has highlighted that fire size amplifies summer surface warming over burned areas, particularly in temperate and boreal forests, underscoring the interdependent nature of climate and fire dynamics (Nesbit et al., 2023). Such warming impacts post-fire forest regeneration, permafrost degradation, and ultimately future fire behavior, further illustrating the need for climate-smart forest management (Gill et al., 2022; Reich et al., 2022).

The significance of fire prediction as a preventive strategy is underscored by the high ecological and economic costs of fire suppression. The "firefighting trap"—where resources are primarily allocated to immediate fire suppression, detracting from long-term prevention efforts—illustrates a fundamental flaw in conventional fire management (Collins et al., 2013). In contrast, fire-smart management emphasizes a balanced approach integrating forest and fire management across both the stand and landscape levels to reduce the socioeconomic impact while promoting ecological benefits (Hirsch et al., 2001). Advanced technologies, such as remote sensing, geographic information systems (GIS), and big data analytics, have proven valuable in enhancing predictive capabilities, enabling forest managers to anticipate fire occurrence and behavior more accurately (Attri et al., 2020; Lee et al., 2019). Prediction-based management offers a proactive and adaptable framework prioritizing the safety and sustainability of ecosystems and communities.

The case of the Republic of Korea (South Korea; hereafter referred to as "Korea") presents a notable example of this prediction-based approach, providing insights into forest fire management that could refine global practices. The fire season in Korea is primarily concentrated in the spring, with peak occurrences in March and April (Lee et al., 2019). Recognizing this seasonal pattern, Korean fire management has extended its precautionary period from October to May, including midwinter, to account for heightened risks. This extended vigilance, coupled with an integrated approach adopting big data analytics, GIS-based decision-making, and interagency collaboration, allows Korea to proactively manage forest fire risks in line with its seasonal and spatial characteristics (Lee et al., 2019). Korea's post-fire management strategies emphasize restoration and erosion control before the rainy season to protect soil integrity and enhance forest resilience (NIFS, 2018). These strategies demonstrate the benefits of predictive-technology-driven fire management for fostering a sustainable approach to forest conservation and community protection.

This study hypothesizes that prediction-focused, technology-integrated forest fire management, as demonstrated by the illustrative case of Korea, can mitigate more effectively the risks and impact of forest fires than suppression-centered approaches. By examining Korea's experience in developing and implementing a smart forest fire management system, this study aimed to provide a framework for incorporating predictive fire management strategies into forest management practices worldwide. Our findings have implications for global forest conservation efforts and contribute valuable insights into the role of prediction and technology in enhancing ecosystem resilience and mitigating climate risk in the face of growing wildfire challenges.

II. Methodology (Materials And Methods)

Study design: This study employs the qualitative case study methodology outlined by Stake (1995) to explore the development and implementation of a smart forest fire management system in South Korea. The case study approach is well-suited for investigating complex social phenomena in a real-life context, allowing for in-depth analysis and understanding of Korea's forest fire management practices and the perspectives of key stakeholders involved in these processes. This method provides a comprehensive review of Korea's approach to forest fire prediction and prevention and offers insights for other countries worldwide to improve their efforts in the field.

Research context: Korea's unique topography and vegetation, combined with seasonal climate patterns, create favorable conditions for forest fires, making their management a critical component of national disaster preparedness (Lee et al., 2020). Forests cover over 63% of Korea's land area, and highly flammable coniferous forests comprise more than 37% of the nation's forested regions. From 2010 to 2019, an average of 440 forest fires occurred annually, leading to the destruction of approximately 857 hectares of land yearly. While human negligence accounted for approximately 34% of these incidents, natural factors, such as dry climatic conditions and specific environmental characteristics, also play a significant role in the ignition, spread, and intensity of wildfires. The risk of forest fires is particularly elevated during the dry spring season from March to May and is most severe along the eastern mountainous regions, where historically destructive fires typically occur in April (Sung et al., 2022).

Several catastrophic forest fires in Korea's recent history have highlighted the need for a comprehensive and technologically advanced forest fire management system. Notably, the 1996 Goseong fire, the 2000 East Coast fire, one of the most devastating fires in the country's history, and the 2005 Yangyang fire, which led to the destruction of the revered cultural heritage site of the Naksan-sa Temple, underscored the urgency of strengthening forest fire prevention and response mechanisms. In response, the Korean government undertook the initiative to establish a robust legal and institutional framework for forest fire prevention. In 1999, the Korean Forest Service (KFS) created the Forest Fire Prevention and Control Division to coordinate prevention efforts between affiliated institutions and regional offices. Additionally, the Forest Training Institute was expanded to include a Forest Fire Prevention Training Department that provides essential training and resources for the personnel engaged in fire prevention. Furthermore, forest fire prevention regulations were integrated into the Forest Act, and guidelines for forest fire management were codified through the creation of Integrated Forest Fire Directive Guidelines. To enhance oversight, the East Coast Forest Fire Management Center was established in 2006 to support region-specific forest fire management efforts.

In line with broader governmental goals for digitalization and e-government, in the early 2000s, the KFS began to incorporate advanced information technology into its forest fire management systems. During this period, Korea actively promoted digital infrastructure across government agencies, laying the groundwork for efficient data-driven governance. The KFS leveraged this national initiative by introducing the Forest Geographic Information System (FGIS), a GIS-based platform using digital topographical maps and satellite imagery from the Ministry of Land, Infrastructure, and Transport. This platform facilitated the mapping and monitoring of forested areas and supported data-driven decision-making for fire prevention.

Further advancements followed in 2004 when the National Institute of Forest Science (NIFS), an affiliate of the KFS, developed the Korea Forest Fire Danger Rating System, a system assessing fire risk based on topographic and meteorological data; however, its predictive accuracy was constrained by the limited data available at that time. Recognizing these limitations, the Korean government has committed to enhancing the effectiveness and precision of forest fire prediction and monitoring systems. The previous web-based platform was gradually deemed inadequate as it relied on data from a limited set of sources and offered restricted accessibility compared to more contemporary mobile-based solutions.

In response to these challenges, the KFS launched a sophisticated smart forest fire prediction and monitoring system that has become an integral component of the country's integrated Forest Disaster Management System (FDMS). This advanced system integrates data from over 25 external geospatial, meteorological, and environmental data sources, providing real-time, consistent information on fire risks to both the KFS and the public (NIFS, 2018). The system collects forest fire data through a variety of channels, including satellite imagery, heat-sensing drones, emergency calls, and a GPS-enabled mobile application that allows citizens to report the exact location of a fire, upload photos and videos, and track fire progression, thereby facilitating prompt and informed responses. Big data gathered in real-time are displayed on a central dashboard in the KFS Forest Disaster Situation Room, where digital maps and satellite images allow officers to monitor fire risks, track fire spread, and quickly mobilize resources for suppression. These comprehensive efforts highlight Korea's commitment to adopting an integrated data-driven approach to forest fire management, aimed at minimizing the environmental, economic, and social impacts of forest fires.

Data collection: To address the research objectives, data were collected using two primary methods: document analysis and semi-structured interviews. The combination of these methods enabled a thorough exploration of policies, practices, and stakeholder experiences related to forest fire management in Korea.

Document Analysis: Document analysis served as a foundational method for gathering contextual and policy-related information on Korea's forest fire management practices. A review of policy documents and key legislative materials, including official guidelines and regulations, provided insights into the institutional framework underlying forest fire management in Korea. Publications by the KFS and the NIFS detail the roles, strategies, and programs implemented by these agencies for fire prevention and management. Additionally, research articles on forest fire management and policy analysis have enriched the study by providing evidence-based insights into prediction-focused management practices and the current academic discourse. The following documents were reviewed:

	Document Type	Description
1	Laws and Decrees	Includes key legislative documents
2	Policy Documents	Documents outlining forest fire management policies and legal guidelines
3	Reports and Publications by the KFS and the NIFS	Official reports and publications providing insights on forest fire management strategies
4	Peer-reviewed Journal Articles	Scholarly articles on forest fire management and policy analysis
5	Other Relevant Publications	Publications relevant to forest fire management

This analysis of official documents, laws, and scholarly literature provided a comprehensive view of Korea's legal and administrative framework for forest fire management, creating a deeper understanding of the case and aiding the development of relevant interview questions for stakeholders.

Semi-structured Interviews: To complement the document analysis and gain deeper insights into Korea's forest fire management system, semi-structured interviews were conducted with ten key stakeholders, which were selected based on their expertise and experience in forest fire management, and particularly in prediction-focused strategies. The interviewees included current and former government officials from the KFS and its regional offices, as well as from the NIFS, one representative managing and updating the system of a private company, and an external academic expert on the system. The interviews provided a range of perspectives from individuals directly involved in policy formulation, field operations, and system development. All interview participants were anonymized to ensure confidentiality. The following roles were represented:

	Position	Institution
1	High-level leader	Korea Forest Service
2	High-level officer, ICT Management & Statistics	Korea Forest Service
3	High-level officer, ICT Management & Statistics	Korea Forest Service
4	Officer, ICT Management & Statistics	Korea Forest Service
5	High-level officer, Forest Fire Prevention & Control	Korea Forest Service
6	Officer	Eastern Regional Office of Forest Service
7	Officer	Northern Regional Office of Forest Service
8	Officer	East Coastal Forest Fire Center
9	Officer	National Institute of Forest Science
10	Professor, Fire Management	University
11	High-level leader	Private company

Each interview lasted for approximately one hour, with questions designed to gather insights into participants' experiences, perspectives on prediction-based fire management, and the challenges and successes associated with Korea's approach. The semi-structured interviews allowed for flexibility in the discussion, encouraging interviewees to elaborate on their responses and providing unique insights into their roles and experiences.

Data Analysis: The data collected from both the document analysis and the interviews were thematically analyzed, with themes identified based on the recurring patterns and key issues raised by the participants and the reviewed documents. This process involved coding the data to highlight the areas of consensus, challenges in current practices, and potential improvements. The thematic analysis enabled an understanding of the interconnected systems within Korea's forest fire management system and highlighted the specific role of predictive approaches in enhancing the effectiveness of fire prevention and control strategies.

By combining document analysis with semi-structured interviews, this methodology provided a comprehensive view of Korea's smart prediction-based forest fire management system, facilitating an in-depth understanding of the country's unique approach and its potential applicability to other contexts.

III. Results

Tracing the development and implementation process

Phase 1: Linking external information systems and developing an integrated Forest Disaster Management System (FDMS)

Following the development of the Informatization Strategic Plan by the KFS in 2013, the initial phase of the FDMS project began in 2014. This plan laid the groundwork for an integrated forest geospatial information system aimed at improving the quality and efficiency of forest management services. As part of the National e-Government Support Projects, the KFS, funded by the Ministry of Security and Public Administration (MSPA), established the first phase of the FDMS, which involved linking multiple external information systems and creating a centralized platform for forest management. Additionally, the KFS secured funding to integrate big data from the MSPA into a new forest fire prediction system enhancing fire forecasting through advanced data analysis.

The need for inter-divisional coordination was evident in the early planning stages, as each division contributed essential expertise to the successful implementation of the system. One interviewee highlighted this need: "The project required collaboration among different divisions… It was essential to organize a meeting with officials from various divisions to discuss the ISP project and its implementation plan to ensure smooth execution." Another participant expanded on the challenges, noting that "Pooling data required cooperation from various government institutions. Sometimes, these agencies change the data structure and/or servers without notifying the KFS system management team, disrupting real-time data flow and causing system errors." To address these technical and interagency complexities, the KFS assigned the ICT Management and Statistics Division within its Planning and Coordination Bureau to lead system development. Recognizing the cross-disciplinary nature of forest fire management, the KFS has established specialized task forces to facilitate collaboration and clarify roles across divisions. As one participant described, "We decided to create two task forces to implement the project and assign clear roles and responsibilities: one TF for Forest Disaster, to develop and implement the integrated management of forest disaster ISP, and another TF for Climate Change Response, to share progress and coordinate with the Ministry of Environment" (personal communication).

However, some resistance emerged from old divisions, such as the Forest Fire Prevention and Control Division, where officers accustomed to the existing prediction systems viewed the new system as disruptive. To overcome this opposition, the FDMS development team focused on demonstrating the system's superior user friendliness and technical capabilities. Training sessions were organized for over 200 officers, particularly those in the Forest Disaster Prevention Bureau and affiliated KFS organizations, to familiarize them with the new system. As one participant observed, “With a guaranteed retirement age of 60, the average age of system users was 45 or older, and this demographic struggled with making basic use of computers or even smartphones, despite efforts to educate them.”

Despite initial skepticism, an evaluation by the National Information Society Agency in 2014 declared the FDMS a success, emphasizing the enhanced efficiency and precision of forest management services. The Forest Spatial Data Infrastructure Portal within the FDMS introduced 60 services, including forest fire prediction, landslide monitoring, and pest alert systems, utilizing data pooled from multiple agencies, such as the National Geographic Information Institute, the Korea Aerospace Research Institute, and the Korean Meteorological Administration. This interconnected infrastructure reduced the time required to generate statistical reports from one hour to one minute and the time to process climate data from three hours to 50 minutes, marking a significant improvement in administrative efficiency. Additionally, precision was enhanced by updating the digital map scale from 1:25,000 to 1:5,000, increasing the forest fire prediction accuracy from 74.2% in 2014 to 83.3% in 2015.

Phase 2: Scaling up nationwide to local and municipal levels

In 2015, the second phase of the FDMS project aimed to extend the benefits of the system to local and municipal governments. Key upgrades included the implementation of a multi-forest fire management system, integration with the 119-fire emergency call system (enabling the automatic retrieval of call records), and the launch of a “Smart Forest Disaster Management” mobile application. This GPS-enabled app allowed field officers and the public to report fires in real time and share precise location data and multimedia content, which could reduce the average analysis time for fire locations from one hour to less than 30 minutes.

To facilitate an efficient response, the FDMS reclassified forest management areas into 79 districts, allowing easier location sharing and accurate identification of fire sites. Additionally, a Forest Fire Situation Monitoring System, piloted in 2015, was made accessible for the local governments in 2016, generating approximately 8,000 web page visits within the first year. Collaboration with the Ministry of Land, Infrastructure and Transport further enhanced the visual data accuracy of the system by integrating satellite imagery and high-resolution maps.

Phase 3: Enhancing user-friendliness and public access

In 2016, the FDMS project entered its third phase, focusing on improving public access to forest fire data and enhancing the user interface of the system. This phase responded to increasing calls from the media and National Assembly for greater transparency and accessibility to government services. Following criticisms regarding limited public access to information during a major forest fire in Gangneung in 2017, the KFS enhanced the “Smart Forest Disaster Management” application to allow users to report, track, and monitor forest fire incidents and government responses. The application’s expanded functionality enabled field officers to communicate more effectively with the KFS Situation Room and connect with the Forest Aviary System to coordinate air support.

User support was strengthened by the establishment of a dedicated help desk, addressing 797 requests from 198 KFS-affiliated organizations, including 411 requests from local governments. In this phase, SMS notifications regarding fire status updates were also automated to expedite communication among KFS officers, further improving response coordination.

Phase 4: System updates for enhanced access and coordination

The fourth phase of the FDMS project focused on expanding access to forest fire management data beyond the internal KFS administrative network. In 2018, KFS-affiliated organizations gained online access to the FDMS through a government VPN, while additional information on fire incidents was made available to the public through a mobile application. User feedback, particularly from the Forest Disaster Management Bureau, guided the correction of technical issues and interface updates to optimize the usability and reliability of the system. The FDMS continued to evolve by connecting with additional data sources to enhance interagency coordination and facilitate comprehensive countermeasures for forest fires.

Continuous innovation and system enhancements

The development of Korea’s forest fire management system is an ongoing process, marked by continuous updates, monitoring, and integration of cutting-edge technologies to enhance its effectiveness. Recent research has underscored the importance of advanced data systems and decision support tools in modern wildfire management, highlighting Korea’s commitment to evolving strategies in response to emerging challenges (Lim & Lee, 2024). Current studies advocate the integration of data from multiple agencies, the application of big data analytics, and the implementation of GIS-based decision-making systems, all of which support a more comprehensive and adaptive approach to wildfire responses (Kim & Lee, 2024).

To further strengthen decision-making, researchers have proposed a conceptual framework for an Intelligent Decision Support System that incorporates artificial intelligence and open-source intelligence to enhance disaster management capabilities, allowing for more predictive and responsive measures (Jung et al., 2020). To complement these efforts, a smoke dispersion forecast system was developed to model and predict the spread of pollutants from forest fires by integrating diverse data sources, together with models improving resource allocation and mitigating the health impact of smoke exposure (Lee et al., 2019). These ongoing improvements not only enhance the visualization of complex data but also enable faster and more precise decision-making, aligning Korea's wildfire management system with the leading global practices in data-driven and technology-integrated disaster management. Together, these efforts reflect an ongoing commitment to refine Korea's wildfire response capabilities through innovative, evidence-based approaches, ensuring that the system remains adaptable and effective in the face of evolving wildfire risks.

Outcomes

The FDMS has significantly enhanced Korea's forest fire management capabilities. The Forest Spatial Data Infrastructure Portal now provides access to 186 types of geospatial data central to forest management, such as forest fire prediction, landslide monitoring, and pest alerts, integrating information from both the KFS and external agencies. As a result, the forest fire prediction accuracy has improved from 74.2% in 2014 to 83.3% in 2015, with a slight adjustment to 82% by 2017, partly owing to the evolving climate variables. The FDMS allows for 24/7 real-time fire monitoring through the KFS website and the "Smart Forest Disaster Management" app. The integration of data sources, such as satellite analysis, CCTV, drones, and public reports, has reduced the time required to confirm forest fire incidents from 30 minutes to less than five minutes by 2018 (NIFS, 2018).

The mobile application also streamlined operational costs by consolidating four separate applications into a single platform, thereby reducing administrative expenses by approximately 75%. GPS tracking within the app allows real-time monitoring of over 12,000 field agents during high-risk fire seasons, thereby improving response coordination. The app's capability to map and assess damaged areas further enhances the precision and effectiveness of on-ground responses.

The use of the FDMS has steadily increased, with web access visits rising from an average of 2,182 per month in 2015 to 9,396 per month in 2017. The effectiveness of the system was recognized in 2017 after receiving the E-Government Award for best practice in public sector digital transformation. In recent years, the KFS has shared its FDMS model with Latin American and Asian countries, contributing to international efforts to enhance disaster management capabilities.

IV. Discussion

The development of Korea's integrated smart FDMS demonstrates a comprehensive approach to modern wildfire management, integrating advanced technologies, data-driven decision-making, and interagency collaboration. This case-study highlights several key insights into how data integration, predictive modeling, and user-centered design contribute to improved fire prevention, response, and resilience. The success of the FDMS lies in its phased development, where each stage introduced strategic improvements in the system scope, technological sophistication, and accessibility, enhancing Korea's capacity to manage forest fires with precision and agility.

One of the most significant achievements of the FDMS is its predictive capability, which is a core component that aligns with global recommendations for proactive wildfire management. The system's use of big data analytics and GIS-based tools for predicting and monitoring fire hazards enables forest managers to identify potential risks in real time, thereby improving response efficiency. Many prior studies suggest that the shift from reactive suppression to proactive prevention through technology can reduce the costs and risks associated with large-scale forest fires (Lee et al., 2019; Scholten et al., 2021). Furthermore, integrating data from diverse sources, such as satellite imagery, weather data, and GPS-enabled citizen reports, enhances the predictive accuracy and situational awareness of the system, which are critical in the face of climate-induced changes that exacerbate fire risks. This adaptability is vital after recent trends have shown an increase in fire intensity and frequency worldwide, calling for fire management systems that can swiftly adapt to dynamic environmental conditions.

However, the FDMS also faces a few challenges, particularly regarding user adoption and system optimization. Although the scope of the system has expanded to include municipal and local governments, early resistance among field officers has highlighted the importance of continuous training and system usability. Research on technology acceptance in disaster management emphasizes that user engagement and training are crucial for effective system implementation (personal communication; Jung et al., 2020). The gradual improvements in FDMS user accessibility, especially through the "Smart Forest Disaster Management" mobile app, have addressed some of these challenges by enabling streamlined reporting and real-time information sharing. By incorporating user feedback and optimizing the platform to reduce data load times, the KFS has demonstrated a commitment to making the system more user-friendly and operationally efficient. The success of the project was largely attributed to the presence of a strong leadership that could advocate for and actively promote the system's use among government officials. As noted by one interviewee, "frequent communication with end users to understand their needs and preferences helped engage the users and promote their use of the system. Teams with a manager who strongly supported the use of the system were able to successfully absorb and improve it" (personal communication). Other interviewees pointed out the pivotal role of the manager, who was "central to the success of the project. He played a key role as an implementation manager with both technical knowledge and an understanding of the government organization and functioned to effectively coordinate among the various actors involved and integrate the perspectives of both developers and system end users" (personal communication).

The FDMS can further benefit from continued investment in intelligent decision support systems and AI to enhance predictive accuracy and response strategies based on real-time data, allowing for more adaptive responses to emerging wildfire conditions. Furthermore, the development of a smoke dispersion forecast system represents an innovative approach to addressing the broader environmental impact of forest fires, particularly regarding air quality and public health risks. Implementing such tools aligns with the goals of climate-smart forestry, which advocates management practices that mitigate climate risk while promoting forest resilience.

In summary, Korea's phased approach to developing the FDMS underscores the value of adaptive and data-driven strategies for wildfire management. Although the system has significantly improved forest fire prediction and response, ongoing enhancements in AI and IDSS integration could further strengthen its capabilities. Thus, the FDMS can serve as an example for other nations, demonstrating how technology, policy integration, and user-centered design can contribute to more resilient and sustainable wildfire management systems worldwide.

V. Conclusion

The evolution of Korea's integrated smart FDMS offers a valuable example of how technology and interagency collaboration can transform wildfire management practices. Through a phased approach, the KFS has built a robust system that leverages predictive modeling, big data analytics, and GIS-based decision-making to address the increasing risks of forest fires. By integrating diverse data sources, including satellite imagery, weather forecasts, and GPS-enabled citizen reports, the FDMS allows real-time monitoring and rapid response, which are critical for reducing the ecological and economic impacts of forest fires. The FDMS exemplifies the global shift toward proactive and predictive fire management strategies that aim to prevent fires rather than solely focus on suppression.

The FDMS has also demonstrated the importance of user-centered design and accessibility in technology adoption. By addressing feedback from field officers and adapting the system to include a mobile application, the KFS has made it easier for users at all levels—government officials, field agents, and citizens—to engage in fire prevention and response. This focus on accessibility has improved the efficiency of fire management operations while reducing administrative costs. However, as climate change continues to amplify fire risks, further investment in AI-driven decision support systems and smoke dispersion modeling will be necessary to enhance the predictive accuracy and response capabilities of the FDMS.

In conclusion, Korea's FDMS serves as a model for integrating advanced technology with data-driven approaches for wildfire management. The success of the system underscores the need for continuous innovation, interagency cooperation, and public engagement in disaster management. As wildfire threats increase globally, the lessons learned from Korea's experience with the FDMS can inspire similar efforts worldwide, contributing to more resilient and sustainable fire management practices that are essential for safeguarding ecosystems and communities worldwide.

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