Forest Fires Mitigation Practices and Researched Recommendation

Pakistan, like many other countries, is experiencing an increase in forest fires due to climate change. Implementing global best practices for mitigation and management can help reduce their frequency and impact.

Forest Fire Impacts and Implications

Research shows that wildfires can cause a large increase in gaseous air pollutants such as carbon monoxide, nitrogen dioxide, acetaldehyde and formaldehyde (Finlay et al., 2012). Wood smoke has high levels of particulate matter and toxins, Adverse health consequences can occur as a result of short- or long-term exposure. Respiratory morbidity predominates, but cardiovascular, opthalmic and psychiatric problems can also result (HPI).

Wildfires represent a hazard that is primarily influenced by humans and thus to a degree can be predicted, controlled and, in many cases, prevented. Wildfire occurence, characteristics and impacts are closely linked to other hazards: droughts, heat waves and extreme weather events can influence fire intensity and severity and thus the duration, size and controllability of wildfires. The effects of wildfires on vegetation cover and soil stability may create secondary hazards/subsidiary perils, such as post-fire landslides, mudslides, flash floods, erosion and siltation.

Risk factors

- Increasing demand for agricultural lands for food and the necessity to use fire for land-use change.
- The expansion of residential areas/infrastructures built near fire-prone.
- Extended periods of drought and extreme heat.
- Wildfires cause more land degradation (soil erosion, loss of land productivity) and as a consequence create more flooding and landslides.

Vulnerable areas

- Agricultural and pasture lands in which fire is used for controlling weeds, bush encroachments, and for land clearing.
- Fire-prone natural forest, bush land and grassland ecosystems with high occurrence of natural fires in the subtropics or northern latitudes.
- Agricultural and forest plantations.
- Residential areas or scattered houses/infrastructures nearest to fire-prone vegetation.
- Residential areas or individual structures made of easily flammable materials.

- Abandoned rural villages and human settlements with no one to manage, prevent or respond to wildfires.

Prevention Strategies

A. Community Awareness & Education

i. Launch campaigns to educate communities on fire prevention, such as safe agricultural practices and avoiding open fires during dry seasons.

ii. Promote community-based forest management programs.

B. Monitoring and Early Warning Systems

i. Deploy satellite-based remote sensing and Geographic Information Systems (GIS) for real-time fire monitoring.

ii. Establish early warning systems to alert local communities and authorities.

C. Legislation & Policy

i. Strengthen laws against deforestation, illegal logging, and slash-and-burn practices.

ii. Implement zoning policies to reduce human activities in high-risk areas.

D. Controlled Burns

i. Use prescribed burns to reduce fuel loads in a controlled and safe manner.

ii. Train forest staff to conduct and manage these burns effectively.

Response Strategies

A. Rapid Response Teams

i. Form specialized firefighting units trained for forest fire management.

ii. Equip them with advanced fire suppression technologies, such as aerial firefighting tools.

B. Incident Command Systems

i. Adopt standardized systems like the Incident Command System (ICS) to coordinate firefighting efforts.

ii. Engage local, provincial, and national authorities in a unified response plan.

C. Community Involvement

i. Train and involve local communities in firefighting, especially in remote areas.

ii. Establish volunteer societies, fire brigades to act as first responders.

Partnerships

i. Collaborate with international organizations for funding, expertise, research and technology transfer.

Post-Fire Recovery Measures

A. Reforestation

i. Replantation of native and fire-resistant tree species in burned areas.

ii. Involve local communities in reforestation projects to ensure sustainability.

B. Soil and Water Management

i. Use erosion control measures like check dams and contour trenching to prevent soil degradation.

ii. Implement watershed management practices to restore hydrological balance.

C. Wildlife Recovery

i. Create safe corridors and sanctuaries for wildlife affected by fires.

ii. Monitor and rehabilitate endangered species.

Innovative and Technological Solutions

i. Drones: Use drones for aerial surveillance and mapping of fire-prone areas.
ii. AI and Machine Learning: Analyze historical fire data to predict and prevent future occurrences.
iii. Mobile Apps: Develop public apps for real-time alerts and fire reporting.

Risk reduction practices

- Limit development and vehicular movement in high forest fire risk areas.
- Clear the vegetation surrounding homes and other structures.
- Build fire lanes and/ or fire breaks between homes and any forested or bush land areas, if a natural firebreak does not exist.
- Plant vegetation of low flammability.
- Use fire-resistant building materials.
- Use traditional and advanced methods of prescribed burning for sustainable agriculture and flora and fauna management.
- Enact legislation, policies and regulation at the appropriate jurisdictional levels.
- Conduct community-based fire risk minimization activities during all stages of fire management.
- Provide community alerts through fire danger rating systems.
- Educate the community and raise public awareness about the risks of wildfires.
- Develop firefighting capacities and public safety.
- Enhance the Integrated Forest Fire Management (IFFM) concept through increased community participation.
- Mandatory evacuation plans can help limit the number of people affected by forest fires in areas where they are more likely to occur.
- Conduct detailed assessments to determine which plant species are prone to igniting fires. Remove these plants from high-risk regions to lessen the likelihood of forest fires.
- Investment in fire suppression and efforts to avert forest fires, such as cutting fuel loads and re-establishing natural fire cycles in ecosystems.
- Implement the proven practices and tools such as fire monitoring watch towers and early detection, fire danger rating, and asset vulnerability management through buffer zones and the adoption of codes.
- Increasing the tree-to-person ratio in Pakistan.
- Use drones to track fire activity, computer models to forecast fire behavior, and infra-red satellite sensor data to identify flames and heat in smoke.

- Establish and maintain fuel management zones around communities, infrastructure, and high-risk wildfire areas.
- Insurance companies should promote fire safety practices according to issed guidelines.
- Contribute to bush removal, forest thinning, forest floor bio-mass debris and vegetation management techniques in the sectors like logging.
- Create framework, like “Pakistan Wildfire Framework,” to combine innovative and efficient techniques with existing forest fire management procedures.
- Encourage practices of a/re/forestation and sustainable management that increase carbon sequestration while mitigating the consequences of climate change.
- Investigation for fire start and arson incidences and penalties be applied to individuals/responsible for intentional or negligent fires.
- Create defensible spaces/buffers between the building and the vegetation or any wild area that surrounds it.
- The skidding lanes should be installed in potentially higher risk places.
- To prevent forest fires, AI is being employed at Universities and research for front tier technologies are being used to create detailed geospatial maps.
- For timely responses to fire situations a rapid response force equipped with high-end extinguishing capabilities and by efficient dispatch and deployment of Rescue 1122 fire crews.
- Conduct awareness campaigns and safety precautions for the upcoming forest fire season to the forest guards and communities living in or dependent on forest resources.

Case Studies of Best Practices

A. Australia

- Fuel Management: Australia uses prescribed burns and community awareness campaigns to mitigate fire risks.
- Emergency Response: The country has a well-established ICS and aerial firefighting units.

B. United States

- Forest Management: Focuses on thinning overgrown forests and reintroducing natural fire regimes.

- Public-Private Partnerships: Collaborates with NGOs and private companies for fire prevention programs.

C. Canada

- Early Warning: Uses satellite monitoring and AI for early detection.
- Community Resilience: Implements FireSmart programs to engage local communities in fire prevention.

Climate Change Adaptation

- Invest in long-term strategies, such as afforestation with climate-resilient species and improved water resource management.
- Advocate for global cooperation in addressing the root causes of climate change.

By adopting and adapting these strategies, Pakistan can effectively mitigate and manage forest fires while building resilience against future climate impacts.

Anticipation Actions for Forest Fire Management in Pakistan

Anticipation actions aim to proactively reduce the likelihood and impact of forest fires by preparing systems, resources, and communities before a fire event occurs. These actions complement mitigation and response efforts.

1. Risk Assessment and Mapping

A. Identifying High-Risk Areas

- Use GIS and satellite data to create detailed fire risk maps highlighting areas prone to forest fires.
- Include factors like vegetation type, proximity to human activities, and historical fire data.

B. Climate Change Scenarios

- Model the impact of changing weather patterns (e.g., higher temperatures, reduced rainfall) to anticipate future fire risks.
- Identify seasonal windows of heightened vulnerability for targeted action.

C. Multi-Hazard Assessments

- Combine forest fire risks with other climate-related risks (e.g., floods and droughts) for integrated planning.

2. Early Warning Systems

A. Predictive Analytics

- Utilize AI and machine learning to analyze weather patterns and vegetation conditions for fire risk forecasting.
- Integrate systems like NASA's Fire Information for Resource Management System (FIRMS) for real-time monitoring.

B. Meteorological Inputs

- Collaborate with meteorological departments to monitor temperature, humidity, wind speeds, and lightning occurrences—critical factors for forest fire ignition.

C. Community Alerts

- Develop community-specific alert mechanisms via SMS, mobile apps, and local radio broadcasts to warn residents in vulnerable areas.

3. Preparedness and Resource Mobilization

A. Resource Prepositioning

- Stockpile fire suppression equipment (e.g., water tanks, fire retardants) in regions identified as high-risk.
- Pre-position firefighting units near vulnerable forests during peak fire seasons.

B. Training and Drills

- Conduct fire simulation exercises to train response teams and communities in fire suppression techniques.
- Provide capacity-building programs for forest department personnel and local volunteers.

C. Infrastructure Development

- Build and maintain firebreaks—cleared or plowed strips in forests that prevent fire spread.
- Develop water storage facilities like reservoirs and ponds within or near forests for rapid access.

4. Sustainable Forest Management

A. Vegetation Management

- Reduce the buildup of dry leaves, deadwood, and undergrowth (fuel loads) through controlled grazing and manual clearing.
- Introduce agroforestry practices in surrounding areas to reduce dependence on forest resources.

B. Planting Fire-Resistant Vegetation

- Reforest with fire-resistant native species to create natural barriers against fire spread.

C. Buffer Zones

- Establish buffer zones between forests and human settlements to minimize fire risks.

5. Community-Led Anticipatory Actions

A. Community Forest Management Groups

- Form local committees responsible for monitoring fire risks and implementing preventive measures.
- Involve women and marginalized groups in decision-making to ensure inclusivity.

B. Livelihood Alternatives

- Promote alternative livelihoods (e.g., beekeeping, eco-tourism) to reduce dependency on forest resources and slash-and-burn practices.

C. Fire Danger Behavior Regulation

- Introduce and enforce regulations on activities like campfires, agricultural burning, and industrial activities near forests during fire-prone seasons.

6. International Cooperation and Knowledge Sharing

A. International Collaboration

- Work with neighboring countries to monitor transboundary forest fires and share resources during emergencies.

B. Global Partnerships

- Engage with international organizations like the UN-REDD

Gap Analysis:

1. Limit development and vehicular movement in high forest fire risk areas

Current Status: Limited enforcement in many regions. Development continues in vulnerable areas due to economic growth pressures.

Gap: Lack of zoning restrictions in high-risk zones.

Action: Strengthen land-use policies and enforcement, set stricter regulations for development in high-risk areas, and incorporate fire risk assessment in urban planning.

2. Clear the vegetation surrounding homes and other structures

Current Status: Some local areas implement this practice, but it is not widespread.

Gap: Limited awareness and resources for homeowners to clear vegetation.

Action: Provide education and financial incentives for homeowners to clear vegetation and maintain defensible space around properties.

3. Build fire lanes and/or fire breaks between homes and any forested or bushland areas, if a natural firebreak does not exist

Current Status: Inadequate infrastructure in many fire-prone regions.

Gap: Insufficient funding and planning for fire lanes or breaks.

Action: Establish government-funded programs to create fire lanes and conduct regular maintenance.

4. Plant vegetation of low flammability

Current Status: Limited guidelines on the use of fire-resistant plant species in landscaping.

Gap: Lack of widespread adoption of fire-resistant vegetation.

Action: Promote fire-resistant landscaping through incentives and provide clear guidelines on plant species suitable for fire-prone areas.

5. Use fire-resistant building materials

Current Status: In some high-risk areas, fire-resistant materials are used, but not universally.

Gap: Higher costs and lack of awareness discourage adoption.

Action: Mandate fire-resistant materials in building codes for fire-prone zones and provide incentives for homeowners to upgrade their structures.

6. Use traditional and advanced methods of prescribed burning for sustainable agriculture and flora and fauna management

Current Status: Traditional methods are employed, but advanced techniques like precision burning and remote monitoring are underutilized.

Gap: Limited use of modern prescribed burning methods.

Action: Invest in training and tools for fire management teams to integrate advanced techniques with traditional knowledge.

7. Enact legislation, policies, and regulation at the appropriate jurisdictional levels

Current Status: Varies by region, with some areas having strong fire management laws and others lacking them.

Gap: Inconsistent legislative frameworks across regions.

Action: Ensure national-level policies are consistent and adequately enforced across all levels of government.

8. Conduct community-based fire risk minimization activities during all stages of fire management

Current Status: Community involvement is often ad-hoc and not systematic.

Gap: Lack of structured community engagement.

Action: Establish formal community education programs and local fire management teams.

9. Provide community alerts through fire danger rating systems

Current Status: Fire danger systems exist but are not always effectively communicated to the public.

Gap: Low awareness of fire danger systems.

Action: Strengthen communication channels and promote fire danger awareness campaigns.

10. Educate the community and raise public awareness about the risks of wildfires

Current Status: Awareness campaigns are sporadic.

Gap: Insufficient public education on wildfire risks.

Action: Increase funding for wildfire education campaigns, targeting both rural and urban populations.

11. Develop firefighting capacities and public safety

Current Status: Firefighting capabilities vary by region, with some areas under-resourced.

Gap: Lack of uniformity in firefighting preparedness and response.

Action: Strengthen training, equipment, and emergency response coordination.

12. Enhance the Integrated Forest Fire Management (IFFM) concept through increased community participation

Current Status: IFFM is underused in some areas.

Gap: Limited community involvement in fire management.

Action: Expand community training and integrate IFFM practices into local fire management systems.

13. Mandatory evacuation plans can help limit the number of people affected by forest fires in areas where they are more likely to occur

Current Status: Evacuation plans exist but are not always mandatory or well-practiced.

Gap: Lack of coordinated evacuation protocols.

Action: Implement mandatory evacuation plans, conduct regular drills, and create clear evacuation routes.

14. Conduct detailed assessments to determine which plant species are prone to igniting fires

Current Status: Some regions conduct plant assessments, but this is not universal.

Gap: Inconsistent plant species risk assessments.

Action: Develop and implement nationwide guidelines for assessing and removing flammable plants.

15. Governments should invest in fire suppression and efforts to avert forest fires

Current Status: Inadequate investment in fire prevention and suppression in some regions.

Gap: Underfunding of fire management programs.

Action: Prioritize funding for fire suppression and prevention programs, including forest fuel management.

16. Implement proven practices and tools such as fire monitoring watch towers and early detection

Current Status: Some regions have watch towers, but early detection tools are not universally available.

Gap: Lack of comprehensive fire detection infrastructure.

Action: Install more fire watch towers and integrate modern detection technologies like drones, satellites, and sensors.

17. The government should confirm its commitment to increasing the tree-to-person ratio in Pakistan

Current Status: There are no clear policies to address the tree-to-person ratio.

Gap: Lack of tree planting and forest restoration initiatives.

Action: Launch large-scale tree planting initiatives and forest restoration programs.

18. Use drones to track fire activity, computer models to forecast fire behavior, and satellite data to identify flames

Current Status: Limited use of drones and satellite data in many regions.

Gap: Insufficient integration of cutting-edge technology.

Action: Expand the use of drones, satellite data, and fire forecasting tools for real-time monitoring.

19. Establish and maintain fuel management zones around communities, infrastructure, and high-risk wildfire areas

Current Status: Some communities have fuel management zones, but they are not always well-maintained.

Gap: Lack of regular maintenance of these zones.

Action: Implement systematic fuel management programs and enforce regular upkeep of zones.

20. Insurance companies should promote fire safety guidelines

Current Status: Some insurance companies provide fire safety guidelines, but it's not widely enforced.

Gap: Limited insurance involvement in fire prevention.

Action: Require insurance companies to incentivize fire prevention measures through premium reductions.

21. Contribute to the fight against fuel through brush removal, forest thinning, and vegetation management techniques

Current Status: Vegetation management is practiced, but not consistently across regions.

Gap: Lack of coordinated efforts for vegetation management.

Action: Develop government-funded programs for systematic brush removal and forest thinning.

22. Create framework, like "Pakistan Wildfire Framework," to combine AI techniques with existing forest fire management procedures

Current Status: AI techniques are being explored but are not fully integrated.

Gap: Insufficient AI-based approaches in wildfire management.

Action: Develop and implement an AI-based framework for wildfire risk assessment and management.

23. Encourage practices of forestation and sustainable management that increase carbon sequestration

Current Status: Forestation practices exist but are not widespread.

Gap: Limited focus on sustainability and carbon sequestration.

Action: Promote afforestation programs and sustainable forest management practices to increase carbon storage.

24. Penalties should be applied to individuals who intentionally or negligently cause fires

Current Status: Some areas have penalties, but enforcement is inconsistent.

Gap: Lack of strict enforcement and penalties.

Action: Strengthen legal frameworks and increase enforcement of penalties for negligent or intentional fire setting.

25. Create defensible spaces between the building and the vegetation or any wild area that surrounds it

Current Status: Some homes have defensible spaces, but it is not mandatory.

Gap: Limited adoption of defensible spaces.

Action: Mandate defensible spaces in high-risk areas and incentivize homeowners to create them.

26. The skidding lanes should be installed in higher-risk places

Current Status: Skidding lanes are not widely used.

Gap: Lack of infrastructure in forested areas.

Action: Develop and implement skidding lane systems in high-risk forest areas.

27. In order to prevent forest fires, frontier technologies are being used to create detailed geospatial maps

Current Status: Limited use of geospatial maps in fire prevention.

Gap: Lack of comprehensive geospatial mapping.

Action: Invest in geospatial mapping technologies and integrate them into fire risk management plans.

28. Provide timely responses to fire situations by efficient dispatch and deployment of Rescue 1122 fire crews

Current Status: Fire response systems exist but are not always efficient.

Gap: Delayed response times due to resource limitations.

Action: Strengthen emergency response capabilities, including timely deployment of firefighting units.

29. Deception and outright theft of forest products should be considered as forestry transaction crimes

Current Status: Theft of forest products is not always treated as a crime.

Gap: Lack of criminalization of forest product theft.

Action: Implement legislation that treats theft of forest products as a criminal offense and enforce it rigorously.

30. Conduct the country's health awareness campaigns and safety precautions for the upcoming forest fire season

Current Status: Health campaigns exist but are not comprehensive.

Gap: Inadequate focus on health awareness.

Action: Launch national health and safety awareness campaigns leading up to fire seasons, emphasizing prevention and safety measures.