

Prevention of Forest Fires in the Wildland-Urban Interface

Good Practices Guide for Government Institutions



**Asia-Pacific
Economic Cooperation**



Executive Summary

The intensity and increased extension of fires in the wildland-urban interface areas in recent years has generated significant socio-environmental damage and economic and human losses in various economies; it is a scenario that is exacerbated by the action of climate change and other anthropological variables.

Climate change, increased development into forested areas, and human behaviors continue to raise the threat posed by these destructive fires. Research and predictions by major international organizations paint an alarming picture in terms of the threat of wildfires as the number, frequency, and intensity are only expected to continue to increase.

This guide of good practices aims to contribute to the strengthening of policy on prevention – including public-private strategies – through the generation of technical guidelines on planning instruments in disaster risk management, environmental management, and climate change. By identifying and examining the good practices that have worked in other economies, wildfire risk reduction planners can learn and build their capacities to meet the ever-growing challenge of fires.

This guide was developed within the framework of the APEC project entitled “Cycle of Workshops to Strengthen Fire Prevention Capacities in the Wildland Urban Interface.” The project consisted of an exploration of regional and international good practices for strengthening government and community level capacities in risk assessment, legislation and policy frameworks, budgeting, community engagement, and other preventive actions. The following good practices guide demonstrates successful practices from APEC economies, such as Australia, New Zealand, Chile, China, Canada, and the United States of America. It also explores good practices from other economies not within APEC, such as Fiji, Georgia, and Zimbabwe, that may be helpful in developing measures to counter the threat of wildfires.



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Definitions

Agricultural burning	The intentional use of controlled burning specifically to remove crop debris and residues following a harvest in agricultural land such as farms and orchards
Climate Change	The long-term shifts in temperatures and weather patterns.
Climate Change Adaptation	Changing the way humans interact with nature or changing the way nature interacts with humans
Climate Change Mitigation	Finding methods to decrease carbon emissions, increase oxygen emission, and finding sustainable and renewable energy.
Cultural burning	The intentional use of fire by indigenous peoples to achieve cultural objectives
Defensible Space	An area around a structure in which grass, trees, and shrubs have been managed in such a way as to reduce the risk of fire.
Evaluation	The process to determine whether the project is achieving its goals. This seeks to understand why a project encountered challenges, as well as why it might have had success. ¹
Exposure	The estimated losses or potential the impact due to the vulnerability of the people and community from wildfire, ²
Forest Fire	An unenclosed and freely spreading combustion that consumes the natural fuels of a forest taller than 2 meters
Fire-lane / Fire-line	Manmade and maintained routes through forests that provide a foot or machine access to a strategic location.
Firebreak	Manmade breaks in between flammable vegetation that seek to slow the spread of flames and embers.

Fire regime	The pattern, frequency, and intensity of the bushfires and wildfires that prevail in an area over long periods of time. It is an integral part of fire ecology, and renewal for certain types of ecosystems
Fuel-break	A wide block, or dense strip, where heavy, or flammable vegetation has been permanently changed to one of lower fuel volume or reduced flammability.
Fuel management	Interventions carried out prior to a fire that seek to prevent the spread or reduce the potential severity.
Green fire-break	Strips of low flammability species that are planted around or between areas of more flammable vegetation.
Hazard	An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss. ³
Monitoring	The regular collection of information about all project activities to determine whether the project is progressing according to plan and helps to identify problems and potential solutions in a prompt manner. ⁴
Prescribed fire	The intentional use of controlled burning to manage fuels and landscapes.

Preventive forestry	The preservation or improvement of a forest and control of damage to the forest by natural or man-made causes, (i.e., forest fires, plant pests, and adverse climate conditions).
Risk	The likelihood of loss of life, injury or destruction and damage from a disaster in a given period of time. ⁵
Territorial planning	The process by which optimum forms of land use and management are indicated, considering the biophysical, technological, social, economic and political conditions of a particular territory.
Vulnerability	The susceptibility of people, property, industry, resources, ecosystems, or historical buildings and artifacts to the negative impact of a disaster. ⁶
Wildfire	An unenclosed and freely spreading combustion that consumes the natural fuels and combustible material of an area (i.e., grass, weeds, shrubs, trees, etc.).
Wildland-Urban Interface	The WUI is the zone of transition between unoccupied land and human development. It is the line, area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. ⁷



Acronyms

NASA	National Aeronautics and Space Administration (United States of America)
NFPA	National Fire Protection Association
SENAPRED	The National Service for Disaster Prevention and Response (Chile)
UAV	Unmanned Aerial Vehicle
UNDP	United Nations Development Programme
UNDRR	United Nations Office of Disaster Risk Reduction
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UN-REDD	United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation
USAID	United States Agency for International Development
WWF	World Wildlife Fund
WUI	Wildland-Urban Interface
M&E	Monitoring and Evaluation

NASA	National Aeronautics and Space Administration (United States of America)
NFPA	National Fire Protection Association
SENAPRED	The National Service for Disaster Prevention and Response (Chile)
UAV	Unmanned Aerial Vehicle
UNDP	United Nations Development Programme
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UNESCO	United Nations Educational, Scientific, and Cultural Organization
UN-REDD	United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation
USAID	United States Agency for International Development
WWF	World Wildlife Fund
WUI	Wildland-Urban Interface
M&E	Monitoring and Evaluation



Summary of Key Messages

- The costs associated with wildfires is growing dramatically throughout the APEC region. Economies are experiencing historically unprecedented losses, both financially and in area burned.
- Due to climate change, it is anticipated that the occurrence of wildfires will continue to grow. More frequent fires can generate more carbon emissions which will, in turn, continue to contribute to climate change.
- Wildfires are estimated to produce 5 to 10% of global CO₂ emissions each year. Climate adaptation policies at the economic level must include provisions for reducing the risk associated with wildfires.
- While the aim of this document is to reduce the risk of wildfires, it is important to remember that fire is an important land management tool, and it is critical to be able to safely retain this tool. Wildfire risk reduction does not mean the removal of all fires but controlling the times and how fire is used to reduce the risk of wildfires. Eliminating all fires can have a greater risk compared to enabling certain fires, noting at times despite best endeavors some of these may end up being wildfire events.
- Numerous factors influence the type of interface critical infrastructure and human developments have with forested areas. These factors, such as tree types, topography, hydrology, soil type, and micro weather patterns should be examined when assessing wildfire risk at the local level.
- Performing risk assessments requires a partnership between the public government entities and the private and academic sectors. Private and academic institutions can leverage technology and resources that may not always be available to the public government entities.
- Improvements in technology, such as satellite imagery, unmanned aerial vehicles, cellular and internet communications, and artificial intelligence are being leveraged throughout the APEC region to great effect to assess and reduce risks associated with wildfires.
- Territorial planning is critical for controlling human development and actions that can contribute to wildfire risk. At the heart of territorial planning is implementing and enforcing restrictions on where and how humans build in relation to forested areas and other fuel sources.
- Territorial planning should also address actions, such as agricultural and cultural burning, which play a role in forest management but can also lead to an increase in risk.
- Planning in the development of urban and rural areas should seek to limit the presence of unregulated camps and buildings while increasing the access to water sources for fire suppression and maintaining access for firefighters.
- Proper maintenance of forests, combined with creation of defensive landscaping techniques, can greatly reduce wildfire risk.

- Proper guidance should be provided to community planners and individual property owners regarding these maintenance and landscaping techniques, including creating defensible spaces, fuel breaks, and the planting of fire-resistant vegetation.
- Involving the individual citizens of a community is an essential tool in managing risk. The majority of wildfires in most APEC economies are the result of human action, whether intentional or accidental. Increased community outreach and education can change many of the behaviors that are leading to these fires.
- Individual property owners require the knowledge to protect their homes, businesses, farms, and other interests. By providing owners with the information and resources necessary, economies can help to reduce the risk of wildfire by empowering individuals to make their communities more resilient.
- Community volunteers can be leveraged to conduct risk reduction efforts. Programs, such as the Community Emergency Response Team, are frequently used throughout the APEC region to respond to disasters. These same response teams can be assigned reduction roles to assist with building resilience and mitigating risk at the community level.
- Wildfire risk reduction planning should take into account historically vulnerable populations within the community, such

as those disproportionately affected by gender, race, sexual identity or orientation, disability, socioeconomic status, or other factors. Ensuring that plans are sensitive to these groups can reduce potential negative impacts during and after a wildfire.

- Gender mainstreaming should be encouraged within firefighting and disaster management roles. With women representing half of the population in most economies, it is important to gain that perspective on policies, plans, and procedures. Additionally, women represent a modest fraction of the workforce in the fire service.
- The effectiveness of programs for risk reduction, capacity building, community outreach, etc. needs to be continually assessed to determine effectiveness. In order to accomplish this, economies need to establish a system of monitoring and evaluation.



CHAPTER 1

Wildfire Risk in APEC

- Worldwide, the cost of wildfires is increasing every year. Factors such as climate change, urban development in forested areas, and human behavior greatly contribute to this increase. The report titled “Cost of Carbon Project 2014, Flammable Planet: Forest Fires and the Social Cost of Carbon” estimated that the global damage from forest fires associated with climate change will be around \$50 to \$300 billion annually. The Food and Agriculture Organization of the United Nations estimates that between 3% and 4% of the Earth’s land surface is burned annually. The United Nations Environment Programme predicts that the number of wildfires will increase by 50% by the year 2100. According to the World Wildlife Fund, the length of global fire seasons has increased by 19% on average. This increase in the threat and impact of wildfires presents serious challenges for government disaster risk reduction planners at all administrative levels within APEC economies.
- APEC economies are particularly affected by this threat, as devastating wildfires have consumed millions of hectares, destroyed miles of homes and critical infrastructure. Within the APEC region, the threat of wildfire is very real. According to the Global Facility for Disaster Risk Reduction (GFDRR)’s ThinkHazard! tool, 19 of the APEC economies are rated as High-Risk for wildfires. According to this rating, these economies have a greater than 50% chance of encountering weather

that could support a significant wildfire that is likely to result in both life and property loss in any given year⁸. Figure 1 illustrates the experience of one of the economies, demonstrating a linear increase in both the number of fires and the surface areas affected. The impact of climate change, extended drought conditions, and human factors are playing a major role in this increase.

- Recently, several APEC economies have been experiencing wildfire seasons that exceed historical trends in the amount of destruction caused. Indonesia lost 2.6 million hectares of land in 2016, with eight provinces losing more than 100,000 hectares each.⁹ Australia endured significant losses during the 2019 – 2020 fire season, with 30,000 square kilometers burned, over 9,300 buildings destroyed, and 34 deaths¹⁰. Russia lost over 17 million hectares of forest to wildfires in 2021.¹¹
- The cost of suppressing wildfires is also increasing. In the United States of America, the cost of suppressing

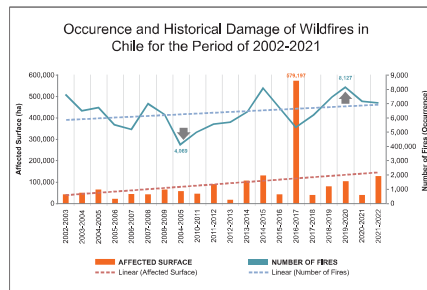


Figure 1. Chile has experienced an increase in both the number of fires and the surface area burned over the past 20 years. (Credit: CONAF)

fires rose from \$425 million between 1985 and 1999 to \$1.6 billion between 2000 and 2019. Spending at the state-level in California alone in 2019 to 2020 exceeded \$700 million¹². Canada has seen an increase of an average \$150 million per decade since 1970 in suppression costs, with wildland fire protection exceeding \$1 billion for six of the last 10 years according to Natural Resources Canada.¹³

- While wildfires are on the increase globally, proper planning, preventive measures, and community engagement do help to reduce a community’s overall risk. Figure 1 illustrates the total increase of wildfires throughout Chile over a 20-year period. However, the Region of

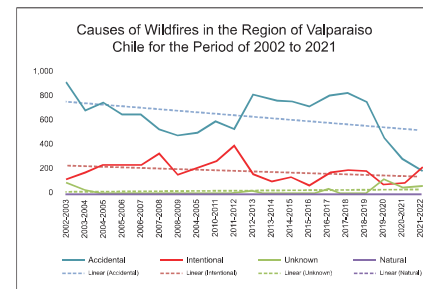


Figure 2. Decrease in fires and area burned in Valparaiso, Chile over 20-year period. (Credit: CONAF)

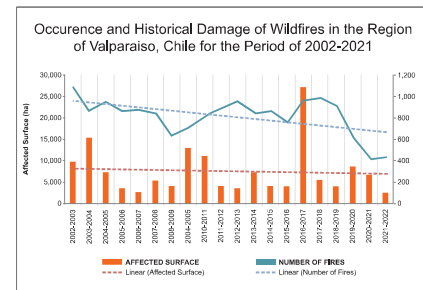


Figure 3. Causes of wildfires in Valparaiso over 20-year period. (Credit: CONAF)

Valparaiso in Chile demonstrated an overall decrease for the same period (Figure 2). Increased efforts in planning, education, and prevention helped to drastically reduce natural and accidental fires, though intentional causes still remain a threat (Figure 3).¹⁴

- As part of the effort to build capacity of APEC economies to prevent fires, particularly in the Wildland-Urban Interface where wildland areas meet human development, APEC and the National Service for Disaster Prevention and Response (SENAPRED) of Chile have partnered to develop a guide of international good practices to assist risk reduction planners at all levels. The following good practices were identified through research of available reports, articles, and websites of APEC economies, as well as survey and consultative interviews with regional experts. In addition, in November 2022, a cycle of workshops was conducted that provided an opportunity for experts from the APEC economies to share their knowledge with wildfire risk reduction planners. Experts at these workshops represented economies from Australia, Chile, Japan, Mexico, New Zealand, Peru, and the United States of America.

Note on Terminology

- Experts in the field of wildfire management will note that there is a distinction to be made between the terms of “wildfire” and “forest fire”.
 - Forest Fire.** “Forest Fire” can be described as an unenclosed and freely spreading combustion (fire) that consumes the natural fuels of a forest taller than 2 meters.

- **Wildfire.** Wildfire” can be described as an unenclosed and freely spreading combustion (fire) that consumes the natural fuels of an area (i.e., grass, weeds, shrubs, trees, etc.).
8. Though the two terms are frequently used interchangeably, the term wildfire has a wider ranging applicability. Therefore, the authors of this guide have chosen to use the term “wildfire” when discussing the destructive fires that are threatening the APEC economies.
 9. An additional term of note is “Wildland-Urban Interface”. **Wildland-Urban Interface**, or WUI, is the area where houses and other human structures are found or mixed with forest vegetation and other types of plant fuels, which requires a different fire protection model than that applied in forest land¹⁵.

APEC Economy Survey

10. As part of the project to develop good practices within APEC, a survey was conducted to establish a baseline of practices throughout the economies. During the month of October 2022, the 21 economies and other partner stakeholders were invited to participate in the survey that sought to examine:
 - a. Comprehensive assessment of exposure, vulnerabilities, and risks
 - b. Political recognition
 - c. Clarity and alignment of legal and policy frameworks
 - d. Thorough identification of roles and responsibilities of stakeholders
 - e. Risk reduction measures
11. Of those invited to participate, 8 economies and 1 partner organization provided responses.
12. Good practices identified during the survey included:
 - a. Legislative or national policy requirements provide substantial support to encourage communities to conduct risk assessments.
 - b. Climate change as a factor influencing wildland-urban interface risk is receiving more political recognition in the economies.
 - c. Economies are using a diverse approach to conducting risk assessments, including simulation modelling and artificial intelligence.
 - d. Local community engagement has successfully reduced risks in many of the economies.
 - e. Risk assessments are being used to drive key reduction planning, such as response and evacuations, as well as identifying and prioritizing spending for reduction initiatives.
 - f. Academic institutions and non-governmental organizations are frequently included in risk assessment and reduction initiatives.
 - g. Economies are demonstrating commitment to long-term risk reduction through international treaties and agreements, grant and education programs, and research.
13. The following opportunities for improvement were noted:
 - a. While it would be beneficial to provide economy-wide coverage, early warning systems need to be prioritized and implemented in areas of highest risk in some of the economies.

- b. An increase in the inclusion of historically vulnerable populations should be made in risk assessments, such as women, children, the elderly, persons with disabilities, those who identify within the LGBTQ+ community, low socio-economic status, and others who tend to suffer disproportionately to the rest of the community in disasters.
- c. The roles and responsibilities of the local government administrative units, private sector, and private-public cooperations should be more clearly defined in economy strategies to wildland-urban interface risk reduction.
- d. More training or testing of the public and public alert systems is needed to ensure the individuals of the economy understand how they will be alerted and what is expected of them.

Wildfire Behavior Triangle: The Focus of Prevention

14. In order to grow and spread, wildfires need three components, which collectively make up the Wildfire Behavior Triangle. These elements are Topography, Weather, and Fuel. Removing one or more of these elements reduces the threat of wildfire or the destruction they can produce.
15. Of the three, fuel is the easiest for humans to control. Policies discussed in this document will focus on using territorial planning, preventive forestry, and community outreach to control the fuel component of the Wildfire Behavior Triangle, as well as the sources of ignition.

Focus Areas for Good Practices

16. The good practices compiled for this guide represent the following areas:
 - **Legislative and Policy Frameworks for Wildfire Risk Reduction.** Efforts to reduce risk are strongest when they are supported by legislation or formal policy frameworks.
 - **Funding for Wildfire Risk Reduction.** These good practices are aimed at helping risk reduction planners seek and justify financial support for reduction initiatives.
 - **Risk Assessment.** This section will help planners understand and address the driving factors that increase their risk, as well as to categorize the threat of wildfires more effectively to their communities.
 - **Territorial Planning.** Implementation of proper planning and land use restrictions can contribute to a reduction in risk.

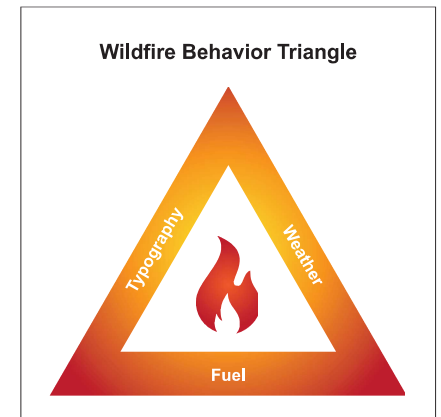


Figure 2. Decrease in fires and area burned in Valparaiso, Chile over 20-year period. (Credit: CONAF)

- **Preventive Forestry.** In addition to restrictions on construction and development, implementing good practices in forestry management to reduce fuel sources and provide defensive space around infrastructure will also aid in the reduction of risk.
- **Community Outreach and Engagement.** Risk reduction planners cannot do it alone. Leveraging community resources and addressing human factors that contribute to wildfires is essential to reducing risk.
- **Integration of Technology.** Advancements in technology can be leveraged to make more effective data-driven decisions, develop more resistant construction materials, monitor conditions, more rapidly warn the public, and many other preventive actions.

- **Monitoring and Evaluation.** Once plans, policies, legislation, and actions have been implemented, it is important to review their progress to determine if they are adequately meeting their objectives for risk reduction.

Climate Change and the Influence on Wildfires

17. The global phenomenon of climate change has major implications for understanding the risk of wildfires and planning to reduce them. Climate change has been linked to higher temperatures, lower soil moisture, and the drying of organic materials that serve as fuel for fires. The number of wildfires is on the rise, and the United Nations Environmental Programme has predicted there will be a 50% increase in these events by the year 2100. Several global trends are demonstrating the impact climate change has on wildfires:



- Increasing global temperatures and decreasing precipitation are leading to fires burning with more intensity.
 - Increased frequency of fires can decrease the amount of time communities and ecosystems have to recover between fires.
 - Increases in the severity of fires can lead to changes in the dominant tree species and compositions of a forest area.
 - Fires contribute to significant losses in revenue from tourism and agriculture.
 - Extreme temperatures and loss of habitat from fires adversely affects the wildlife of an area. This can contribute to pushing certain species closer to extinction.
 - More severe fires increase soil erosion and lead to water quality issues.
 - Without vegetation, flooding and debris flows can become more common, even long after fires have been extinguished.
 - Deforestation alters the hydrology of a forest, creating drier conditions that will contribute to fire spread.
18. Wildfires conversely have an influence on climate change. The loss of vegetation to absorb carbon dioxide and increased emissions of carbon dioxide from the fires themselves can also contribute to climate change. According to WWF, the State of California in the United States of America emits more carbon annually from wildfires than it does from use of fossil fuels.¹⁶
19. Two key concepts to remember when thinking about climate change are “mitigation” and “adaptation.”
- **Mitigation** of climate change involves finding methods to decrease carbon emissions, increase oxygen emission, and finding sustainable and renewable energy.
 - **Adaptation** for climate change involves changing the way humans interact with nature or changing the way nature interacts with humans.¹⁷
20. Developing policies to reduce wildfires helps to both mitigate and adapt to climate change. Improvements in fire prevention, including preventive forestry, help to reduce carbon emissions by reducing the number and intensity of wildfires. Policies directed towards land use planning, community engagement, and forestry management help to adapt the way humans interact with nature.

CHAPTER 2

Legislation and Policy Framework for Wildfire Risk Reduction

Introduction

1. Legislation and policy are the tools by which economies can advance wildfire risk reduction. The implementation of policy may be easier for economies to immediately accomplish as it does not require the passage of law. Policy can be issued under the statutory authorities of a disaster management office or forestry service. Policy greatly benefits from having legislative support; however, such legislation often takes time to approve.

2. Legislation and policies should be developed or revised with clear goals in mind. The goals for wildfire reduction frameworks should be:

- a. **Goal 1: Reduce occurrence of unwanted fires.** Such policies or regulations should be focused on reducing or eliminating human actions that contribute to wildfire ignitions. This includes regulation of agricultural or garbage burning, implementing safe burning guidance, community education, and stricter enforcement of recreational camping policies.

Wildfires frequently begin with a natural occurrence, such as a lightning strike, or for human intervention. While it may not be possible to reduce some types of natural ignition, properly planning and focused action can reduce impact of these unwanted fires. It is

therefore essential to advance the regulation of agricultural or garbage burning, forest management plans, a forest policy that contains a mandatory program in areas of risk that addresses community education, local protection plans, among others, in addition to a national program of dissemination and education for the prevention of forest fires. These activities need to be strengthened by laws on forest management and forest fire reduction under a strong legislative framework to prevent unwanted fires.

- b. **Goal 2: Reduce fire intensity.** These frameworks involve the proper management of fuel loads in areas of high risk. Proper maintenance, such as thinning and clearing of deadfall will help to reduce the intensity of fires by reducing combustible materials. Similarly, construction regulations, such as building materials and restriction of development in high-risk areas, help to reduce potential fuels.
- c. **Goal 3: Reduce area to burn.** Frameworks and regulations that empower a community to conduct sustainable forestry will prevent the spread of fire, reducing the area that burns. Such actions will be discussed later in this guide, but include defensible spaces

around structures and powerlines, firebreaks, and planting fire resistant vegetation.

- d. **Goal 4: Implement fire management regime.** While the previous goals discuss specific actions to take, a systematic approach must be set forth in policy and legislation with an intention of sustainability. A long-term commitment to proper forestry management and prevention is necessary.
- 3. When developing policies, legislations, and guidance to empower communities, the following should be considered¹⁸:
 - a. Policies and legislation should have clear objectives.
 - b. Incorporate the goal of minimizing the wildfire hazard to people, property, and infrastructure at all stages of the planning.
 - c. Plans and policies are not legally binding, but they create a foundation for future implementation through by-laws and other regulatory instruments.
 - d. Establish clear criteria for when a wildfire mitigation or risk reduction plan should be required and the type of information the plan must contain.
 - e. Incorporate wildfire hazard exposure zones into community mapping.
 - f. Include agencies or organizations that will have responsibility for

managing various aspects of a WUI fire in the policy framework development.

- g. Undertake comprehensive reviews of existing zoning laws, applicable codes, and regulations as part of the process for developing wildfire reduction measures.

APEC economy experience

- 4. The National Fire Protection Association (NFPA) in the **United States of America** recommends five core tenets that must be supported by all levels of government when building their legislation and policy frameworks for the reduction of wildfires. These tenets will help to greatly reduce risk.
 - a. Require all homes and businesses in the wildland-urban interface (WUI) to be more resistant to ignition from wildfire embers and flames.
 - b. Current codes and standards, as well as sound land-use planning practices must be in use and enforced for new development and rebuilding in wildfire-prone areas.
 - c. Fire departments for communities in the WUI must be prepared to respond safely and effectively to wildfires.
 - d. Governments must increase resources for vegetative fuel management on public land.
 - e. The public must understand its role and take action in reducing wildfire risk.¹⁹

- f. In addition, while not part of the NFPA's core tenets, the public should have access to information which supports their knowledge and understanding of current risk, including advice on when it is safe to have fires and activities which may be contribute to increased chances of unwanted fires.

Good practice guidance Designing regulation and frameworks

- 5. The following principles have been accepted in APEC as good practice for regulation-making²⁰. These principles can be adopted specifically to the task for developing regulations and legislation for wildfire risk reduction.

- 5.1 **Clearly define the problem.** To reduce wildfires, these policies or legislation should clearly define what that means. The goal of the legislation could be to (1) reduce the frequency of wildfires; (2) reduce the intensity of wildfires; and/or (3) reduce the impact of wildfires.
- 5.2 **Justify government action.** The need for government intervention should be evidence-based, establishing that government action is appropriate to address the wildfire risk, the benefits and costs of government involvement, and alternate mechanisms for addressing the problem (such as intervention by non-governmental organizations or private sector).
- 5.3 **Consider a range of policy options (including alternatives to legislation).** Policy-makers should weigh the risks of potentially

over-regulating the problem. Consider that over-regulation can often lead to poor compliance as people resist what they consider to be burdensome regulations. Policy or guidance can provide direction and guidance without legislation.

- 5.4 **Weigh the benefits and costs of legislation and policy.** Policy and legislation makers should estimate the expected benefits of each proposal and feasible alternatives. This should include economic consequences of intervention, such as loss of productivity or reduction in jobs due to regulations in the forestry sector. The converse may also be applicable: cost benefits may be realized when considering reduction in wildland fires, areas burned, intensity and frequency.
- 5.5 **Consult with interested parties.** Development of legislation and policy should include open and transparent consultation with communities potentially impacted, businesses with interests that could be affected, and government and academic experts in the field. Policies and legislation pertaining to the reduction of wildfires should include consultation with forestry management organizations, national disaster management offices, and agricultural experts.
- 5.6 **Consider enforcement and incentives for compliance.** There should be some form of enticement associated with the policy or legislation to encourage



compliance, such as reduction in insurance rates or associated government grant funding. There should also be consideration as to enforcement of such policies and legislation, including how to monitor compliance and consequences for non-compliance. Policy and legislation makers should consider how to motivate people to successfully implement these changes.

- 5.7 **Review mechanisms to ensure the continuing effectiveness of the policy or legislation.** A system of monitoring and evaluation should be instituted to determine if the policy or legislation is having the desired effect, ensuring that it remains

relevant over time, and seek out ways to improve it. Monitoring and evaluation will be discussed later in this document.

Practical steps and tips to implement good practice

- 6. Within economy-level legislation and policies, clearly define the relationship between the state, or provincial governments, the local government administrative units and economy-level authorities. All entities need to participate in risk reduction, and therefore, it is essential to clearly delineate the tasks for each level of government administration. The definition of private sector responsibilities or involvement should also be included, particularly for economies that have private or commercially owned forests.



7. State or provincial legislation within an economy is often inconsistent when addressing hazards²¹. Economy-level legislation should require the development of state and provincial plans for wildfires, and those state legislations should require the development of wildfire plans at lower administrative levels when the risk of wildfires is present.
8. Implement legislation or policies that require the development of community-based plans to address wildfire safety, including describing the hazards and risks in the community as well as defining objectives to reduce risk over time and the actions necessary to achieve these objectives.
9. Develop standards across the economy for performance-based product testing to reflect how materials will perform when exposed to flames, radiant heat, and impact of embers during wildfires. Incorporate these tests and results into building codes. Require that architects, builders, and homeowners use these standards when performing new constructions or improvements to existing homes and buildings.
10. Develop land use standards when planning for building within the WUI. The siting of structures, establishment of defensible space between structures, access to water supply, and other considerations should be considered by economies prior to land development.
11. Policies and legislation should be supported with adequate funding. Funding should be available for adequate staffing, enforcement, monitoring and evaluation, or technical assistance. As with clearly defining roles and responsibilities at each level of government, so too should the responsibilities for budgeting be clearly defined. It cannot be expected that the economy would pay for all risk reduction activities, nor could it be assumed that local communities would be able to support these on their own. A balance must be struck.
12. Pre-existing legislation aimed at climate change adaptation, protecting wildlife, forests, and other environmental concerns may provide the legislative support needed to strengthen fire prevention capacities. Often, these legislations will have mechanisms that could be used to support policies intended to reduce the occurrence, intensity, and impact of wildfires.

CHAPTER 3

Funding for Wildfire Risk Reduction

Introduction

1. Each economy typically has budgeting for fire prevention activities. Budgeting for risk reduction activities comes from a variety of sources. According to the October 2022 survey, 40% indicated a national risk reduction or disaster management fund, 30% indicated a state or provincial risk reduction or disaster management fund exists, and 30% noted a grant program for disaster mitigation. Additionally, 20% noted the involvement of the private sector in funding reduction in private forests, and 10% received funding from non-governmental organizations or donors.
2. Half of the respondents did not have an estimate on how much their economy spends each year on wildland-urban interface risk reduction. Ten percent estimated over \$1 billion USD, 10% estimated between \$500 million and \$1 billion USD, 10% estimated between \$1 million and \$500 million USD, and 20% estimated under \$1 million USD per year.
3. Funding for risk reduction and fire prevention capacity building should be driven with the goal of sustainability in mind. To be sustainable, this funding should be:
 - a. Linked to identified risks and established goals for reducing these risks. Therefore, comprehensive risk assessments should be performed in order to inform and prioritize spending.
 - b. Supported by legislation. This will help to ensure continued funding over a longer period of time.
 - c. Tied to clearly defined and achievable metrics. Continued financial commitment should have a method of determining the return on the investment to ensure money is being used effectively.
4. Development of additional funding mechanisms at the sub-economy level, particularly at the community level, can further enhance the capacity for the implementation of a comprehensive risk reduction program. One such approach is the **participatory budgeting** approach that will be discussed further in this section. This approach has been successful in other locations at the community-level, and is discussed as an approach that entities can advocate for within their economies.
5. International donors can also be a source for funding. Non-governmental organizations represent a source for technical assistance, advocacy, and, in some instances, funding for the implementation of fire prevention programs.

Non-APEC economy experience

6. While not within APEC, the country of **Georgia** has had success in the implementation of **participatory budgeting**.²² In this approach, a portion of money is allocated at the municipal level for projects that are of interest to the community. The community is given

direction of what the money should be used for (i.e., wildfire or flood risk reduction projects), members of the community can then submit project proposals within those guidelines for the municipality to vote on for funding. For example, one municipality allocates 100,000 Georgian Lari (approximately \$37,500) for disaster risk reduction projects each year. Participatory budgeting helps to not only reduce risk but encourages active participation by the community in the process. Typically, funding for these projects stems from municipal budgets.

APEC economy experience

7. **Australia** has budgeted \$600 million for general disaster preparedness through the National Recovery and Resilience Agency, which provides economy-level support or fuel management and prevention projects for wildfires in addition to cyclones and other disasters.²³
8. **Canada's** budget for the 2022 wildfire season was \$516 million, with economy-level support for the training of firefighters, purchasing of equipment, emergency planning, fuel management, and incorporating indigenous knowledge into fire management.²⁴
9. The 2023 budget for wildland fire and hazardous fuels management for the **United States of America** was \$2.97 billion, with the budget request for 2024 expected to be 28% higher.²⁵ This budget includes economy-level

support for fuel management, securing contracts, investing in unmanned aerial vehicles for surveillance, and the hiring of more firefighters.

Examples of international donors supporting wildfire capacities in APEC region

10. **Peru** and **Indonesia** entered into capacity-building partnerships with the **International Tropical Timber Organization** in 2021. These partnerships seek to build capacity within the local communities, non-governmental organizations, fire brigades, indigenous groups, farmers, and others. The expected outcomes are the reduction of the number of wildfires and overall losses; improved agricultural and preventive forestry practices, improved fire prevention, management of early response protocols, and installation of early warning systems. Investment in capacity building for both countries combined was \$2.2 million USD in 2021.
11. The **United Nations Reducing Emissions from Deforestation and Forest Degradation (UN-REDD)**, with funding from the **United States Agency for International Development (USAID)**, conducted capacity building training for firefighters in **Indonesia** in 2018. This program enabled Indonesian firefighters to learn from South African firefighters who have extensive experience managing the peatland wildfires that are common in both countries²⁶.



12. Many international donors, such as the **World Wildlife Fund (WWF)** or the **Asia-Pacific Network for Sustainable Forest Management and Rehabilitation**, offer grants from reforestation. Such grants could be used to support projects that build resilient forests in high-risk communities.

Good practice guidance Building the justification for risk reduction budgeting

13. Requesting money for risk reduction or capacity building can be a daunting task initially. While there is never a guarantee of successful funding, recommendations for building a stronger justification for requesting money²⁷ are listed below.

- 13.1 Develop a baseline definition of risk reduction and capacity building. A common understanding will help with sustained investment and enable risk reduction entities at all levels to address wildfire mitigation in a consistent manner.

- 13.2 Identify potential funding sources. Funding sources could be annual budget line-items, economy-level grants, or private-sector or non-governmental organization donations.

- 13.3 Create an inventory of risk reduction activity occurring at the community levels as a guide for other communities and economy-specific best practices.

- 13.4 Meet with politicians at each government administrative level to brief them on current challenges for wildfire risk reduction funding.

- 13.5 Implement a pilot program with

a partner community to measure the success of such funding. Demonstrating the positive use of funding will aid in justifying more of it.

- 13.6 Identify or create a structure to manage and coordinate these activities. Normally, this can be handled by national disaster management office. A single entity being informed of the progress and potential challenges in risk reduction implementation can help with building stronger justifications for funding.

Implementation of Participatory Budgeting

14. Participatory budgeting, as mentioned previously in the experience of Georgia, has several benefits that would make this an appealing option for governments at all levels²⁸.

- **Reduction of alienation between people and the administration.** This approach promotes understanding for other points of view and strengthens the identification of the people with their community.

- **Promotion of good governance and transparency.** Participation in the process for selection of spending helps to promote accountability and more transparency for government entities.

- **Improvement of decisions and early detection of potential conflicts.** The use of local knowledge leads to good, reasonable, and comprehensible decision-making and adds legitimacy and acceptance to spending.

- **Strengthens the commitment of the citizens.** Participation helps individuals to become better citizens as they see how they can contribute to action.
15. Implementation of participatory budgeting to support wildfire reduction should include the following procedures: Procedure for establishing a Participatory Budget Working Group;
 - Procedure for establishing a Participatory Budget Working Group;
 - Procedure for developing and submitting project proposals;
 - Procedure for public voting or selection of project proposals;
 - Procedure for conducting awareness raising campaign for project proposal period;
 - Monitoring procedure for the implementation of projects financed by the participatory budget;
 - Procedure for evaluating the effectiveness of the participatory budget process.
 16. In the example of Georgia, funding comes directly from the municipal budget, limiting total amounts to relatively smaller projects. A good practice suggestion would be for economies to provide additional funding to communities at high risk for wildfires to support more or larger projects to enhance the effectiveness of this community engagement.
- Practical steps and tips to implement good practice**
17. Increase investments in and improve coordination of existing economy-level programs where wildfire resilience is either a core or complementary outcome. Programs, such as forestry management, tourism, or climate adaptation may have elements that intersect with wildfire resilience and should be incorporated into funding regimes for wildfire risk reduction.
 18. Annual funding should be made available to support comprehensive forestry management, such as thinning and removal.
 19. Projects that focus on mitigating other disasters, such as flooding, landslides, or earthquakes may have positive impacts on reducing wildfire risk. The focus and funding for these projects may be used to further wildfire projects. Broaden the focus of risk reduction to explore how strategies for other natural disasters may benefit the efforts to prevent wildfires.
 20. Expand public-private partnerships, private investment, and other innovative strategies to strengthen government initiatives in resilience. Private sector, particularly those with property adjacent to or interests involving forests often become excellent partners in resilience, providing risk reduction planners with access to resources, expertise, and sometimes funding to support on-going efforts.



CHAPTER 4

Risk Assessment

Introduction

1. Research has shown that the frequency and intensity of wildfires is expected to grow with the influence of climate change. With this in mind, government and community planners must conduct a realistic risk assessment of their jurisdictions in order to ensure that every effort is being made to reduce the potential occurrence or the potential impact of these fires. A proper risk assessment helps to inform legislation and policies, budgeting, purchasing of equipment, training and exercise, land-use restrictions, and other key elements of planning.
2. Key terms for Risk Assessment²⁹
 - a. **Hazard:** An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss. For the purposes of this good practices guide, hazard will focus on wildfire as the event that has potential to cause the above harms.
 - b. **Vulnerability:** The susceptibility of people, property, industry, resources, ecosystems, or historical buildings and artifacts to the negative impact of a disaster.
 - c. **Exposure:** The estimated losses or potential impact due to the vulnerability of the people, environment, and community from wildfire.

- d. **Risk:** The likelihood of loss of life, injury or destruction and damage from a disaster in a given period of time.
 - e. **Risk Assessment** is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from hazards.
3. The three most important best practices for governments and communities to understand and adopt are:
 - a. **Risk assessments must be conducted at the local level.** While economy-level ministries and technical experts may be needed to assist in performing these assessments, an evaluation must include the local perspective. Local communities have numerous unique characteristics that will change their risk for wildfire. Among these unique characteristics are different wind patterns, forest types, types of interfaces, and soils which influence the risk of wildfires³⁰.



Image 3 demonstrates differing examples of interfaces with undeveloped land. The interaction with the forest or undeveloped land can be further categorized as “Interface” or “Intermix”. In an ‘interface’, houses and settlements are built right up to the forest line (Image 4). In an “intermix”, houses are interspersed among the forest (Image 5).

- b. **Establish recurring Risk Assessment activities.** Risk assessments must be routinely repeated within the local community. As the community evolves, expands, and develops capacities, the risk of that community for wildfires will change as well. Hopefully, this will be for the better, but circumstances do change overtime which can negatively impact risk. For example, in times of economic instability and decline, communities often see the rise of unregulated camps for migratory workers or homeless citizens;³¹ these are frequently built on the fringes of a community, often in the interface with wildlands.
- c. **Utilize risk assessment to address vulnerabilities.** The process of assessing risk helps to identify and prioritize vulnerabilities in communities. These could include poor forestry maintenance regimes, critical infrastructure near forested areas, or large concentrations of



Image 3: This collection of images demonstrates that there are different types of interfaces between forested and developed land. This highlights the necessity to conduct more local assessments for risk. (Photo credit: CONAF)



Image 4: Example of interface zone.



Image 5: Example of interface zone.

elderly or people dependent on mass transportation. Identifying vulnerabilities alone is not enough, action should be taken to address these vulnerabilities, such as by implementing structural measures, increased public education, or planning.

Risk assessments at the local level

4. Risk assessment should be performed at each level of government within the economy. The economy-level should encourage and, to the extent possible, require the completion of risk assessments at the state and city/village levels.
5. To properly determine risk, assessments must be completed at the local level. Local communities have several unique characteristics that can alter the level of risk between neighboring cities or villages, and even create varying levels of risk within a specific community.
6. Common factors that drive wildfire risk that may vary at the local level include³²:
 - **Climate Change.** As previously mentioned, climate change will have a major influence on the risk of wildfires. Climate change is anticipated to make wildfires more frequent and intense while also extending the traditional fire seasons.



Image 8: Topography influences the spread of wildfires. Fires spread more quickly uphill. (Photo credit: CONAF)

- **Land Management.** The regime of planning and land use regulation that a community implements has a profound impact on the risk. Well-established and enforced regimes can greatly decrease risk. Territorial planning and land-use regulations will be discussed further in this good practice guide.
- **Weather.** While trends in climate change are often measured on an economy-wide scale, it is important to also remember that climate trends can vary at the local level based on terrain or topographical features such as elevation, distance from Equator, mountain ranges, types of forests, proximity to coast, etc. Drought conditions will also raise the risk profile of a community.
- **People.** Risk assessment must also incorporate the sociological aspects of the community. This includes customs and cultural beliefs, especially with regard to how members of the community view ownership of the land. Additionally, this includes behaviors, such as agricultural burning or recreational use of forests, which can increase risk. Finally, it should also include factors such as the prevalence of historically vulnerable populations which increase the impacts and complexity of fires.

Within the category of people, additional variables must be considered³³:

- a. Population growth or decline for the community;
- b. Age of the population;

- c. Housing ownership;
 - d. Age of the housing stock;
 - e. Languages used by the population;
 - f. Level of coordination and cooperation among the community;
 - g. Income;
 - h. Disability;
 - i. Mobility or reliance upon mass transportation;
 - j. Employment and commuter trends
- **Forest structure and conditions, land topography.** The land itself will vary from community to community, sometimes drastically changing the risk profile. The type of forests and trees, slope and elevation, soil, and density of vegetation influence risk, as does the presence of dead leaf / tree fall and the maintenance of these forests.
 - **Fuel Load.** Efforts, or the lack of effort, to manage the fuel within the forest will influence risk. Whether a community actively tries to control the presence of dead leaf / tree fall, implement fire breaks, or take other preventive forestry actions will have a positive or negative affect on the risk profile.

APEC economy experience

7. Examples of APEC economies incorporating technology to advance risk assessment include the Center for Climate Research & Resilience (CR2)'s application of artificial intelligence to assess wildfire risk in **Chile**; the development of a smart phone application for warning and reporting of wildfires in the **Republic of Korea**; and **China's** use of unmanned aerial

vehicles to monitor conditions and early identification of fires in a UNESCO park. These good practices will be discussed further in Section 9 on Integrating Technology.

8. There are many examples of multi-agency working groups that are successful in linking academic and scientific resources with local and economy-level planners. One such example is **Australia's** National Bushfire Intelligence Capability. The National Bushfire Intelligence Capability describes itself as a "holistic system that collaboratively engages partners to design and implement social, informational, and technical infrastructure so that Australia can access national perspectives on wildfire risk and hazard.³⁴" This economy-level working group partners local government, economy-level government agencies, landowners, land-use planning agencies, emergency management agencies, climate services, scientific researchers, and others. This assembly of partners helps to promote the sharing of data, trends, geospatial information products, and lessons learned throughout Australia.
9. In the **United States of America**, the completion of a state-level risk assessment (referred to as a Threat-Hazard Identification and Risk Assessment) is required to be performed annually as a prerequisite to federal preparedness grants. By linking the completion of risk assessments to grant funding opportunities, an economy can encourage states and local governments to accomplish this task

Good practice guidance
Conducting a wildfire risk assessment

10. A survey conducted by APEC and the Ministry of the Environment of Chile (MMA) as part of the project to strengthen fire prevention capacities in the WUI found that approximately half of APEC economies who responded have conducted a risk assessment for wildfires.



Image 9: Risk Assessment process

11. Risk assessment is the process of determining potential impacts (i.e., loss of life, economic injury, or property damage) resulting from a hazard. At a national level the risk assessment also tries to understand what is the maximum creditable event which may occur and the impacts that could come from this and how these impacts might extend beyond just the locally impacted area. Including political and international reputation. The assessment also seeks to understand the current mitigation work happening, any gaps which exist and what barriers to overcome. This helps other government support agencies to understand the risk and where they way be need or could add value.

12. The following steps for performing a risk assessment are a good practice developed by the Federal Emergency Management Agency (FEMA) in the **United States of America**³⁵.

12.1 Step One: Identify Hazards. A **hazard** is “an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or a thing.” In this case, the hazard would be a wildfire; however, this approach can be used for all natural and manmade hazards.

12.2 Step Two: Profile Hazard Event. During this step, risk assessors will seek to determine “how bad could it be?” To make this determination, assessors will consider the geographic location where the hazard is likely to occur, the potential extent or intensity of the event, the probability or frequency with which it occurs, and any past occurrences of similar hazards.

12.3 Step Three: Inventory Assets. This step seeks to determine what “assets” would be affected by the hazard. For this, “assets” are people, property, critical infrastructure, or activities in the community that would be impacted or disrupted by a wildfire. During this step, it is helpful to review critical facilities (such as hospitals, transportation, power generation, etc.), high density housing, or concentrations of vulnerable populations (i.e., elderly, disabled, low income, etc.) that are in or near areas threatened by this hazard.

12.4 Step Four: Estimate Losses.

The final step is to predict how these assets will be affected by the hazard, or wildfire. Loss estimation includes:

- Estimate the losses to structures;
- Estimate the losses to contents of structures;
- Estimate the losses to structure use and function;
- Calculate the loss from an event;
- Calculate the loss to each asset (building, person, etc.);
- Calculate the estimated damages for each hazard event.

Practical steps and tips to implement good practice

13. Develop a working group of experts from the community, national ministries, private sector, and other subject matter experts to perform the risk assessment at the community level. This will help to enable risk assessors to leverage available resources from the scientific, academic, and private sector, such as artificial intelligence, to conduct community-level risk assessments.

14. The NFPA in the United States has developed a Community Wildfire Risk Assessment template that can be utilized by any community. This tool is available online and can guide those conducting the assessment through developing a team to perform the assessment, evaluating vulnerability to structures, assessing conditions of structures, identifying immediate hazards, and other common concerns related to risk assessment³⁶. The

template can be located at: <https://www.nfpa.org/-/media/Files/Firewise/Get-started/FirewiseCommAssess.ashx>

15. Include requirements to perform risk assessments in economy-level and community-level legislation and policies. Requirements should include provisions for performing these on a semi-annual basis to continually update the risk profile. Policies and legislation should also note when risk assessments should be performed. For example, **Canada** strongly encourages the completion of a wildfire risk assessment whenever there is vegetation that can sustain combustion within 500 m of a structure³⁷.

16. Assessment of risk also needs to evaluate the cascading events that can be triggered by a wildfire. For example, the loss of vegetation from a fire can contribute to flooding as plants are no longer available to absorb excess water. This can also contribute to mudslides or other gravitational disasters in slopes and mountainous areas.

17. Risk assessment should be performed at regularly scheduled intervals, as well as after the occurrence of a major wildfire or other disaster. This will help to evaluate the effectiveness of efforts to reduce risk as well as assess the impact of changes in the population and community development.

18. Care needs to be taken when carrying out risk assessments and how that information is socialized. New findings can potentially devalue homes or property located in high risk areas, or insurance companies could use this information to withdraw coverage or increase premiums.

CHAPTER 5

Territorial Planning

Introduction

1. **Territorial planning** is the process by which optimum forms of land use and management are indicated, considering the biophysical, technological, social, economic, and political conditions of a particular territory. It includes the establishment of land use priorities, measures of environmental protection, public health, heritage protection and other measures, creation of residential areas and manufacturing, engineering, social infrastructure systems, creating conditions for regulation of employment and development of activities of the resident population and the reconciliation of public and private interests.³⁸
2. Territorial planning must be based on a thorough evaluation of the risks and vulnerabilities of the economy, state, and local city/village levels. In order to ensure that effective policies and land use plans are developed and maintained, planners must have access to the necessary tools and resources. These include:
 - a. Trained planners. Often, natural resources departments and ministries do not have properly trained land-use planners.
 - b. Data sets and geospatial intelligence. Planning should be supported by the most state-of-the-art technology available. Data sets, digital overlays, aerial imagery, etc. will all greatly enhance the effectiveness of planning. This may necessitate the inclusion of the academic and scientific community in planning partnerships in order to access these resources.
 - c. Policy and legislative support. As previously discussed, policy frameworks and legislation should be implemented to provide consistent guidance and legal requirements for the support necessary to complete risk assessments and land-use planning.
 - d. Proper enforcement. Without a mechanism to monitor and enforce territorial plans, these efforts will be unsuccessful.
 - e. Metrics for evaluation. Metrics should be established that help to determine effectiveness of the programs, such as the reduction or elimination of new construction in high-risk areas.
3. The October 2022 survey of economies found that 30% of respondents did not have formal mechanisms for the early warning of wildfires and others had somewhat limited areas of coverage for early warning systems. Planning for the implementation of early warning systems should be a priority of territorial planning efforts.
4. As wildfires are often caused by human action during recreational use of forests, it is valuable to note if national preparedness and prevention strategies have been developed to reduce the human factor. According to the survey, national guidelines or prevention strategies have been developed in 30% of participating economies, state or provincial guidelines have been developed in 20%, local guidelines have been developed in 10%, and individual parks and forests implement their own strategies in 10% of respondents.
5. Unclear land use zoning, land tenure, and land access or use rights can contribute to the increase in wildfires. Often, without these clearly defined, there is little or no sense of ownership among the local population and can lead to careless use of fire for land clearing and development³⁹.
6. Land use planning and zoning must seek to prevent or limit the development of new settlements in high-risk areas. A recent surge has been noted in unregulated settlements and camps in high-risk areas, especially in low socioeconomic communities or those with a high rate of homelessness. These camps provide a source of ignition as well as a community vulnerability that greatly increases wildfire risk. Additionally, organized development, such as housing or industry, but also be restricted or prohibited in areas of high-risk to fullest extent possible.
7. Planning should include provisions to protect the environment and biodiversity, as well as cultural and historical sites and icons against wildfires. For example, **Peru** has developed plans to address threats to the famed Machu Pichu site, which is of significant cultural and tourist importance to the economy⁴⁰.
8. Risk may vary within a community based on variations in topography, interface, or forest type. In situations such as this, some communities, such as Sante Fe, New Mexico and Flagstaff, Arizona in the **United States of America** have implemented a practice of Overlay Zoning⁴¹. In this approach, certain areas may have additional regulations placed on them to address the variations in risk.
9. **Canada** has developed a *National Guide for Wildland-Urban Interface*, which provides extensive recommendations on the types of issues that would benefit from territorial planning. Such issues include⁴²:
 - a. Requiring the alignment of land use planning with hazard and risk evaluation.
 - b. Evaluating efforts to control wildfire risk and how they may impact risk for other hazards, such as removal of vegetation that may lead to soil erosion and contribute to flooding.
 - c. Restricting the development of infrastructure or buildings in high-risk and sensitive areas; and to establish criteria for the types of conditions under which development in high-risk areas may be approved.



- d. Requirements for road networks and access to benefit firefighters and evacuation.
 - e. Standardization of protective distances to be maintained between homes, buildings, and infrastructure from forested or undeveloped land.
10. Studies in underdeveloped areas of **Brunei Darussalam** highlight the importance of planning for adequate access to water for fire suppression. In this instance, underdeveloped rural areas have limited access to treated water that can be consumed by humans. In the event of a fire, this source of water could be accessed for fire suppression. Rather than rely on the limited store of treated, potable water, recommendations were made to require planning for accessing streams, lakes, reservoirs, or other collection methods of non-treated, non-potable water.

Non-APEC economy experience

11. In 2004, **Brazil** created its Action Plan for Prevention and Control of Deforestation in the Amazon. This is managed by a working group of 13 ministries under the direct coordination of the Executive Office of the Presidency. Over 200 measures have been implemented to reduce illegal cutting of forests and preserve the ecosystems within the Amazon. These measures are based around (1) territorial and land use planning, (2) environmental control and monitoring, and (3) fostering sustainable production activities⁴⁴.

Good practice guidance Improving land use planning

12. Land use planning has long been considered one of the most rational and

cost-effective approaches to reducing the risk of wildfires. Two areas to focus on for improving land use planning within an economy are⁴⁵:

12.1 Inconsistent planning throughout the economy.

Without comprehensive guidance at the economy-level, state/provincial or local planners may implement different and conflicting requirements for planning. Some communities may be required to develop general risk reduction or wildfire prevention plans, while neighboring jurisdictions do not; thereby creating conditions that could promote the spread of wildfire between the two communities. Establishing a standard that can be applied across the economy will greatly enhance efforts to reduce risk.

12.2 Land use planners are often left out of regulation development.

Decisions regarding land use are frequently made without the support of the economy's land use experts. Natural resources ministries may not have the technical knowledge to apply territorial planning to the reduction of wildfires. Ensuring that natural resources experts work collaboratively with wildfire response departments and other land use experts will help to ensure that a more holistic approach is used to reduce wildfires.

13. Support land use planning with wildfire risk maps. Geospatial studies of interfaces, forest types, elevations, and regional weather can provide

planners with a more detailed and scientifically-based picture of areas of the community that are at high-risk for wildfires. Examples of this include the previously mentioned CR2 artificial intelligence mapping in **Chile** and the National Bushfire Intelligence Capacity in **Australia**. These models illustrate how leveraging access to scientific communities, academic knowledge, and private sector resources can better map local risk and more effectively align recommendations on land use planning.

14. Land use planning can be further broken down into five types of planning⁴⁶:

14.1 Community Plans. Within Community Plans are the Comprehensive Plan for setting forth a government's vision, policy direction, and strategies; a Community Wildfire Protection Plan that identified and prioritizes hazardous areas and makes recommendations for communities and homeowners to take to reduce risk of ignition and spread; and a Hazard Mitigation Plan which outlines long-term strategies the government and partners are taking to reduce wildfire risk.

14.2 Land Development. Land Development Plans include regulations for urban subdivisions, zoning regulations, open space policies, and landscaping regulations.

14.3 Building & Fire Codes. These codes consist of requirements for public safety, such as access and egress requirements, maximum occupancies, or building material

requirements. Additionally, some communities develop specific WUI Codes to address the unique challenges of the interface zone which often includes building materials, construction density, vegetation management, emergency vehicle access, and restrictions on hazardous land uses.

14.4 Fuels Treatment. This plan identifies the permissible measures that can be used to remove vegetation, reduce the availability of fuel, or treat the vegetation that cannot be removed to limit the potential for ignition.

14.5 Funding and Engagement. This planning includes developing a budget for risk reduction activities and creating strategies for public education and involvement in community-based risk reduction activities.

Implementing early warning systems

15. Implementing an early warning system can be a complex and expensive endeavor. However, it will undoubtedly save lives during major fires, making the cost-benefit almost undefinable.

16. The following are good practice steps for the planning and implementation of an early warning system.

16.1 Ensure the process is people-centric, understanding how various populations within the economy consume and use information, such as official warnings and social media, and the level of trust they have

of government information. Workshops and engagement meetings will likely be required to ensure comprehension.

- 16.2 Properly assess risk and identify areas of highest danger.
- 16.3 Secure funding for early warning system; this may come from economy budgets or international donors.
- 16.4 Develop an implementation plan, focusing on areas of highest risk.
- 16.5 Build capacities to manage the system. This will include training, Standard Operating Procedures, and public information sharing.
- 16.6 Test the early warning system. The effectiveness of the system must be tested through drills and other simulation exercises. This is necessary to ensure that all responsible staff understand their roles and procedures, as well as measuring if the warning system performs up to expectations, and that the public knows how to react to warnings.

Practical steps and tips to implement good practice

- 17. Territorial planning must include provisions to ensure adequate route access for firefighting apparatus and access to water for suppression.
- 18. Develop plans for collecting and accessing nontreated water for fire suppression operations, particularly in underdeveloped areas with limited access to potable water.

- 19. Communities should adopt clearly defined Wildland-Urban Interface Codes to provide a set of mitigation development standards, such as structure density, location, building materials, and other fire protection requirements for areas of a jurisdiction that interface with forests and other flammable vegetation.
- 20. Land use zoning should address land change practices, such as mechanical and agricultural burning, as well as protect for continuation of land management burning subject to clear control and measures which enable these practices to continue but in a control way to reduce the risk of causing a wildfire. Additionally, land access and use rights should be clearly defined to promote a sense of ownership among the population.
- 21. Create economy-level recommendations and educational materials for reducing the risk of wildfires associated with camping and other recreational activities.
- 22. Implement a system for providing the public with information on the current fire danger in their area. This should also include direction on where the public can get more guidance on protective actions, restrictions, and advice on burning during times of high fire risk.



CHAPTER 6

Preventive Forestry

Introduction

1. **Preventive forestry** can be defined as the branch of forestry which is concerned with the preservation or improvement of a forest and prevention and control of damage to forests by natural or manmade causes like fires, plant pests, and adverse climatic conditions (such as climate change).⁴⁷ This includes the preventive steps communities, private landowners, and governments can take to reduce the risk of wildfires by addressing sources of fuel and ignition.
2. Preventive forestry includes the modalities of cultivation or modifications to the structure of vegetation formations through interventions of forest management to prevent or hinder the initiation and propagation of wildfire. Preventive forestry also addresses **fuel management**, or interventions carried out prior to a fire that seek to prevent the spread or reduce the potential severity.
3. To be most effective, preventive forestry measures should be taken prior to wildfire season. However, it is important to note that with the influence of climate change, conditions conducive to wildfires are occurring outside of the traditional period when they were most common; leading to potentially longer wildfire seasons and off-season fires.
4. The most common methods for preventive forestry include the trimming, pruning, and removal of combustible waste from dense vegetation and the creation of fire breaks and fire lanes. Diversifying the species of vegetation in

a forest can be useful in creating green firebreaks, or strips of fire resistant plants. The incorporation of defensible spaces, or layers of landscaping techniques around homes or critical infrastructure, is highly effective in reducing risk. Finally, a very useful method that is not without some degree of controversy, is the use of prescribed or controlled burning to reduce fuel loads. These will be discussed in further detail.

Common methods for preventive forestry

5. **Eliminate combustible waste through pruning, removal, or controlled burning.** During these actions, excess fuel, such as dried tree limbs, are removed through intentional cutting or controlled burning. This measure seeks to reduce the availability of combustible materials. Controlled burning should be regulated and conducted by trained individuals to prevent the unintentional spread of fires.
6. **Incorporate strips of firebreaks in forests.** This action seeks to create space between fuel sources, such as dense vegetation, that can slow the spread of flames and allow firefighters an opportunity to contain the fire. Fire breaks should be at least three meters wide.⁴⁷ Fire breaks must be maintained annually, or overgrowth can negate the intended purpose of the and contribute to fire spread. Shaded fuel-breaks are strips of land in which vegetation has been modified rather than removed. An

example of this is sculpting trees so that their crowns no longer touch⁴⁹.

7. **Keep a distance of 10 meters from roadside and 5 meters from electrical lines.** This action helps to separate the forest from common sources of ignition. According to data from the Texas Wildfire Mitigation Project, more than 4,000 wildfires in the State of Texas over the period of 2019-2022 were caused by contact with power lines⁵⁰. Separating forest from the road by 10 meters serves several purposes, including reducing the exposure of forests to ignition sources, such as discarded cigarettes, serving as a fire-break, and helping to keep routes of travel open for emergency vehicles. High winds greatly increase the risk of ignition from powerlines contacting trees in poorly maintained interface areas.
8. **Ensure that forestry vehicles and equipment have access to strategic locations.** When planning preventive forestry, it is important to ensure firefighters, maintenance crews, and other critical personnel have access to strategic locations of the forest. Implementing **fire-lanes** can help efforts to maintain access for firefighters responding to fires in hard-to-reach locations. Fire-lanes can also serve to help breaks the forest into compartments, if constructed in the right place these can help contain a fire to one or more compartments saving the rest of the forest. Much like fire-breaks, these lanes will need to be maintained annually to control overgrowth and reduce fuel sources.

9. **Diversify the species used and keep distance from interface areas.** Developing standards for defensible space, or the area around a structure that is free from vegetation, can create additional breaks to slow the spread of fire. Additionally, working with plant experts to identify less-flammable or fire-resistant plants will help to create additional fuel breaks for slowing fire spread. These strips of low flammability plants between or around areas of more flammable vegetation are called **green firebreaks**. Forestry and agricultural experts should be consulting during land use planning or preventive forestry phases to identify the best species of resistant vegetation to use⁵¹.
10. **Restrictions on certain high-risk activities.** Stopping any activities with forests during periods of high fire danger when a spark or heat source has a higher chance of causing a wildfire.
11. **Vehicle maintenance.** Ensuring any machinery, equipment used in forested areas is maintained to a high standard to prevent sparks or heat building up starting a fire including diesel power equipment exhausts are fitted with spark arrestors. Equipment should regularly be inspected during operations for vegetation buildup around working parts and any faults.
12. **Signage for responders and the public.** Signage which denotes location will help with fire reporting and response crew more rapidly identify which part of the forest they are responding to,

including where water points and other facilities are located. Education signage for the public will also help campers, hikers, and other visitors using the forest know what to do to prevent a wildfire.

13. Additional information on fire behavior and how various species of trees act as fuel can be found at the U.S. Forest Service's website. This technical information can assist planners with both territorial planning and planning of preventive forestry actions. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5109950.pdf



Image 7: Defensible space zones around a home.

Creation of Defensible Space

14. Providing the community, in particular individual property owners, with the knowledge of actions they can take to reduce their risk will greatly decrease the community's risk of wildfires.
15. Economies should establish the standards for these defensible spaces, providing communities and individuals with clear guidance on steps to take in each zone of defensible space.

16. **Defensible space** is an area around a structure in which grass, trees, and shrubs have been managed in such a way as to reduce the risk of fire. It is recommended that actions be broken into Four Zones based on distance to structures or roadways.

- **Zone Zero:** The area from the wall of a structure to 1.5 m.
- **Zone One:** The area from 1.5 to 10 m from a structure.
- **Zone Two:** The area from 10 to 30 m from a structure.
- **Zone Three:** The area from 30 to 100 m from a structure; or 0-3m horizontally and 3 m vertically from roadways.

17. Many guides have been established by organizations and response agencies within economies such as the **United States of America** and **Canada** that suggest actions the property owner can take to reduce the fuel load and ignition sources within these zones. It is recommended that each economy develop its own standards for defensible space zones and the actions to be taken within each zone.



Image 8: Prescribed burning to reduce fire load. (Photo credit: Laurence Rosenberg)

Use of controlled burning

18. **Prescribed fire**, or the intentional use of controlled burning to manage fuels and landscapes, and **cultural burning**, the intentional use of fire by indigenous peoples to achieve cultural objectives, should be considered when developing preventive forestry and reduction strategies. When used correctly, prescribed fire and cultural burning can be effective means for reducing fuel and providing significant benefits for fire-dependent ecosystems, wildlife, and human communities. Both forms of burning have inherent risks associated with them that can contribute to, and often ignite, major wildfires if done incorrectly. As such, it is therefore unsurprising that controlled burning is coming under pressure to reduce or have greater controls around. However, communities with indigenous populations who have historically utilized cultural burning should be encouraged to continue to do. More "modern" fire prevention specialists should also learn from these indigenous practitioners, who have practiced good stewardship and safety with their practices for centuries⁵².
19. Agricultural and garbage burning are also forms of controlled burning that need regulation education, and guidance on safe burning practices. **Agricultural burning** is the intentional use of controlled burning specifically to remove crop debris and residues following a harvest in agricultural land such as farms and orchards. Burning of garbage is frequently practiced throughout the world to reduce refuse, especially in more rural areas with

limited access to landfills or waste disposal. If left unregulated, these forms of controlled burning are likely to greatly increase the likelihood of wildfires igniting. Community members should be provided with more information on current fire danger conditions and times when these activities are high risk of causing a wildfire.

20. Indonesia's catastrophic 2015 wildfire season, in which over 2.6 million hectares of land were burned, was largely due to over 100,000 manmade fires to prepare land for agriculture or clearing for other access. A lack of supervision of the fires by those who set them, insufficient law enforcement, and drought conditions caused many of these fires to burn out of control⁵³. This further highlights the need for more stringent control of agricultural burning.

Prevention after the fire

21. It is critical to remember that fires change the characteristics of the land and often leave the area more vulnerable to additional fires. Some fires cause damage that requires special efforts to prevent additional fires and complications. Loss of vegetation exposes soil to erosion, water runoff may increase and cause flooding, sediments may move downstream and damage houses or fill reservoirs thereby endangering species and community water supplies.⁵⁴
22. Specialized teams or experts should be part of preventive forestry plans to assist with determining proper actions to take after a fire to prevent additional wildfires, erosion, or floods.

23. Regulations may be required to establish timelines after the fires during which burned land should not be developed on.
24. Post-fire activities, such as cleaning, soil recovery, reforestation, etc. should be factored into preventive forest planning and financing. Investing in proper recovery activities will assist in preventing future fires in the area and promote healthy forests.



Image 9. Defensible space saved this particular home in Nebraska, USA two years in a row. (Photo Credit: Andrew Avantaggiato)

APEC economy experience

25. **China** is among the leading economies in the world to implement green firebreaks. More than 364,000 km of green firebreaks had been planted by 2018, with plans to sustain the practice with a target of an additional 167,000 km by 2025. Chinese studies have found these to be a low-cost, biodiversity-friendly, and long-term compliment to traditional fire prevention approaches.⁵⁵
26. The Scion Research Institute in **New Zealand** is a good practice of private or non-governmental organizations being used to advance the science and guidance for reduction of wildfires. Much of the information in this chapter has been provided by the experts from this organization and its extensive research into forests and wildfires.

27. Some economies have had success with the implementation of a Burn Area Emergency Response (BAER) program. Developed in the **United States of America**, it provides a specialized response of experts during and following a fire to assess the damage to the environment, potential impacts beyond the fire (such as soil erosion, water quality, etc.), and develop recommendations for preventive and restorative actions to take.⁵⁶
28. Drone Amplified, a company in the **United States of America**, has developed an unmanned aerial vehicle platform to deliver small incendiary balls to trigger prescribed burning in difficult to reach areas of a forest to assist with management of forest conditions and to combat wildfires.⁵⁷

Good practice guidance

Leverage non-governmental and private sector organizations

29. The success of organizations such as **Australia's** National Bushfire Intelligence Capacity **Chile's** CR2, and **New Zealand's** Scion Research Institute, demonstrate the benefits of linking the private sector, academic institutions, and non-governmental organizations with the economy and local governments. The experts available from these sectors can provide extensive insight into the development of effective preventive forestry techniques that will be culturally, financially, and operationally acceptable to the economy.

Practical steps and tips to implement good practice

30. Each local government should determine their own minimum fire-break standards based upon the level of threat and size of properties to be protected. Threats may be influenced by factors such as type of forests, soil, and other fuel conditions present in the community. Breaks may exceed 3 meters, but that should serve as the minimum distance.
31. Clearly define the goals and objectives of the preventive forestry plan. Determine if the plan seeks to reduce fire occurrence, reduce fire intensity, reduce fire growth, or restore the normal **fire regime** for the area.⁵⁸ Fire regime must include the annual maintenance of fire breaks, fire lanes, and defensible spaces around roads, powerlines, and other critical infrastructures.
32. Institute a program of annual maintenance of fire-breaks to reduce risk from overgrowth or leaf fall; incorporate support from private land-owners and community action groups to support these efforts.
33. Institute a program of scheduled and managed thinning of forest areas to reduce tree density. This will encourage increased growth of healthy trees and reduce excess fuels in an area, thereby making wildfires more manageable.⁵⁹
34. Incorporate provisions into land-use planning that address the post-fire implications for vegetation and soil, such as the replacement of damaged burn area with civil works projects to reduce future vulnerability.⁶⁰
35. Implement a program of monitoring forests for pests and diseases⁶¹. Healthy trees are less likely to burn as they retain more moisture.
36. Communities should be educated on preventive guidelines they can take to reduce property damage.
37. Planning of forests should include consideration for the spatial structure that ensures fuel sources have breaks, adequate management of urban-rural interface, respect for indigenous communities, recognition of ecological functionality, and appropriate management to protect the quality and quantity of water generated by the basins.⁶²
38. The use of prescribed fire and cultural burning can be an effective method of reducing fuels in wildfire prone areas. However, practitioners of this burning should receive expert training and oversight. Additionally, this is an excellent opportunity to seek out and incorporate indigenous safety practices that have been used in cultural burning activities for centuries.



CHAPTER 7

Community Outreach and Engagement

Introduction

1. Community involvement in wildfire risk reduction is an essential component to any risk reduction plan. Community involvement is so integral for four main reasons:
 - a. Individual behavior has often contributed to the level of risk in a community. According to the WWF, humans are responsible for 75% of all wildfires around the globe annually. By educating the individual, risk reduction planners can decrease actions that contribute to wildfires (i.e., unregulated agricultural burning, carelessly discarding cigarettes or campfires, etc.) and increase positive actions (conservation, landscaping, individual preparedness, etc.).
 - b. Property owners have a responsibility in properly securing their homes, businesses, farms, etc. from fires. By educating the property owner and empowering them to take proactive steps to reduce threats, the overall risk profile for the community can be lowered.
 - c. Community action groups or volunteers can be utilized to carry out risk reduction activities. In many areas, volunteers form Community Emergency Response Teams (CERT) that can be used, not only to respond to a disaster, but to carry out pre-disaster mitigation activities,

such as clearing old vegetation, monitoring early warning systems, or educating neighbors.

- d. Community engagement helps to identify historically vulnerable populations and to increase understanding of the potential challenges encountered by these groups during wildfires.

Individual Education

2. Effective education of the individual in a community can help to increase their voluntary compliance with regulations when they become more aware of why they must adhere to these guidelines. When the individual understands how their compliance can save lives, property, and community, they usually become more willing to be a part of risk reduction efforts. Individual education may consist of topics such as:
 - a. Behaviors or actions that contribute to wildfires.
 - b. Early warning systems used in the community.
 - c. Creating a communications plan for your family.
 - d. Caring for pets or domestic livestock in an emergency.
 - e. Developing a preparedness plan or preparedness kit for the home.
 - f. Mitigation measures to take around the home or at work (to be discussed in the next subsection).

Property Owner Education

3. Property owners may feel overwhelmed by the requirements or by the task of reducing wildfire risks, leading them to feel as they have no control over the situation. By providing property owners with consistent and simple messaging about actions that can be taken to properly landscape or harden their structures, public outreach campaigns can have a more successful impact on community preparedness.

Community Emergency Response Teams

4. Many communities around the world have adopted the Community Emergency Response Team (CERT) program as a means of encouraging and organizing volunteers within the

community to augment emergency responders in times of disaster. Typically, CERT volunteers undergo training in fire safety, light search and rescue, team organization, and disaster medical operations. Frequently, the teams are used to support responses to earthquakes, floods, and tropical storms. During wildfires, CERT members are often used to staff emergency shelters.

5. While the primary purpose of these teams is for emergency response, it is becoming more common for them to conduct community education programs and engage in community mitigation projects. These teams are also being utilized to teach Cardiopulmonary Resuscitation (CPR) and first aid and disaster preparedness for individuals and families. Additionally, they can be used to perform simple mitigation projects, such as removal of fuels or installation of fire and smoke detectors.

Outreach to Historically Vulnerable Populations

6. With natural disasters, including wildfires, occurring more frequently, it is becoming more apparent that certain segments within a population suffer disproportionately than others. In disasters, gender and social inequalities are magnified, leading to more direct and indirect impacts to historically vulnerable groups. Understanding how certain groups can be impacted more than others is important in risk reduction planning. Community outreach will be



Image 10: CERT members undergo first aid training in the United States. (Photo credit: Devin Kerins)

critical to developing this understanding and confidence on the part of the vulnerable populations.

7. Historically vulnerable populations include those from indigenous, racial, ethnic, sexual orientation and gender-identity minority groups, persons with disabilities, those with chronic illnesses, children, the elderly, and especially women. These can also include those with socio-economic vulnerabilities, such as female-headed households, single parent family structures, those living in poverty in both rural and urban settings, internally displaced persons, refugees, asylum seekers, or migratory workers.
8. Frequently, well-intentioned policies can actually be detrimental to these groups. Evacuation procedures may not reflect physical mobility needs, shelters may not be laid out to allow privacy for breastfeeding mothers, or provision of relief may limit the participation of single-parents. Understanding the role gender and historical vulnerabilities play in society can have a profound impact on wildfire reduction, response, and recovery.
9. Among those who are of low socioeconomic status or homeless, there has also been an observed increase in the number of unregulated camps being created by those with no other means of shelter in many economies. These camps are often built in areas at increased risk of wildfire. Image 11 demonstrates the concentration of unregulated camps developing in areas of high wildfire risk in the Valparaíso Region of Chile.

10. Conducting outreach specifically targeted at these historically vulnerable populations can open better dialogue between emergency planners and these communities to promote an improved understanding of their concerns and potential challenges when faced with wildfires or other disasters.
11. While women constitute approximately half of the population of APEC economies, they are dramatically underrepresented in the fire service. The **United States of America** has found that women only represent 5% of the fire service work force. Efforts must be made throughout all economies to increase the participation of women in fire service and emergency management positions.

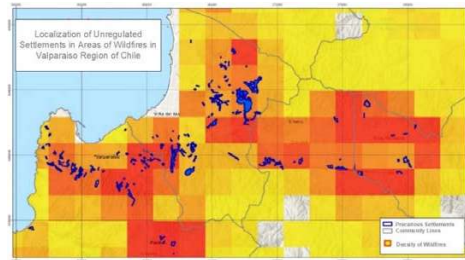


Image 11: Concentration of unregulated camps (in blue) in areas of high risk for wildfires (red and orange), (Credit: CONAF)



Image 12: High fire risk warning shared by National Weather Service (Credit: National Weather Service)

Early Warning Systems

12. Early warning systems are an integral part of disaster risk reduction and public safety. The ability to provide early notification of a pending emergency can potentially save thousands of lives. Within the survey, 30% of respondents did not have an early warning system in place, 30% were uncertain, and 10% declined to answer. Of the remaining respondents, 10% had an early warning system that covers the entire economy, 10% had coverage in only the highest risk areas, and 10% had coverage in only some of the highest risk areas.
13. Early warning systems require integrated monitoring for wildfires and a comprehensive strategy for alerting the public. A single method cannot be reliable upon to alert all in the public. A thorough understanding of how various segments of a population receive and consume information, particularly emergency warnings, will help to better inform the efforts of economy and community level governments to reach the threatened populations. Examples of variations in consuming information include:
 - a. Younger populations are currently more likely to receive news from social media than traditional methods.
 - b. Elderly populations will be less likely to receive news from social media and are often more reliant on more traditional forms of media such as television or radio.
 - c. Men are more likely to receive early warning from a formal source while women are more likely to receive warning from informal or social sources.⁶³
14. Early warning messaging for the public should be easy to understand and include simple directions. Image 12 is an example of a high fire risk warning shared by the National Weather Service in the **United States of America** on their social media page.
15. A variety of methods to convey a coordinated and timely message will reach the largest audience. Within the APEC economies, these include sirens, SMS/text alerts, automated phone systems, and traditional media methods such as television and radio alerts. Technological advances are being integrated into these systems to further enhance the effectiveness of early warning systems, and those will be discussed further in the next section.
16. An annual test of the early warning system should be conducted with the public to ensure functionality of the system and an understanding of the public on what the system means. The public is only periodically trained or informed on how the warning system will alert them in 50% of respondents.
17. The following is an example of a simple test to run with the community. First, notify the public in advance of a pending test. Direct them to visit the agency's social media page when the warning is sounded and provide the following information: (1) the individual's location when they heard the warning; (2) was the warning clear; (3) what method of warning was received; and (4) do they understand what they should do if they heard this warning during in a real wildfire emergency.

APEC economy experience

18. Many agencies, such as Cal Fire and FEMA in the **United States of America**, have had major success reaching large audiences through interactive webinars^{64 65}. The shift of much of society to more virtual based interactions during the COVID-19 pandemic has demonstrated the effectiveness of using these platforms to reach people who might never have been able to attend in-person training.
19. **Peru** actively engages the indigenous communities as partners in fire preparedness and response. As part of the national response planning, the National Institute of Civil Defense (INDECI) has incorporated mechanisms to utilize indigenous fire suppression teams⁶⁶.



Image 13: Forestin, the mascot for CONAF in Chile. (Photo Credit: CONAF)

20. UNESCO and the Ciletuh-Palabuhanratu Geopark in **Indonesia** use scientists from area universities and government agencies to educate students, visitors, and community members on the hazards associated with earthquakes, tsunamis, and wildfires in the park⁶⁷. Training focusing on school children has the added benefit of encouraging those children to take the message home to their families.

21. FEMA's Region 2 in the **United States of America** has implemented a program in the State of New Jersey called "Prepare to Recovery" in which they train CERT members to teach a comprehensive community preparedness program within their towns. Often, community members react better when taught by other community members with whom they can identify.
22. Many economies have success using mascots to promote fire prevention. **Chile** has created Forestin the coypu, **Mexico** has Savi the Squirrel, and the **United States of America** has Smokey the Bear. Some of these economies, like **Mexico** and the United States of America, have developed application-based games, activities, and social media pages for these characters to further draw younger audiences into fire prevention.
23. **Viet Nam** partnered with international donors to implement the project *Support for the Strengthening Institutional Capacity for Disaster Risk Management in Viet Nam*⁶⁸. This project build capacities on gender equality, mainstream gender equality in disaster risk management legislation, and increase gender leadership in institutional disaster risk management systems. Overall, this contributed to the development of female voices and representation in community-based disaster risk management.
24. FEMA in the **United States of America** has implemented a *Ready Seniors Workshop*⁶⁹ program to strengthen preparedness and business continuity capacities for the organizations or businesses that provide critical medical,

social, psychological, transportation, or other support services to the elderly or those with disabilities.

25. FEMA has mandated the hiring of a Disabilities Integration Specialist in each Region following Hurricane Katrina⁷⁰. This position helps to implement policies and procedures during all phases of a disaster to ensure that the needs of persons with access and functional needs are adequately represented.

Non-APEC economy experience

26. A good practice implemented in Africa was the development of *Girls in Risk Reduction Leadership (GIRRL)*⁷¹. This initiative was implemented in Lesotho, Malawi, Zambia, and Zimbabwe and sought to teach and encourage girls to become disaster risk reduction leaders in their communities. In this project, schoolgirls in Africa can be trained as leaders and resource personnel in their community to identify hazards and encourage disaster risk reduction measures.
27. **Fiji** has developed an Emergency Operations Center that would be activated specifically for the needs of persons with disabilities during a disaster.⁷²

Good practice guidance

28. Community outreach and education campaigns should follow consistent messaging to individuals and property owners. They should seek to encourage community members to act on their own behalf to improve the community at large. Some recommendations to incorporate when creating or refining a community outreach program include⁷³:
 - 28.1 Establish a committee of fire and education experts to develop the

outreach strategy and materials for the public. Materials should be risk informed and easy to understand. Messaging to the public should be unified to ensure consistent information.

- 28.2 Develop core-messages that are consistent, offer attainable solutions, and whose impacts can be measured. Messaging should be consistent but customizable to reach local populations, education levels, languages, etc.
- 28.3 Utilize the risk assessment to inform where education efforts should be focused. All citizens need training, but more intensive training efforts should be focused on those areas of highest risk.
- 28.4 Coordinate messaging with high-risk seasons. Prevention messaging and activities can be conducted throughout the year, but stress preparedness and prevention in the weeks leading up to the start of wildfire season.
- 28.5 Create and support recognition programs that target and highlight individual citizens, neighborhoods, and community successes.
- 28.6 Engage state and economy-level wildfire stakeholders to develop the education campaign targeted toward at-risk communities.
- 28.7 Develop campaign objectives that are clear and measurable.
- 28.8 Leverage both traditional and social media opportunities.
- 28.9 Identify community influencers who can be used to spread the information.

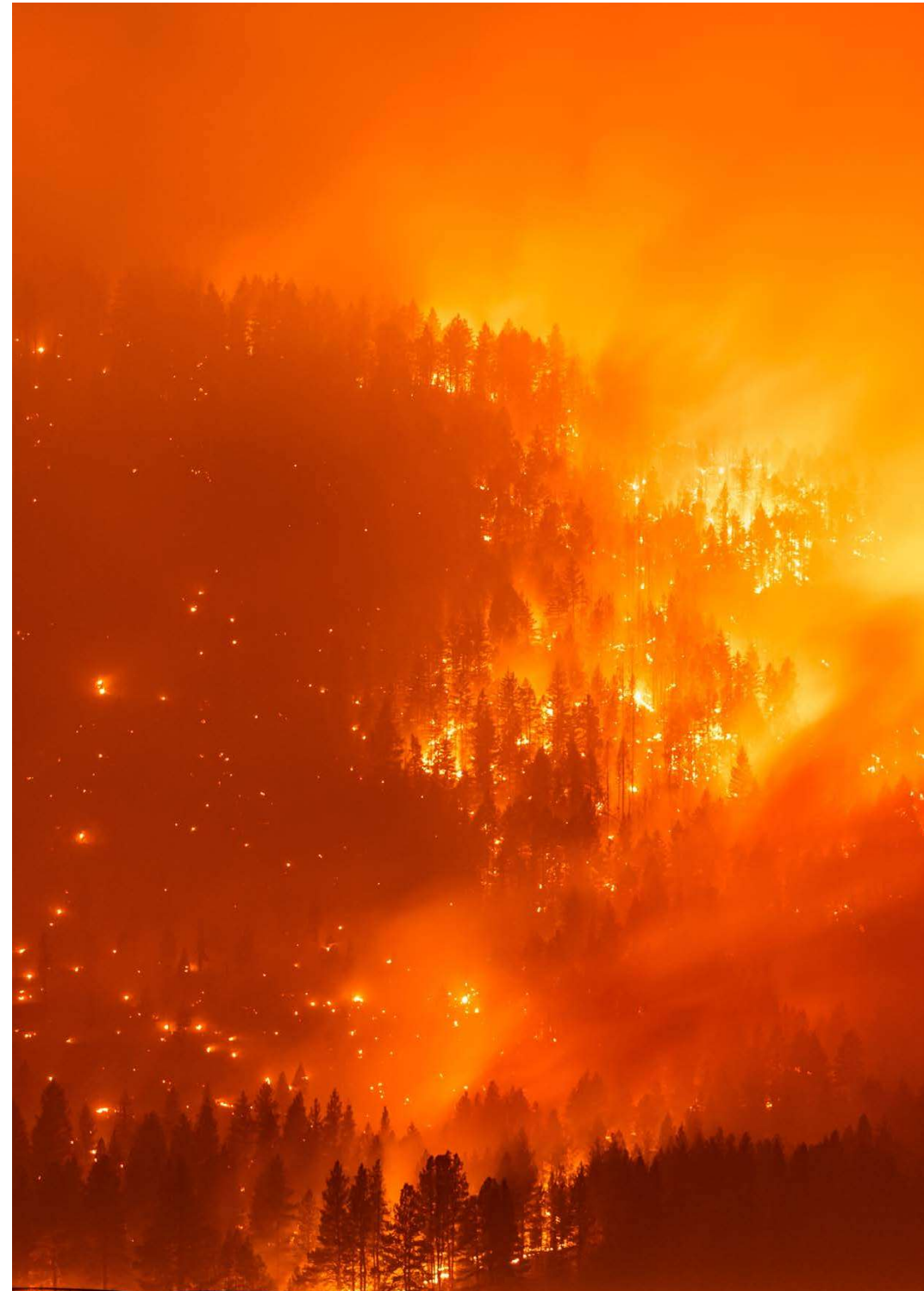
- 28.10 Establish metrics to measure the success of the campaign.
- 28.11 Designate a Wildfire Prevention Month in which the public is provided with high-profile outreach efforts, education events, or social media messaging.
- 28.12 Implement or expand fire prevention education with young children in schools. Cartoons, comics, and coloring books have been effective in many economies for capturing the attention of young children and getting them to spread the message of prevention at home.

Gender mainstreaming and outreach to vulnerable populations

- 29. To reduce the disproportionate suffering that these groups within the community experience, local and government planners must ensure that the unique challenges are considered in risk reduction efforts. Despite the growing attention placed on this inequality in disaster impacts, there is currently no global guidance on how to make disaster risk reduction and wildfire risk reduction plans more responsive to gender and vulnerability. The following represent good practices being used by APEC economies to address these disparities.
 - 29.1 Create community action groups to advocate for women and vulnerable populations during risk reduction planning. This will help to ensure that policies can be reviewed to identify potential biases against these groups.
 - 29.2 Review policies, legislations, and standard operating procedures in place or under development to

identify opportunities to strengthen the commitment to protecting women and other historically vulnerable populations.

- 29.3 Encourage the hiring of more women into firefighting or disaster risk management roles. An increase of women in these roles will require steps to address workplace cultural aspects that bias against females. This includes, but is not limited to, ensuring proper sanitation and hygiene facilities are available, personal protective equipment that is designed for female bodies is purchased, and educating males to eliminate workplace humor or activities that would be viewed as 'misogynistic or sexist'.
- 29.4 Support the development of inclusive and accessible early warning systems for wildfires. This includes understanding how various audiences receive and consume information, such as the use of social media, cellular phones, and other technologies.
- 29.5 Recognize the broader benefits of incorporation of gender and vulnerable populations in forest fire risk reduction planning. There are positive effects from well-defined and formal inclusion of women and vulnerable groups in wildfire risk reduction planning; including contributing to the greater gender equality and broader community empowerment.



CHAPTER 8

Integrating Technology

Introduction

1. Major advancements in technology provide vast opportunities for improving risk reduction. Innovations in communication, satellite imagery, artificial intelligence, social media, and unmanned systems are among many of the more common technologies that are being integrated with success throughout the APEC region to reduce risks for various hazards, including wildfires.
2. Technological advances are not readily available to all communities, however. Additionally, communities may not have the technical knowledge to interpret results and apply them appropriately

to wildfire risk reduction. Partnerships with economy-level ministries, non-governmental organizations, scientific research organizations, and academic institutions are required to make such technologies accessible and useful to the community-level efforts to reduce wildfires.

3. Technology can also be applied to the research and development of fire-resistant materials. Private-public partnerships can help identify and develop materials for building construction, external jacketing of electrical wires, flame-resistant coating for utility poles⁷⁴, or reducing other sources of potential ignition in WUI areas.



Image 14: Screenshot of current fires in the APEC region on April 01, 2023, as seen from the NASA FIRMS website.

APEC economy experience

4. The National Aeronautics and Space Administration (NASA) of the **United States of America** is providing extensive technological and scientific support to the effort of preventing and responding to fires around the world. The agency has developed a Disasters Program within the last two years to build the infrastructure to support research and monitoring into a variety of natural disasters, including wildfires, and to foster new relationships with local, regional, and international disaster response agencies. Resources provided by NASA help to locate hot spots and smoke plumes that may signal a wildfire, track and predict smoke models for decision-making, and map the extent of changes to an ecosystem following a fire⁷⁵.

- 4.1 NASA's Fire Information for Resource Management System (FIRMS) is a web-based platform that uses satellite observations to detect active fires and thermal changes and deliver this information in near real-time to decision-makers through email alerts, online maps, and other web services⁷⁶. Certain data can be exported into KML, CSV, or ShapeFiles formats, which can allow planners and managers to use this information in ArcGIS and other mapping and modeling programs. Image 14 shows a screenshot of the APEC region

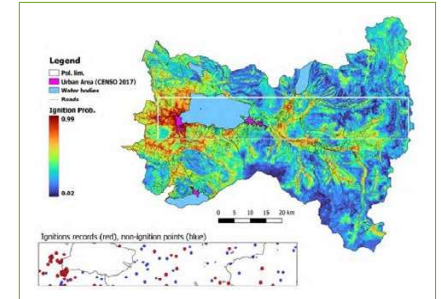


Image 15: Artificial intelligence modeling ignition probability correlated to areas of population density. (Credit CR2)

from the FIRMS website. FIRMS can be accessed at: <https://firms.modaps.eosdis.nasa.gov/>.

- 4.2 Another of the many tools available from NASA is the MODIS Instrument. This satellite imagery system can detect actively burning areas or hot spots by recognizing temperatures higher than the background. It can be used to show the extent of burned areas, allowing for better informed post-fire decision-making⁷⁷.

5. **The Republic of Korea** has developed a smartphone application that enables users to report the exact location of a forest fire, share photos and videos of it, and track its spread⁷⁸. This use of technology enables ordinary citizens to be an integral part of preventing large fires by enabling them to report wildfires more rapidly and accurately. Extensive research was done to identify what motivates citizens to want to assist in reporting fires, what would prevent them from wanting to report fires, and how

to make this system as user-friendly as possible. A study for effectiveness showed that the average time for the forest service to detect a wildfire was significantly reduced from 30 minutes to 5 in 2018 due to the incorporation of this app with other mechanisms (such as satellite images, closed circuit television cameras, and heat-sensing drones).

6. Scientific modeling can provide a greater detail of risk assessment. Some institutions employ artificial intelligence to analyze topography, soil, weather, and other variables which provide a more comprehensive assessment of risk. The Center for Climate Resilience Research (CR2) in **Chile** has made great progress in applying artificial intelligence and machine learning to the study of wildfire risk⁷⁹. This approach can use computer algorithms to rapidly analyze large amounts of data, including photos, topography, and other data sets to predict risk more accurately for community.
7. The technology being developed by CR2 combines the use of remote sensing equipment with geospatial information to produce high-resolution images and spatial data. The material is then analyzed through machine learning, deep learning, and Convolutional Neural Networks (CNN) to provide a more enhanced fire risk assessment, propose management alternatives to minimize fire risk, and evaluate the effectiveness of mitigation activities.
8. Descartes Lab in the **United States of America** using artificial intelligence to analyze images from two weather satellites every ten minutes to identify indicators of hotspots that may signal a

wildfire. Various algorithms are rapidly run to determine if a fire is present, and the results are then sent to state fire managers for early notification and warning⁸⁰.

9. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) of **Australia** partnered with the Australian Insurers NRMA to conduct research into developing FireBlanket, an early detection and monitoring system for detecting smoke from wildfires. This is similar in concept to a tree mounted system called Senticnel[®] that was created in **Spain**. These tree mounted monitoring devices are placed in high-risk areas and serve as smoke detectors to enhance rapid recognition⁸¹.
10. WIFIRE Lab, a component of the University of California, San Diego in the **United States of America**, has developed the FireMap platform. This artificial intelligence program can rapidly analyze conditions and develop a predictive map of where the wildfire is likely to spread⁸².
11. Risk management stakeholders in **China** have partnered with UNESCO to employ unmanned aerial vehicles (UAV) in the Danxiashan Geopark to pinpoint actual and potential hazards. Since 2008, advanced technology has been used to identify, study, and monitor 27 geological disasters, 50 potential disaster points, and 3 unstable slopes. UAV have been used since 2015 to conduct the monitoring of potential disasters and forest fires.⁸³
12. The **United States of America's** United States Forest Service is using virtual reality to train firefighters for hazardous wildfires. Three-dimensional simulators

provide a realistic and safe environment to train their smokejumpers. This is used to provide initial instruction, but also can be deployed to fire stations to conduct refresher training. The virtual reality allows trainers to change and increase the complexity of variables in training scenarios to further stress and challenge firefighters, helping to prepare the smokejumpers for parachuting into wildfire conditions⁸⁴.

13. Google has implemented a system to incorporate machine learning to review satellite imagery to track wildfires and inform communities at risk. The system receives information and images from geostationary satellites in North America and Australia to provide coverage and warning for communities in **Australia, Canada, Mexico, and the United States of America**⁸⁵.

Good practice guidance

14. The development of and integration of advanced technologies requires a coordinated effort most effectively led at the economy-level. Community-level planners and fire management specialists will benefit most from this technology, but frequently do not have access to it. Creation of Public-Private Partnerships will greatly enhance

the ability of high-risk communities to leverage existing resources and expertise to reduce wildfires.

15. Economies should prioritize addressing technological gaps in high risk areas. Many high-risk areas do not have access to stable internet or smartphone connectivity, much of which would be essential for the application of technological innovations. Investments in improving risk reduction should consider including investment in supportive infrastructure.
16. Involve target populations when designing new technologies. The technology must be easily understood and user-friendly, as well as inexpensive enough to make it affordable for the communities. Making technology too complicated for the end-user will almost certainly render the new technology ineffective.
17. Build upon indigenous knowledge. Many indigenous communities have managed the risk of wildfires for centuries without the assistance of drones, artificial intelligence, or cellular communication. Utilizing that level of expertise, combined with the latest innovations will provide a much higher degree of prevention for communities.

CHAPTER 9

Monitoring and Evaluation

Introduction

1. With so much effort being put forth into reducing the risk of wildfires, it is crucial that planners take the time to evaluate if these efforts are effective. As interventions are being developed, mechanisms for reviewing and assessing the progress and effectiveness need to be created.
2. Implementing a Monitoring and Evaluation Program (M&E) provides key guidance on future intervention activities. It also provides information on how an intervention is doing and whether it is achieving the objectives it seeks to address⁸⁵.
 - **Monitoring** is the regular collection of information about all project activities. It shows whether the project is progressing according to plan and helps to identify problems and potential solutions in a prompt manner.
 - **Evaluation** seeks to determine whether the project is achieving what it set out to do. This seeks to understand why a project encountered challenges, as well as why it might have had success.
3. Monitoring occurs throughout the intervention, while evaluation takes place at specified times during the intervention. A baseline status should be determined prior to the interventions commencing. A plan should be in place to conduct scheduled reviews or evaluations throughout the process of the implementation. During these

scheduled evaluations, planners should review the data collected during the on-going monitoring. Regular and planned evaluations help to ensure:

- Projects are modified to meet emerging challenges or needs.
- Available resources are redirected to support the project if needed.
- Indications have been established to predict potential failure of the project.
- Progress toward successful completion is communicated to the community and other stakeholders.
- All groups involved in the project are accountable for their respective performance.
- Resources, including funding, are being utilized in the most efficient manner.

APEC economy experience

4. In the 2022 survey, 60% of respondents reported a formalized system of monitoring and evaluation was used to review the effectiveness of policies, legislations, and other activities.
5. FEMA in the United States of America has implemented a procedure by which it deploys specialists to major disasters and major projects to gather lessons learned and good practices for its Continuous Improvement Program⁸⁶. This collection of on-going data and feedback from staff helps to adjust the Agency's approach more effectively to on-going operations.

Non-APEC economy experience

6. The National Disaster Management Centre of South Africa has developed its own Disaster Management Monitoring & Evaluation Framework. What makes this document quite useful for economy and community planners is that it defines the role of economy level ministries, as well as provincial-level disaster management personnel in the M&E process. This can be helpful in providing a starting point for wildfire risk reduction planners seeking to implement M&E from which they begin defining specific roles and responsibilities. This document can be accessed at: <http://www.ndmc.gov.za/Frameworks/Disaster%20Management%20Monitoring%20and%20Evaluation%20Framework.pdf>

Good practice guidance Developing a results-based Monitoring and Evaluation Program

7. The following are good practice steps to building an effective results-based Monitoring and Evaluation Program:⁸⁷
 - 7.1 **Conduct a readiness assessment of participants.** M&E will require a team. Most desirably, it should include representation from organizations involved in the reduction of wildfires. These participants should have an understanding of the purpose of M&E and be capable of making objective observations and evaluations.

- 7.2 **Agree on performance outcomes to monitor and evaluate.** Each reduction project is different and will likely have different end-goals. For example, these could be the reduction of the frequency of fires or the reduction of intensity of the fires. The purpose and desired outcome must be clearly defined for the M&E team.
- 7.3 **Select key indicators.** The monitoring team must identify indicators that can be observed and recorded that relate to whether the project is progressing and effective.
- 7.4 **Gather baseline data.** The starting point for M&E must be the current state without the implementation of the project. This will enable evaluators to accurately gauge any changes that are occurring as a result of the project.
- 7.5 **Set realistic interim targets.** Successful completion of a project may be a lengthy process depending on its complexity and scope. It is therefore helpful to break the project down into achievable and realistic milestones. This helps evaluators assess if the project is moving in the anticipated direction.



7.6 Building a monitoring system.

The most appropriate monitoring system depends on the level of development in the economy, the size of the project, and the number of trained people to assist with the monitoring. Monitoring also consists of how the team will collect, store, analyze, and share the information.

7.7 Use evaluation information.

As the information is collected and analyzed by the monitoring process, experts should develop findings on what this information means. If the project is experiencing complications, recommendations for corrective actions should be identified.

7.8 Report findings. The findings should be shared with the key decision-makers in a report containing easily understood explanations and actionable recommendations.

7.9 Use findings. The findings of the report should drive action on the part of stakeholders and decision-makers. If complications have been identified, then corrective action should be taken.

7.10 Sustain the M&E system within the risk reduction process. This model of M&E should be applied to all aspects of disaster risk management. The more ingrained it becomes in a policy and culture of emergency management, the more proficient the planners will become and the more successful these risk management project will be.

Practice steps and tips to implement good practice

8. Clearly defining the information needed to make decisions greatly increases the usefulness of M&E programs. A World Bank evaluation of gender-informed disaster risk management projects in **Vietnam** and **Laos PDR** showed the challenges originally encountered with developing gender-sensitive policies was the lack of data disaggregated by sex⁸⁸. Without a clear definition of the information necessary to collect during the M&E process, it is difficult to identify, understand, and address specific project needs. Good practice M&E programs begin with this clear definition of data points and reviews throughout the monitoring process to ensure necessary information is being collected.
9. The United Nations Development Programme (UNDP) has developed a comprehensive manual for M&E. This product, available in English, Spanish, Russian, and Chinese, provides excellent guidance on planning, implementation, defining roles and responsibilities, and assessing results. The material is also accompanied by helpful webinars. This can be found at the UNDP website: <http://web.undp.org/evaluation/guideline/index.shtml>.
10. Though not as extensive, UNDRR has its own very useful framework and guidance for M&E available on its website <https://www.undrr.org/publication/monitoring-and-evaluation-framework>.

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