CHAPTER 3
IT ONLY TAKES A SPARK: THE HAZARD OF WILDFIRES

Prologue: The 2012 Waldo Canyon Fire

On 23 June 2012, cyclists spotted smoke and flames in a forested valley during a training ride a few miles outside of Colorado Springs (Colorado, USA). Erratic winds and what was to be the hottest and one of the driest years in many parts of the US led to the rapid spread of the Waldo Canyon Fire. By the time the fire was fully contained nineteen days later, it had led to the evacuation of 32,000 persons, cost two lives and destroyed 347 homes, the largest number in the history of Colorado. Overall, the 4,167 wildfires recorded in Colorado in 2012 caused losses of more than half a billion US dollars.[207]

What's in a Name?

Since the beginnings of human history, human beings and fire have enjoyed an intimate but uneasy relationship. While the control of fire was central to the development of human civilization, over the ensuring millennia fire has posed a constant threat to human beings and their settlements. Indeed, even though fire safety rules and regulations have steadily increased in recent centuries, approximately 2,500 persons are killed in 350-400,000 residential fires in the US each year.[208] While the number of residential fires seems to be stable or even decreasing, at least in developed countries,[209] another type of fire has gained increased attention and poses a different kind of threat: wildfires.

Uncontrolled fires originating outside of major human settlements are called wildfires, wild land fires, bushfires, forest fires, vegetation fires or peat fires, depending on the country and category of vegetation burned. In recent years, some of these fires have devastated large areas and received significant media coverage. This list includes a whole series of major wildfires in the western US in recent years; the 2009 devastating Victoria fires in Australia; the haze from Indonesian forest fires, which regularly results in a large band of smoke over Singapore and parts of Malaysia; and the 2010 forest and peat fires in Russia, which coupled with a heat wave, doubled the daily mortality rate in Moscow. In this chapter,

207 Tom McGhee, "4,167 Colorado wildfires caused record losses of $538 million in 2012," The Denver Post, 19 January 2013, www.denverpost.com/breakingnews/ci_22396611/4-167-colorado-wildfires-caused-record-losses-538#ixzz2JOM7DztZ. See also: Joey Bunch, "2 killed in Waldo Canyon Fire Identifies," The Denver Post, 5 July 2012, www.denverpost.com/wildfires/ci_21013712; DenverNews, "Video Captures Start of Waldo Canyon Fire," 29 June 2012, www.thedenverchannel.com/news/video-captures-start-of-waldo-canyon-fire

208 FEMA, US Fire Administration, "U.S. Fire Administration Fire Estimates," 7 November 2012, www.usfa.fema.gov/statistics/estimates/index.shtm

209 Relatively few reliable global comparisons on fires exist.

we discuss the hazard of wildfires, beginning with definitions, an overview of some of the largest wildfire disasters in recent years and a statistical comparison between wildfires and other types of disasters. This is followed by analysis of the relationship between wildfires and global megatrends, such as urbanization and climate change. The chapter closes with an examination of the response of governments, fire fighters and communities to the increasing threat of in wildfires.

SECTION 1
Wildfires: From Hazard to Disaster

EM-DAT defines a wildfire as "an uncontrolled burning fire, usually in wild lands, which can cause damage to forestry, agriculture, infrastructure and buildings."[210] While there are different definitions of wildfires, it is generally agreed that wildfires, whether accidentally or deliberately caused by human beings, originate outside of densely populated human settlements and that humans lose control over how the fires burn, at least for a period of time.

Compared to other kinds of hazards such as earthquakes, volcanic eruptions, floods or storms, where humans have little influence on the onset of the hazard, humans are directly implicated in causing wildfires. For example, in the US in 2011, of 74,126 recorded wildfires, 63,877 or 86.2 percent of fires were caused by humans.[211] The way in which a wildfire spreads depends on a set of factors, including topography, weather (with dry and hot conditions usually favoring the onset of fires and wind determining their spread) and fuel (the material available for the fire to burn).

More than most other hazards, human action can not only mitigate the effects of wildfires but can intervene to prevent its onset and spread. While humans stand little chance of stopping floods or landslides once they have begun, many countries have become quite adept at successfully fighting wildfires, meaning that the hazard often can be controlled before it causes a disaster. Forests and grasslands can be burned proactively to prevent uncontrolled burning. Forest areas can be cleared of dry fuel to prevent fires from starting.

Even though they are often harmful to humans, naturally occurring wildfires play an important ecological role. The process of burning returns nutrients to the soil, destroys dead or decaying matter and can also rid forests of both disease-ridden plants and insects which harm the forest ecosystem.[212]

The Food and Agriculture Organization's 2010 Global Forest Resource Assessment reports that an average of 64 countries, representing 60 percent of the global forest area, reported 487,000 vegetation fires per year during the period 2003-2007. The list was topped by

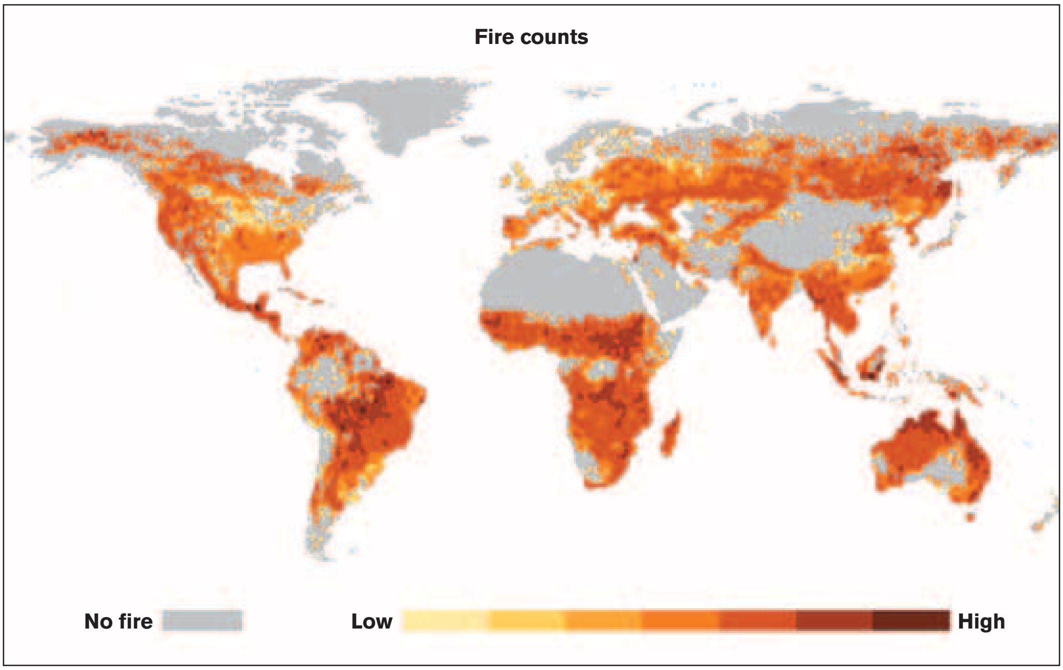
210 EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, "Glossary," accessed 25 January 2013, www.emdat.be/glossary/9

211 National Interagency Fire Center, "Lighting and Human Caused Fires," accessed 15 January 2013, www.nifc.gov/fireInfo/fireInfo_stats_lightng.html

212 National Geographic, "Wildfires, Dry, Hot and Windy," accessed 5 February 2013, http://environment.nationalgeographic.com/environment/natural-disasters/wildfires

Mozambique, the United States, Madagascar, Poland, Portugal, the Russian Federation, Spain, Argentina and Hungary, all of which reported an average of more than 10,000 fires per year. The low number of reporting countries shows that on global levels, serious data and reporting gaps on wildfires exist.

Graph 5 Number of Observed Fire Occurrence Readings from Combined Remote Sensing Products, 1996-2007[213]



In terms of the surface area burned by wildfires (including forested and non-forested areas), data from 78 countries, representing 63 percent of the global forest area, reveal that an average of just under 60 million hectares (148 million acres) of land was burned per year during the 2003-2007 period, an area approximately the size of Ukraine. The largest areas burnt were reported by Cameroon, Mali, Botswana, Chad, Namibia, United States, Ghana, Canada, Mongolia and Senegal.[214]

While globally there are a large number of wildfires, a large majority of them do not cause disasters as they do not threaten human health, lives and livelihoods. The International Disaster Database (EM-DAT), which only records disasters of a certain size,[215] reports

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213 Data from MODIS (Moderate Resolution Imaging Spectroradiometer) and ATSR (Along Track Scanning Radiometer). From Max A. Moritz, M. A. Parisian, E. Batliori, M. A. Krawchuk, J. Van Dorn, D. J. Ganz and K. Hayhoe, *Climate change and disruptions to global fire activity,* Ecosphere, June 2012, Volume 3, no. 6, Art. 49, p.11, www.esajournals.org/doi/pdf/10.1890/ES11-00345.1

214 UN Food and Agriculture Organization of the United Nations (FAO), *Global Forest Resources Assessment 2010, Main Report*, 2010, pages 75ff.

215 For an explanation see Annex I of this Review or www.emdat.be

156 wildfire disasters in the 2000-2011 period, making up only 3.39 percent of all natural disasters recorded in the database during that decade. The 780 fatalities from wildfires that the database records make up 0.07 percent of global disaster fatalities during the period. This is still more than the number killed by volcanoes (0.05 percent), but far below the number of deaths caused by earthquakes (responsible for 63.5 percent of fatalities), storms (16 percent), extreme temperatures (13.46 percent), floods (6.2 percent) and drought.[216]

To get a better picture of the scope of and challenges caused by wildfires, we look in more depth at some of the major wildfire disasters in recent years.

Table 8 Major Wildfire Disasters, 1983-2012, in Terms of Fatalities and Economic Damage[215]

Country	Date	Fatalities	Economic Damage (millions USD)
Indonesia	September 1997*	240	8,000[216]
China	May 1987	191	110
Australia	February 2009*	180	1,300[217]
Australia	February 1983	75	400
Greece	August 2007	67	1,750
Indonesia	August 1991	57	13.2
Nepal	March 1992	56	6.2
Russia	July 2010*	53	1,800
Canada	January 1989	1	4,200
United States	October 2003	4	3,500
United States	October 2007	8	2,500
Spain	July 2005	11	2,050

* See below for more in-depth information on these wildfires.

Indonesia, 1997-1998

The wildfires in 1997 on the islands of Kalimantan and Sumatra in Indonesia were the largest in the country's history. Reports indicate that a total of five million hectares (12 million acres) of land were burned of which approximately 20 percent was forested land, 50

216 EM-DAT - The International Disaster Database, accessed 31 January 2013, www.emdat.be/

217 EM-DAT - The International Disaster Database, accessed 9 October 2012, www.emdat.be/

218 The ADB provided an alternate estimate of $6,307,000. Alternate estimate from Luca Tacconi, "Fires in Indonesia: Causes, Costs and Policy Implications," Center for International Forestry Research, Occasional Paper No. 3, February 2003.

219 Estimates on land burned differ widely. Consider, for example, the 1998 survey from the European Union Forest Fire Response Group (EUFFRG), which estimates the affected land area at 2 million hectares. See: David Glover and Timothy Jessup, *Indonesia's Fires and Haze: The Cost of Catastrophe,* Singapore: Institute of Southeast Asian Studies, 1999.

percent was agricultural land and 30 percent was non-forest vegetation and grasslands.[220] The evidence suggests that many of the fires were deliberately set either to clear land for palm oil and rubber plantations or by smallholders using slash-and-burn techniques.[221] Slow-burning peat fires, which proved especially hard to extinguish, caused high levels of haze and carbon dioxide emissions. These fires took place in peat swamp forests, many of which were drained in the 1990s to be converted to agricultural production.[222] In mid-to-late November, the fires were extinguished by heavy rainfall, but reignited on Kalimantan in early 1998. Persistent and heavy haze covered the islands and surrounding region for several weeks, impacting air quality in neighboring Singapore and Malaysia.[223] Because of their impact on forests in Indonesia and the amount of carbon emitted, these fires have been described as one of the century's worst environmental disasters. (See Table 9 below for a cost breakdown by the Asia Development Bank.)[224]

Table 9 Cost Breakdown of 1997 Indonesia Wildfires[223]

Item	Cost (millions USD)
Fire-related costs	
Timber	1,839
Estate crops	319
Firefighting costs	12
Carbon emissions	1,446
Non-timber forest products	631
Buildings and property	1
Flood protection/erosion and siltation	1,767
Smoke hazard-related costs	
Health	148
Tourism	111
Transportation	33
Total	**6,307**

220 Estimates on land burned differ widely. Consider, for example, the 1998 survey from the European Union Forest Fire Response Group (EUFFRG), which estimates the affected land area at 2 million hectares. See: David Glover and Timothy Jessup, *Indonesia's Fires and Haze: The Cost of Catastrophe*, Singapore: Institute of Southeast Asian Studies, 1999.

221 J. Jackson Ewing and Elizabeth McRae, "Transboundary Haze in Southeast Asia: Challenges and Pathways forward," NTS Alert October 2012, Centre for Non-Traditional Security Studies, S. Rajaratnam School of International Studies, www.rsis.edu.sg/nts/html-newsletter/alert/nts-alert-oct-1201.html

222 Reuters, "Indonesia peat fires help fuel annual choking haze," 29 August 2007, ww.reuters.com/article/2007/08/29/idUSJAK291803._CH_.2400

223 Elizabeth Frankenberg, Douglas McKee and Duncan Thomas, "Health Consequences of Forest Fires in Indonesia," *Demography*, vol. 42, no. 1, February 2005, pp. 109-129.

224 Luca Tacconi, "Fires in Indonesia: Causes, Costs and Policy Implications," *Center for International Forestry Research*, Occasional Paper No. 3, February 2003.

225 Asian Development Bank estimate; adapted from Luca Tacconi, "Fires in Indonesia: Causes, Costs and Policy Implications," Center for International Forestry Research, Occasional Paper No. 3, February 2003, p. 8.

While the fires of 1997-1998 were by far the worst in the region's recent history, fires and deforestation continue to pose a major threat throughout the region. Especially in El Niño years, which bring drier conditions to the region and raise the risk of fires, haze has become a major bone of contention in the region. Since the 1990s, ASEAN has taken on the issue and in 2002 adopted a legally binding Agreement on Transboundary Haze Pollution which committed the parties to the ambitious task of drastically reducing forest fires in the region. While this agreement has been signed by all ten ASEAN members, so far Indonesia has declined to ratify the agreement, presumably because of concerns about sovereignty or reputation.[226] Meanwhile Indonesia has taken steps to deal with the issue unilaterally, for example by outlawing the clearing of land by burning, but capacity challenges limit the enforcement of those laws.[227]

Australia's Black Saturday Bushfires, February 2009

After two months of almost no rain and a day with temperatures of up to 115 degrees Fahrenheit (46 degrees Celsius) and northwesterly winds over 62 miles per hour (100 kilometers per hour), the worst bushfire in Australia's history occurred on 7 and 8 February 2009 in Victoria. 173 people were killed and approximately 430,000 hectares (one million acres) of land were directly affected by the fires, including 70 national parks and reserves and 3,550 agricultural facilities. Some 2,000 properties and 61 businesses were reportedly destroyed in numerous communities.[228]

Australia pursues a 'prepare, stay and defend or leave early' policy, urging people either to stay and defend a well-prepared home or to leave for a safe place well before a fire threat occurs. A study of 100 years of bushfire casualties has demonstrated that most fatalities occurred on open ground, when victims fled the flames at the last moment, rather than in homes. The February 2009 Victorian Black Saturday bushfires seriously challenged many of the assumptions behind the 'prepare, stay and defend or leave early' policy. Studies in the aftermath of the Black Saturday showed that of the 173 people who died in 2009, 113 perished inside their homes and a further 27 just outside their homes. Research showed that not only were people unaware of the fire risk or insufficiently prepared to defend their properties, but also that the extreme conditions of that day would have required a different approach.[229] The Royal Commission formed to investigate the fires called for a revision of

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[226] J. Jackson Ewing and Elizabeth McRae, "Transboundary Haze in Southeast Asia: Challenges and Pathways forward," NTS Alert October 2012.

[227] Liz Gooch, "Malaysia Haze Points to a Regional Problem," *The New York Times*, 23 June 2012, www.nytimes.com/2012/06/24/world/asia/smoky-haze-over-malaysia-signals-a-regional-problem.html?_r=0; see also: Vanda Felbab-Brown, "Indonesia Field Report III – The Orangutan's Road: Illegal Logging and Mining in Indonesia," Brookings Institution, 7 February 2013, www.brookings.edu/research/reports/2013/02/07-indonesia-illegal-logging-mining-felbabbrown

[228] Victoria Department of Sustainability and Environment, "Bushfire history – Major bushfires in Victoria," 2012, www.dse.vic.gov.au/fire-and-other-emergencies/major-bushfires-in-victoria; see also: ABC, "Black Saturday", accessed 30 January 2013, www.abc.net.au/innovation/blacksaturday/#/stories/mosaic

[229] Bushfire CRC, "Evaluation of 'Stay or Go' Policy," accessed 31 January 2013, www.bushfirecrc.com/projects/c6/evaluation-stay-or-go-policy

Victoria's bushfire safety policy, including investment in better warning systems, improved flexibility in responding to heightened risks on particularly severe days and improved bushfire safety education.[230]

Russia, July and August 2010

Hundreds of wildfires spread throughout European Russia in late July and early August 2010, stemming from record high temperatures of up to 100 degrees Fahrenheit (38 degrees Celsius).[231] Years of poor planning also contributed to the severity of the fires, as flames swept through peat bogs which had been initially drained (and not re-flooded) by Soviet engineers to provide a source of peat for electrical power.[232] The direct death toll as a result of the wildfires was recorded as 53 people, but this does not include the far higher numbers who died from smog-related effects or the heat wave itself. According to the EM-DAT, these two phenomena caused over 55,000 fatalities. Smog and heat saw Moscow's mortality rates double from the previous year.[233] The Russian Federation's health ministry reported that carbon monoxide levels climbed to more than six times their maximum permissible level, with other unspecified toxins reaching up to nine times acceptable limits.[234] Wildfire flames engulfed and destroyed more than 2,000 homes, propelling Russian authorities to dispatch 2,000 defense ministry troops and 3,000 interior ministry personnel to assist the 10,000 firefighters in suppressing these blazes.[235] More than 14 million hectares (34 million acres) of land were affected, destroying approximately one-quarter of the country's grain crop. Because of the grain losses, the government imposed a ban on exporting wheat, one of the country's main exports.[236]

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230 2009 Victorian Bushfires Royal Commission, *Final Report, Summary*, July 2010, www.royalcommission.vic.gov.au/Commission-Reports/Final-Report/Summary

231 BBC News, "Death Rate Doubles in Moscow as Heatwave Continues," 9 August 2010, www.bbc.co.uk/news/world-europe-10912658; see also: Jakarta Post, "Moscow Deaths Double Amid Smog to 700 People a Day," 9 August 2010, www.thejakartapost.com/news/2010/08/09/moscow-deaths-double-amid-smog-700-people-a-day.html

232 New York Times, "Past Errors to Blame for Russia's Peat Fires," 12 August 2010, www.nytimes.com/2010/08/13/world/europe/13russia.html?_r=2&ref=world

233 EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, www.emdat.be; see also: BBC News, "Death Rate Doubles in Moscow as Heatwave Continues", 9 August 2010, www.bbc.co.uk/news/world-europe-10912658

234 Christian Science Monitor, "Russia Wildfires: Thick, Toxic Smog Chokes Moscow Residents," 8 August 2010, www.csmonitor.com/World/Europe/2010/0808/Russia-wildfires-Thick-toxic-smog-chokes-Moscow-residents

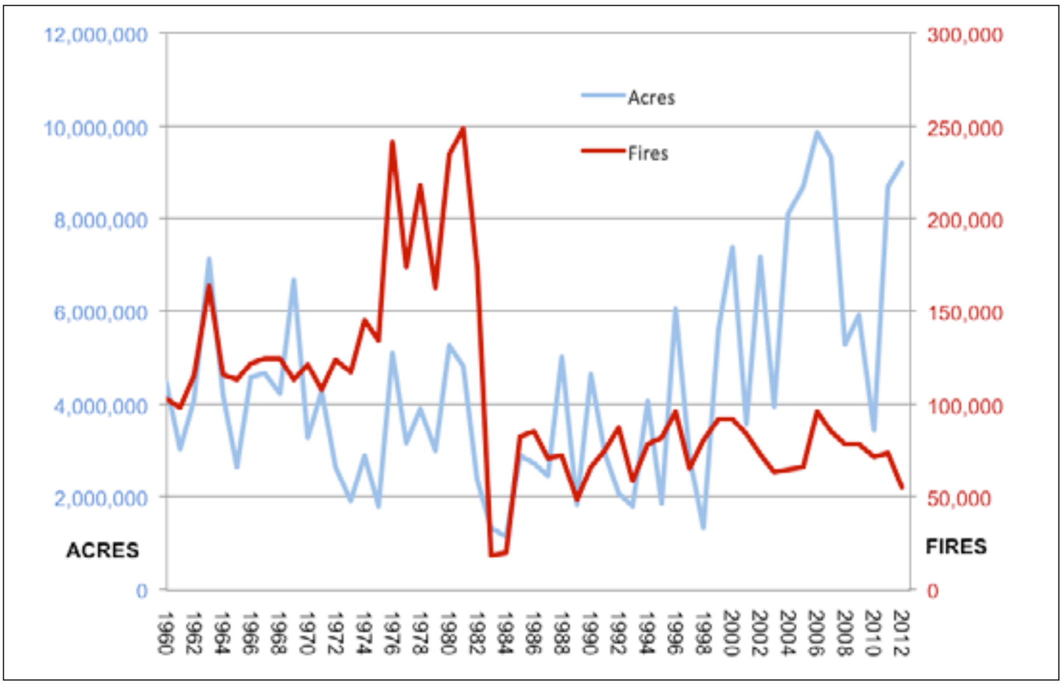
235 Al Jazeera English, "Russia Struggles with Wildfires", 3 August 2010, http://english.aljazeera.net/news/europe/2010/08/201083114931428770.html

236 IRIN, "ASIA: Unquantifiable damage caused by wildfires," 11 October 2010, www.irinnews.org/Report/90729/ASIA-Unquantifiable-damage-caused-by-wildfires; see also: International Business Times, "UN Calls for Emergency Meeting on Rising Food Prices," 3 September 2010, www.ibtimes.com/articles/49115/20100903/wheat-russia-un-fao-export-food-grain-prices-cereal-outlook.htm

SECTION 2
More Fires on the Horizon: Wildfire Trends, Urban Sprawl and Climate Change

As discussed above, while wildfires are a hazard that occurs with high frequency in many climate zones and countries, they rarely develop into major disasters. However, when they do become major disasters, they can become both deadly and expensive. In this section we look how global developments and trends, such as urbanization and climate change, affect wildfires. While it is not representative of all countries and climate zones, we focus on the example of the US to discuss some of these trends because it is a heavily exposed country in terms of wildfires and because data availability is high.

Graph 6 Wildfires and Acres Burned in the US, 1960-2012[237]



As evident in Graph 6, the overall trend in the US has been a significant decline in the number of wildfires over time, coupled with a steep rise in the acreage burned by those fires. This is due to the fact that there has been an increase in the number of larger, more extreme fires in recent years. This increase in the number of larger fires is the result of a decade-long policy of fire exclusion and suppression, which on the one hand minimized the

237 National Interagency Fire Center, "Total Wildland Fires and Acres (1960-2009)," accessed 4 February 2013, www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html

area burned during that time, but on the other hand led to the buildup of fuels, which in the long run significantly increased the fire risk and allowed larger fires to develop.[238]

Another reason for the rise in area burned is climate change. There is a strong relationship between climate change and wildfires, as climate conditions influence the availability and type of fuel, atmospheric conditions and ignitions. A hotter and drier climate in many parts of the world will lead to more favorable conditions for wildfires, while increased precipitation or desertification in other regions might actually decrease wildfire risk. Particularly in temperate regions, such as the US, the earlier onset of spring pushes the snow-melting season forward, leading to drier soils and vegetation earlier in summer. This, in turn, lengthens the dry season and leads to increased fire risk. Higher average temperatures can also lead to droughts and drier summers. Moreover, changes in precipitation and in fauna and vegetation affect the water cycle and water tables. All these factors influence wildfire patterns. For the US, especially its western parts, most models and scientists anticipate a significant increase in both wildfire probability and the potential areas at risk of burning because of a warmer climate.[239] Another effect of climate change might be the greater prevalence of harmful and invasive species, such as the mountain pine beetle. Warm temperatures in the US contribute to the rapid spread of the mountain pine beetle which is an invasive species that kills pine forests, making them more prone to wildfires.[240]

Without going into the intricacies of climate change models and the variation of their predictions, climate change science predicts major shifts in wildfire susceptibility in different regions. A recent study by Moritz et al, analyzing fire probability predicted in 16 global climate change models, shows significant differences in changes in fire probability between lower and higher latitudes. According to the study, most of the predicted increase will occur in the higher northern latitudes, while fire activity will decrease in the equatorial regions, a trend which will grow through the end of the century. However, the study also notes that there is little agreement between climate change models in the changes they project for about half of the globe.[241]

There is an interesting feedback loop between climate change and forest fires. While a changing climate leads to a higher wildfire risk in many regions, forests and wildlands also absorb major quantities of carbon emissions. Estimates show that US forests absorb between one million and three million metric tons of carbon dioxide each year, thus offsetting between 20 percent and 46 percent of the country's greenhouse gas emissions. When trees are burned or decompose, they release their carbon back into the atmosphere. Loss of

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238 Fire suppression policies developed in the early twentieth century, partly as a reaction to major forest fires in 1910. Research into the usefulness of fire for forest ecology in the 1970s led to a gradual rethinking of the suppression policy. See: U.S Forest Service, "U.S. Forest Service History," updated 26 June 2012, http://www.foresthistory.org/ASPNET/Policy/Fire/Suppression/Suppression.aspx

239 Max A. Moritz, M. A. Parisian, E. Batlliori, M. A. Krawchuk, J. Van Dorn, D. J. Ganz and K. Hayhoe, "Climate change and disruptions to global fire activity," *Ecosphere*, June 2012.

240 Josh McDaniel, "Wildfire and Beetle Kill Across the Rocky Mountains," Advances in Fire Practice Website, 2009, www.wildfirelessons.net/Additional.aspx?Page=141

241 Moritz et al., op. cit., see also: Don McKenzie, "Wildland Fire in a Changing Climate," Symposia at National Council for Science and the Environment, 13th National Conference on Science, Policy and the Environment, Washington DC, 15 January 2013, www.environmentaldisasters.net/topics/view/81494

forest and forest degradation contributes as much as 17.4 percent of global greenhouse gas emissions each year – a quantity higher than emissions from global transport. One of the major drivers of forest loss is transformation of forest to agricultural land for small and large scale agriculture and much of the forest is cleared through fire. Uncontrolled forest fires on the other hand are an important factor in forest degradation in many countries. These facts lead many to conclude that burning forests are major drivers of climate change.[242]

Peat fires release particularly large amounts of emissions into the atmosphere. This is due to the fact that peat represents a huge storage of organic materials, sometimes accumulating over thousands of years. Estimates from the 1997-98 fires in Indonesia are that while only 20 percent of the area that burned consisted of peat, fires in peat areas contributed 90 percent of the total emissions released in the disaster. In total, the Indonesian wildfires in 1997 released greenhouse gases equal to 20 to 40 percent of overall global emissions that year.[243] As more and more peat swamps are drained for land conversion purposes, the fire risk for peat areas significantly increases.[244]

Aware of the strong link between the destruction of forests and climate change, countries under the United Nations Framework Convention on Climate Change (UNFCCC) during the Thirteenth Conference of Parties in Bali (2007) agreed on a program focusing on the reduction of emissions from deforestation and forest degradation. The REDD (Reducing Emissions from Deforestation and Forest Degradation) mechanism was designed to provide incentives for developing countries to make those reductions by protecting forest areas rather than harvesting them.

The REDD mechanism was expanded to become REDD+ in the UNFCCC Copenhagen summit's Accord, which broadened the initiative to include activities in the areas of conservation, sustainable management of forests and the enhancement of forest carbon stocks to reduce emissions. The Copenhagen Accord also created multilateral REDD+ initiatives including the Forest Carbon Partnership Facility (FCPF) and Forest Investment Program (FIP) hosted by the World Bank.[245]

Under the REDD mechanism, developing countries protecting their forests have the carbon of those forests assessed and quantified and then receive compensatory financial support from developed countries.[246] In the first stage of the REDD mechanism, countries develop their 'REDD readiness,' meaning developing the technical and institutional requirements

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[242] Toni Johnson, "Deforestation and Greenhouse-Gas Emissions," Council on Foreign Relations, 21 December 2009, www.cfr.org/natural-resources-management/deforestation-greenhouse-gas-emissions/p14919; see also: The Nature Conservancy, Conservation International and Wildlife Conversation Society, *Reducing Emissions from Deforestation and Degradation (REDD): A Casebook of On-the-Ground Experience,* 2010; Gabrille Kissinger, Martin Herold, Veronique De Sy, Drivers of Deforestation and Forest Degradation, A Synthesis Report for REDD+ Policymakers, Lexeme Consulting, August 2012.

[243] Mike Flannigan, "Peat fires could accelerate climate change," Natural Sciences and Engineering Research Council of Canada, www.eurekalert.org/pub_releases/2012-02/nsae-pfc021512.php

[244] B. Langemann and A. Heil, *Release and dispersion of vegetation and peat fire emissions in the atmosphere over Indonesia 1997/1998,* Atmospheric Chemistry and Physics Discussions, 4, 2117-2159, 2004.

[245] The Forest Carbon Partnership Facility, www.Forestcarbonpartnership.org; The Forest Investment Program, https://www.climateinvestmentfunds.org/cif/node/5

[246] UN-REDD Programme, "About REDD+," accessed 31 January 2013, http://www.un-redd.org/AboutREDD/tabid/582/Default.aspx

to host REDD projects; this stage is followed by the development of REDD demonstration projects. Since 2008, a joint UNDP, UNEP and FAO REDD program supports countries to implement the REDD mechanism on issues such as measurement, reporting and verification of greenhouse gas emissions and monitoring safeguards as well as governance issues.[247]

Urbanization and Settlement Patterns

While the effects of climate change impact the occurrence of wildfires in many areas, it is human action, especially settlement patterns, which are leading to the increase in catastrophic wildfires. With the massive expansion of the wildland-urban interface (WUI), more people are simply living in harm's way. The WUI is the area where houses meet or intermingle with undeveloped wildland vegetation. It is in these areas where the protection of structures is most difficult and where human-caused fires are most common. The WUI in the US covers about 9 percent of the country's territory and 39 percent of all housing units in the US are located at the WUI.[248] Similar trends are observed in other regions of the world, such as southern Europe.[249]

The trend of increasing urbanization goes hand in hand with the rise in the number of houses destroyed by wildfires each year. The average number of structures lost in wildfires in the US has increased dramatically since the 1990s. In the 1960s, the average number of houses lost per year was 209; in the 2000s it had increased more than tenfold to 2,872. 2011 saw a peak with the destruction of 5,850 structures.[250] As urbanization is a global megatrend, with more than half of the world's population living in urban areas since 2008, many countries may encounter similar challenges of managing the cohabitation of human beings and nature in areas of urban sprawl.[251]

The expansion of both the WUI and the areas affected by wildfires in the United States have led to a massive increase in wildfire suppression costs. While annual fire suppression costs were around $400 million in the 1970s, these costs rose to $1.4 billion in the 2000s, with a peak of $1.8 billion in 2007. This means that the percentage of the US Forest Service's total budget devoted to fire suppression has increased from 13 percent in 1991 to 48 percent of the budget during the 2009 fiscal year. Most of the funds have been spent on a small number of very large fires.[252] The fact that fighting fires consumes such a high percentage of the agency's budget means that other tasks – such as managing forests and preventing wildfires – get short shrift.

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247 For more information see: UN-REDD Programme, "The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries," http://www.un-redd.org/

248 V. C. Radeloff et al, "The Wildland-Urban Interface in the United States," *Ecological Applications,* vol. 15, no. 3, 2005, p. 799.

249 European Environmental Agency, "Analysing and managing urban growth," 25 January 2011, www.eea.europa.eu/articles/analysing-and-managing-urban-growth

250 Karen Warnick, "Wildfire Forum – 2011 lessons learned, 2012 prediction, community protection," Arizona Insurance Council, 24 April 2012, www.azinsurance.org/WMI2012WFForum.html

251 UNFPA, "Urbanization: A Majority in Cities," accessed 28 February 2013, http://www.unfpa.org/pds/urbanization.htm

252 Timothy Ingalsbee, *Getting Burned: A Taxpayer's Guide to Wildfire Suppression Costs,* Firefighters United for Safety, Ethics, & Ecology, August 2010, p. 7.

UNITED STATES Fires and smoke in Georgia and Florida. Photo: © Thinkstock.com

UNITED STATES Smoke from the Waldo Canyon Fire in Colorado Springs. Photo: © Laura Gangi | Dreamstime.com

SECTION 3
Fight Fire with Fire: Concluding Thoughts

> *"When we develop somewhere, the planning process should do a risk assessment for a range of things including flood, sea level rise and bushfire. My argument is that what people need to do is not a risk assessment based upon the climate they have been observing, but a risk assessment of what the climate is projected to be in 2050 or 2100."*[253]
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> —**David Karoly**, Climatologist, Head of Victoria Government's climate change advisory group

Wildfires are a complex phenomenon and as they occur in almost all vegetation zones and on all continents, the challenges faced by different countries and communities are diverse and manifold. No other natural hazard is more connected to human behavior as evidenced in the many ways that humans shape, reshape, foster and destroy their habitats. From indigenous farmers, who use slash-and-burn agriculture to feed their families, as their ancestors did for millennia, to palm-oil producers torching primary forests to expand their plantations, from city dwellers who want to live in a green and forested suburb even though it is at risk of wildfires, to the hiker who throws away a burning cigarette – all are shaping the profile of global wildfire risk.

Statistically, the likelihood of an individual human being getting killed by a wildfire is fairly negligible, but the human and material costs from wildfires have been increasing in recent decades. Given that climate predictions suggest that developed countries in temperate regions will face increased risk from wildfires, it is likely that economic damages from wildfires will rise substantially in the coming decades. Moreover, there is a strong argument that perhaps the most significant cost of wildfires is not the material losses they cause or the price of fighting them, but the impact that wildfire emissions have on climate change. While scientific debate continues about the exact amount of carbon emissions caused by wildfires, recent studies estimate that fires in the US release about 290 million metric tons of carbon dioxide each year. At the 2011 rate of $9.20 for a ton of sequestered carbon, offsetting these emissions would cost a staggering $2.6 billion. In comparison, the REDD global carbon market in 2011 was estimated to be worth $237 million.[254]

At the same time, it is important to recognize that wildfires fulfill an important ecological role in natural systems and stopping them completely would be both impossible and harmful. Mechanisms are thus needed to manage the hazard of wildfires which take into account human safety and human forest economy, as well as forest ecology, habitat conservation

253 Adam Morton, "Climate change must be 'a factor' in deciding whether to rebuild," The Age, 11 February 2009, www.theage.com.au/national/climate-change-must-be-a-factor-in-deciding-whether-to-rebuild-20090210-83l5.html#ixzz2JOnikFrR

254 Ecosystem Marketplace, "Forest Carbon Prices Doubled in 2012," 2 November 2012, www.ecosystemmarketplace.com/pages/dynamic/article.page.php?page_id=9399&section=news_articles&eod=1; see also: National Science Foundation, "U.S. Fires Release Enormous Amounts of Carbon Dioxide," Press Release 07-163, 31 October 2007, www.nsf.gov/news/news_summ.jsp?cntn_id=110580. On overall emissions from deforestation see: Nature, "Scientists publish consensus statement on deforestation emissions," 4 December 2012, http://blogs.nature.com/news/2012/12/scientists-publish-consensus-statement-on-deforestation-emissions.html

and climate change mitigation and adaptation. In many cases practices to reduce the risk of catastrophic wildfires and to protect communities from the risk of fires are already well-known. Progress is also being made in managing sustainable forests and providing incentives for conservation rather than the destruction of forest and wildland areas.

Forest and Wildfire Management

Forest management experts have developed a range of proposals on how to more effectively manage wildfires in an era of climate change. US experts, for example, have proposed increasing landscape and biological diversity, detecting and eliminating invasive species and improving watershed management and planning on larger scales. In terms of adapting to climate change, they propose strong partnerships between scientists and resource managers to figure out the best adaptation responses for forest and wildland ecosystems. They also propose treating large fires as an opportunity to develop management plans for what happens after the fires and implementing early detection and rapid response mechanisms to deal with fires at an early stage. The experts also suggest significantly more investment in treating fuels and more prescribed burning of forests under safe conditions.[255]

More, but smaller, wildfires would cause less damage to both forest ecology and human beings as they are less costly, easier to contain and less intensive, thereby allowing better regeneration of forests. But preventing fire through prescribed burnings is not uncontroversial as even prescribed fires can get out of hand, leading to evacuations and property loss.[256] Prescribed fires also cause smoke and haze, which is at minimum a nuisance and often poses a serious health hazard to people living close to the area of prescribed fires. For those reasons, local officials are usually not ardent supporters of managing fire risks through prescribed burning. Colorado Governor John Hickenlooper, for example, suspended the use of such burns in March 2012 after a prescribed fire destroyed dozens of homes near Denver.[257]

On the international level, the UN Food and Agriculture Organization has developed Fire Management Voluntary Guidelines which are aimed at assisting countries in developing an integrated approach to fire management, from prevention and preparedness to

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[255] Fuel treatment reduces the amount of burnable materials in a forest by removing dead vegetation and trees, especially at the ground level and/or thinning out the forest. This leads to less intense forest fires.

Jeremy S. Littell et al, *U.S. National Forests adapt to climate change through Science-Management partnerships,* Climatic Change, 5 February 2011; see also: David L. Peterson et al, *Responding to Climate Change in National Forests: A Guidebook for Developing Adaptation Options,* US Department of Agriculture, Forest Service, November 2011; David L. Peterson, "Wildland Fire in a Changing Climate," Symposia at National Council for Science and the Environment, 13th National Conference on Science, Policy and the Environment, Washington DC, 15 January 2013.

[256] See for example: The Denver Channel, "Prescribed Burns Getting Out Of Control Not Unheard Of: At Least 5 Wildfires In Colorado Last Year Started As Planned Burns," 28 March 2012, www.thedenverchannel.com/news/prescribed-burns-getting-out-of-control-not-unheard-of

[257] Fox News, "Colorado governor suspends prescribed burns after deadly wildfire destroys homes," 28 March 2012, www.foxnews.com/us/2012/03/28/colorado-governor-suspends-prescribed-burns-after-deadly-wildfire-destroys/#ixzz2K8hf56Mu

suppression and restoration. The guidelines suggest that 'good fires' should be advocated and supported and that fire regimes should assist in maintaining sustainable, properly functioning ecosystems. In other words, attention should be paid not only to the damage and destruction caused by fires but also to the underlying ecological and social causes of fire.[258]

It is also significant that climate change negotiations have addressed the crucial role of forests in the global ecosystem, especially with respect to the global carbon balance. While still controversial, particularly evidenced in the critique that it would lead to commodification of forests and further violations of the rights of indigenous peoples and local communities, REDD+ is starting to fulfill an important function by supporting developing countries to reduce emissions and sustainably manage forests. To counter some of the criticism it has attracted, REDD+ has sought to develop safeguards to protect the rights of stakeholders, particularly indigenous groups.[259] It is too early to judge how successful the program will be over the long term and whether it will be able to slow deforestation and forest degradation on a large scale, but even with these uncertainties, the engagement of a wide range of actors, from governments to development actors and civil society, has fostered important research and discussion around issues of climate change mitigation through sustainable forestry and wildland management.

Dealing with Risk

As discussed above, one of the main reasons for the increase in wildfire disasters has been the ongoing encroachment of human settlements into wildland areas. Most of the costs in fighting fires stem from protecting human settlements from wildfires. In many cases in the developed world, people who lose their homes are either insured or receive government assistance to rebuild their houses. While wildfires have not led to a situation comparable to flood insurance, where private insurers in the US have declined to provide coverage and the federal government had to step in, a rise in wildfire damage would raise the distinct probability that the public could end up subsidizing people who build in risky areas. While there is a need for a wider societal discussion on who should bear the risks of settling in potentially vulnerable areas, certain steps could help to lessen the exposure and losses from wildfires:

- Zoning: Authorities should restrict building in the most vulnerable areas or at least urge people who want to build in high risk areas to carry a certain amount of the risk, by either compelling them to purchase insurance policies and/or to take stringent fire mitigation measures.

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258 FAO, "Forest and other vegetation fires," 27 March 2012, www.fao.org/forestry/firemanagement/en; see also FAO, *Fire Management Voluntary Guidelines,* Fire Management Working Paper 17/E, 2006, www.fao.org/docrep/009/j9255e/j9255e00.htm

259 Climate Justice Now, "REDD-plus decision further shapes actions on forests," 22 December 2012, www.climate-justice-now.org/%E2%80%9Credd-plus%E2%80%9D-decision-further-shapes-actions-on-forests/

- Risk mapping: Fire risk maps should be publicly available and fire risk should be clearly communicated to community members so they can make informed decisions about where to build. Risk mapping should be informed by the latest science on climate change's impact on wildfires. As this is difficult for small communities, collaboration is needed between communities, national governments and scientists to develop risk maps for high risk areas.

- Mitigation: People living in high-risk areas should be pushed or incentivized to invest in fire mitigation measures, using fire retardant materials and mitigating fire risk in vulnerable neighborhoods. In the US, some insurance companies evaluate houses' wildfire risk and threaten to drop homeowners' policies if owners do not improve the fire safety of their houses. Specific mitigation measures might be rewarded with discounts on insurance rates.[260]

  Special attention should be paid to safeguarding plants, businesses and research facilities that deal in dangerous and hazardous materials. During the 2010 Russian wildfires, one of the issues was the risk of spreading nuclear fallout from the 1986 Chernobyl nuclear disaster through the wildfires.[261] In the US in 2011, raging wildfires in New Mexico forced the evacuation of the nuclear lab at Los Alamos.[262] Facilities with a certain risk profile should not be built in high wildfire risk areas and if they are already there, stringent wildfire safety and contingency plans need to be created and enforced. Inhabitants need to be informed of secondary and cascading risks stemming from wildfires through such facilities and authorities need to develop contingency plans for the probability of such cascading effects.

- Public education and information: As Australia's policy shows, defending a house is a possible option, but this needs technical training and information for those living in fire-prone areas as well as warning systems that clearly indicate when defense is not advisable. Public education about evacuation procedures, routes and emergency shelters should also be a standard procedure in wildfire-prone areas.

- Particularly in countries that will experience higher risk of wildfires in the future, discussion is needed about the risks to firefighters' health and life. In 2011, 61 firefighters were killed on duty in the US (the ten-year average is 91), seven of them while fighting wildfires.[263] Not every building or structure might be worth saving when firefighters' lives are on the line.

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260 Bankrate.com, "Wildfires spark home insurance preconditions," 25 June 2012, www.bankrate.com/finance/insurance/wildfires-spark-home-insurance-preconditions.aspx; see also: CNN, "The next battle for wildfire victims: Insurance," 25 October 2007, http://money.cnn.com/2007/10/23/news/companies/california_fires/index.htm

261 Time Magazine, "Fallout from Russia's Fires: The Ashes of Chernobyl?" 19 August 2010, www.time.com/time/world/article/0,8599,2011860,00.html#ixzz2KK4CRYwa

262 New York Daily News, "New Mexico wildfires force evacuation at Los Alamos nuclear laboratory," 27 June 2011, www.nydailynews.com/news/national/new-mexico-wildfires-force-evacuation-los-alamos-nuclear-labratoryarticle-1.129481#ixzz2KK56VZm2

263 National Fire Protection Association, "Firefighter Fatalities in the United States, 2011," accessed 4 February 2013, www.nfpa.org/publicJournalDetail.asp?categoryID=2603&itemID=57591&cookie%5Ftest=1

More Data, More Research

Researching the phenomenon of wildfires makes it clear how limited data on wildfires are compared to data on other natural hazards. While there seem to be numerous initiatives to strengthen data and reporting on wildfires globally, most notably through remote sensing (which helps to track the number of fires and the amount of area burnt) there is little comprehensive data about economic costs of wildfires and their broader effects, such as on health.

Given that climate change will change fire risks and patterns in many countries, the scaling down of climate models for regional and local areas is particularly important for the coming decades, as is research on how forest management and communities in fire-prone regions can adapt to climate-triggered changes in wildfire hazards.[264] Donor countries should support research and data collection in developing countries and foster learning and exchange to promote sustainable forest management around the globe.

As forests and wildlands in many countries lose out against food and agricultural production or resource extraction, there is an ongoing need to study best practices in sustainable forest use and forest conservation. For example, in examining biofuels, research is needed on how developed economies' sometimes misguided green policies and consumption patterns can have a diminishing footprint on forests and wildlands in developing countries, many of which are burned for the benefit of those who put more greenhouse gasses in the atmosphere than the average person in a developing country.

Wildfires are one of the most complex natural hazards as they closely interrelate with human activity and agency. Many solutions for intelligently dealing with wildfires (using them when needed and preventing them when necessary) already exist, but given the massive challenges there is a need to scale-up effective interventions and to more proactively and effectively share information about what works in managing wildfires. Both urbanization and climate change will lead to major shifts in wildfire risk around the globe. Urban planners and municipal policymakers must consider wildfire risk in planning settlement patterns. Because of the strong interlinkages between forests and climate change, managing wildfire risk is also part of both climate change mitigation and adaptation policies.

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[264] Downscaling climate data is a strategy for generating locally relevant data from Global Circulation Models (GCMs). The overarching strategy is to connect global scale predictions and regional dynamics to generate regionally specific forecasts. For more information see: University of British Columbia, "Downscaling Climate Data," climate-decisions.org, accessed 12 February 2013, www.climate-decisions.org/2_Downscaling%20 Climate%20Data.htm