A local resident battles wildfire in Portugal.

PHOTO: GLOBAL MEDIA GROUP/SIPA USA/NEWSCOM

Edited by **Jennifer Sills**

Agricultural policy can reduce wildfires

Last year, once again, forest fires took their toll in southern Europe. In Portugal alone, at least 500,000 ha were burned, 100 people were killed, and 500 houses were lost (*1*, *2*). As in most Mediterranean countries, wildfires raged mainly through abandoned farmland that has turned into forests and shrublands.

Agriculture is an important driver of European wildfires. It is a major source of fire ignitions (*3*, *4*). Additionally, farmland abandonment and policies promoting forestry increase fire hazard, as they lead to vegetation growth and fuel build-up in the landscape (*5*). However, agriculture is also part of the solution. Agricultural areas, such as crops, orchards, and grasslands, are much less fire-prone, particularly if they include irrigated crops (*5*, *6*). The European Union's Common Agricultural Policy (CAP) is a powerful financial instrument that can contribute to sustainable environmental management and climate change adaptation. The vision for CAP, recently proposed by the European Commission (*7*), addresses natural hazards from climate change, including fire, but focuses on farmers and their crops.

The CAP should assume a larger role in reducing fire hazard by addressing four priorities. First, CAP should foster the maintenance or reintroduction of extensive livestock grazing in areas prone to abandonment. Second, CAP should promote agricultural use in the wildland-urban interface, mainly around villages in remote areas where the historical surrounding agricultural area has been lost, resulting in vegetation succession and an increased risk of economic damage and loss of human lives, as fires enter villages. These agricultural belts can passively protect urban areas and valuable infrastructures, in addition to facilitating both firefighting operations and the suppression of fire ignitions. Third, CAP should decrease fire ignitions by regulating the burning of crop residues, the use of fire by shepherds in mountain ranges, and the use of agricultural machinery during the dry season. Fourth, CAP should promote adequate forest management in high–fire risk areas, including protecting and restoring open woodland vegetation (such as wood pastures), giving preference to agro-forestry over dense tree plantations, restoring the use of understory biomass as bio-energy to avoid accumulation of flammable material, and selecting native, less fire-prone, tree species in forestry [such as native oak species instead of pine or eucalyptus (*5*, *8*)].

Megafires are mostly driven by weather conditions (*9*), and with climate change we should anticipate an increase in their frequency and impact, especially in southern Europe (*10*). The current strong investment in fire suppression, in a context of farmland abandonment, results in increased fuel loads and potential for larger future fires (*11*). The European agricultural policy should instead balance fire suppression with nature-based solutions. Multifunctional, fire-resilient, mosaic landscapes can maintain both natural and cultural assets and serve to reduce fire intensity and damage when burned.

Francisco Moreira[1,2]* and Guy Pe'er[3,4,5]
[1]CIBIO/InBIO, University of Porto, 4485-601, Vairão, Portugal. [2]CEABN/InBIO, School of Agronomy, University of Lisbon, Tapada da Ajuda, 1349-017, Lisboa, Portugal. [3]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, 04103, Leipzig, Germany. [4]University of Leipzig, 04109, Leipzig, Germany. [5]UFZ–Helmholtz Centre for Environmental Research, 04318, Leipzig, Germany.
*Corresponding author. Email: fmoreira@cibio.up.pt

REFERENCES

1. S. Gómez-González *et al.*, *Environ. Sci. Pol.* **81**, 104 (2018).
2. "Portugal fires burn 520,000 hectares, nearly 60 percent of EU total" *Reuters* (2017); www.reuters.com/article/us-portugal-fire-area/portugal-fires-burn-520000-hectares-nearly-60-percent-of-eu-total-idUSKBN1CN2F4.
3. A. Ganteaume *et al.*, *Environ. Management* **51**, 651 (2013).
4. F. X. Catry, F. C. Rego, F. L. Bação, F. Moreira, *Int. J. Wildland Fire* **18**, 921 (2009).
5. F. Moreira, *J. Environ. Management* **92**, 2389 (2011).
6. S. Oliveira, F. Moreira, R. Boca, J. San-Miguel-Ayanz, J. Pereira, *Int. J. Wildland Fire* **23**, 620 (2013).
7. European Commission, "The future of food and farming: Communication from the Commission to the European Parliament" (European Economic and Social Committee and the Committee of the Regions, 2017).
8. F. Moreira, P. Vaz, F. Catry, J. Silva, *Int. J. Wildland Fire* **18**, 563 (2009).
9. P. M. Fernandes, A. M. G. Barros, A. Pinto, J. A. Santos, *J. Geophys. Res. Biogeosci.* **121**, 2141 (2016).
10. W. M. Jolly *et al.*, *Nat. Commun.* **6**, 7537 (2015).
11. R. D. Collins, R. de Neufville, J. Claro, T. Oliveira, A. P. Pacheco, *J. Environ. Management* **130**, 1 (2013).

10.1126/science.aat1359

Rethinking wildfires and forest watersheds

In December 2017, wildfires burned large swaths of southern California, dramatically ending an already destructive wildfire season in the United States. The 2017 wildfire season burned more than 3.9 million hectares in the United States, the third-most area burned in 1 year since 1960 (*1*). The largest of the fires, the Thomas Fire in Ventura County, CA, burned more than 1140 km^2, including thousands of structures, forcing more than 100,000 residents from their homes (*2*).

The devastating impacts of the most recent wildfire season are consistent with the trends of increasing occurrence of large wildfire activity, longer wildfire durations, and longer wildfire seasons that have been evident since the mid-1980s (*3*). Similar trends of increasing wildfire activity have occurred elsewhere in the world, including

Canada, Australia, and regions of South America, Eurasia, and Africa (*4*). Given that Earth's climate continues to warm and that historical land use and fire suppression activities have resulted in dense forests that provide fuel for fires, these accelerating trends are projected to continue into the foreseeable future (*5*).

The costs associated with fighting these large wildfires now account for more than half of the U.S. Forest Service annual budget. Even before the December wildfires, 2017 was the most expensive year on record, with costs for wildland fire suppression exceeding $2 billion (*6*). However, the full economic costs of wildfire should also consider expenditures associated with preparedness, property losses, health care and loss of human life, tourism, and damage to the natural resource base. The true costs of the fires are likely 2 to 30 times as high as the reported suppression costs (*7*).

Counterintuitively, the threats and costs once fires are contained may be more disastrous than the fire itself. The secondary threats of wildfires to water supply are particularly concerning, as almost two-thirds of municipalities in North America receive their drinking water from forested areas (*8*). Key threats include increased potential for erosion, landslides, debris flows, floods, and introduction of contaminants to streams, with potentially catastrophic implications for community infrastructure, drinking water treatment, public health, and aquatic ecosystem health (*9*).

Given the rising threats and costs associated with the current wildfire trend, we must change the way we manage both wildfires and forested watersheds. For example, the use of prescribed fire or fostering of fires that burn more frequently and under less extreme conditions can improve forest resilience and reduce the magnitude and longevity of effects (*10*). These land-use activities, especially in forests near communities, have potential to substantially reduce impacts if they are strategically located (*11*). However, it is not economical or feasible to protect all forests through active forest management. As such, it is critical to continue to develop and use the tools we have to produce maps that identify locations and times (e.g., early warning systems) of high fire risk, which can guide our policy and management efforts. Such efforts should also integrate and focus on areas that are critical for provision of a freshwater supply, to protect water resources for healthy aquatic ecosystems and human populations downstream (*12*).

Kevin D. Bladon
Oregon State University, Corvallis, OR 97331, USA.
Email: bladonk@oregonstate.edu

Canada's iconic wilderness includes Bow Lake and Crowfoot Mountain in Banff National Park.

REFERENCES

1. National Interagency Fire Centre, "Total wildland fires and acres (1960–2016)" (Boise, ID, 2017).
2. CAL FIRE, "Thomas Fire" (Sacramento, CA, 2018).
3. A. L. Westerling, H. G. Hidalgo, D. R. Cayan, T. W. Swetnam, *Science* **313**, 940 (2006).
4. W. M. Jolly *et al.*, *Nat. Commun.* **6**, 7537 (2015).
5. M. D. Flannigan, M. A. Krawchuk, W. J. de Groot, B. M. Wotton, L. M. Gowman, *Int. J. Wildland Fire* **18**, 483 (2009).
6. U.S. Department of Agriculture, "Forest Service wildland fire suppression costs exceed $2 billion" (Washington, DC, 2017).
7. L. Dale, "The true cost of wildfire in the western U.S." (Western Forestry Leadership Coalition, Lakewood, CO, 2009).
8. Committee on Hydrologic Impacts of Forest Management, "Hydrologic effects of a changing forest landscape" (The National Academies Press, Washington, DC, 2008).
9. K. D. Bladon, M. B. Emelko, U. Silins, M. Stone, *Environ. Sci. Technol.* **48**, 8936 (2014).
10. C. S. Stevens-Rumann *et al.*, *Ecol. Lett.* **21**, 243 (2018).
11. D. M. J. S. Bowman *et al.*, *Nat. Ecol. Evol.* **1**, 0058 (2017).
12. F.-N. Robinne *et al.*, *Sci. Total Environ.* **610-611**, 1193 (2018).

10.1126/science.aar8120

Invest long term in Canada's wilderness

Increasing global demand for Canada's resources is eroding the country's iconic wilderness, intact ecosystems, and rich megafaunal diversity (*1*, *2*). To meet its 2020 commitments to the United Nations Convention on Biological Diversity (CBD), Canada must protect 17% of its terrestrial area and 10% of its marine area (*3*); currently, only 10 and 1%, respectively, are protected (*4*). Polls suggest that 87% of Canadians support increased landscape protection (*5*). On 8 January, 116 Canadian politicians called for a historic $1.4 billion in government funding to conserve Canada's exceptional wilderness and biodiversity between 2018 and 2020, with $470 million per year to support efforts after 2020 (*3*). This investment is essential to enact the land and water protection Canadians want. We support this call to action.

However, even if Canada meets its CBD commitment to protect 17% of its terrestrial area, wildlife conservation will fail if Canada neglects the other 83%, which will remain unprotected. In western Canada, 35% of the provincially managed landscape has been affected by industrial activity (*6*). These effects are gradually compromising the persistence of many high-profile species, including the grizzly bear, caribou, elk, wolverine, and mountain goat (*6*). The growing threats to Canada's functional ecosystems are not matched by increasing funds to manage and conserve wildlife and habitats. Funds provided to wildlife management agencies in western Canada pale in comparison to neighboring jurisdictions and are in decline (*7*). We strongly urge provincial governments to honor their promise to address this wide funding deficit (*8*) to ensure the effective management and conservation of Canada's species outside protected areas.

Canadian governments have a responsibility not only to their citizens, who overwhelmingly support conservation, but also to the world as stewards of 24% of the planet's remaining wilderness (*2*). Increased investment in both protected and unprotected areas is vital to safeguard Canada's immense wilderness and wildlife capital.

Clayton T. Lamb,[1]* Marco Festa-Bianchet,[2] Mark S. Boyce[1]
[1]Department of Biological Sciences, University of Alberta, Edmonton, AB T6G 2E9, Canada. [2]Université de Sherbrooke, Sherbrooke, QC J1K 2R1, Canada.
*Corresponding author. Email: ctlamb@ualberta.ca

REFERENCES

1. M. Hebblewhite, *Biol. Cons.* **206**, 102 (2017).
2. J. Allan, O. Venter, J. Watson, *Sci. Data* **4**, 1 (2017).
3. W. Amos *et al.*, "Support for a historic investment in protecting Canada's land, freshwater, and ocean" (2018); http://wamos.liberal.ca/wp-content/uploads/sites/1508/2018/01/EN_Final-letter-with-signatories-Budget-2018-1-1.pdf.
4. Environment and Climate Change Canada, "Canadian environmental sustainability indicators: Canada's protected areas" (2017); www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=478A1D3D-1.
5. Earnscliffe Strategy Group, "National conservation survey" (2017); http://earnscliffe.ca/wp-content/uploads/2017/11/National-Conservation-Survey.pdf.
6. N. Shackelford, R. J. Standish, W. Ripple, B. M. Starzomski, *Cons. Biol.* 10.1111/cobi.13036 (2017).
7. R. Archibald, D.S. Eastman, R. Ellis, B. Nyberg, *J. Ecosyst. Management* **14**, 1 (2014).
8. "British Columbia to increase investment in wildlife management," *BC Gov News* (2017); https://news.gov.bc.ca/14367.

10.1126/science.aat1104

Rethinking wildfires and forest watersheds

Kevin D. Bladon

Science **359** (6379), 1001-1002.
DOI: 10.1126/science.aar8120