

Will the Desert Darken Your Door?



The desert has crept up on the town of Kolmanskop in Namibia. Credit: iStock.com/javarman3

Forests, while providing economic and recreational services, contribute to the climatic and hydrologic regulation of the landscape. Although fires are natural phenomena that contribute to the shaping of forest ecosystems, climate change exacerbates the threat of wildfires [Westerling, 2016]. A 2016 study reported that the burnt area in the northwestern United States expanded by almost 5,000% in the first decade of the 21st century relative to the years 1972–1983 [Abatzoglou and Williams, 2016].

Since records have existed, Earth's temperature has increased by more than 1° [Intergovernmental Panel on Climate Change, 2013]. However, temperature rise is just one of the many factors influencing wildfire risk. An add-on danger comes from extreme weather events, whether droughts or heat waves, earlier or later in the season in many regions of the world [Stott, 2016].

For example, in Spain, July temperatures in 2017 rose 3° above the average. Rains, when they arrive, are frequently late, sporadic, and torrential. Anomalous high temperatures, combined with recurrent and intense droughts, wreak havoc in the Mediterranean regions worldwide by extending the fire season to late autumn months.

Spain's drought, of course, triggered wildfires in the Iberian Peninsula. Similar droughts and wildfires have swept Mediterranean regions and burned unprecedented expanses of California, central Chile, South Africa, and elsewhere. In Iberia alone, the fires killed hundreds of people and displaced thousands of households in what Portugal's prime minister António Costa described as his country's "greatest human tragedy in the living memory."

Such linkages between drought and wildfires are well studied. But emerging research shows that there is more to that connection. The continuing and expanding cycle of wildfires may rapidly perpetuate arid conditions, transforming once lush landscapes into deserts before our very eyes.

Sound dramatic? It's happening right now, as you read.

Wildfire-Triggered Tipping Points

A discovery that has long intrigued ecologists is that ecosystems can quickly flip states of equilibrium [Scheffer *et al.*, 2001]. Wildfires are devastating environmental perturbations that can surpass evolutionary processes to keep pace with the rapidly changing conditions in the physicochemical and biological environ-

ment. And their effects can push ecosystems toward a critical tipping point of catastrophic loss of species and productivity.

The history of the Earth system indicates that abrupt environmental changes do occur. Just 5,500 years ago, giraffes, hippos, lions, and antelope roamed lands lush in vegetation and vast wetlands that today constitute the largest desert on Earth. However, the termination of this "green period" was abrupt, and within decades to centuries, the Sahara tipped to today's state of extreme aridity [deMenocal *et al.*, 2000].

Conceptual and empirical models of northern Africa support the existence of alternative stable ecosystem states [Brovkin *et al.*, 1998]. Right now, the ecosystem is in a "desert" system state with low precipitation and absent vegetation. But scientific evidence suggests that the region could maintain a "green" system state with moderate precipitation and permanent vegetation cover similar to what scientists know existed in the past. So how did northern Africa get to the state it is in today?

Although scientists attribute such transformations to natural climate change, the changes are most likely exacerbated by a terrestrial-atmospheric feedback loop of enhanced albedo and dust entrainment via excessive grazing and fire feedback mechanisms [Wright, 2017]. Such feedback mechanisms not only may reduce forest resilience but also can push the system closer to a point of irreversible damage [Runyan *et al.*, 2012]. And now the lone and level sands stretch far away.

Anthropocene's Collateral Damage

Mounting scientific evidence forecasts that environmental changes could be abrupt and, once certain limits are crossed, irrevocable. As in the history of the Sahara, the current massive destruction of forest and vegetation cover may well be the tipping point toward desertification and the deterioration in the quality of ecosystems and human life. Deforestation may lead to an increase in fire frequency, which in turn may inhibit the regrowth of forest vegetation [Hoffman *et al.*, 2003].

So how do we as a society realize that the costs of inaction on climate change are infinitely more expensive than those of prevention? It seems like an uphill battle: Throughout their brief history of life on Earth, humans have found that damaging the environment is far swifter than ecosystem recovery.

We live in the Anthropocene, when 7.5 billion humans have a common stake in the health of this planet. Hippocrates said that the greater the evils are, the more vigorous the remedy is. As this is our era, we should harness our numbers to fix it.

Some regions are doing just that, with ambitious projects to tackle desertification. India has shown the strength of cooperation as more than 1.5 million volunteers planted 66 million trees in just half a day, and similar planting efforts have been carried out in the Atlantic forest of Brazil and inner Mongolia [Runyan and D'Odorico, 2016].

We should take the spirit of those projects and amplify it to restore our historically degraded environments. The challenge of fires is shared across the landscape, so government plans should work in partnership with local organizations, private land managers, and stakeholders. Colleges, universities, agencies, and nonprofits should focus on restoring native forests and replacing fast growing invasive tree plantations that increase the risk and severity of wildfires [Martinez-Harms et al., 2017].

It is no longer enough to appease our consciences by turning off the lights for 1 hour on World Environment Day or recycling or biking to work. We, collectively, must do more to actively repair the damage we have wrought.

Fight Catastrophe Fatigue

Today citizens may be weary of the catastrophic messages of scientists who predict ecological collapse. When faced with leaders who insist on believing that life is eternally resilient or become dazzled by globalized technology as the solution or simply flat out reject science, it's easy for the public to sink into indifference.

To fight this indifference, we as scientists need to show people the damage that's happening around them—not in some far-flung corner of the world or at an imperceptible



California wildfires on 5 December 2017. Credit: MODIS on NASA's Terra satellite

molecular level in the atmosphere. We need to show them what's happening in their backyards, in their parks, around their schools. Landscapes are fundamentally altering as one wildfire season bleeds into the next.

Such alteration is something that people can see and touch and breathe [Moritz, 2012]. The tangible nature of this consequence of climate change may be vital to getting people to care. And once they care, perhaps they'll take action to recover our native forests, before the ash and desert dust darken future generations' doors too.

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