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PERSPECTIVE

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Tree planting: A double-edged sword to fight climate change in an era of megafires

The world's forests are one of the largest carbon sinks, making a substantial contribution to counterbalance the increase in atmospheric carbon from anthropogenic sources (Bastin et al., 2019). For this reason, there is broad support to forest conservation and restoration as an effective way to fight climate change. The European Union, following the Green Deal roadmap towards a decarbonization of the economy, has committed to ambitious habitat restoration goals in particular those with the most potential to capture and store carbon. These include, for example, planting three billion trees by 2030 in its recently adopted Biodiversity Strategy. Here, we argue that these policies entail important challenges associated with fire risk, being a commonly overlooked risk (e.g., Anderegg et al., 2020), that needs to be carefully evaluated when deciding where and how to restore forests across Europe. This is especially relevant under the combined effects of climate-related factors (such as prolonged droughts or weather conditions that favor fire) and increasing high-intensity fires in productive-forested ecosystems, already evident in the Mediterranean basin, but also increasingly important in other areas of the planet.

Forest conservation and restoration are not only beneficial for climate mitigation but also for other ecosystem services, such as soil retention or timber production, conservation of biodiversity and cultural values (FAO & Plan Bleu, 2018). Forest conservation and management also promote local economies through direct and indirect job opportunities, such as seed collection and cultivation, plantation of seedlings, timber harvesting and ecotourism (FAO & Plan Bleu, 2018).

But not all that glitters is gold behind restoring forests for climate mitigation, and there are voices claiming that the increase in forest cover could have undesired effects on climate mitigation itself (e.g., through changes in albedo; Anderegg et al., 2020) and derive social and ecological impacts if promoted as a simple and rapid solution to counterbalance greenhouse gas emissions (Holl & Brancalion, 2020). For example, broad-scale reforestation might cause the loss of other habitats of conservation importance, such as low-intensity farming systems of high ecological value, spread of invasive species and pests and reduce water availability (Holl & Brancalion, 2020). There are also social impacts behind unplanned reforestation, leading to farmers' displacement from traditional lands (Holl & Brancalion, 2020). However, even the most ecological-driven options, such as afforestation through secondary succession, are not risk free.

An important, but still not commonly discussed, concern when assessing the potential impacts of reforestation strategies for climate mitigation is the increasing wildfire hazard (but see Fady et al., 2021). Larger and more connected forested areas could lead to landscapes that are more prone to fire and difficult to manage. This is especially the case when forests are promoted in areas where future climatic conditions will be sub-optimal leading to plant stress or when planting fast-growing species (e.g., Pinus or Eucalyptus) in high-density stands that will increase fuel availability and fire intensity potential (Veldman et al., 2019). Moreover, the effectiveness of traditional fire risk prevention measures through fuel-reduction practices, such as mechanical thinning or grazing, is questioned in these novel emerging flammable landscapes (Wintle et al., 2020). The increase in fire risk is especially relevant in a context of climate change, with dry-spell periods and extreme fire weather conditions becoming more common across larger areas of Europe extending toward Northern latitudes, where current risk fire is lower (Figure 1).

Although fire is a key ecological disturbance driving ecosystem dynamics, functioning and biodiversity worldwide (Kelly et al., 2020), the increasing frequency of the so-called megafires poses new challenges for environmental and health protection never faced before. Indeed, in the last years, we have witnessed an increase in the prevalence of these large fires and how they override the current firefighting systems, posing an increasing threat to health, the economy and biodiversity (Wintle et al., 2020), and significantly contributing to increase carbon emissions globally. Planting more trees or letting forest regrow naturally could, therefore, have unexpected costs and counterproductive consequences not only for climate mitigation but also for society and biodiversity. This would be the case for large areas across EU where there is high potential for forest restoration (considering climate, edaphic and topographic variables; Bastin et al., 2019), but where future projections of weather conditions also point toward a large increase in wildfire hazard (e.g., Northern Spain and Portugal, Southern France, Southern Germany and Austria or the Balkans; Figure 1). Is it then worth the risk, or should we invest in alternative climate-smart options more resilient to fire?

In this context, restoration efforts for climate change mitigation in regions where fire and other risks could cancel out the benefits of forest restoration and must target a more balanced range of alternatives. For example, wetlands restoration or recovery of grasslands can contribute to climate change mitigation while also promoting fire-resilient landscapes (Moreira & Pe'er, 2018). These alternatives also help counterbalance the loss of habitats of conservation concern that have suffered a steep decline over the last decades due to land abandonment and forest expansion

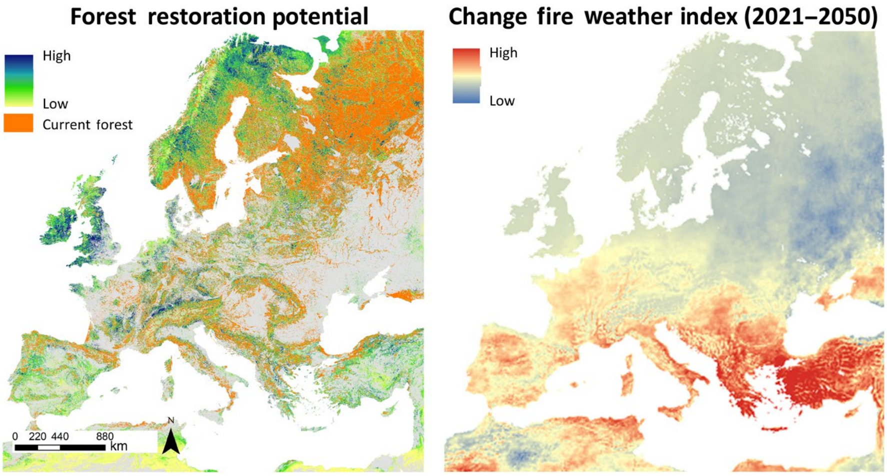

FIGURE 1 Projected Fire Weather Index (FWI) under the high-emissions RSP 8.5 scenario by 2050 and Forest Restoration Opportunities (FRO). Note that many areas across Mediterranean Europe with high forest restoration potential are areas where the FWI is projected to increase the most in the coming decades, and larger continuous forested areas could also appear across other regions in central and northern Europe, with increasing fire risk. The change in FWI represents difference in the FWI between 2021 and 2050. The FWI is calculated as the sum of the daily fire weather index over the European fire season divided by the total number of days within this date range. Values (non-dimensional) have been averaged for six different models under RSP8.5 scenario. The higher the index value, the more favorable the meteorological conditions to trigger a wildfire are. The FRO represents the suitability of currently unforested areas to hold forest under future climatic conditions. Values show the tree coverage potential within each 1 km resolution pixel [Colour figure can be viewed at wileyonlinelibrary.com]

and maintain traditional and cultural practices and landscapes. Moreover, investing in restoration of these other habitats also suits drier and more fire-prone regions, like the Mediterranean, where forest productivity is water-limited and generally low, making tree planting a doubtfully effective option for climate mitigation (Strassburg et al., 2020).

In summary, forest restoration either by planting trees or allowing natural recovery will undoubtedly contribute to the global strategy of mitigating climate change impacts. However, the increase in fire risk associated with this strategy in a climate change context must be acknowledged and considered when deciding where and how to invest in forest restoration. The issues exemplified here at the European scale apply to other regions of the planet equally committed to restoring forest habitats, and under similar fire risk. For example, early target proposals for the Convention on Biological Diversity to be agreed in 2021 include the restoration of 350 million hectares of the World's deforested and degraded land. Globally, priority should be given to areas that have been under higher deforestation pressure over the last decades, or where investment will be more effective such as the Tropics (higher carbon sequestration rates; Strassburg et al., 2020), and always keeping in mind that forest restoration (or any other habitat) cannot substitute the reduction of direct emissions of greenhouse gases to fight climate change.

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DATA AVAILABILITY STATEMENT

Forest Restoration Potential (Bastin et al., 2019); Fire Weather Index (https://cds.climate.copernicus.eu/#!/home).

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