



Book Review

Fire science: from chemistry to landscape management

By Francisco Castro Rego, Penelope Morgan, Paulo Fernandes, and Chad Hoffman
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This is a comprehensive book that covers almost all aspects of wildland fire. Indeed, the authors write ‘Our book is about both fire behavior and fire effects AND how they are linked’. The book is organised in three large sections that includes (1) Combustion and Heat Transfer Processes, (2) Fuels, Fire Behavior and Effects, and (3) Managing Fuels, Fires, and Landscapes.

The Combustion and Heat Transfer section begins with what is needed for ignition, defines flammability, and provides appropriate examples related to wildland fuels. The chemistry of fire is explored from atoms to larger fuels, including smoke production. Most sections in the Heat Transfer and Processes section include an interactive spreadsheet (provided in online supplementary materials) where the reader can explore how changing different inputs (weather, slope, etc.) impacts the outcome of the various processes. These spreadsheets are a great idea and will allow people to better understand challenging concepts. Maybe in the next edition R scripts can be provided along with the spreadsheets to do these calculations.

Many figures are excellent in presenting key information such as Fig. 6.2 that depicts different fuel layers and specific fuel types, Fig. 6.4. that presents different fire types and their spread characteristics, and Fig. 6.5 that has an actual flame with all flame dimensions identified. These figures and others included in the book are great teaching and learning aids.

In the Fuels, Fire Behavior and Effects section the authors do a good job of condensing major points such as predicting fire behavior, writing ‘A limitation of current approaches is in the ‘engine’ of the systems. For example, US modeling tools rely on the basic equations developed by Rothermel (1972), based on the conservation of energy principle with empirical adjustments. No explicit reference to heat transfer

mechanisms is made in these approaches’. They also provide rules of thumb that would be of interest to a large number of people such as ‘the (fire) rate of spread doubles for every 10 degree increase in terrain slope’.

The book has a large section on extreme fires, that is not common in textbooks. With the occurrence of such type of fires increasing globally, this information should be of interest to a broad group of readers. The authors provide some interesting examples including how mass fires can be created in Australia writing that ‘some types of eucalypt bark (from trees called stringybarks) are easily torn off tree stems by strong convection currents generated in fires, but the bark pieces are too heavy to travel far. The bark embers generated can produce concentrated short distance spotting (less than 100 m), allowing for a mass fire or firestorm effect if ember density is enough’. Such conditions can be created in many other places across the globe (California, southern Mediterranean Europe) where introduced *Eucalyptus* species grow next to the wildland–urban interface. Extreme fires have been primarily tied to extreme weather events associated with global climate change and alterations in fuel types and load associated with fire and land management practices. The book discusses these important points and allows the reader to better understand fire and global change.

Books are challenging to publish since science continues to move forward but a book always has a publication date. One area that the book discusses is ‘How much high severity fire is natural or desirable’ and that this has been ‘debated’ by both fire scientists and fire managers. The science of this topic related to frequent-fire adapted forests has recently been summarised in two important papers (Hagmann *et al.* 2021; Hessburg *et al.* 2021; both published after the release of this book). While some people will continue to debate this

topic in the media, the science is clear and these papers provide the evidence on how much forests have changed and what can be done to conserve them into the future.

One area where the book could have included more materials is Indigenous cultures and fire. There is some text under the Learning from Traditional Practices and Scientific Knowledge section plus a nice case study titled 'Indigenous Cultural Burning and Fire Stewardship' written by F. Lake, M. Huffman, and D. Hawkins. In this case study the authors write 'Whereas western science knowledge has strength in reduction reasoning, traditional knowledge has strength in seeing phenomena as holistically interconnected'. Western science has a great deal to learn from Indigenous cultures regarding the stewardship of fire-adapted ecosystems.

The authors are to be commended in writing the section on Social Changes: New Challenges and Opportunities. This is an important section that calls out past and continued discrimination and harassment of women in the fire management and fire science fields. There is a long history of injustice and abuse in institutions that surround fire. While attention to this topic has increased recently, much more needs to be done.

The authors do a very good job of describing fire as an ecological process and the importance of heterogeneity when they write 'Describing fire regimes is challenging for several reasons. First, it is difficult to characterize a fire regime with a single metric, and we must consider variability. Variability is often more important than the mean or median'. Too often we have been happy with average characteristics when describing fire's impacts on landscapes, the book provides excellent reasons why we need to go beyond this perspective.

The case studies included in the Managing Fuels, Fires, and Landscapes section are excellent and need to be highlighted. These studies integrate many of the concepts that are covered in the book. The vegetation types covered are diverse and include forests, tropical savannahs, shrublands, woodlands, and grasslands, from the US, Australia, South Africa, and France. The case study from Florida should be required reading for anybody in the US and elsewhere interested in building a prescribed fire program in forests or woodlands. It provides information on how this region has been successful regarding fuels treatments and the reduction of wildfire area. It also includes a summary of policy developments that were critical to this program including the 1990 Florida Prescribed Burning Act. The authors included text showing that private and public land managers burn in late winter to spring with between 900 and 1900 prescribed burns per month. This is a mature program that gives hope

to other areas interested in increasing prescribed fire. The case study of the Mediterranean woodlands and forests in Western Australia is also inspiring to people working to develop such programs around the world and the work in the US Great Plains may be surprising to some people who have not heard of this very large and successful program.

The last case study that I will mention is 'Integrated Fire Management: Landscape Fire on the Payette National Forest in Idaho'. The authors describe their work to create a larger program in the Rocky Mountains and provide keys to success regarding implementing forest restoration and fuels treatments writing 'There will always be a reason not to move forward, there will always be hurdles to overcome, and there will always be a risk of failure. Success requires ... hiring people with drive and grit, and facilitating an environment where planners and implementers are not afraid to fail'. I applaud this perspective in what it will take to move forward to increase ecosystem resilience and the services that they provide.

I have been teaching fire ecology and fire behaviour classes at multiple universities for more than 20 years. This book would be very good for such classes and also helpful to anybody that wants to learn more about wildland fire. We have a great deal of work to do in many areas related to fire worldwide. Castro Rego, Morgan, Fernandes, and Hoffman say this well when they write 'We hope that you too will find beauty, possibility, and the means to make a difference in fires'.

S. Stephens

Professor of Fire Science, Henry Vaux
Professor of Forest Policy, Department of
Environmental Science, Policy, and
Management, UC Berkeley
Email: sstephens@berkeley.edu

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Conflicts of interest. The authors declare no conflicts of interest.