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Fire in the Environment: The Ecological, Atmospheric, and Climatic Importance of Vegetation Fires, edited by P. J. Crutzen and J. G. Goldammer. Dahlem Workshop Environmental Sciences Research Report ES 13, John Wiley & Sons, 1993, 400 pp., US $170.00 (ISBN 0-471-93604-9).

THIS IS a remarkable book, both for its interdisciplinary scope and for its vision and courage in attempting to understand and predict the diverse consequences for the global environment of burning vegetation. Not until well into the 1970s was the subject raised seriously, then especially by Paul Crutzen who realized that accelerated deforestation of the tropics was probably having a global impact on atmospheric chemistry, global air quality, and climate. Since then the subject's many facets have been explored by ecologists as well as by atmospheric chemists and climate specialists. In this book Crutzen and Goldammer present the latest thinking of this diverse group of scientists in a Dahlem Workshop Report. The participants, principally from the fields of ecology, forestry, and related life sciences, represent academic and research institutions in the USA (18), Germany (11), France (5), Brazil (2), Canada (2), South Africa (2), Australia (1), Italy (1), Sweden (1), UK (1), and Zimbabwe (1).

Framing the book's seventeen chapters of background papers are a lead chapter on the scientific rationale of fire in the environment and four reports that express the consensus of subgroups of eleven or twelve participants on characteristics of fire, impacts on the atmosphere and on ecosystems, and the role of humans in changing the nature of fires around the world. Fire has always been a natural process on which ecological health depends, although sometimes with drastic consequences such as at the K/T boundary 65 million years ago when major wildfires were rampant. About 1.5 million years ago early man "discovered" fire and has been applying it to his purposes ever since. As long as human-caused fires were few and small compared to natural fires, the environmental consequences were temporary and sustainable. However, in most parts of the world today vegetation fires set by mankind have become more important than natural fires. Those associated with deforestation in the tropics are a prime example. But what about wildfires in forests that are contaminated with toxic chemicals or radioactive debris, such as around Chernobyl? Accurate forecasts of these and a myriad of other future scenarios or consequences present a major challenge. The Dahlem Workshop Report is a major step in bringing together experts in a wide range of disciplines to meet this challenge.

To say "where there is smoke there is fire" greatly oversimplifies biomass burning or the problem of quantifying characteristics of vegetation fires. After carefully considering the problem and our grossly inadequate knowledge base, it is proposed to design a "vegetation fire information system" in which separate data bases are organized into a geographic information system that embraces vegetation parameters and meteorological data. Since the laboratory for fire research is more likely to be the real world rather than experiments of burning under controlled conditions, especially for large fires, satellite observations can be used to trigger initiation of a fire model in which modular components may be called up so as to produce fire-related parameters for a particular spot on Earth. Results from a series of fire events can then be integrated statistically, and the model tested for general validity. Is such a system too elaborate for such a simple thing as a fire? Not according to the Dahlem Workshop consensus, especially when the importance of fire, now mainly human-induced, is realized and all facets of fire-related phenomena are recognized.

To what extent is biomass burning already changing atmospheric chemistry, climate, and biogeochemical cycles on a global scale? Some trace gases are rising in air concentration, notably tropospheric ozone, probably as a secondary reaction product of combustion gases. Areas covered with smoke are increasing, especially in South America, and can be seen from spacecraft. Smoke is an aerosol containing a variety of biologically important trace elements as well as soot carbon. Such an aerosol can affect the earth's radiation balance, cloud cover, and climate. For more quantitative assessments, networks of measurements need to be strengthened and modeling efforts intensified.

Key aspects of the impacts of fires on ecosystems are fire-related spatial patchiness, difficulty in prediction of fires and their impacts, various feedbacks between vegetation and fires, and the long-term effects of fires on fluxes of carbon, nitrogen, and phosphorus. In contrast to atmospheric chemistry, where much attention is being directed to global scale effects, ecologists focus on many scales, from quite small to very large, and on the variability or patchiness within ecosystems. Impacts of rare high-intensity fires may differ markedly from those of frequent small fires. Natural ecosystems of vegetation and fauna have always depended on fires, with numerous feedbacks, and either human-induced or human-prevented fires can disturb their balance. The effects of fire on availability and transport of nutrients may be profound, although much is yet to be learned. Future research should emphasize long-term field experiments, especially with high-intensity fires, in which regional or global scale researchers take advantage the expertise of ecosystem-level specialists.

The role of humans in shaping fire regimes has been increasing steadily since 1.5 million years ago, especially in the past few centuries of expanding European culture and at a greatly accelerated rate in the industrial period since 1850. Mankind burns vegetation for a variety of reasons, some of which are constructive, in order to maintain ecosystem processes and protect resources, but others are often destructive, including clearing land, extracting resources, and conducting warfare. Governments can provide incentives either to protect or to destroy forests, an issue especially important in tropical countries today. Extensive collaboration between social, biological, and physical sciences will be needed to formulate effective fire policies at all spatial scales from local to global.

The consensus reached among experts, outlined above, and the seventeen in-depth position papers that support it make this book a "must read" for geoscientists and others concerned about guiding future human activity toward sustainability in the global environmental system in which we live. In our use and misuse of fire this guidance will especially be needed in the years ahead.

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