Chapter 6
Satellite Observation of Biomass Burning
Implications in Global Change Research

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Abstract Biomass burning, which involves wildland fires as well as agricultural and grassland burnings, plays a critical role in the environmental equilibrium of our planet, since it is a major driving force in land cover transformations and contributes significantly to greenhouse gas emissions. Several satellite missions provide critical information required to better understand the temporal and spatial distribution of biomass burning. Satellite images provide objective and comprehensive information on global patterns of fire occurrence, as well as data on factors affecting fire ignition and propagation. Recent improvements in spatial, temporal, and spectral resolution of satellite remote sensing systems reduce past uncertainties – systems can now be used to obtain a more precise evaluation of burned areas and post-fire effects on soils and plants. Greater efforts are required to operationally use Earth Observation data in fire prevention and early warning. Longer time series data are required to acquire a better understanding of fire regimes, and their mutual relationships with global warming.

6.1 The Role of Fire in Global Change Analysis

Fire is a natural process driving landscape transformation for many terrestrial ecosystems, which are adapted in one way or another to recurrent burning. Fire has positive and negative effects on soil, water, vegetation and the atmosphere, the review of which are outside the scope of this text. Figure 6.1 presents a general scheme on which aspects of biomass burning might be considered at global-scale, by identifying the uses of fire by human beings, the effects of fire on environment and society, and the main factors driving global fire activity.

Fire results in the transformation of dead or senescent vegetation into its mineral components, providing a short-term pulse of key nutrients that facilitate vegetation regrowth. Intentional setting of fire is a common practice in savanna areas of Africa or South America, where millions of hectares are burned annually to remove unpalatable grasses and to promote the growth of fresh grass for grazing (Van Wilgen 1997). In forested areas, fire aids in stand thinning, the clearing of understory vegetation, and promotes vertical stratification of the forest canopy. As a result of these
positive feedbacks, natural fire regimes provide a common framework for species succession (Johnson and Miyanishi 2001; Omi 2005).

However, fire has also been used historically as a clearing tool for land use transformation, removing trees from forested areas for agricultural or grazing purposes. These transformations may be perennial or cyclical, depending on the type of agricultural practice in place. For most tropical countries, shifting cultivation has been the traditional form of farming (Spencer 1966). This regime is based on using fire to remove forest cover while fertilizing the land by providing N and other nutrients to mineral soils. After a few years, yields are reduced as a result of intense rainfall that results in leaching of nutrients from soils and soil erosion. As a result, farmers need to move to another forested area to start a new cycle, and from there on to another one, until they return to the original location in 30 to 40 years. In recent decades, these cycles have been shortened, as a result of a more intense land use, and therefore the crop production is increasingly degraded. Reduced agricultural yields, in turns, increases poverty and migration to urban regions.

The use of fire for permanent land cover change has been historically associated with movements of the agricultural frontier, as it was evident in the temperate forest of North America during the eighteenth and nineteenth centuries (Pyne 1995). Currently, the conversion of forested to agricultural or grazing areas is mainly occurring in tropical forests. Deforestation is one of the main factors to take into account in global carbon budgets, since they affect large areas (Houghton et al. 1985), and accounts for a significant proportion of total greenhouse emissions: 26% for carbon dioxide, 48% for methane and 33% for nitrous oxide has been estimated from deforestation processes (Houghton 2005). The relation between fire and deforestation, both complete clearing and selective logging, has been well documented (Cochrane et al. 1999; Skole and Tucker 1993; Souza et al. 2005).

For industrialized societies, the opposite trend has been observed, since land abandonment has occurred over the past century, as a result of changes in economic

Fig. 6.1 Framework for analysis of biomass burning at global scale