Ignitions for Peat Fires in Indonesia: A Critical Look

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Fires in the peatlands of Kalimantan and Sumatra in Indonesia are significant sources of greenhouse gases (GHG). Ignitions for these fires are widely regarded as occurring because of land clearing associated with palm oil and timber production and smallholder agriculture. The scale of peat forest degradation has led to intra- and inter-governmental, academic, and NGO efforts to monitor, document and reduce GHG emissions. Laws and policies are emerging as a result of these efforts. However, naming broad economic reasons for fire use in peatlands is inadequate for formulating land management policies and for implementing programs to reduce GHG emissions from peatlands. A more detailed understanding of the biophysical conditions and human activities associated with peatland fires is needed.

GHG emissions depend on the amount and type of fuel that is consumed and on how it is burned (Stockwell et al. 2014, 2016). Monitoring and documentation of GHG emissions is limited by the failure to adequately distinguish between surface fires that consume predominantly woody and herbaceous fuels via flaming combustion versus peat fires that consume organic soil and buried wood predominantly via smoldering combustion. Depending upon a suite of environmental conditions, peat consumption can vary by orders of magnitude if and when surface fires transition into burning peat soils. Once established, peat fires can persist for weeks, initiating new surface fires whenever relative humidity and wind are favorable.

From a fire environment perspective, i.e., the union of weather-climate, vegetation-fuels, and terrain-hydrology, it is critical to understanding the surface fire-ground fire continuum and how this plays out on the peat-swamp landscape. Fire is a rare occurrence in pristine peat-swamp forests due to the lack of fine, dry surface fuels and the high peat moisture content. However, as the degree of degradation increases, both surface fuels (principally ferns, graminoids, sclerophyllous shrubs, and non-woody litter) and organic soil (figs. 1A, B) become increasingly susceptible to burning (Graham et al. 2014; Siegert et al. 2012). Unlike the pristine forest, the degraded peat swamp is highly heterogeneous with varying surface fuels, concentrations of woody debris, and micro relief that affect fire potential. Our observations suggest that people have a good sense as to when fire will spread as a function of the vegetation-fuels, relative humidity and wind. It is common to see recently burned areas with well-defined boundaries borders, as well as people igniting fires during mid-day optimum conditions. However, many fires are ignited without clear boundaries borders and become unregulated, free-burning fires. Once ignited, surface fire spreads as long as there are continuous fine fuels that are dry enough to burn. In degraded peat-swamp forests, afternoon relative humidity and wind commonly favor surface fire spread during the dry season (Usup et al. 2004) (fig. 2). These fires wander haphazardly across the landscape. They often spot across roads and canals. Surface ignition of peat from embers has been observed (figs. 1C, D). While it was found in

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Figure 1—Surface characteristics of degraded peat (A-D). Dry, cracked and fissured peat and exposed rotten wood form favorable conditions for peat fire initiation (A, B). Ember-initiated spot fire in degraded peat roughly 50 meters from an active surface fire (C, D). (Photos by Kevin C. Ryan, March 5, 2014, Riau, Sumatra).

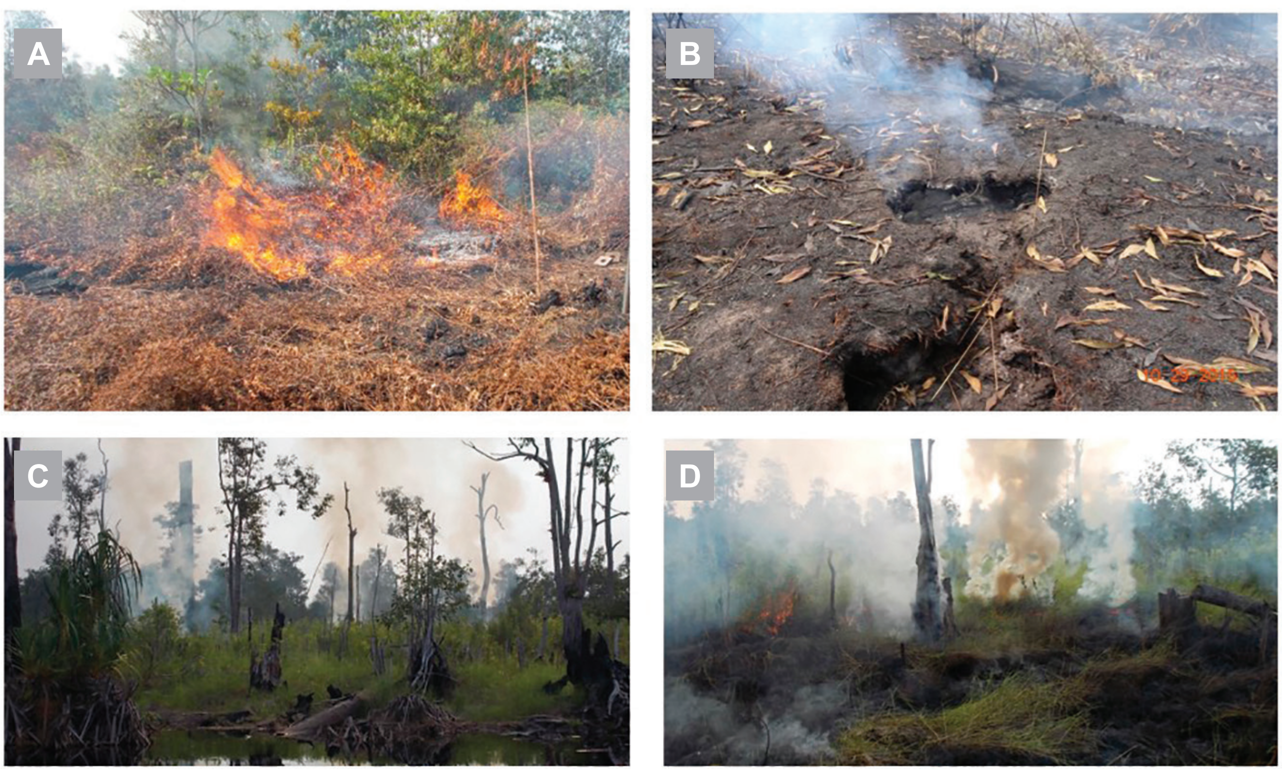

Figure 2—Surface fire–ground fire transition dynamics (A-D). Surface fire ignited by smoldering peat (A). Minimum surface fire spread rates exceed 100 times maximum ground fire smoldering rates. Thus, areal coverage by fire is dominated by surface fuel conditions. Surface fires ignite ground fuels preferentially through rotten, partially buried wood, cracks and fissures, and root channels (B). Once established, they provide “hold-over” ignition sources for adjacent surface fuels (A). Transitions commonly occur on a diurnal cycle during the dry season (C, mid morning – B, mid afternoon) but sustained smoldering combustion has been observed (kcr) eight weeks into the rainy season and intense nighttime flaming is commonly observed during droughts. (KFCP file photo, Central Kalimantan).

some Central Kalimantan studies (Usup et al. 2004) that surface vegetation fires burning in slashed grass did not transition to ground fires, our observations indicate that such transitions do commonly occur in other fuels, typically leading from surface fires to smoldering combustion in the peat as a result of the ignition of partially buried and decayed wood. Ground fires reemerge as surface fires whenever relative humidity and wind favor flaming combustion (fig. 2A). These fires (fig. 2B) can persist for weeks and may not self-extinguish until the water table rises as the rainy season develops. The flaming-smoldering transition dynamics are easily observed (figs. 2C, D) but remain to be rigorously documented. The process confounds fire detection, for example, via multiple, same-pixel MODIS hot-spot detections, and fire causation investigations. Given the scope and complexity of the fire problem, i.e., the sheer number of fires and their remoteness, the fire management organization in Indonesia, currently lacking the capacity to effectively suppress fire, limits actions to 'point protection' of rural homes.

To be successful, programs to reduce emissions from peatland fires must: 1) recognize the diverse human activities and objectives associated with fire use which, in addition to those mentioned above, include: asserting land-rights and improving access and habitat for hunting and fishing; 2) accept that some of these activities may be difficult to regulate because of being transient and occurring in remote locations; and 3) recognize that not all ignitions in and around peatlands lead to sustained peat fires. A better understanding is needed of not only the human activities associated with the ignitions, but also their timing, locations, methods, and the biophysical conditions under which they occur.

In accord with the preceding paragraph, our research, carried out in a peatland area of Central Kalimantan over an extended period, identified a wide array of human actions involving fire use in and around peatlands. In addition to ignitions for agricultural land clearing, which tend to be confined mainly to mineral soils and shallow-peat areas close to human settlements, we found numerous instances of ignitions in or close to deep-peat areas for such purposes as setting vegetation on fire to facilitate access to salvageable logs or fishing grounds or to provide fresh browse to attract deer and other game. Unlike the agriculture-associated ignitions that have a fairly predictable spatial and temporal distribution based on such factors as land tenure, soils suitability, and the seasonal "window" for land preparation early in the dry season, ignitions for the other purposes identified by us in degraded peat areas are transient, ephemeral, widely scattered, and, accordingly, less conspicuous. Such ignitions are less amenable to management, and, in accord with this, fire management, policy, rhetoric, and even research have been biased to focus primarily on the use of fire in agriculture and to neglect other uses that may result in peat fires.

To illustrate the operation of this bias in research, we cite here an article by Gaveau et al. (2014). The authors claim that most fires in their 2013 study area in Riau in Sumatra were for the purpose of agricultural land clearing, but they do not support their claim with any data resulting from observations of actual ignitions and their consequences. Instead they write, "Burn locations [within plantation concessions partially occupied by smallholders] suggest ignition by both communities and companies." This suggestion is followed by the assertion that "most fires are lit in order to prepare land for cultivation," (p. 5), citing Murdiyarso et al. (2010). But the cited article is a general review of GHG emissions from tropical peatlands, not specific to the study area in Riau. Nor does the review by Murdiyarso et al. (2010) cite any empirical studies of how peat fires start or of how surface fires spread—the distinction between causes of the start of fires and causes of their spread being a significant one (cf. Vayda 2006, emphasizing this point for fires in tropical moist forests). Rather, the authors of the review write, "land clearing by fire was *assumed* to be part of the land management system," (emphasis added); and "After clearing the forest, the land is prepared for cultivation, and fire is often used," (Murdiyarso et al. 2010, p. 19658). Even if we accept the general statement that fire is often used for agricultural clearing in tropical peatlands, that is not the same as saying that most peatland fires start from land clearing for agriculture or, even more unjustifiably, that most peatland fires transitioning from surface fires to underground peat fires start with ignitions for land clearing. Nevertheless, many have accepted these unjustified notions as conventional wisdom not requiring any further direct, evidentiary support even in specific cases where fire causes and burning methods are ostensibly of interest (see, for example, Harrison et al. 2009; Page et al. 2009; and Someshwar n.d.). Far from bearing out these notions, a recent remote-sensing study by Cattau et al. (2016) concluded that only 1-2 percent of the tens of thousands of fires detected by the MODIS satellite from 2000 through 2010 in a 2.5 Mha study area in Central Kalimantan peatland were fires that started either within oil-palm concessions or within 5 km of settlements and their nearby farms.

The difficulties in implementing a policy of fire control in peatlands by means of controlling fires from the sort of transient, ephemeral, scattered, and less conspicuous ignitions described by us argue for a policy that gives less priority to fire suppression and instead devotes more effort and resources to restoring the pre-agricultural hydrology and vegetation that made the peatlands previously much less vulnerable to fire than they are today. We therefore welcome the recent regulatory actions taken by the Indonesian government to initiate a policy of peatland protection, rehabilitation, and sustainable management (Mongabay 2015).

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