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INDEPENDENT STRATEGIC ANALYSIS OF AUSTRALIA'S GLOBAL INTERESTS

Strategic Analysis Paper

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Global Wildfires, Carbon Emissions and the Changing Climate

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Key Points

- Wildfires release considerable quantities of carbon into the air when they burn vegetation and are an important factor inflating the global burden of carbon emissions.
- Worldwide, fires burn an estimated 350 to 450 million hectares of forest and grassland every year. This is equivalent to around 3.85% of global land area.
- Carbon emissions from all sources of fire amount to between 2 and 4 billion tonnes each year, about half of those from fossil fuel combustion.
- Carbon emissions from fires create a feedback effect on the climate. Fires release carbon and other GHGs, causing temperatures to rise faster and higher. This further dries out forests and creates conditions that increase the likelihood of fire.
- Changing land-management techniques in savannah and scrubland could dramatically decrease the risk of large, carbon emitting fires, reducing the global GHG burden.

Summary

As the UN Framework Convention on Climate Change (UNFCCC) enters its final week in Warsaw, nations are struggling to agree on mechanisms to encourage reductions in fossil fuel emissions and halt the progress of potentially catastrophic changes to the global climate. A factor rarely considered in these climate talks and in emission reduction strategies is the greenhouse gas (GHG) contribution of wildfires. Every year, wildfires ravage an area of the planet larger than India, rapidly releasing huge pulses of GHGs into the atmosphere. Deforestation-related fire is an important factor inflating the global burden of carbon

emissions and climate change. In recent years there has been a rise in the global incidence of large, uncontrolled fires which is expected to accelerate in the future as a result of rising global temperatures and changing precipitation patterns. While wildfires are a global scale environmental process, they are also heavily influenced by human land-management decisions. Changing land-management techniques in savannah and scrubland could dramatically decrease the risk of large, carbon emitting fires, reducing the global GHG burden. This paper will provide an overview of current global wildfire carbon emissions and consider future projections and impacts.

Analysis

Wildfires act as a biological filter, regulator and global vegetation consumer and have a crucial function in in many ecosystems; however, they also accelerate the world's natural carbon cycle in a manner that increases the burden of global warming. As forest or peat fires devour trees, vegetation and other biomass, they release the carbon and other trace gases stored in the vegetation into the atmosphere. Every year, more than 8 per cent of biomass produced is consumed by wildfires.

For a natural system in a steady state, the CO_2 released by a fire will be reassimilated by photosynthesis over the ensuing period of regrowth and won't contribute to atmospheric carbon variations in the long-run. However, where additional changes to the ecosystem are occurring – such as conversion to agricultural land-use, changing fire regimes, or altered precipitation patterns – the carbon stocks in the biomass and soil can change, resulting in a net loss of CO_2 to the atmosphere.

In addition to carbon emissions, wildfires also release an abundance of other trace gases into the atmosphere. Biomass burning is an important source of carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O), volatile organic compounds and particulate matter. Black carbon aerosols, in particular, may be the factor with the second strongest effect on global warming after CO_2.

Around the world, the majority of fires are caused by humans except in remote regions like boreal forests and treeless tundra. Ignition patterns are dominated by grazing management and agricultural practices. When mapping global wildfire patterns it can be difficult to distinguish between naturally occurring wildfires, accidentally lit fires, and agricultural fires and control burns. Agricultural fires often burn larger areas than wildfires, particularly across Sub Saharan Africa and South America. With different grazing and land management practices, these fires and the carbon emissions they release could be largely avoided.

The global incidence of wildfires

Worldwide, fires burn an estimated 350 to 450 million hectares of forest and grassland every year. This is equivalent to around 3.85 per cent of global land area (not including Greenland and Antarctica). As seen in the time-lapse NASA satellite images of global fires between 2000 and 2012, different regions of the world have distinct seasonal fire patterns.

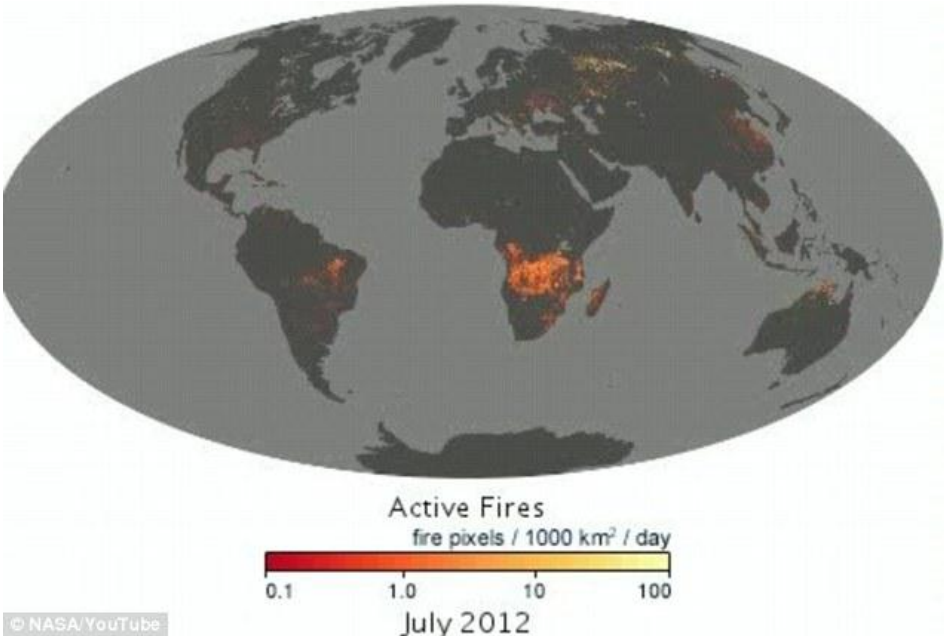

Figure 1: Global fire incidence in 2012.
(See NASA satellite images of global fires between 2000 and 2012)

The largest ratio of burned area occurs in Africa and the northern parts of Australia. Savannah fires in Africa and Australia account for more than 80 per cent of global burned area. Africa alone accounts for at least 70 per cent of the world total. Both regions have short return intervals. Fire can burn all over these areas within several years. As Figure 1 shows, there are two main regions of annual burning activity in Africa. The northern zone covers an area of Sudan, Chad and Ethiopia, while the south includes parts of the Democratic Republic of Congo (DRC), Angola, Tanzania and Mozambique. In Africa, the majority of wildfires are lit because of human land management interventions.

South America and South East Asia also experience widespread wildfires. Intense burning occurs in the heart of South America between August and October each year, largely caused by agricultural land management practices. Sections of the Amazon are burnt as well as large swathes of the Cerrado – the grasslands and savannah ecosystem to the south. Fires are common throughout South East Asia, but are particularly prevalent in Malaysia and Indonesia which both have extensive peat lands that are extremely sensitive to fire.

Calculating wildfire emissions

Calculating the quantity of GHG emissions from wildfires is a complicated process due to the difficulties involved in both determining the area of land burnt and the range of factors that determine the emission rate. There is currently a dearth of comprehensive studies on global wildfire carbon emissions. Amongst existing studies, emission estimates vary considerably. Fire emissions are a function of four factors and are calculated by the formula:

Fire emission = Burnt area x fuel load x combustion efficiency x gas specific emission factors

Considerable challenges are involved in mapping large areas of burnt land because of the temporal nature of fire patterns. A popular method is to map active fires using satellite bound thermal sensors as a proxy for burnt area; however a key flaw in this approach is interruption by cloud cover which can lead to unacceptably low detection rates. Mapping burn scars from satellite imagery is a somewhat more reliable approach, but one that is also prone to issues. In addition to correct estimates of the total area burnt, knowledge of the characteristics and condition of the biomass are also required. For these reasons considerable uncertainties remain attached to calculations and large differences exist in emission estimates between studies.

Global wildfire emissions

Carbon emissions from all sources of fire amount to between 2 and 4 billion tonnes each year, about half of those from fossil fuel combustion. Deforestation burning contributes 650 million tonnes of this. Of the total carbon emissions from wildfires between 1997 and 2004, Africa contributed 52 per cent, South America 30 per cent and South East Asia 10 per cent. The remainder of emissions came from boreal and other regions. In addition to CO_2, wildfires emit 10 per cent of global methane and between 10 and 20 per cent of nitrous oxide each year. Thus they have a significant effect on atmospheric chemistry.

Africa contains 14 per cent of the global population but only produces 3 per cent of fossil fuel emissions. It does, however, emit over half of global carbon from biomass burning as a result of the fires which rage across the continent throughout the year. During the time period from 2001 to 2005, Africa released an average of between 650 and 790 million tonnes of carbon into the air each year.

The tropical forests of South East Asia do not burn nearly as often as the African savannahs but the presence of combustible peat creates fires that burn almost annually and release higher amounts of carbon into the air than forest and vegetation fires do. In Indonesia in 1997, agricultural forest fires ignited peat lands which smouldered for months, releasing the equivalent of 20 to 40 per cent of worldwide fossil fuel emissions for the year.

Despite the low contributions of Europe and North America to global wildfire carbon emissions, fires can be the main source of pollution for certain regions and time periods. Only a very small part of total emissions from biomass burning comes from continental and Eastern Europe, mostly from Russia, the Ukraine, Kazakhstan and the Mediterranean states of Portugal, Spain, France, Italy and Greece.

Fire incidence and carbon output in North America is not as extreme as in South America or Africa; however, fires are prevalent in several western and south eastern areas. Wildfires in the western United States can pump as much CO_2 into the atmosphere in just a few weeks as cars in those areas do in an entire year. On average, US wildfires release 290 million tonnes of carbon into the atmosphere each year. This is equivalent to between 4 and 6 per cent of US GHG emissions from fossil fuels.

Climate change and positive feedback

There has been a recent burst in the incidence of large wildfires and global fire activity is projected to continue increasing in coming decades as a result of climate change. Rising temperatures promote wildfires by drying out forests and creating more biomass for burning, creating fire prone weather conditions and lengthening the fire season. Fire regimes are also strongly influenced by reducing rainfall trends.

The statistical relationship between the present day climate and increasing fire incidence is not conclusively agreed upon by scientists. However, there is considerable support for the link between future climate change and a rise in the occurrence of wildfires. At a major scientific meeting in Vancouver in 2012, forest researcher Mike Flannigan from the University of Alberta in Canada, stated that 'In a warmer world, there will be more fire. That's a virtual certainty… I'd say a doubling or even tripling of fire events is a conservative estimate.' Climate models predict that higher temperatures and longer droughts will increase wildfire frequency, particularly in semi-arid regions.

The trend is not uniform worldwide. It is likely that the tropics, including South East Asia and tropical Africa will experience less frequent fires because of increased precipitation patterns. For much of the rest of the world though, the frequency of wildfires will increase by at least 50 and up to 300 per cent.

Carbon emissions from fires create a positive feedback on the climate. Fires release carbon and other GHGs, causing temperatures to rise faster and higher. This further dries out forests and creates conditions that increase the likelihood of fire. Thus climate change and wildfires are mutually reinforcing.

As climate change threatens lives, population health, food security and economic growth, measures that can reduce greenhouse gas emissions are increasingly important. Carbon released from wildfires is a major contributor to the global GHG burden but is rarely included in national calculations of emission outputs because it is assumed that fires are a natural process that cannot be significantly altered by human intervention. A conceptual paper recently released by Future Directions International and Soils for Life – Regenerate Australia: Our Greatest Challenge and Opportunity – outlines the potential to employ land management techniques in northern and inland Australia to considerably reduce the frequency of major wildfires and thus shrink Australia's carbon emissions, helping us to meet our GHG reduction targets. Through the successful development and dissemination of these practices Australia could also aid a reduction in the global wildfire carbon emissions. Given similar fire conditions, this innovation would be particularly helpful in the regions of Africa that currently experience the highest rates of annual biomass burning.

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