Natural Resources Canada | Ressources naturelles Canada

Bulletin 50

FRONTLINE EXPRESS

Canadian Forest Service – Great Lakes Forestry Centre

Peatland Fires and Carbon Emissions

INTRODUCTION

Forest fires are a significant activity in forest ecosystems in Canada. Annually, an average of 9000 fires burn more than 2 million ha, which is twice the average area burned in the early 1970s. While there are ecological advantages to fires in the boreal forest, such as stand renewal, fires that encroach on human settlement or other high value areas can be financially devastating and endanger lives.

Fire management is the most expensive aspect of forest management, costing Canada an average of $500-800 million per year. Various modeling scenarios predict increases of double or more in the area burned by the end of this century. These predictions are based on climate models and the relationship between fire and weather. For example, since temperature is the most important predictor for area burned, and with warmer temperatures expected due to climate change, an increase in area burned is expected. This changing trend in fire activity will have major implications for forest ecosystems, forestry activities, community protection, and carbon budgets.

The effects of forest fire on the boreal forest have received considerable attention, but less is known about the vulnerability of boreal peatlands to burning. Peatland ecosystems cover 2-3% of the earth's land surface, but 25-30% of the boreal forest region. It is estimated that they store 30% of the world's terrestrial carbon, or about 300 Pg (petagrams or billion metric tons), a substantial proportion of the estimated total boreal forest carbon stock of 471 Pg. These carbon reservoirs are likely to become increasingly vulnerable to fire as climate warming progresses.

GREAT LAKES FORESTRY CENTRE (GLFC) RESEARCH

GLFC scientists are studying peatland fires as part of their efforts to monitor and predict changes in forest fire activity and the effects on global climate. These predictions require a baseline of recent fire activity that can be combined with climate models to predict future fire frequency, severity and impacts. If peatlands start to burn at a greater rate or to a greater depth, which may be expected under a warming climate, fires in the boreal region could contribute to even greater carbon emissions.

An examination of North American forest fires in the last 50 years indicates an increase in very large fires (greater than 1,000 km^2 or 100,000 ha) and a greater number of fires occurring late in the growing season. This seasonal change in fire pattern may make peatlands more vulnerable to deeper burning, because the water table is usually lower later in the season.

Importance of understanding peatland fires

Fires in boreal forests typically recur every 50-500 years, while those in peatlands recur less frequently. Fire frequency estimates based on the examination of charcoal in Canadian boreal peat cores, gave a range of 80-1100 years. Other estimates of fire return intervals in central Alberta peatlands based on fire perimeter and land cover maps were 105-123 years, depending on the type of wetland.

Peat fires release significant amounts of greenhouse gases. In Indonesia for example, where peatlands are not as extensive as in the boreal region, peat fires in 1997 released the equivalent of 20-50% of global fossil fuel emissions. Peatlands store tremendous reservoirs of soil carbon. While models for predicting fuel emissions from fires

are still being developed, preliminary estimates suggest that peat fires across western Canada emit about 6 Tg (teragrams or million metric tons) of carbon annually, while fires Canada-wide emit about 27 Tg, indicating that peat fires are already contributing significantly to carbon emissions. Deep burning peat fires have the potential for even higher emissions, as carbon density of peat increases exponentially with depth. In addition to releasing carbon dioxide and other greenhouse gases, peat fires release mercury into the atmosphere at a rate 15 times greater than upland forests, which may be a serious human health concern.

Peatlands vary in their moisture conditions and fuel structure, thus their vulnerability to burning and rates of fuel consumption also varies. However, human activities such as the draining of wetlands and climate change will increase the susceptibility of peatlands to fire. Warming temperatures will lead to more droughts, greater evapotranspiration and a subsequent lowering of the water table, which will leave peat more vulnerable to burning. Climate change may also lead to melting of permafrost, which can lead to additional peat material being consumed by fire and increased emissions.

In addition to a greater number of fires under a warmer climate, there will likely be an increase in the number of fires that escape initial attack. These fires typically burn the largest areas. For example, 97% of fires are controlled before they reach 200 ha in size, but those that escape increase in size and account for close to 97% of area burned. Peat fires can be difficult to extinguish and severe fires in peatlands can last for months, even burning throughout the winter under the snow layer. These are often smoldering fires that create a lot of smoke from incomplete combustion and result in greater emissions of carbon monoxide.

Currently, fire management agencies have to find the balance between protecting high value areas, such as those with human habitation or industry and recreational areas, while recognizing the ecological need for fire in others. Since traditional approaches to fire suppression, namely fire crews and air tankers, may be reaching their limit of economic and physical effectiveness, changes will have to occur in the way fires are managed as a result of climate change. Limited resources will mean that not all fires can be suppressed. Certainly current resources will not be adequate if fires increase at the predicted rate as a disproportionate number of fires may escape initial attack under a warmer climate.

CONCLUSIONS

Canada is recognized as a world leader in many aspects of fire research and management and GLFC scientists have an international reputation for being on the leading edge of fire research. Their findings have had a significant impact on our understanding of the role of fires in global climate change. GLFC scientists are collaborating with other peatland researchers from government agencies and universities in Canada, the US and Russia to study peatland fire and understand the implications of changing fire regimes on northern peatlands and the circumboreal forest. By studying changes in fire patterns and behaviour over time, scientists are gathering valuable information that will provide forest managers with the tools to best manage their resources. By providing projections of future fire regimes, resource managers and policy makers will be better able to prepare for the changes ahead.

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ISSN 1496-7847