Outline

- Fire in Canada
- Climate Change (briefly)
- Fire and Climate Change
- Options?
Canadian Fire Statistics

• Incomplete prior to 1970.
• Currently - average of 7000 fires a year burn 3 million ha – about 1.5 million ha in the 1970s.
• Often high intensity/high severity crown fires.
• Area burned is highly episodic:
  – 0.4 to 7.6 million ha
• Lightning fires:
  – 40% of total fires
  – represent 90% of area burned
• Fire size:
  – 3% of fires are >200 ha
  – represent 97% of area burned
Alberta is Different

- Spring fires – 51% of the annual area burned is from May fire starts
- 82% of the fires in May are human-caused
- 10 year average of 1,500 fires burning 200,000 ha
- 2015 1,700 fires burned almost 500,000 ha

1931 - 2015
Map of evacuations, and evacuations with structure loss due to fire 1980-2007

National map of the “human-wildland interface”
Fire Management

- Canadian fire management agencies among best in the world.
- Canadian Forest Fire Danger Rating System.
- Initial attack but if fire escapes...
- Traditional approach has been total fire suppression – now some regions use appropriate response.
Fire Issues

• An average of $800 million spent by fire management agencies in Canada a year on direct fire fighting costs.
• Health and safety of Canadians – evacuations – smoke.
• Property and timber losses due to fire.
• Balancing the positive and negative aspects of fire.
• Traditional approaches to fire suppression (e.g., crews, air tankers) may be reaching their limit of economic and physical effectiveness.
Fire Impacts

- Location, location location
- Slave Lake May 2011.
- Fort McMurray 2016.
- 2017 New Zealand, Chile, Portugal, Spain, South Africa, USA (CA) and Canada (BC, AB, NT, SK and MB).
Forest Fires – 3 Ingredients

• Fuel – type, loading, moisture, structure, chemical composition etc.
• Ignition - human and lightning
• Weather – hot, dry windy. Extreme weather
Atmospheric CO$_2$ at Mauna Loa Observatory

Scripps Institution of Oceanography
NOAA Earth System Research Laboratory

http://www.esrl.noaa.gov/gmd/ccgg/trends/
2016 saw record highs for both land and ocean surface temperatures and set a combined global record for the third year in a row.
Climate Change Projections

- GCMs project up to a $6^0$ C increase in global mean temperature by 2100.
- Greatest increases will be at high latitudes, over land and in winter/spring except the Arctic Ocean when seasonally ice-free.
- Projected increases in extreme weather (e.g., heat waves, drought, floods, wind storms and ice storms).
- Spatial and temporal variability in climate change.
Projected temperature changes vary considerably from year to year.
Projections of area burned based on weather/fire danger relationships suggest a 75-120% increase in area burned by the end of this century according to the Canadian and Hadley models respectively.

Fire & Temperature

- Key variable in fire activity for 3 reasons:
  - First, the amount of moisture the atmosphere can hold is highly sensitive to temperature. This drives fuel moisture; if temperature increases then significant increases in precipitation are needed to compensate. Approx. 15% increase in prec. for every degree of warming.
  - Second, temperature has a strong positive correlation with lightning…the warmer it is the more lightning we have.
  - Third, the warmer it is the longer the fire season; particularly important at high northern latitudes.

Methods - 1

- Three GCMs – CanESM2, HadGEM2-ES, CSIRO-Mk3.6.0.
- Three RCPs – RCP2.6, RCP4.5, RCP8.5.
- Canadian FWI System is a weather based system – temperature, relative humidity, wind speed and precipitation.
Methods - 2

- Calculate the fire intensity, rate of spread, depth of burn, fuel consumption, crown fraction burned using the Canadian Fire Behaviour Prediction (FBP) System as well as days above specified thresholds (e.g., HFI > 2,000 and 10,000 KW/m).

- Fuels – used a national fuel classification (250 m) for the forested regions of Canada. Aggregated fuels to a predominate fuel type for 40 km by 40 km cells.

- Time periods include baseline as well as 2021-2040 and 2081-2099.

Percent change in days with HFI > 2,000 kW/m

RCP4.5 2021-2040
Percent change in days with HFI > 10,000 kW/m

RCP4.5 2021-2040
Change in days with HFI > 2,000 kW/m

RCP4.5 2021-2040
Change in days with HFI > 10,000 kW/m

RCP4.5 2021-2040
Escaped Fires....

- Increased fire intensity may lead to more escapes.
- Extended attack simulation showed that projected intensity increases resulted in very substantial increases in burned area.
  - Driven by the change in frequency of being above suppression intensity thresholds.
Context & Options

• Fuel, ignitions and hot, dry, windy weather are part of our future so we need to learn to live with fire.
• 3 ingredients but can only manage the fuel and human-caused fires.
• Context for Canada – climate change = more extreme weather = more fire on the landscape.
• FireSmart Canada – fuel management, planning, education, cooperation, training and development.
• Update the Canadian Forest Fire Danger Rating System.
• Need for an Early Warning System and Appropriate Response.
• Now more than ever Canadians live and work in the forest.
• Development increasing in parts of the country.
• More people = more fire and more exposure to fire.

In the last 10 years, 60% of new homes in the U.S. have been built on lands adjacent to fire-prone public lands.
Summary

- Fire and weather are strongly linked.
- Changes in forest fires may be the greatest early impact of climate change on forests.
- Fire activity will increase in a changing climate, but will be variable in time and space.
- Significant increases in fire intensity expected in a warmer world especially towards the end of the century.
- Increases in the number of days with head fire intensity above 2,000 and 10,000 kW/m may significantly impact fire management with increases in fire escapes and area burned.
Photo credit: Dennis Quintilio

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