



NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

Tracking Climate Change Effects in the Canadian Forest

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and Pierre Bernier



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Forest Change Initiative

- Under the Adaptation theme of the Government of Canada's Clean Air Agenda
- The CFS initiated the FC initiative to support adaptation to climate change in Canada's forest sector
- Objective: maximizing opportunities and minimizing risks associated with climate change



Three main deliverables

- Tracking System → document past trends and future projections of forest change
- Adaptation Toolkit → provide actionable scientific information for the forest sector, including maps, decision support systems, synthesis of information and adaptation options
- Integrated Assessment → implications of climate change for Canada's forests and forest sector under a range of future climate scenarios

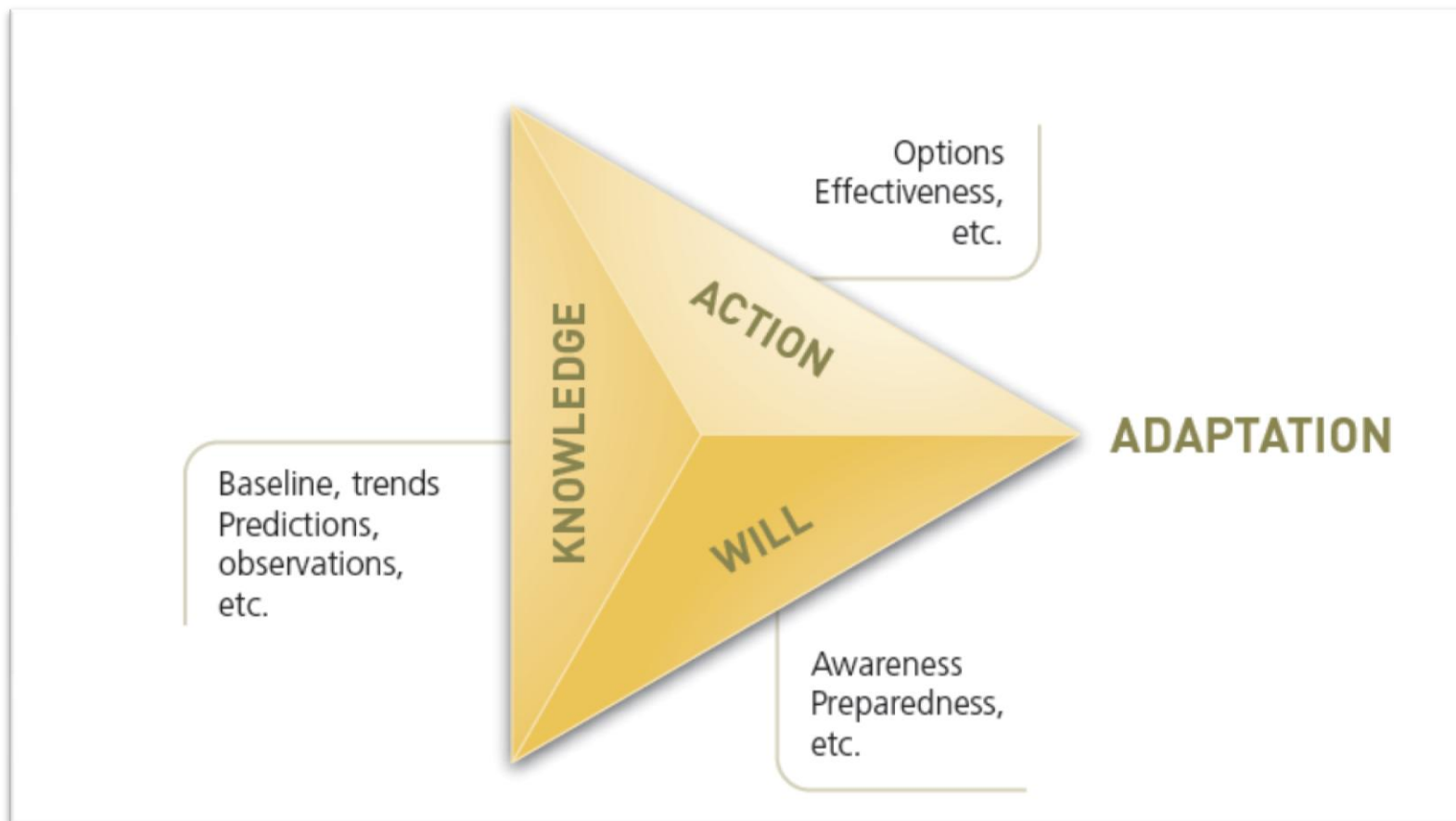


Background (tracking)

- It is imperative to explore and implement adaptation measures in addition to mitigation
- Adaptive framework → cycle of monitoring, assessing and adjusting
- A tracking system that reports on relevant indicators of CC is an integral part of this adaptation cycle



Climate change indicators can provide different types of information required for efficient adaptation



Tracking System deliverables

1) Information Report:

Tracking Climate Change Effects: Potential Indicators for Canada's Forests and Forest Sector

2) Establishment of a Tracking System



Tracking System deliverables

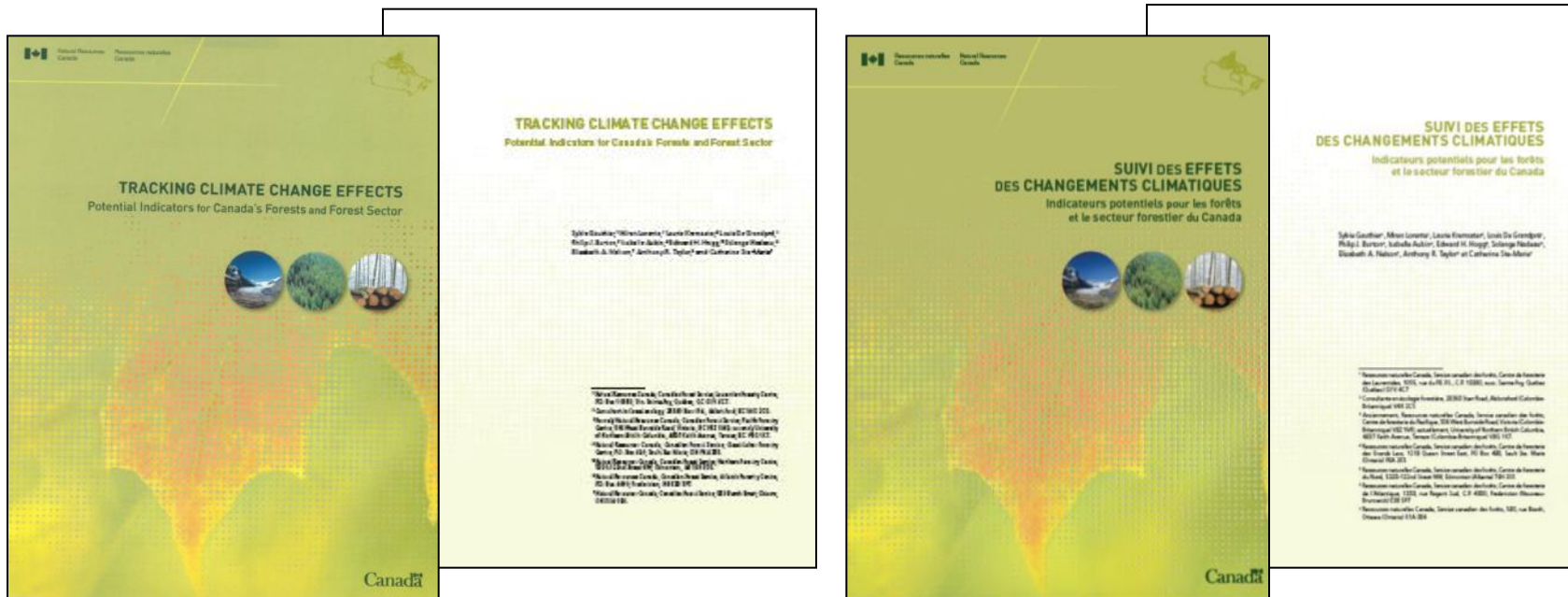
1) Information Report:

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2) Establishment of a Tracking System



The Information Report



Gauthier, S.; Lorente, M.; Kremsater, L.; De Grandpré, L.; Burton, P.J.; Aubin, I.; Hogg, E.H.; Nadeau, S.; Nelson, E.A.; Taylor, A.R.; Ste-Marie, C. 2014. Tracking Climate Change Effects: Potential Indicators for Canada's Forests and Forest Sector.

English: <http://cfs.nrcan.gc.ca/publications?id=35231>

Français: <http://scf.nrcan.gc.ca/publications?id=35568&lang=fr> CA



The Information Report

- Overarching goal: to provide potential indicators and selection criteria to develop a tracking system for Canada's forests and forest sector
- Specific objectives:
 - To present a suite of potential indicators of CC
 - To provide criteria to select and prioritize indicators to track CC effects



Writing team

- Included at least one member from each CFS centre



Methodology

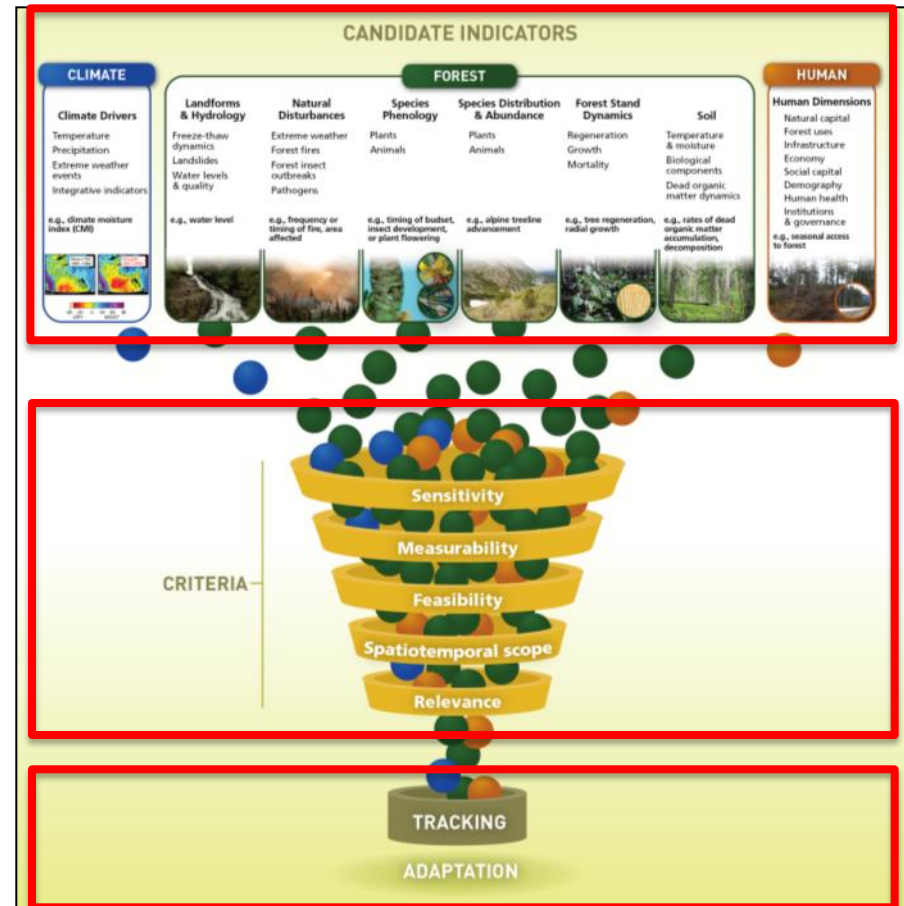
- Collection and interpretation of the information gathered in a series of workshops with CFS experts and forest industry, university and provincial government representatives
- Synthesis of the literature review and web scan of existing indicators (~ 500 papers and 150 websites inventoried)



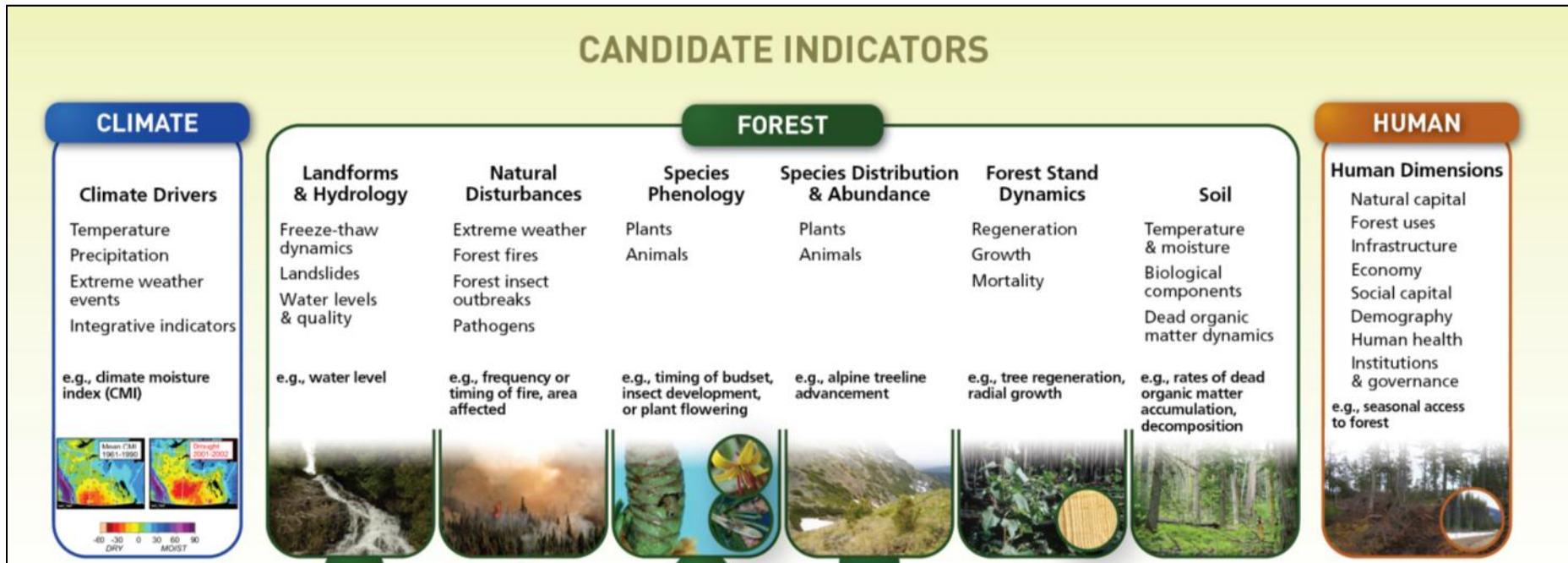
The Information Report

Approach: 3-step process

1. Candidate indicators are identified
2. They are filtered through a set of criteria
3. Selected indicators are incorporated into a tracking system



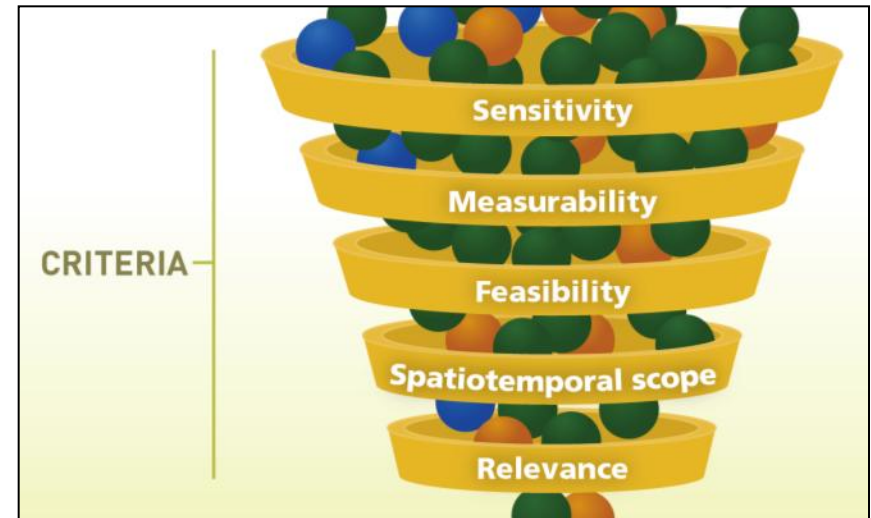
1. Identification of candidate indicators



- From workshops + scan
- Assigned to one of three systems: climate, forest or human

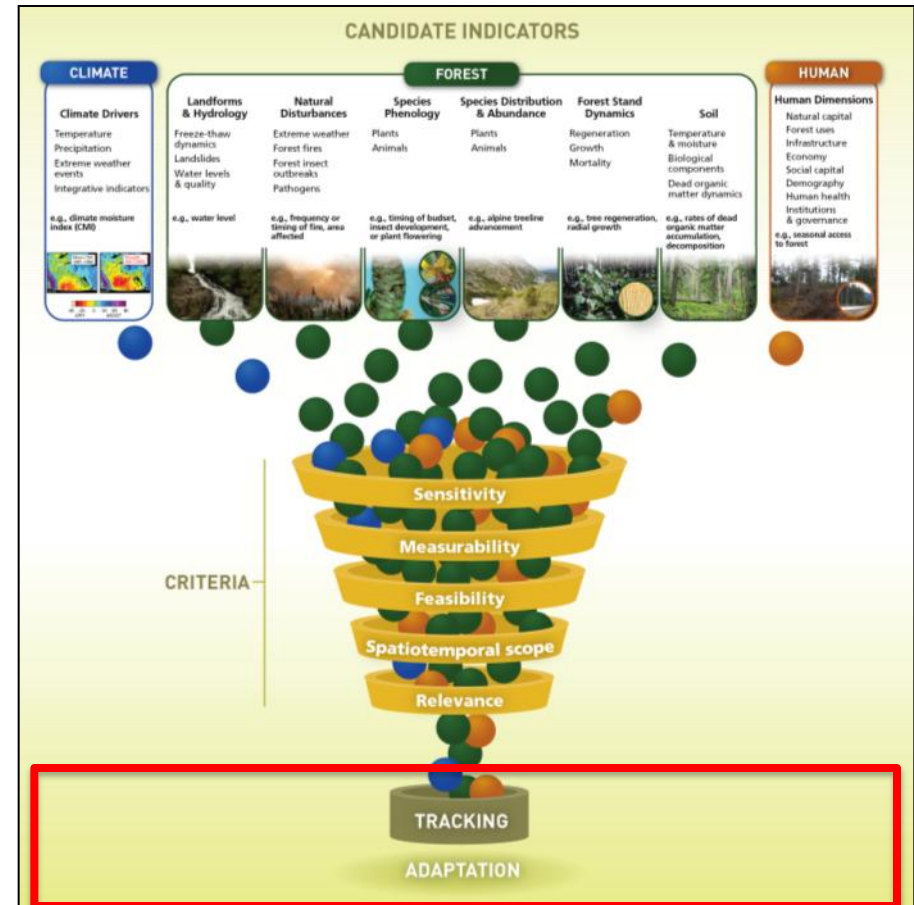
2. Filtering through a set of criteria

- Sensitive → strong signal-to-noise ratio
- Empirically and objectively measurable
- Measurement and use of an indicator should be feasible
- Spatiotemporal scope → ≠ regions, long-term
- Relevance → how well they inform the objectives of a specific tracking system



3. Incorporating indicators to a tracking system

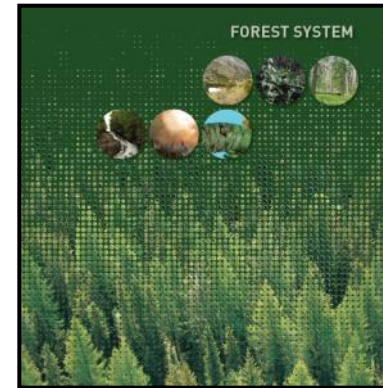
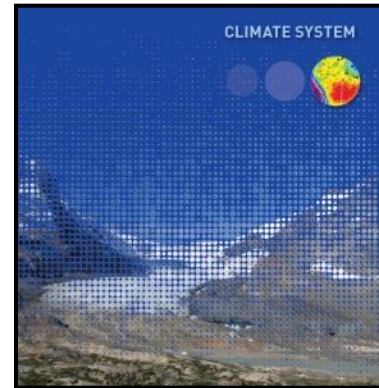
- After tracking changes over time, some indicators may have to be refined or new ones developed



The Information Report

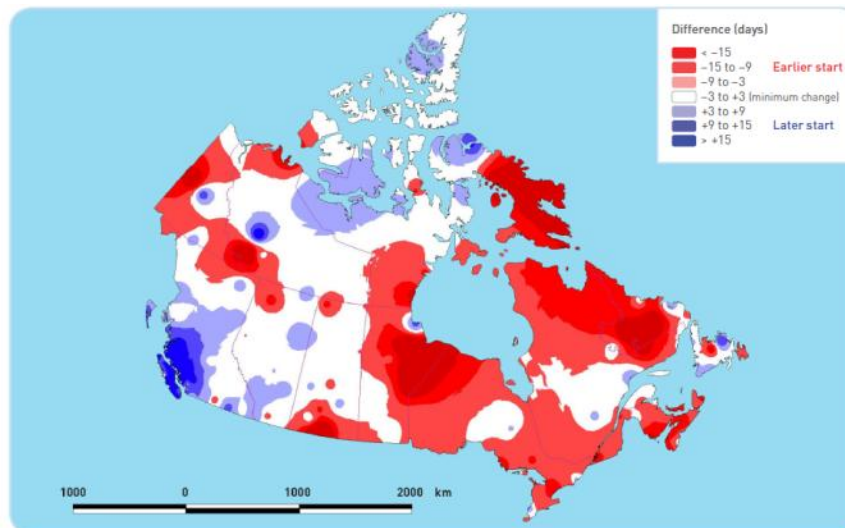
Structure

- For each system:
 - Rationales
 - Potential indicators
 - Linkages among indicators
 - Preliminary assessment for the climate and forest systems:
 - Sensitivity and feasibility
 - Based on expert judgment and a literature review



Example

DIMENSION	INDICATOR	SENSITIVITY	FEASIBILITY	KEY CONSIDERATIONS
Integrative indicators	Canadian Forest Fire Weather Index (FWI) <i>See also Precipitation, Forest Fires and Forest Uses</i>	High	High	<ul style="list-style-type: none"> • Changing FWI reflects changes in temperature, wind, relative humidity and precipitation patterns. • The start and the end of the FWI calculations can be used: <ul style="list-style-type: none"> - on-the-ground measure of snow arrival and disappearance - measure of the length of the fire season



Example of an integrative index (FWI) in which Canadian fire season start dates (Julian days) over the last 10 years are compared with those from 1970 to 2002. (Richard Carr, Natural Resources Canada, in preparation)



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The Information Report

- Identifies opportunities and challenges:
 - Standards allowing systematic data collection
 - Knowledge translation and extension services
 - Collaboration and coordination among stakeholders
 - Increase awareness and preparedness → development of adaptation options
 - Monitor the effectiveness of the implemented actions
 - Short term cost vs. Cost of inaction
- Is an important step toward the implementation of a system to track indicators of CC effects on Canada's forests and forest sector



Tracking System deliverables

1) Publication of an Information Report

Tracking Climate Change Effects: Potential Indicators for Canada's Forests and Forest Sector

English: <http://cfs.nrcan.gc.ca/publications?id=35231>

Français: http://scf.nrcan.gc.ca/publications?id=35568&lang=fr_CA

2) Establishment of a Tracking System



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2) Establishment of a Tracking System



Home > Forests > Indicators home

Forests

Forest Topics

Forests in Canada

Boreal forest

Climate change

Carbon accounting

Frequently asked questions

Forest carbon

Forest change

Impacts

Mitigation

Adaptation

International negotiations

Fire

Industry

Innovation

Insects and diseases

Inventory

Remote sensing

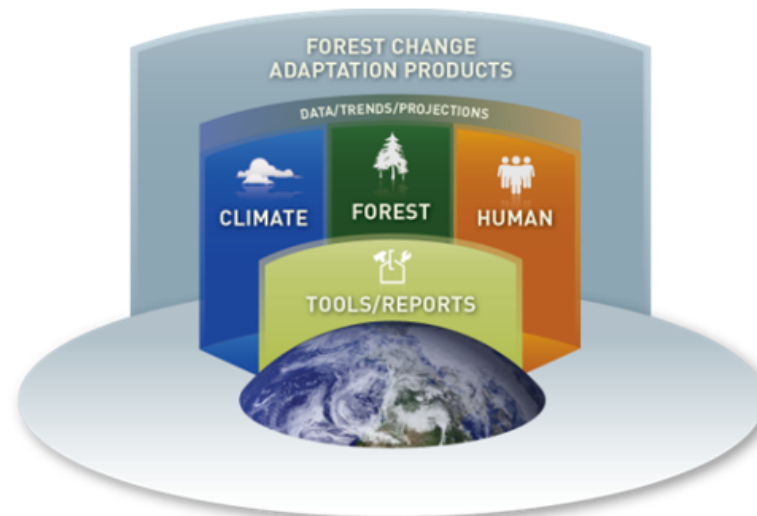
Forest Resources

FOREST CHANGE: Enhancing Forest Sector Competitiveness in a Changing Climate

Under the Adaptation theme of the Government of Canada's Clean Air Agenda, the Canadian Forest Service (CFS) receives \$1 million a year for five years (2011-2016) to support adaptation to climate change in Canada's forest sector, with the objective of contributing to maximizing opportunities and minimizing risks associated with climate change.

Forest Change has three main deliverables:

- A [Tracking System](#) to document past trends and future projections of forest change across Canada using a cohesive set of relevant indicators;
- An [Adaptation Toolkit](#) to provide actionable scientific information for the forest sector, including maps, decision support systems, synthesis of information and adaptation options;
- An Integrated Assessment of the implications of climate change for Canada's forests and forest sector under a range of future climate scenarios.



The TRACKING SYSTEM

Making indicators available to the community

What it is:

- **A dynamic delivery mechanism for indicator-based information**

Its objectives:

- **To increase awareness of on-going climate-induced changes in the forest and the forest sector**
- **To inform decision making in the forest sector**



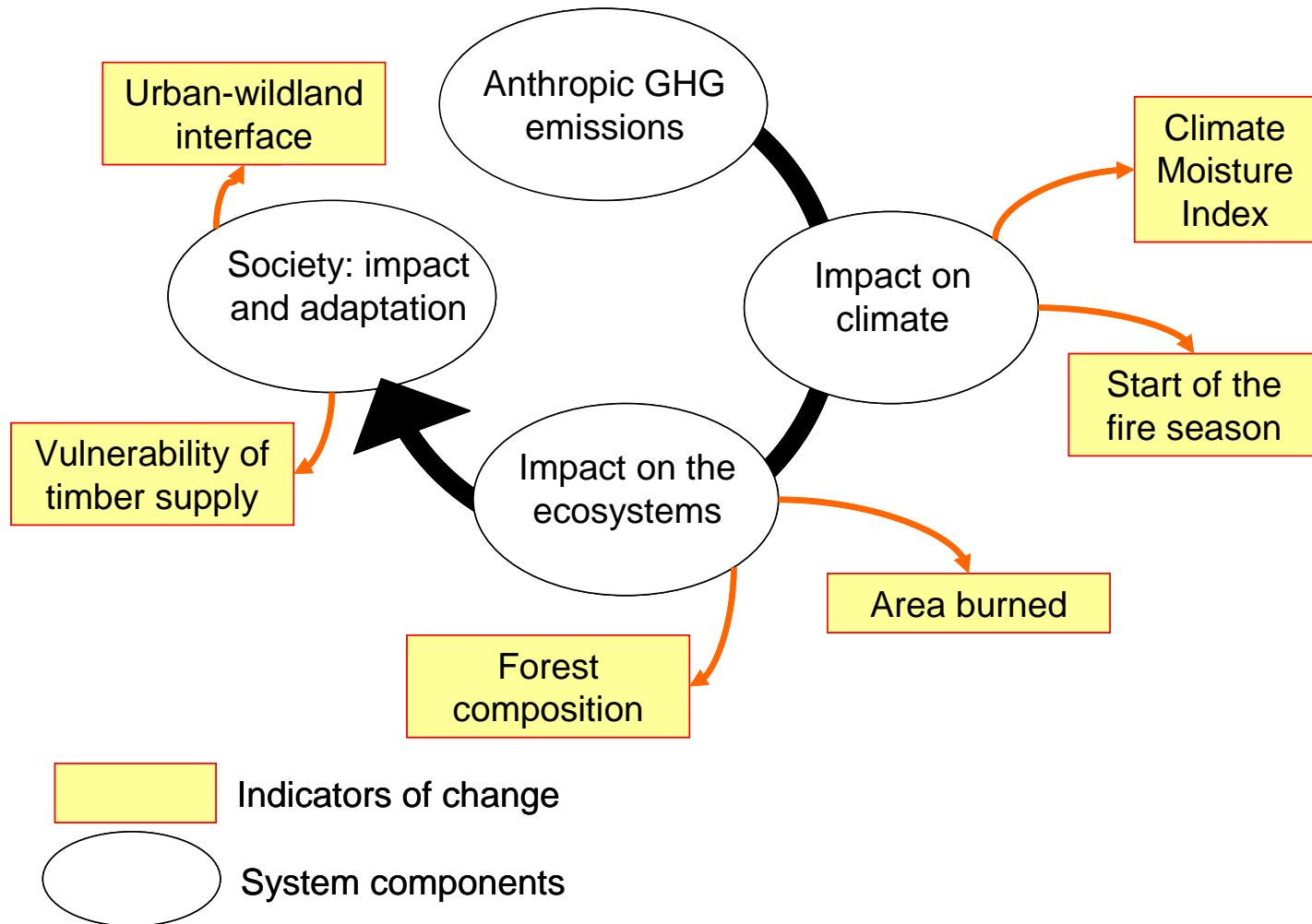
Properties of Tracking System:

The Tracking System:

- One-stop portal to data and analytical results on CC impacts on the forest and the forest sector
- Opened to the general public for browsing and data downloads
- Flexible to accommodate updates and new indicators



Forest Change Indicators: tracking a chain of causality



Tracking System

- From a list of approximately 150 indicators proposed in an Information Report ([Tracking Climate Change Effects: Potential Indicators for Canada's Forests and Forest Sector](#)), thirteen were selected based on their sensitivity to climate change and on monitoring feasibility.
- Indicators of changes in the climate system, forest system and human system were identified.
- For each indicator, trends and future projections of forest change across Canada over time are being generated.
- This Beta-version of the Website includes seven [indicators](#) that are being reworked with new projections and standardized maps.
- The Tracking System is planned to go live on Natural Resources Canada's CFS Website by the end of the program.

Indicators



Indicators of Climate Change

- **Drought:** [is drought an emerging threat to Canada's forests?](#)
- **Forest fires:** [is the fire season lengthening in parts of Canada?](#)



Indicators of Forest Change

- **Tree distribution:** [are forests on the move?](#)
- **Forest fires:** [is area burned increasing in Canada?](#)
- **Tree mortality:** [is tree mortality increasing?](#)



Indicators of Impacts on Humans

- **Cost of fire protection:** [are wildfire suppression resource expenditures increasing?](#)
- **Wildfire evacuations:** [are wildfire evacuations increasing?](#)
- Will shorter periods of frozen ground impact forest harvest? (Available in 2014)

Indicator structure:

1. Why is this indicator important?
2. What has changed? → *Baselines/trends*
3. What is the outlook? → *Projections*
4. Data downloads → *Enhance analytical capacity*
5. References → *Provide technical background*



Example of an indicator:

Forest fires: is area burned increasing in Canada?



Indicator: **Fire area burned**

[« Previous indicator](#)

[Next indicator »](#)

Key points

1. Fire and area burned heavily influence landscape diversity and productivity, forest resource availability, and human safety, health and property.
2. There has been increasing trends in both annual area burned and number of large fires over the 1959-1999.
3. Both annual area burned and occurrence of large fires will increase.

- [Why is this indicator important?](#)
- [What has changed?](#)
- [What is the outlook?](#)
- [Sources and information](#)



Why is this indicator important?

Fire and area burned heavily influence landscape diversity and productivity, forest resource availability, and human safety, health and property.

Wildfires are a major natural disturbance in Canadian forests^{6,9}, where they burn on average 1.8 million ha annually (for the period 1959-1997¹⁰). Fires largely shape landscape diversity and productivity⁸ and strongly influence the carbon flux in boreal forest ecosystems^{1,4,7}. They impact forest resource availability and accessibility as well as human safety, health and property. Fire occurrence and extent ([Box 6](#)) are strongly driven by weather conditions during the fire season. Hence, projected changes in climate should have a direct impact on the fire regime observed in Canadian forests.

BOX 6: The Fire Area Burned Indicator

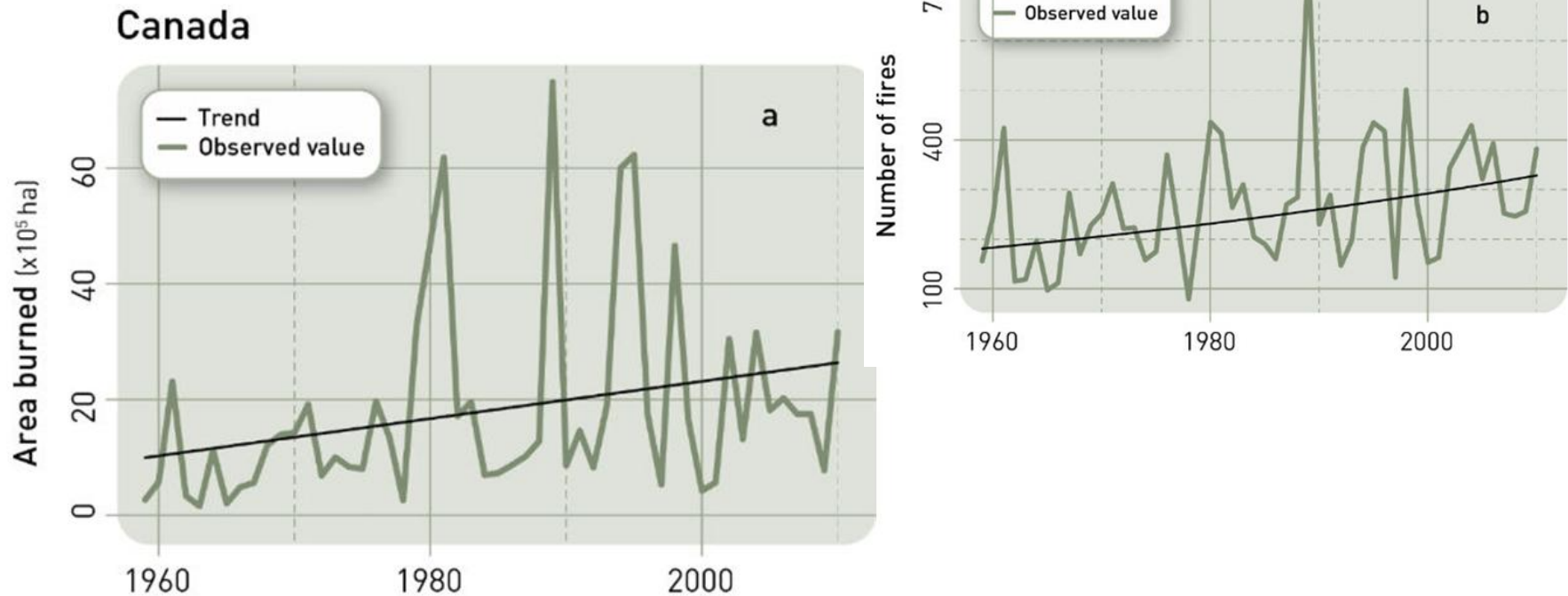
- Annual area burned refers to the average surface burned annually in Canada.
- Changes in annual area burned were examined by Homogeneous Fire Regime (HFR) zones. These zones represent areas where fire regime is rather similar over a broad spatial scale, at least for the 1959-1999 period⁴. Such zonation is useful to identify zones with unusual fire regimes that would have been overlooked if only mapped using existing administrative and/or ecological classifications. Trends in annual area burned (AAB) by large fires (> 200 ha) and the number of these fires per HFR zone were analyzed for the 1959–2010 period using the data from the [Canadian National Fire Database](#) (point version).



What has changed?

There has been increasing trends in both annual area burned and number of large fires over the 1959-1999.

The average annual area burned and average number of forest fires (Fig. 1) over the 1959-1999 time period show increasing trends for both variables. Although these results show an increasing trend in both annual area burned and number of large fires, one must be very careful when interpreting these trends. Small gaps in regional data availability, and the possibility of unrecorded fires in low-density areas may have influenced these results.



Information for graph

Trends in annual area burned (AAB) by large fires (> 200 ha) and the number of these fires per HFR zone were analyzed for the 1959–2010 period using the data from the [Canadian National Fire Database](#) (point version). This database is a collection of forest fire locations (> 0.1 ha) as reported from provinces, territories and Parks Canada.

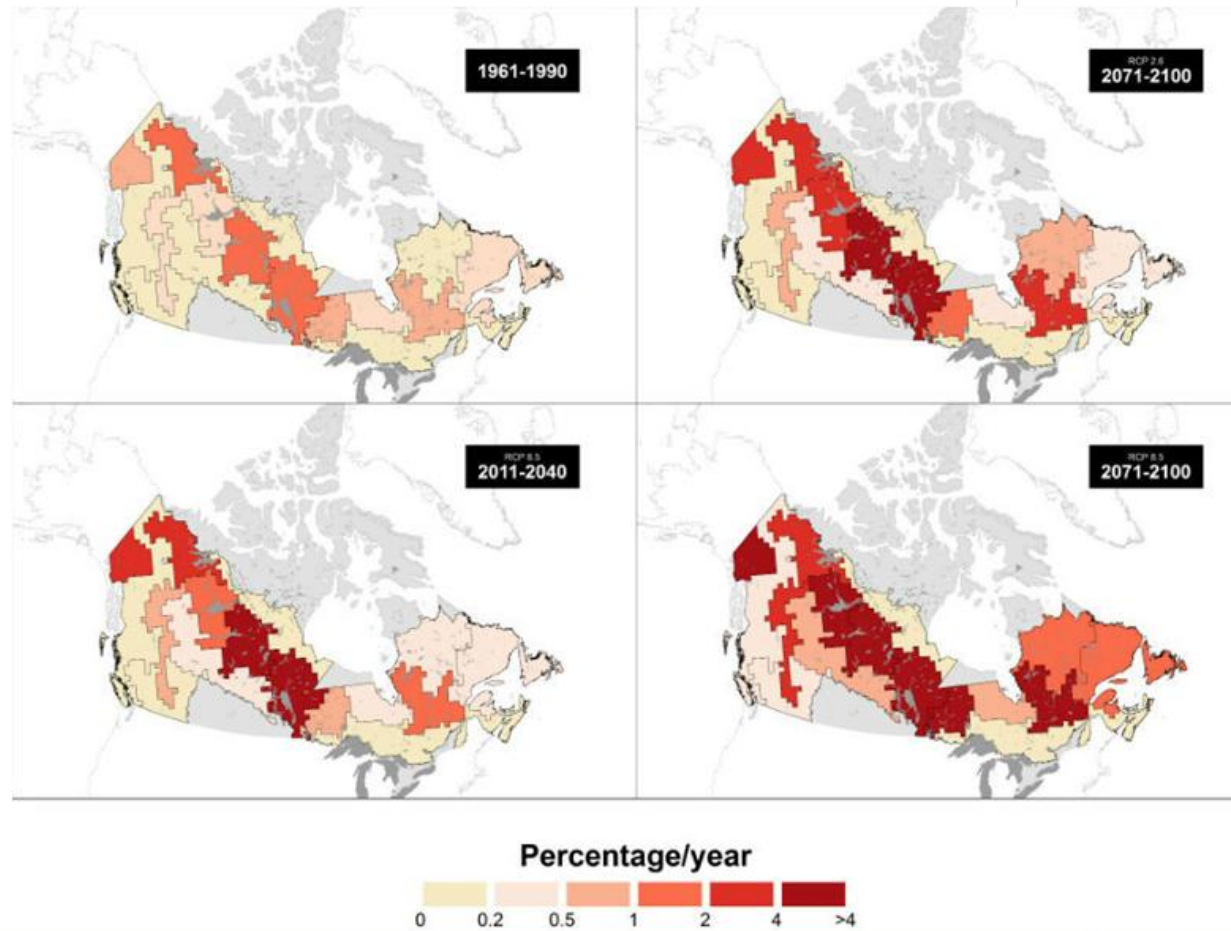
*Newfoundland and Labrador did not report fire data to the National Fire Database for 2000 and after.



What is the outlook?


Both annual area burned and occurrence of large fires will increase.

Overall, models projected a 4.4 increase in AAB by the end of the 21st century, shifting from 0.35% for the 1961-1990 (baseline) period to 1.55% by 2071-2100. However, changes in AAB and number of fires are not distributed evenly across Canada. Large increases in AAB and number of fires would mostly occur in zones where they are already high (> 0.5%), and most zones will experience at least a 1.5- and 2-fold increase in the number of fires and AAB respectively. Large shifts are also projected for central British Columbia as well as in eastern Canada and northern Quebec. More years with prolonged [drought conditions](#) and an earlier [start of the fire season](#) should result in much more area burned in most Canadian forests^{2,4,5}.





Sources and information

- 1 Amiro et al. 2009
- 2 Balshi et al. 2008
- 3 Bond-Lamberty et al. 2007
- 4 Boulanger et al. 2013
- 5 Flannigan et al. 2005
- 6 Johnson 1992
- 7 Kasischke 2000
- 8 Payette 1992
- 9 Rowe and Scotter 1973
- 10 Stocks et al. 2002

 **Downloads to come.**

Feedback

 Please note that this feature is still under construction. For feedback regarding this indicator or the site itself, please contact  [Miren Lorente](mailto:Miren.Lorente). Thank you.

Was the indicator clearly explained? Yes No

Do you understand the images? Yes No

Was this information helpful? Yes No

Comments



Indicator	System	Comments
Drought indices	Climate	Ready or coming soon
Start of Fire Season	Climate	
Species distribution of major tree species	Biophysical	
Burned area and fire number	Biophysical	
Tree mortality	Biophysical	
Wildfire evacuations	Human	
Cost of fire protection	Human	
Pest species distribution	Biophysical	Available in March 2015
Percent of young forest	Biophysical	
Freeze-thaw cycles	Climate	
Wildland-Urban Interface	Human	
Timing of budburst	Biophysical	Available in December 2015
Radial growth (dendrochronology)	Biophysical	
Biodiversity	Biophysical	



Tracking System Indicators

- Beta Version:

<https://apps-scf-cfs.nrcan.gc.ca/indicator/en>

Username: indicators

Password: @ind13demo



Questions ?

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Natural Resources Canada

Energy | Mining/Materials | Forests | Earth Sciences | Hazards | Explosives | The North | Environment

Home > Forests > Indicators home

Forests

Forest Topics

- Forests in Canada
- Boreal forest
- Climate change
 - Carbon accounting
 - Frequently asked questions
 - Forest carbon
 - Forest change**
 - Impacts
 - Mitigation
 - Adaptation
 - International negotiations
- Fire
- Industry
- Innovation
- Insects and diseases
- Inventory
- Remote sensing

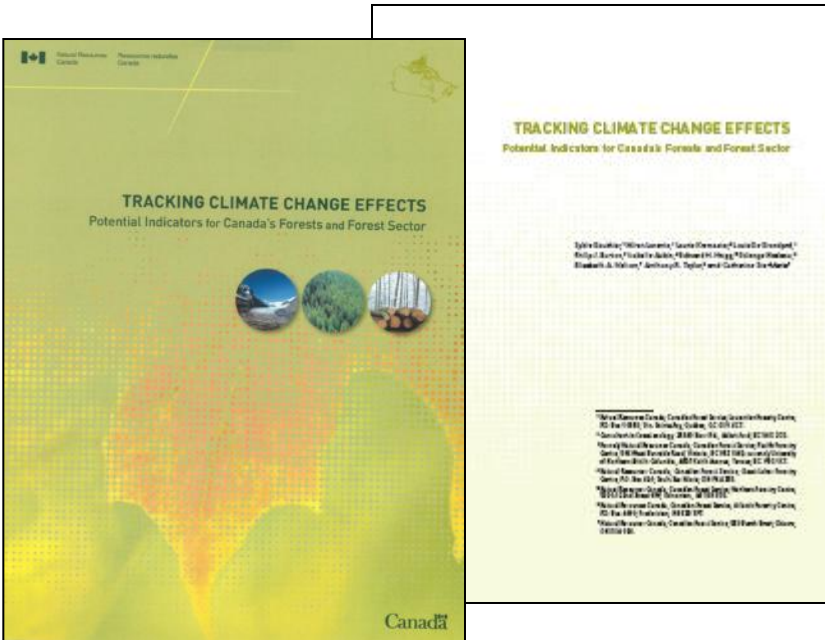
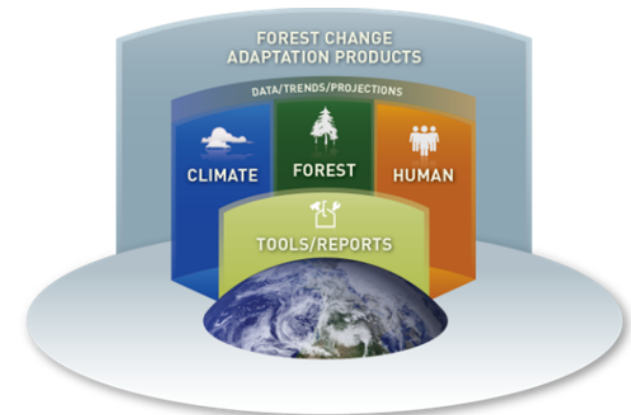
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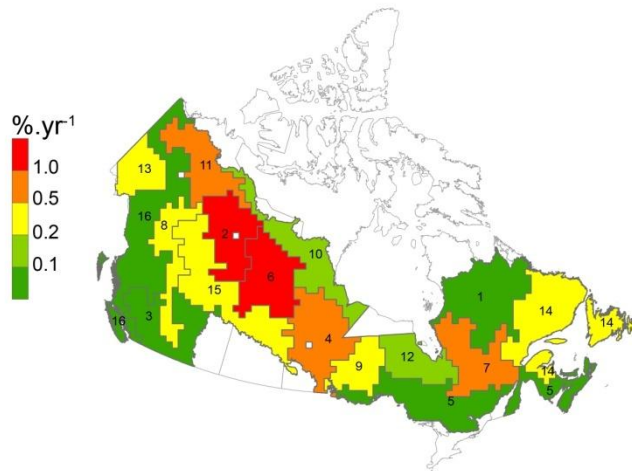
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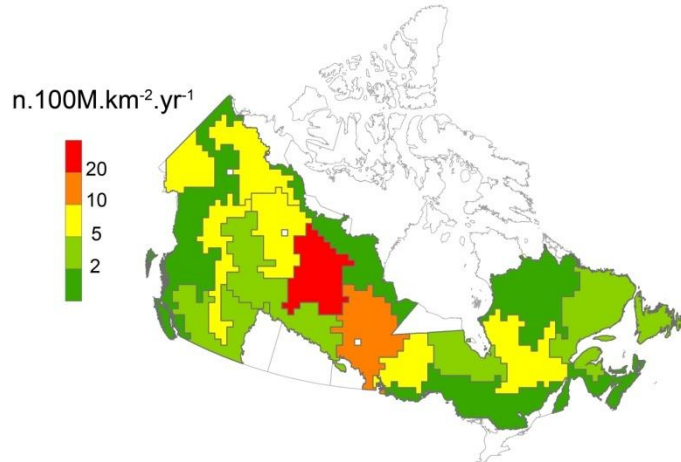
Canada

2) Tracking annual area burned

Annual area burned



Number of fires

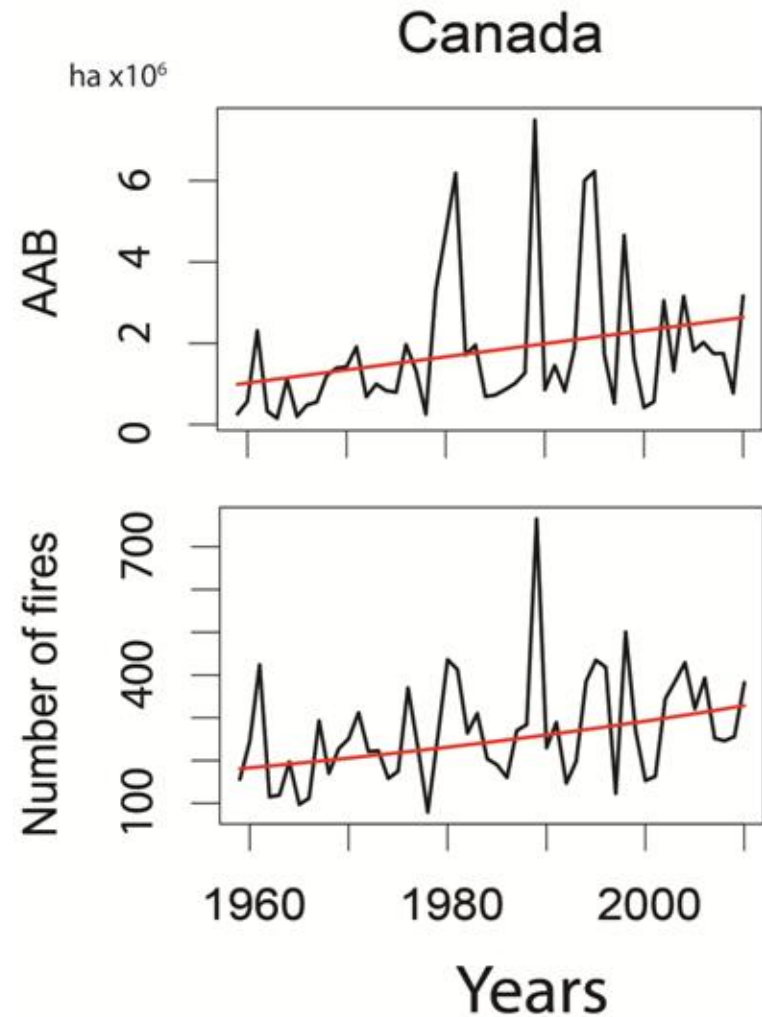


- **Source data:**
National Fire Database
(1959-2010)
- **Spatial units:**
Homogeneous fire regime zones
- **Looking for:** trends, regime shifts or occurrence of extreme years
- Easily **yearly updatable**

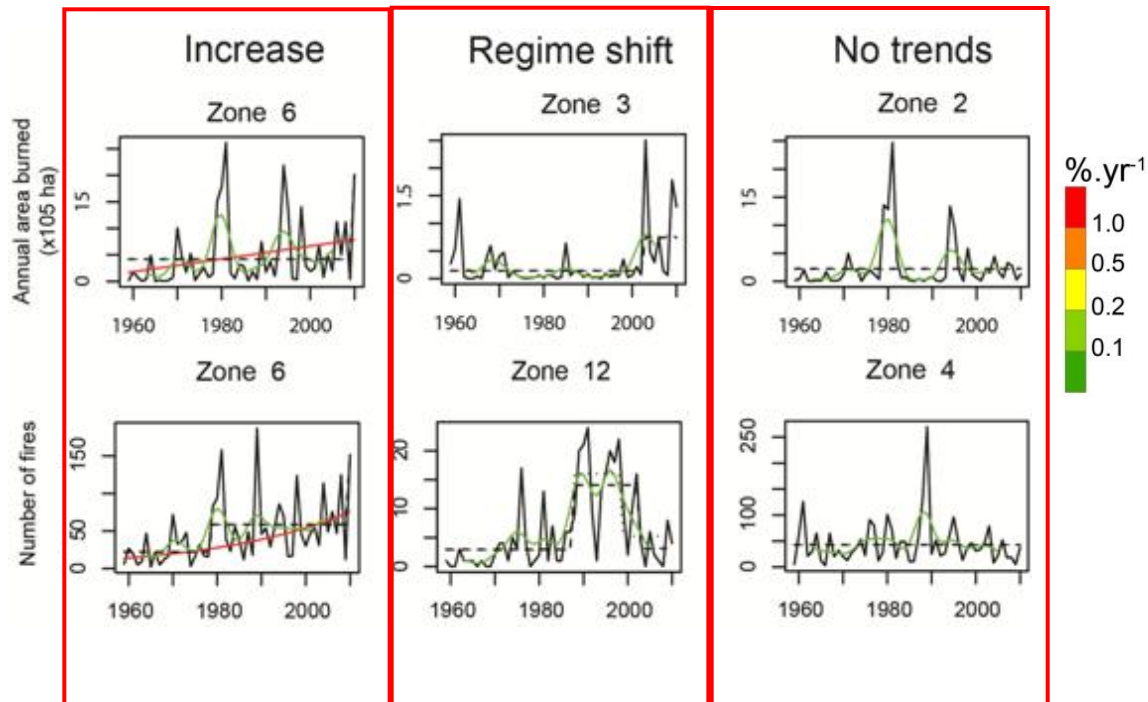


Trends in Canada

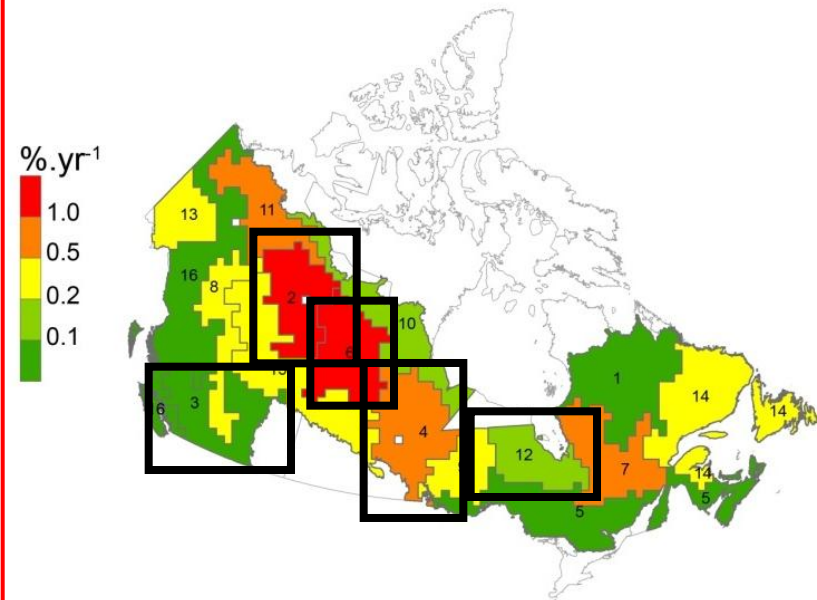
Since 1960
an increase in
area burned and
number of fires



Trends in area burned



Annual area burned



Contact Information

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