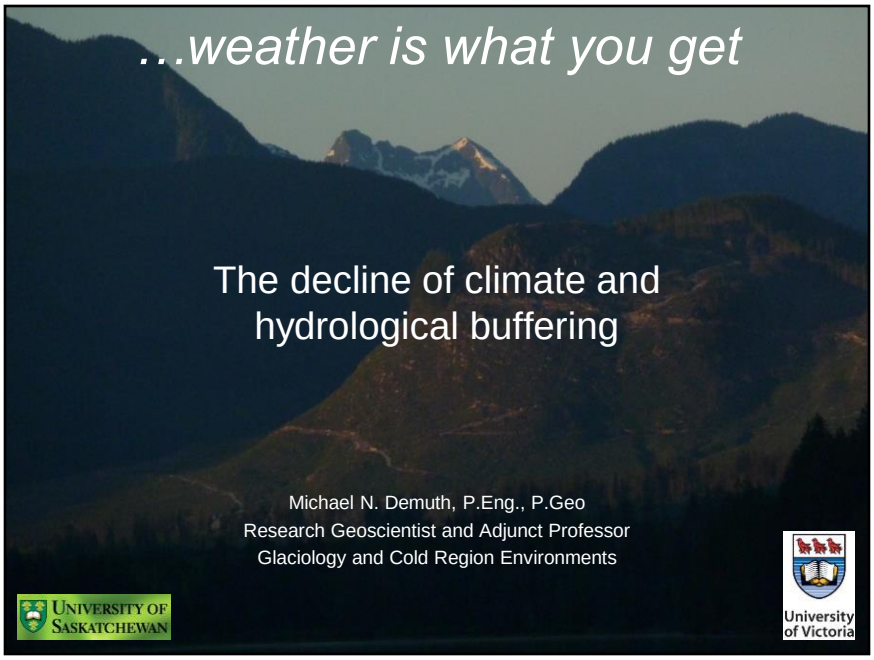


michaeldemuth@uvic.ca

604 578 0453

https://people.geog.uvic.ca/MikeDemuth

Presentation Outline

- Climate history
- Climate *variability*
- Climate *change*
- Climate and hydrological stationarity
- Connecting-the-Dots – Land and Water
- The perfect storm – land use and extreme weather
- Some notes on sociology, hope and urgency

Climate history, variability and change

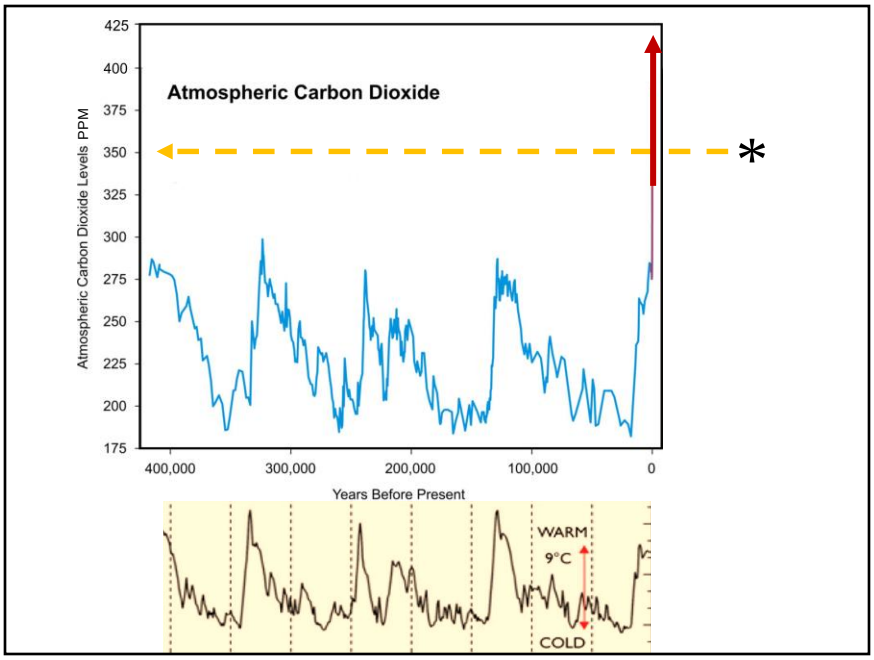
Climate and hydrological stationarity

Connecting-the-Dots – Land and Water:
The importance of…
-Uplands / Mountain headwaters
-Intact streams, including small streams
-Riparian zones
-Connectivity

River flows and hydrology

The perfect storm – land use and extreme weather

Some notes on sociology, hope and urgency



Much of what we have learned about climate change and climate variability has been derived from ice cores extracted from the Earth's perennially frozen regions – usually at high elevations and/or high latitudes…

…where climate indicators and pollution history are preserved

This graph represents global Carbon Dioxide levels derived from instrumental records and that from the Law Dome and Vostok Ice Cores, Antarctica (by measuring the chemical composition of air bubbles).

The broad variation in the line illustrates multiple Ice Ages with smaller cooling and warming episodes along the way between Ice Age and non Ice Age climates.

Other cores would include those from Greenland and the ice caps of the Canadian Arctic Archipelago.

I'll refer to 350 PPM later in the presentation

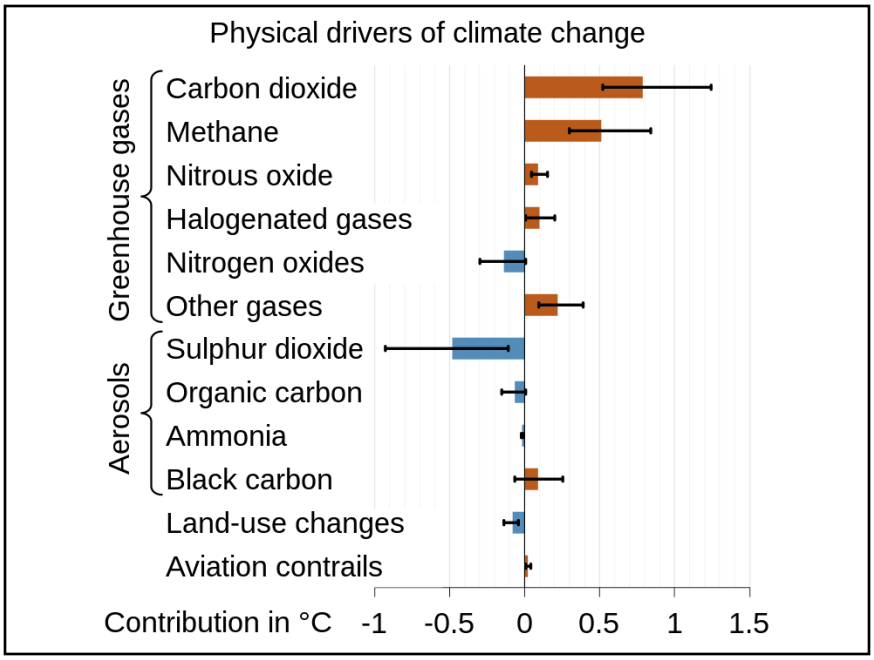


Figure: GHGs and aerosols in order of their importance in driving climate heating as a function of abundance and radiative forcing.

Abundance only:

Water vapor * not listed in figure – plays largest role in the Greenhouse Effect (36-66% clear sky; 66-85% when accounting for clouds)

Carbon dioxide

Methane

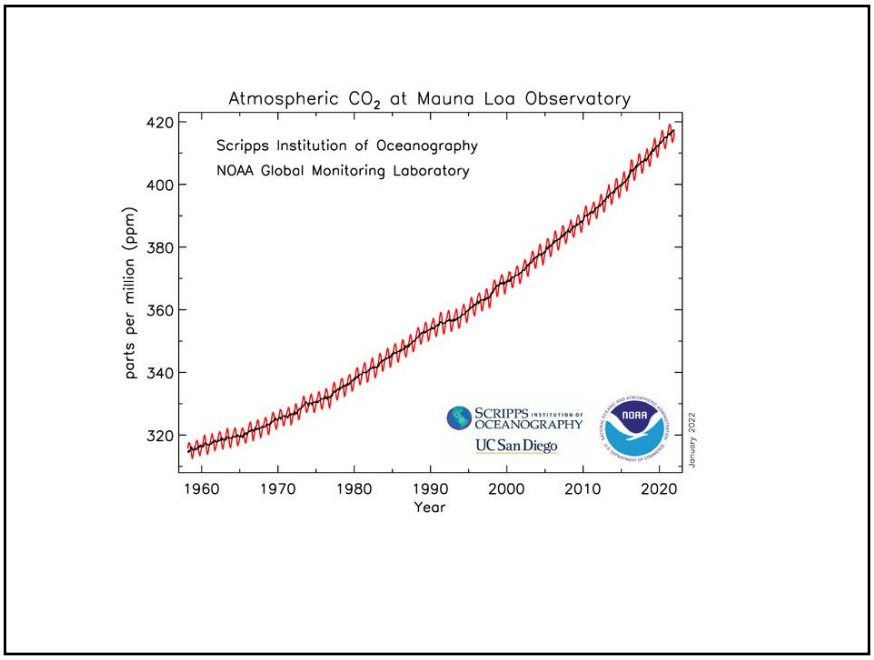
Nitrous oxide

Ozone

Chlorofluorocarbons (CFCs and HCFCs)

Hydrofluorocarbons (HFCs)

Perfluorocarbons (CF4, C2F6, etc.), SF6, and NF3



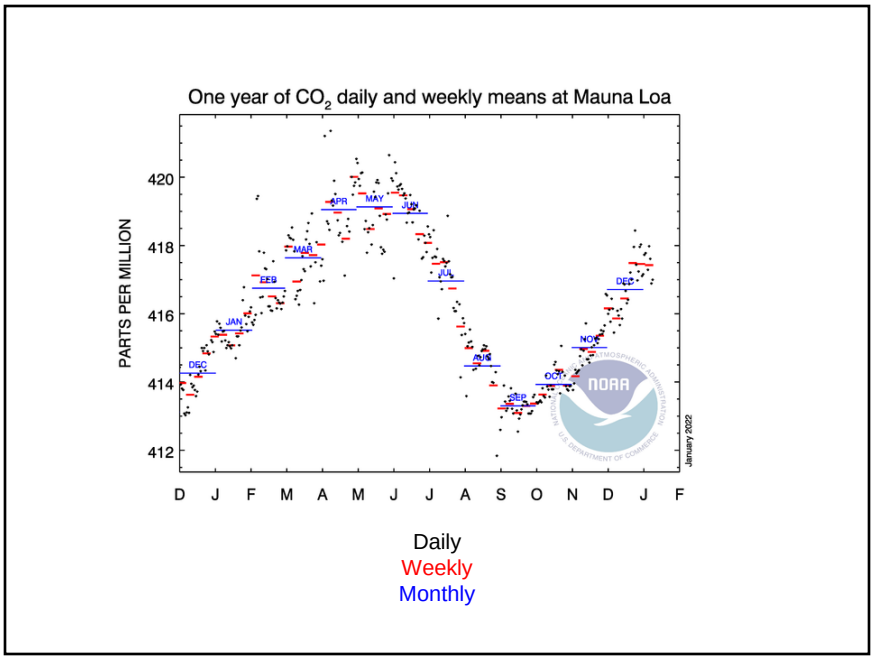
Let's zoom in …

… the variation of contemporary CO2 levels is commonly illustrated using the Keeling Curve…

… named in honour of Research Geochemist C. David Keeling who was notable for developing the instrumentation for and initiating the systematic monitoring of atmospheric carbon dioxide at NOAA's MLO

… work his son Ralph Keeling continues to this day.

Note seasonality…



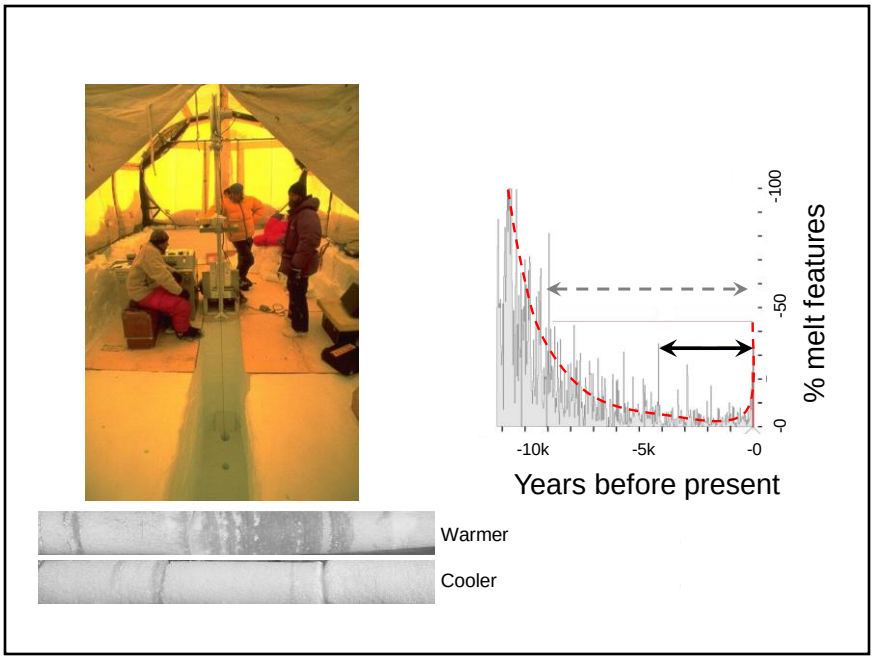
Seasonality:

-the uptick during the Northern Hemisphere's Autumn and Winter in response to a reduction in CO2 scavenging from trees and plants that are in dormancy; and an increase in the CO2 released from the decay of leaf liter

-this uptick in carbon dioxide mixes with emissions from anthropogenic sources and CO2 concentrations generally peak by early Spring

-with Spring and Summer, new and growing plants drawdown a significant amount of carbon dioxide through photosynthesis

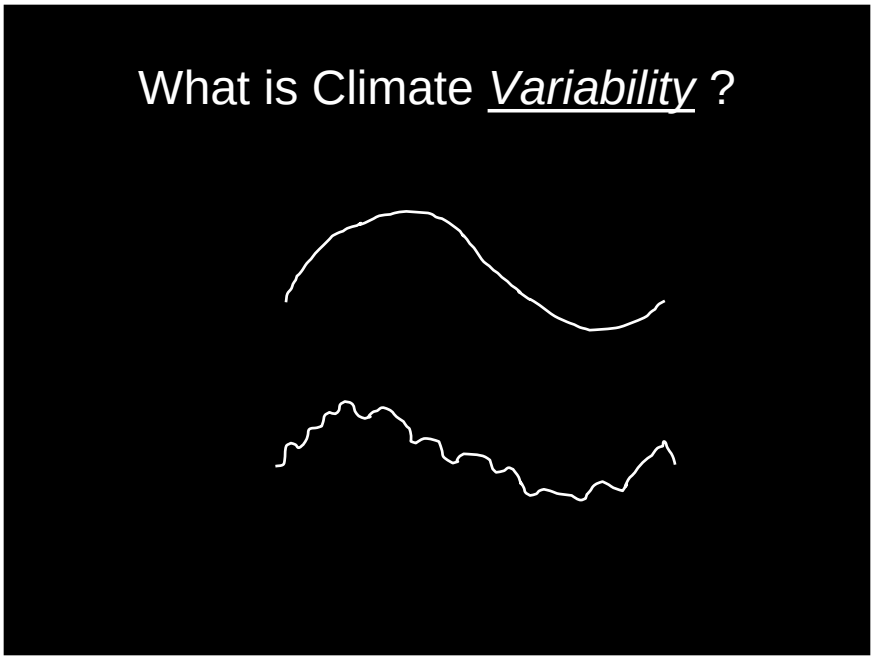
-notably, CO2 from forest and grassland fires can be transported over large distances, and so the regular and enormous "seasonal" fires in South America and Africa can intensify the annual cycle



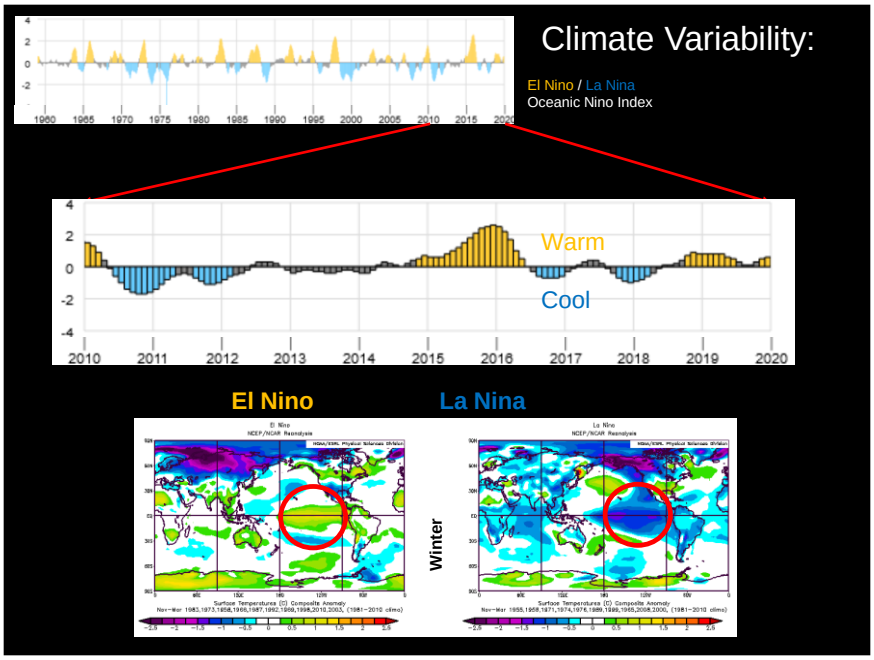
Ice core sites can be chosen so that Summer melt features are captured.

Summer melt rates on the ice caps of the Canadian Arctic Archipelago have increased greatly in the past decades

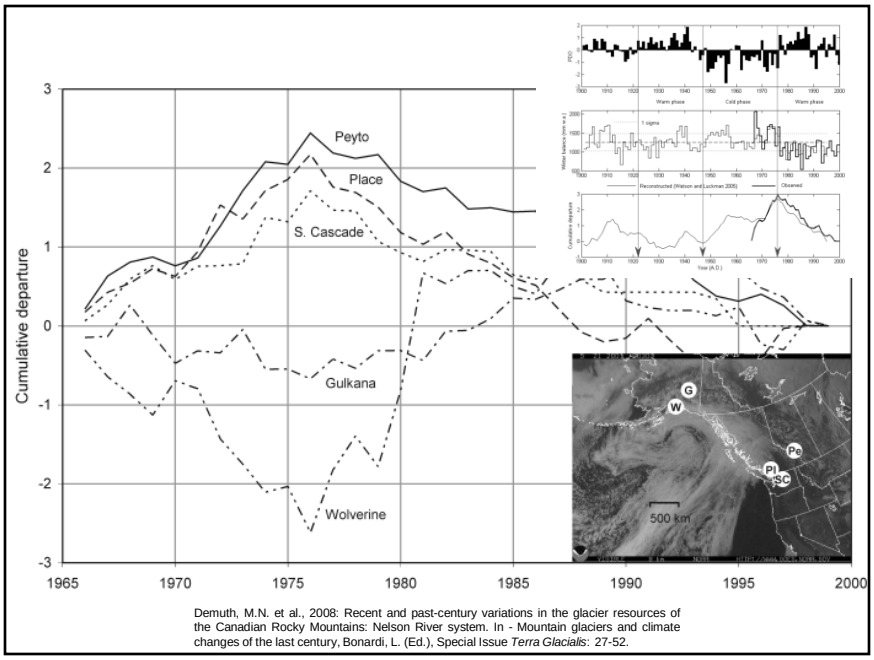
The present thermal state of the ice caps resembles that last inferred c. 3 – 4 k years ago; possibly 9 k years ago



Climate ***Variability*** – generally manifests itself as CYCLES – f.ex., ENSO, PDO



An example and very relevant to us is the familiar El Nino Southern Oscillation or ENSO … basically, cooler and warmer modes of temperature variability of equatorial waters in the Pacific Ocean, and thereby various ocean and atmosphere phenomenon driven by the temperature difference between those waters and those closer to where we all are.



Demuth, M.N. et al., 2008: Recent and past-century variations in the glacier resources of the Canadian Rocky Mountains: Nelson River system. In - Mountain glaciers and climate changes of the last century, Bonardi, L. (Ed.), Special Issue *Terra Glacialis*: 27-52.

Another extratropical mode of oscillation, influencing atmospheric circulation for western North America, including the average position and strength of the Aleutian low pressure centre, is something called the Pacific Decadal Oscillation or PDO – an Index, based on the temperature difference between equatorial waters and those of the Northeast Pacific.

It behaves much like ENSO spatially (with a cold and warm phase) but over longer (decadal to multi-decadal) time scales

During a PDO cold phase, the Aleutian Low is deeper and shifted further eastward thereby biasing moisture bearing weather systems further south

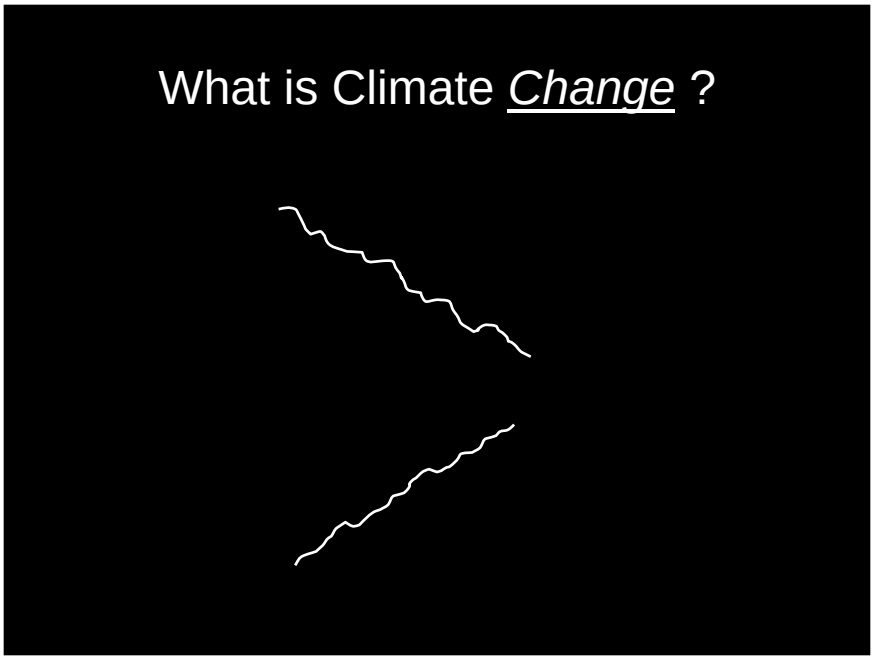
Conversely, during a PDO warm phase, storms track further north on average, effectively starving the southern Alpine and sub-Alpine regions of snow

Despite all the broad generalities in its genesis, the cold-warm-cold shifts of the PDO and their meteorological manifestations have been impressively abrupt…

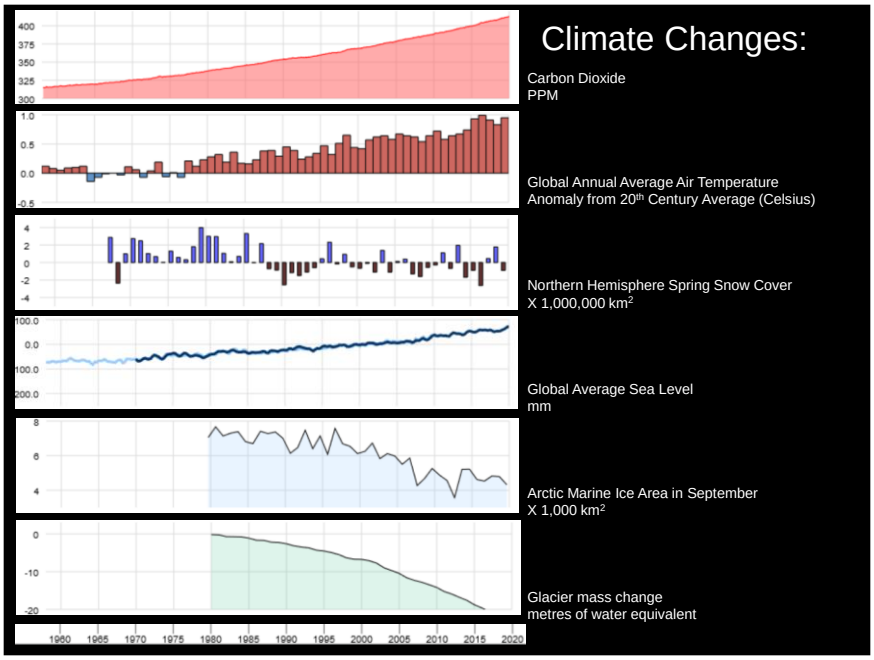
... refer to PDO shifts shown in figure top right: 1922, 1947, 1978; and main figure illustrating shift in glacier nourishment 1976

… though in more recent decades, the pattern has been less distinct…

… possibly as a result of persistent warming of the atmosphere and oceans by the effects of climate change



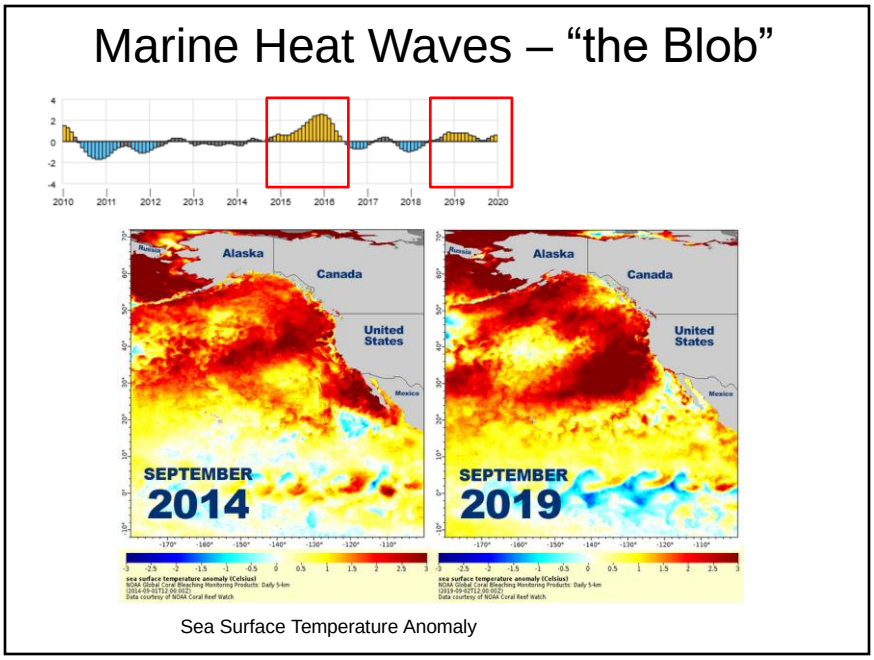
Generally speaking, human-caused impacts on the climate, or Climate ***Change***, are fingerprinted as trends



Some examples:

- contemporary/Post Industrial changes in CO_2
- global air temperature
- snow cover
- sea-level change
- marine ice cover
- glacier mass change

Adapted from the NOAA Global Climate Dashboard (climate.gov)



THE CHALLENGE…

We don’t feel changes in global average air temperature

We do notice its specific thematic and cumulative effects, f.ex., glacier recession

We do feel instances and periods where both CC and CV have likely conspired … f.ex., The Blob, named by NOAA Research Meteorologist Nick Bond

Seven years ago a large region of anomalously warm sea water disrupted the West Coast marine ecosystem, depressing salmon returns – but also influenced terrestrial conditions to the detriment of snowpacks and glaciers (glaciers suffered record or near-record mass losses)

These effects were, in-part, intensified by a long-lasting El Nino cycle (into 2015 and 2016

In 2019, a new expanse of anomalously warm water developed stretching roughly from Alaska south to California; an expanse ranked as the second largest marine heatwave (area) in the northern Pacific Ocean in the last 40 years, after the 2014 Blob

Now, cold water up welling from the ocean depths along the coast can hold the zone of warm seawater offshore, but since this upwelling generally subsides in the Autumn as coastal wind patterns

change, the heatwave would be able to move onshore and affect coastal and inland temperatures.

The causes are complicated and the result of much more than just the ENSO periodicity, but certainly El Nino persistence appears to have played a role in it's duration and the degree it affects seawater temperatures at depth

Bottom Line:

Temperatures and related conditions we currently consider extreme will become more common under a warmer climate

Climate change and climate variability superimpose, thereby influencing what we observe or experience …

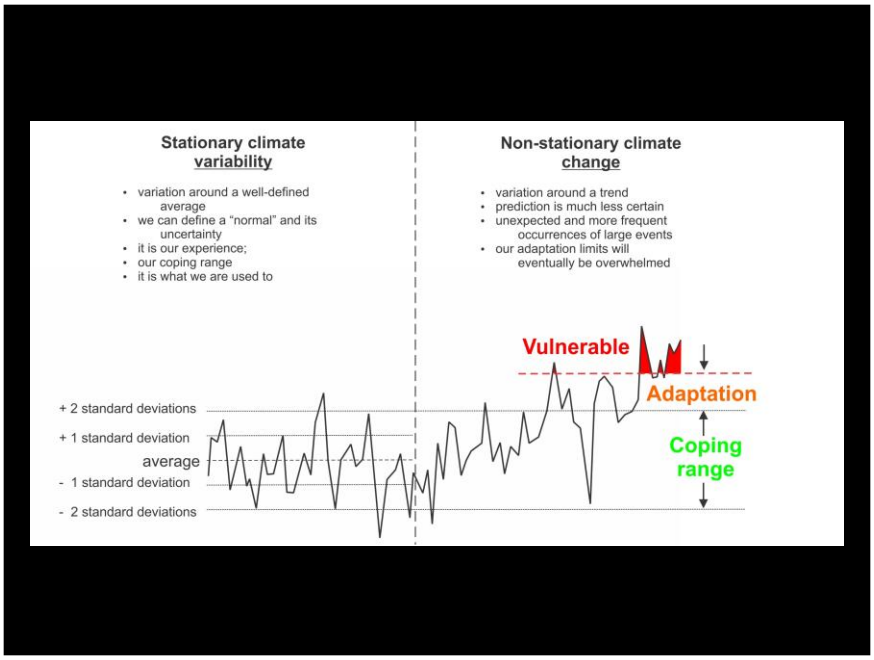
… that is, trends may be enhanced or diminished by certain phases of variability

Climate & Hydrological Non-stationarity

Mike Demuth adapted from concepts by Ian Burton

Stationarity is variability around a well-defined average… the final frame of this slides animation is presented and discussed in the next slide.

The .PDF version of this slide will be “blank”



So, again, the difference between climate variability and climate change. The line could represent air temperature, or days of drought, any other climate variable…

Climate is what you expect – *Weather is what you get*

The take-aways are that...

… enduring climate conditions beyond our coping range will require adaptation, but it is likely that the ability to adapt will be hampered by the adaptation deficit - *where we fail to recognize that the behaviour of our climate system and related services is very quickly heading beyond our coping range*.

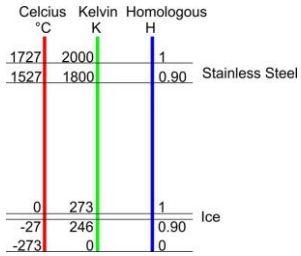
… in a non-stationary climate system, forecasting weather and hydrological behaviour based on the past is unreliable and even hazardous.

Cold Matters but Ice Is HOT !!

Never warmer than 0°C

Floats in its own melt

Hot ? … Homologous temperature ratio: $H = \frac{T}{T_m}$



Readily deforms under its own weight

Glacier ice is a geological material formed by deposition, consolidation and **dynamic flow.**

So, before we look at a couple of examples of the impact of climate variability and change in our region, here is some homework for you. **Basically, ice, relative to it's melting temperature, is a hot material !**

I like to use this "teaching moment" to challenge the notion of the permanence of ice.

H represents the material working temperature as a fraction of its melting point temperature (Kelvin scale)

When H = 1, T working = T melting

EXAMPLE … For H = 0.9 (i.e., 246 K / 273 K) , represents a working temperature for ice of -27 °C

Equivalent to stainless steel at a working temperature of 1,527 °C

T lead about 270 °C

T aluminium about 570 °C

For most practical considerations / applications, ice is only, at most, c. 40 K from its melting point !!

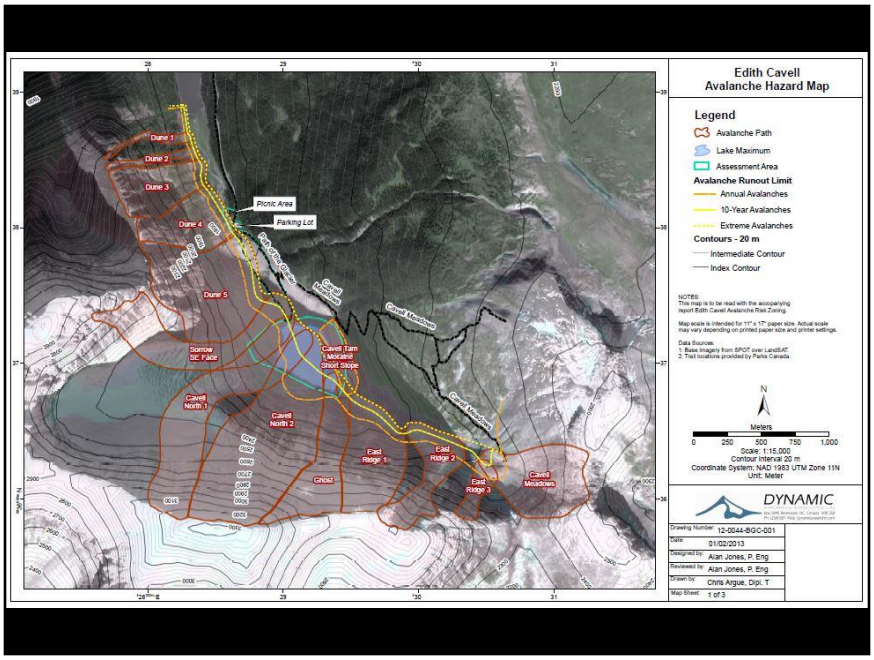
Glacier serac detachments, while episodic, are very dangerous – more so when entire glaciers detach.

An indicator that climate heating and meltwater is penetrating areas we only ever considered perennially cold – in this case our high elevation, north faces

This event occurred some years ago …

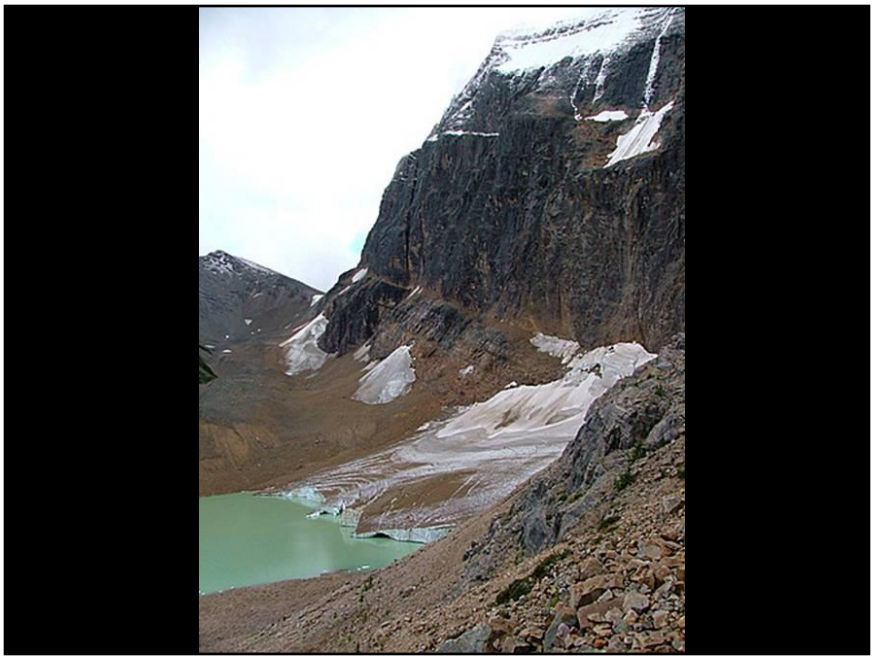
Ghost Glacier Ice Avalanche, 2012 August 9-10, **dusk<>dawn**, Mount Edith Cavell, South Jasper Ranges, Alberta, Jasper National Park of Canada

…. nearly a complete detachment event



General configuration of the valley below and several avalanche paths on the north face of Mount Edith Cavell

About 125,000 m^3 detached…

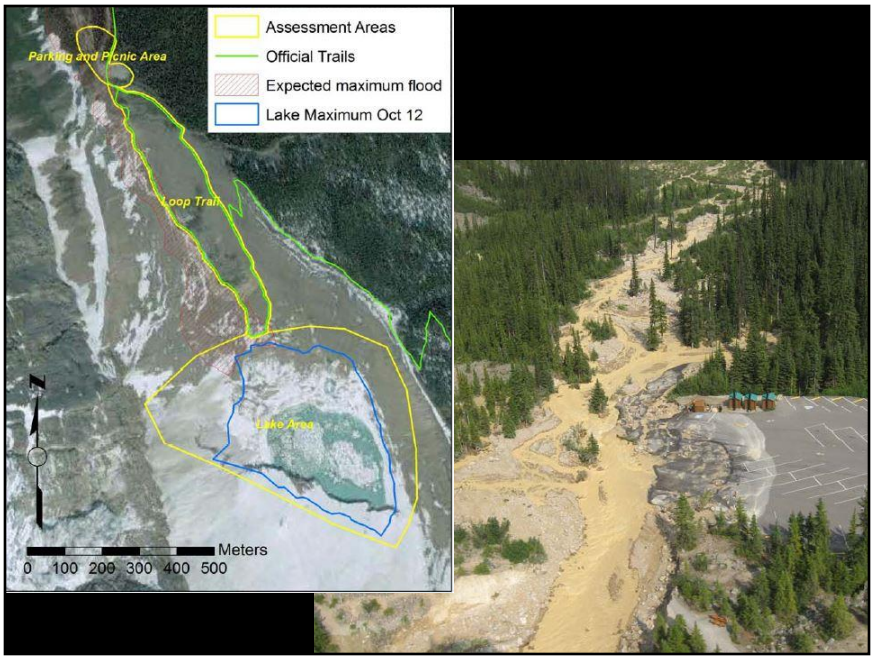


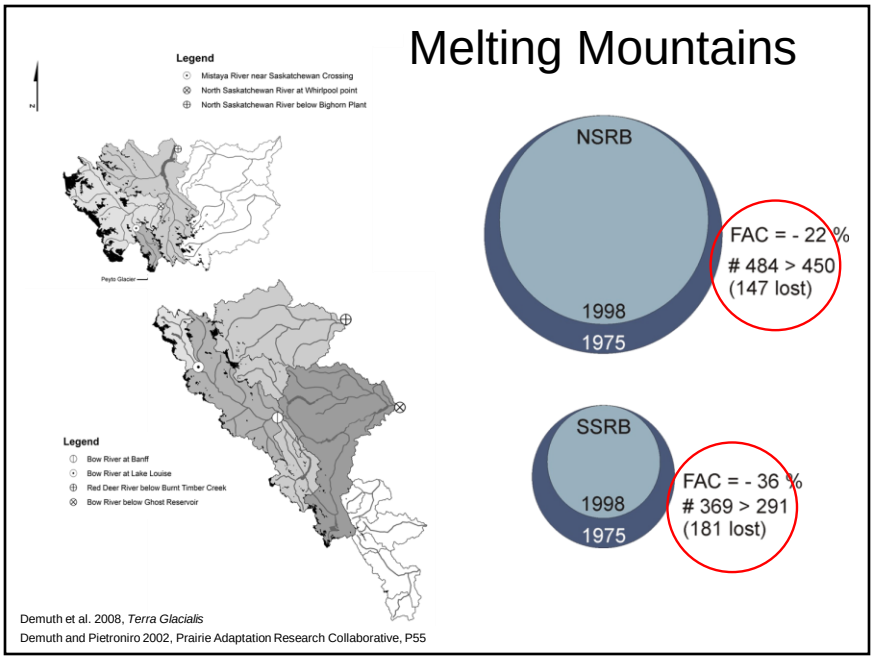
… and fell some 1,200 vertical metres

The trajectory and entry of the ice mass into the impounded Cavell Tarn created a displacement wave which over-topped and eroded the end moraine, creating a new channel, followed by the lake partially emptying

Stranded bits of glacier after seasonal drawdown of the lake (2 months after event)

Margaret 5’ 8”


Assessment Areas
Official Trails
Expected maximum flood
Lake Maximum Oct 12
Parking and Picnic Area
Loop Trail
Lake Area
Meters
0 100 200 300 400 500



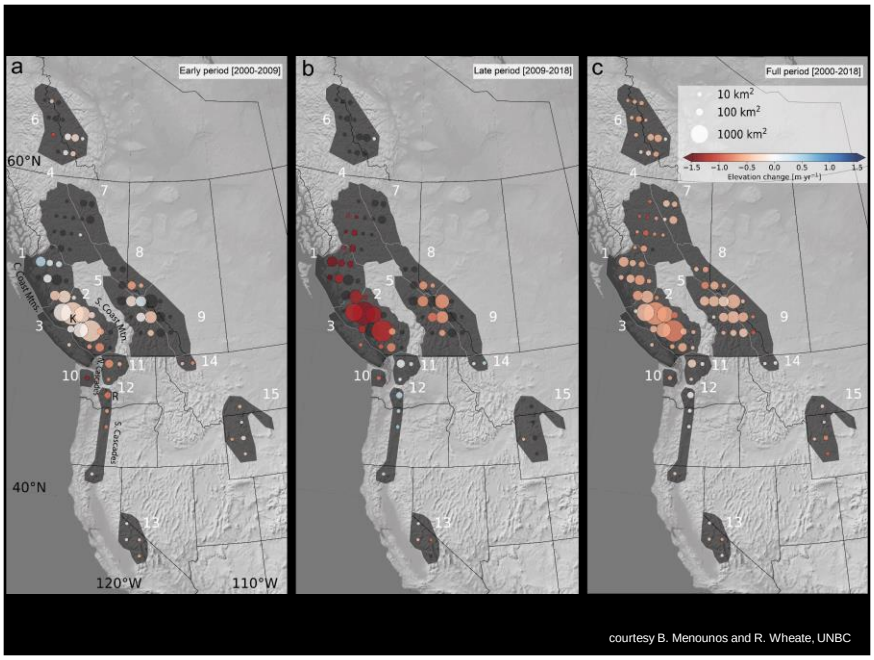
Some early work concerning glacier losses in the Rocky Mountain Eastern Slopes - using legacy mapping, photography and orbital remote sensing

Note # of glaciers lost …

In particular note that the difference between the # of glaciers is not equal to the # glaciers lost because some glaciers fragmented into smaller distinct ice masses

Also noteworthy is the finding that numerous glaciers retreated into topographical niches where they are reliably nourished by drift snow and protected from solar radiation

Demuth, M.N. et al., 2008: Recent and past-century variations in the glacier resources of the Canadian Rocky Mountains: Nelson River system. In - Mountain glaciers and climate changes of the last century, Bonardi, L. (Ed.), Special Issue Terra Glacialis: 27-52.



A more recent Pan-Cordillera effort – using laser mapping and orbital remote sensing in conjunction with legacy mapping and photography

Both area-wise change (size of circle) and surface elevation change (colour of circle) is indicated

The last two decades are characterized almost entirely by area-wise diminution and surface lowering …

… showing signs of acceleration - increased warming and, if one drills a little deeper, positive feedbacks related to glacier size and diminishing surface albedo are at play

Speaking of surface albedo, another version of this trope …

… can reduce surface albedo to 0.2

Edward Struzik photograph
August 29, 2016
Bologna Glacier
Nahanni National Park Reserve, NT

Forest fire soot is darkening the surface of glaciers in western and northern Canada – even the Greenland Ice Sheet - intensifying meltwater generation …

… further affecting glaciers that are already losing mass and retreating at unprecedented rates due to climate heating and unreliable nourishment by snowfall

Connecting the dots …1

The Importance of **Intact Uplands**

- **Capture precipitation** (and runoff from the Cryosphere)
- **Forests and soils capture and filter** water
- Provide for **storage**
- Source of **nutrients and sediment/gravel**
- **Support diverse ecological communities**
- **Store carbon**

Next, I want to talk about the importance of intact systems – specifically those related to land and water – some basic concepts *from top to bottom*

I've adapted the next several slides from a Land-Water-Fish syllabus developed by my colleague Kelley Chapman of Powell River

INTACT UPLANDS:

-Forests and Cryosphere moderate air temperature

-Capture precipitation; surface runoff is diverted into streams, lakes and wetlands and nourishes groundwater

-Forests and soils capture and filter out sediments and pollutants in runoff and groundwater

Very importantly! … intact uplands store water collected during wet periods; helps to maintain stream flows during drier episodes; glaciers, in particular, store water during cool climate episodes; release water during warm ones – essentially extending the seasonal flow peak into Summer when other inputs are absent (ppt) or in decline (snowmelt) …

-they reduce flooding – winter wet season stream flows less destructive !!

-weathering in upland areas slowly releases nutrients from rocks into water; produces sediments and gravels that enter downstream reaches

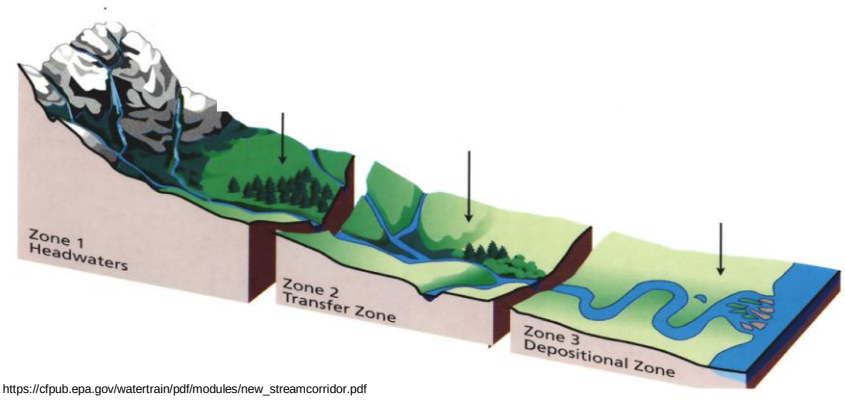
-they support diverse ecological communities (plants, insects, wildlife)

-and they sequester carbon in vegetation and soils

Connecting the dots …2

The Importance of **Intact Streams**

- Energy, weathering and material/nutrient transport



https://cfpub.epa.gov/watertrain/pdf/modules/new_streamcorridor.pdf

From top to bottom the overall longitudinal profile of most streams can be divided into three general zones (after Schumm 1977).

Zone 1, or headwaters, often exhibit the steepest gradient.

Mountain headwater streams flow swiftly down steep slopes and cut deep v-shaped valley. Rapids and waterfalls are common.

Gravel and sediments recruitment occurs in headwaters, and are then transferred by flow down to lower zones.

Zone 2, Low elevation streams merge and flow down gentler slopes

Valley broadens and the river begins to meander

This **transfer zone** receives some of the eroded material

Wide floodplains and meandering channel patterns are common

Zone 3, The gradient flattens

At lower elevations rivers wander and meander across broad, nearly flat valleys

At its mouth it may divide into many separate channels as it flows across a delta built up of river-borne sediments into the sea.

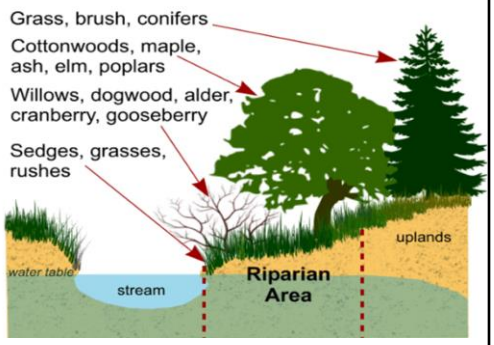
This is the primary **depositional zone**

Note: erosion, transfer, and deposition occur in all zones, but **the *zone concept* focuses on the most dominant process**.

Connecting the dots …3

The Importance of **Riparian Areas**

- **Stabilize** stream banks
- **Regulate** water temperature
- **Reduce evaporation**
- **Store water**
- **Filter water**
- **Support diverse ecological communities**
- **Store carbon**



https://www.crd.bc.ca/education/our-environment/ecosystems/terrestrial/riparian-zones

So very important are the Riparian Areas – *the stream adjacent regions that exhibit high productivity, species richness and* diversity; *composed of moist to saturated soils, water-loving plant species and their associated ecosystems*

The vegetation that grows in riparian zones is specially adapted to wet soil conditions, and can tolerate periodic flooding. This vegetation fills an important niche that connects the water's edge with the adjacent dry land, and in so doing accomplishes a number of functions:

A. Trees and shrubs that border and overhang streams and lake shores moderate the temperature through shading and the cooling effect of evapotranspiration. This directly benefits fish and aquatic invertebrates, and prevents excess algae growth

B. The roots of plants growing along and near stream banks, lake shores and estuaries provide structure and strength, collect sediment and thus prevent banks and shorelines from being washed away

C. Leaves, twigs, needles and whole trees that fall into water bodies provide nutrients to aquatic invertebrates, which in turn nourish fish

D. Large trees that have fallen into streams help to dissipate the energy of flowing water, protect stream banks and create pools and refugia for fish

Large woody debris…

… again:

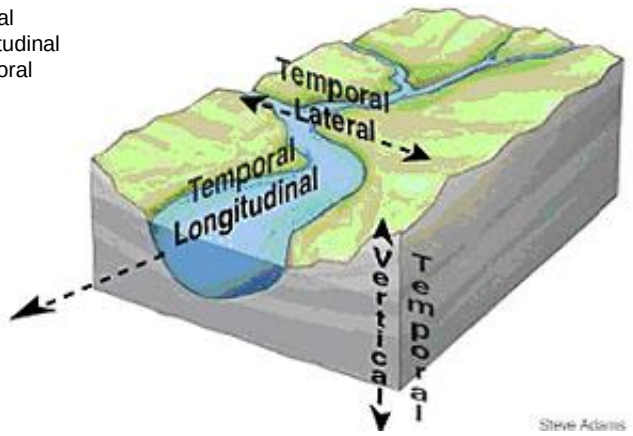
-Stores sediment (water slows, sediments settle out)
-Helps to form pools and channel structure
-Provides habitat for invertebrates and fish

That’s a Char - Bull Trout … beautiful !!

Connecting the dots …4

A Healthy Watershed is a Connected Watershed

- Lateral
- Vertical
- Longitudinal
- Temporal



Spatial and time varying connectivity is important…

Ensures natural river processes (f.ex., channel maintenance, floodplain evolution) continue to occur and ensures there is a flow of energy and nutrients between and within aquatic and terrestrial environments (f.ex., Autumn leaves washed into the stream provide food for aquatic insects)

Without it, fragmented habitats, whether they be terrestrial or aquatic, will have lower species abundance and diversity; difficult for species to re-colonize habitats that are isolated.

As it concerns flooding, **lateral connectivity is extremely important:**

- Is the river able to connect with its floodplain (f.ex., during floods) ?
- Is there a connection between the aquatic and upland environments ?
- Is there a healthy riparian area ?

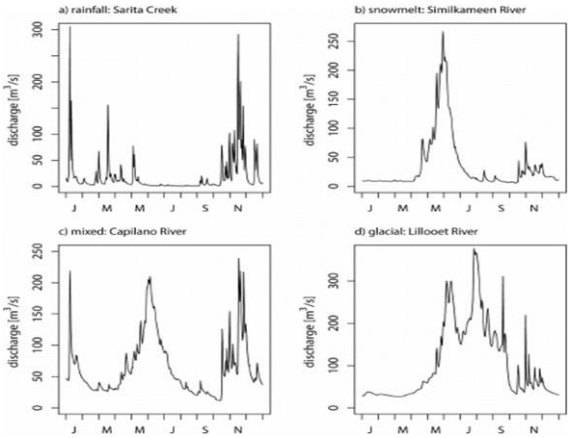
Vertical Connectivity: is the river connected to underlying groundwater/aquifers ?

Longitudinal connectivity: how connected is the river along its length? Is it broken up by dams, weirs or natural obstacles ?

Temporal connectivity: how is the river connected over time – does it dry up into disconnected pools during the dry season ?

Connecting the dots …5

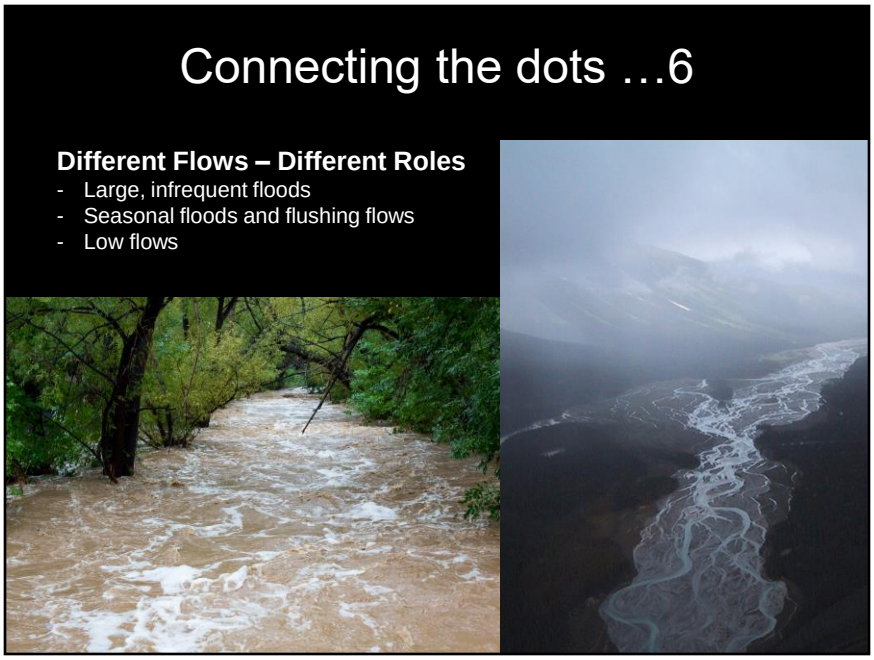
Fingerprinting stream hydrology



Now, discharge is the central driving entity of a stream ecosystem

So let's have a quick look at typical river discharge characteristics – the hydrograph

… note pluvial, nival and glacial fingerprinting – note especially the extended flow peak for catchments containing glaciers



Large, infrequent floods:

-Shape river valley and floodplains

-Flush-out large blockages and boulders

-Deposit fertile sediments on floodplains

Seasonal Floods & Flushing Flows:

-Stimulate germination of riparian plants

-Clean-out sediments & pollutants

-Maintain deep narrow channels

-Create *pool-and-riffle* morphology for fish

Low flows:

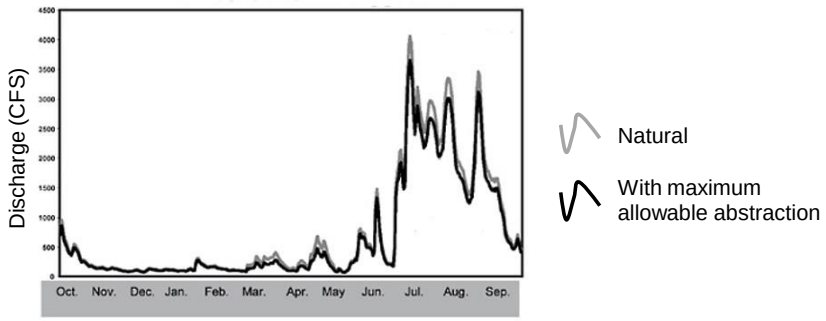
-Provide minimum survival conditions for aquatic life & riparian plants

-Trigger dormancy in some plants, fish and insects

Connecting the dots …7

Ecological (Environmental) Flows Needs

- EFN = water required to sustain a healthy aquatic environment
- Guidance: artificial abstraction <= 10-15% of instantaneous natural flow
- No artificial abstraction during low flow regime



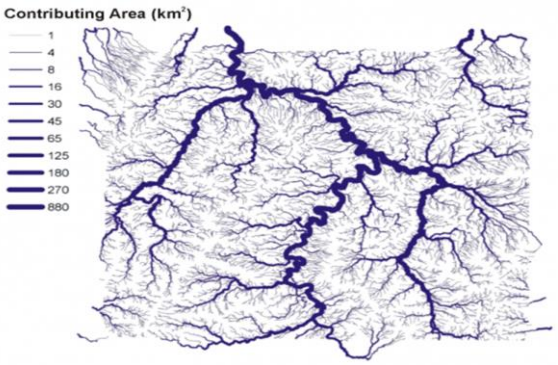
Finally, another important concept is **Ecological Flows**

Schematic illustrates Percent of Flow Approach

Connecting the dots …8

The Importance of **Small Streams**

- 90-95% of total number of streams per total stream length in a watershed
- 70-80% of the total drainage area
- Support an additional 100-2,000 young Salmonids per km of fish bearing stream downstream



… and let's not forget small streams - they are small, but numerous!

Estimates of the number of young-of the-year salmonids that could be supported by invertebrates and other food sources from small non-fish-bearing streams range from 100 to 2,000 for every kilometre of fish-bearing watercourse downstream

Although fish density may be greater in larger systems because of better access, year- round flow, and larger areas of complex habitat, small streams are equally important as they are the conduits for the elements needed to maintain the functioning condition of downstream reaches

Small streams and their adjacent riparian zones also support fish, amphibians, and insects at the reach level, further increasing their significance within the watershed

So, what I've been attempting to emphasize is that ***intact systems provide buffering …*** *and in concordance with the theme of the Speaker Series,* ***preserve biodiversity***

As it concerns forestry, and sustainable forestry in particular, I give you the definition **by the 1993 Ministerial Conference for the Protection of Forests** and adopted by the United Nations:

Recognizes forests serve society in essential ways beyond supplying timber. This includes purifying our water and air, moderating floods, providing food and medicines, and providing habitat for wildlife.

However, …

BC Council of Forest Industries (BC COFI):

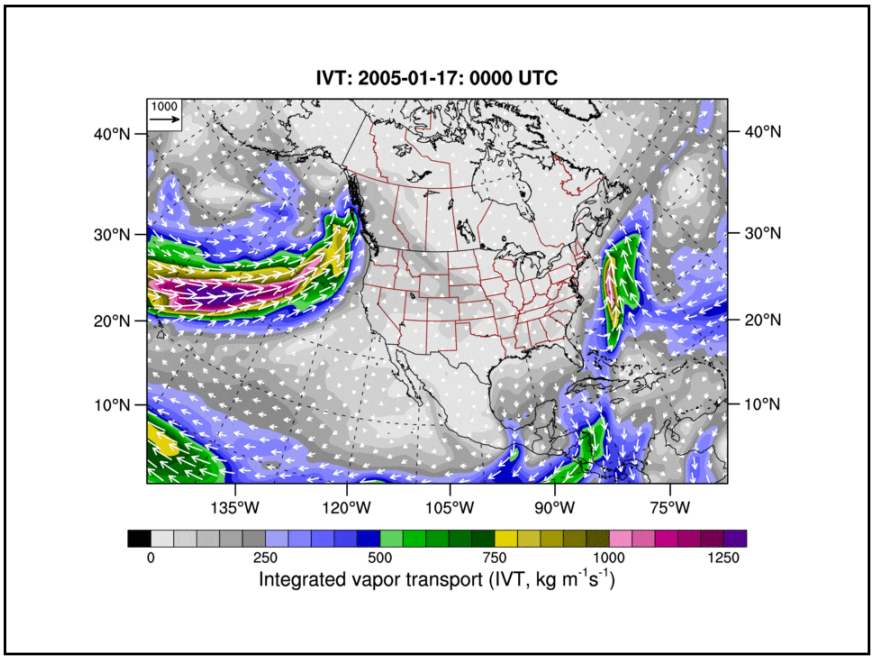
BC Leads the World in Sustainable Forestry

Government of B.C.:

B.C. is a world leader in sustainable forest management with leading-edge environmental practices.

From Grand Chief Stewart Phillip (Syilx/Okanagan) et al.'s piece in The Tyee (November 12, 2021) on failed provincial forestry policies…

… I quote …



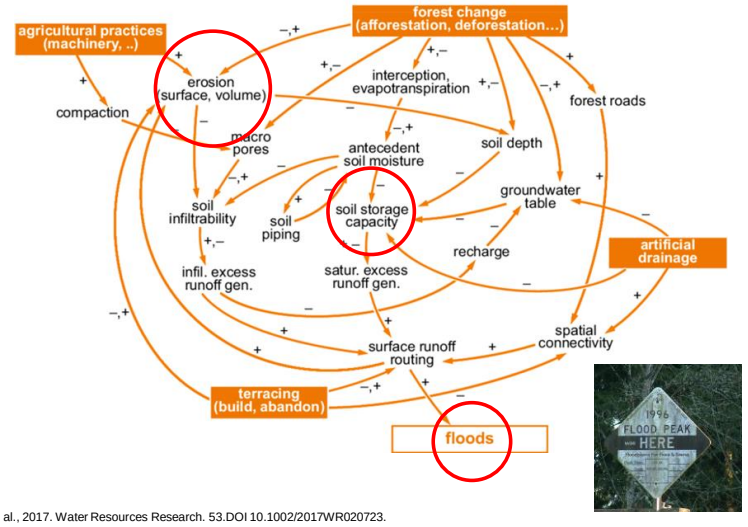
Then this…

Not unique, but …

… couple this to certain antecedent conditions (f.ex. soils fully saturated; isothermal snow cover) and other precursors (land use practices and changes)

Note also how far inland an AR exert its influence

Land-use Change Effects on Floods



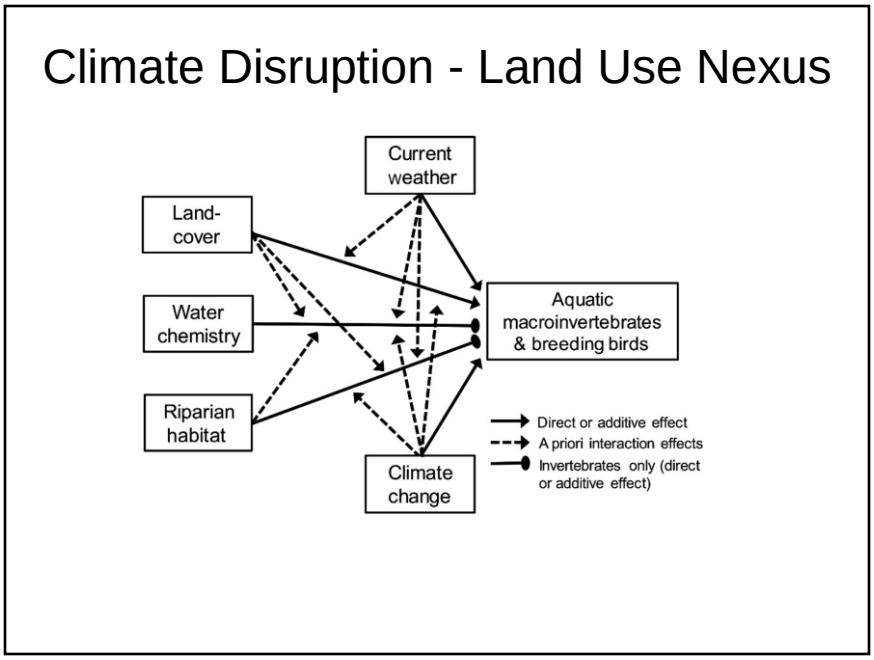
Rogger et al., 2017. Water Resources Research. 53.DOI 10.1002/2017WR020723.

Effects on floods at the catchment scale of process interactions resulting from land-use change

…where + and - signs indicate whether an increase in a variable increases or decreases another variable

Citation:

Rogger, Magdalena & M., Agnoletti & Alaoui, Abdallah & Bathurst, J.C. & Bodner, Gernot & Borga, Marco & Chaplot, Vincent & Gallart, Francesc & G., Glatzel & Hall, Julia & J., Holden & Holko, Ladislav & Kiss, Andrea & Kohnová, Silvia & Leitinger, Georg & Lennartz, Bernd & Parajka, Juraj & Perdigao, Rui & Blöschl, G.. (2017). Land-use change impacts on floods at the catchment scale – Challenges and opportunities for future research. Water Resources Research. 53. 10.1002/2017WR020723.



The link between land use and the climate is complex

Here we have direct/additive effects (know from empirical observation/understanding); and a priori effects (from theoretical deduction)

1. First, land cover--as shaped by land use practices >>affects the global concentration of greenhouse gases;

2. Second, while land use change is an important driver of climate change, a changing climate can lead to changes in land use and land cover;

f.ex. 1, agrarians might revert areas subject to erosion to pasture land

f.ex. 2, higher temperatures affect mountain Cryosphere and vegetation cover higher in the catchment as well as water needed for irrigation lower in the catchment

Citation:

Rogger, Magdalena & M., Agnoletti & Alaoui, Abdallah & Bathurst, J.C. & Bodner, Gernot & Borga, Marco & Chaplot, Vincent & Gallart, Francesc & G., Glatzel & Hall, Julia & J., Holden & Holko, Ladislav & Kiss, Andrea & Kohnová, Silvia & Leitinger, Georg & Lennartz, Bernd & Parajka, Juraj & Perdigao, Rui & Blöschl, G.. (2017). Land-use change impacts on floods at the catchment scale – Challenges and opportunities for future research. Water Resources Research. 53. 10.1002/2017WR020723.

"*The timing is just,.. it's atrocious. OK, at this very moment, I say we sit tight and assess.*"

*

[*If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 PPM to at most 350 PPM.*]

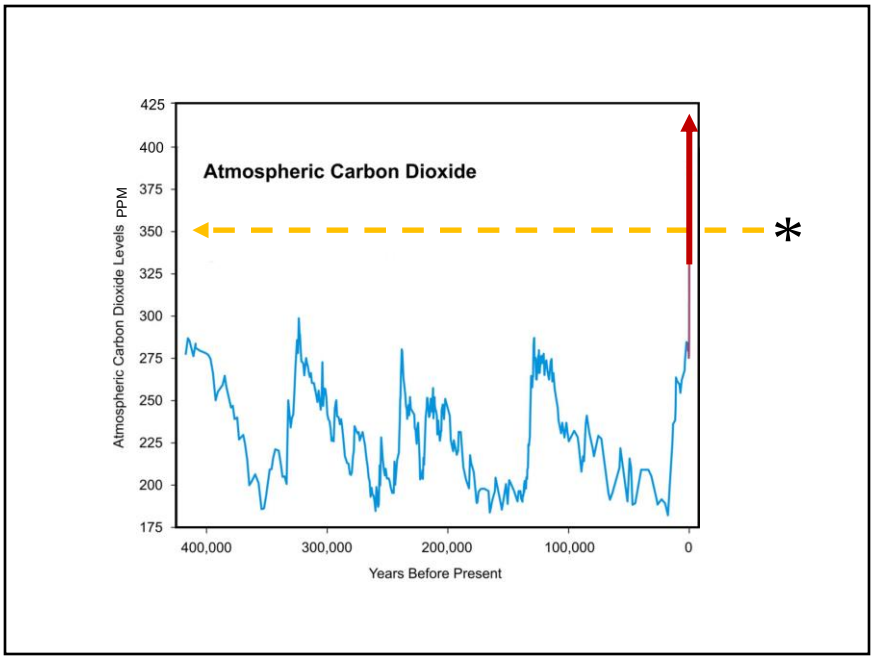
Hansen, J. et al. (2008)

So before we get lost in the weeds of schematics, let's remind ourselves…

Jim Hansen posited this dire warning back in 2008 !!

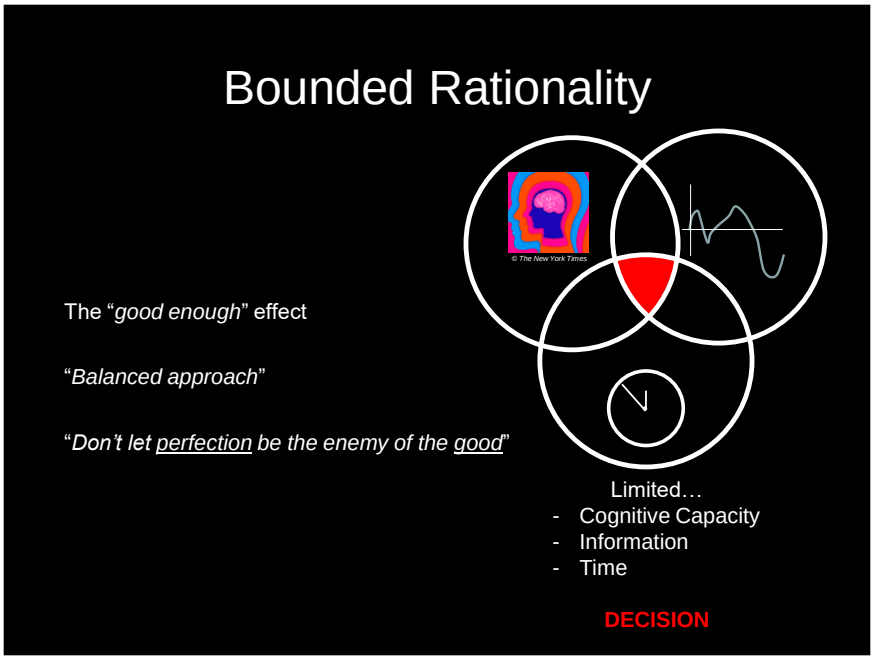
… headlined by some of my current sentiments apropos a recent film you've likely all seen or heard about

Hansen, J., M. Sato, P. Kharecha, D. Beerling, R. Berner, V. Masson-Delmotte, M. Pagani, M. Raymo, D.L. Royer, and J.C. Zachos, 2008: Target atmospheric CO_2: Where should humanity aim? ***Open Atmos. Sci. J.***, 2,(217-231), DOI: 10.2174/1874282300802010217.



REMINDER !!

It's 2022 and we are straying into 420 territory.



So let's consider some ways in which we got here…

The idea of ***bounded rationality*** (posited in 1955 by behavioral scientist and Nobel Laureate Herbert A. Simon) to counter the commonly held belief that being economical was equivalent to being rational.

Bounded rationality causes us to make satisfactory choices, but that does not mean that those choices are optimal.

Other tropes related to bounded rationality include "What you see is all there is" …

… where we limit decisions to information right in front of us, and fill in the rest with our own story or biases

In a biodiversity policy context – say we are attempting to understand and possibly align ourselves with a particular argument on say, climate action or forestry practice – we need to be aware of our imperfect decision-making, because proponents (and opponents) will use (these) vague qualifiers …

Individuals are most affected by bounded reality, whereas working in groups can help us to avoid the cognition-information-time conundrum

"Well, the handsome astronomer can come back anytime. But the yelling lady, not so much."

To protest or not to protest …

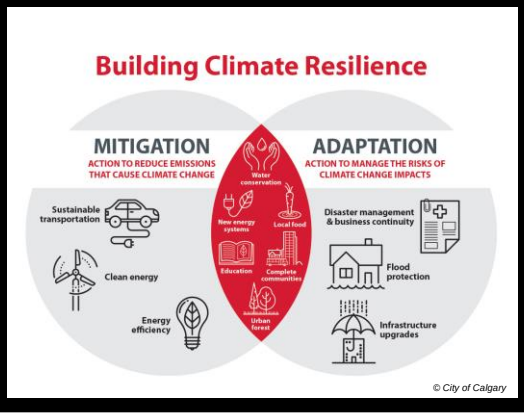
How do we influence/sway leaders and politicians … education ? – protest ? – both ?

Science – Policy, push – pull

Avoiding the Unmanageable

and

Managing the Unavoidable



Our goal should be …

… this rhyming idiom by V. Alaric Sample, Pinchot Institute for Conservation: writing about Climate Change Effects on the Natural Resources within America's Federal Public Lands.

… a metaphor for **Mitigation** (Avoid the Unmanageable) and **Adaptation** (Manage the Unavoidable)

… We need to do both

Hopefulness and Urgency - I

Wisdom in Reading and Listening

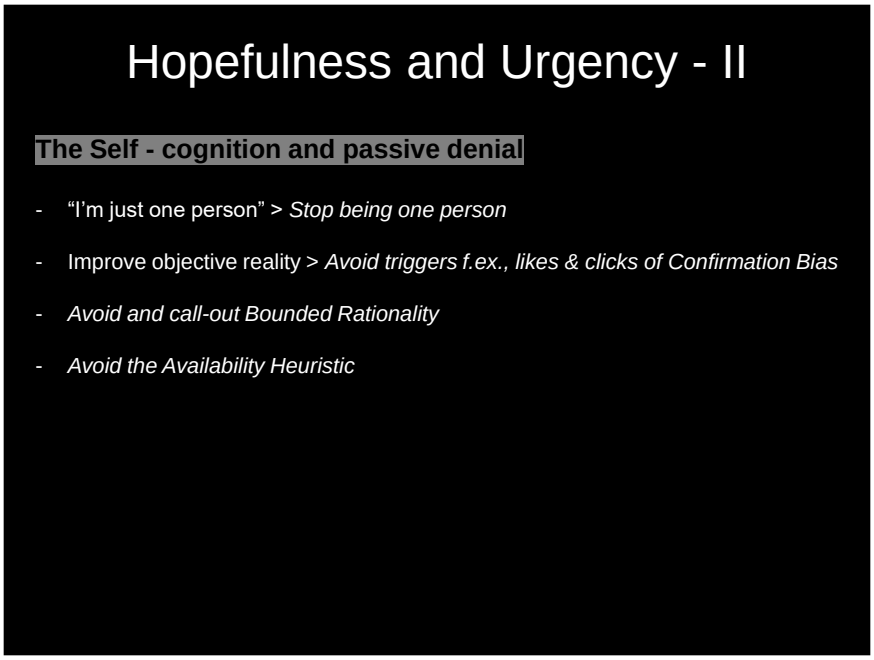
- *Ministry for the Future* by Kim Stanley Robinson
- *Regeneration-Ending the Climate Crisis in One Generation* by Paul Hawken
- *Braiding Sweetgrass-Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants* by Robin Wall Kimmerer
- Keep up to date > *IPCC Assessment and Special Reports (just the summaries :)*
- Critical thinking / Analysis / Consensus building forums > *f.ex., The Pembina Institute, is a Pan-Canadian resource on climate change and energy sector transformation. f.ex. "Canada's readiness to deliver a safe climate"*

  https://www.pembina.org/pub/all-hands-on-deck

Ministry4theFuture: Will nations go it alone ? Do we act as advocates for the rights of future generations of the world's citizens? – those rights being as valid as those of present generations.

Regeneration: describes how an inclusive movement can engage the majority of humanity to save the world from the threat of global warming, with climate solutions that directly serve our children, the poor, and the excluded.

Braiding Sweetgrass: a merging of the tools of science and the teachings of plants and animals



On the later point…

***Heuristic*:** ways to speed up decision making and finding solutions; f.ex., rules-of-thumb

***Availability Heuristic*:** people use the most easily accessible information to inform their decision-making:

-ease of retrieval

-recency and vividness

Can lead to risk-averse behaviour (say, not breaking out of the status quo) … a perceived risk versus actual risk thing

Climate Action is:

… is a values-base liberation of our conscious and unconscious capacity that lives at the intersection of one's humanity, intellect and passion, and strives to contribute to the stabilization of the Earth's climate system and the sustainable functioning of all it supports. It is related to and distinct from Environmental Action / Activism.

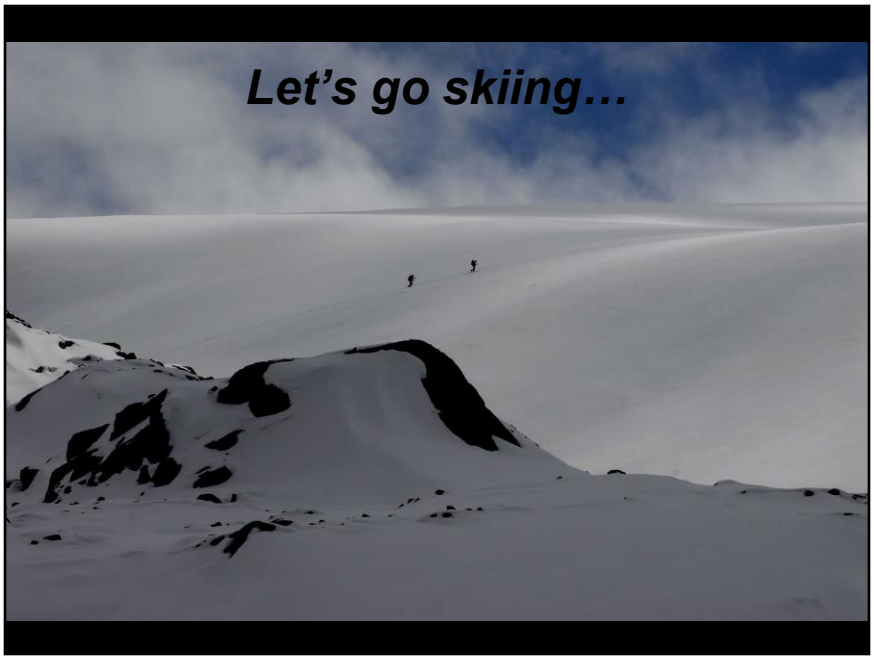
Our climate system has been disrupted to such a degree that there will be long, hard work ahead to make systemic and structural changes to how we travel, grow food and conduct trade and commerce - that we need to restore the functioning of our planet's durable but finite ecosystem.

We have a tendency to confine our arguments to National Circumstances – f.ex. the logical fallacy of those against as per capita emission metrics.

On that point, there should be put in place a common but differentiated set of responsibilities as it concerns fulfilling emission reduction commitments; that developed countries must take a proportionally higher role in the long-term emission reduction effort.

AND … on the dual goals of attaining net carbon neutrality by 2050 and limiting warming to 1.5 °C. Net neutrality by 2050 is all the rage and talking points, but please remind your leaders – that the pathway to 2050 is critical.

Modelling shows that continuing high emissions for a while, say, past 2030, and then dropping to net zero will still have us warm to and beyond 1.5 °C beyond pre-industrial and thereby experience some of the serious impacts that climate heating has to offer.


Let’s go skiing…