LECTURE 2_3:

CLIMATE CHANGE

IMPLICATIONS OF…

& MAP LITERACY 1 (MQ.1)

Text Reference: Dearden and Mitchell (2012), pp. 209-217

T. Randall, Lakehead University, WA 2014

Outline

Low-lying island nation in the Indian Ocean (Maldives) is planning to re-locate should predicted sea level rise occur. From: Dearden and Mitchell (2012)

- ***Activity:*** Map Literacy List #1
- Figure 7-6:
  - Summary of expected impacts in Canada over the 21st Century
- ***Specific Impacts*** {Terrestrial Systems; Agriculture; Freshwater Systems; Fisheries; Cryosphere; Oceans and Coastal Systems; Infectious Diseases}
- Other important global impacts {Ozone depletion; Global Sea Level Rise}

Map Literacy 1

Climate Change lectures

January 14, 2014

Map Literacy (list 1, January 14, 2014)

Communities, Jurisdictions

1. Churchill, MB
2. Inuvik, NWT
3. Whitehorse, Yukon

Natural Features

1. Mackenzie River
2. Mackenzie Delta
3. Hudson Bay
4. Prairies
5. Rocky Mts
6. Wapusk National Park
7. Ellesmere Island

Basics (5):

- Vancouver; Toronto; Winnipeg; Halifax; Edmonton

Summary of Impacts

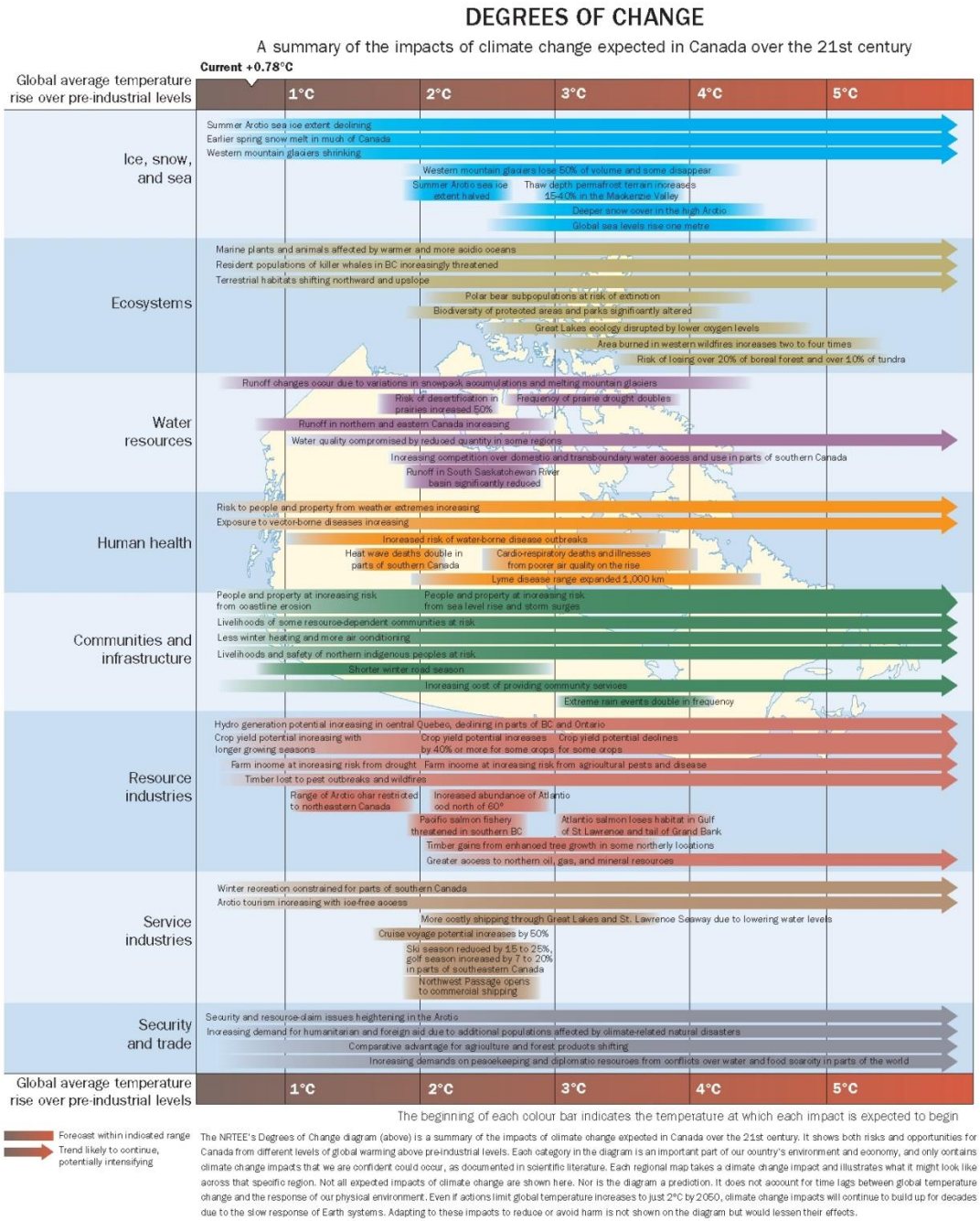


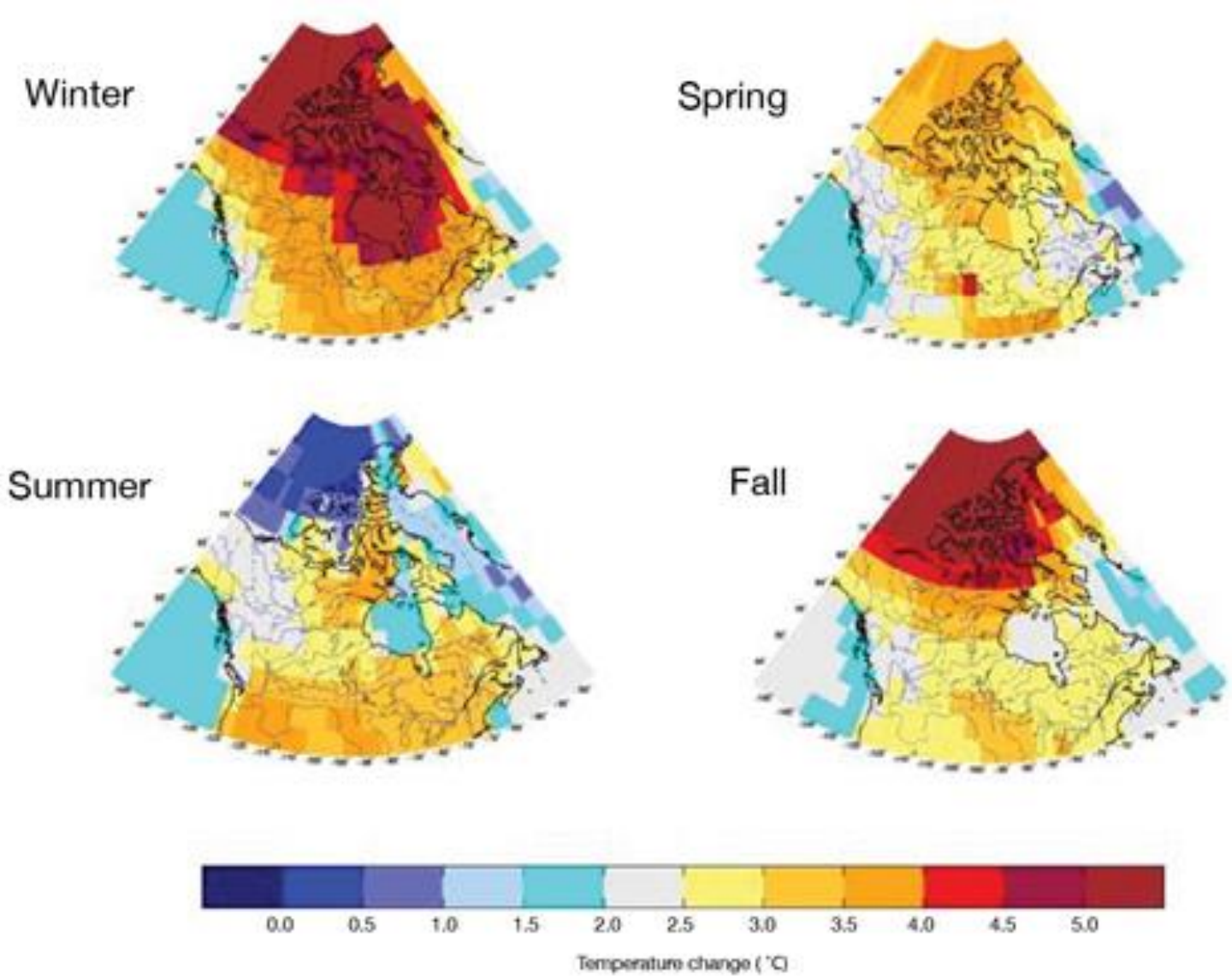
Figure 7.6 | Summary of the impacts of climate change expected in Canada over the twenty-first century. *Source: NRTEE (2010: O15).*

Figure 7.6:
Summary of the impacts of climate change expected in Canada over the twenty-first century. Source: NRTEE (2010).

From: Dearden and Mitchell (2012)

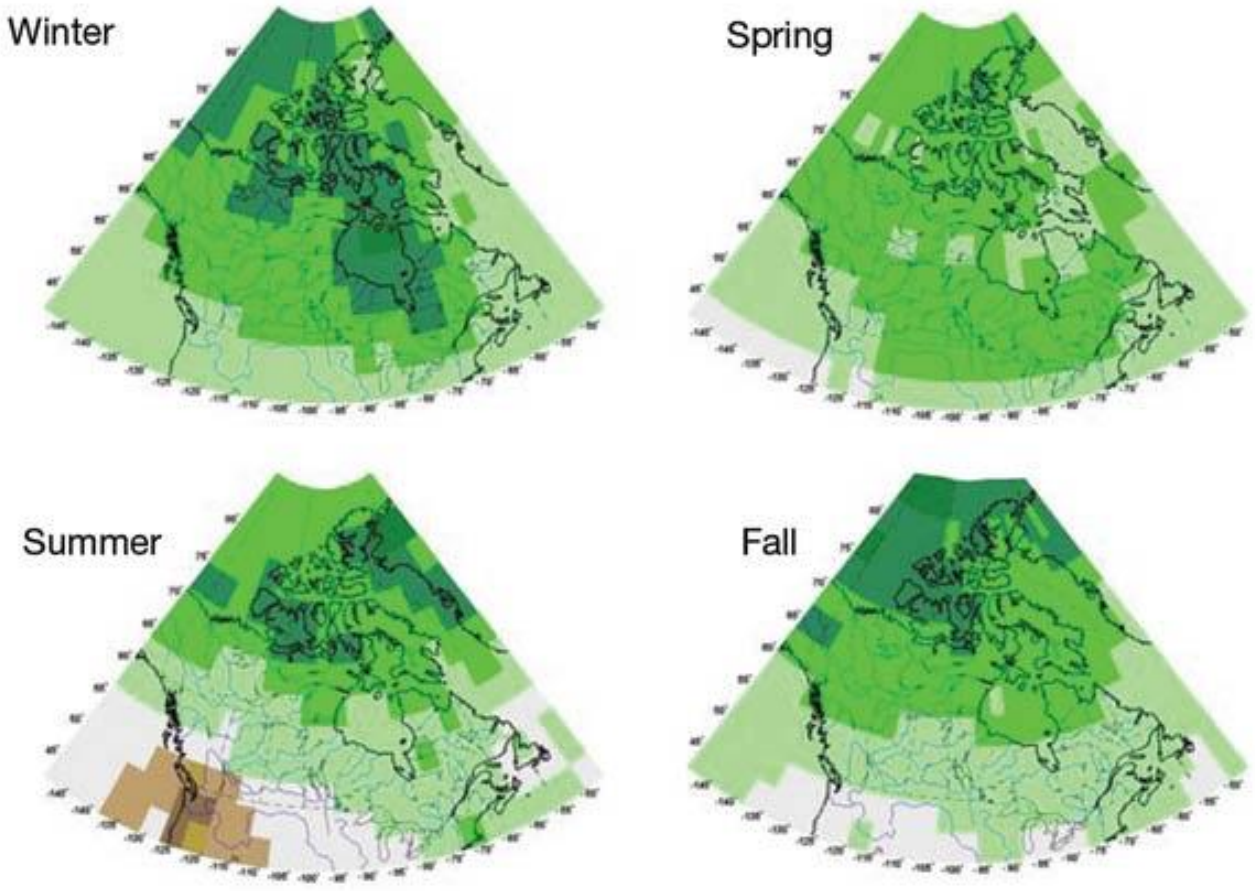
Expected Implications of Climatic Change

- Explore the range of physical, environmental, social and economic implications of expected climatic change;
- Current warming +0.78 deg C over pre-industrial levels;
- Projected temperature and precipitation changes are anticipated to have greater seasonal and latitudinal variations in Canada (*see next slide*)



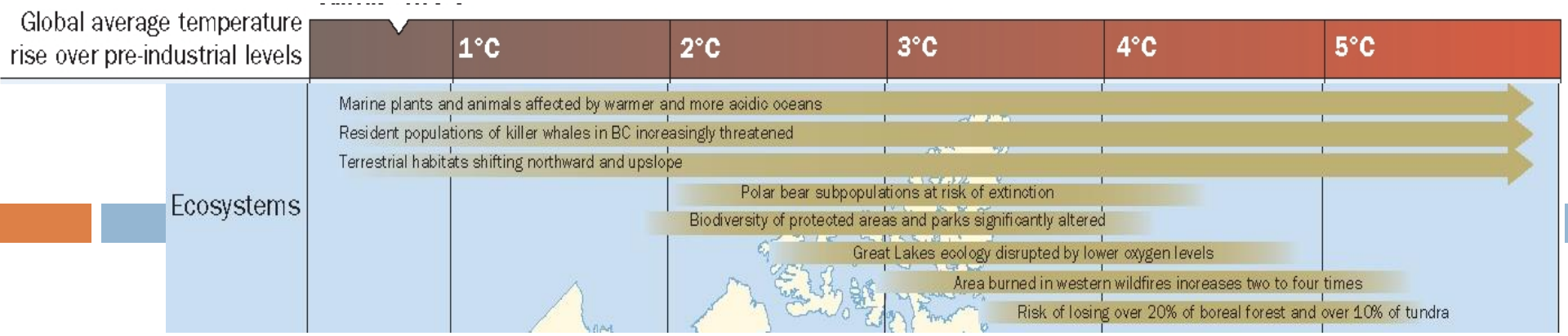
Modeled Seasonal Change in Temperature across Canada by 2050

Source: Natural Resources Canada (2007b)



Modeled Seasonal Change in Precipitation (relative to 1960-1990) based on the median of seven global climate models across Canada by 2050 (green = wetter; brown = drier)

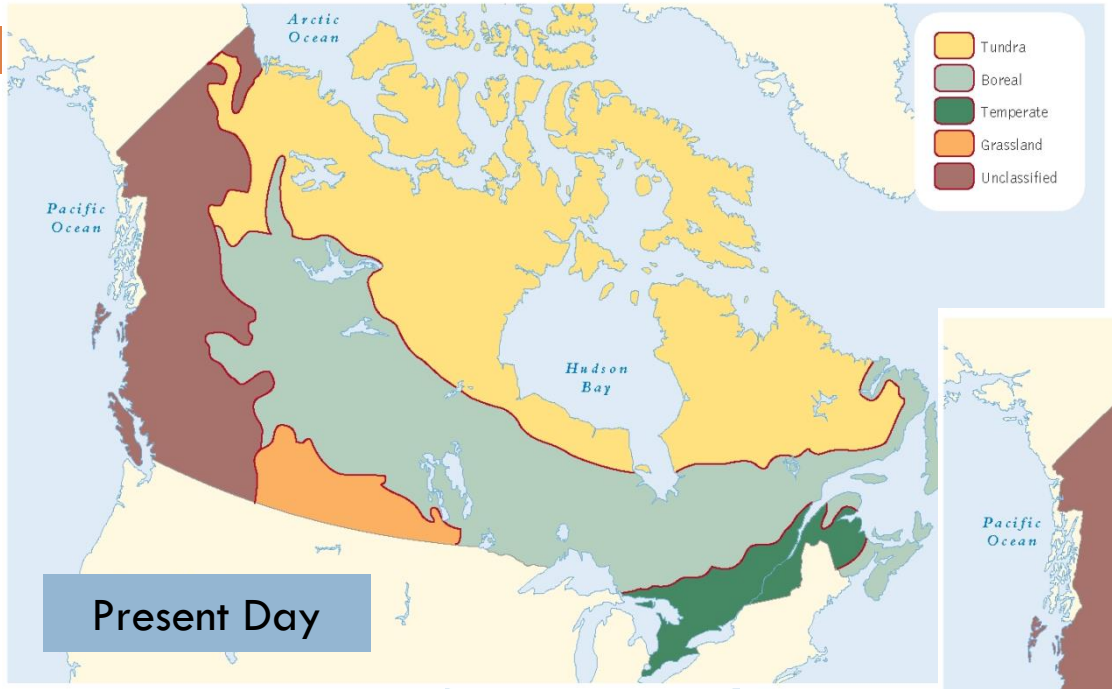
Source: Natural Resources Canada (2007b)



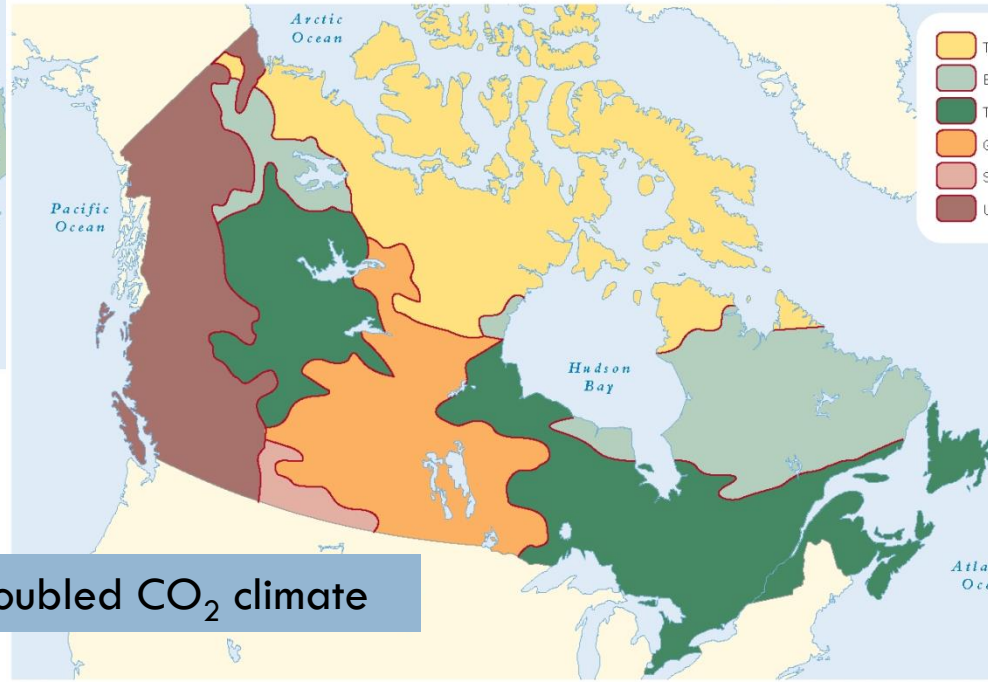
Impacts on the Ecosystems

- Significant changes for both terrestrial and aquatic systems (including those to flora and fauna)
- Dramatic shifts of boreal forest (e.g.), and these forests more susceptible to insect infestation, disease and fires
- Future of polar bear habitat along Hudson Bay (future of Wapusk National Park) – similarly other NPs may evolve away from the representative ecosystems they were created to protect

Figure 7.7 Changes in forest and grassland boundaries (modelled for a doubled CO_2 climate)



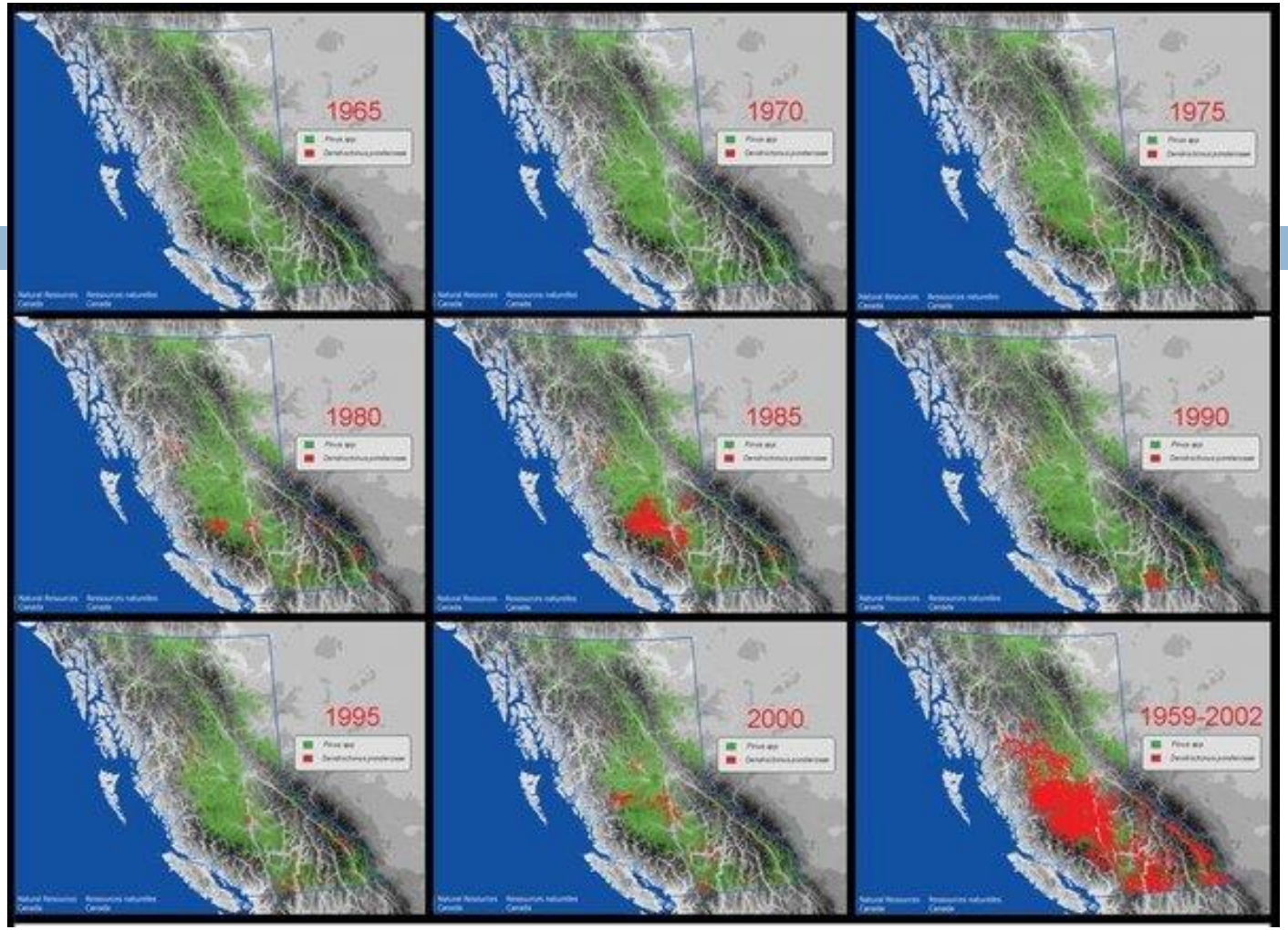
Present Day



Doubled CO_2 climate

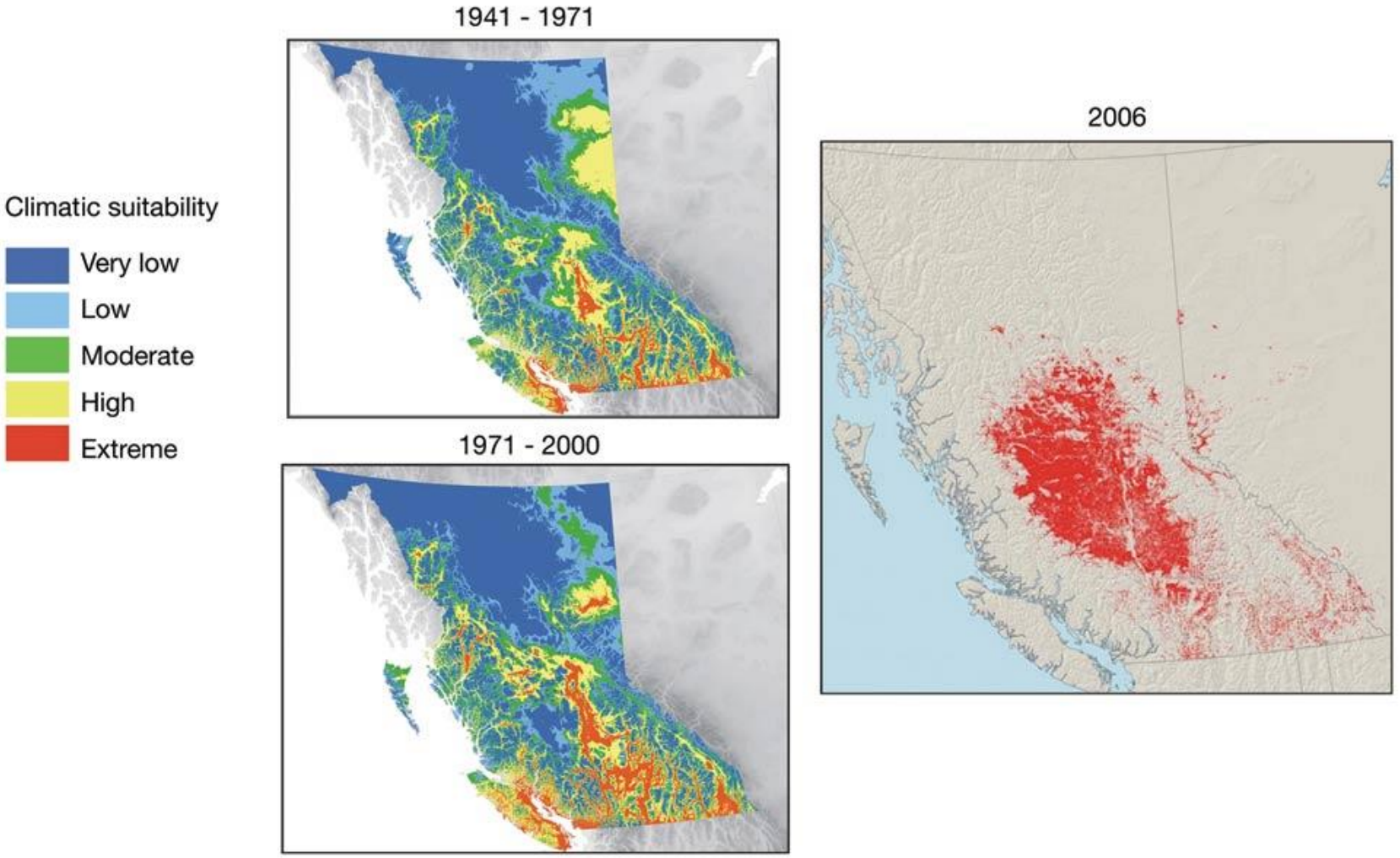
Tundra
Boreal
Temperate
Grassland
Semi-arid
Unclassified

Adapted from Hengeveld 1991 and Curran 1991 by Dearden and Mitchell (2012)

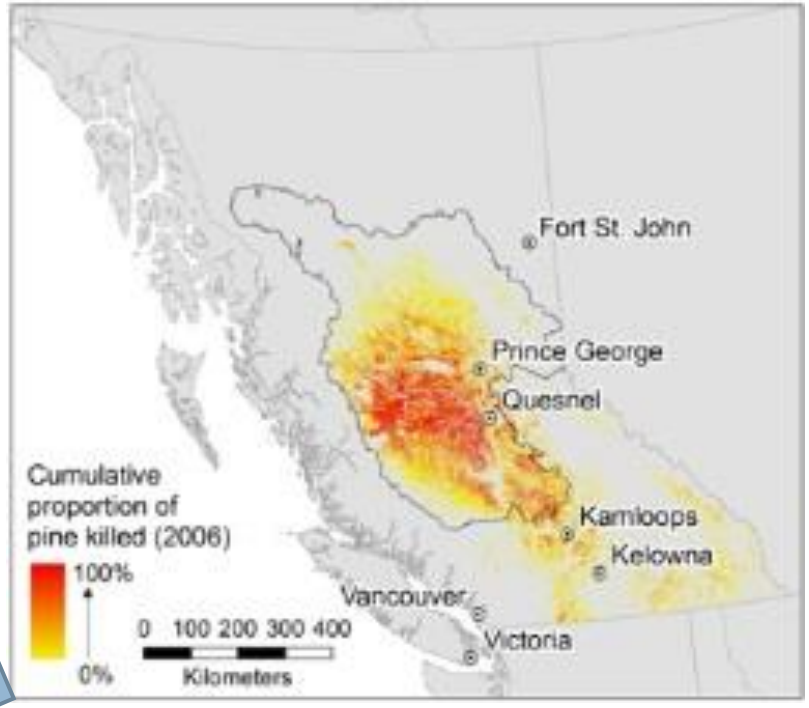


British Columbia is ground zero for mountain pine beetles with rapid increases in infestations starting in the late 1990s and early 2000s.The final image shows all the areas where infestations have been recorded between 1959 and 2002. Image: Natural Resources Canada

(Read more at: http://phys.org/news190275053.html#jCp)

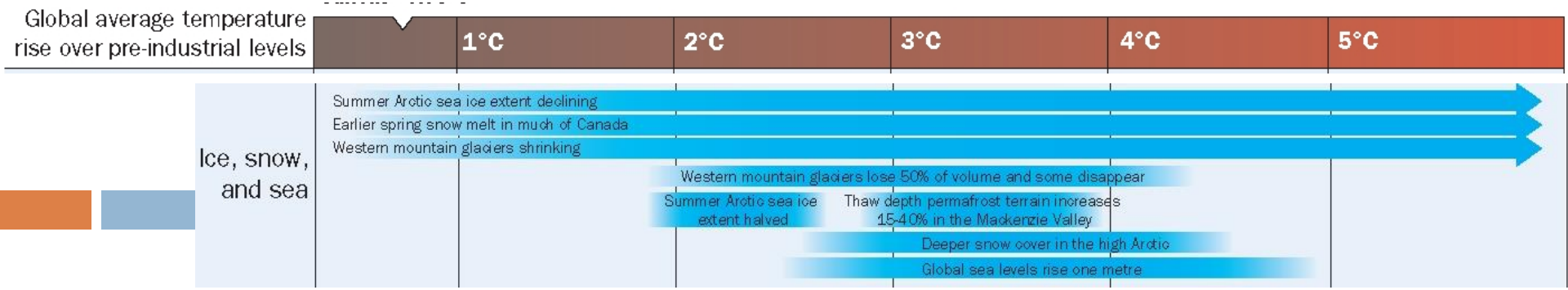


(Left) Historical distributions of climatically suitable habitats for the mountain pine beetle (MPB) in British Columbia (adapted from Carroll et al., 2004). Areas with 'very low' suitability are unsuitable for MPB, where as 'extreme' areas are those considered climatically optimal. (Right) Total area affected by mountain pine beetle in British Columbia in 2006 (Natural Resources Canada, 2007a)



http://science.natureconservancy.ca/centralinterior/central.php

Socio-economic impacts



Impacts on the Cryosphere

- Higher prospective temperatures at higher latitudes;
  - → ice sheets (Greenland Ice Sheet, Fig. 7.8; Antarctic Ice Sheet,)
  - → reduced valley glacier extents
  - → sea ice cover (albedo feedbacks)
  - → sea level forecasts
  - → shifting of permafrost zones and thawing of ground ice

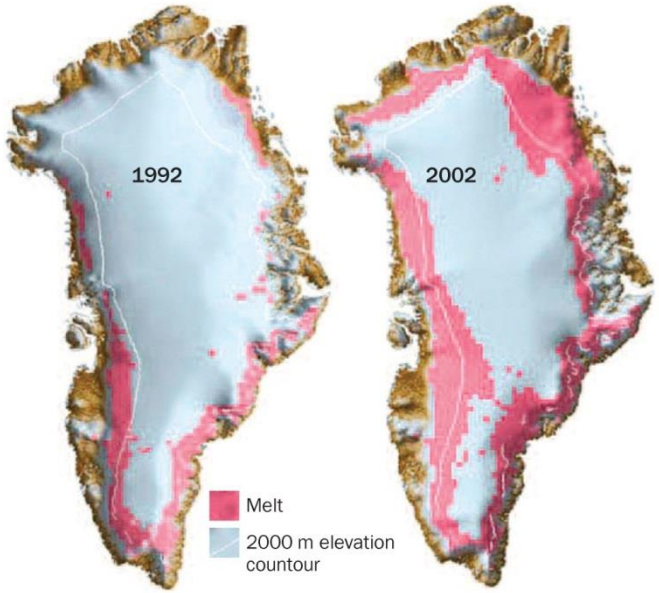
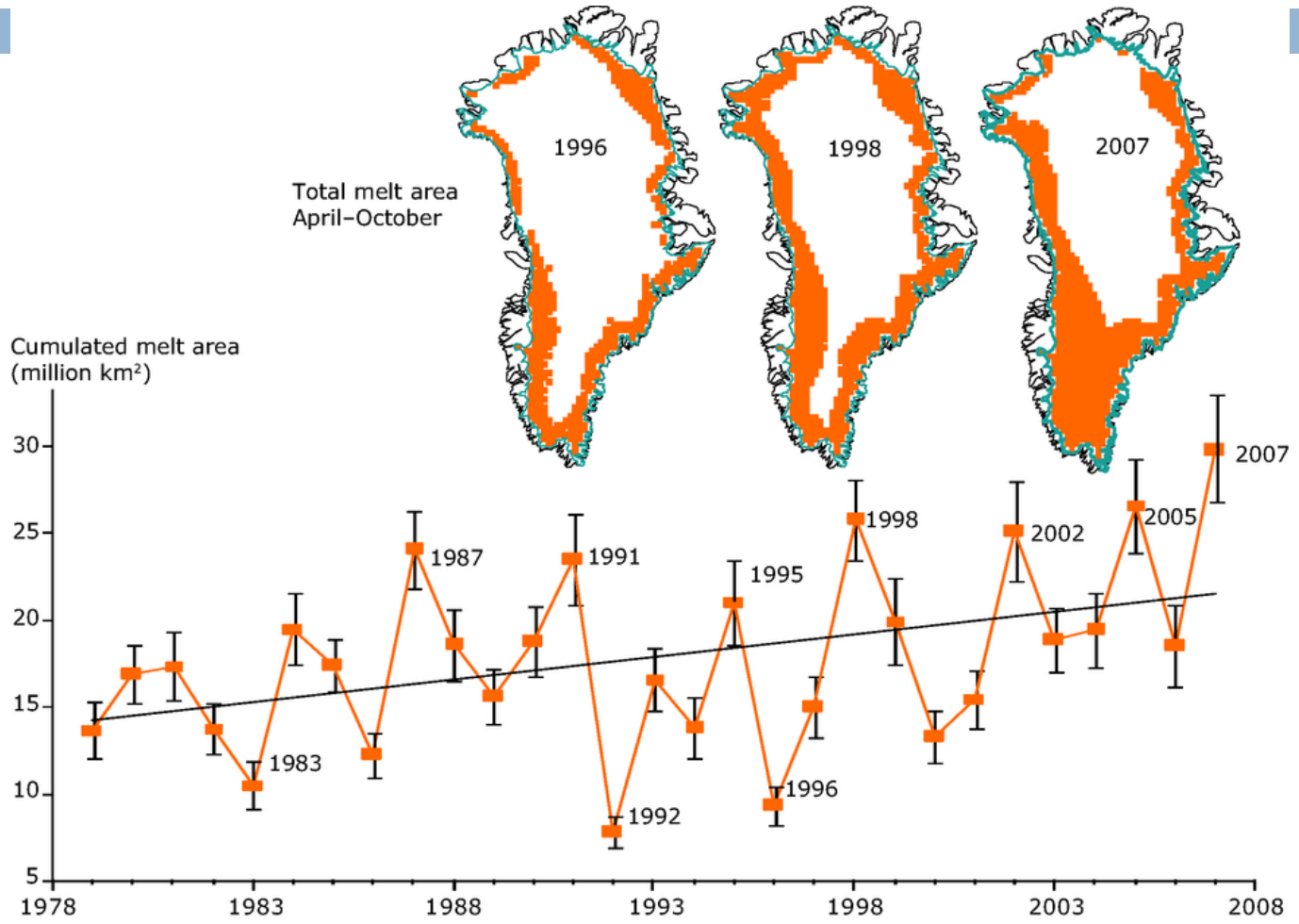


Figure 7.8 | Greenland ice sheet melt, 1992 and 2002. *Source: Walsh et al. (2004: 205).*

From: Dearden and Mitchell (2012)

Melt, Greenland Ice Sheet (1979 to 2007)

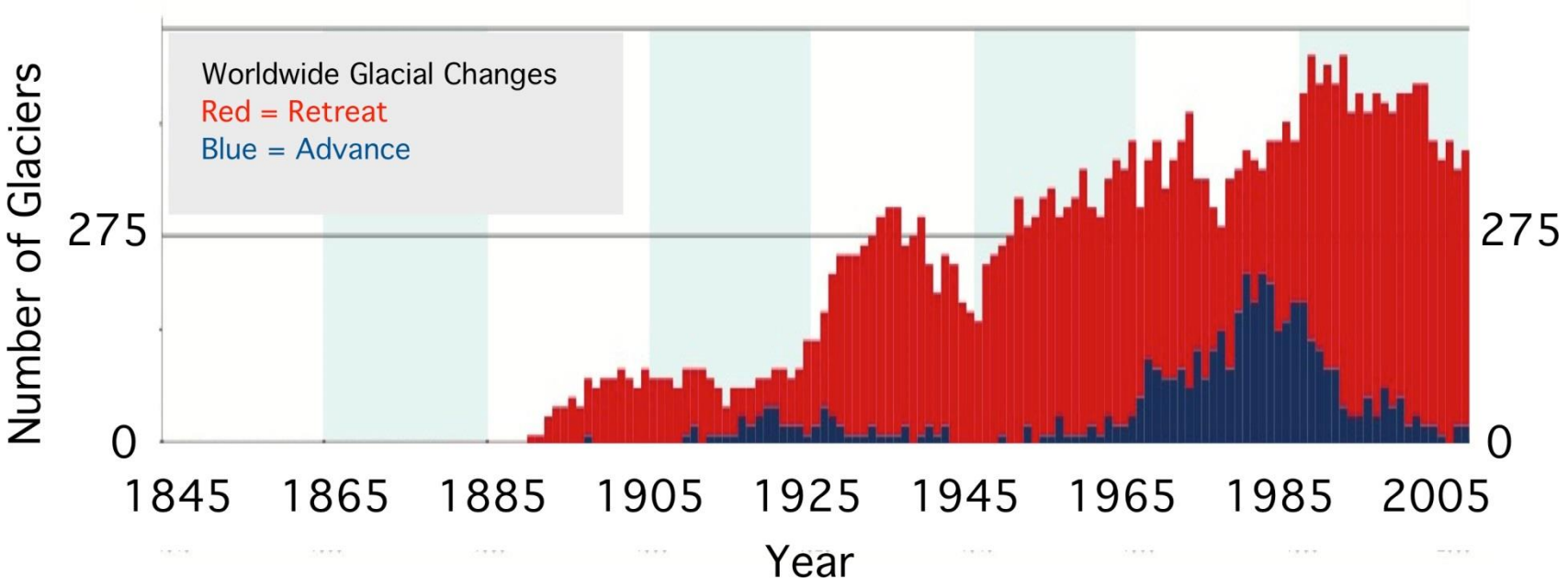


Source: European Environment Agency (2007)

http://wwws3.eea.europa.eu/data-and-maps/figures/area-of-greenland-ice-sheet-melting-1979-2007/image_xlarge

Other evidence of observed climate change / global warming

- Negative mass balance in most of the world's glaciers and ice sheets



Sea Ice Extent (Polar Ice Cap)

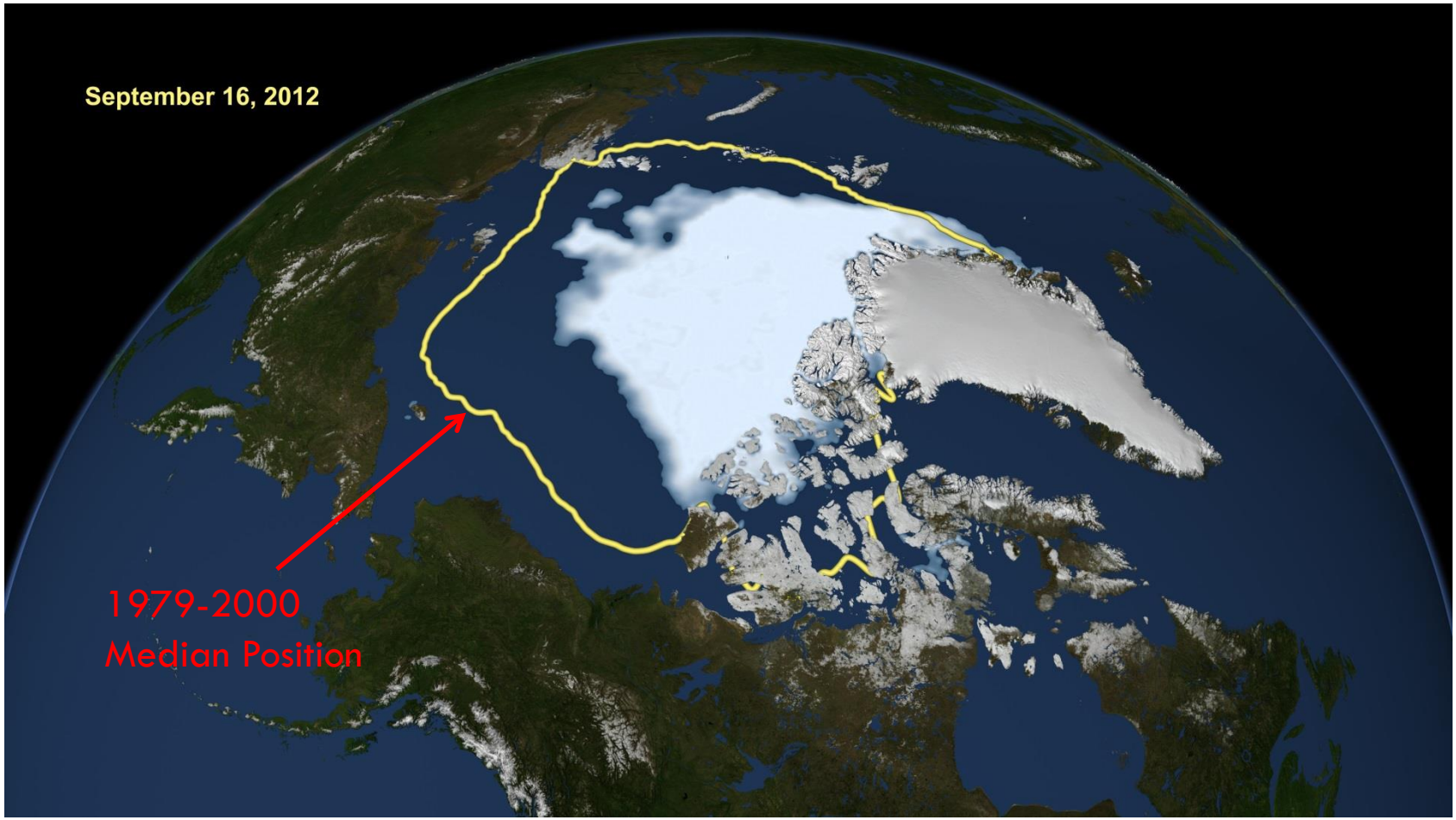
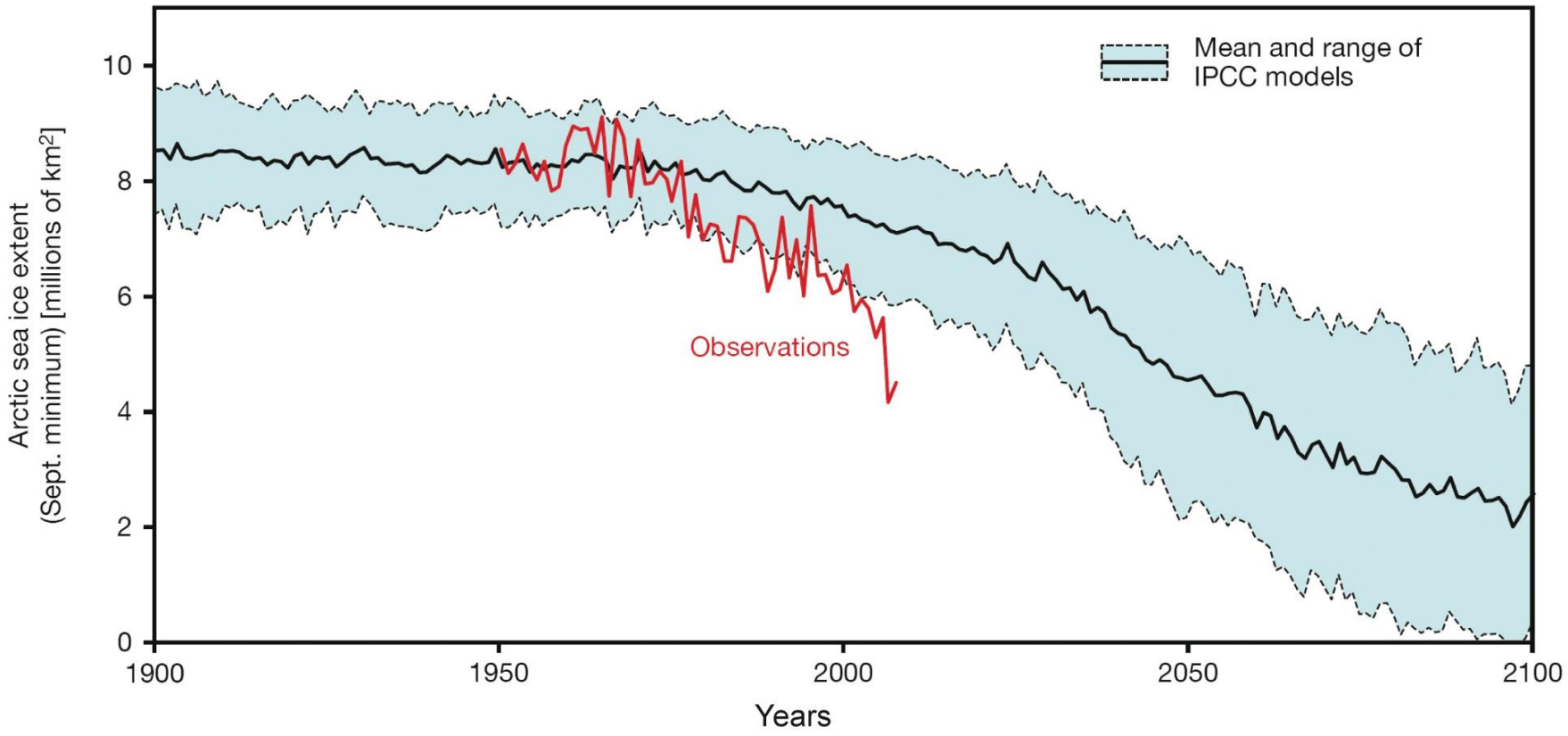


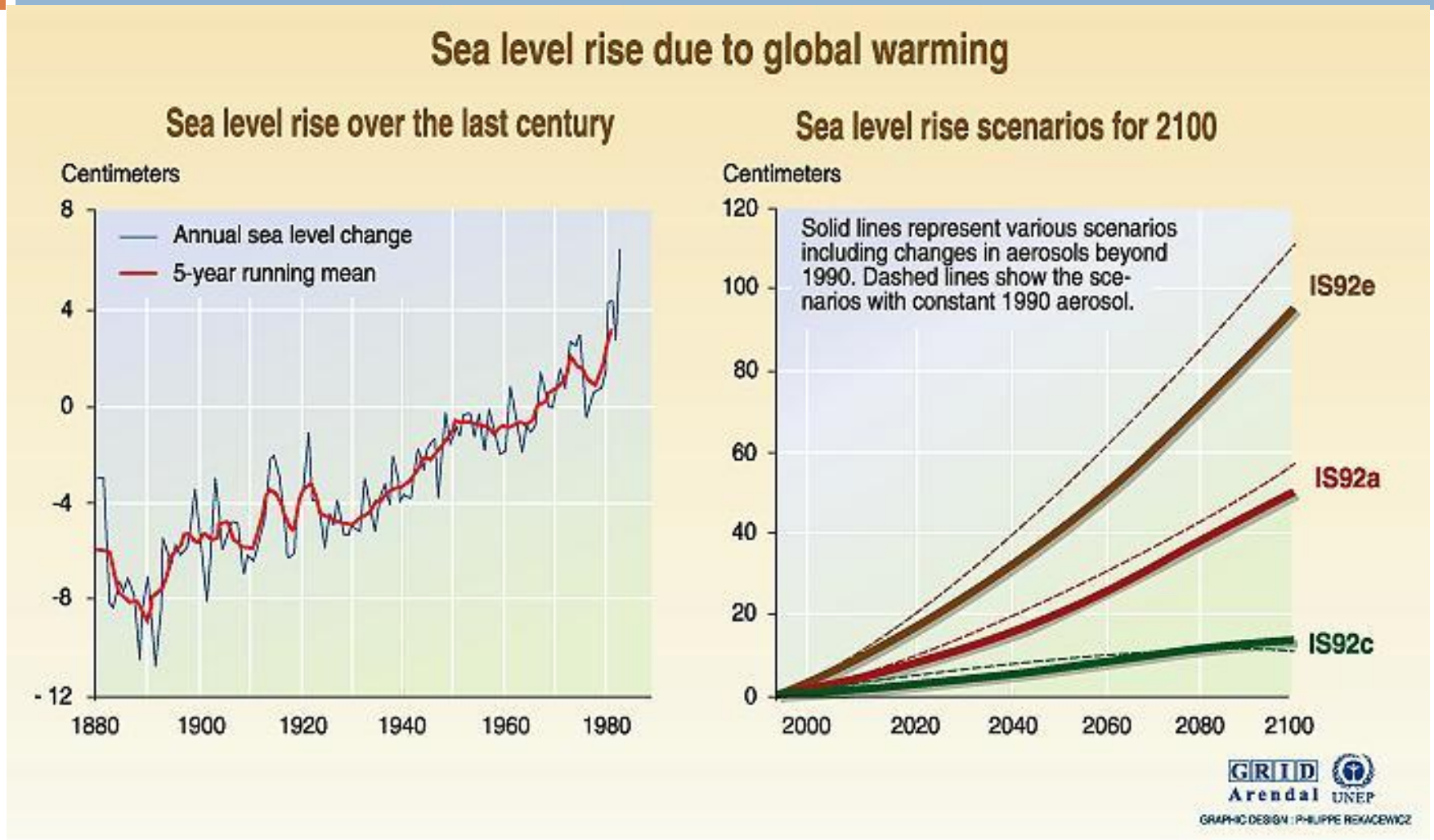
Image Source: NASA
Interpretation: http://inhabitat.com/

Arctic Sea Ice Extent (Observed & Forecast)



http://www.pik-potsdam.de/news/press-releases/files/sea-ice.jpg

Sea Level Changes (Observed & Forecast)



Source: Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1995; Sea level rise over the last century, adapted from Gornitz and Lebedeff, 1987.

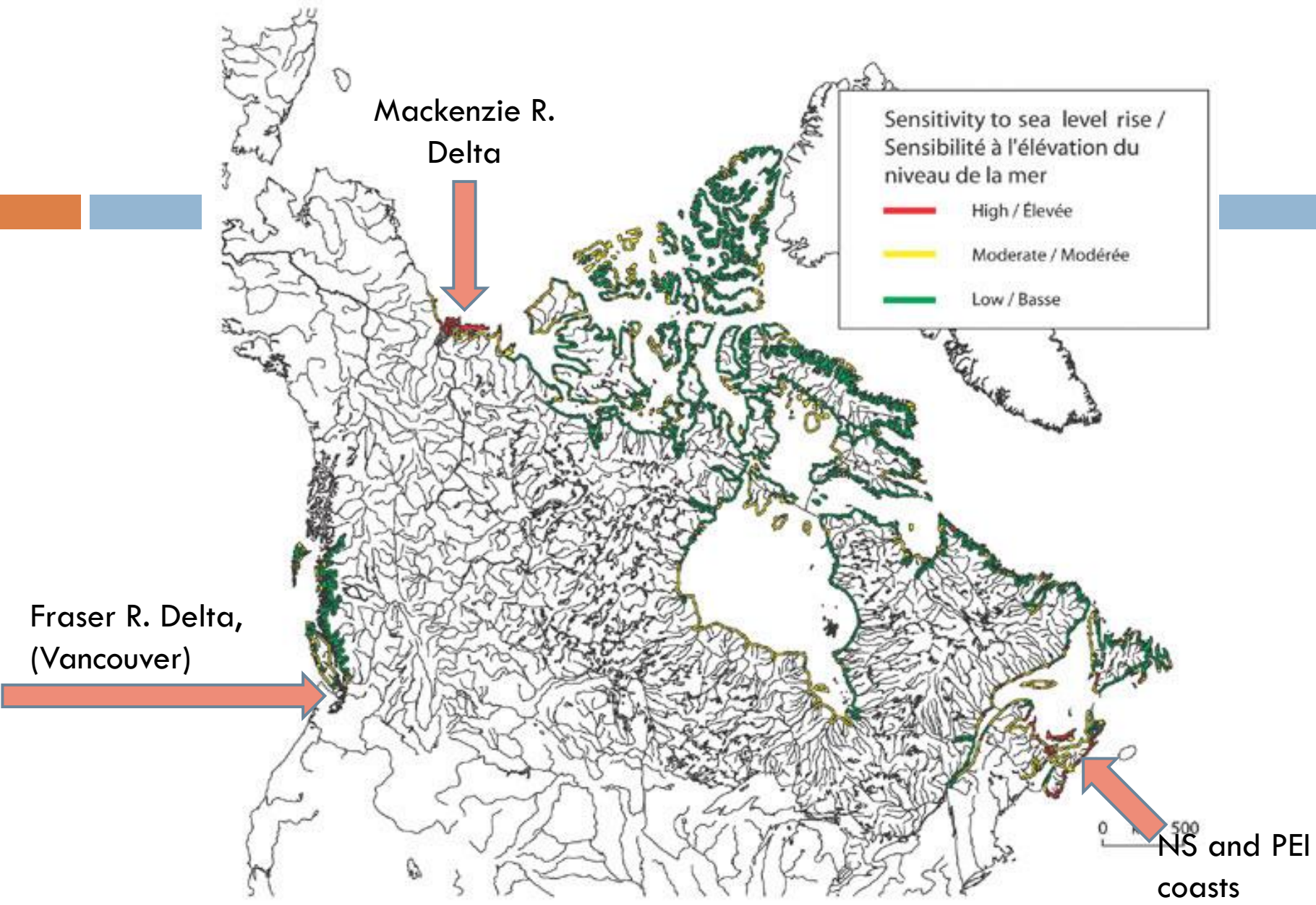
Sea Level Changes

IPCC predicts
9 to 88 cm by
2100

+
Storm Surge

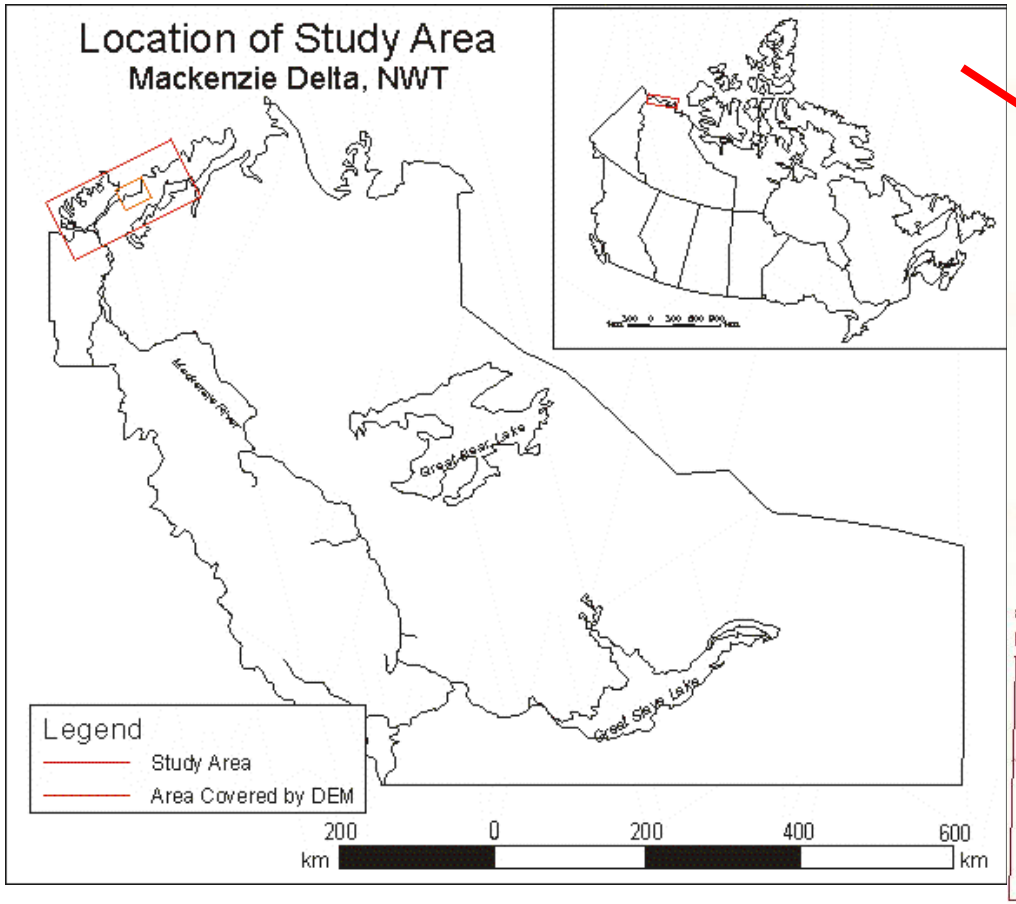
Predictions of sea level rise in responses to a modeled rise in global temperature by 2100 (compiled by Mallory Carpenter 2009)

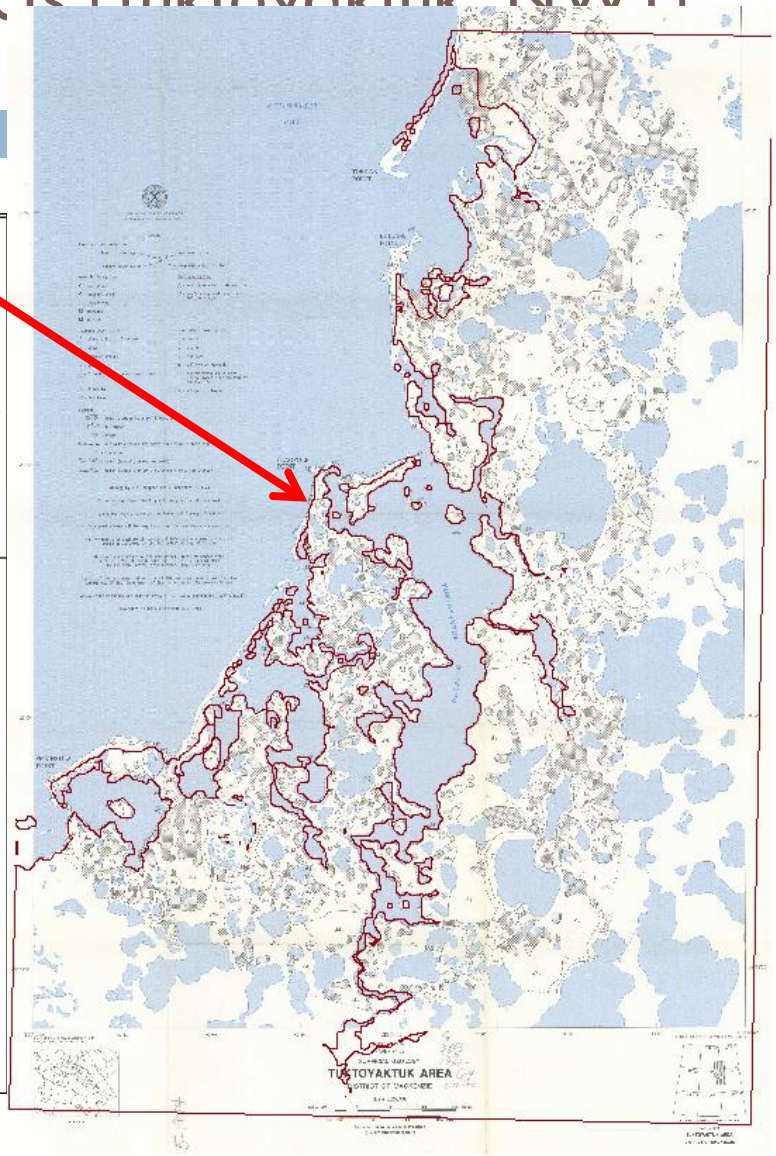
Author(s)	Area of Study	Modeled Temp. Change (C)	Minimum Prediction	Maximum Prediction
Alley, R. B. *et al.* (2005)	Greenland	5°	40 cm	50 cm
Aunap, R. *et al.* (2001)	Estonia	2.3-4.5°	n/a	100 cm
Begin, Y. and Robichaud, A. (1997)	New Brunswick	n/a	20 cm	40 cm
Bray, M. J. and Hooke, J. M. (1997)	England	n/a	n/a	50 cm
Daniels, R. C. (1992)	South Carolina	1-5°	25 cm	200 cm
Ely. C. and Jorgenson, T. (2000)	Alaska	n/a	10 cm	90 cm
Fitzgerald, D. M. *et al.* (2008)	Conceptual	n/a	20 cm	60 cm
Harvey. N. and Woodroffe, C. (2008)	South Australia	n/a	33 cm	110 cm
IPCC (2001)	Conceptual	1.8 °	9 cm	88 cm
NRC (2007)	Canada	1.4°	9 cm	88 cm
Nicholls, R. J. (2002)	Global	n/a	23 cm	96 cm
Senior C. A. *et al.* (2002)	England	n/a	9 cm	88 cm
Shaw, J. *et al.* (1998)	Canada	2°	n/a	49 cm
Thumerer, T. *et al.* (2000)	England	1.5°	49 cm	94 cm
USGS (2000)	Eastern USA	n/a	15 cm	95 cm



Sensitivity of Canadian coasts to sea level rise as determined by NRC's 2004 adaptation report. Source: NRC (2004)

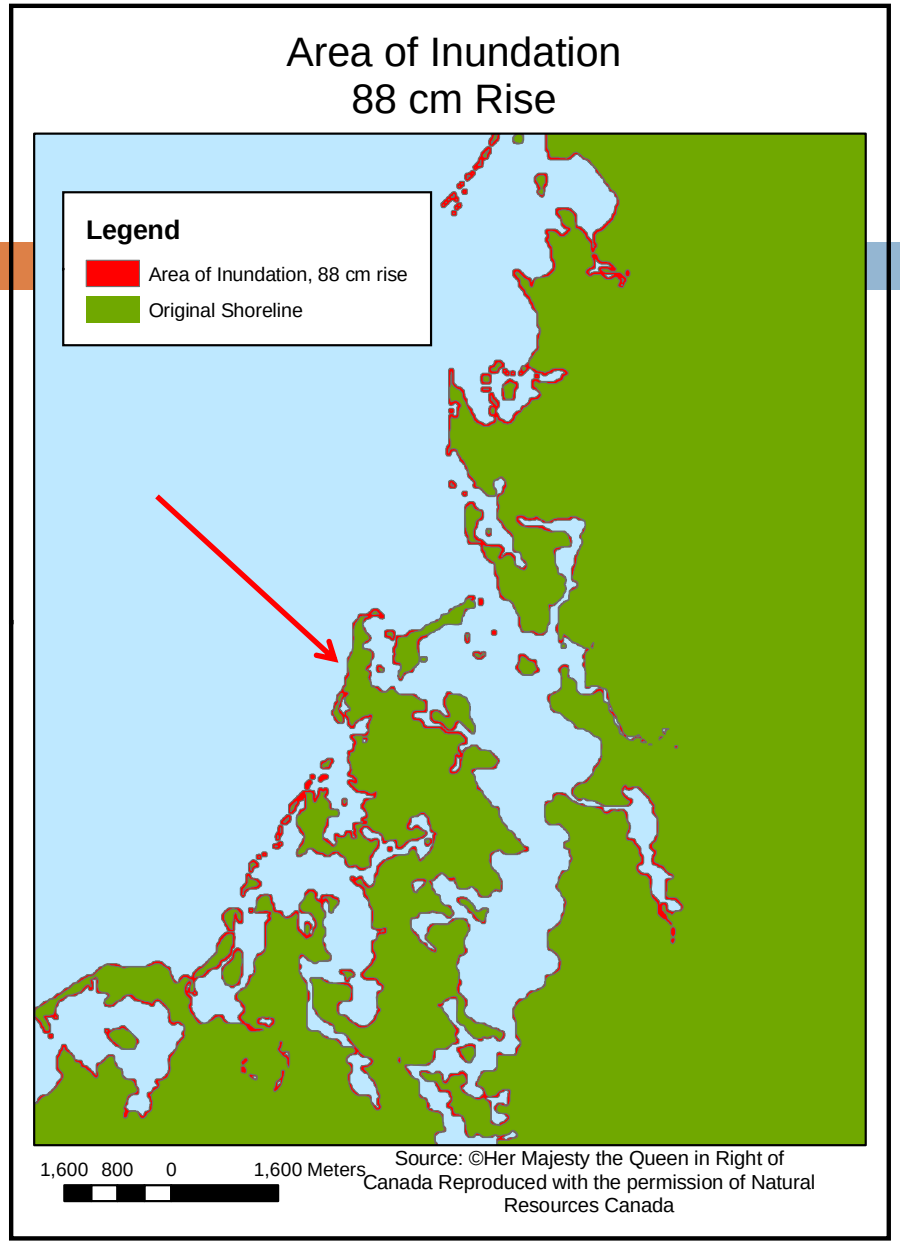
Case Study: Sea Level Impacts (Tuktoyaktuk, NWT)

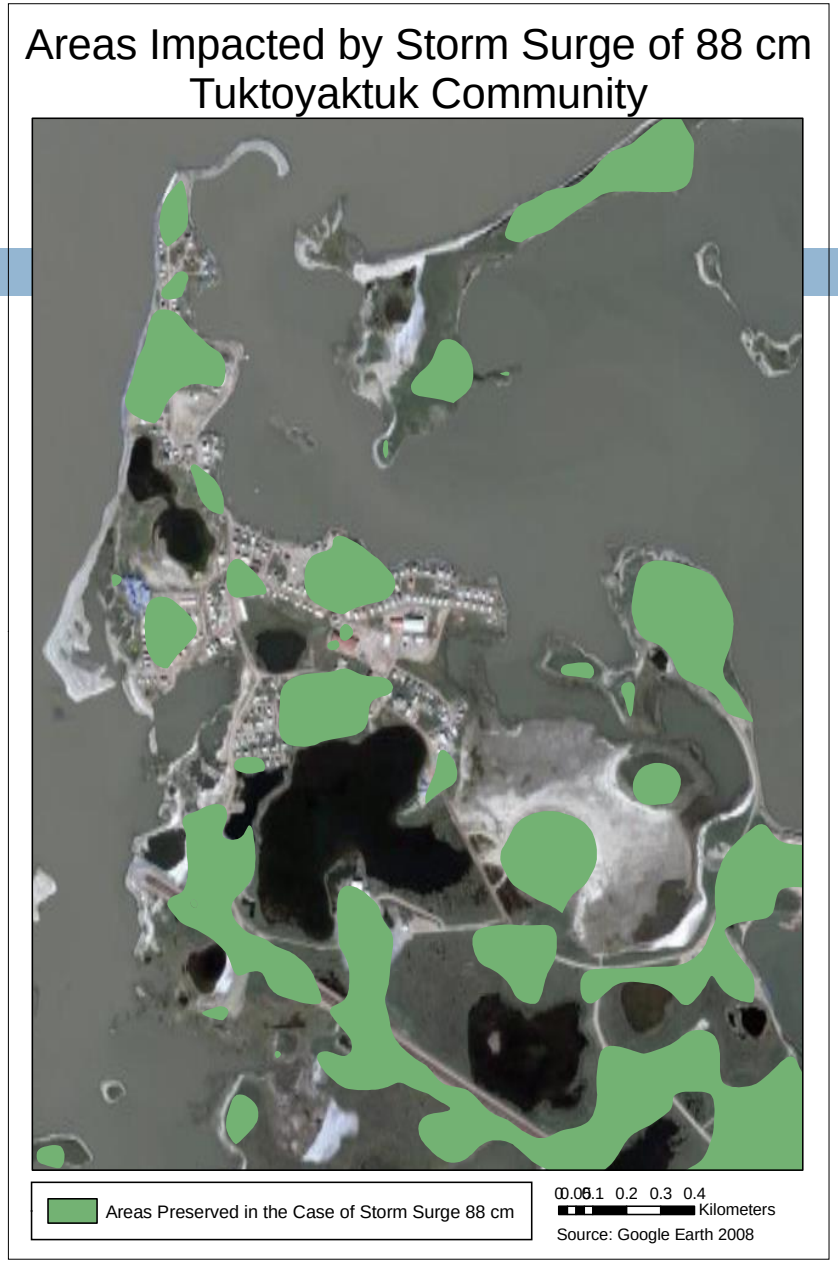




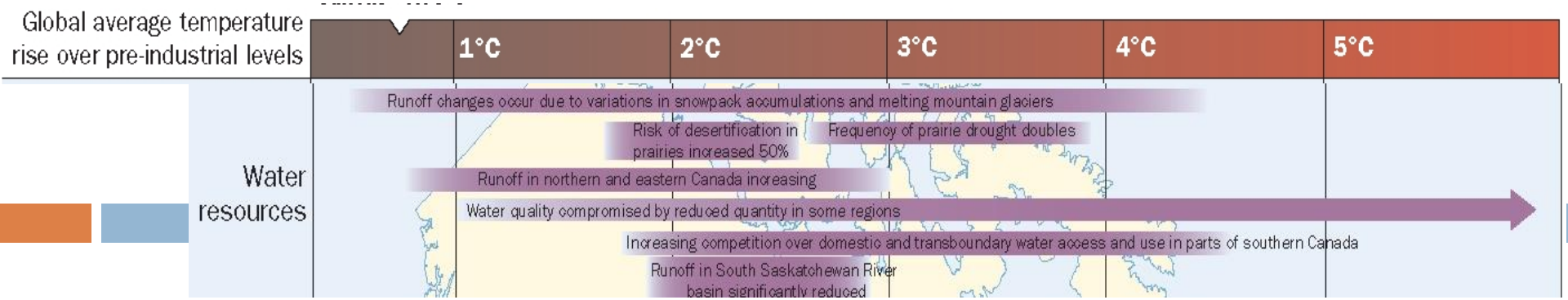
Source: Carpenter (2009).

Surfcial Geology for coastline near Tuk





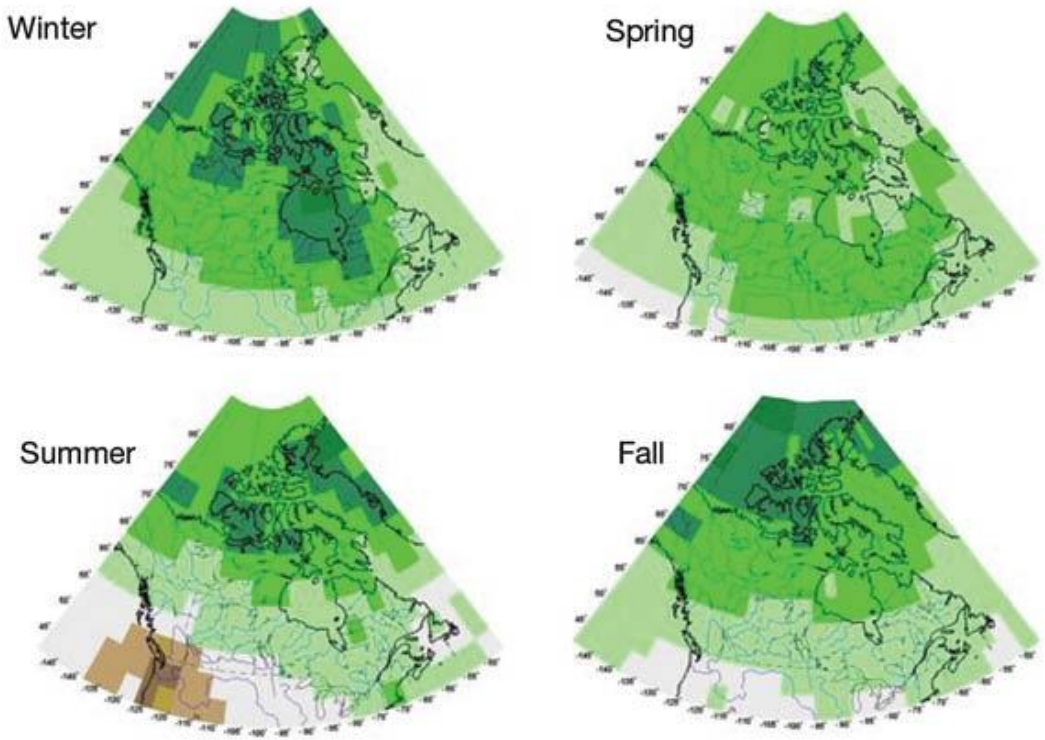
(L) Area of inundation in event of projected 88 cm sea level for Tuktoyaktuk and environs; (R) Areas affected by 88cm + 2.5m storm surge. Source: Carpenter (2009).

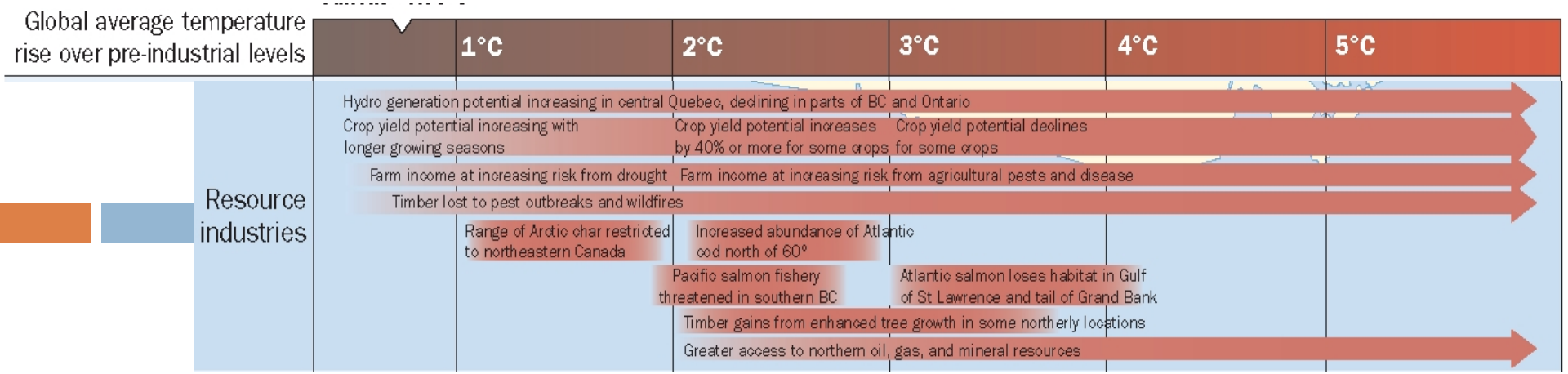


Impacts on Water Resources

- every part of Canada except the southern Prairies and southwestern BC has become wetter

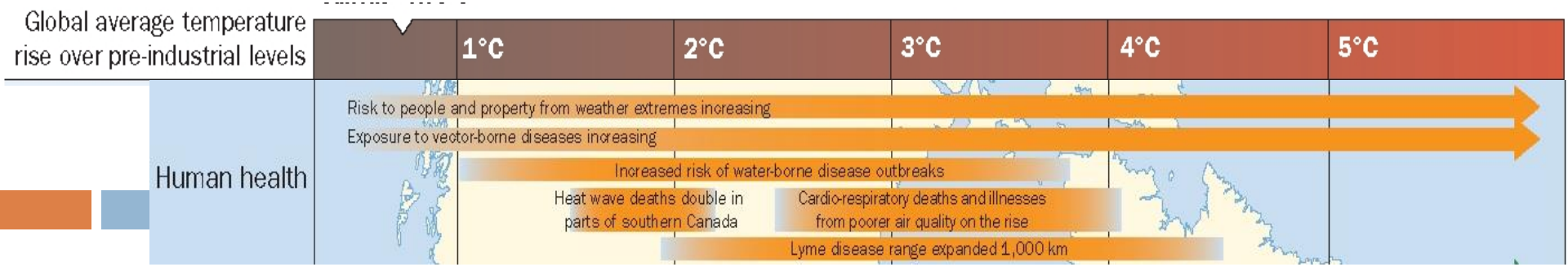
Modeled Seasonal Change in Precipitation (relative to 1960-1990) based on the median of seven global climate models across Canada by 2050 (green = wetter; brown = drier)
Source: Natural Resources Canada (2007b)





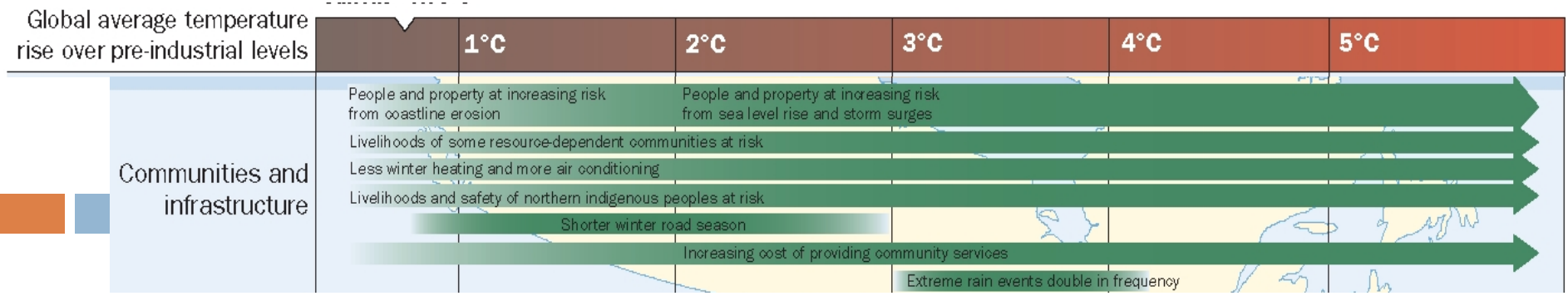
Impacts on Resource Industries

- (AGRICULTURE) Positive impact for all regions but the Prairies (one of the few countries in the world to benefit) – *extended growing season; reduced frost damage*
- (FORESTRY) Increasing losses of timber to pest outbreaks and wildfires
- (FISHERIES) Fish are vulnerable to changes in temperature, precipitation, wind patterns, and chemical conditions. If water levels drop or there are more periods of lower water levels, the mortality of spawning salmon in BC rivers is likely to increase.



Impacts on Human Health

- Given the prediction of the IPCC about climate change in North America, Health Canada has indicated that Canadians can expect to experience a greater incidence of disease
- This includes infectious diseases such as Lyme disease, dengue fever, West Nile virus, and malaria



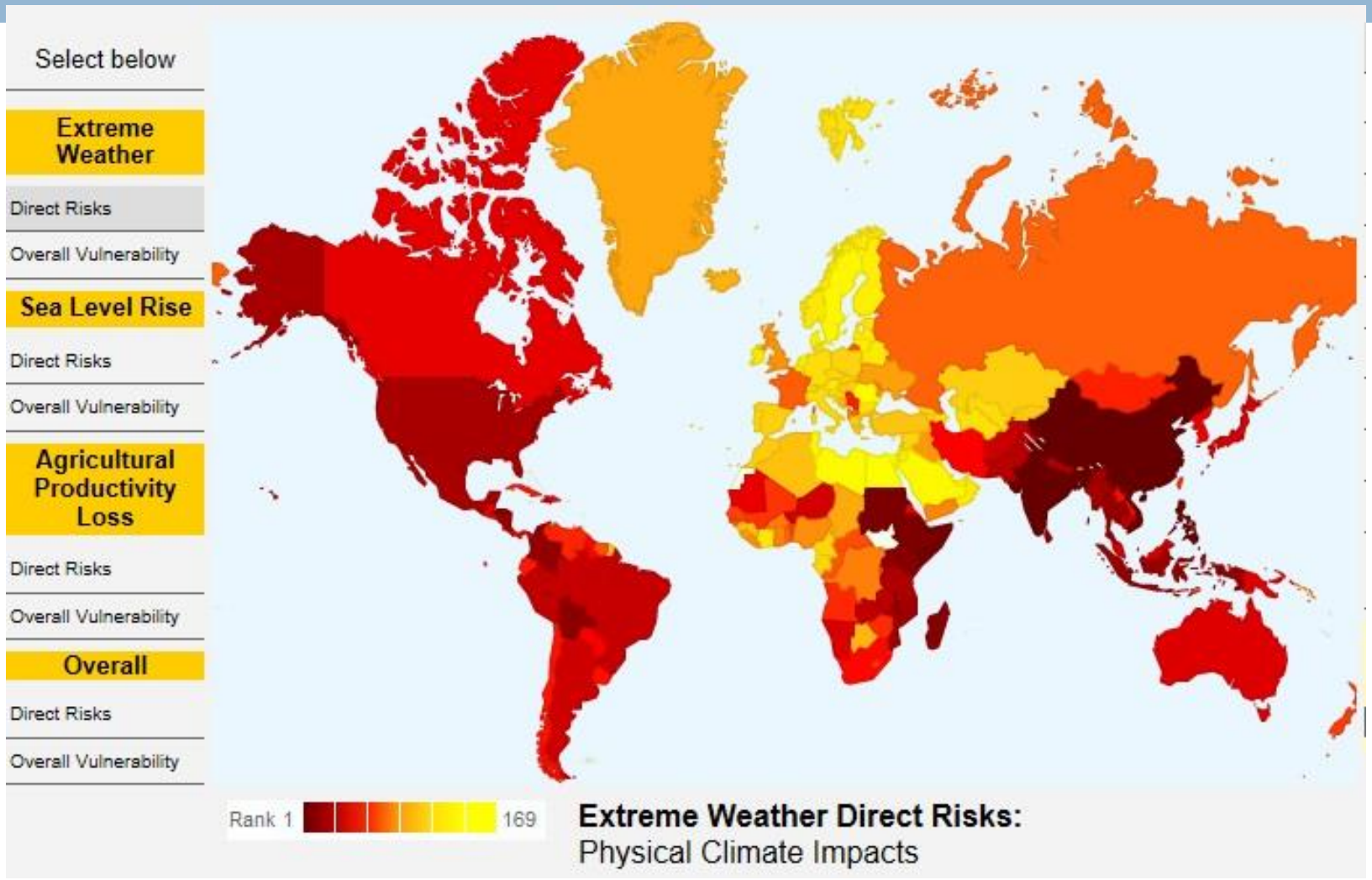
Impacts on Communities and Infrastructure

- Livelihoods affected in *some* resource-dependent communities, especially northern indigenous communities
- Shorter winter road season
- Property risks (coastal areas, including inland) from rising sea levels and increased storminess …

Online interactive map – Impact of Climate Change (Wheeler, 2011)

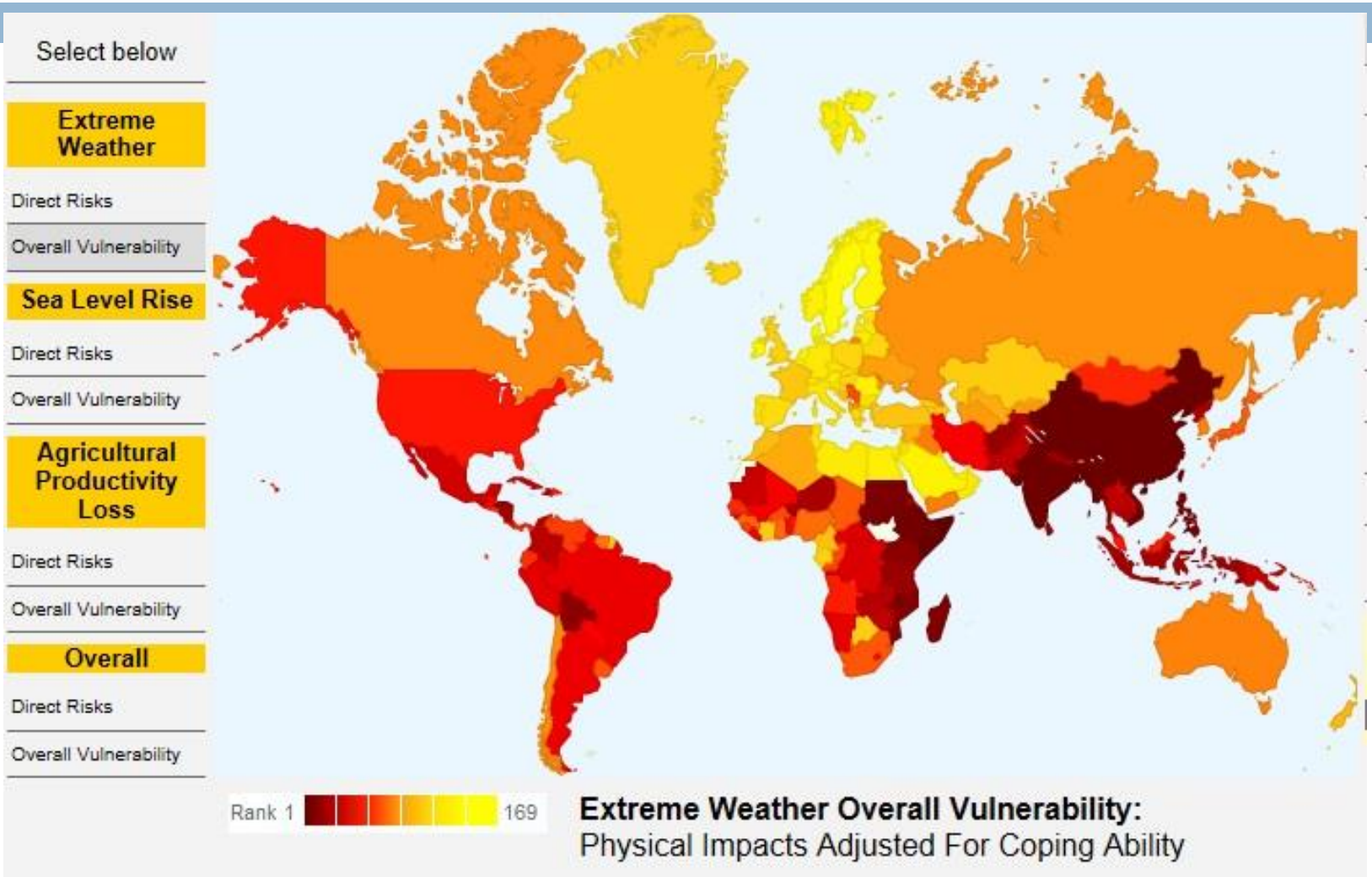
- Centre for Global Development (based in Washington DC) – accessed January 2014
  - http://www.cgdev.org/page/mapping-impacts-climate-change?utm_=
- Two dimensions of mapping impacts
  - "Direct Risk" (risk from physical climate impacts alone)
  - "Overall Vulnerability" (direct risks adjusted for countries' ability to cope with climate impacts).

Example 1: Risks: Extreme Weather



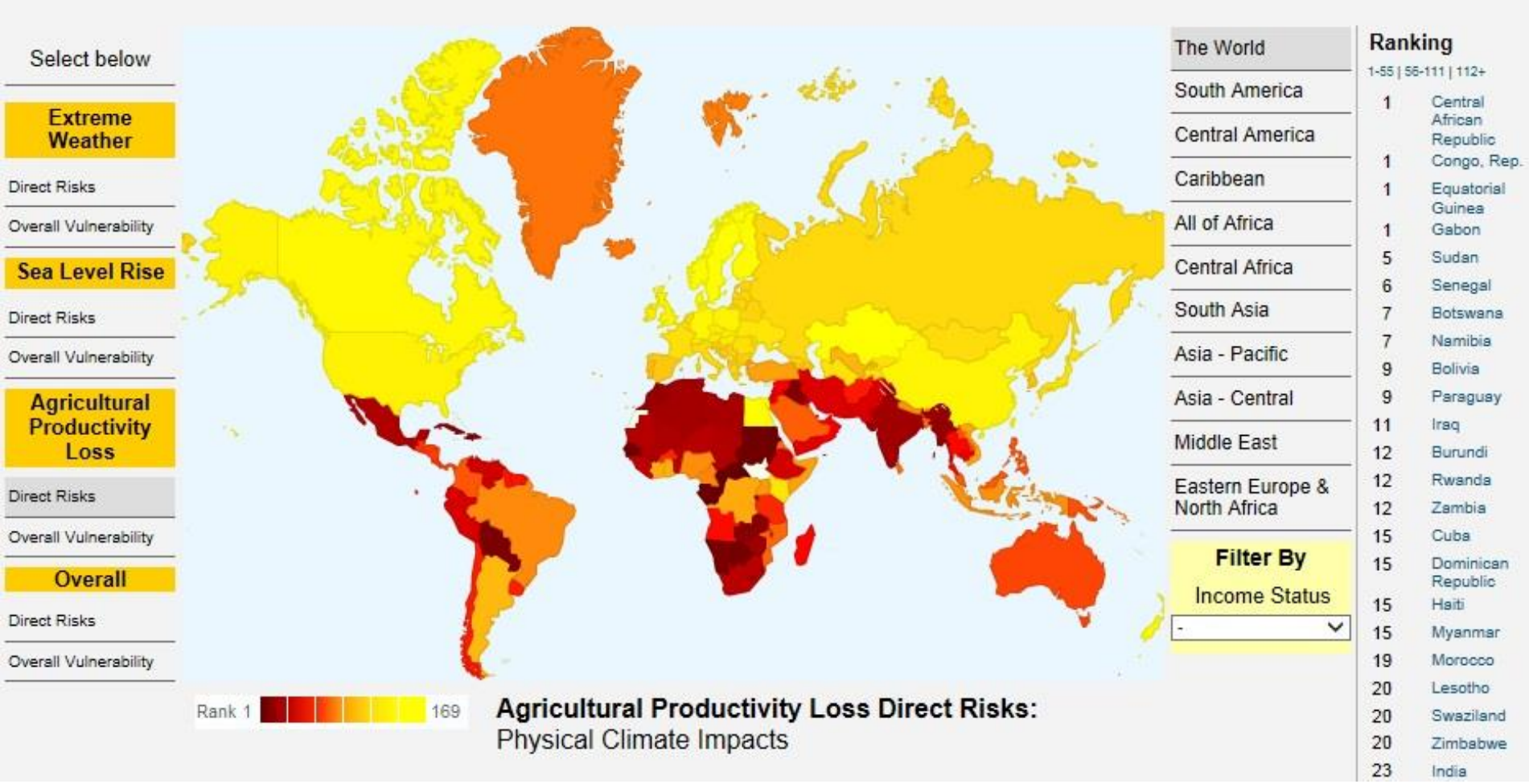
http://www.cgdev.org/page/mapping-impacts-climate-change?utm_=

Example 1: Overall Vulnerability: Extreme Weather



http://www.cgdev.org/page/mapping-impacts-climate-change?utm_=

Example 1: Risks: Agricultural Productivity Loss



http://www.cgdev.org/page/mapping-impacts-climate-change?utm_=

References

- Carpenter, M. 2009. *Modeled Impacts of Future Sea Level Changes for the Tuktoyaktuk Peninsula, NWT using a Geographic Information System*, Unpublished HBA thesis, Department of Geography, Lakehead University
- Dearden, P and Mitchell, B. 2012. *Environmental Change and Challenge*, Fourth Edition, Don Mills, Ontario: Oxford University Press {chapter 7}
- Wheeler, David 2011. Quantifying Vulnerability to Climate Change: Implications for Adaptation Assistance, *Working Paper by Center for Global Development*. Washington, DC, 53 pp. {pdf available at http://www.cgdev.org/sites/default/files/1424759_file_Wheeler_Quantifying_Vulnerability_FINAL.pdf}
- Natural Resources Canada (NRC). (2004) Climate Change Impacts and Adaptation: A Canadian Perspective. Ottawa: Natural Resources Canada.
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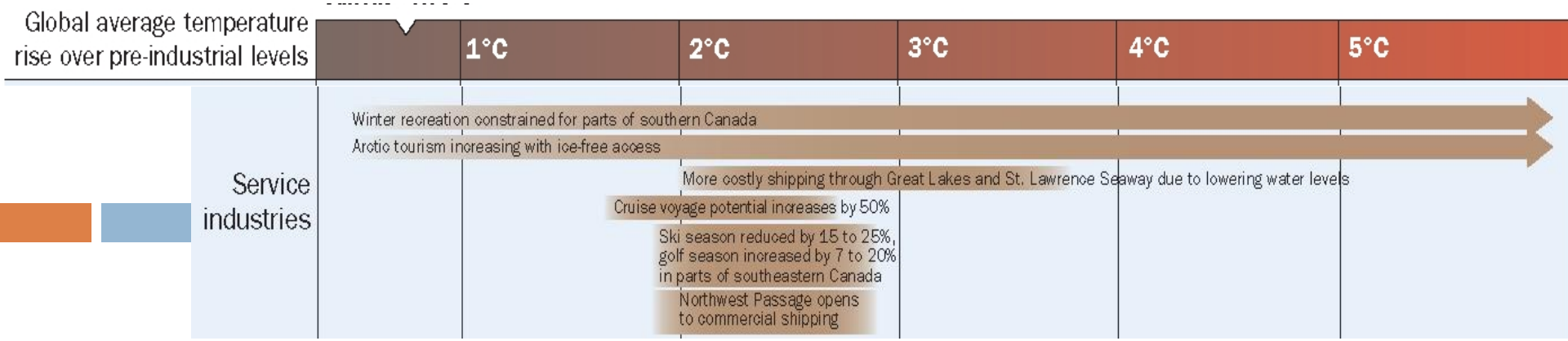
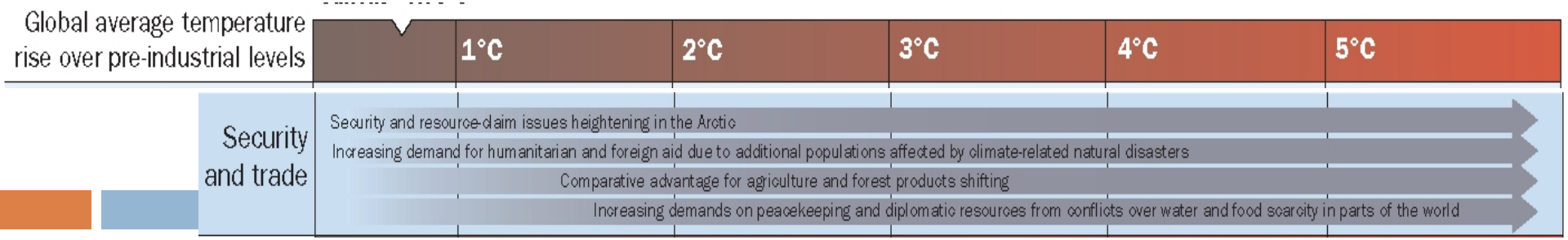


Impacts on Service Industries



Impacts on Security and Trade