

DEVELOPMENT AND CLIMATE STRESSORS ON THE HYDRO-ECOLOGY OF THE MACKENZIE RIVER BASIN

TERRY PROWSE

WATER & CLIMATE IMPACTS RESEARCH CENTRE
ENVIRONMENT CANADA/UNIVERSITY OF VICTORIA

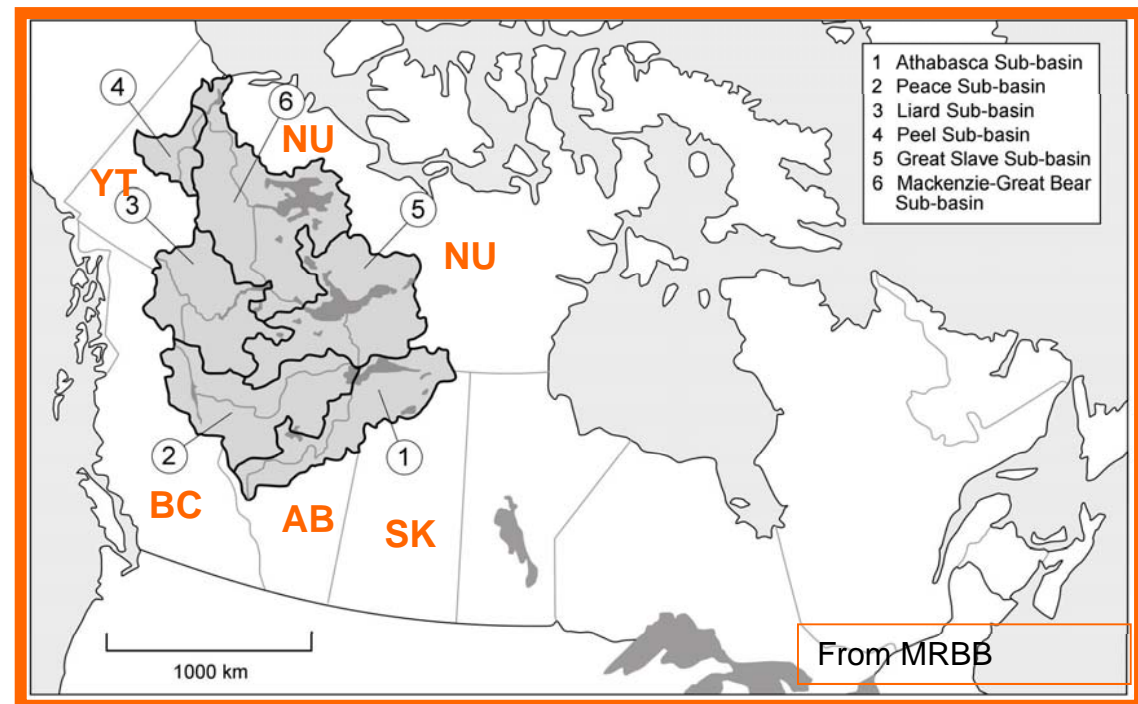
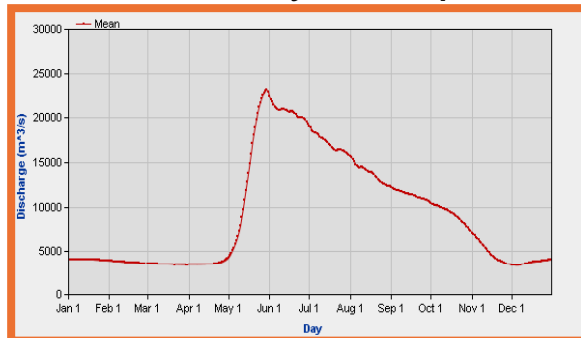


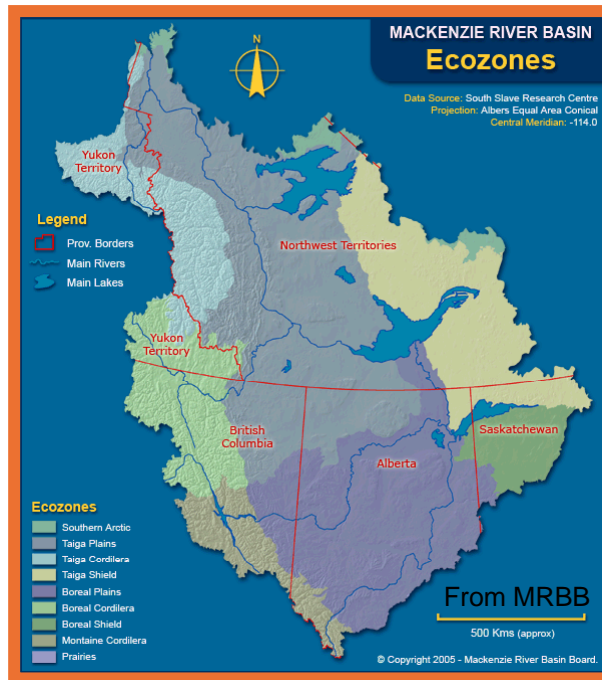
Basin Size

- 1.8×10^6 km²; 20% Canada
- Covering 15° Latitude
- 12th Largest Globally
- 4th Largest to Arctic Ocean



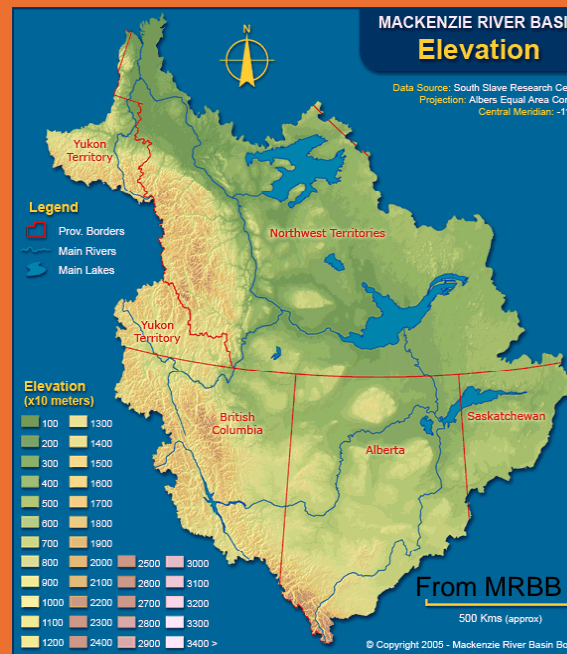
- Mean annual flow = 10,000 m³
- Length = 4241 km
- Nival regime with peak flow in June: 70% May to September;





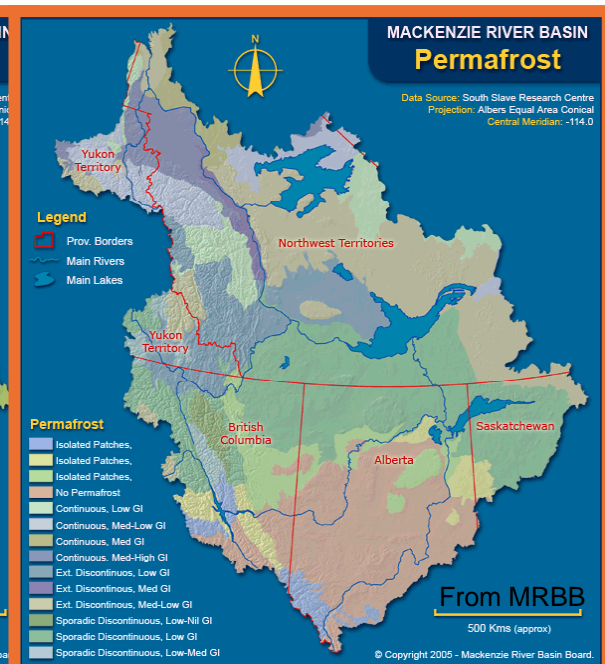
Ecozones

- Prairies
- Boreal
- Taiga
- Arctic



Elevation

- Rocky Mountain headwaters
- peaks at ~ 4000 m

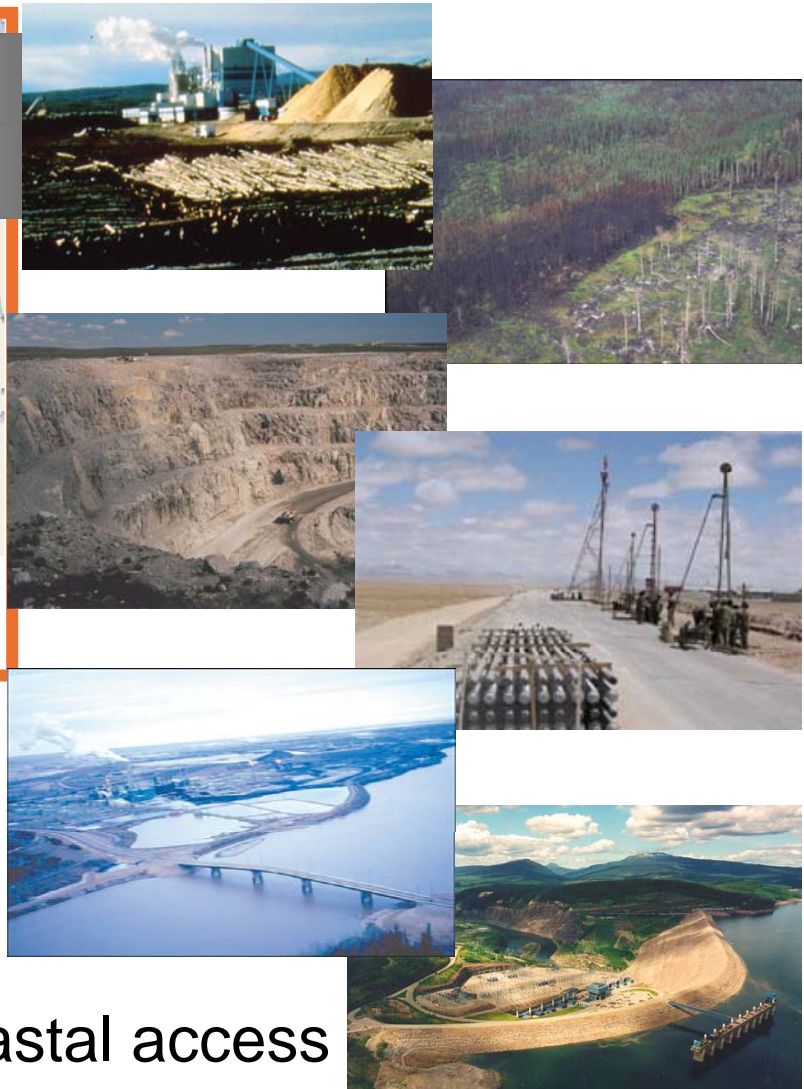
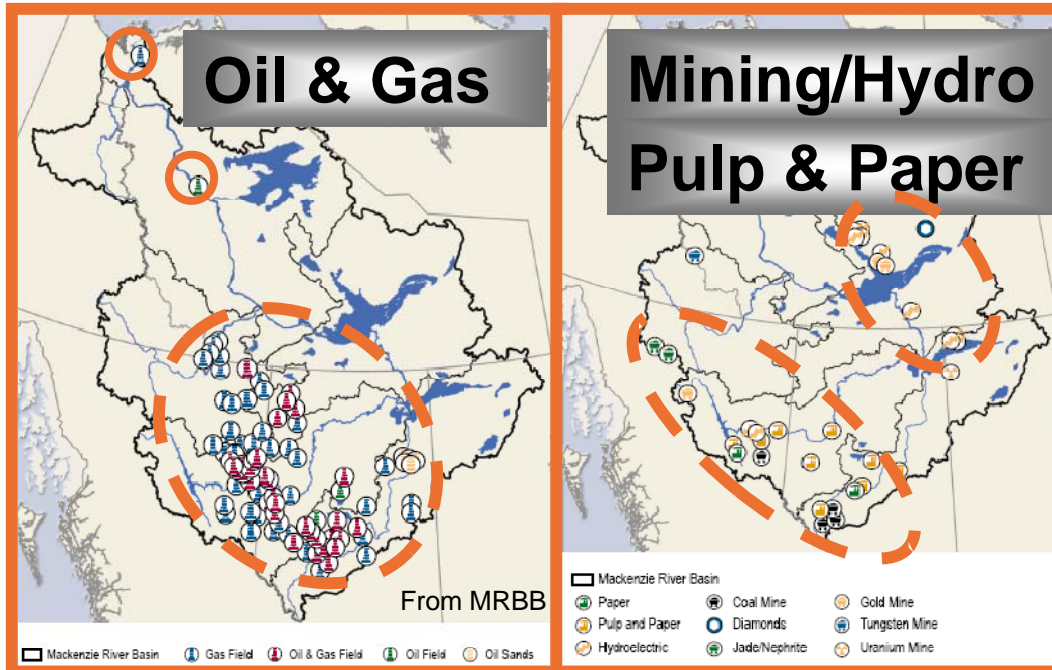


Permafrost

- 0 in Prairies
- Southern Isolated
- North Continuous



Major Environmental Issues



- Concentration in South
- More recent in the North
- Future climate influences

- e.g., mining storage, new coastal access

“State of the Aquatic Ecosystem Reports”

SUMMARY OF OVERALL ASSESSMENTS OF INDICATORS FOR THE SIX SUB-BASINS OF THE MACKENZIE RIVER BASIN							
MRBB GOAL	Indicator	Athabasca	Peace	Liard	Peel	Great Slave	Mackenzie Great Bear
IMPROVE WATER QUALITY	Traditional Knowledge	▼	☒			☒	
	Dissolved Phosphorus	▼					
	Dissolved Oxygen	▼					
	Absorbable Organic Halides		☑				
	Organic Matter in Pulp Mill Effluent		☑				
	Sewage Effluent		☑				☑
	Arsenic in Yellowknife					▼	
	Water Quality Guidelines and Indices	☑	☑	☑	☑	☑	☑
ENSURE SUFFICIENT WATER QUANTITY	Traditional Knowledge		☒			☒	▼
	Flow in Rivers	☑	▼▼	▼▼	▼	▼	☑
	Water Level of Lake Athabasca	☑				▼	
SUSTAIN IN-STREAM WATER USES	Timing of Spring Freshet					▼	
	Traditional Knowledge	▼	☒				
	Water Allocations	☑	▼	☑			☑
	Fishing	☑	☑	▼	☑	☑	☑
	Harvest of Fur-Bearers	☑					
	River Tourism				☑		
ENSURE HEALTHY, ABUNDANT AND DIVERSE AQUATIC SPECIES AND HABITAT	Transportation (Ferries and ice Bridges)					▼	☑
	Hydroelectric Facilities					▼	
	Traditional Knowledge	▼	☒	☒	☑	☒	▼
	Fish Populations				☒	▼	
ENSURE HUMAN HEALTH AND SAFETY	Waterfowl Populations		◀▼▶			◀▼▶	
	Species at Risk	☑	▼	▼		◀▼▶	
ENSURE HUMAN HEALTH AND SAFETY	Traditional Knowledge	☒					
	Fish Consumption Advisors	▼	▼			▼	▼
	Flood Hazard Management			☑			☑

- Mackenzie River Basin Transboundary Waters Master Agreement.
- Mackenzie River Basin Board: influences regulatory decisions such as via: “State of the Aquatic Ecosystem Reports” by basin

☑	Environmental quality is favourable or improving or pressure on the environment is decreasing.
▼	Environmental quality is intermediate or there is no clear trend in environmental quality because of 1. insufficient information or 2. the presence of mixed (positive and negative) signals.
☒	Environmental quality is unfavourable or deteriorating or pressure on the environment is increasing.

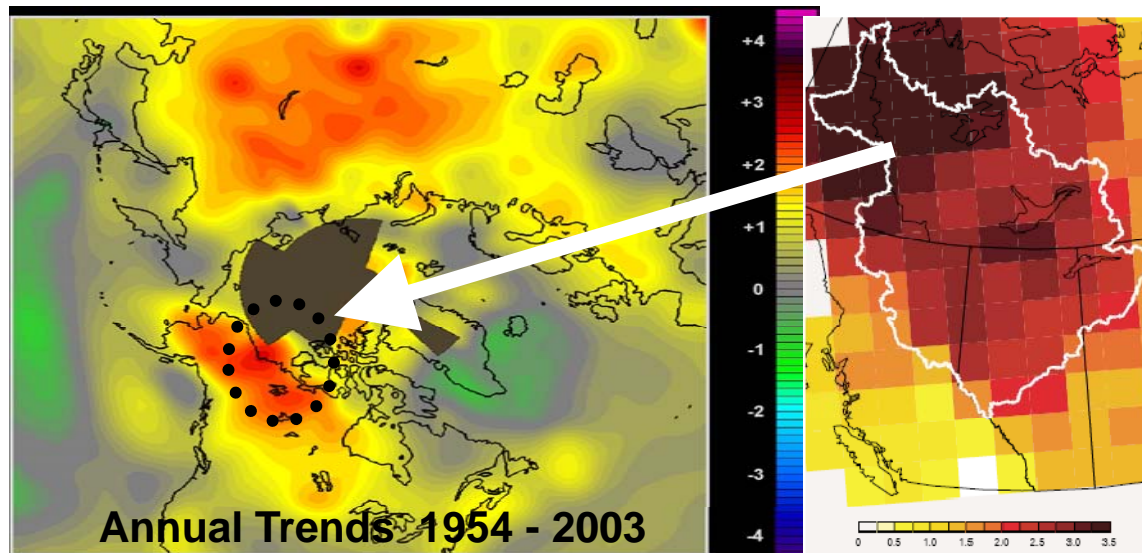
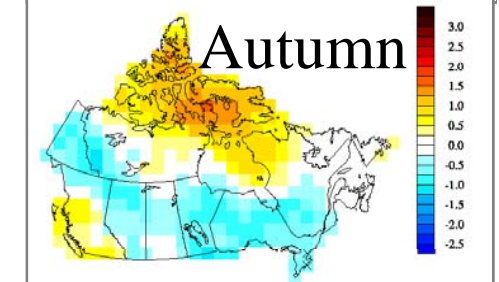
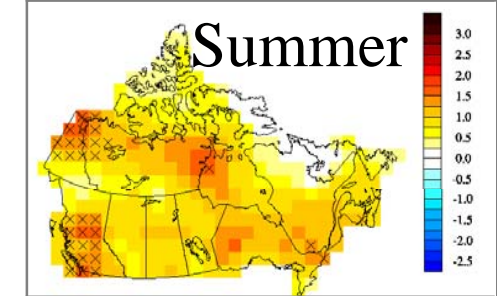
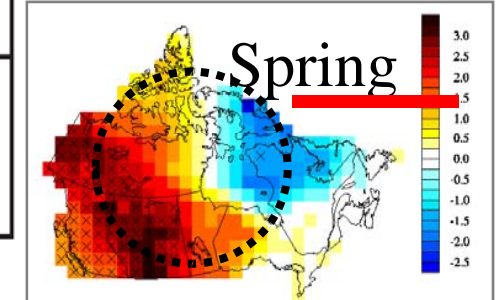
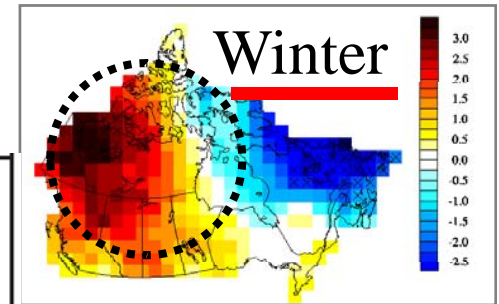
From MRBB



Overall Assessments

- Climate Change a key concern
- MRB a "hot spot"
- Winter/Spring largest changes

	Traditional Knowledge	<input checked="" type="checkbox"/>
	Spring Melt of River and Lake Ice	<input checked="" type="checkbox"/>
	Permafrost	<input type="checkbox"/>
CONTAMINANTS	Mercury	<input type="checkbox"/>
	Chlorinated Dioxins and Furans	<input checked="" type="checkbox"/>



Source: <http://arctic.atmos.uiuc.edu/>

From Zhang et al. (2000)

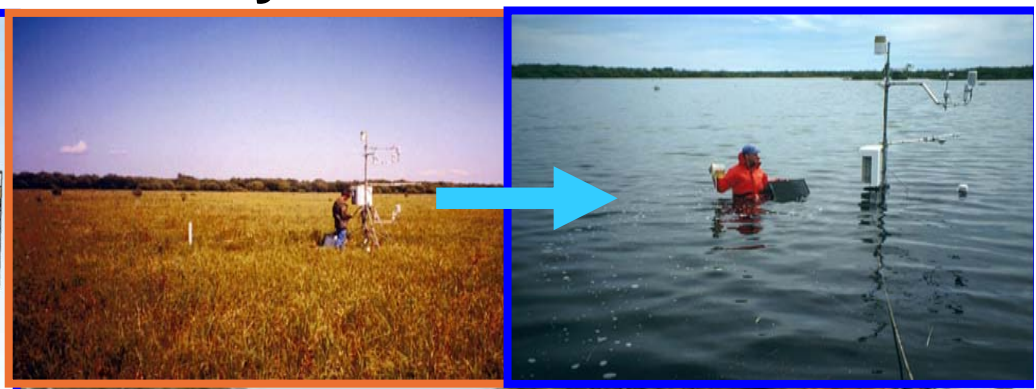
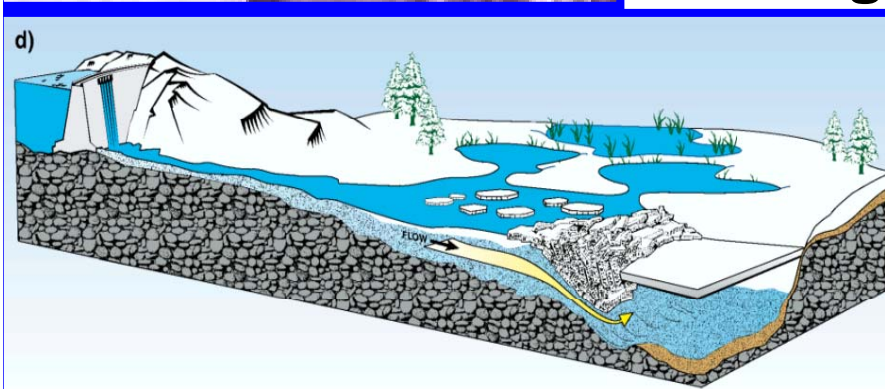
NRBS: Effects of Climate & Flow Regulation

- Peace-Athabasca Delta
- World's largest freshwater inland delta
- World Heritage Site
- Ramsar Wetland Site



NRBS: Climate Results

- Flooding found to be result of ice jams not open-water floods & regulation
- Flows for ice jams declined due to climatic reduction in spring snowmelt
- Dam release of water enhanced ice jam flooding of Delta
- Unique physical adaptation to climate change cited by IPCC

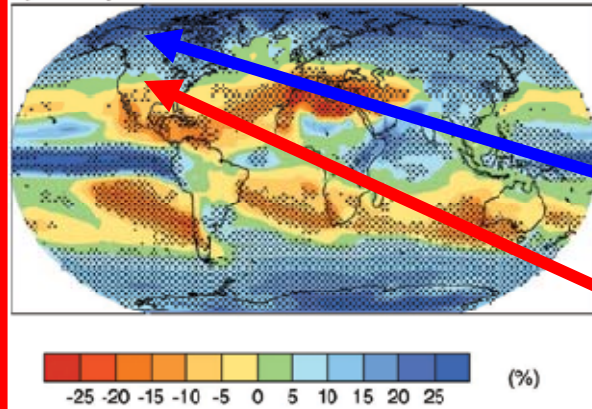


Future Hydrologic Regime of the MRB

PROJECTIONS

2080–2099 / 1980–1999

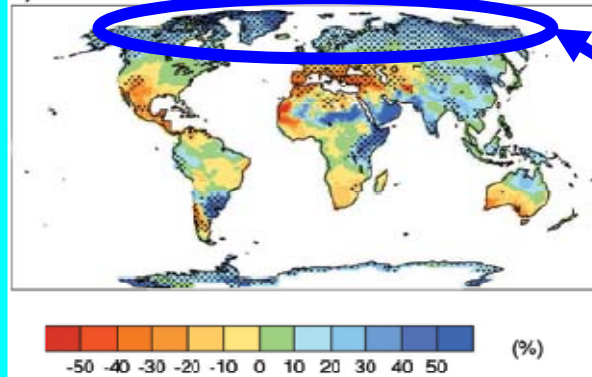
a) Precipitation



For North America:

- Precipitation:
- increases (+20%) in North
 - decreases in South

c) Runoff

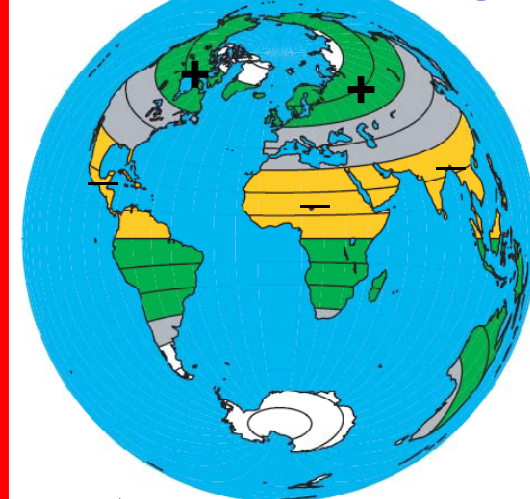


Similar +20% increase in Arctic River flow projected

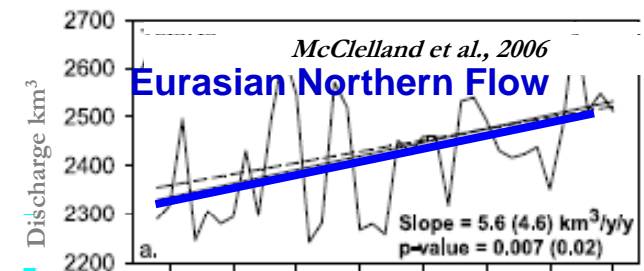
From IPCC 2008

General northern increases in Precipitation & Runoff already observed in last 1/2 C

Precipitation Changes

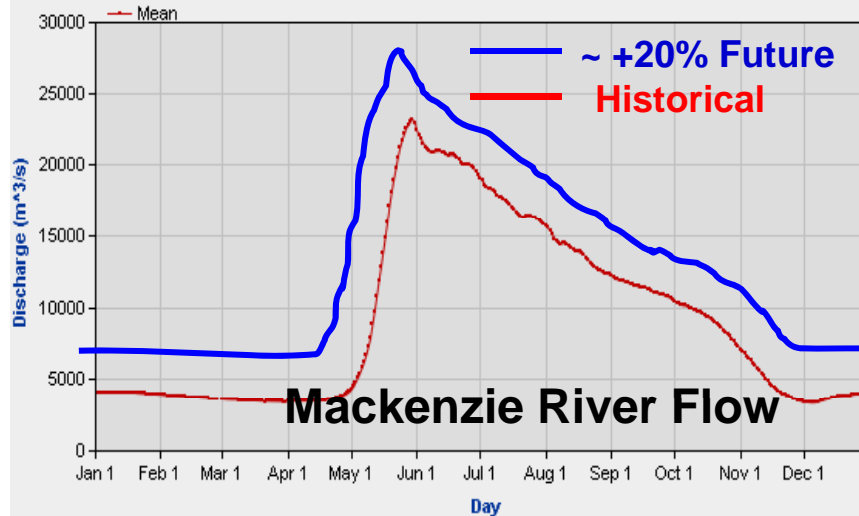


From Zhang et al., 2007



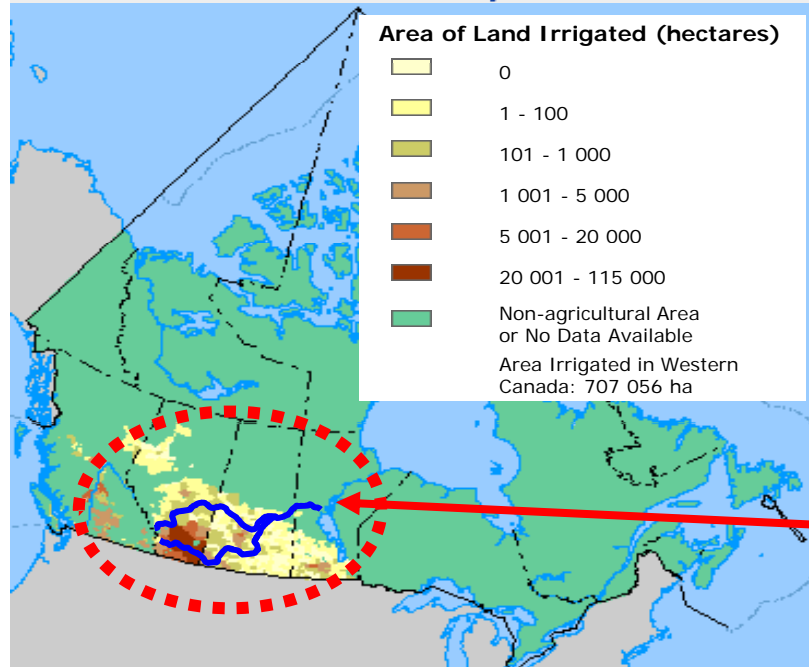


Daily Discharge for MACKENZIE RIVER AT ARCTIC RED RIVER (10LC014)



RATIONALE AGAINST FLOW DIVERSION

- Invasive species
- Instream Flow Needs (IFN)
- Marine productivity
- Climate feedbacks: sea ice and thermohaline circulation



- Projected 20% climate-induced increase in flow of Mackenzie River = 2000 m³/s; a “water rich” region
- If the climate-induced increase is “removed”, but the historical flows retained, what happens to scientific argument against diversion?

Significance of flow volume:

- Only 1/3 of the projected increase = annual flow of the Saskatchewan River; a “water poor” region”



FINAL THOUGHTS

- The Mackenzie River Basin will increasingly be influenced by development, particularly at increasingly higher latitudes as the region's untapped natural resources are accessed
- Climate change will play an expanding role in water-conservation and water-management decisions related to such development
- Given the climatic redistribution of precipitation and runoff, northern rivers might become key major water resources; requiring important environmental management decisions to be made



Merci

