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17 GOALS TO TRANSFORM OUR WORLD

Assessing freshwater ecosystem condition in Canada

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Canada

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1) What are SEEA – EEA guidance documents saying?

What do condition accounts measure?

Indicators in the ecosystem condition account reflect the **general condition or state** of an ecosystem and the relevant trends in that condition:

- These indicators may reflect such aspects as the occurrence of species, soil characteristics, water quality and ecological processes (e.g. net primary production).
- The indicators selected should be **relevant for policy and decision making** and reflect policy priorities (e.g. preservation of native habitat); pressures on ecosystems (e.g. deposition levels of acidifying compounds versus critical loads for such compounds) or the **capacity of ecosystems to generate one or more services** (e.g. attractiveness of the ecosystem for tourism).
- **Different ecosystem types require different indicators**. For example, condition indicators relevant for forests will be less relevant for cropland.

Recommendations for compiling condition accounts

Some more recommendations and steps for the measurement of condition are listed below. In each of these steps, **the indicator's scientific validity, the ease of communication and the availability of data** should be considered:

- Select the **measurement approach** (minimum, partial or fully spatial) and **select a specific ET** for initial focus.
- Select condition indicators that represent the main ecological characteristics of the ETs, and consider whether **indicators reflecting ecosystem integrity indicators of pressures on ecosystems** should be included.
- Choose an **appropriate reference period** for the condition measure, or alternatively use the 'opening stock'
- Record and report on the **variability and sources of error** in the data.

Issues for further research

At this stage in the development of ecosystem accounting, most importantly a clearer direction is needed on the extent to which the characteristics used for the measurement of condition **go beyond ecological characteristics and also incorporate non-ecological characteristics**, for example indicators of environmental pressures. But there are more areas of research:

Ecosystem condition accounts

This example shows a basic **condition account compiled in physical terms** using a variety of indicators for selected characteristics. The accounting structure provides a basis for organizing relevant indicators by ecosystem types and for distinct points in time (opening and closing of the accounting period).

Explore the highlighted areas to get more information!

		Proxy ecosystem type (based on land cover)														
		Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas
Example indicators of condition		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Vegetation (e.g. native cover)	Op															
	Clo															
Water quality (e.g. turbidity, pH)	O															
Soil (e.g. erosion, pH, nutrients)																
	Cl															
Carbon (e.g. net primary productivity)	Op															
	Clo															
Biodiversity (e.g. species richness)	Op															
	Clo															
Habitats (e.g. fragmentation)	Op															
	Clo															
Overall index of condition	Op															
	Closing condition															

The rows may reflect a number of indicators or aggregations of **indicators for individual ecosystem characteristics**. For example, accounting for soil condition may require information on texture, nutrients, pH, organic matter content and other factors, while for inland water bodies the characteristic of water quality, indicators of pH, turbidity and oxygen content levels may be combined. Note that condition accounts may also include indicators reflecting human pressures and non-ecological factors.

Canada

2 a) Environment and Climate Change Canada's water quality indicator

Canadian environmental sustainability indicators

- The water quality index calculation considers 3 factors to summarize water quality at a site (Eq. 1):
  - scope (F1) is the percentage of parameters for which the water quality guidelines are not met.
  - frequency (F2) is the percentage of samples for which the water quality guidelines are not met.
  - amplitude (F3) refers to the amount by which the water quality guidelines are not met.
  - score is normalized to yield a score between 1 and 100.

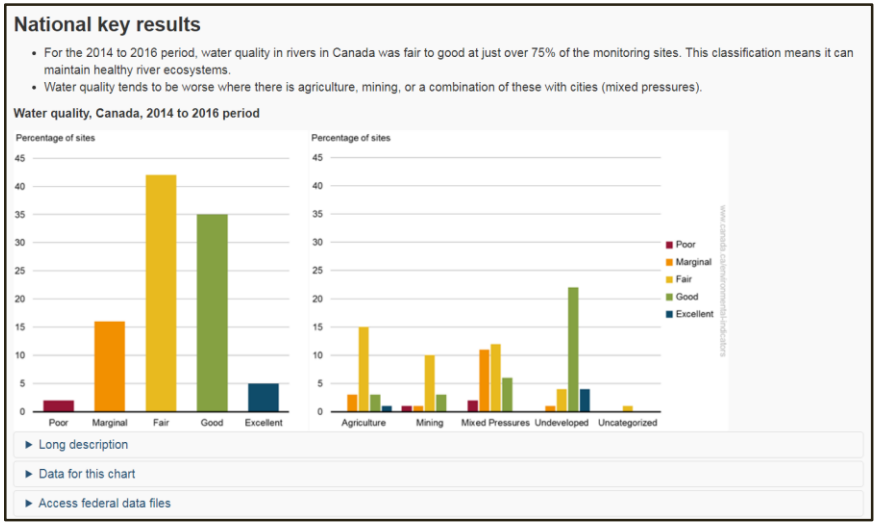
Equation 1.

$$\text{Water quality index} = 100 - \sqrt{\frac{F_1^2 + F_2^2 + F_3^2}{3}}$$

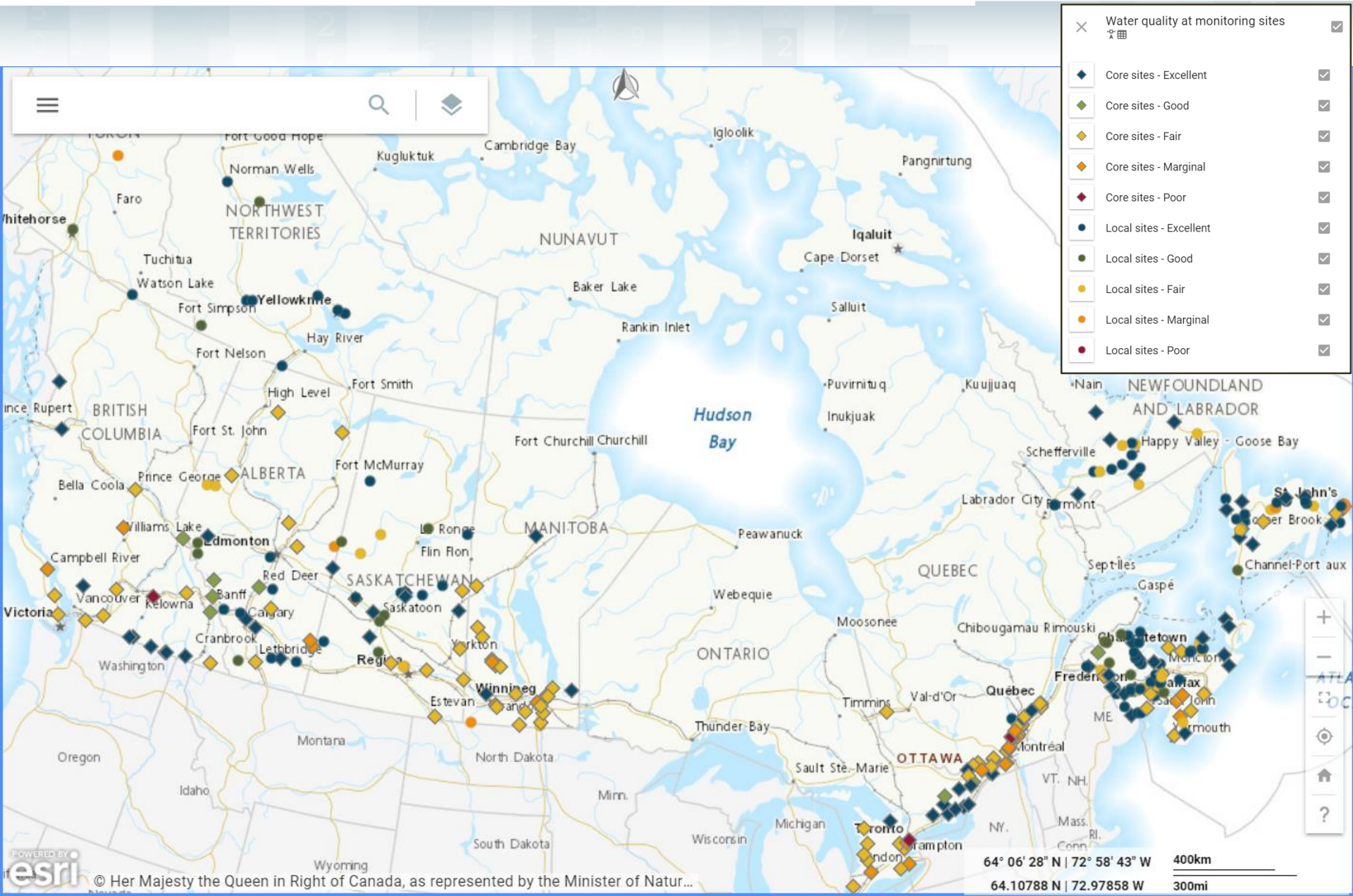
Water quality scores are grouped into 5 categories following the Canadian Council of Ministers of the Environment's water quality index (Table 2).

Table 2. Score rankings for the Canadian Council of Ministers of the Environment's water quality index

Ranking	Interpretation
Excellent (95.0 to 100.0)	Water quality is protected with a virtual absence of threat of impairment; conditions are very close to natural.
Good (80.0 to 94.9)	Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.
Fair (65.0 to 79.9)	Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
Marginal (45.0 to 64.9)	Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.
Poor (0 to 44.9)	Water quality is almost always threatened or impaired; conditions usually depart from natural or desired levels.



2 a) Environment and Climate Change Canada's water quality indicator



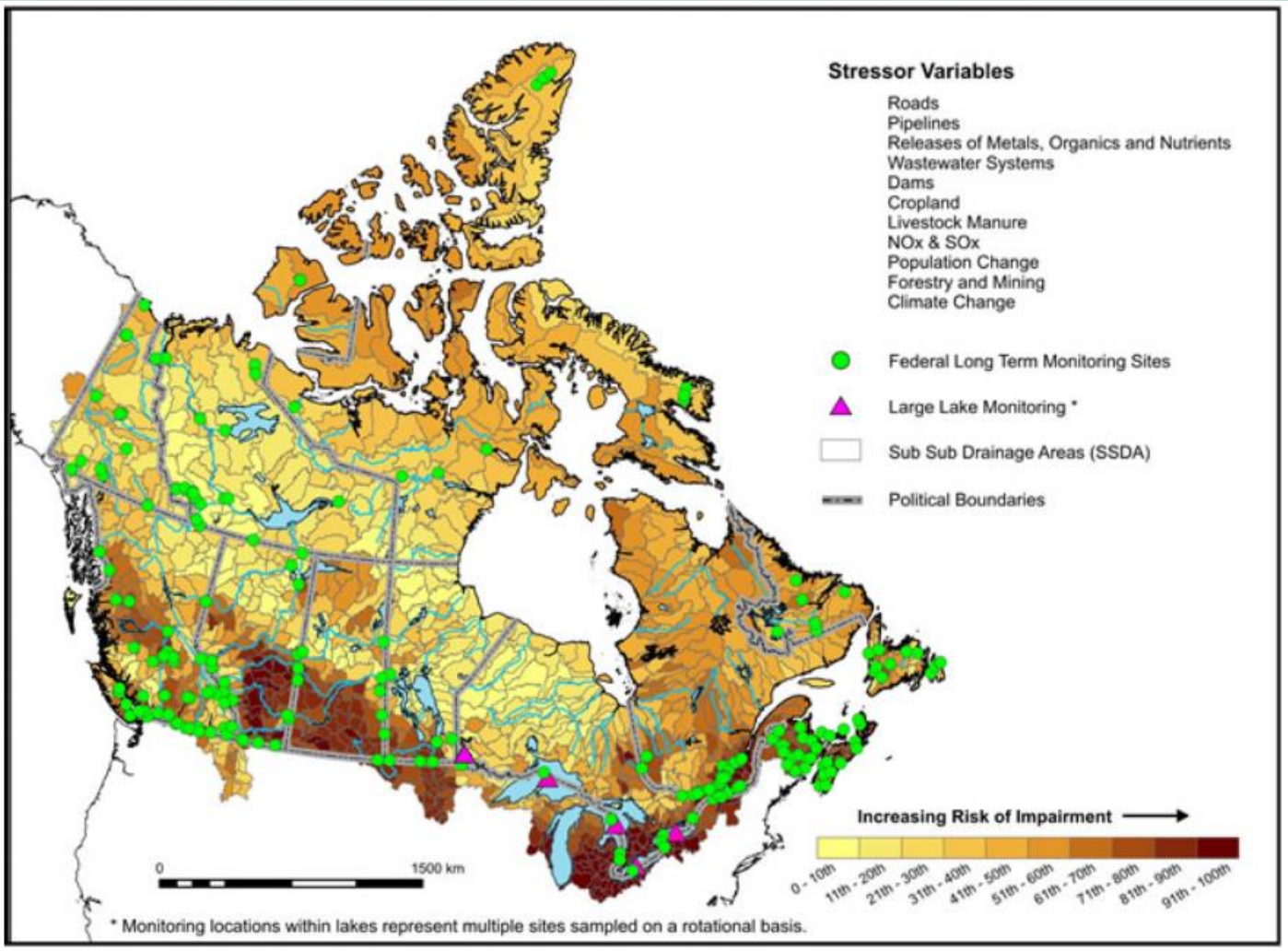
2 b) Environment and climate change Canada's risk-based basin analysis (RBBA) indicator

- RBBA is a spatial analysis tool used to quantify the relative risk to water quality in Canada's 1,138 sub-sub-drainage areas (SSDA's).
- RBBA tool aggregates stress from 16 human activities and classifies basins on a relative risk scale.
- challenges in terms of appropriate weighting of each variable - default to equal weights.
- useful for discussing in the context of SDG 6.6

http://www.ec.gc.ca/eaudouce-freshwater/default.asp?lan%20g=En&n=50947E1B-1

2 b) Environment and Climate Change Canada's risk-based basin assessment indicator

Canada
www.un.org/desa

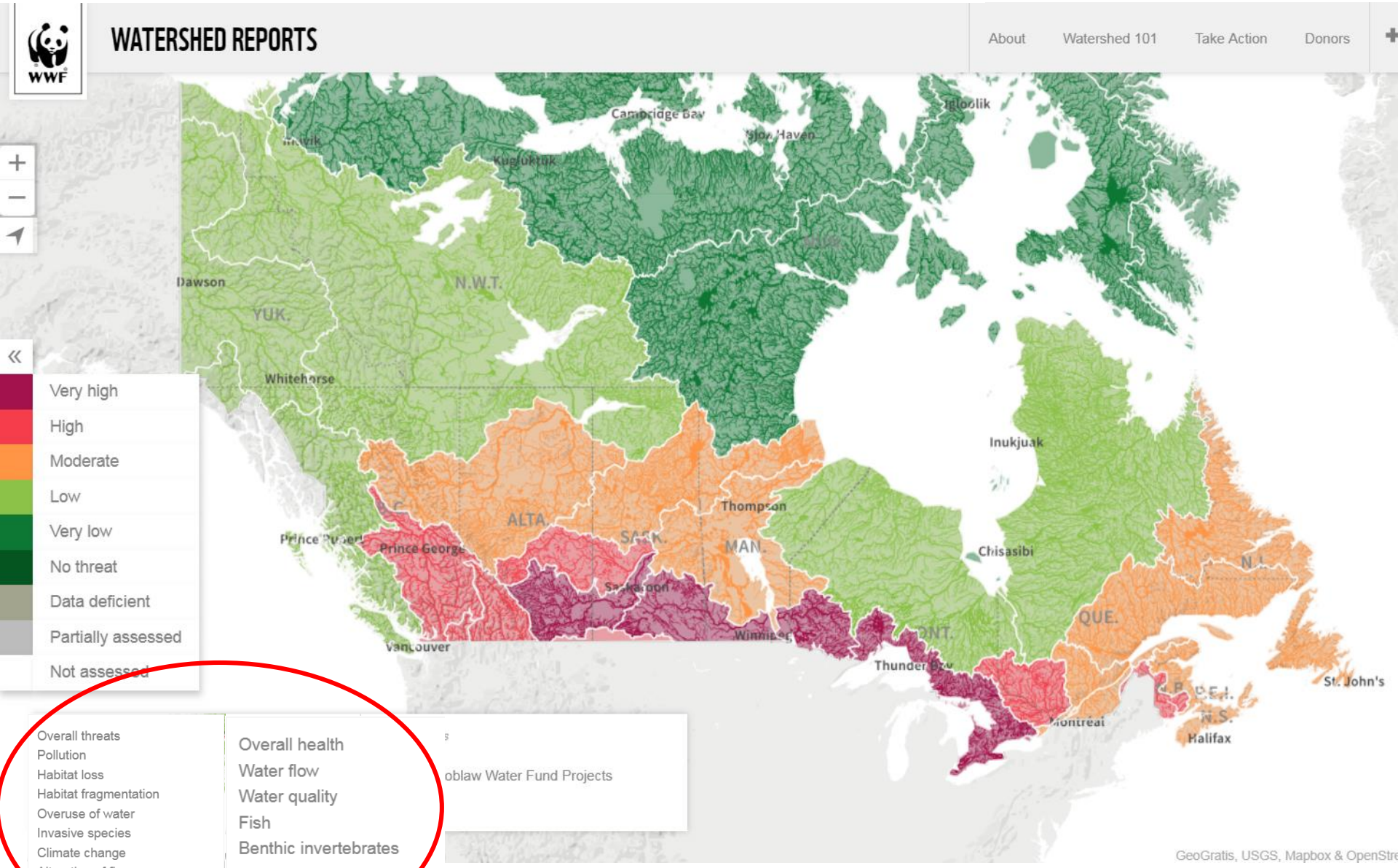


The map of Canada showing the sub-sub-drainage areas classified according to their risk factors that can threaten the water quality. The main risk factors are the presence of road networks, pipelines, urban discharges and contaminants, dams and agriculture. The sub-sub-drainage areas associated with the highest risk are concentrated in the Prairies, the Great Lakes, the St. Lawrence River and the Maritimes.

2 c) World Wildlife Fund; rivers at risk indicator

www.un.org/desa

Canada



http://www.wwf.ca/?4820

3) Measuring change in freshwater ecosystems at Statistics Canada (STC)

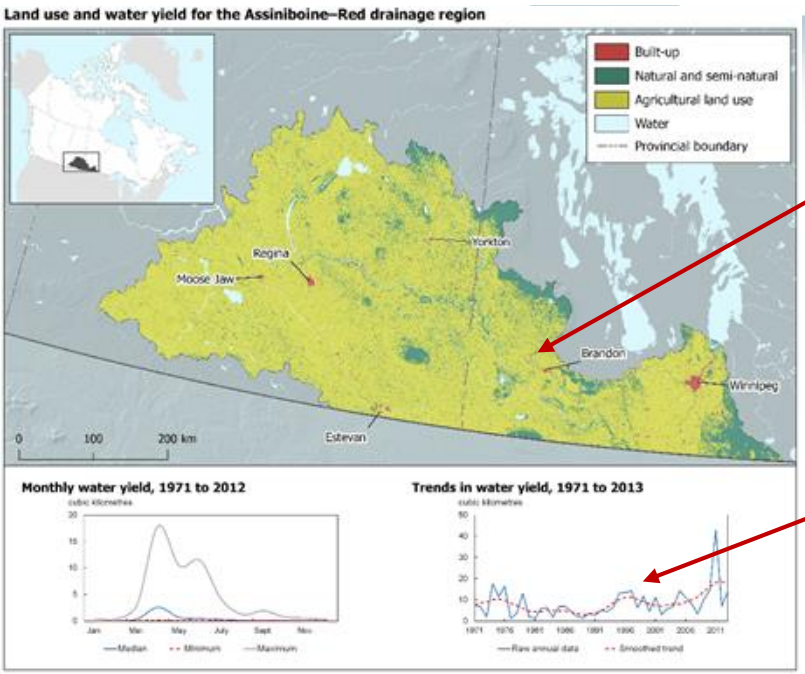
- STC has used a combination of variables to measure change in its publications (*Human Activity and the Environment* and data tables)
- STC uses direct ecosystem measures such as turbidity, water quality indicator data, water yield trends and water withdrawals
- STC uses drivers of change or contextual variables such as land cover and land use change, soil nutrient residuals, temperature change and linear density to assist in interpreting change
- compiling time series data has often been challenging and reference periods are determined by what data is available

3) Freshwater ecosystem condition account; targeting change

What do we need to measure? Influences?

1. Emissions
   - land use management; nutrients from agriculture, turbidity and risk to water indicator
   - pollution; National pollution release inventory
2. Land use and cover change
   - fragmentation
   - land conversion
3. Climate change
4. Intake, use and abstraction
5. Invasive species

3 a) Building a condition account



Notes: The land use map is derived from remote sensing data products and administrative data sources. Water yield data were derived from discharge values contained in Environment and Climate Change Canada's HYDAT database. Additional information is available in Appendix D.

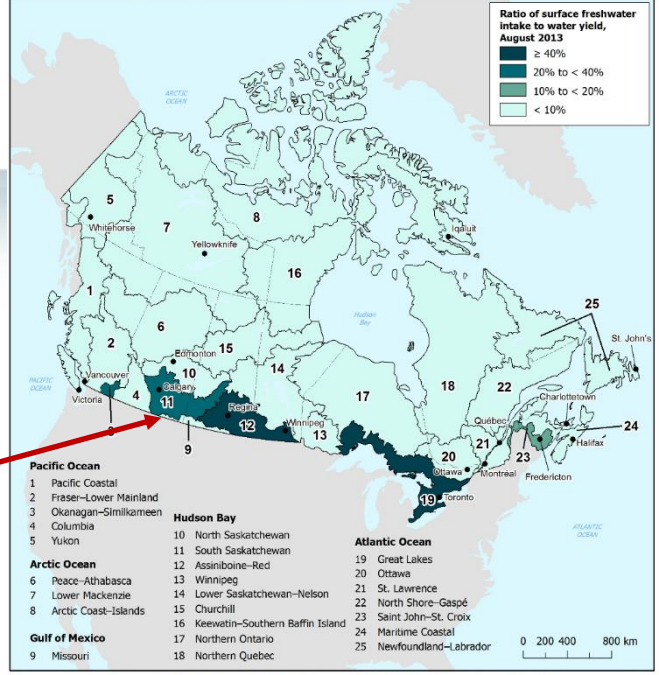
land use and land cover change

water withdrawals

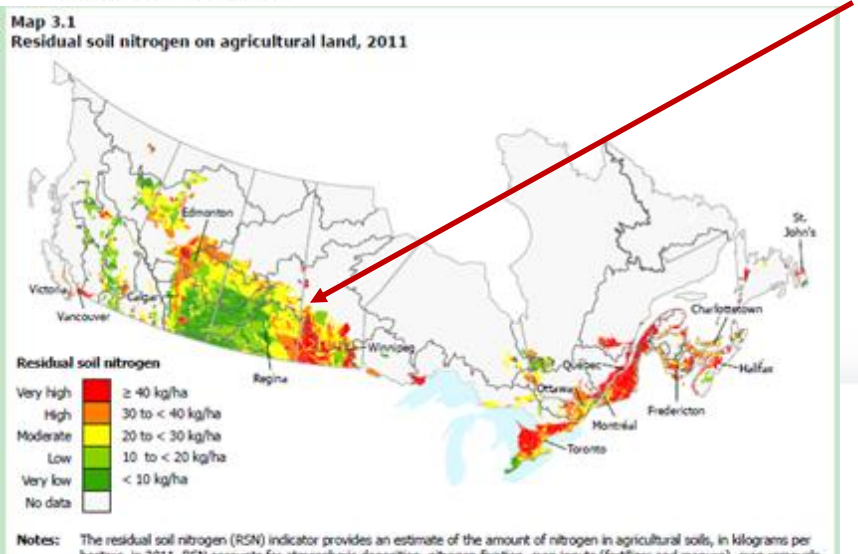
trends

nutrients; residual soil nitrogen

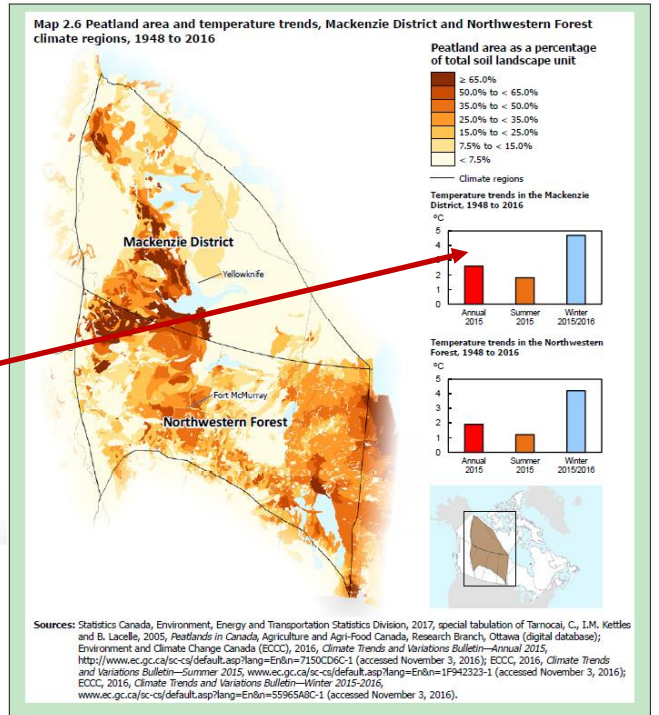
temperature change



Human Activity and the Environment 2016: Freshwater in Canada



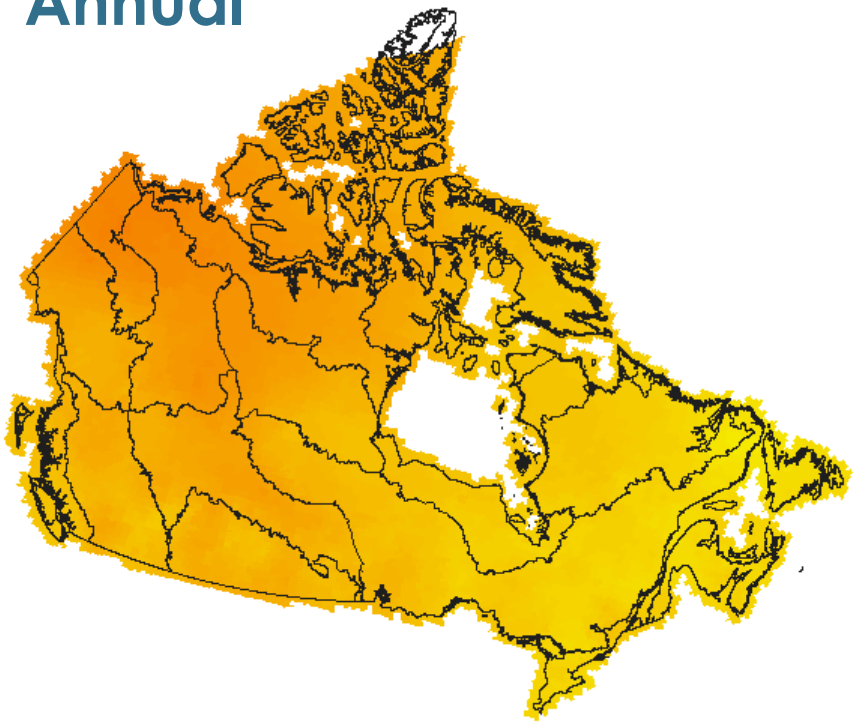
Notes: The residual soil nitrogen (RSN) indicator provides an estimate of the amount of nitrogen in agricultural soils, in kilograms per



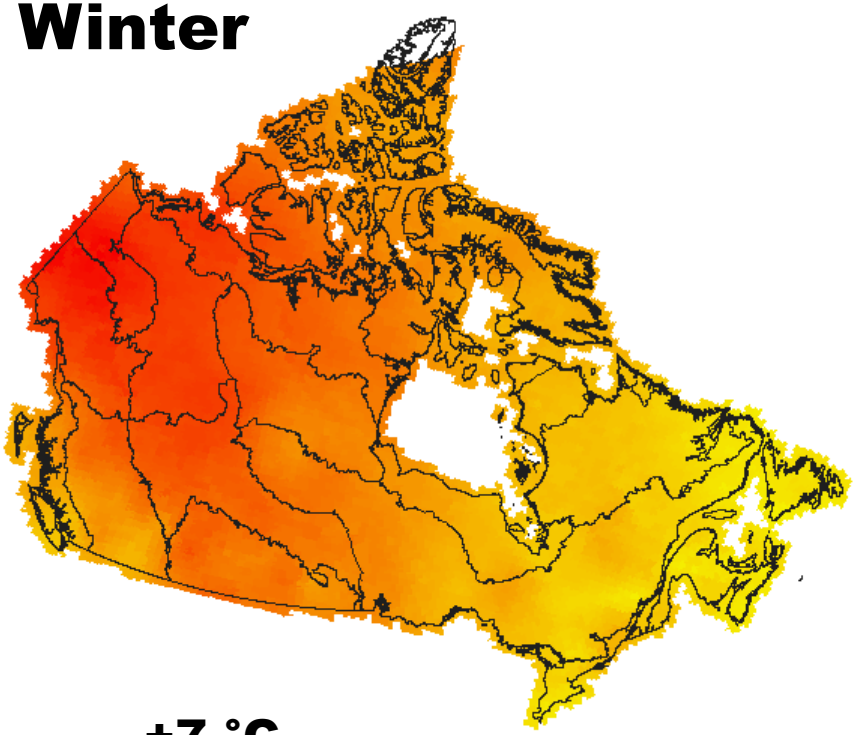
Sources: Statistics Canada, Environment, Energy and Transportation Statistics Division, 2017, special tabulation of Tarnocai, C., I.M. Kettles and B. Lacelle, 2005, *Peatlands in Canada*, Agriculture and Agri-Food Canada, Research Branch, Ottawa (digital database); Environment and Climate Change Canada (ECCC), 2016, *Climate Trends and Variations Bulletin—Annual 2015*, http://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=7150CD6C-1 (accessed November 3, 2016); ECCC, 2016, *Climate Trends and Variations Bulletin—Summer 2015*, www.ec.gc.ca/sc-cs/default.asp?lang=En&n=1F942323-1 (accessed November 3, 2016); ECCC, 2016, *Climate Trends and Variations Bulletin—Winter 2015-2016*, www.ec.gc.ca/sc-cs/default.asp?lang=En&n=55965A8C-1 (accessed November 3, 2016).

Long-term trends of temperature change (°C) for 1948-2016

Annual



Winter



0 +7 °C

3 a) Building a condition account

indirect measures of condition

direct measures of condition (with time series)

Table 2 – continued

Variables of demand for wetland services, indicators of demand for multiple services, southern Canada, 2011

	Sub-drainage area code	Area[1]	Indicators of demand for multiple services					
			Population	Population density	Land in agriculture	Livestock density	Average natural land parcel size	Average distance to natural land parcel
	code	square kilometres	persons	persons per square kilometre	percent of area	animals per square kilometre	square kilometres	metres
Southern coastal waters, British Columbia	08G	41,986	687,662	16.4	0.3	13	183.3	2
Vancouver Island	08H	34,882	737,398	21.1	1.4	20	93.7	4
Nechako	08J	47,332	61,488	1.3	4.4	1	248.0	2
Upper Fraser	08K	67,088	73,650	1.1	3.0	1	734.5	1
Thompson	08L	55,777	185,393	3.3	10.1	25	381.0	2
Lower Fraser	08M	61,880	2,018,645	32.6	5.4	281	80.6	10
Columbia	08N	102,925	488,653	4.7	3.1	7	390.6	2
Queen Charlotte Islands	08O	10,049	4,370	0.4	0[s]	0	83.4	0[s]
Skagit	08P	1,027	140	0.1	0.3	0	1,021.5	0
Missouri	11A	27,097	8,701	0.3	84.9	0	3.4	366

Table 3

Variables of demand for wetland services, indicators of demand for individual services, southern Canada, 2011

	Sub-drainage area code	Area[1]	Streamflow regulation	Water quality regulation			Recreational and educational use	
			Flow variability[2]	Land area fertilized	Nitrogen in manure from livestock	Phosphorous in manure from livestock	Average natural land parcel size	Average distance to natural land parcel
	code	square kilometres	CV of flow in major river	percent of area	kilograms per square kilometre		square kilometres	metres
Saint John and Southern Bay of Fundy	01A	41,987	0.99	1.5	145	39	57.0	14
Gulf of St. Lawrence and Northern Bay of Fundy	01B	60,653	1.06	0.5	63	16	88.6	6
Prince Edward Island	01C	5,943	0.67	16.8	818	215	2.3	229
Bay of Fundy and Gulf of St. Lawrence, Nova Scotia	01D	21,499	0.75	2.6	353	93	19.9	26
Southeastern Atlantic Ocean, Nova Scotia	01E	23,222	0.75	0.5	38	10	39.8	4
Cape Breton Island	01F	10,685	0.75	0.3	42	11	38.0	6
Northwestern Lake Superior	02A	51,541	0.53	0.1	11	3	104.2	1

Table A.3

Selected indicators of pressures on water quality by drainage region

		Residual soil nitrogen on agricultural land, 2011[1]	Residual soil nitrogen on agricultural land, normalized across the total area of the drainage region, 2011[1]	Risk of phosphorus release from agricultural soils, 2011[1]	Risk of phosphorus release from agricultural soils, normalized across the total area of the drainage region, 2011[1]	Nitrogen emissions, National Pollutant Release Inventory, 2014[2]	Phosphorus emissions, National Pollutant Release Inventory, 2014[2]	Median monthly maximum turbidity, 2013[3]
	code	kg/ha	kg/km²	mg/kg	mg/kg	tonnes		nephelometric turbidity units
Canada	…	23.2	133.4	1.7	0.0	754,011	40,443	..
Pacific Coastal	1	22.0	6.8	2.9	0.0	10,390	493	0.9
Fraser–Lower Mainland	2	23.2	105.5	3.3	0.0	26,489	34,660	1.4
Okanagan–Similkameen	3	20.3	184.5	2.6	0.0	201	0	1.4
Columbia	4	21.4	30.2	2.5	0.0	2,468	1,373	0.7
Yukon	5	…	…	…	…	0	0	..
Peace–Athabasca	6	25.4	215.1	1.6	0.0	155,828	133	5.0
Lower Mackenzie	7	26.8	0.1	1.5	0.0	22,559	0	4.6
Arctic Coast–Islands	8	…	…	…	…	7,607	0	F
Missouri	9	11.1	922.5	1.6	1.1	16,289	0	F
North Saskatchewan	10	20.0	1,314.5	1.5	0.6	127,820	82	9.0
South Saskatchewan	11	14.2	1,099.9	1.8	1.1	107,769	331	6.3
Assiniboine–Red	12	24.7	1,822.4	1.3	0.7	30,260	524	7.7
Winnipeg	13	31.6	30.3	1.8	0.0	1,703	47	2.4
Lower Saskatchewan–Nelson	14	29.4	337.0	1.3	0.0	1,427	10	20.9
Churchill	15	28.0	94.9	1.6	0.0	12,724	0	4.5
Keewatin–Southern Baffin Island	16	…	…	…	…	1,327	0	F
Northern Ontario	17	25.4	1.6	2.9	0.0	6,543	19	4.9
Northern Quebec	18	25.0	1.1	3.5	0.0	5,169	13	F
Great Lakes	19	37.5	405.6	1.8	0.0	106,099	781	5.0

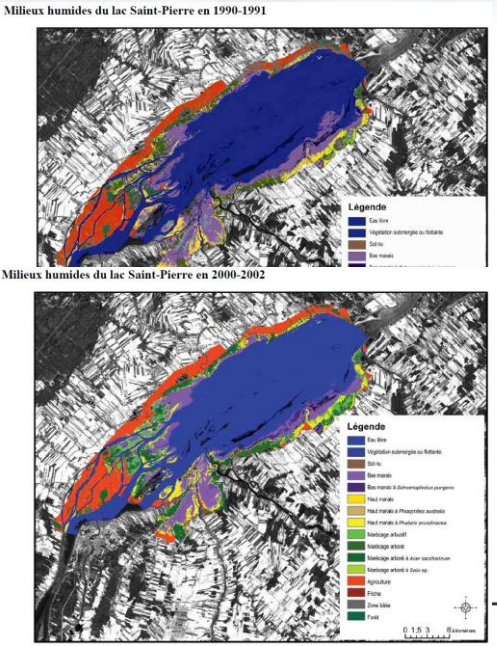
Table A.1

Selected land cover and land use statistics by drainage region, 2011

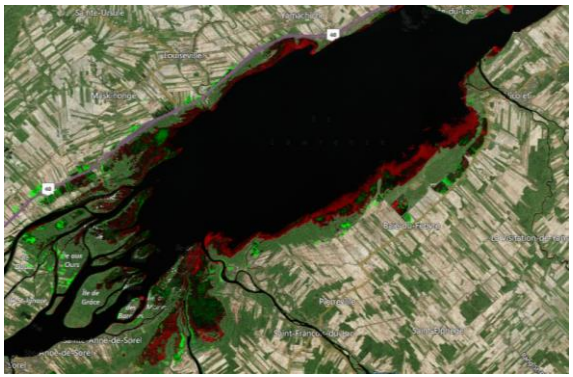
	code	Total area[1]	Water area[1]	Land area[1]	Built-up area, 2011[2]	Arable land, 2011[3]	Natural land for pasture, 2011[3]	Natural and semi-natural area, 2011[4]	Fertilized area, 2011[3]	Irrigated area, 2011[3]	Barriers, 2011[5]	Barrier density, 2011[5]
				km²							m	m/km²
Canada	…	9,978,923	1,169,561	8,809,362	59,351	428,953	146,775	9,343,844	249,056	7,665	1,494,919,813	169.7
Pacific Coastal	1	334,455	14,219	320,236	1,547	493	635	331,781	183	79	45,332,602	141.6
Fraser–Lower Mainland	2	233,104	8,937	224,167	2,481	3,294	7,786	219,544	1,224	725	84,982,300	379.1
Okanagan–Similkameen	3	15,603	585	15,018	432	342	1,062	13,766	150	182	11,080,603	737.8
Columbia	4	87,323	2,348	84,975	666	403	898	85,356	148	117	29,827,848	351.0
Yukon	5	332,906	9,540	323,366	340	0	0	332,566	0	0	13,344,637	41.3
Peace–Athabasca	6	485,145	16,725	468,420	2,774	30,241	11,018	441,112	15,065	13	77,076,176	164.5
Lower Mackenzie	7	1,330,490	177,000	1,153,490	619	33	32	1,329,806	2	0	21,374,471	18.5
Arctic Coast–Islands	8	1,764,280	175,804	1,588,476	52	0	0	1,764,228	0	0	2,592,429	1.6
Missouri	9	27,096	915	26,181	313	11,264	11,139	4,380	3,931	144	15,343,911	586.1
North Saskatchewan	10	150,151	7,242	142,909	4,608	74,498	23,740	47,305	44,992	94	118,881,300	831.9
South Saskatchewan	11	177,623	6,219	171,404	4,866	89,676	48,350	34,732	51,958	5,236	140,858,590	821.8
Assiniboine–Red	12	190,704	8,846	181,858	5,987	118,065	21,505	45,146	74,969	266	181,360,534	997.3
Winnipeg	13	107,655	20,525	87,130	914	787	349	105,605	316	1	19,766,658	226.9
Lower Saskatchewan–Nelson	14	360,887	67,617	293,270	2,290	30,894	9,901	317,802	18,752	117	69,974,401	238.6
Churchill	15	313,568	51,918	261,650	763	5,786	4,753	302,267	1,844	5	18,492,635	70.7
Keewatin–Southern Baffin Island	16	939,569	161,011	778,558	25	0	0	939,544	0	0	385,997	0.5
Northern Ontario	17	691,809	56,064	635,745	878	485	134	690,311	88	0	27,268,966	42.9
Northern Quebec	18	940,193	149,081	791,112	749	214	15	939,215	21	0	19,679,873	24.9
Great Lakes	19	317,860	111,577	206,283	10,998	32,846	2,606	271,411	20,631	397	185,410,480	898.8
Ottawa	20	146,353	14,550	131,803	3,508	6,689	1,163	134,993	2,963	26	84,994,689	644.9
St. Lawrence	21	118,733	8,801	109,932	5,971	15,222	1,000	96,540	8,451	206	120,259,882	1,093.9
North Shore–Gaspé	22	369,095	36,933	332,162	1,599	2,372	48	365,076	700	14	39,638,603	119.3
Saint John–St. Croix	23	41,903	1,716	40,187	1,274	1,340	162	39,128	610	3	33,250,648	827.4
Maritime Coastal	24	122,057	6,495	115,562	4,215	3,922	441	113,480	2,007	40	99,884,596	864.3
Newfoundland–Labrador	25	380,361	54,893	325,468	1,486	87	40	378,749	51	0	33,856,985	104.0
Newfoundland (Island)[6]	…	111,186	14,235	96,952	1,240	86	40	109,819	51	0	29,637,886	305.7

3 b) SDG 6.6 – freshwater ecosystem change

Canada



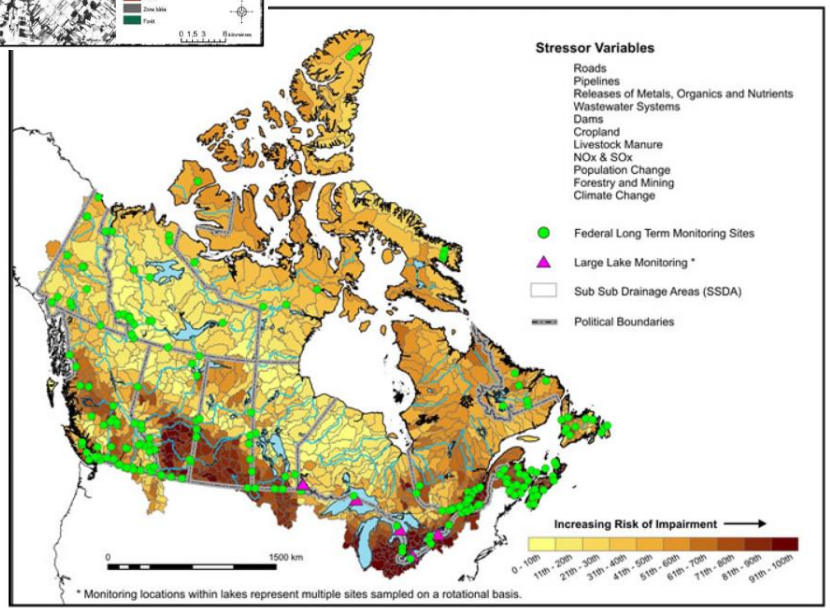
Global surface water data and change over 30 years.



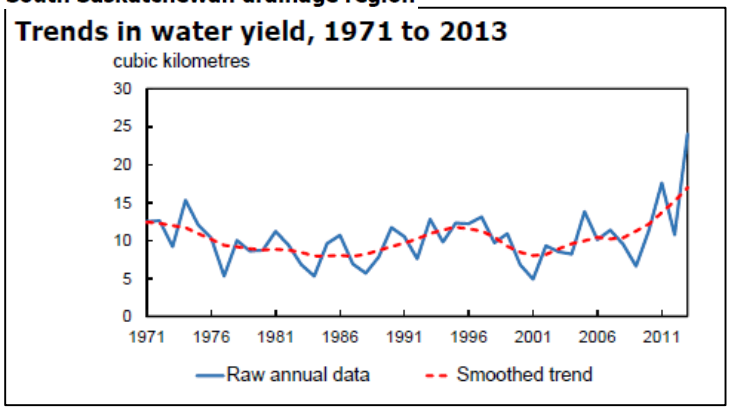
SDG Indicator 6.6.1:

- **Target 6.6: By 2020 protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes**
  - *2020 synchronizes with the Aichi Biodiversity Targets of the CBD but will continue beyond that date to synchronise with the rest of the 2030 Agenda.*
- **Indicator 6.6.1: Percentage of change in water-related ecosystems extent over time.**
  - *Their spatial extent*
  - *The quantity of water contained within these ecosystems*
  - *The health or state of these ecosystems*

UNEP



South Saskatchewan drainage region



Some challenges and gaps

- finding consistent data and methodologies across national and regional scales is difficult (invasive species)
- integrating variables to analyse multiple influences (weighting) is complicated
- finding appropriate time series data is challenging
- reference periods are determined by what data is available not by what is optimal
- communicating pressures and change coming from multiple variables is challenging
- normalizing data to make it comparable is challenging
- analysing acute vs chronic influences is challenging

Thank you, questions ?

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