Draft note on spatial and temporal scales in water accounting

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Spatial variation of water renewal

The amount of water that is available to ecosystems and citizens across the world varies widely (Figure 1). Expressed as a depth, the average annual water yield of Brazil is 967 mm. Accumulated, this water would reach the waist of most adults, while the yield of South Africa, at 41 mm, would barely wet one's feet. In Canada, at 348 mm, the accumulated annual water yield would almost reach the knees**.** Put another way, Canada's average annual water yield per unit area is 0.348 m3/m2, or 348 litres of renewable freshwater for every square metre of the country. This yield is substantially higher than the yield in drier countries such as Australia and South Africa that have one-fifth and one-eighth of this amount, respectively. Brazil, a tropical country with significant precipitation, has 0.967 m3/m2, almost triple the production of water per unit area in Canada

However, this measure of water abundance is estimated on a national scale; the picture can change substantially on a regional scale. For example, there is as much disparity between regions within Canada as there is between countries (Figure 1). A lot of water is produced on the coasts, while the Prairies in particular, are relatively dry. In fact, there are as many disparities within Canada as there are across the world. Moreover, 98% of Canadians live in the southern part of the country which is responsible for only 38% of Canada's renewable freshwater. The water yield will vary markedly even in a relatively ecologically homogenous area such as the Canadian Prairies (Figure 2).

This demonstrates that scale matters. Perhaps this is truer for larger countries, but nevertheless a variable that needs to be addressed in order to account appropriately for water.

Temporal variation of water renewal

Time also matters. The production of renewable water by freshwater ecosystems is unequally distributed throughout the year. In much of Canada the bulk of the water yield comes in spring and greatly declines through the summer months in any given year. However, this timing varies widely across the country. Throughout the continental interior, maximum precipitation generally occurs in summer, while this is the driest time of year on the west and east coasts. The Prairies and Arctic receive very little precipitation in winter, partly due to cold temperatures that limit the air's capacity to hold water vapour. In comparison, in winter coastal British Columbia receives most precipitation as rain, and the east coast receives a mix of rain and snow, with more rain near the Atlantic Ocean and more snow further inland.

Spatio-temporal variation of water demand

Finally, is goes practically without saying that the demand for water in Canada will also vary spatially and temporally; demand is highest generally through the summer, with the highest demand generally in July and August. While demand is relatively stable from November to April, the rise and fall between April and November can be attributed to a wide variety of seasonal uses, including lawn and garden watering, agricultural irrigation and livestock watering, tourism, car washing and outdoor swimming pools, among others. In Canada, the variation in demand from year to year is far less than the annual seasonal variation.

Understanding the temporal relationship between supply and demand provides insight into when

pressure is exerted on water resources in specific regions. Figure 3 illustrates this point by mapping, in a relatively coarse area, the relationship between water use and water as a proxy for a demand to supply indicator.

Runoff modelling required

SEEA Water recognises the importance of spatial distribution of water by stressing the importance of analysing water by river basins. However, what seems to be missing from the discussion is the usefulness of the modelling of water flows, i.e. modelling runoff. This modelling is important for many reasons, including the following three: firstly, it is often the case that the gauge for measuring the flow of the river in a river basin is not located at the output of the basin, thereby requiring a way to impute the missing flows that are not captured by the gauging instrument. Secondly, since river basins are usually ordered in a nested hierarchy ranging from the small watersheds to the large ocean draining basins, there is a need for the capacity to move up or down the hierarchy depending on the scale of the analysis, a capacity which generally requires modelling data. Thirdly, especially in countries with a marine coast, water will run off to the ocean without being first channelled in a river of any significance – and therefore will not be gauged[1]. The modelling of runoff is a statistical activity that is necessary to appropriately account for water, but seldom mentioned in SEEA.

The SEEA Physical Supply and Use Table (PSUT) is presented as a national account table, with no recommendations to account at regional scales. This may be because countries traditionally do not compile water demand by river basins. However, given the arguments presented above with regards to the usefulness of supply and demand indicators at the regional scale, it would be worth discussing the advantages and

[1] The Statistics Canada standard for water statistics refers to “drainage areas” and not “river basin”; river basins do not cover the whole territory, whereas drainage areas do. This is an important consideration, especially in accounting. See http://www.statcan.gc.ca/subjects-sujets/standard-norme/sdac-ctad/sdac-ctad-eng.htm for more information.

drawbacks of stratifying by river basins the surveys that provide water use data. Such a stratification allows the data to be compiled and published using a geography that is appropriate for water accounts. Statistics Canada stratifies the Industrial Water Use – Manufacturing Industries, as well as the Agricultural Water survey and Survey of Drinking Water Plants using both drainage regions and provincial boundaries. This stratification allows for the sub-national reporting of data. It does, however, also engender issues of data quality, residual disclosure and cost.

Where has time gone?
With regards to time steps, the SEEA technical note provides three examples of time scales for water accounts – calendar, fiscal and hydrological years: Arguably, a fourth dimension needs to be considered. Water accounting needs to be conducted at the infra-annual step, at a minimum at the hydrological season or quarter, if it is to provide data that is appropriate for a supply and use indicator. In Canada, the Survey of Industrial Water Use, the Agricultural Water Survey, and the Survey of Drinking Water Plants all gather water data on a monthly step, allowing StatCan to produce an indicator for the month where the discrepancy between supply and demand is highest.

Conclusion
The purpose of this note was to launch a discussion on the issues related to spatial and temporal scale in water accounting. The simple concepts presented may well be considered oversimplified and superficially discussed, but it remains that examples of national water accounting at the regional and infra-annual scale remain few and far apart, and, to my knowledge, not present in the current recommendations on water accounting.

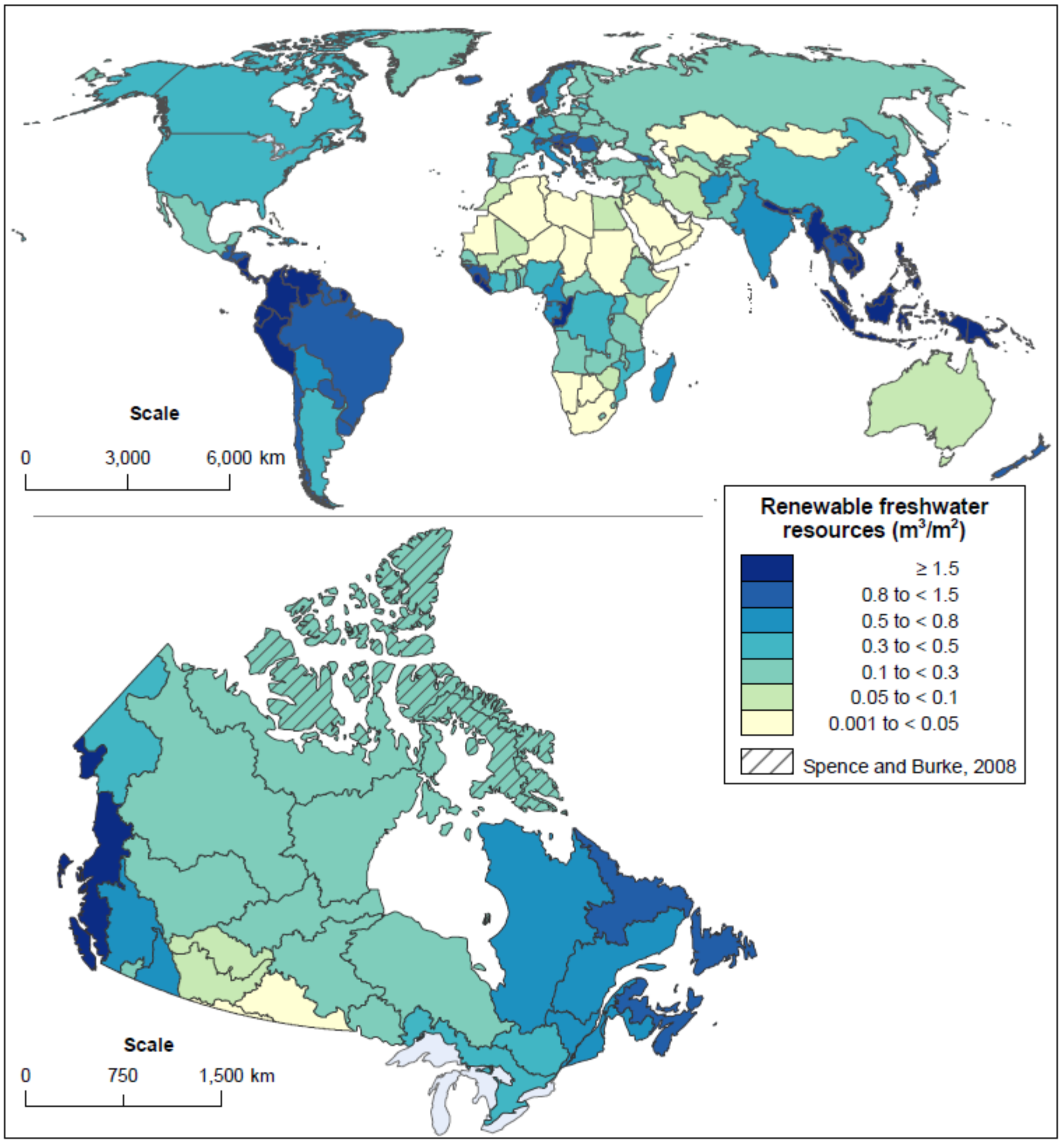


Figure 1: Renewable water resources, Canada and the world

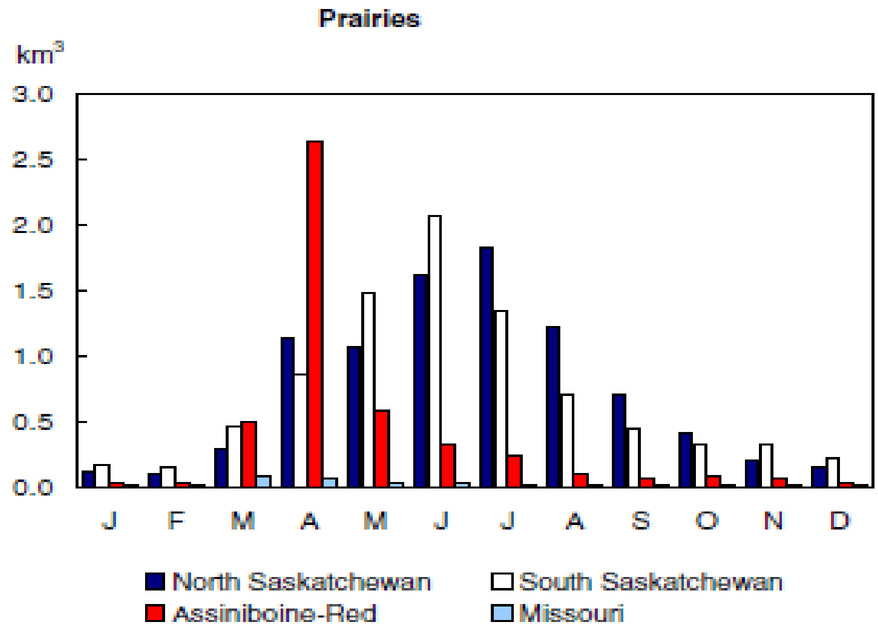
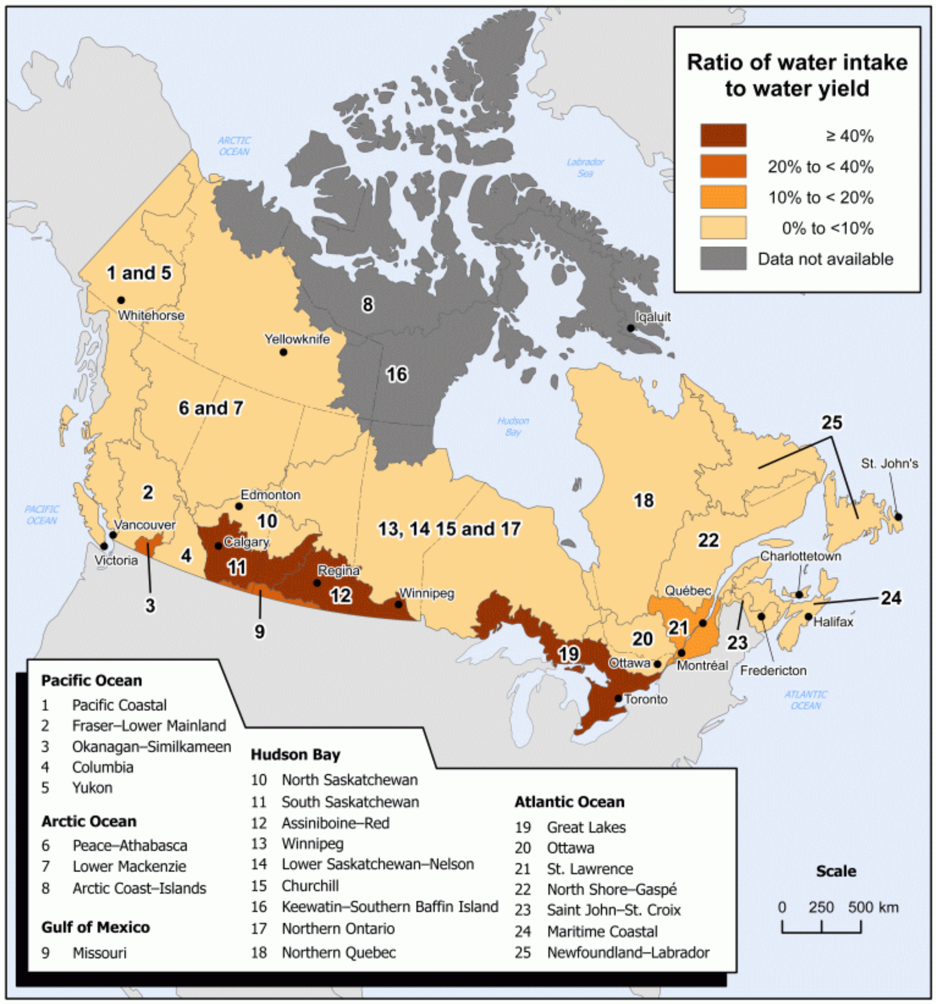


Figure 2: Monthly Water Yield for Selected Drainage Regions, 1971 to 2004



Note(s): The following drainage regions were aggregated to protect confidentiality; Pacific Coastal (1) with the Yukon (5); Peace-Athabasca (6) with the Lower Mackenzie (7); and the Winnipeg (13), Lower Saskatchewan-Nelson (14), Churchill (15) and Northern Ontario (17). Data that contributed to intake volumes (demand) were compiled from Statistics Canada: Industrial Water Survey, 2005; Households and the Environment Survey, 2006; Survey of Drinking Water Plants, 2005 to 2007; and Agricultural Water Use Survey 2007. Data from Agriculture and Agri-Food Canada and Canada Mortgage and Housing Corporation were used to help allocate and derive some intake volumes. Water yield volumes (supply) used for each drainage region are a 34-year median (1971 to 2004) for the month of August.

Source(s): Canada Mortgage and Housing Corporation, 2007, *Household Guide to Water Efficiency*, Product number 61924.
Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

Figure 3: Water demand and supply indicator