Impacts of the strongest El Niño episodes on characteristics of annual minimum streamflow in southern Quebec

Impacts des épisodes EL Niño les plus intenses sur les caractéristiques des débits minimums annuels au Québec méridional

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RÉSUMÉ

On a comparé la magnitude des débits minimums extrêmes journaliers de 9 rivières réparties dans trois régions hydroclimatiques du Québec méridional avant, pendant et après trois épisodes les plus intenses d'El Nino (1982/83, 1997/1998 et 2009/2010). La magnitude la plus basse survient pendant l'avènement El Nino dans les trois régions hydroclimatiques. Toutefois, cette tendance est moins marquée pour l'épisode El-Nino de 1997-1998. Il s'ensuit que les épisodes El Nino les plus intenses sont associés à une diminution des débits minimums extrêmes journaliers au Québec.

ABSTRACT

We compared the magnitude of extreme minimum daily flows for nine rivers in three hydroclimate regions of southern Quebec before, during and after the last three most intense El Niño episodes (1982-1983, 1997-1998 and 2009-2010). The lowest magnitudes are recorded during the El Niño events in all three hydroclimate regions although this trend is not as strong for the 1997-1998 episode. Thus, in Quebec, the most intense El Niño episodes are associated with a decrease in extreme minimum daily flows.

KEYWORDS

Débits minimums extrêmes, El Nino, intensité, magnitude, Québec.

1 INTRODUCTION

El Niño is a climate phenomenon with impacts affecting many regions of the World. In Canada, many studies have shown the influence of this phenomenon on the spatial and temporal variability of hydroclimate variables (e.g., Shabbar, 2006), although its effect is much stronger in the western than in the eastern part of the country. In Eastern Canada, correlations calculated between ENSO indices (El Niño/Southern Oscillation) and streamflow in rivers at different time scales are generally weak or non-existent (e.g., Assani et al., 2011). This situation may be explained by the fact that the effects of the most intense El Niño episodes on streamflow may be blurred by less intense episodes. To test this hypothesis, we examined the effects of the three most intense El Niño episodes of the last 30 years on the magnitude of annual minimum daily flows. According to Shabbar (2006), El Niño effects are associated with a significant decrease in precipitation and an increase in winter temperatures in the eastern part of Canada. These effects should, in principle, produce a decrease in the magnitude of minimum flows because the main influence on these flows is infiltration of snowmelt water, the main source of aquifer recharge in Quebec (Larocque and Pharand, 2010).

2. METHODS

We analyzed minimum daily flows for nine rivers in the three hydroclimate regions (Southeast, Eastern and Southwest) of southern Quebec (Fig. 1). Streamflow measurements in these rivers have been collected since the early 1930's. For each river, only the lowest minimum flows recorded each year (October to September), or annual minimum daily flows, were considered. Daily flow data were taken from the Environment Canada website (http://www.wsc.ec.gc.ca/applications/H2O/index-eng.cfm, viewed in March 2014).The most intense El Niño episode considered were restricted to those recorded during the last 30 years, and occurred in 1982-1983, 1997-1998 and 2009-2010. The analytical method consisted in comparing the magnitude of annual minimum daily flows before, during and after each most intense El Niño event.

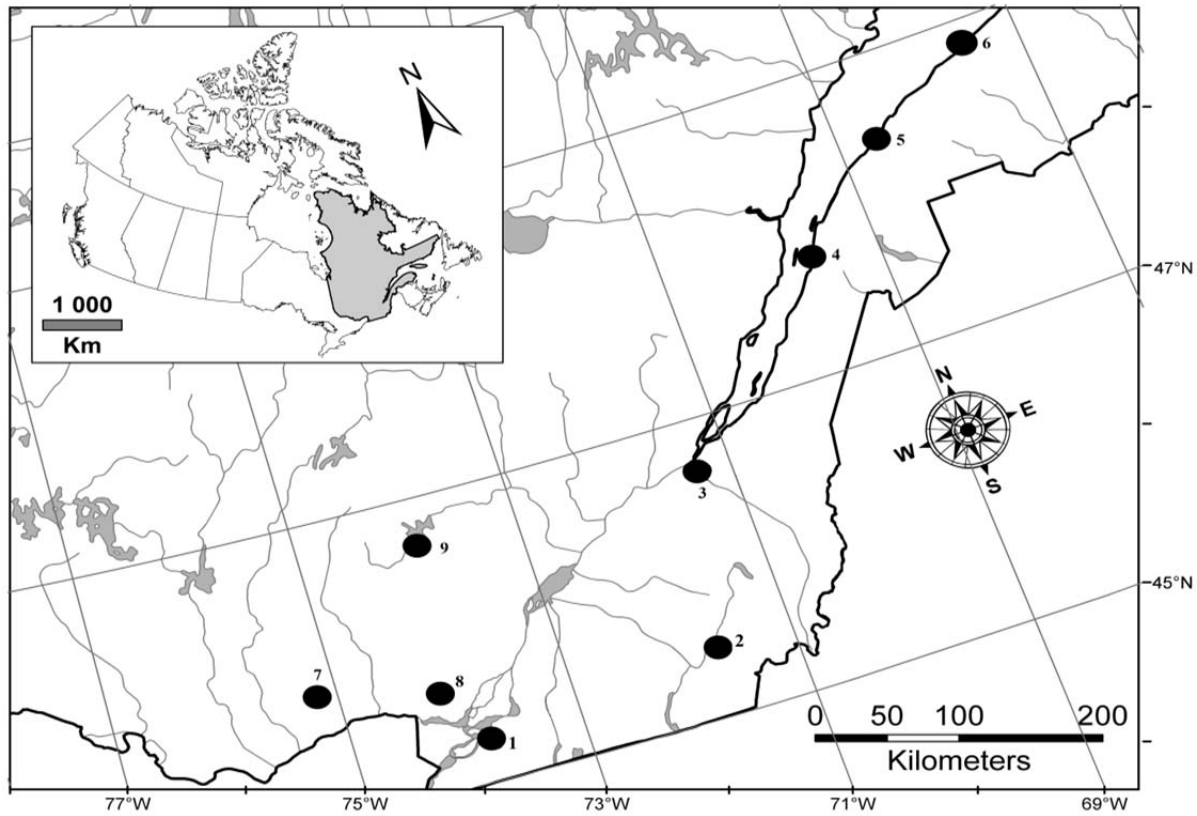

Fig.1. Location of rivers. 1 = Chateaugay River, 2 = Eaton River; 3 = Beaurivage River; 4 = Du Loup River; 5 = Rimouski River; 6 = Blanche River; 7 = De La Petite Nation River; 8= Du Nord River; 9 + Matawin River.

3. RESULTS

Results of this comparison of the magnitude of annual minimum daily flows are shown in Table 1, from which it can be seen that for the 1982-1983 and 2009-2010 El Niño episodes, the lowest magnitude occurred during the El Niño years in all three hydroclimate regions. In contrast, for the 1997-1998 El Niño event, the lowest magnitude values occurred both before and after the actual El Niño episode. Thus, the most intense El Niño episodes do not all have the same effect on the magnitude of annual minimum daily flows in Quebec.

Table 1. Comparison of the effects of the last three most intense El Niño episodes on the magnitude of annual minimum daily flows (m^3/s) in southern Quebec.

Regions	**Rivers**	**El Nino episode 1982-83**			**El Nino episode 1997-98**			**El Nino episode 2009-2010**		
		T-1	T0	T+1	T-1	T0	T+1	T-1	T0	T+1
Southeast	Châteaugay	6.72	1.48	0.989	5.02	3.95	5.04	6.20	3.50	5.36
	Eaton	1.01	0.52	0.93	0.88	0.55	0.55	0.75	1.08	0.97
	Beaurivage	0.77	0.51	0.51	0.97	1.01	0.54	1.44	0.61	1.72
East	Du Loup	1.64	0.95	1.61	1.51	1.81	2.16	5.90	3.24	5.11
	Rimouski	3.9	1.70	3.63	2.72	2.26	1.97	3.68	1.80	4.59
	Blanche	0.22	0.19	0.33	0.36	0.17	0.04	0.14	0.14	0.45
Southwest	De La Petite Nation	3.23	2.30	4.40	2.84	2.14	2.95	7.77	3.13	3.24
	Du Nord	4.13	4.15	6.05	3.22	4.28	3.01	5.88	3.80	4.25
	Matawin	3.66	3.13	5.95	3.62	5.32	1.79	4.25	3.41	9.24

T-1 = year prior to El Niño episode; T0 = year of El Niño episode; T+1 = year following El Niño episode.

4. CONCLUSION

This study suggests that the lowest magnitudes are recorded during the El Niño events in all three hydroclimate regions although this trend is not as strong for the 1997-1998 episode.

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