Analysis of the morphological evolution of a semi-alluvial river channel: the case of the Matawin River

Analyse de l'évolution morphologique du chenal d'une rivière semi-alluviale. Cas de la rivière Matawin

Yanick Boucher, Ali A. Assani

Département des Sciences de l'Environnement, Université du Québec à Trois-Rivières, Québec, Canada
Yanick.Boucher@uqtr.ca; Ali.Assani@uqtr.ca;

RÉSUMÉ

La rivière Matawin est une rivière type du Bouclier Canadien caractérisée par une alternance quasi régulière des tronçons sableux, caillouteux et rocheux. Nous avons comparé l'évolution morphologique de trois tronçons sableux séparés par des tronçons caillouteux et rocheux pendant la période 1937-1995 à partir de l'analyse diachronique des photographies aériennes. Aucun changement de largeur ni de sinuosité ne fut observé dans les trois tronçons malgré une hausse significative de la magnitude des crues automnales, hivernales et printanières. L'alternance des tronçons constitués par des matériaux de différente sensibilité à l'érosion conférerait une grande stabilité au chenal de la rivière Matawin.

ABSTRACT

The Matawin River is a typical Canadian Shield river characterized by quasi-regularly alternating sandy, pebbly and rocky reaches. We compared the morphological evolution of three sandy reaches separated by pebbly and rocky reaches during the period from 1937 to 1995 based on the diachronic analysis of air photographs. No change in width or sinuosity was observed in any of the three reaches in spite of a significant increase in the magnitude of fall, winter and spring floods. The alternating sequence of reaches comprising materials with different sensitivity to erosion confers great stability to the Matawin River channel.

KEYWORDS

Bouclier canadien, largeur, Matawin, photographies aériennes, sable, sinuosité

INTRODUCTION,

Although studies of the temporal variability of seasonal maximum flow upstream from the Matawin dam have highlighted a significant increase in the magnitude of these flows in winter, spring and fall, the consequences of this increase in streamflow on the morphological evolution of the Matawin River channel have never been examined. The goal of this study is to test the hypothesis that this increase in magnitude of seasonal maximum flows caused a widening and decrease in sinuosity of the Matawin River channel, consistent with models of the morphological evolution of channels as a function of streamflow proposed by Schumm (1968).

2. METHODS

Upstream from the dam, the Matawin River drains a 1390 km^2 area. Its channel morphology is typical of Canadian Shield rivers, in that it is characterized by quasi-regularly alternating sandy, pebbly and rocky reaches. To analyze the morphological evolution of this channel as it relates to changes in streamflow, we carried out the diachronic analysis of air photographs taken in 1937/1939, 1975, 1983 and 1995 at scales on the order of 1/15000. All the photos were taken when streamflow was below bankfull. Prior to proceeding with the morphological analysis of the channel, the photos were digitized, georeferenced and orthorectified. Three reaches (fig.1), ranging in length from 7 to 12 km, were selected for analysis because of their greater sensitivity to erosion. We used the Kruskal-Wallis method to constrain the temporal variability of the mean values of bankfull width for each individual reach on one hand, and to compare the mean values of bankfull width for the three reaches, on the other. No channel depth measurements were taken.

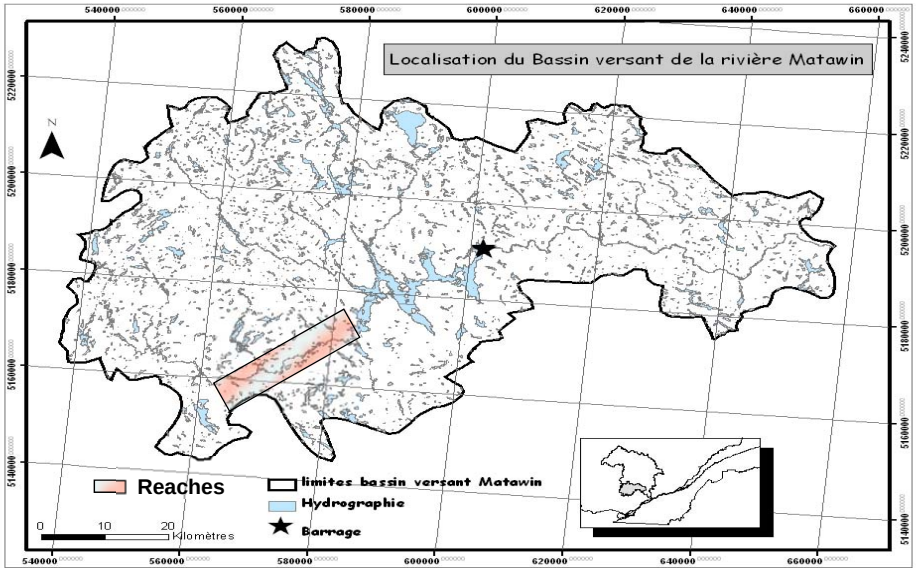

Fig.1. Location of reaches analyzed

3. RESULTS

Mean values of the bankfull width of the three sandy reaches are shown in Table 1. A comparison of these mean values revealed no significant difference in bankfull width between the three reaches. Diachronic analysis of air photographs did not reveal any change in bankfull width in any of the three reaches. As for sinuosity, which is shown in Table 2, no change is observed for any of the three reaches. This lack of change in width and sinuosity in spite of an increase in seasonal maximum daily flows may be due to the intercalation of pebbly and rocky reaches between the sandy reaches, with the pebbly and rocky reaches acting as local base levels that make the sandy reaches relatively stable under evolving flow conditions.

Table 1. Comparison of the spatial and temporal variability of mean bankfull with (m) of three sandy reaches in the Matawin River upstream from the Matawin dam using variance analysis.

Reaches	1937-39	1975	1983	1995	p-values
I (701)	43.4 (8.92)	39.1 (9.02)	39.7 (8.48)	41.7 (7.88)	0.065
II (761)	39.8 (8.27)	35.8 (6.33)	37.8 (6.34)	39.1 (7.31)	0.163
III (1831)	39.1 (10.10)	39.1 (9.27)	38.6 (9.16)	40.2 (8.89)	0.626
p-values	0.124	0.547	0.214	0.287	

(761) = number of bankfull width measurements; (8.92) = standard deviation of the mean.

Table 2. Comparison of the temporal variability of sinuosity in three sandy reaches in the Matawin River upstream from the Matawin dam.

Reaches	1937-39	1975	1983	1995
I	2.67	2.69	2.68	2.70
II	1.51	1.53	1.55	1.54
III	1.60	1.60	1.63	1.60

4. CONCLUSION

Although seasonal maximum daily flows have increased, the Matawin River channel did not undergo any change in width or sinuosity. This stability may be related to the presence of pebbly and rocky reaches that act as local base levels for the sandy reaches.

BIBLIOGRAPHIE (3 MAXIMUM)

Alibert, M., Assani, A.A., Gratton, D., Leroux, D., Laurencelle, M., 2011. Statistical analysis of the evolution of a semialluvial stream channel upstream from an inversion-type reservoir: the case of the Matawin River (Quebec, Canada). Geomorph., 131, 28-34.

Schumm, S.A. (1969) River metamorphosis. *J.hydraulics ASCE*, 255-273.