

Dynamics of Phosphorus Transport at Spring Melt in a Small Agricultural Watershed of Eastern Canada



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Introduction

Soil loss from water erosion can be especially high when snowmelt or rain occurs on unfrozen soil overlying a subsurface frozen layer (Schillinger, 2001). Therefore, it is expected that snowmelt runoff and erosion can also move particulate and dissolved phosphorus fractions from agricultural fields to surface water bodies. In Canada, winter conditions lead to frequent freezing of surface soils due to simultaneous low temperature and thin snow cover (van Bochove et al., 2001), thus sustaining a high risk of snowmelt runoff/erosion at spring. Although soil and water conservation BMPs essential for draining off the water gradually while minimizing soil erosion and washout due to inrushes of water are promoted, very few data exist to document efficiently the P transport at snowmelt runoff in Canada. This study is part of the Canadian Watershed Evaluation of BMPs project (WEBs) and gives preliminary results on P transport dynamics during snowmelt.

Experimental site



Figure 1. Composite map showing from left to right the large Chaudière River watershed in which are included the Bras d'Henri watershed and the instrumented micro-watershed.

The study was conducted on an extensively instrumented micro-watershed of 240 hectares drained by two main branches (Branch 14 and Branch 15) and centered at 46°29'11" N – 71°12'58" W and situated within the Bras d'Henri River watershed in the province of Quebec. The Bras d'Henri River is an affluent of the Beauvillage River identified as one of the tributaries critical to the water quality of the Chaudière watershed owing to intensive animal production. The Chaudière watershed is among the thirty-three main watersheds identified in the province of Quebec where a water management plan is required.

Results

Figure 2. Snow depth and total precipitation (a) 2007 and (b) 2008.

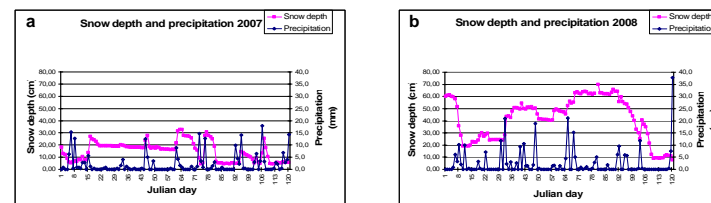


Figure 3. Air and soil (10 cm) temperatures (a) 2007 and (b) 2008.

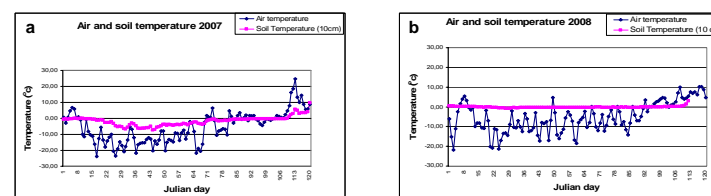


Figure 4. Frozen/unfrozen soil mapping (240ha) using RADARSAT-1 images (a) March 16, 2007 (b) March 10, 2008.

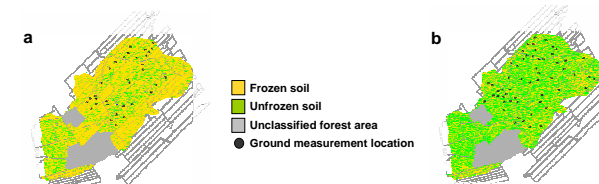


Figure 5. Dissolved phosphorus (DP), Particulate phosphorus (PP) and Suspended Solids (SS) at outlets (a) 2007 and (b) 2008

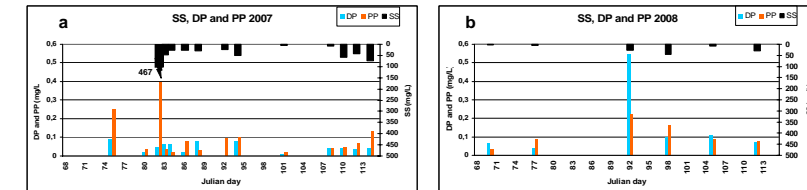
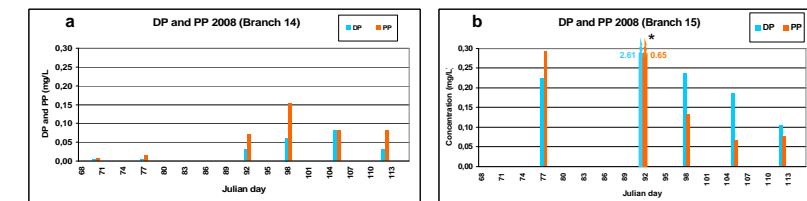
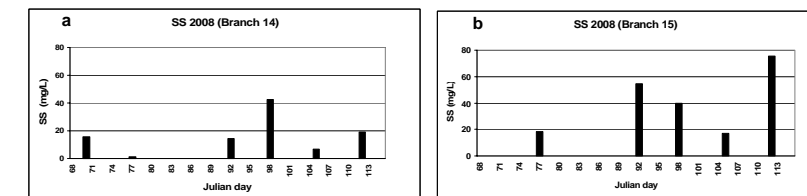


Figure 6. Dissolved phosphorus (DP) and Particulate phosphorus (PP) in 2008 (a) Branch 14 and (b) Branch 15.



* High values of DP and PP on Day 92 correspond to a slurry tank overflowing.

Figure 7. Suspended solids in 2008 (a) Branch 14 and (b) Branch 15



Conclusions

Winter conditions have exhibited important interannual contrasts, especially during the months preceding the main snowmelt in late March – early April as shown in Figures 2, 3 and 4. During winter 2007, the soil surface horizon remained mainly frozen because of the combination of cold air temperature and a relatively small snow depth soil coverage. In opposition, air temperature was milder and the early and deep snow accumulation on the soil surface was much more important leaving the soil surface horizon predominantly unfrozen during winter 2008.

Snowmelt runoff on frozen soils in 2007 (Day 82) showed an important soil erosion event coupled to an important loss of particulate phosphorus while no such important soil erosion event is observable over unfrozen soils during the important snowmelt episode in 2008 (Day 100). The unfrozen soil conditions have enhanced snowmelt water infiltration as shown by lower values of suspended solids and higher values of dissolved phosphorus at outlets.

The two main branches draining the watershed showed contrasted activities in terms of soil erosion and forms of phosphorus losses in 2008. Numerous parameters such as land use, slopes, streambed characteristics, soil texture and class could explain these differences. More studies are needed.

References

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Acknowledgements

The authors are thankful to Dr. Beáta Novotná, Nadia Goussard and Catherine Bossé for their precious collaboration.