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Quantification of peatland specific yield: toward a general peatland water storage indicator

Marc-André Bourgault (1,2), Marie Larocque (1,2), Michelle Garneau (2,3)

(1) Université du Québec à Montréal Département des sciences de la Terre et de l'atmosphère , (2) GEOTOP Research Center, (3) Université du Québec à Montréal Département de Géographie

Peatlands are water saturated environment that can be connected to rivers and aquifers. This connectivity is in part controlled by peat properties such as hydraulic conductivity (K) and specific yield (SY). For the last twenty years, many studies have quantified these parameters in peatlands, contributing to better understand peatland hydrological functions such as water storage, river base flows, and groundwater recharge. Nonetheless, the understanding of peatland water storage capacity is still very limited both at local and global scale, in part due to the lack of unique and simple method to quantify the spatial variations of these properties. The objective of this project is to 1) develop a new in situ method to quantify vertical specific yield variations and 2) evaluate the use of this method to quantify storage capacity of peatland. Using an approach based on the water table fluctuation (WTF) method, a program was developed in R to quantify vertical variation of SY with depth for the hydrologically active layer of five southern ombrotrophic peatland complexes of the St. Lawrence Lowlands (southern Quebec, Canada). In each peatland, three water table wells (2 cm diameter and 1 m deep) were installed upgradient, mi-gradient, and downgradient. The wells were instrumented to measure water levels every 5 minutes during summer 2014 and 2015. The range of mean annual water table depths varies from 9.4 to 49.3 cm below the peat surface. Near each piezometer, a 1 m long peat core was sampled using a box corer. Each core was divided into 7 x 7 x 7 cm3 peat cubes and analysed using gravitational drainage experiments. In one of the peatland complexes, a 25 x 60 x 40 cm3 peat sample was collected in the upgradient location. Using a tension table, specific storage was measured on this peat sample at 1.0 cm intervals between 0-20 cm and 2.5 cm intervals between 20-36 cm. The WTF method and the gravitational drainage experiments show similar results, confirming the validity of this method applied to the peatland. The SY varies from 0.13 to 0.97 at the top of the peat deposit, to 0.01 - 0.13 at the lowest measurement level. SY rapidly decreases with depth within 20 cm of the peat surface, independently of the location. The rate of SY change with depth increases when specific storages reach 40 %. ANOVA tests performed on SY WTF calculations show that the specific peatland complex (p value = 10-14), the month of the year (p value = 0.0045) and the location within a peatland (p value = 0.01) can be considered as controls upon SY. However, peatland complex is by far the dominant explanatory factor to understand vertical specific yield variation of the hydrologically active layer. The WTF method is low-cost and easily implemented, requiring only water table level fluctuations and precipitation data. It has the potential of increasing significantly the available data necessary to better understand the influence of, hydrogeological contexts, anthropogenic perturbations and hydro-climatic contexts on peatland.