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Wave-current induced erosion of cohesive riverbanks in northern Manitoba, Canada

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Abstract The field of cohesive soil erosion is still not fully understood, in large part due to the many soil parameters that affect cohesive soil erodibility. This study is focused on two channels, 2-Mile and 8-Mile channels in northern Manitoba, Canada, that were built to connect Lake Winnipeg with Playgreen Lake and Playgreen Lake with Kiskikittogisu Lake, respectively. The banks of the channels consist of clay rich soils and alluvial deposits of layered clay, silts and sands. The study of erosion at the sites is further complicated because the flow-induced erosion is combined with the effects of significant wave action due to the large fetch length on the adjacent lakes, particularly Lake Winnipeg that is the seventh largest lake in North America. The study included three main components: field measurements, laboratory experiments and numerical modelling. Field measurements consisted of soil sampling from the banks and bed of the channels, current measurements and water sampling. Grab soil samples were used to measure the essential physical and electrochemical properties of the riverbanks, and standard ASTM Shelby tube samples were used to estimate the critical shear stress and erodibility of the soil samples using an erosion measurement device (EMD). Water samples were taken to estimate the sediment concentration profile and also to monitor changes in sediment concentration along the channels over time. An Acoustic Doppler Current Profiler (ADCP) was used to collect bathymetry and current data, and two water level gauges have been installed to record water levels at the entrance and outlet of the channels. The MIKE 21 NSW model was used to simulate waves using historical winds and measured bathymetry of the channels and lakes. Finally, results from the wave numerical model, laboratory tests and current measurement were used to estimate the effect of each component on erodibility of the cohesive banks.

Key words riverbank erosion; cohesive soil; wave current; erosion modelling; MIKE21