Bed shear strength and resistance to erosion of surficial sediments on Roberts Bank

Earth Sciences Sector

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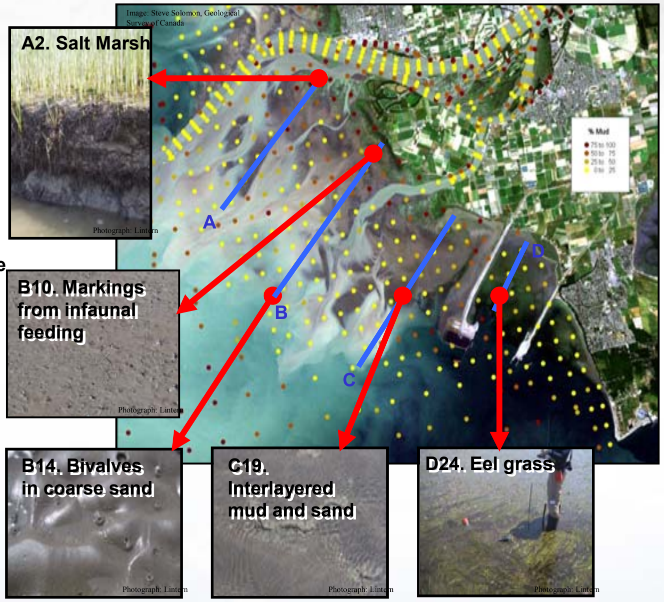
The Roberts Bank study aims to predict the response of the Tidal flat to an increase in sea level by tens of centimetres, and an increase in the frequency of storm events. The strength of the bed and its resistance to erosion are key factors for predicting the response of the bank to these changing conditions.

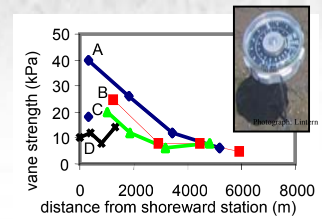
Funding for this work was provided by NRCan-ESS's Reducing Canada's Vulnerability to Climate Change Program, by Canada's Climate Change Impact and Adaptation Program and by Environment Canada's Disposal At Sea Monitoring Program.

Roberts Bank combines many different types of sedimentary environments with tidally dominated biological zones. Both sediment type and biological activity play important roles in bed stability. The pictures here show a few of the interesting features found in the study area. The satellite image indicates the proportion of mud-sized particles in the sediment.

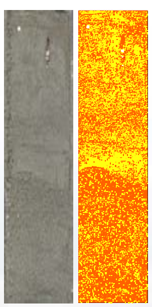


The Hand shear vane is used to give in situ vane shear strength. The vane is inserted into the sediment and turned at a constant rate. At a threshold spring tension the sediment fails, and the dial gauge locks into position indicating the vane shear strength.

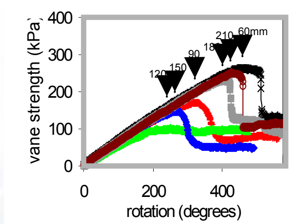
The plot at the right shows the results of the vane strength measurements for the surface sediment along each of the transects A to D. The data show a remarkable trend that shoreward stations have higher strengths than the seaward stations. They also show a decreasing strength from north (A) to south (D). This roughly corresponds to the higher proportions of mud found in the shoreward and northern sections of the study area (see satellite photograph). The single diamond shows a measurement made in an erosional pothole within the saltmarsh at station A1, and indicates that the sediment in this pothole is much weaker than nearby sediment which has been altered by a vegetated surface.



Results of hand shear vane measurements for transects A to D. Near shore and northern stations have greater strengths



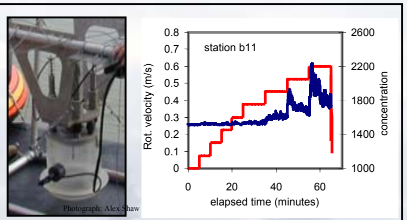
Push cores are collected at each station, and split longitudinally for analysis. A novel method has been employed to scan very high resolution core images using a top-down scanner. Image analysis allows grainsizes to be estimated, and also provides colour data which may be used to denote different types of biological activity. The images at the left show the split core from B11 and the results of the grainsize estimation. The method is clearly capable of distinguishing between shells, sandy mud and sand, with a distinct discontinuity at 120 mm.



Typical lab shear vane result, for each 30mm down a split core.

The lab shear vane provides accurate variations of bed shear strengths with depth. Vane strength measurements are made at 30mm intervals from the surface on the split cores. The result is shown above for the core pictured above left. This core shows decreasing peak sediment strength from 60mm to 120mm, and then increasing strength below the discontinuity.

Miniflume is a unique device for measuring the erodibility of beds. It consists of paddle stirrers which rotate between two concentric Perspex cylinders. The speed of the rotation is incrementally increased, eventually leading to shear forces large enough to cause failure of the bed. The concentration of the eroded sediment is measured using an optical backscatter probe. The plot at the right shows a typical result. Bed erosion (increase in concentration) is detected at a rotation speed of 0.45 m/s, approximately 35 minutes into the experiment. After this, further sediment is eroded at each increase in rotation speed, indicating the strength of underlying layers.



Miniflume and results for station B11, showing the onset of erosion at a rotational velocity of 0.45m/s.

Computer Models of coastal sedimentation rarely use measured values of bed strength, and it is often quoted as being the main weakness in the validity of these models. The data collected for Roberts Bank will provide one of the first useful datasets for calibration and improvement of both 1-D and 2-D models.