Central Beaufort Sea Wave and Hydrodynamic Modeling Study:

Coastal Erosion Forecasting and Modeling

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Sedimentary Analysis

In order to support the sediment transport and shoreline change modeling and forecasting, sixteen sediment grab samples from the Foggy Island Bay seafloor were collected and analyzed for grain size distribution (Table 1). The Foggy Island Bay seafloor is mainly fine sand. However, three samples were gravelly sand and two were silty sand. Analysis of a 2-liter sample of water found a total suspended sediment concentration of 0.031 g/liter, with a median grain size (d50) of 0.02 mm. [*Note: Details of the water sample location, depth, and time of sampling provided in the April 2019 Annual Report*].

Table 1. Location, median (d50) grain size, and ninety-percentile (d90) grain size from sediment grab samples collected July 21-25 from the Foggy Island Bay seafloor.

latitude (deg. N)	longitude (deg. E)	d50 [mm]	d90 [mm]	classification
70.2993	-147.1868	0.11	0.24	fine sand
70.2279	-147.3665	0.13	0.22	fine sand
70.3137	-147.4962	1.56	14.17	gravelly sand
70.2425	-147.6447	0.12	0.23	fine sand
70.2958	-147.6448	0.37	14.84	gravelly sand
70.4037	-147.6466	0.13	0.23	fine sand
70.4199	-147.7973	0.14	0.24	fine sand
70.4000	-147.7971	0.14	0.23	fine sand
70.3450	-147.7946	0.14	0.36	fine sand
70.3176	-147.7963	0.14	0.24	fine sand
70.2967	-147.7938	0.08	0.51	silty sand
70.3600	-147.8454	0.14	0.25	fine sand
70.3990	-147.9158	0.13	0.19	fine sand
70.4261	-147.9148	0.23	1.53	gravelly sand
70.4535	-147.9187	0.08	0.14	silty sand
70.3567	-147.8383	0.12	0.33	fine sand

Modeling of Coastal Erosion

The project scope includes the hindcasting and forecasting of shoreline change (i.e., coastal erosion) on decadal time scales as well as the modeling and forecasting of coastal geomorphic change and sediment transport during individual storm events. In order to achieve the long-term hindcasting and forecasting of shoreline change, researchers are developing a semi-empirical,

"one-line" model using COSMOS software. The one-line model assumes that a single line, the shoreline, can explain coastal geomorphic change. As the shoreline advances or retreats (i.e., as the coast experiences accretion or erosion) the coastal morphology continues to maintain the equilibrium beach profile, and it shifts with the shoreline. COSMOS is an advanced, open source one-line model that allows for flexible parameter optimization, and the accommodation of Arctic-specific parameterizations.

Historic shoreline position data is critical for the development of predictive shoreline change models. Hence, in this project, we have emphasized the collection of shoreline position data through collaborations with Coastal Frontiers, BP, and Hilcorp Corporation. Figure 1 depicts example shoreline position data for a portion of the Foggy Island Bay coast at Point Brower.

Figure 1. Depiction of historic shoreline position data by Point Brower, Foggy Island Bay.

In addition to the one-line modeling, the project is developing an Arctic-capable, process-based coastal geomorphic change model, focused on determining sediment transport and coastal change during individual storm events. Coastal processes in the Arctic differ from those in the non-Arctic because of the importance of both thermal and mechanical processes. In the Arctic, coastal soils and sediments are locked in place by permafrost or seasonal ice and thawing of that permafrost or ice is a prerequisite for mechanical removal. We have coupled a state-of-the-art, open-source geomorphic change model (Xbeach) with a thermal model accounting for heat transfer in Arctic settings, creating Arctic Xbeach. An example Arctic Xbeach calculation of geomorphic change at Barter Island on the Alaska North Slope is provided in Figure 2.

Figure 2. (a) Observed and (b) Arctic Xbeach-calculated of geomorphic change over a 7 - week period at Barter Island, North Slope Alaska.