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# Threats to Coastal Infrastructure from Erosion and Flooding

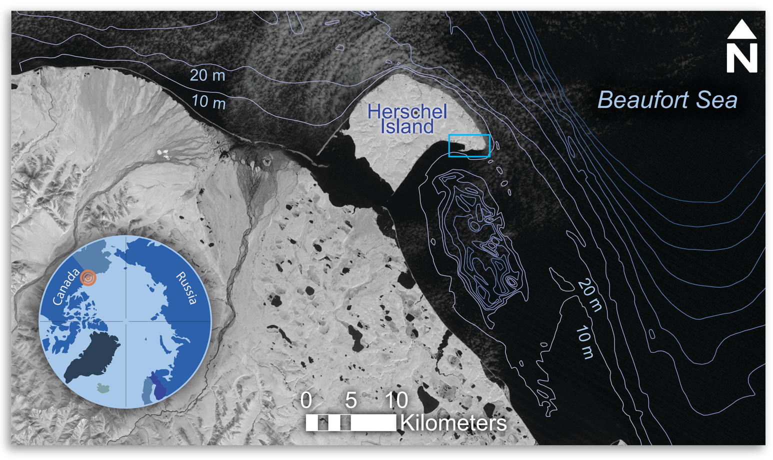
## A Case Study from Herschel Island, Yukon Territory, Canada

**Rationale:**
Erosion and flooding amplified by climate change & sea level rise threaten:
- Arctic coastal infrastructure
- cultural, and archeological sites

**Objectives:**
- assess coastal erosion
- assess flooding potential
- create a decision making tool (map) for hazard mitigation

**Key Findings:**
- acceleration of erosion rates:
  - 1952-1970: -0.6 ± 0.5 m·yr-1
  - 1970-2000: -0.5 ± 0.4 m·yr-1
  - 2000-2011: -1.3 ± 0.7 m·yr-1
- settlement vulnerable to flooding

## Study Area



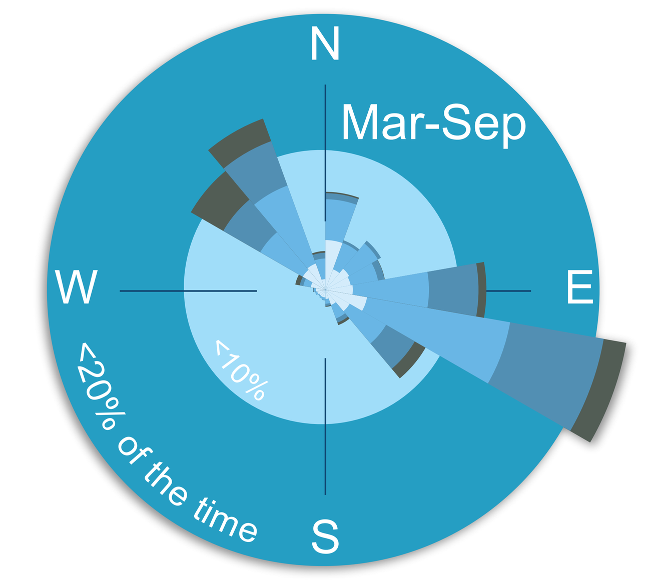




**Fig. 1** Wind direction and speed frequency in the ice-free periods (2009-2012) at the weather station on Simpson Point.

## Spit Evolution and Shoreline change

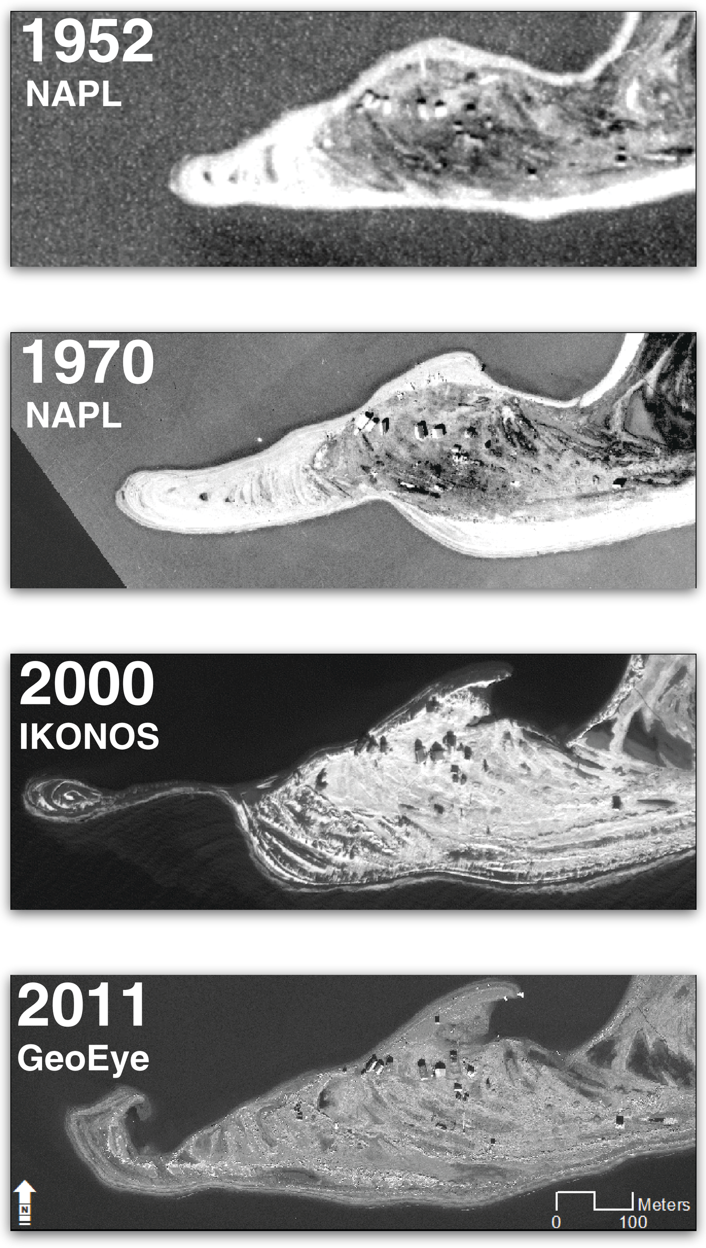



**Fig. 2** Evolution of Simpson Point over the period of the study.

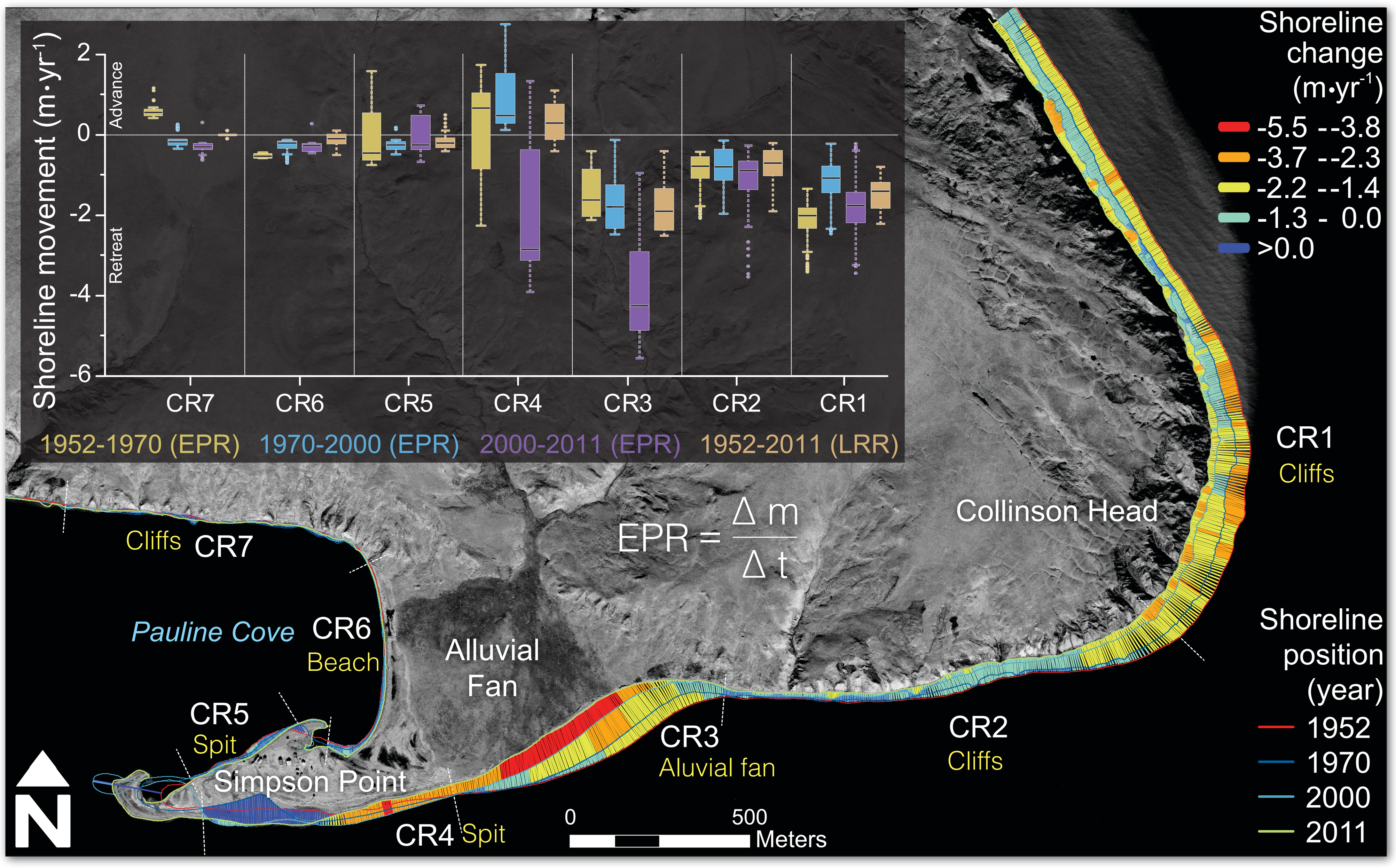
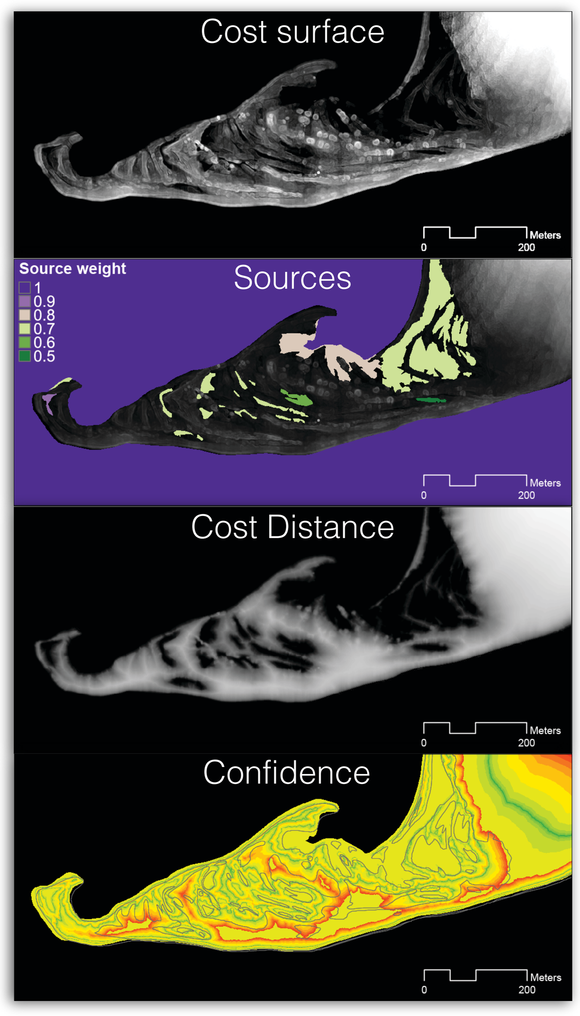



**Fig. 3** Analyzed coast divided in coastal reaches (CRs) reflecting varying morphology and exposure. Digitized shorelines enclose clipped transects used in DSAS classified according to retreat rate. The insert shows boxplots of shoreline retreat for different time periods. The end-point rate rates (EPR) indicate rates among time periods, the linear regression rate (LRR) includes all time periods.

## Geohazard mapping

- Cost-distance analysis based on 2013 LiDAR DEM and slope rasters
- shoreline movement rates over study period projected to 2031 and 2061



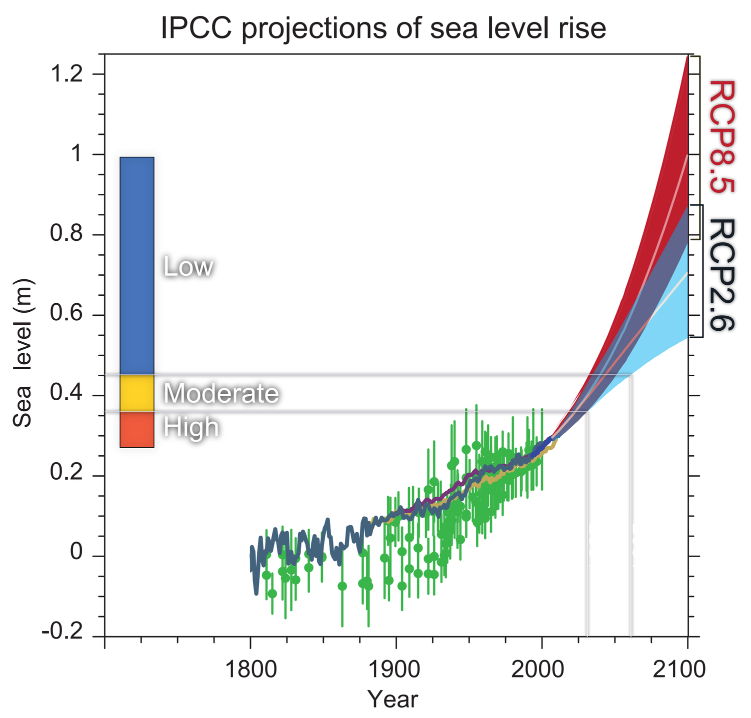




**Fig. 4** Sea level projections according to representative concentration pathways (RCPs) by the Intergovernmental Panel on Climate Change[2]. The risk typologies were selected to match the projected sea level elevation.

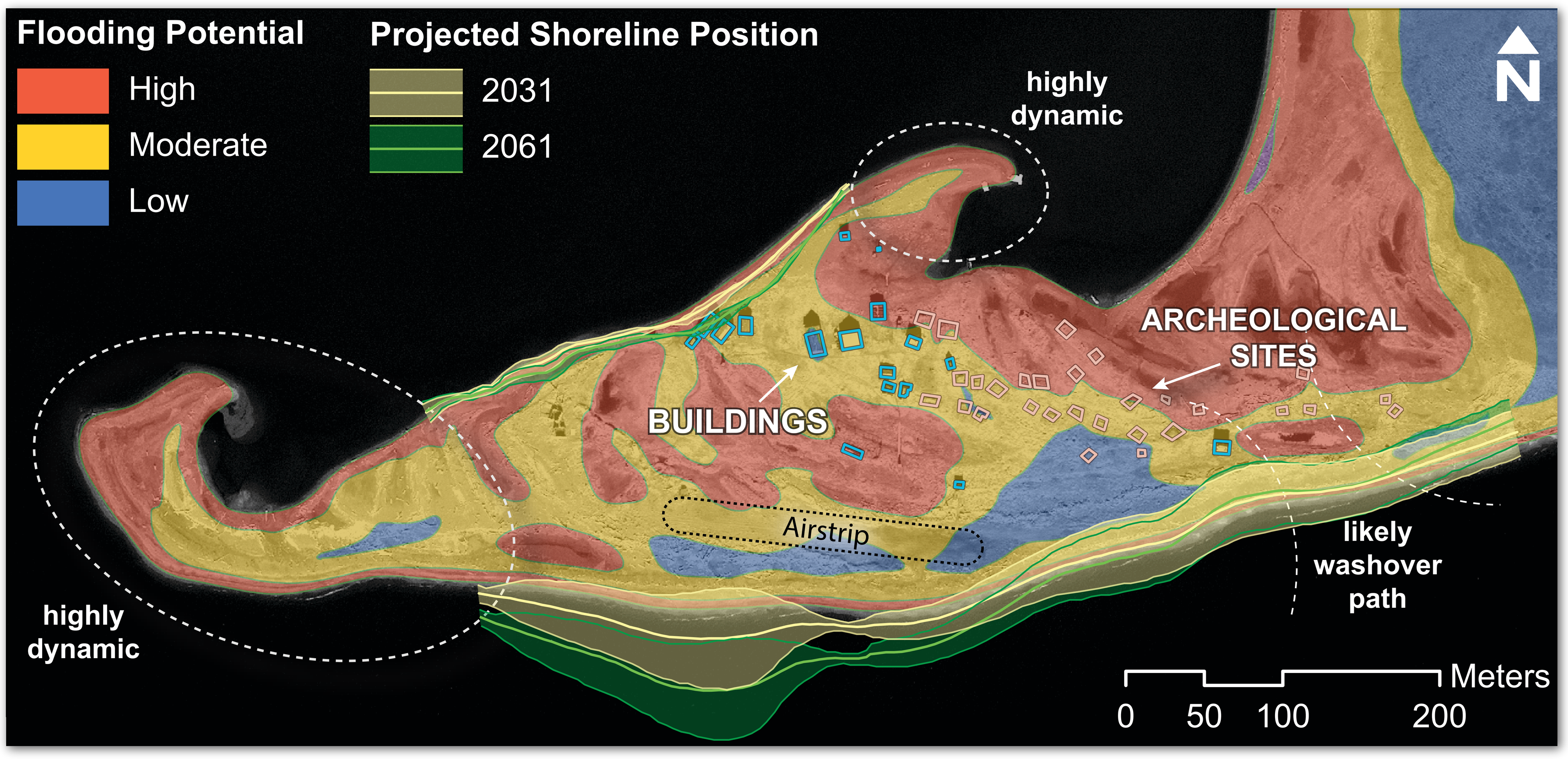



**Fig. 5** Coastal geohazard map indicating areas prone to flooding, dynamic areas with high hazard potential, and projected shorelines with standard error of the shoreline movement rate. Risk typologies superimposed on the 2011 image: 1. High: 0.0-0.1 m ASL, subject to frequent flooding, reflecting the IPCC sea level projections by 2031; 2. Moderate: elevation range 0.1-0.4 m ASL. Areas subject to flooding with water levels matc hing for 2061; 3. Low: elevations above 0.4 m, subject to flooding with water levels exceeding the sea level projected for 2061 by IPCC. Buildings and archeological sites are highlighted as blue- and peach colored rectangles.

## Discussion

- enhanced erosion in CR1 related to exposure to NW storms, possibly ice processes
- decrease in erosion 1952-1970 vs. 1970-2000 possibly related to decrease in storm activity
- geohazard assessment requires better data quality, particularly sea level datum

**References**
[1]Thieler, Robert E., Emily A. Himmelstoss, Jessica L. Zichichi, and Ayhan Ergul. 2009. The Digital Shoreline Analysis System(DSAS) version 4. 0 - an ArcGIS extension for calculating shoreline change. U. S. Geological Survey.

[2]Church, P.U. Clark, A. Cazenave, J.M. Gregory, S. Jevrejeva, A. Levermann, M.A. Merrifield, et al. 2013. Sea level change. Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom: Intergovernmental Panel on Climate Change-IPCC, C/O World Meteorological Organization, 7bis Avenue de la Paix, CP 2300 CH-1211 Geneva 2 (Switzerland).

[3]Radosavljevic, Boris, Hugues Lantuit, Wayne Pollard, Paul Overduin, Nicole Couture, Torsten Sachs, Veit Helm, and Michael Fritz. 2015. Erosion and Flooding—Threats to Coastal Infrastructure in the Arctic: A Case Study from Herschel Island, Yukon Territory, Canada. Estuaries and Coasts: 1–16. doi:10.1007/s12237-015-0046-0.

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