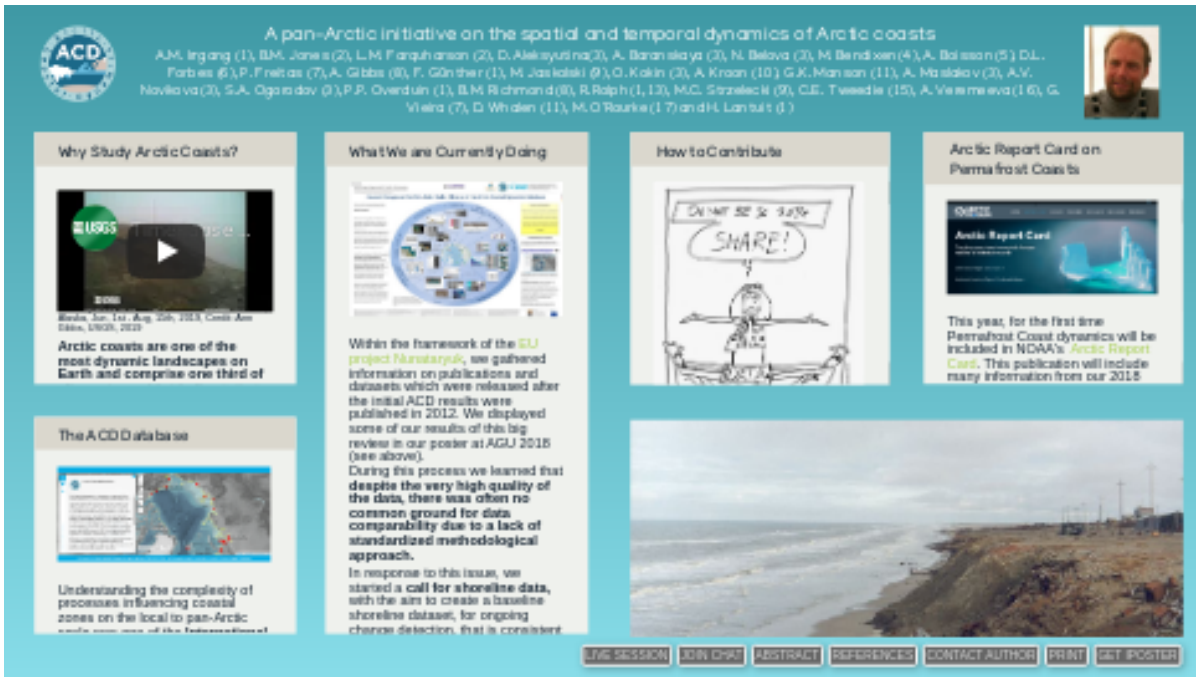
A pan-Arctic initiative on the spatial and temporal dynamics of Arctic coasts



A.M. Irrgang (1), B.M. Jones (2), L.M. Farquharson (2), D. Aleksyutina(3), A. Baranskaya (3), N. Belova (3), M. Bendixen (4), A. Boisson (5), D.L. Forbes (6), P. Freitas (7), A. Gibbs (8), F. Günther (1), M. Jaskolski (9), O. Kokin (3), A. Kroon (10), G.K. Manson (11), A. Maslakov (3), A.V. Novikova (3), S.A. Ogorodov (3), P.P. Overduin (1), B.M. Richmond (8), R.Rolph (1,13), M.C. Strzelecki (9), C.E. Tweedie (15), A. Veremeeva (16), G. Vieira (7), D. Whalen (11), M. O'Rourke (17) and H. Lantuit (1)

ENTER NAMES OF AFFILIATED INSTITUTIONS

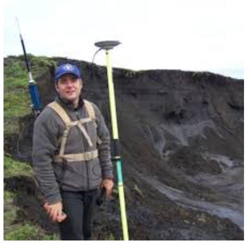










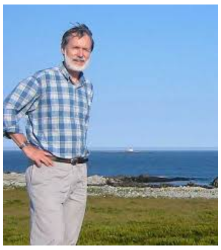





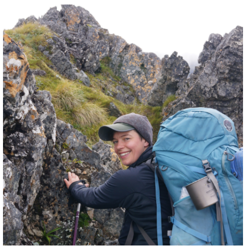












PRESENTED AT:

AGU FALL MEETING
Online Everywhere | 1–17 December 2020

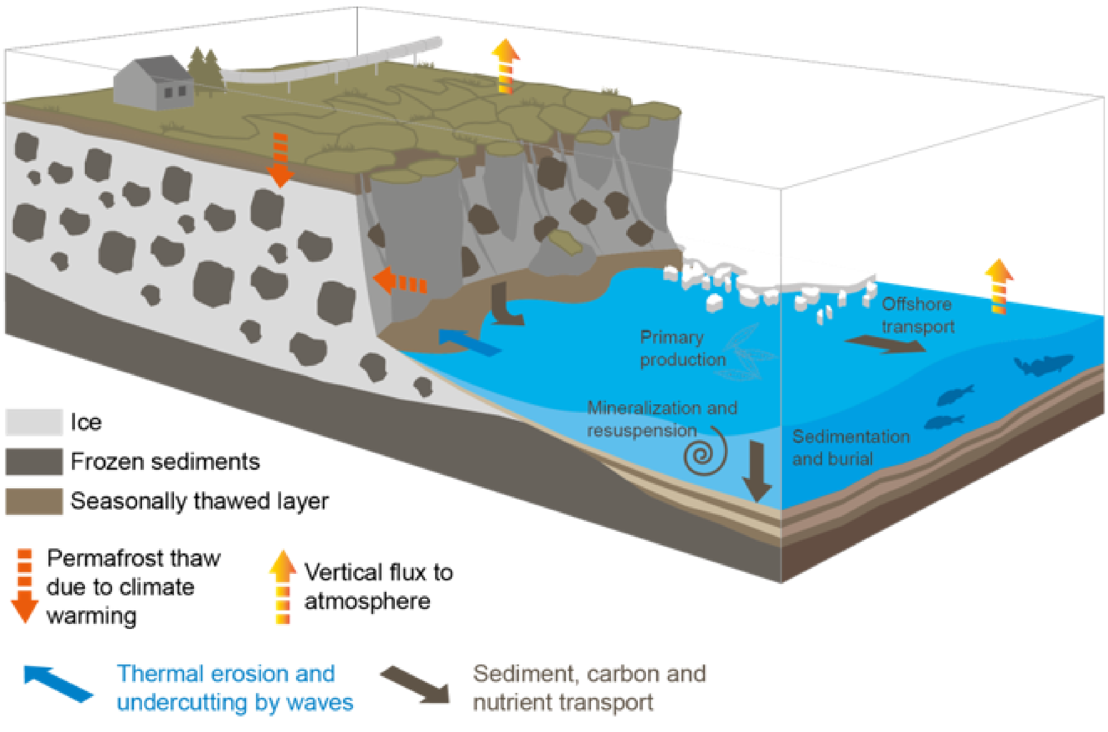
WHY STUDY ARCTIC COASTS?

[VIDEO] https://www.youtube.com/embed/k2AQhAdWkHY?rel=0&fs=1&modestbranding=1&rel=0&showinfo=0 Time-lapse video of bluff erosion at Barter Island, Alaska, June 10 & Aug 15th, 2019, Credit: Ann Gibbs, USGS, 2019

Arctic coasts are one of the most dynamic landscapes on Earth and comprise one third of all coasts worldwide (Lantuit et al., 2012). There are many reasons why it is important to understand their dynamics.

Most Arctic coasts consist of Permafrost, ground which remains below 0 °C for at least two consecutive years. Since **permafrost contains at least 20 % more carbon as is currently circulating in our atmosphere (Hugelius et al., 2014; Houghton, 2007),** it is important to study mechanisms which lead to its disruption and thus remobilization of the previously locked carbon. Coastal erosion is such a mechanism.

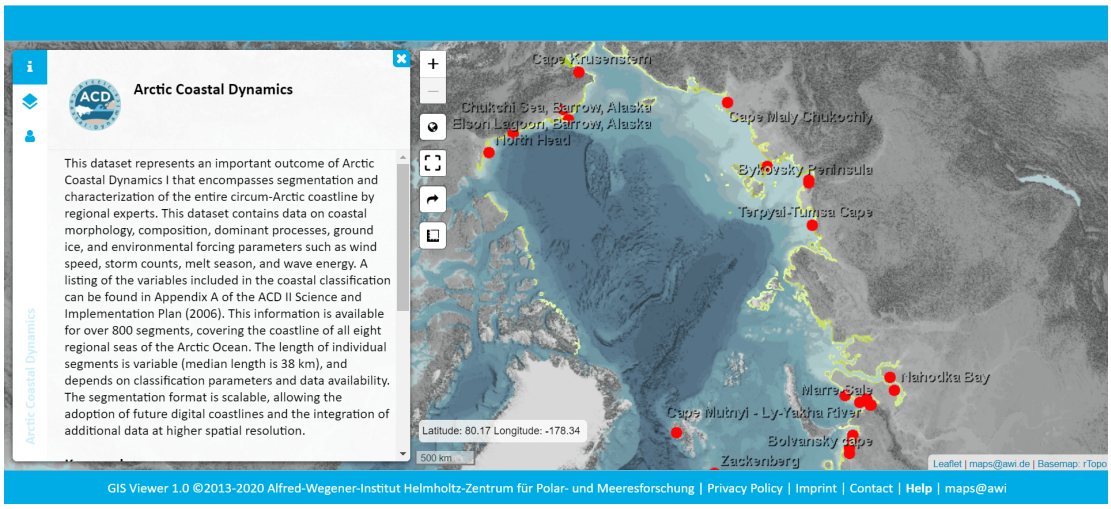
Fourty-six percent of all Arctic residents live within the coastal zone (Jungsberg et al., 2019). Understanding coastal dynamics is crucial for planning sustainable development of settlements, especially those that are prone to erosion and/or flooding. Further, enhanced sediment, nutrient and carbon input from coastal erosion may have the potential to influence food webs (Fritz et al., 2017). This can also have an impact on Arctic residents who rely on subsistence fishing and hunting for food.



Conceptual figure of the Arctic Coastal Zone.

Picture Credit: Fritz et al., 2017

THE ACD DATABASE

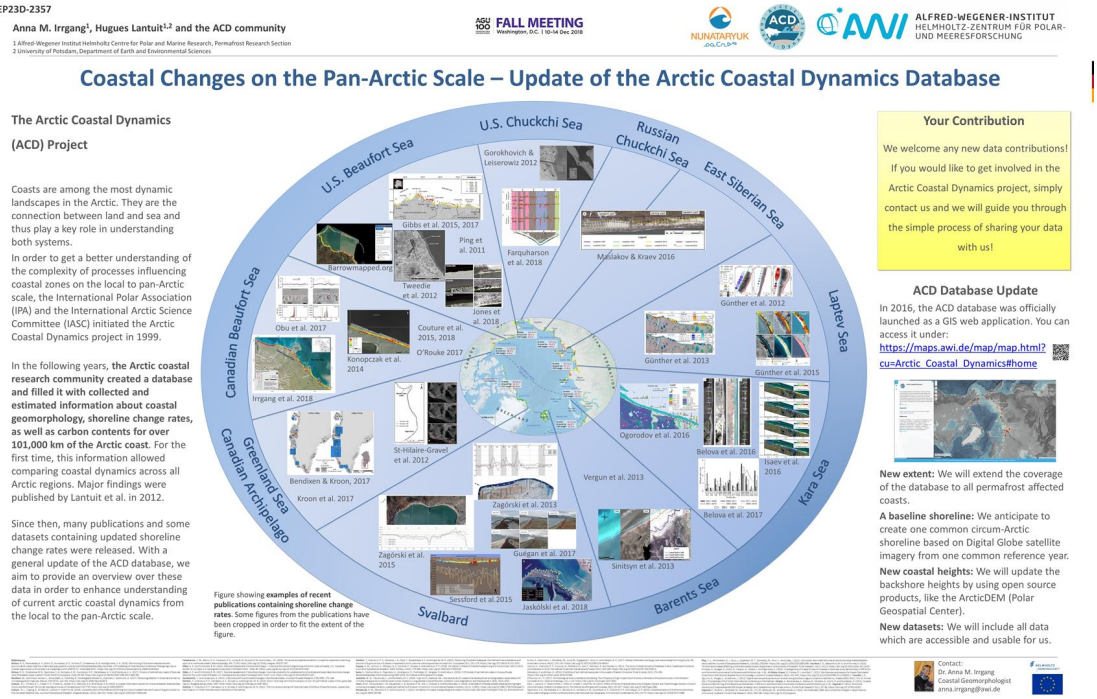


Understanding the complexity of processes influencing coastal zones on the local to pan-Arctic scale was one of the **International Polar Association's (IPA (https://ipa.arcticportal.org/)) and International Arctic Science Committee's (IASC (https://iasc.info/)) priorities which led to the initiation of the Arctic Coastal Dynamics project in 1999.**

In the following years, **the Arctic coastal research community created a database (https://maps.awi.de/awimaps/projects/public/?cu=Arctic_Coastal_Dynamics#home) which was populated with observations, estimations and measurements about coastal geomorphology, shoreline change rates and carbon stores for over 101,000 km of the Arctic coast.** For the first time, this information allowed for a comparison of coastal dynamics across the Pan-Arctic.

- Major findings were published by Lantuit et al. in 2012 (https://link.springer.com/article/10.1007/s12237-010-9362-6)
- The database (https://maps.awi.de/awimaps/projects/public/?cu=Arctic_Coastal_Dynamics#home) is accessible online
- The ACD project also has an own webpage (https://arcticcoast.info)

WHAT WE ARE CURRENTLY DOING



Within the framework of the EU project Nunataryuk (https://nunataryuk.org/), we gathered information on publications and datasets which were released after the initial ACD results were published in 2012. We displayed some of our results of this big review in our poster at AGU 2018 (see above).
During this process we learned that **despite the very high quality of the data, there was often no common ground for data comparability due to a lack of standardized methodological approach.**

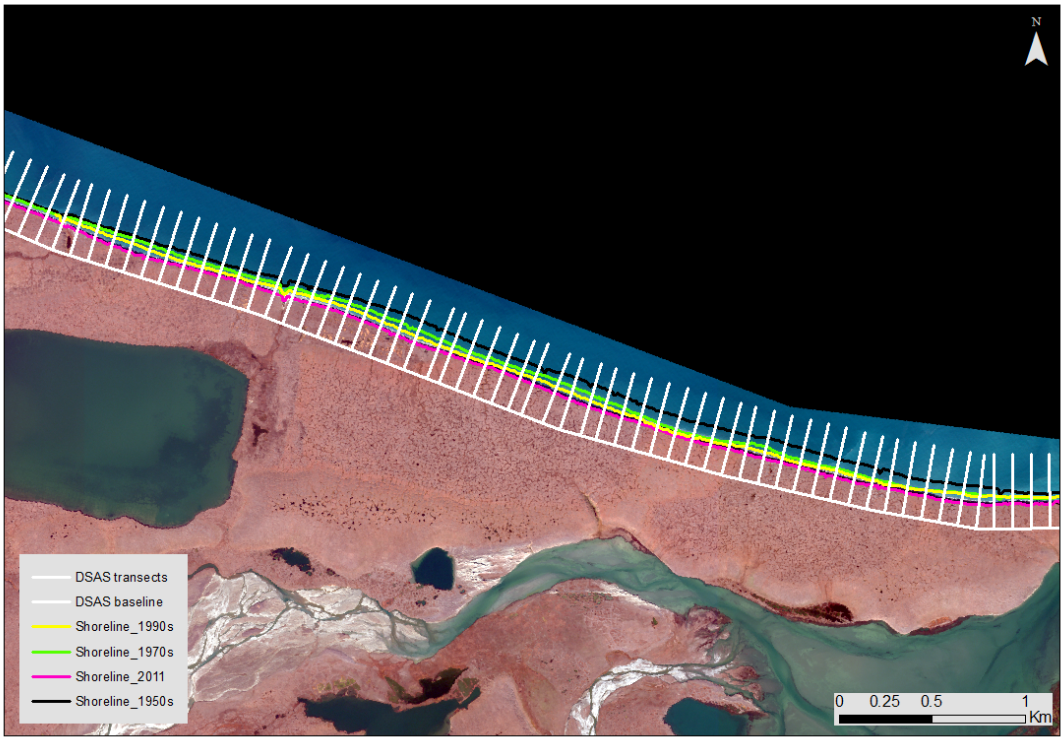
In response to this issue, we started a **call for shoreline data,** with the aim to create a baseline shoreline dataset, for ongoing change detection, that is consistent and comparable across all geographic regions in the Arctic. This motivated over 20 scientists from all over the world to share their data with us. We are now analyzing these data, together with satellite data that we gathered within the framework of the NSF project PerCS-Net (https://permafrostcoasts.org/) in a consistent way to establish a standardized Arctic shoreline database.

We are aware of the differences which arise from different shoreline proxies taken for

Data collection will take into consideration variation in the shoreline proxies taken for shoreline digitalization, as well as different ground image resolutions and scales. This metadata is being collected in parallel with the shoreline vectors in order to document important differences between data sets.

In addition, we are applying the same shoreline change analysis procedure for all digitized shorelines.

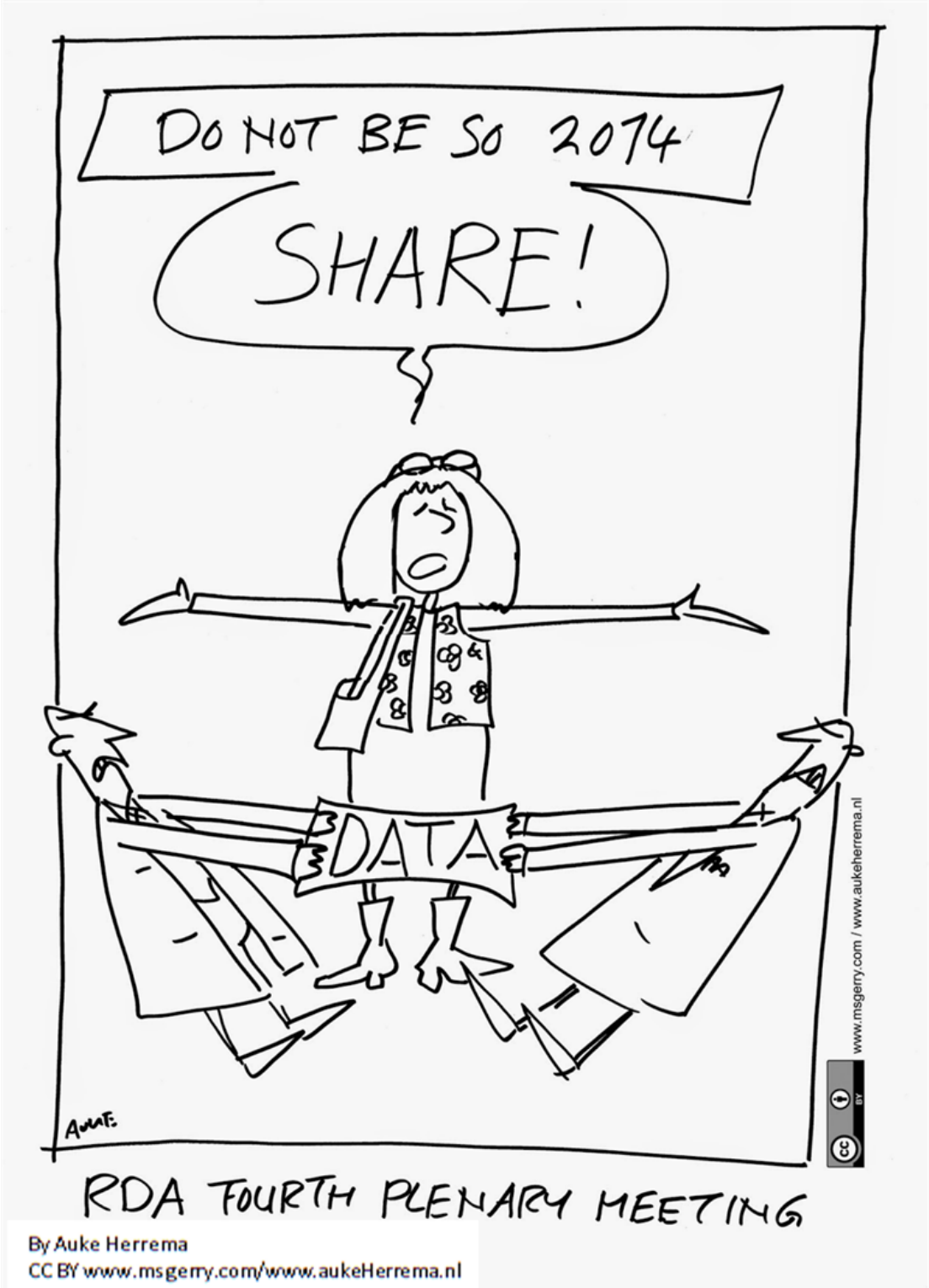
For the analysis of shoreline movements the ESRI ArcGIS software extension DSAS (Digital Shoreline Analysis System) (https://www.usgs.gov/centers/whcmsc/science/digital-shoreline-analysis-system-dsas?qt-science_center_objects=0#qt-science_center_objects) vs. 5.0. will be used. We will create a baseline inland of the shorelines and use a transect spacing of 100 m (see example below). In the case where more than two shorelines are collected, we will conduct separate DSAS analyses for each time period.



Example of standardized DSAS setup along the Yukon Coast, Canada. Map created by A. Irrgang.

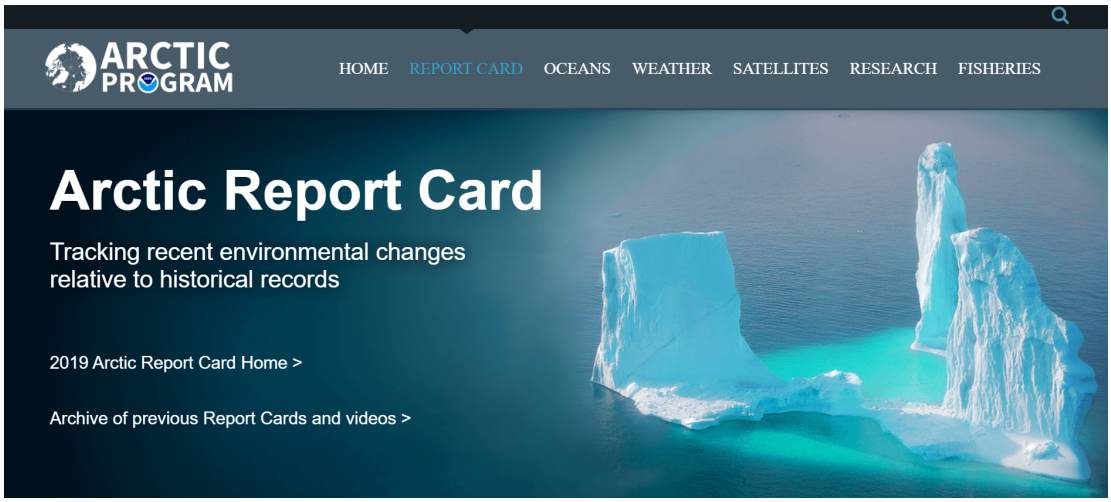
We are aiming to finish our analyses until summer 2021.

HOW TO CONTRIBUTE



We welcome any new data contributions! If you would like to get involved in the Arctic Coastal Dynamics project, contact Anna Irrgang (anna.irrgang@awi.de) who will guide you through the simple process of sharing your data with us! The contribution of your data will be acknowledged by a co-authorship of the resulting products.

ARCTIC REPORT CARD ON PERMAFROST COASTS



This year, for the first time Permafrost Coast dynamics will be included in NOAA's Arctic Report Card (https://arctic.noaa.gov/Report-Card). This publication will include many information from our 2018 review. The ARC will be released at December 08, 2020.

From this year on, we will provide an update on the development of Permafrost coasts on a four years basis.

ABSTRACT

Permafrost coasts make up roughly one third of all coasts worldwide. Their erosion leads to the release of previously locked organic carbon, changes in ecosystems and the destruction of cultural heritage, infrastructure and whole communities. Since rapid environmental changes lead to an intensification of Arctic coastal dynamics, it is of great importance to adequately quantify current and future coastal changes. However, the remoteness of the Arctic and scarcity of data limit our understanding of coastal dynamics at a pan-Arctic scale and prohibit us from getting a complete picture of the diversity of impacts on the human and natural environment. In a joint effort of the EU project NUNATARYUK and the NSF project PerCS-Net, we seek to close this knowledge gap by collecting and analyzing all accessible high-resolution shoreline position data for the Arctic coastline. These datasets include geographical coordinates combined with coastal positions derived from archived data, surveying data, air and space born remote sensing products, or LiDAR data. The compilation of this unique dataset will enable us to reach unprecedented data coverage and will allow us a first insight into the magnitude and trends of shoreline changes on a pan-Arctic scale with locally highly resolved temporal and spatial changes in shoreline dynamics. By comparing consistently derived shoreline change data from all over the Arctic we expect that the trajectory of coastal change in the Arctic becomes evident. A synthesis of some initial results will be presented in the 2020 Arctic Report Card on Arctic Coastal Dynamics. This initiative is an ongoing effort – new data contributions are welcome!

REFERENCES

Affiliations of authors:

(1) Alfred Wegener Institute Helmholtz-Center for Polar and Marine Research Potsdam, Potsdam, Germany
(2) University of Alaska Fairbanks, Fairbanks, AK, United States
(3) Lomonosov Moscow State Univesity, Moscow, Russia,
(4) University of Colorado, Boulder, Boulder, United States
(5) Laval University, Quebec City, QC, Canada
(6) Geological Survey of Canada, Dartmouth, NS, Canada
(7) Institute of Geography and Spatial Planning, Universitade de Lisboa, Lisbon, Portugal
(8) USGS Pacific Coastal and Marine Science Center, Santa Cruz, CA, United States
(9) University of Wroclaw, Wroclaw, Poland
(10) University of Copenhagen, Copenhagen, Denmark
(11) Geological Survey of Canada, Dartmouth, Canada
(12) Humboldt University of Berlin, Berlin, Germany
(13) University of Wroclaw, Geomorphology, Wroclaw, Poland
(14) University of Texas at El Paso, El Paso, TX, United States,
(15) Russian Academy of Sciences, Pushchino, Pushchino, Russia
(16) Universidade de Lisboa, Lisbon, Portugal
(17) Prince of Wales Northern Heritage Centre, Yellowknife, Canada

References:

Fritz, M., H. Lantuit and J. Vonk (2017), Collapsing Arctic coastlines, Nature Clim. Change, 7(1), 6-7, doi: 10.1038/nclimate3188.

Hugelius, G., J. Strauss, S. Zubrzycki, J. W. Harden, E. A. G. Schuur, et al. (2014), Estimated stocks of circumpolar permafrost carbon with quantified uncertainty ranges and identified data gaps, Biogeosciences, 11(23), 6573–6593, doi:10.5194/bg-11-6573-2014.

Houghton (2007): Balancing the Global Carbon Budget - Annual Review of Earth and Planetary Sciences Vol. 35:313-347, doi.org/10.1146/annurev.earth.35.031306.140057.

Lantuit, H., P. P. Overduin, N. J. Couture, S. Wetterich, F. Aré, et al. (2012), The Arctic Coastal Dynamics Database: A New Classification Scheme and Statistics on Arctic Permafrost Coastlines, Estuaries and Coasts, 383-400, doi:10.1007/s12237-010-9362-6.

Jungsberg, L. Turunen E., Heleniak T., Wang, S., Ramage, J. and J. Roto NORDREGIO (2019) Atlas of population, society and economy in the Arctic, doi:10.30689/WP2019:3.1403-2511