2024 ASCE Cold Regions Conference NBS- related special sessions

Title: Natural and Nature Based Solutions in Alaska and the Arctic

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Increasingly, Natural or Nature Based Solutions (NNBS) are being applied as part of engineering solutions for a variety of projects. Very few examples of successful NNBS projects exist for Alaskan and Arctic regions where environmental conditions and social systems are different from the contiguous US. Most applications of NNBS use vegetation and dredged sediments that may not be viable in cold regions. Understanding the definition and constraints around what makes a project part of the NNBS portfolio is critical for communities and decision makers. Government resources intended to support communities in becoming resilient to climate change and hazards are guided in part by public policy in which NNBS is frequently referenced (for example: Executive Order 14072, National Strategy on the Arctic, and National Coastal Resilience Fund). National and international forums have placed definitions and guidance in regard to NNBS applications (IUCN, 2020; White House Council on Environmental Quality, 2022). Even with this guidance, implementation of solutions is still open ended and best informed by what has worked before. This leaves communities uncertain in how to use NNBS terminology and in what solutions can succeed in the Arctic. Not only that, critical components of ensuring NNBS are based on inclusive, transparent, and empowering governance processes requires local governance input. NNBS concepts are also common constructs of Indigenous culture and values which are representative of millennia of place-based adaptive management or stewardship of ecosystems which is not typically represented in NNBS guidance documentation. We plan two sessions, 1. a scientific and engineering session of relevant NNBS projects and 2. a panel session to describe current state-of-the-science, discuss existing policy, and identify gaps in guidance related to Alaskan and Arctic NNBS and why it is relevant to engineering in the Arctic and the future of project development for community resilience. Tribal partners are invited to discuss an ongoing project to define NNBS for their regions to come to shared terminology and understanding with existing public policy and provide guidance to government programs and engineers on the application of NNBS in Alaska.

References:

Executive Order 14072, Executive Order on Strengthening the Nation’s Forests, Communities, and Local Economies, https://www.whitehouse.gov/briefing-room/presidential-actions/2022/04/22/executive-order-on-strengthening-the-nations-forests-communities-and-local-economies/

IUCN (2020). Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: IUCN. https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf

The White House, National Strategy For The Arctic Region (October 2022), https://www.whitehouse.gov/wp-content/uploads/2022/10/National-Strategy-for-the-Arctic-Region.pdf

White House Council on Environmental Quality, White House Office of Science and Technology Policy, White House Domestic Climate Policy Office, 2022. Opportunities for Accelerating Nature-Based Solutions: A Roadmap for Climate Progress, Thriving Nature, Equity, and Prosperity. Report to the National Climate Task Force. Washington, D.C. https://www.whitehouse.gov/wp-content/uploads/2022/11/Nature-Based-Solutions-Roadmap.pdf

Session 1: NBS: a scientific and engineering session of relevant NNBS projects
Session 2: NBS: a panel session to describe current state-of-the-science, discuss existing policy, and identify gaps in guidance related to Alaskan and Arctic NNBS and why it is relevant to engineering in the Arctic and the future of project development for community resilience

Session 2: NBS: a scientific and engineering session of relevant NNBS projects

CONFIRMED TALKS
Kent, KC <KC.Kent@hdrinc.com> – already submitted an abstract 2/14
ronald.mcpherson@hdrinc.com :
Rock Solid: Engineering Coastal Structures in Ice-Prone Zones Kenai Bluffs Bank Stabilization Project

Phil Osborne Phil Osborne <POsborne@nhcweb.com>, "Pearson, Isaac" <ipearson@bristol-companies.com>

Title: Spit Recycling: the Default Nature-based Solution at Shaktoolik, Alaska
Phil Osborne, Principal, Senior Geomorphologist, Northwest Hydraulic Consultants
Isaac Pearson, Senior Civil Engineer, Bristol Engineering Services Company LLC

A sandspit (spit) is a depositional coastal landform that forms where downdrift deposition of alongshore transport ends in deep water (e.g., at the point of shoreline re-entrance). Spit stability is achieved through continued supply of sediment, by the establishment of size grading, or the development of a counteractive cell (e.g., natural recycling) (Carter, 1988). Spits often extend alongshore at the same time as moving onshore and may become unstable when the original sediment supply is interrupted or cut off, or spit elongation leads to net withdrawal of material from the proximal end leading to thinning and sometimes breaching (e.g., Nicholls & Webber, 1987). The process of elongation, thinning, and onshore migration accelerates

under rising sea levels. Shaktoolik, Alaska, a remote village of 260 people located 125 miles (~200 km) east of Nome, on a narrow spit of land between the Tagoomenik River and the Bering Sea, facing significant challenges for long-term protection of infrastructure due to the progression of natural spit processes. The village has been relocated twice in the past; however, a recent assessment concluded that the current location now also faces increasing flooding risk from
both sides of the spit, and erosion from waves and storm surges, with potential to damage infrastructure. Sandspits have often been inhabited by Indigenous communities like Shaktoolik due to proximity to subsistence food sources, and an abundance of flat land that makes them attractive for the construction of airports, and municipal and residential infrastructure. Thus, in the short to medium term, the community has made the decision to stay and defend in place for as long as they can hold out. Out of necessity, Shaktoolik have adopted a nature-based approach, known as spit recycling that involves borrowing sediment from the distal end of the spit where a sediment surplus exists, transporting and placing the sediment in a berm in front of the community to provide protection. Although the berm provides protection from erosion and flooding, the structure is frequently reshaped by waves requiring seasonal reconstruction. In 2022 alone, the berm was impacted by two storms in July and September which caused significant reshaping and redistribution of the sediment and resulted in the need to reconstruct twice in the same season. Although the berm recycling option is relatively low cost the community now questions the sustainability of the approach, given available sand resources and ongoing maintenance requirements and is considering other options. In this presentation we summarize Shaktoolik's experience with the nature-based spit recycling option and progress with the exploration of other nature-based and grey protection options for the community.

References:
Carter, R.W.G., 1988. Coastal Environments. Academic Press Ltd., London, UK, ISBN 0-12-161856-0.

Nicholls, R.J. and Webber, N.B. (1987) The past, present and future evolution of Hurst Castle spit, Hampshire. Progress in Oceanography, 18 (1-4), 119-137. (doi:10.1016/0079-6611(87)90029-2).

"Whitin, Sam" <swhitin@eaest.com>,"Midgley, Taber" <tmidgley@eaest.com> – confirmed attending and **will provide a title ASAP.**

Engineering With Nature® and Progressing Natural and Nature-Based Solutions in Alaska and the Arctic

Lauren Bosche, U.S. Army Engineer Research and Development Center (ERDC) Cold Regions Research and Engineering Laboratory (CRREL); Dr. Jeff King, ERDC Environmental Laboratory (EL); Dr. Tom Douglas, ERDC-CRREL; Dr. Nicholas Cohn, ERDC Coastal and Hydraulics Laboratory (CHL); Sam Whitin, EA Engineering, Science, and Technology, Inc., PBC (EA); Taber Midgley, EA; Ellen Jessup-McDermott, EA

The use of ecosystems and natural methods to reduce infrastructure and community risk has a long legacy, though the formal civil engineering practice of integrating Natural and Nature-Based Solutions (NNBS) in 'traditional' engineered features has only recently been established in the last few decades. The United States Army Corps of Engineers (USACE) Engineering With Nature® (EWN) program has been a leader in this space since 2010, contributing to NNBS projects and demonstrations, policy and research development, and international engagement and partnering with stakeholders to drive NNBS practice forward. Most NNBS and EWN work has taken place at lower latitudes, despite the growing risks and increasing need in the Arctic and sub-Arctic. This disparity is reflected in the guidelines available to support practitioners, such as the International Guidelines on Natural and Nature-Based Features for Flood Risk Management, as there are limited resources that synthesize efforts including NNBS specifically for the Arctic and adjacent regions (Bridges et al., 2021). Many applications of NNBS in warm climates use biologic materials like vegetation, algal mats, and others that may not be viable in cold environments of the Arctic and sub-Arctic. Arctic-specific guidance is critical to NNBS project success in an environment characterized by sea ice cover and thermal dynamics, a distinct cultural and social context, and staggering rates of coastal erosion and permafrost thaw, among other distinct features. This talk will provide a high-level overview of the USACE EWN program and the EWN approach at project sites in Alaska. It will also highlight some of the opportunities to leverage relevant international NNBS guidance documents available in potential applications to Alaska and the Arctic.

References

Bridges, Todd, Jeffrey King, Jonathan D. Simm, Michael Beck, Georganna Collins, Quirijn Lodder, and Ram Mohan. International guidelines on natural and nature-based features for flood risk management. USACE, 2021.

EROSION MITIGATION DESIGN IN THE ARCTIC CONSIDERING CLIMATE CHANGE IMPACTS

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BACKGROUND

The Hamlet of Tuktoyaktuk is a low-lying peninsula in the Arctic along the Beaufort Sea that is vulnerable to severe coastal erosion and intermittent flooding. Most residences and buildings located near the coast have been relocated and those remaining are currently at risk of damage or destruction during storm events. In the longer term, cultural sites such as the graveyard are also at risk and the plan is to relocate the community. Nearby Tuktoyaktuk Island, a beach/bluff system which shelters Tuktoyaktuk Harbour from waves, is eroding and if not protected may be gone by 2050. Baird was retained by the Hamlet of Tuktoyaktuk and Inuvialuit Regional Corporation (IRC) to assess erosion mitigation alternatives and select/implement a preferred design to protect the Hamlet (Figure 1) and Island, which comprise a total shoreline length of approximately 2000 m.

Figure 1 – Hamlet of Tuktoyaktuk.

CLIMATE CHANGE IMPACTS

Climate change is expected to have a significant impact in the Canadian Arctic and was a critical consideration in the erosion mitigation design process. Impacts for this project include increased water levels, a longer ice-free season, increased wave exposure and permafrost degradation. Relative sea level rise (RSLR) of 0.37 m for the year 2050 was used in the design, which was based on the 95th percentile of the RCP 8.5 emissions scenario (James, 2015).

DESIGN CONDITIONS

The designs were developed using the 100-year return period wave and water level conditions. The design life for the structure was set as 30 years (to 2050) given the harsh Arctic conditions.

The wave and water level conditions are both dependent on wind driven storms. The wide and shallow continental shelf at Tuktoyaktuk causes large storm surges (up to 2.5 m) when strong onshore winds are sustained for a significant duration. The MIKE21 HD model was used to determine the design water level, combining the surge, high tide and RSLR. The wave conditions were modelled using MIKE21 SW.

Net longshore sediment transport rates for existing and future climate conditions were estimated through modeling. The projections for future sediment transport rates consider the impact of increased wave action along the project shorelines associated with sea level rise and a longer open water season.

Forces from ice loading were also included in the design. It was determined that the greatest ice loads would occur during the spring break up period when large mobile ice floes may be pushed onshore by strong winds.

Ground ice and permafrost contribute to the challenges of the shore protection design. Ground temperatures were modelled with and without the proposed structures to compare the effect it will have on permafrost degradation and the stability of the structure foundation.

DESIGN ALTERNATIVES

Baird developed three design alternatives, including articulated concrete block mattress, concrete slab, and armour stone revetments. Each alternative was tested in a physical model, including tests with wave and water level conditions ranging in severity from the 2 to 500-year return period events. Modifications were made to each design based on the model results and updated quantity/cost estimates were prepared, with the armour stone revetment identified as the most cost-effective solution.

Final design of the armour stone revetment has been completed, with the design including beach nourishment along a section of barrier beach that had previously been breached. The Hamlet and IRC have submitted a funding application, with bidding and construction pending.

REFERENCES

James, T.S., Henton, J.A., Leonard, L.J., Darlington, A., Forbes, D.L., and Craymer, M. (2015): Tabulated values of relative sea-level projections in Canada and the adjacent mainland United States; Geological Survey of Canada, Open File 7942, 81 p.

Session 3: NBS: a panel session to describe current state-of-the-science, discuss existing policy, and identify gaps in guidance related to Alaskan and Arctic NNBS and why it is relevant to engineering in the Arctic and the future of project development for community resilience

Still to be confirmed
4 15-minute presentations followed by 30 min panel discussion
Jaci - policy/grant/community access background, challenges in the Arctic, guidance document for communities and grant program administrators.

Lauren Bosche - USACE Engineering with Nature program, National/international NNBS guidance and applications to the Arctic/Alaska

Aarron Poe and Nyssa Russell to identify regional Alaska Native Association non-profit partner from the Alaska Conservation Foundation Project - describe project, scope, and initial findings. Defining NBS from the Indigenous lens.

Ellen Jessup McDermott - defining NBS with the community of Point Hope