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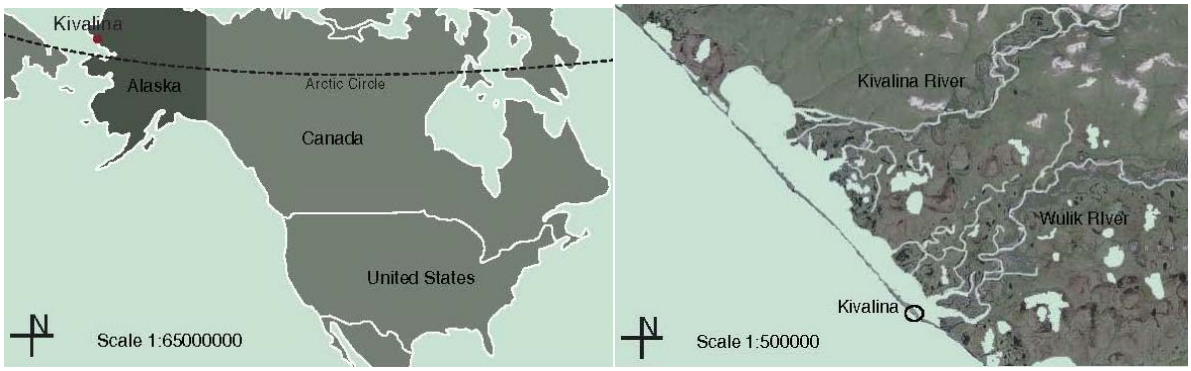
Improving Community-Scale Feces Waste Treatment (CSFWT) in Arctic North America
Climate Foundation

Project Summary
Part I. Description

- **Background or problem statement**
  Kivalina is an Inupiat village 83 miles north of the Arctic circle in Northwest Arctic Borough, Alaska, United States. The coastal village is situated at the southern tip of a barrier island located between the Chukchi Sea and a lagoon at the mouth of the Wulik and the Kivalina River.



Residential homes in Kivalina lack flush toilets and running water. People use honey buckets (paint buckets lined with plastic trash bags and covered with portable seats) to store and haul human waste. Former efforts by several agencies to implement hauling systems or wastewater treatment facilities have failed in the past. The Arctic climatic conditions, high energy costs and remote location make construction and operation of piped systems too expensive for the households. Furthermore, plans to relocate the village have led to limited investment in basic water and sewer services over the past 20 years. Inadequate access to water and wastewater management threatens human health and was the catalyst to start a new approach to combat the difficult challenges in the Arctic wastewater management.

- **General description of the project**
  An alternative sanitation system for the native village of Kivalina has been developed to eradicate the use of honey buckets associated with severe environmental and health risks. The proposed system is a Biochar Sanitation System composed of Urine Diverting Dry Toilets (UDDTs), an improved human solid waste collection system and the controlled pyrolization of feces in the Biochar Reactor. To close the loop, possible uses and value chains of the produced biochar were elaborated. This system will be an off-grid flexible and movable way to sanitize human solid waste and use the end product as a resource. The various infrastructural, climatic, economic, environmental, and social contexts were researched to ensure an appropriate infrastructure for the future Biochar Sanitation System in Kivalina.

- **Outcomes and follow-up**
  The study comprises planning considerations, a winterization study, a community layout, comprehensive planning information and an architectural building survey. The goal of the winterization study was to adapt the required infrastructural components of the chosen toilet facilities and the Biochar Reactor to the Arctic climate. The aim of describing and developing installation details including specifications on the chosen UDDT, collection chamber and a pilot trial was to show the operability and functionality in Kivalina. Furthermore the goal was to determine and compare local waste management economics of the different sanitation utility steps containing time effort, costs and social pattern, to be able to implement well-functioning aspects of the current system into a future waste collection system.
  Future activities comprise engineering, building and deploying the Biochar Reactor. A site for reactor installation in Kivalina has to be selected. Research, consultation, and discussion with Kivalina institutional leaders and operators concerning the recognition of existing and formation of new institutions that will be responsible for the operation and maintenance of the Kivalina Biochar Reactor.

Project Summary
Part II. Analysis

- **Successes**
  During the site visits to Kivalina, the team researched fundamental information necessary for the Biochar Sanitation System proposal development. Researched topics comprised the Kivalina waste management and social organization to manage waste removal and disposal. Individual interviews with representatives of the city and tribal council and phone interviews with experts from different regional agencies were conducted as well as interviews with household members in charge of the honey bucket disposal and with staff in the water and wastewater sector. GIS maps were generated to enable easy GPS data analysis, and to use it as a supportive tool for comfortable visualization of statistical data. Existing maps were digitized, actualized and completed. Based on the collected information, the UDDT model Separett Villa 2910 was selected. Digital drawings were generated for UDDT toilet installation details, the architectural building survey, classification of different housing units, the building descriptions, floor plans and cross sections. Additionally, winterization engineering studies were performed to explore questions regarding risks of freezing, system damages if they do freeze and what can be done to protect those systems. A feasibility study for lactic-acid fermentation and future uses of the produced biochar in Kivalina was conducted. The team created a waste flow diagram as support tool for integrated excreta management.
  The site visit to Kivalina enabled us to meet with regional entities and Kivalina Councils and residents to ensure mutually beneficial collaboration, open communication, and effective working relationships. During Joint Council Meetings, we shared information about biochar technology and its uses around the world; discussed the Kivalina specific Biochar Sanitation System, our collaborative research; and offered ideas about additional funding, resources, and partnerships needed for planning.

- **Challenges**
  Differing architectural conditions and floorplans, snow loads, seasonal and site conditions required us to modulate and iterate the standard version of the Separett Villa 9210 model adequately to the specific site conditions. We have worked expediently to co-design with Kivalina a system that will work long-term, supported by local ownership, operation, and maintenance. Continued access to support and resources can provide service and maintenance needs. Coordination and funding for in-village data collection requires significant planning and remote travel timed with the seasons. Commitment by residents of Kivalina to the project is essential.
  Not all project relevant data about Kivalina is published. Data collection in Kivalina was time-restricted to certain research fields during the field trips. Therefore we included published data analysis of communities comparable to Kivalina, for example the waste composition data.

- **Lessons Learned**
  Local relationships, roles and responsibilities are critical to understand, visualize, and integrate the design of a new waste management plan. Challenges must be addressed combining technology with situational understanding of current roles and relationships responsible for managing waste. We have found that agile development and design methods taking into account what we learn by immersion in village life are critical to design robust and resilient Biochar Sanitation Systems in Kivalina.

  We began to see and understand sanitation as related to Kivalina's goals for decentralized and autonomous systems as a whole, which expanded our research from toilets and biochar into examining possibilities for evaporating urine and waste water at the household level. We recognized that the main sources of project failure are not the quality of technology but qualified human resources including the capture of community interest, management and organization techniques.

- **What Next?**
  The developed Biochar Sanitation System in Kivalina will be deployed and will serve as a model for other Arctic villages with similar problems. Several villages in Alaska, which are using honey buckets presently and are not connected to water and sewer facilities are facing future relocation due to sea-level rising and climate change. The infrastructure of the Biochar Sanitation System can be easily moved to future village sites and simplifies one aspect of relocation.

For more information about the project please contact: Contact:

Dr. Brian von Herzen
Climate Foundation
info@ClimateFoundation.org
+1-775-790-5000