

Mapping Climate Change in a Yupik Eskimo Village

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Located in Western Alaska at approximately 59 degrees latitude and within one mile of the Bering Sea, Quinhagak is a quintessential Yupik Eskimo community of about 600 individuals. Its primary industry is commercial fishing and most residents participate in subsistence hunting and gathering to support their households.

Nowhere is the evidence of climate change more visible than in Quinhagak, Alaska. Thawing permafrost and a decrease in protective sea ice cover are causing considerable beach erosion in this village and countless others across Western Alaska. Besides destroying homes and other village infrastructure, this erosion results in the loss of ancient Yupik Eskimo archeological sites, particularly ones located on the coast.

Seven hundred years-old and older artifacts have been found deposited on the beach and washed out to sea as the result of recent beach cliff erosion. Because many explorers, gold miners and missionaries have taken artifacts in the past, further loss could be a major blow to Yupik cultural heritage.



Melting permafrost and a loss of protective sea ice are creating extensive beach erosion along the Bering Sea in Western Alaska. As a result, many undocumented archeological sites are being lost to the ocean through erosion. (University of Alaska Sea Grant Marine Advisory Program, Deborah Mercy photographer).

Mapping the archeological sites is very important for identifying contents and documenting loss risk. However, several factors contribute to make GPS/GIS mapping difficult in Quinhagak. First is the site's remote location and short summer mapping season. Second is the high cost of bringing in mapping consultants to conduct conventional surveys. And, finally, the archeological sites are culturally sensitive. Many Yupik would prefer that non-Natives not have access to the areas. Therefore, the ideal situation would be for the residents of Quinhagak to map the resources themselves.

Thanks to an ESRI 4-H Train the Trainer Grant and a grant from the Quinhagak Qanirtuug Native Corporation, the University of Alaska Fairbanks (UAF) Cooperative Extension Service and the UAF Marine Advisory Program were able to conduct a three week-long GPS/GIS course for four youth and four adults. The goal of the course was to teach participants how to collect GPS data for use with ArcGIS 10, utilizing inexpensive Garmin eTrex receivers.

Although navigational GPS receivers are in common use in Western Alaska, this does not mean people actually understand the technology. Most could not identify which coordinate system format their receivers were set to or why that mattered when exchanging coordinates with others. Neither were they aware of the errors that can result from using the wrong map datum. Both NAD27 and NAD83 datums are in common use in Alaska.

The first goal of the program was to teach participants the fundamentals of GPS. A geocaching-type course was set up in and around the corporate lands of Quinhagak. Not surprisingly, this turned out to be one of the most fun activities.



Although GPS is an important navigational tool in Alaska, few are aware of the pitfalls that can occur when proper attention is not paid to mixing coordinate systems or datums. (University of Alaska Sea Grant Marine Advisory Program, Deborah Mercy photographer.)

Once everybody was comfortable with the understanding and use of GPS, the program shifted to GIS. Since ArcGIS 10 is a complex program to learn, simpler “transitional” softwares were used to teach fundamental concepts. One such software was EasyGPS. This free program allows users to download and save GPS tracks and waypoints (www.easygps.com). EasyGPS also links

with the air/satellite photos used on the website www.bing.com so that users can view the location of their waypoints.

It was originally intended that the GPS waypoints and track files would be converted to shapefiles for use in GIS using the DNRGarmin software (Minnesota Department of Natural Resources). Unfortunately, that software is not yet completely compatible with ArcGIS 10. The stand-alone freeware version of GPS Utility 5.11 was found to be an excellent alternative (www.gpsu.co.uk).



Archeological data was collected as waypoint and track files in navigational GPS receivers and then converted to shapefiles for use in ArcGIS 10. (University of Alaska Fairbanks Cooperative Extension Service, Stephen C. Brown photographer.)

Teaching participants how to use GIS was initially a very frustrating experience and this began even with the loading of the ArcGIS software. Laptops used by participants spanned three different operating systems: Windows XP, Windows Vista and Windows 7. Because of dissimilar file structures, operating interfaces, security measures and user ability, every installation was unique.

It had been hoped that a combination of hands-on activities and ESRI's Virtual Campus courses would be used to actually teach GIS fundamentals. Unforeseen internet bandwidth limitations to the village made this unrealistic during most times of the day.

As a less-than-desirable but workable alternative, fundamental concepts were demonstrated by the instructor while participants followed along. As is often the case with technology, teen participants quickly mastered the concepts while older participants quickly fell behind. Fortunately, most of the younger participants were willing to help the older ones and became de facto instructors themselves. This was a highly desirable outcome as it is hoped they will go on to teach GPS and GIS to local youth and other groups.

Mapping of archeological sites around Quinhagak eventually became a four-step process. Step one was to map the resource with GPS. Step two was to download the waypoints and track files to the computer using EasyGPS. In step three the .gpx files in EasyGPS were converted to shapefiles using GPS Utility. Finally, in the fourth step, the shapefiles were opened in ArcGIS and given attributes.

One of the downsides of using inexpensive GPS receivers for mapping is their relatively low position accuracy. Receiver Estimated Position Error (EPE) utilizing the Wide Area Augmentation Service (WAAS) was typically around 10 feet. Through statistical averaging techniques, this accuracy was improved.

Point data accuracy was improved by having all participants map the same point repeatedly and then averaging. Line data accuracy was improved by having all participants map the same line feature. All of the individual lines were then brought into ArcGIS and an average of all lines were “eyeballed” and drawn in the GIS. This technique could probably be improved using linear regression to average the line data.

Polygon data was collected similarly to line data. Since the GPS receivers could only collect line data in the form of tracks, feature polygons were collected as lines. Once in ArcGIS, these lines were digitized on screen as polygons.

While the primary goal of this program was to teach participants how to map archeological features and how to teach others the same, there were several side benefits. One of these was river channel mapping. The cheapest way to deliver fuel and other supplies to villages in summer is by river barge. These barges frequently get stuck on shifting sand bars. Participants plan to use what they learned to map river channels to reduce this hazard and the subsequent expense.



Aside from documenting archeological sites, participants were able to map river erosion that destroyed much of Quinhagak's original airport runway. (University of Alaska Sea Grant Marine Advisory Program, Deborah Mercy photographer.)

Another benefit of the program was documenting infrastructure loss. The original airport in Quinhagak had to be abandoned because of erosion from the Kanektok River. By mapping the erosion extent, the Village of Quinhagak will use the resulting GIS maps when applying for state and federal grants.