# Pan-Arctic Digital Elevation Map Workshop

**Technical Representative Report to Arctic SDI National Contact Points**

## Executive Summary

Arctic SDI National Contact Points and Technical Representatives assembled in Waterloo, Canada to review background information and consider opportunities for involvement in and development of a Pan-Arctic Digital Elevation Map in support of the Arctic Council’s Pan-Arctic DEM initiative.

* Paul Morin, Director of the Polar Geospatial Center (PGC), presented PGC’s automated process to create a base product, and discussed opportunities for Arctic nations to support improvement of the base DEM.
* Guomunder Valsson and Eva Representatives from Iceland and Greenland presented their experience working with the PGC data.
* Pat Cummens, ESRI, Inc. representative presented ESRI’s plans for distributing the base PGC data Samples of data were made available to the Technical Representatives for additional review in the near future.
* Kare from CAFF will be described
* Lorna Schmid, Lead National Contact Point of the Arctic SDI, gave an overview presentation on the Arctic SDI. Arctic SDI NCPs from Canada, Denmark, Finland, Iceland, Norway and Sweden were in attendance and Russia participated via Internet meeting. Technical representatives from those countries were also in attendance. See Appendix A for names and email
* Michael Jackson, National Science Foundation, Polar Programs GEO and Marc \_\_\_\_\_\_\_\_\_\_\_ from NSF were in attendance

## Findings on the PGC model (quick anecdotal observations)

In general, the Arctic SDI Technical Representatives find the PGC DEM data to have some issues, but on the whole it is of sufficient quality to be valuable, in particular where other data is sparse. This finding was based on a unanimous polling of Arctic Mapping Agency technical representatives at this workshop. This finding will be substantiated by follow up evaluation.

## Options for Arctic SDI Involvement

1. Do nothing – allow PGC and ESRI to continue work on development of the Pan-Arctic DEM to meet requirements of the US Arctic Council Chairmanship’s initiative
2. Support improvements toPGC’s Worldview-derived DEM

- Develop an Arctic Ground Control Point Database served through Arctic SDI Portal

Consequences:

* Technical Working Group needs to be activated for new service, e.g. WFS
* Determine licensing issues with GCP distribution
* Define metadata and attributes for the GCPs
* Define what types of GCPs are needed (road centerlines, building corners, lidar, UAV strip, traditional points)
* Determine Timeline/Deadline: How soon does PGC need the data?
* Would support other applications, so consider other requirements
* Determine what lidar is needed (Vegetation surface, many or single points, bare earth)

- Review sample datasets and provide input to improve processing algorithms

Consequences

* Resource commitment from nations that participate
* Expected deadline to provide feedback

- Provide ancillary data to PGC to improve data pre-processing - coastal shorelines

Consequences

* Don’t create shorelines if you don’t have them, live with PGC generated shorelines

- Develop coordinated method for reporting areas with errors (WFS)

Consequences

* TWG consider what information is necessary, defines types and magnitudes, etc. of errors to report
* Set up the WFS service

- Arctic SDI work with PGC to coordinate prioritization of trouble areas

Consequences

* Set up contact point to dialog with PGC, to work large area problems in a coordinated fashion that aligns with PGC production
1. Support an Arctic SDI Harmonization Project

- Arctic nations improve PGC data for their own holdings if desired (fill holes, flatten water bodies, hydro enforce DEMs)

Consequences

* Resource Commitment

- Arctic nations serve National data holdings (or improved PGC data) from their servers, and Arctic SDI provide a common service linking to the harmonized data (is a common resolution needed?)

Consequences

* Technical Working Group examine implementing WCS
* Investigate Issue of delivering in 7 projections
* Investigate difference in Canada and Greenland delivery in WCS
* Every country needs to be running its own WCS service (provides update
* Determine what height model to distribute data – recalculate the data to separate geoid models
* Determine licensing issues with DEM distribution
* Determine whether to use an homogenous grid size, or to use varying grid sizes
* Investigate OSKARI as a delivery mechanism to showcase use
* Consider ‘no data’ for nations that don’t

### General Considerations and Potential Support Activities

1) Survey users on their requirements

Consequences

* Review questions and improve questionnaire
* Nations solicit responses from core scientists

2) Technical Working Group of Arctic SDI organize an Elevation Subgroup

Activities

* harmonize data across borders
* share issues and solutions with PGC data

3) Consider crowd sourcing to locate problems

- determine what the problems are that need to be located (i.e. clouds are a known problem, others would be more interesting to request help in finding)- determine what level of detail does PGC want

4) Future use of PGC data for change detection could be beneficial, so encourage PGC to continue the program after the initial deliveries for the Arctic Council commitment

5) Initial assessment by technical representatives on their nation’s potential use of PGC data (to be verified by national mapping agencies)

- Finland, Sweden: completing highly accurate 2m lidar, so don’t see immediate need to use PGC data

- Norway: may use PGC data as hybrid while their lidar program stands up

- Canada: will use PGC data in the north, hybrid approach

- Svalbard: can use PGC data in north, hybrid approach

- Greenland, Iceland: will use PGC Data

- US: will assess use of PGC data to fill holes where ifsar is not yet collected

- Russia: not involved at this point, but could become an issue. Seek their participation, and see what possible solution they could support for an Arctic SDI DEM implementation.

## CONCLUSIONS

1) Recommend supporting Arctic SDI delivery of its version of a Pan Arctic DEM WCS served at a single point but pulled from nations

2) Develop coordinated method for reporting errors (WFS)

3) Recommend development of GCP service (WFS)

4) Recommend review of sample data sets to provide feedback to PGC

5) Recommend strong focus on involving Russian representatives

6) Recommend scheduling location and dates of next workshop – where Russian reps can attend

## Arctic SDI Analysis of Issues & Potential Workarounds with PGC Data

###  - Voids:

* Voids due to canyons: we see it, but it is within expected error for optical DEMs SO we don’t see it as a major issue
* Voids due to clouds: automatically removing clouds and replacing with voids, and any remaining clouds will show up as blunders and can be found and removed , SO we don’t see this as a major issue
* Voids due to water: automatically removing water bodies and replacing with voids, but further investigation needed to see if lake surfaces can be derived and extra work on this issue would be beneficial
* Voids due to shadow casting: we see it, but it is within expected error for optical DEMs SO we don’t see it as a major issue. Arctic nations will investigate and offer feedback to PGC
* Voids due to image quality, (sometimes saturation, aperature setting): it is a problem and poor images should be corrected or not used. PGC is looking into corrections. Voids due to missing imagery: Work in progress, new imagery being tasked

### - Artifacts

* Orange peel: noise in the data; in the case of poor imagery and unacceptable error, unacceptable and replace imagery. Arctic nations will investigate and offer feedback to PGC
* Sinks/holes: we see them, we will inform PGC so they can attempt to clean up the process, and Nations could clean automatically if desired – Arctic SDI will share tools for cleaning
* Noise at edge of scenes – as to be expected

### - Geospatial Accuracy

* After removing blunders, horizontal accuracy is running 3-5 meters in tests done so far (use road intersections, building corners), limited testing supports PGC accuracy assertions, Arctic nations will continue testing and provide updated statement on accuracy
* After removing blunders, vertical accuracy is as to be expected 3-5 meters. Removing blunders takes effort to find the sources and remove them (clouds)

### - Seamlines

* Errors seen are not acceptable and should be corrected. If not corrected by PGC when they mosaic, Nations will need to retrieve the strips and correct mosaicking themselves (need internal discussions on the flow of data and corrections as the process matures)

### - Hydro

* Hydro flattening: automatically removing water bodies and replacing with voids, but further investigation needed to see if lake surfaces can be derived and extra work on this issue would be beneficial
* Hydro enforcement: nations will work on this issue on their own on an as needed basis
* Shoreline: Nations will work on this issue on their own on an as needed basis