How can data be added to a Geographic Information System (GIS)?

A GIS makes information out of data. It is used for viewing spatial data and for performing spatial analyses in order to provide adequate and useful information for scientists, managers and others.

When converting data into a format that is compatible with the GIS software (ArcGIS 9.0), it is imperative that spatial references that are associated with the data during real time acquisition are preserved.

Gridded Bathymetry and Backscatter Imagery

Science Applications International Corporation's (SAIC) ISS-2000 acquires, processes and records data, and provides survey control and underway quality control displays. Data collected using the ISS-2000 software are fully corrected for ship's motion, navigation, sound velocity, and predicted tides (if selected). SAIC's SABER processing software is used to process the raw soundings, analyze the results, manually edit the sounding data to flag outliers (Figure 1 and 2) and derive average X, Y, Z data values (Figure 3).

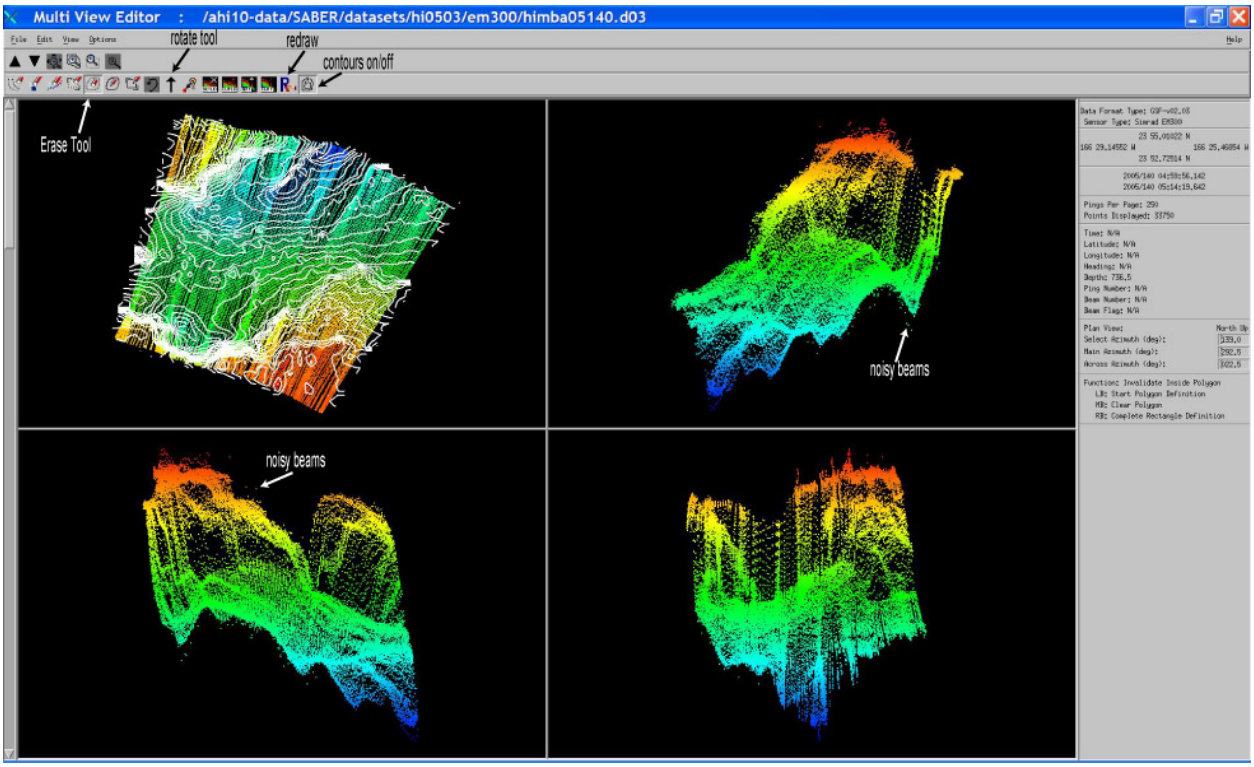


Figure 1: The Multi View Editor is used in SABER to manually edit swaths of multibeam bathymetry. All changes done with this editor are made to the Generic Sensor Format (GSF) multibeam data files by resetting flags, rather than removing or changing the original data.

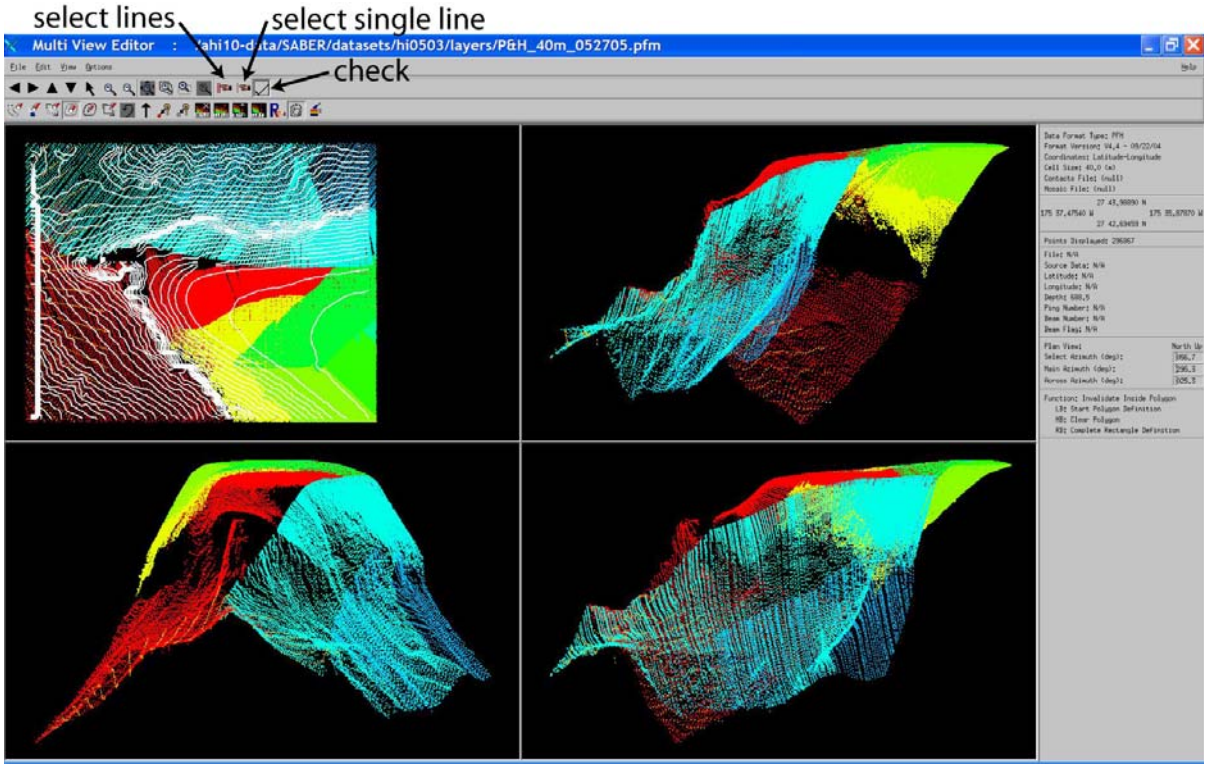


Figure 2: The swath data is gridded as a PFM, Pure File Magic. The PFM is analyzed for missing and erroneous data that were not caught during swath editing.

Upon creation of the PFM, the grid embeds a projection that matches that of the working SABER session. In this case, Universal Transverse Mercator in the associated zone, WGS84 is applied. The UTM WGS84 projection stays with the gridded data set from here on out. After edits have been made to the PFM grid, the edits are then downloaded back to the GSF files, where flags are set to indicate the edits. These finally processed GSF files are used for data synthesis work at PIBHMC and are documented with FGDC-compliant metadata; the GSF files with metadata are sent to the National Geophysical Data Center (NGDC) on a cruise-by-cruise basis.

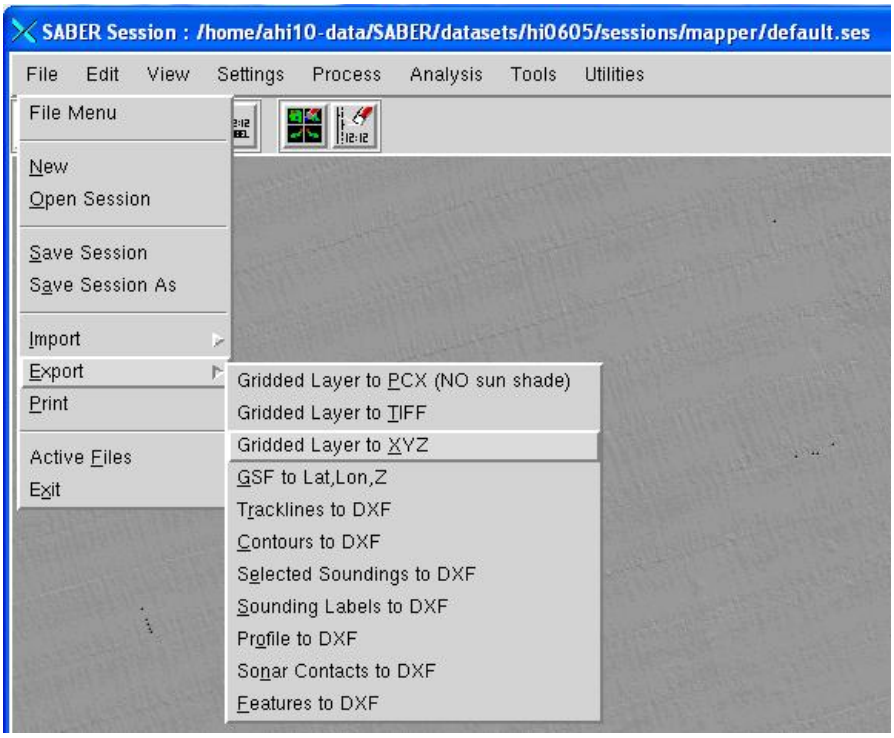


Figure 3: SABER is used to export the gridded bathymetry as an XYZ file that can then be converted to an Arc ASCII file.

After the grid editing is complete, public domain, UNIX-based open source software packages, Generic Mapping Tool (GMT) and MBSystem, are used to interpolate across gaps in data coverage and generate a gridded surface (Figure 4).

- MBSystem: an open source software package for the processing and display of bathymetry and backscatter imagery data derived from multibeam, interferometry, and sidescan sonars (link to http://www.mbari.org/data/mbsystem/.). MBSystem is supported by the National Science Foundation.
- GMT (Generic Mapping Tools): GMT is an open source collection of ~60 tools for manipulating geographic and Cartesian data sets and producing output in the encapsulated Postscript (eps) format. It is supported by the National Science Foundation. (link to http://www.soest.hawaii.edu/gmt/) (See Figure MBSystem and GMT Output)

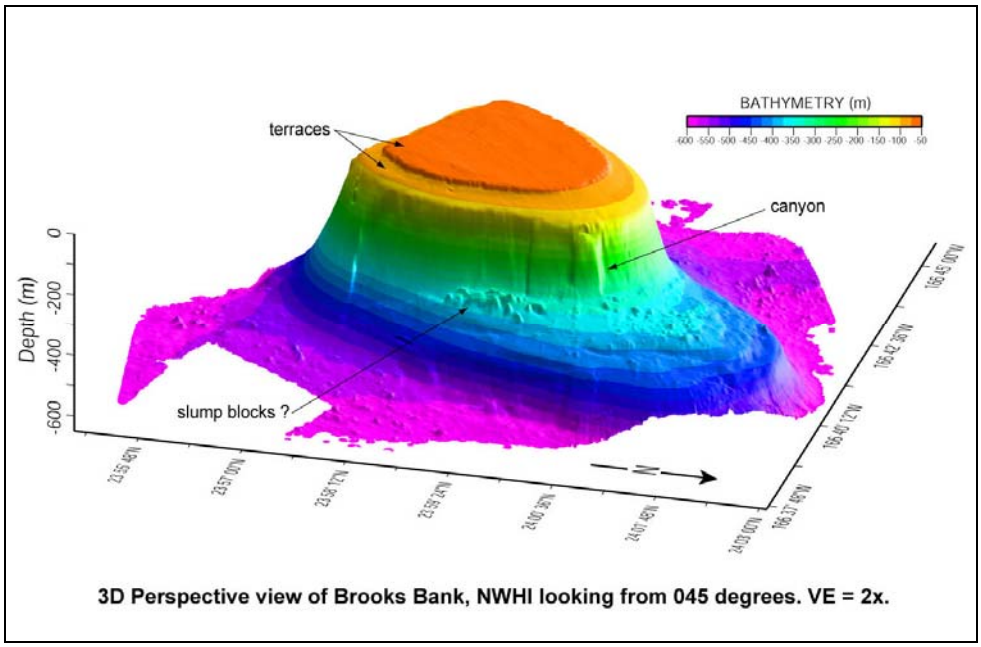


Figure 4: Data processed with SABER were manipulated using MBSystem and GMT to produce this figure.

The gridded bathymetry is converted to an Arc ASCII file using the xyz2grd and mbm_grd2arc or utm2arc commands. With ArcToolbox, the Arc ASCII files are converted to raster grids that are added as data layers to ArcMap projects (Figure 5).

- ArcMap: Geographic Information System (GIS) from ESRI Incorporated. ArcMap provides the ability to layer a variety of different outputs for display and analysis (Figure 6).

Figure 5: ASCII files are converted to Arc Raster grids for use in GIS analysis and maps.

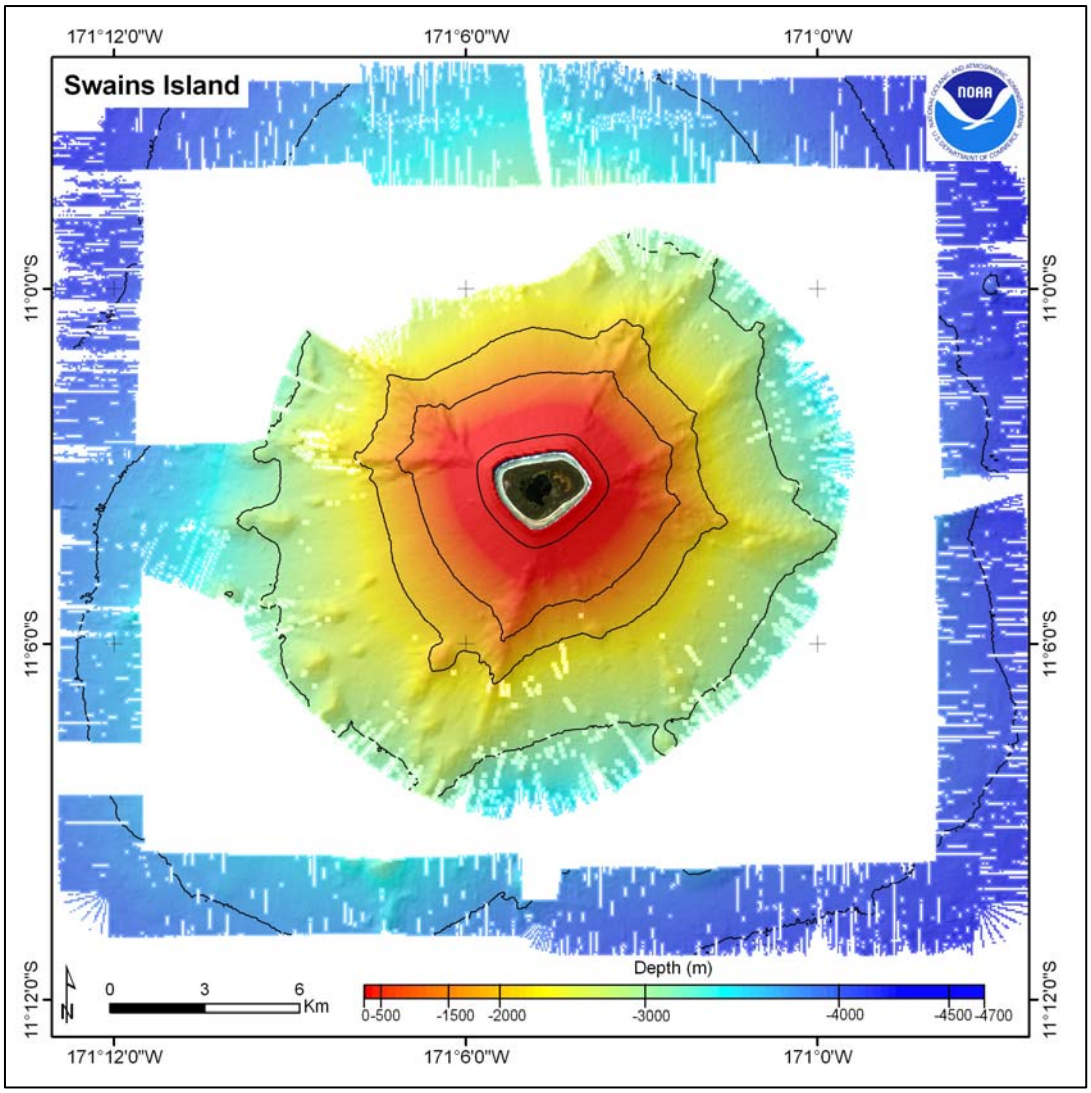


Figure 6: Bathymetry is added to ArcMap as a raster grid and used for map displays, spatial analysis and spatial statistics.

The raster grids are projected as Universal Transverse Mercator, WGS84; in order to establish the projection within the raster grid's metadata and spatial reference, ArcCatalog's ArcToolbox is used to define the projection. The gridded surface from GMT may also be imported to Interactive Visualization System's Fledermaus for 3D Visualization. GMT outputs backscatter imagery as a .geotiff which can be added directly to ArcMap as a data layer. The .geotiff may be added to Fledermaus by importing the imagery and using the cut and drape tool to view it in 3D using the bathymetry as a base layer (Figure 7). To view the .geotiff, it is sometimes necessary to create a world projection file if there is not already one associated with it.

- Fledermaus: a commercial product of Interactive Visualization Systems (IVS) (link to http://www.ivs3d.com/) for scientific 3-D visualization and analysis of multibeam bathymetry and other standard data formats for high density and resolution data. Figure Fledermaus_Output

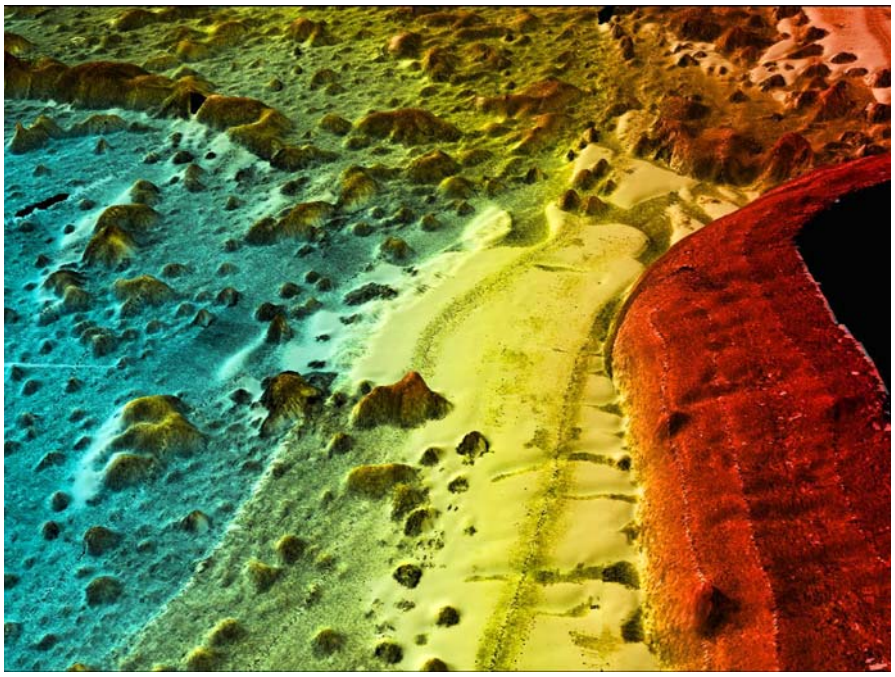
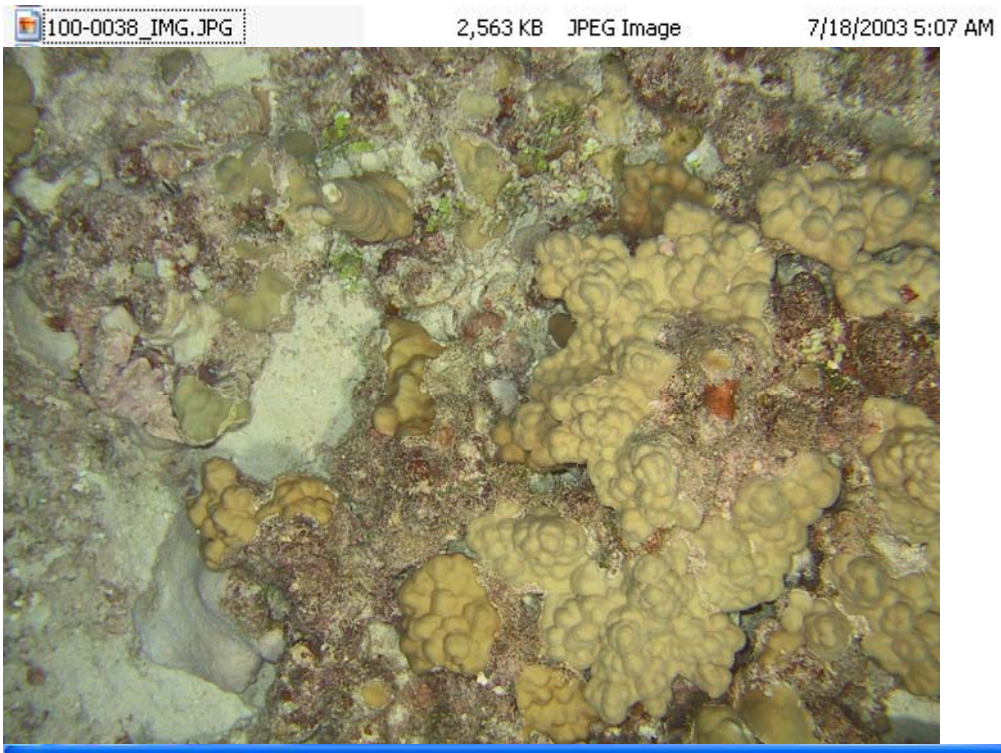


Figure 7: Bathymetry and Backscatter imagery were imported to Fledermaus for 3D visualization that reveals substrate types associated with depth.

Optical Conversion

Optical data, collected as video or digital photos, are georeferenced to the location of the survey platform. The survey platform is most often a research vessel (e.g. NOAA ship or 25' survey launch). Offsets are accounted for in real time positions. Those offsets include a layback for cable angles, GPS unit location in relation to the underwater video or still camera, and the depth of the vehicle that is housing the camera. During data collection, the GPS locations, dates (Julian days) and times (hour, minute, second) are recorded in the acquisition software while the times are also recorded on the video stream or embedded for each photo.

All of the recorded locations, dates and times, along with some other attributes, are output as a comma delimited text file (the type of output is dependent on the acquisition software). The time stamps in the output file are associated with a video frame or photo at some defined increment (e.g. 20 m, 30 sec.) where their time stamps match (Figure 4). From the associations, any analysis or classifications end up with a known location. These data are included in a spreadsheet, saved as a comma delimited file (.csv) (this is currently done in MSExcel) that is made compatible with ArcMap, added to ArcMap with the AddXY tool, and exported as a shapefile.



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H       where     vn = velocity north (m/sec)
H                 ve = velocity east (m/sec)
H                 wc = water column depth (meters)
H                 vd = vehicle depth (meters)
H                 lb =  layback (meters)
H                 wa = wing angle (degrees, + up)
      Edited 12/2/04 to remove erroneous depth measurements
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Figure 8: The time stamp on the frame grab is the same as the time recorded in the raw survey files.