ArcGIS geoprocessing project summary

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Project Objective: Investigate the change in shape and area of inter-tidal zone in Channel Islands Marine Sanctuary (CIMS) regions of interest that result from successive 1-meter changes in sea level due to global warming.

Use these geographic data sets for this study:

- Digital elevation model (DEM) bathymetric data for Santa Barbara Channel and CIMS, in ESRI raster (grid) format. The raster format is a 2-dimensional array of floating point altitude values, below (negative) and above (positive) sea level.
- Outline maps of the CIMS boundaries and the suggested Phase 1 Alternative sites within the CIMS, in ESRI ***shapefile*** format. This is a proprietary ESRI file format used to store geographic feature outlines as vector data.

Step 1: Select correct ESRI mapping product:

ArcMapGIS is most appropriate selection because the ***Spatial Analyst*** package Raster Calculator feature has processing tools for both raster and shapefile data, and because ArcMapGIS is generally more efficient at processing large raster data sets e.g., the bathymetric data).

Step 2: Organize the three geographic data files into an ArcMap *Map File*.

1) Start ArcMap application: Select ***A New Empty Map*** radio button, Click ***Select File/Add Data*** (or the '+' icon in radio button). *From ReserveShapeFiles20Jan* folder, pick 'cinmsbnd.shp', and 'phase_i_preferred_alternative.shp files (ctrl-click to select them both). The files will appear in the Table of Contents, left side of screen.
2) To see the layers, click the check boxes in the Table of Contents. NOTE: layers are displayed in 'reverse order' (last TOC item displayed first). To change the TOC order, place mouse over a layer name, left-click, drag the layer name up or down in the list to a new location. Un-click, and the layer will remain in the new place.
3) Display the large bathymetric coverage grid (raster) dataset **btoplt_20**. Make sure that the 'btoplt_20' is at the bottom position in the TOC so that it is displayed as the base map 'layer'. Note: As this is a raster dataset, It may take several minutes to display.

Step 3: Convert the shapefiles to same map projection coordinate system as the raster bathymetric data.

Since the three geographic data sets did not come from the same source, check that all three are assigned the same map projection coordinate system. If they are not, some ArcGIS geoprocessing operations may fail, or (worse), run but produce inaccurate results. In particular, the bathymetric raster data and the intertidal region (***phase_i_alternative***) shape must be projected into the same coordinate system in order for the raster subsampling ('clipping') operation (Step 5, below) to succeed.

To compare map projections, right-click on a layer name, select ***'properties.***..', then select the Source tab Scroll down the Data Source text box, look for Coordinate System: Note that btoplt_20 uses the *Albers* projection, but both **cinmsbnd** and **phase_i_preferred_alternative** use the *GCS_North_American* projection. From a data processing standpoint, the best thing to do is to re-project the two shapefiles into the same coordinate system as the bathymetric data.

To do this, open the **ArcToolbox** Application: Select ***Data Management Tools / Projections / Project Wizard (shapefiles, geodatabases)*** Use the AddData window, select the shapefile you wish to re-project, then select an output file name and location for the re-projected file. Next select ***Coordinate System.....*** to assign to the shapefile, then ***Import....***and select the bathymetric data subimage (e.g., BathSubsetofMainImage). Check the Coordinate System attributes, then select ***Apply***, then *OK*, then ***Next***, then ***Finish***.

Use the re-projected shapefiles in all subsequent processing and display steps.

Step 4: Extract a subset of the bathymetric data corresponding to the CIMS study area.

Since the bathymetric data file is much larger than the study area, so we can save processing time and possibly disk space by extracting a bathymetric data subimage corresponding to the study area.

The procedure: draw a rectangle around the desired subimage, convert the rectangle to a polygon shapefile, and use it to 'clip' (extract) a bathymetric subimage. This is known as 'Clipping a Raster Dataset': Use the ArcGIS drawing/editing tools to draw a rectangle around the desired subimage, convert it to an Arc shapefile, and use this shapefile as a 'clipping rectangle' to extract the desired subimage from the larger image. Here are the instructions from the ESRI Web Site.

1. Start the **ArcCatalog** application.
2. Right-click your destination folder and select ***New > Shapefile***.
3. Name your shapefile and specify:
    - Feature Type = Polygon (Spatial Reference input is optional).
4. Note: Prior to starting Editing and Clipping make sure that the raster grid, shapefile, and map layer data are projected into the same coordinate system.
5. Use the ArcToolbox Projection Wizard to assign the map layer and shapefiles to the projection coordinate system assigned to the raster dataset (See Step 3).
6. Add the shapefile layer and raster layer to your new map in ArcMap. Activate the Editor Toolbar (Tools/Editor Toolbar) within your ArcMAP user interface. Invoke the Editor (icon in upper left corner of screen) .
7. Click: Editor > Start Editing and specify: a. ***Task = Create New Feature***, b. ***Target = Shapefile***. To use the Editor, click the 'pencil' icon to the right of the Editor menu, then the next 'pencil' icon (sketch tool). Draw and close a 'stretch box' polygon around the region of interest, the go to the Editor menu and click ***Stop Editing*** and then

8. **(Step 4, Continued)** ***Save Edits***. Your polygon shapefile is complete.
9. Select Options in the dropdown menu of Spatial Analyst.
10. Switch to the General tab and specify Analysis Mask = Shapefile.
11. Switch to the Extent tab and specify Analysis Extent = Shapefile.
12. Select Raster Calculator in the Spatial Analyst dropdown menu.
13. Double-click the raster under layers.
14. Evaluate. The resulting Calculation file will appear in the Table of Contents.
15. Save this as a layer by right-clicking on the Calculation entry and selecting 'Save As Layer' file option.

Step 5: Extract second subset of bathymetric data corresponding to the re-projected shapefile (from Step 3).

1. Select ***Spatial Analyst / Options / General tab***, set Working Directory to the appropriate directory and Analysis Mask to the re-projected shapefile. Select the Extent tab, and set the Analysis Extent to re-projected shapefile. Save the Analysis output in the same coordinate system as the active data frame.
2. Select ***Spatial Analyst / Raster Calculator***. Select the raster subimage (the saved 'Calculation' file) by clicking the name, then click **Evaluate** to compute the raster sub-subimage corresponding to the 'phase 1' regions of interest. Call these the 'study area polygons' or 'studypolys'.

Step 6: Simulate global warming by adding constant '1' to the studypolys.

1. Select Spatial ***Analyst / Raster Calculator***.
2. Click on the 'study area polygons' layer, it will appear in the equation building window. Use your mouse or keyboard to build the following equation: [studypolys] + 1.
3. Click ***Evaluate***. The resulting new raster appears in the Table of Contents as 'Calculation'.
4. Right click on the name, select ***Make Permanent***, rename it 'studypolyp1'.Add the new layer to the Table of Contents, (do not build pyramids).
5. Repeat steps 2 through 4 to make more study areas with 2, 3, etc. added to the depths as needed.

Step 7: Create a custom color map to display the inter-tidal areas (depth from -2 to 2 meters).

To do this, highlight the studypolyp1 file (or choose one if you have made > 1) and select ***Spatial Analyst / Reclassify***. This will let you interactively build a set of bins that map the Old (depth) values into fewer groups. Suggest having between three and six bins, with the upper and lower bounds adjusted to use more groups for the most 'interesting' depths (e.g., those from -2 to 2 meters).

Repeat Step 7, adjusting the classification bins, until you are satisfied with the results.