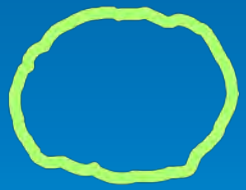
Vertical Datum Transformations: Exploring a GIS Approach

Mike Wilburn - Esri

What is a vertical datum?

- Reference surface of zero elevation for heights at various points
- **Ellipsoid**

- **Geoid**

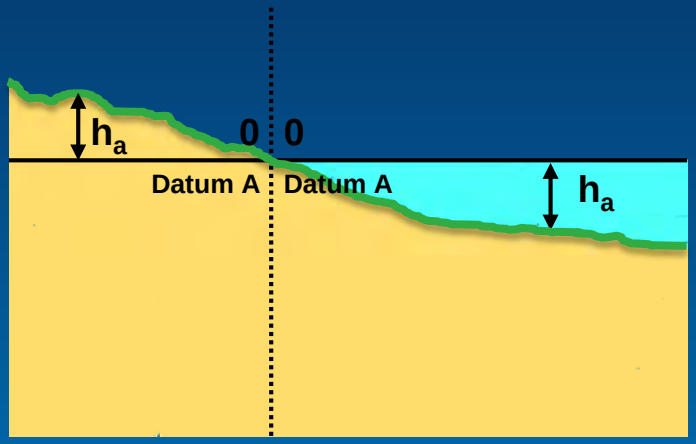


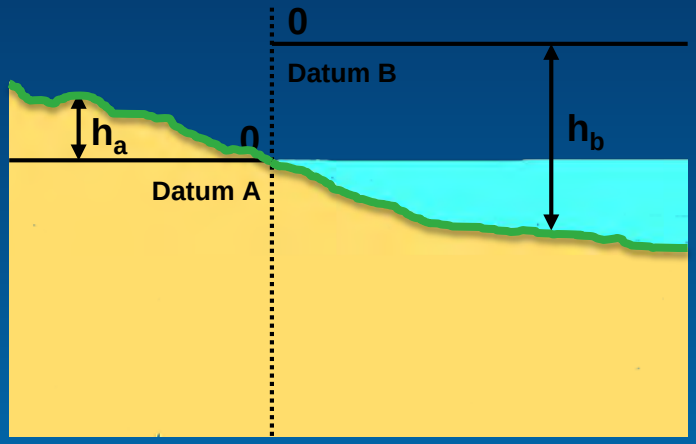
- **Tidal**

Why do we need several datums?

- Better local approximation of the real world
- Improved accuracy of remote sensing
- Changing world
- Special purposes

Pb: Mixing datasets datum





Real world impact: Vertical datum issues during Hurricane Katrina (2005)

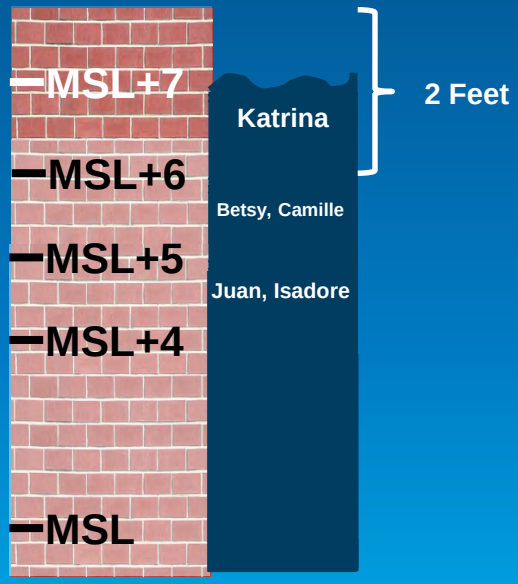
- Levee system failure in New Orleans
  - 1833 deaths
  - US$81 billion

- Report:

  "Investigation of the Performance of the New Orleans Flood Protection Systems"

  - "Vertical Datum" mentioned 75 times*

  - Levee System: *Wrong datums were selected for the contract drawings. Some walls were constructed almost 2 feet lower than intended**



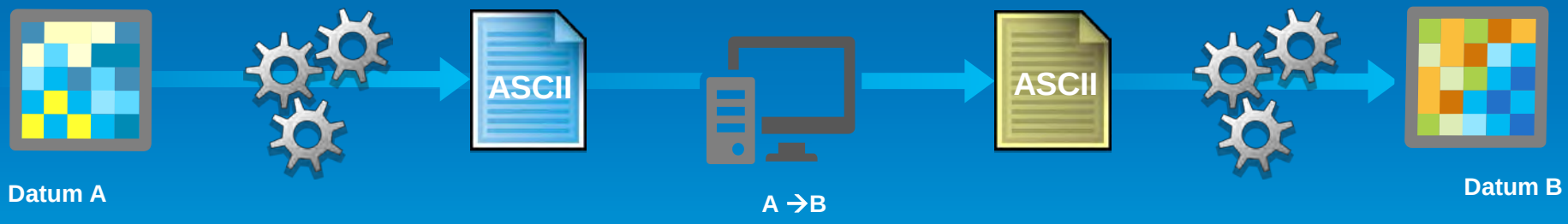
NOAA - National Geodetic Survey:

"Training Required for Proper Use of Vertical Datums"

Current tools:

- Handful of commercial tools
- Limited, ad-hoc solutions
- In North America: NOAA's VDATUM
  - Great tool, free, but has some limitations

- Typical workflow:

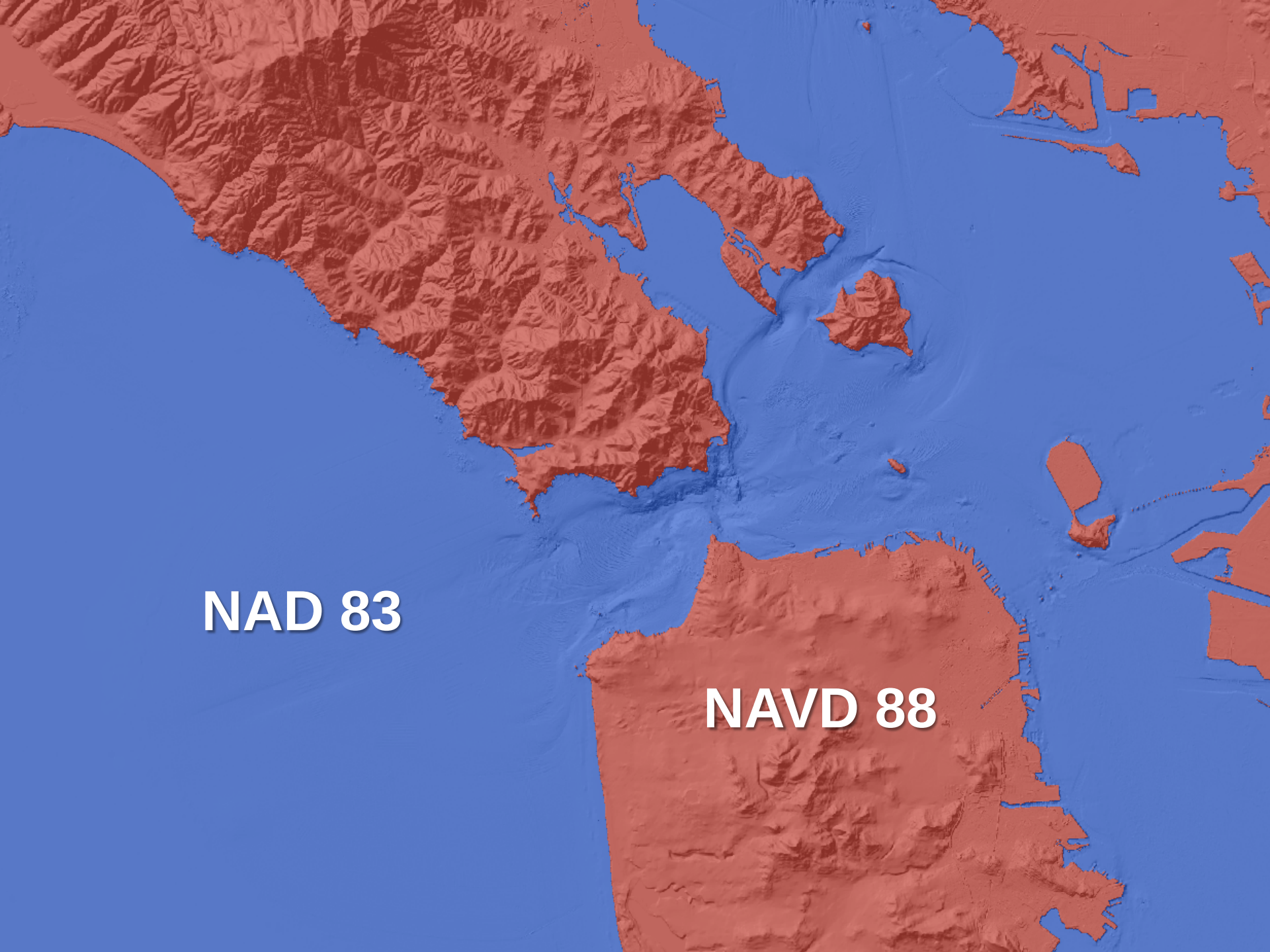


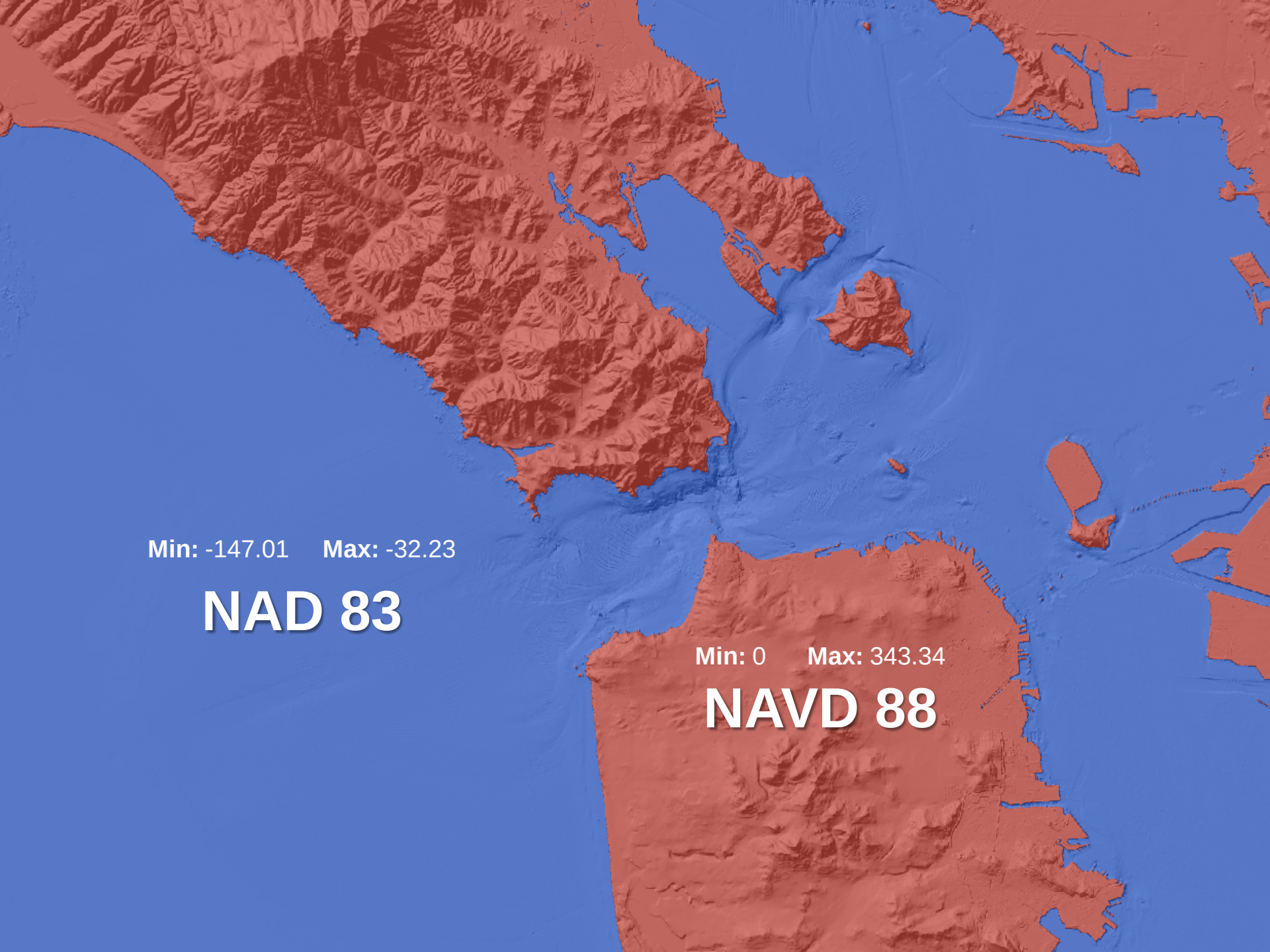
- Limitations: Data manipulations, data duplication, manual process, slow, limited extent

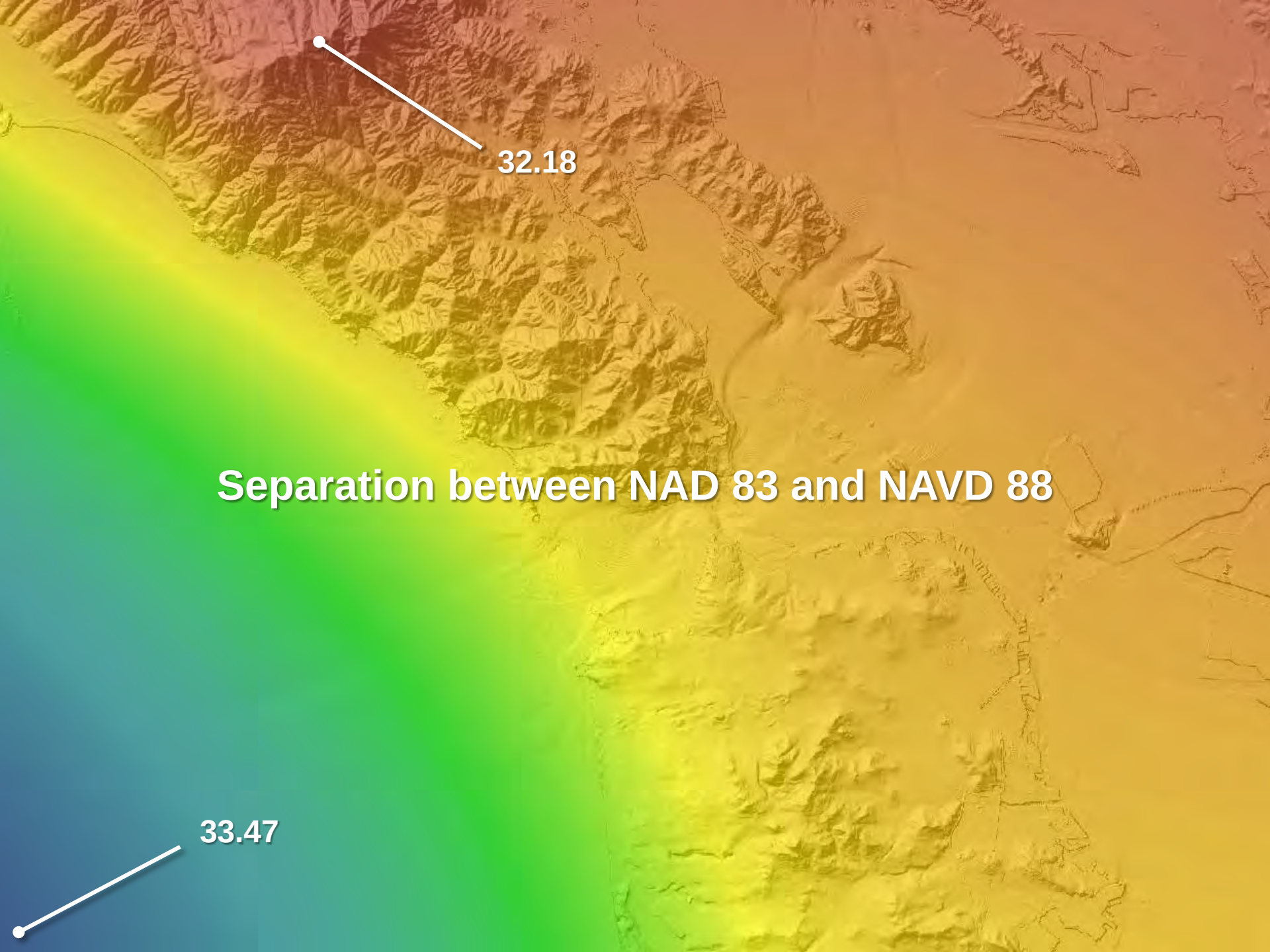
How to improve on it?
Wish list:

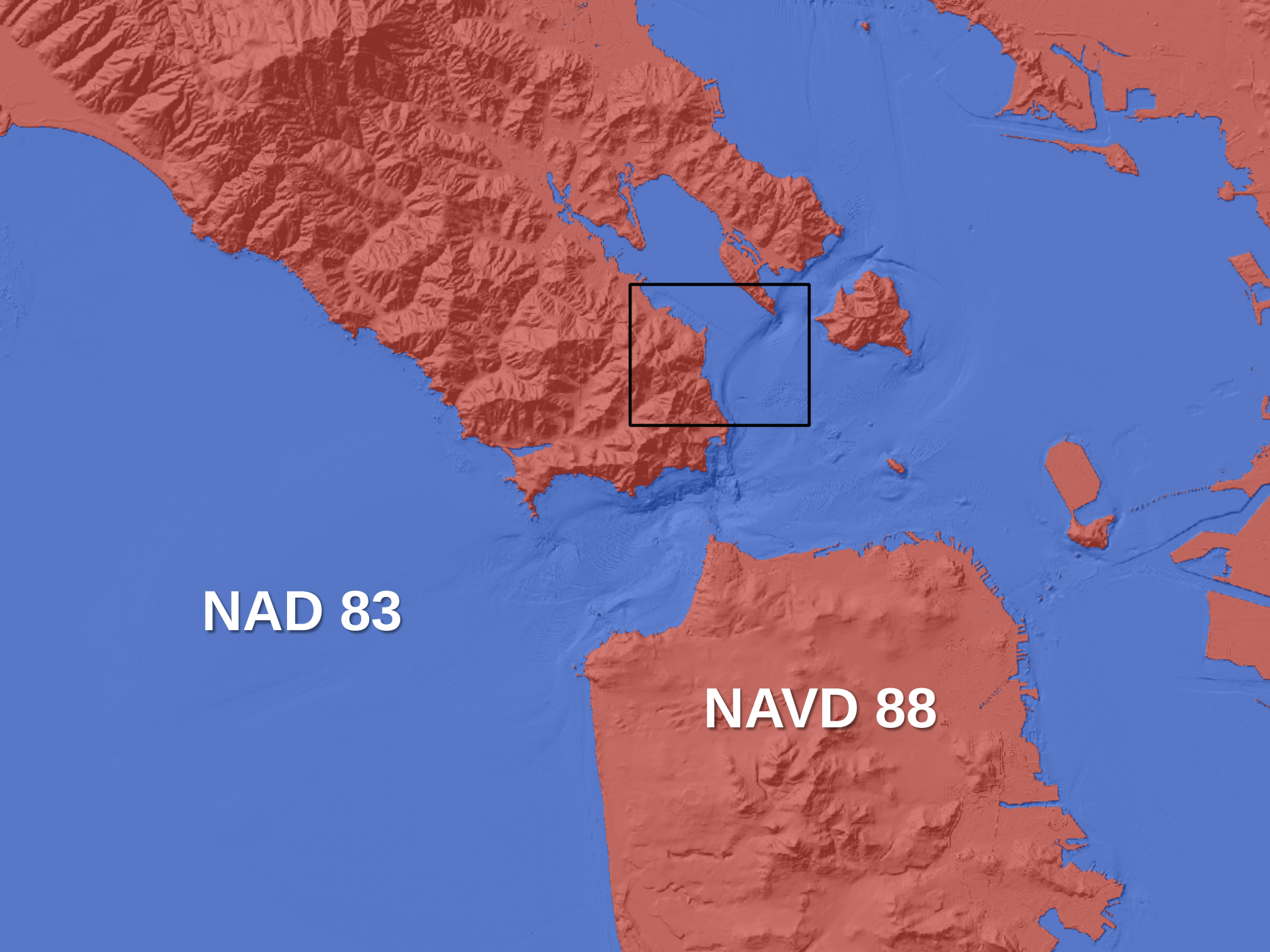
- Convenient
- Fast
- No data duplication
- No need to reformat data
- Cloud-based
- …

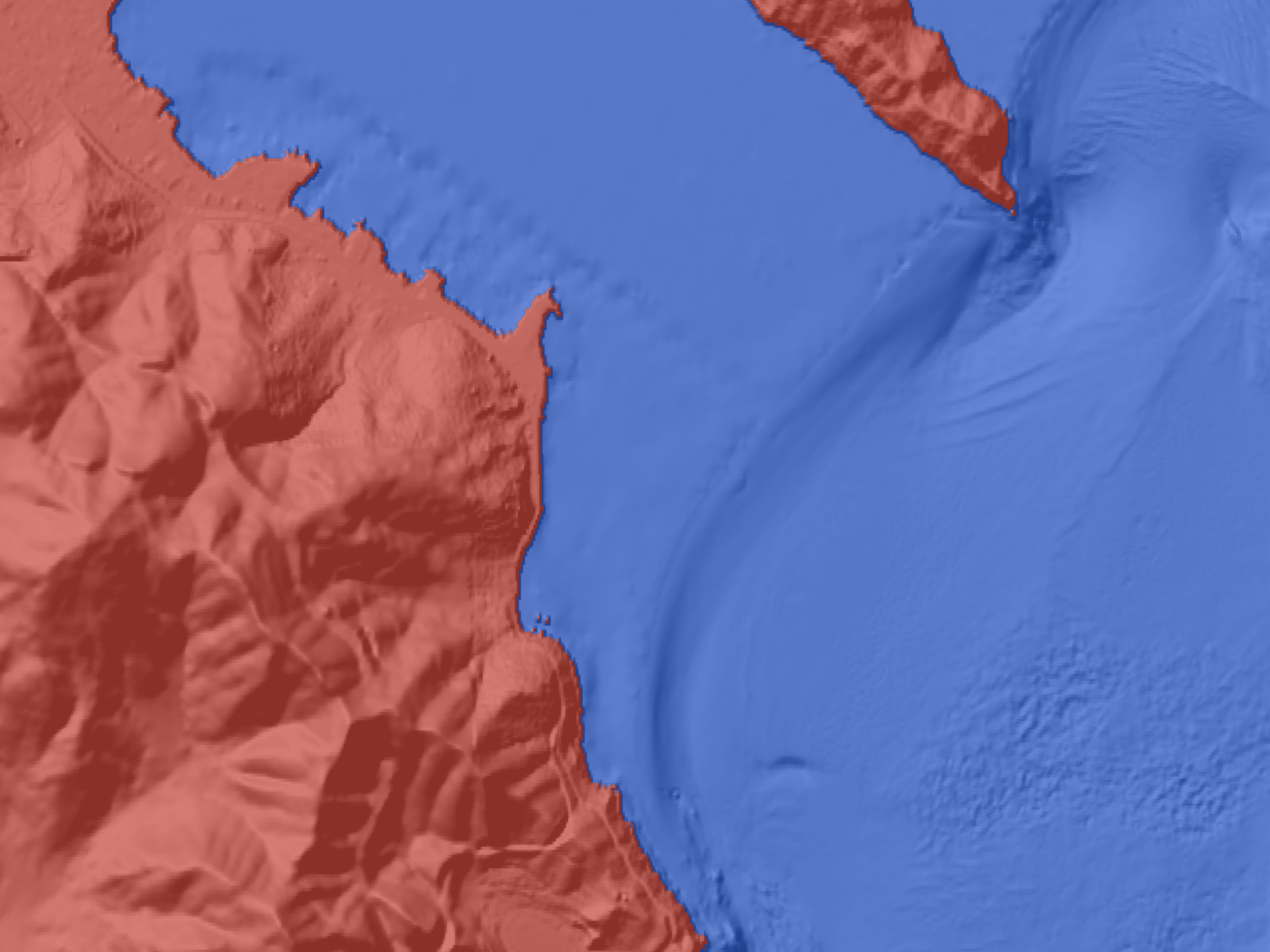
- Proof of concept using Mosaic Datasets

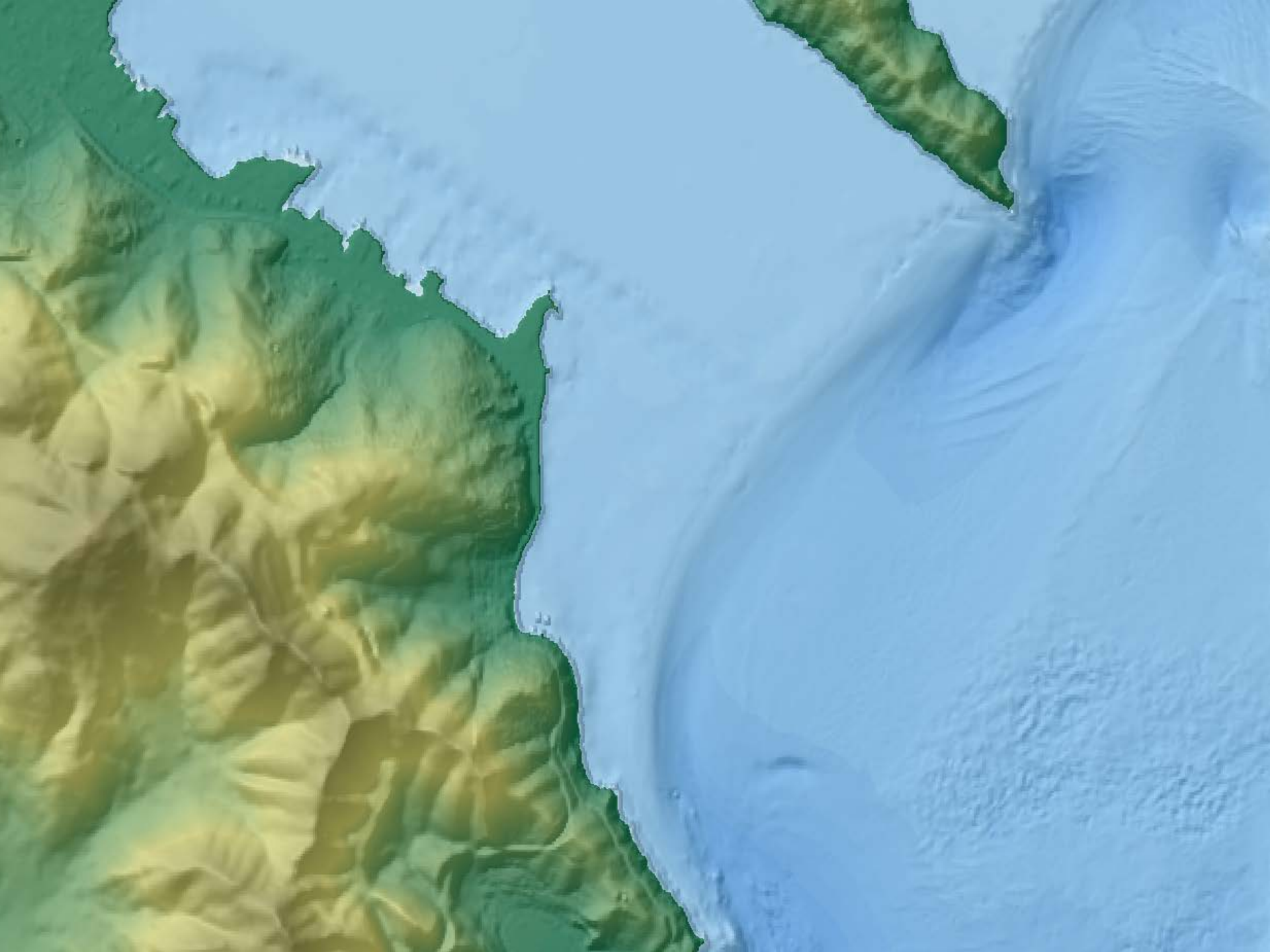

NAD 83
NAVD 88

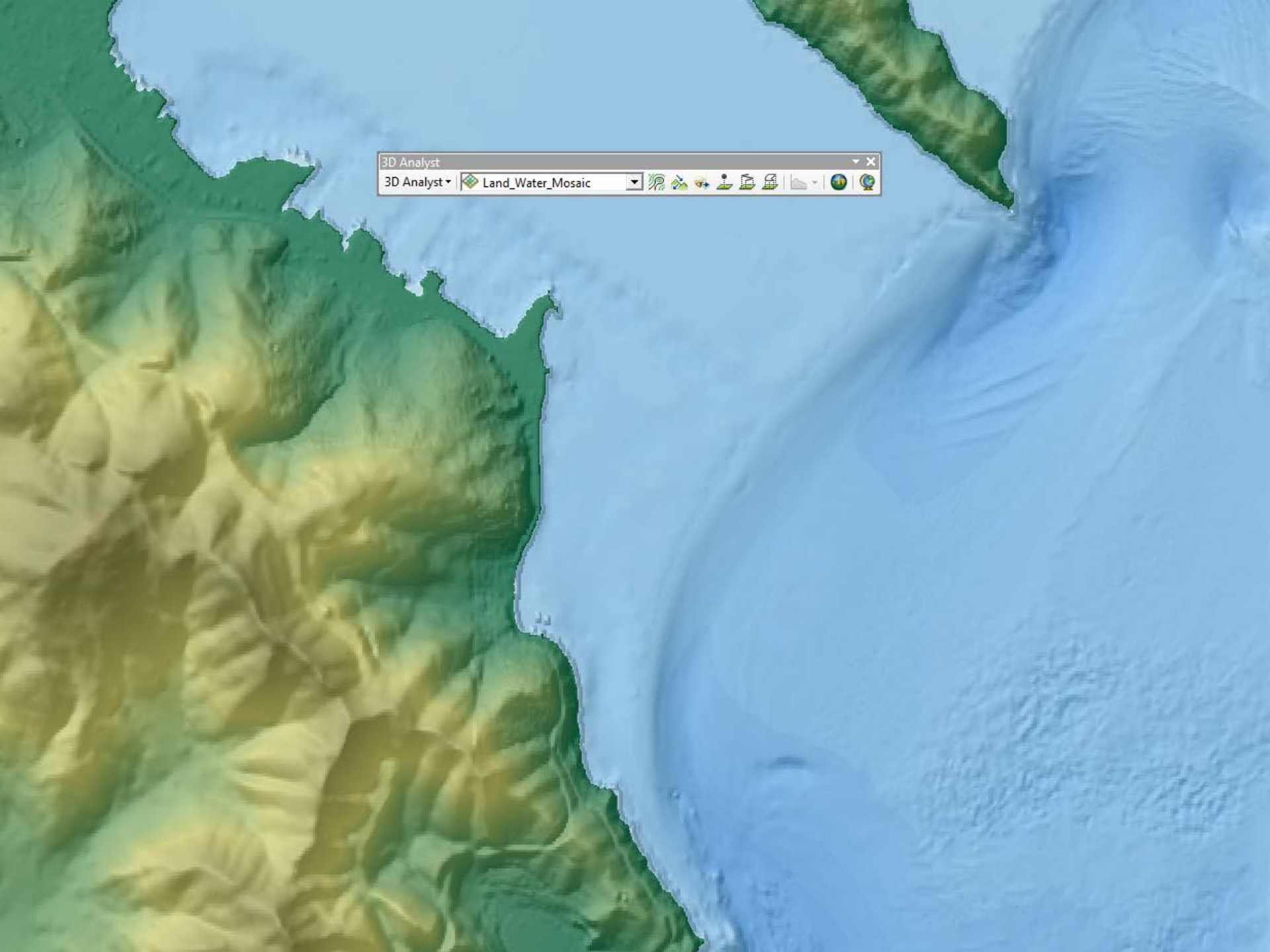

Min: -147.01 Max: -32.23
NAD 83
Min: 0 Max: 343.34
NAVD 88


32.18
Separation between NAD 83 and NAVD 88
33.47


NAD 83
NAVD 88



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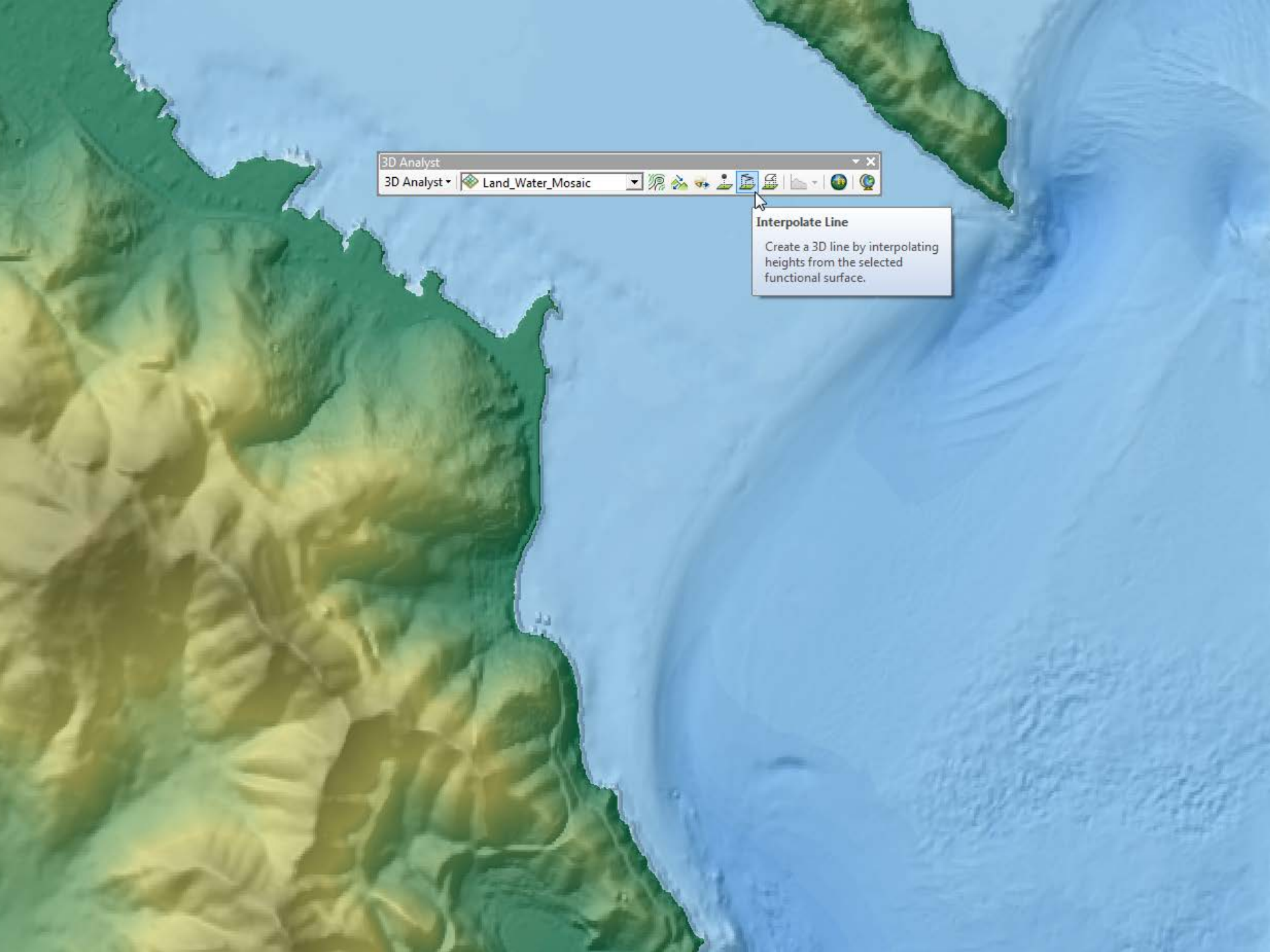
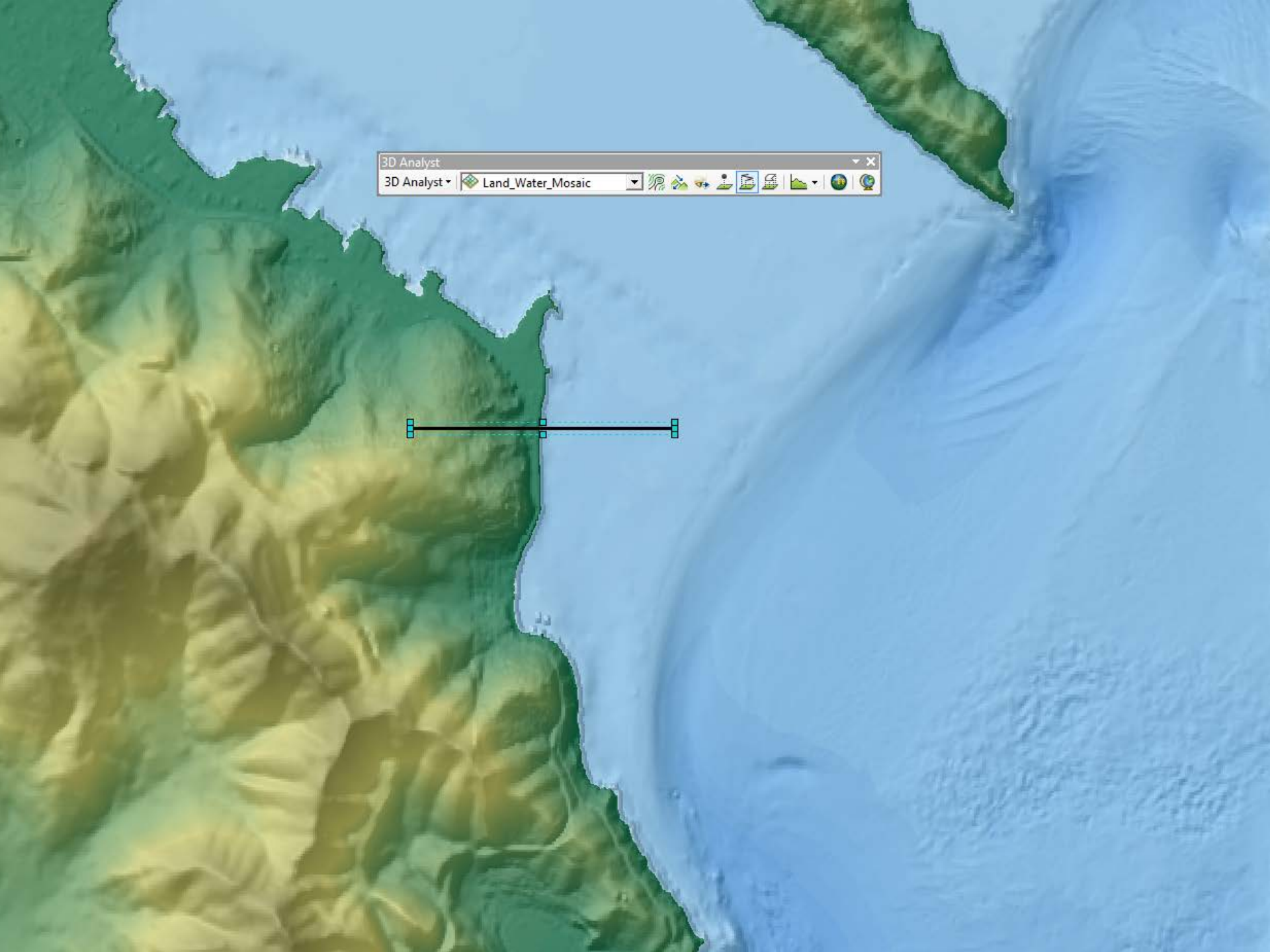
3D Analyst
Land_Water_Mosaic


3D Analyst
3D Analyst
Land_Water_Mosaic
Interpolate Line
Create a 3D line by interpolating heights from the selected functional surface.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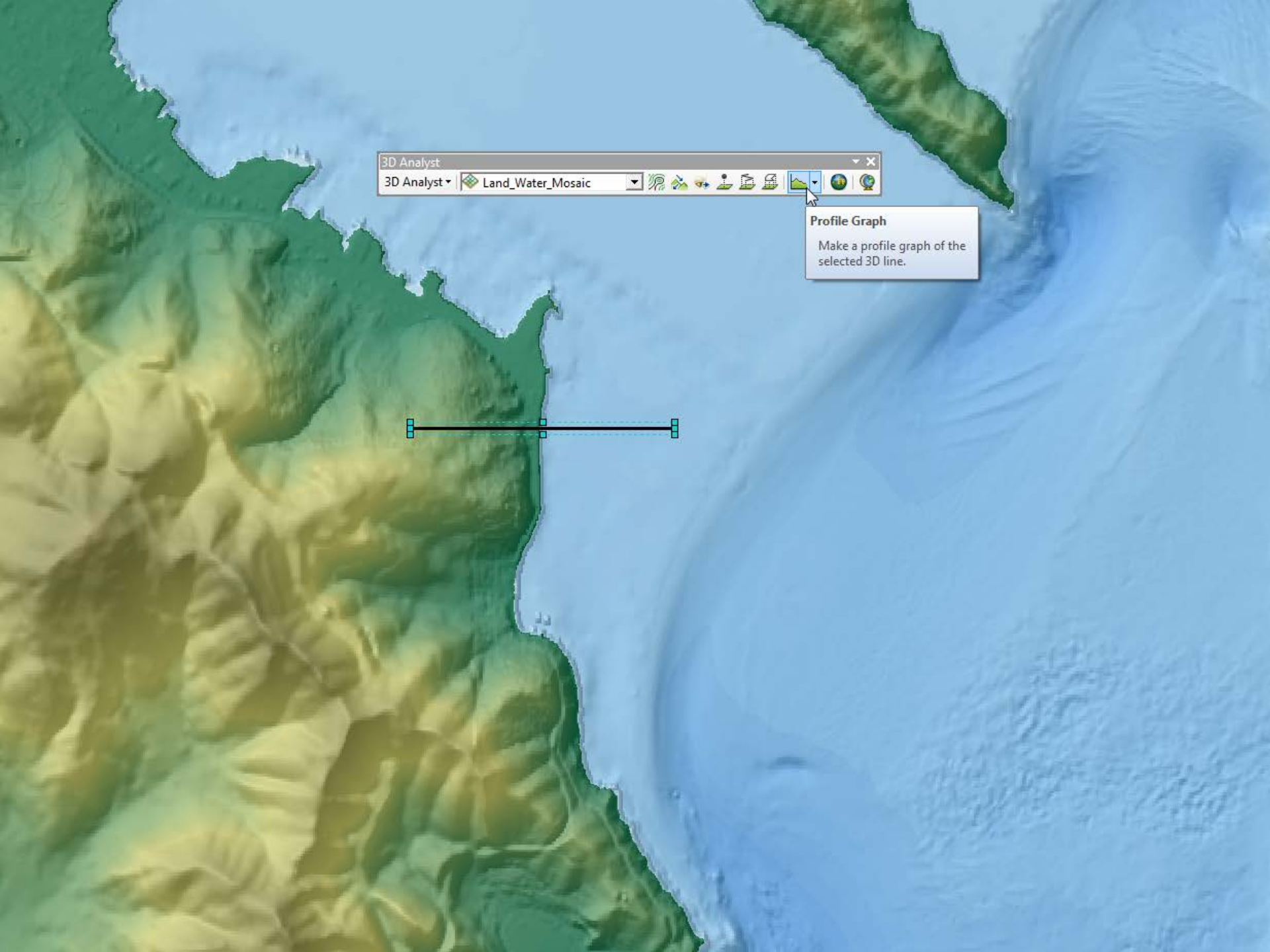
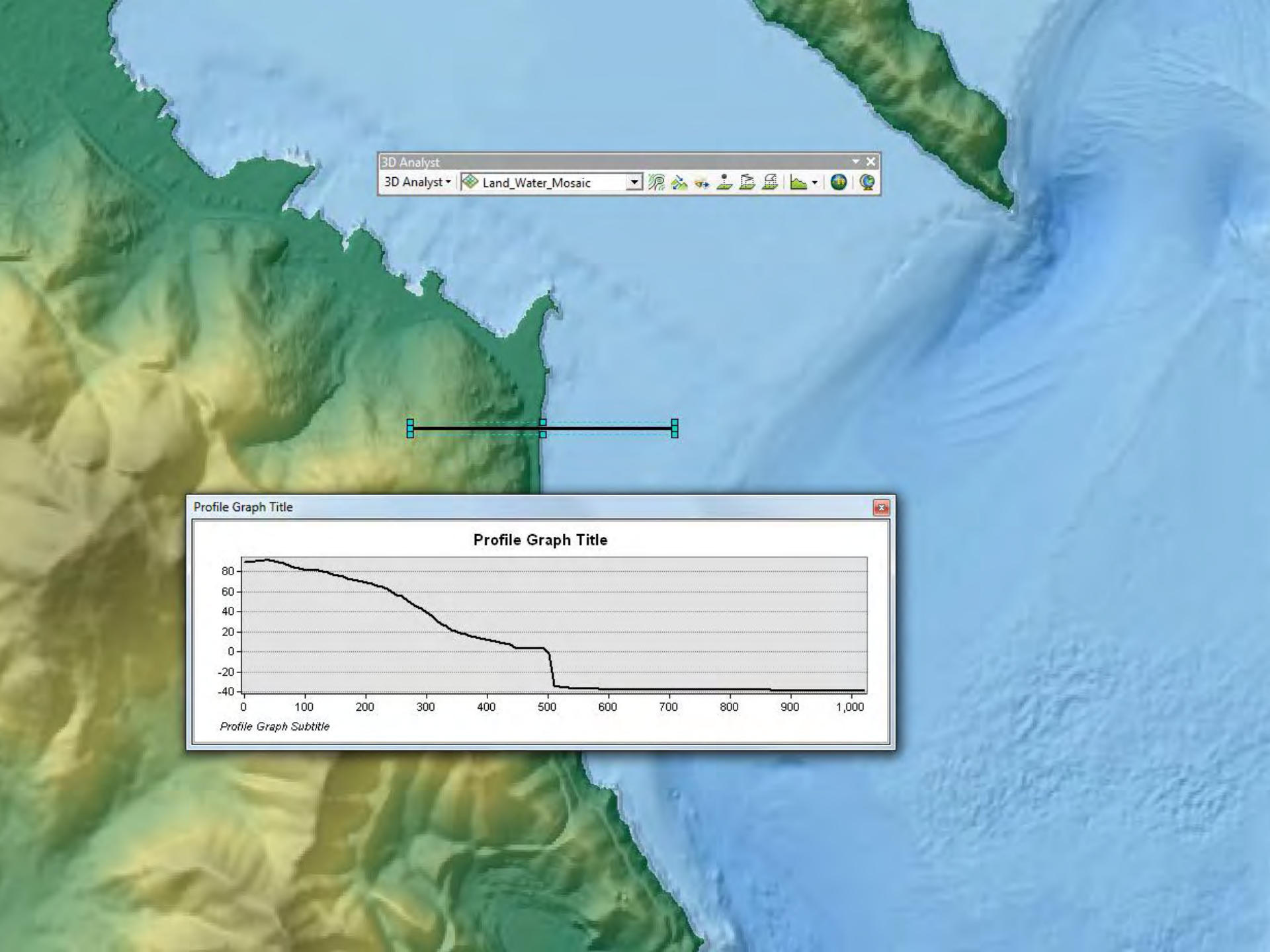
Land_Water_Mosaic


3D Analyst
3D Analyst
Land_Water_Mosaic
Profile Graph
Make a profile graph of the selected 3D line.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3D Analyst
Land_Water_Mosaic
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Profile Graph Title
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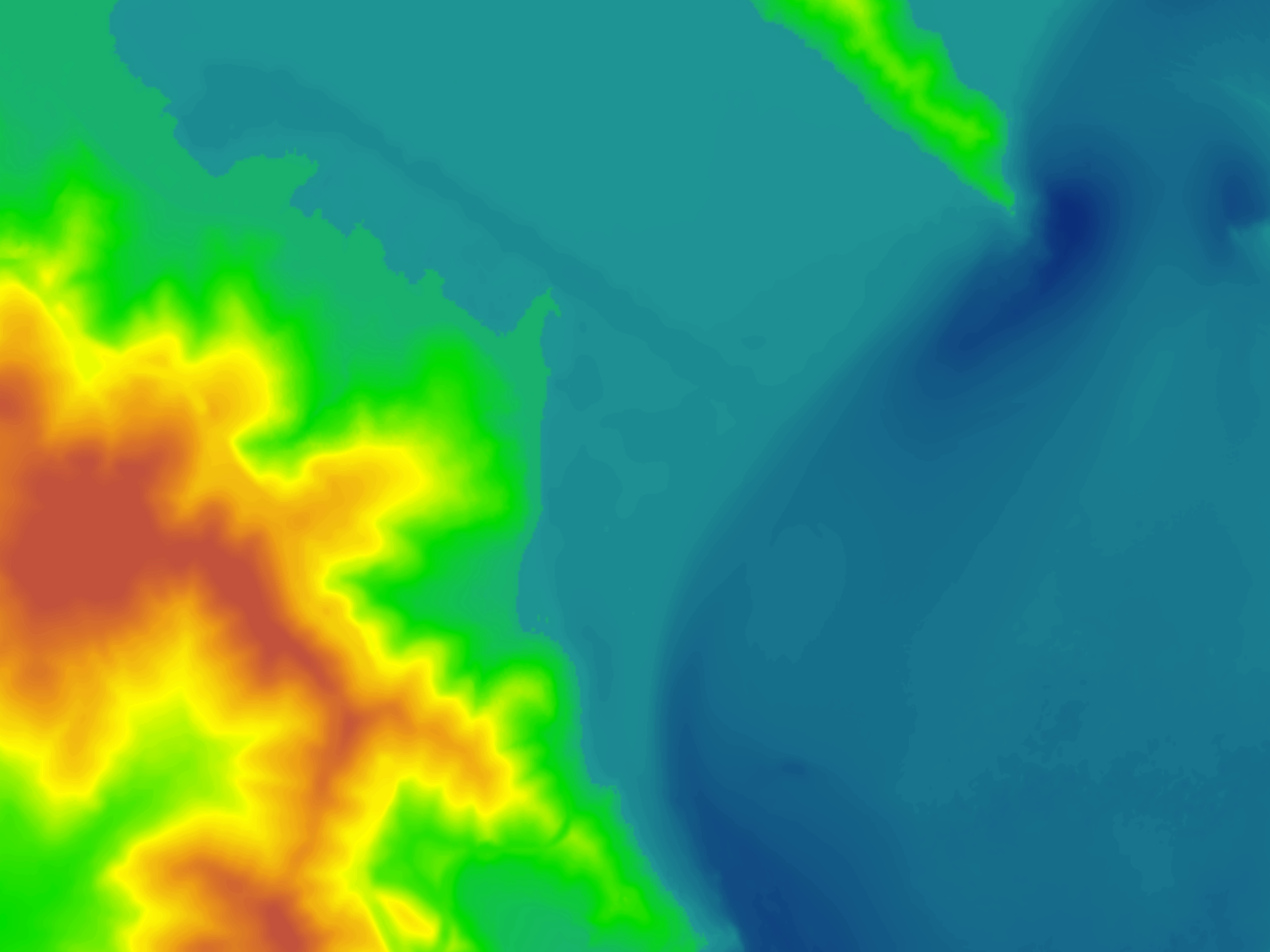
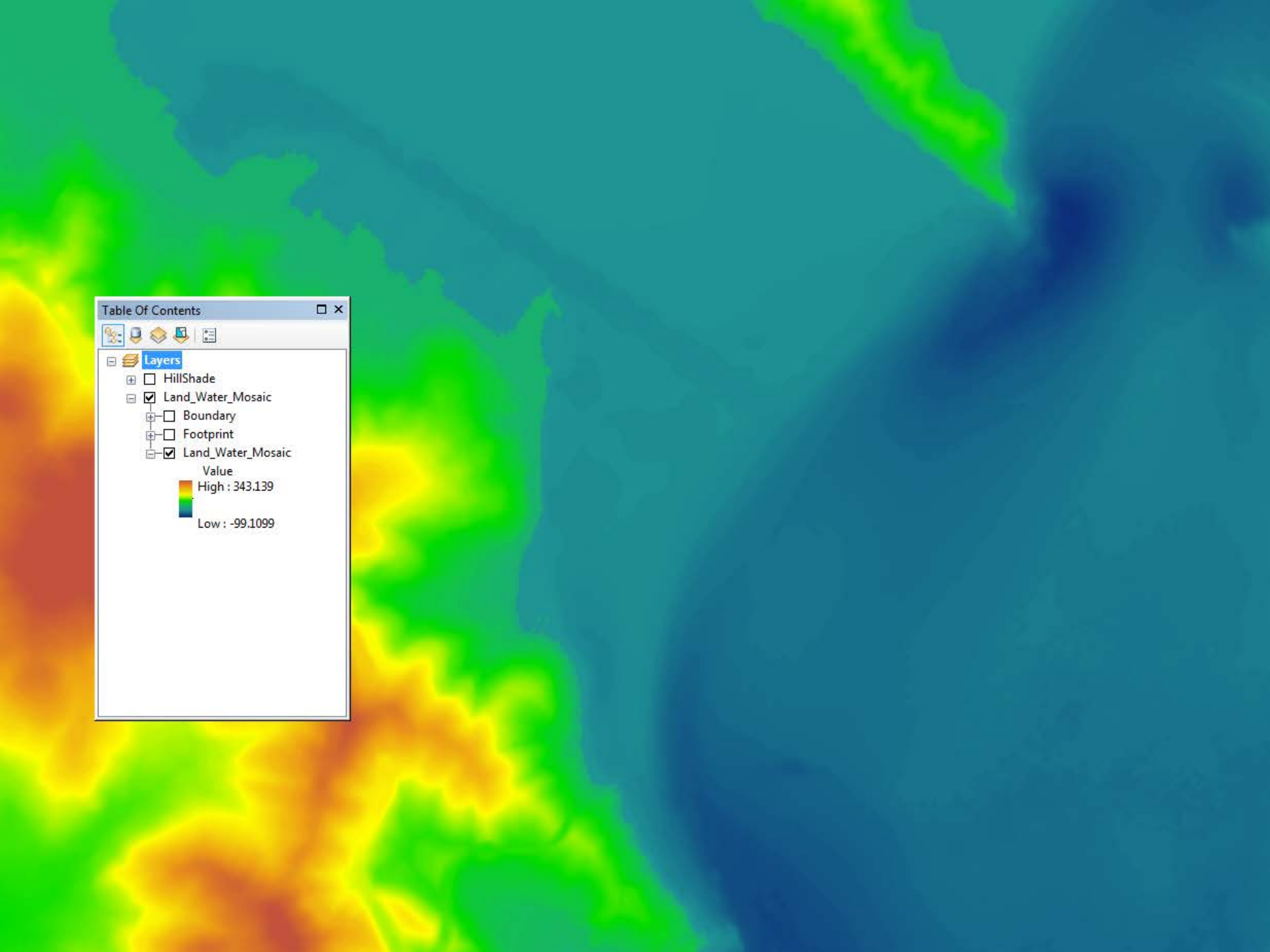
Profile Graph Subtitle

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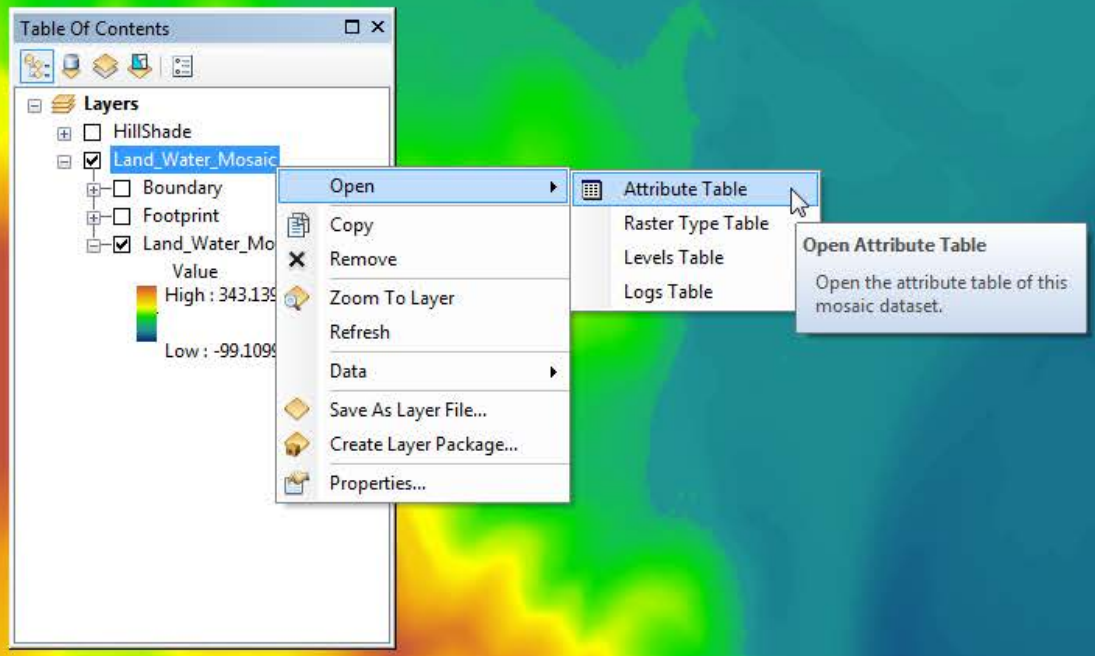
HillShade
Land_Water_Mosaic
Boundary
Footprint
Land_Water_Mosaic
Value
High : 343.139
Low : -99.1099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Footprint
Land_Water_Mo
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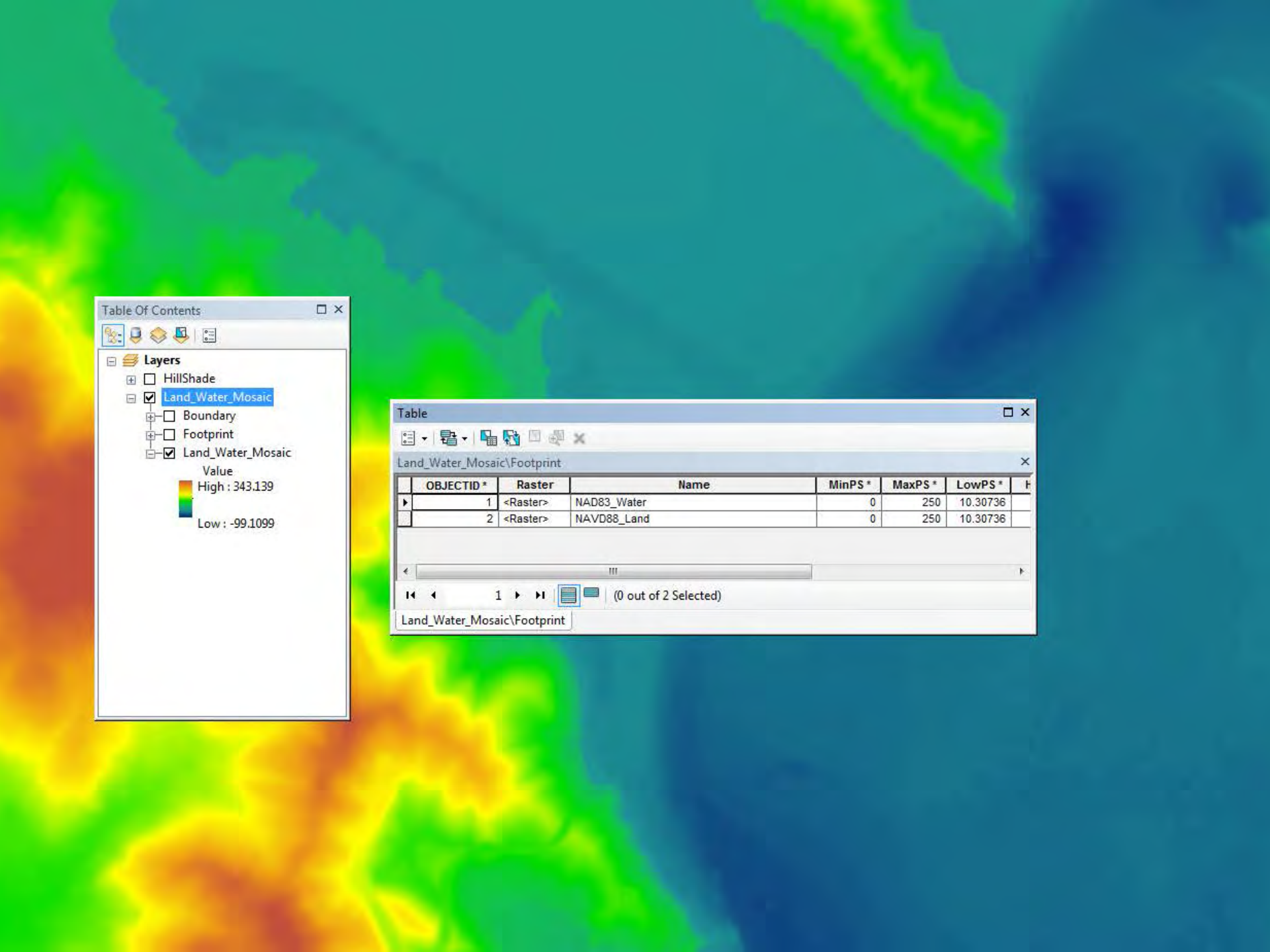
Copy
Remove
Zoom To Layer
Refresh
Data
Save As Layer File...
Create Layer Package...
Properties...
Attribute Table
Raster Type Table
Levels Table
Logs Table
Open Attribute Table
Open the attribute table of this mosaic dataset.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MaxPS *
LowPS *
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NAVD88_Land
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10.30736
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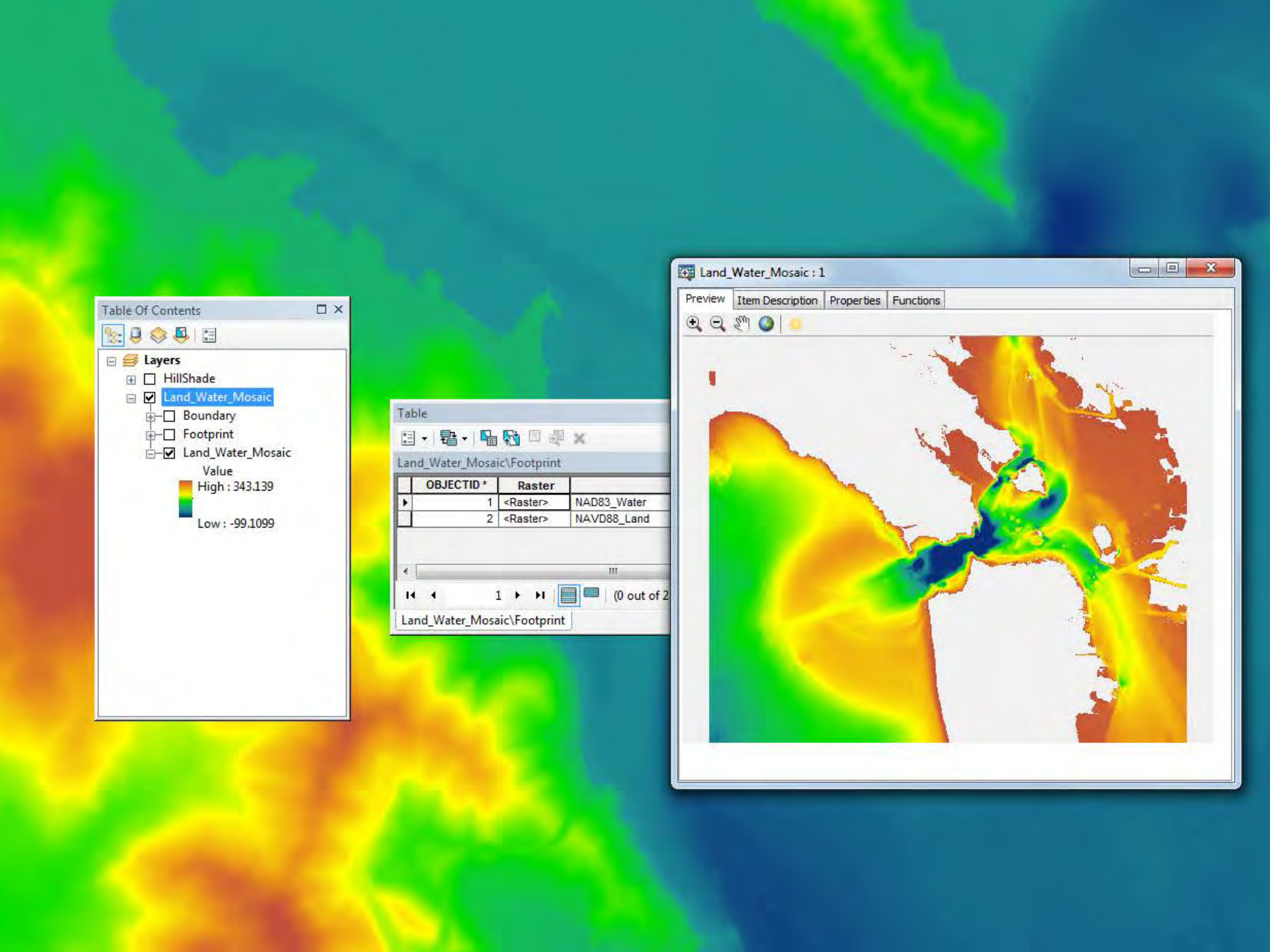
Land_Water_Mosaic\Footprint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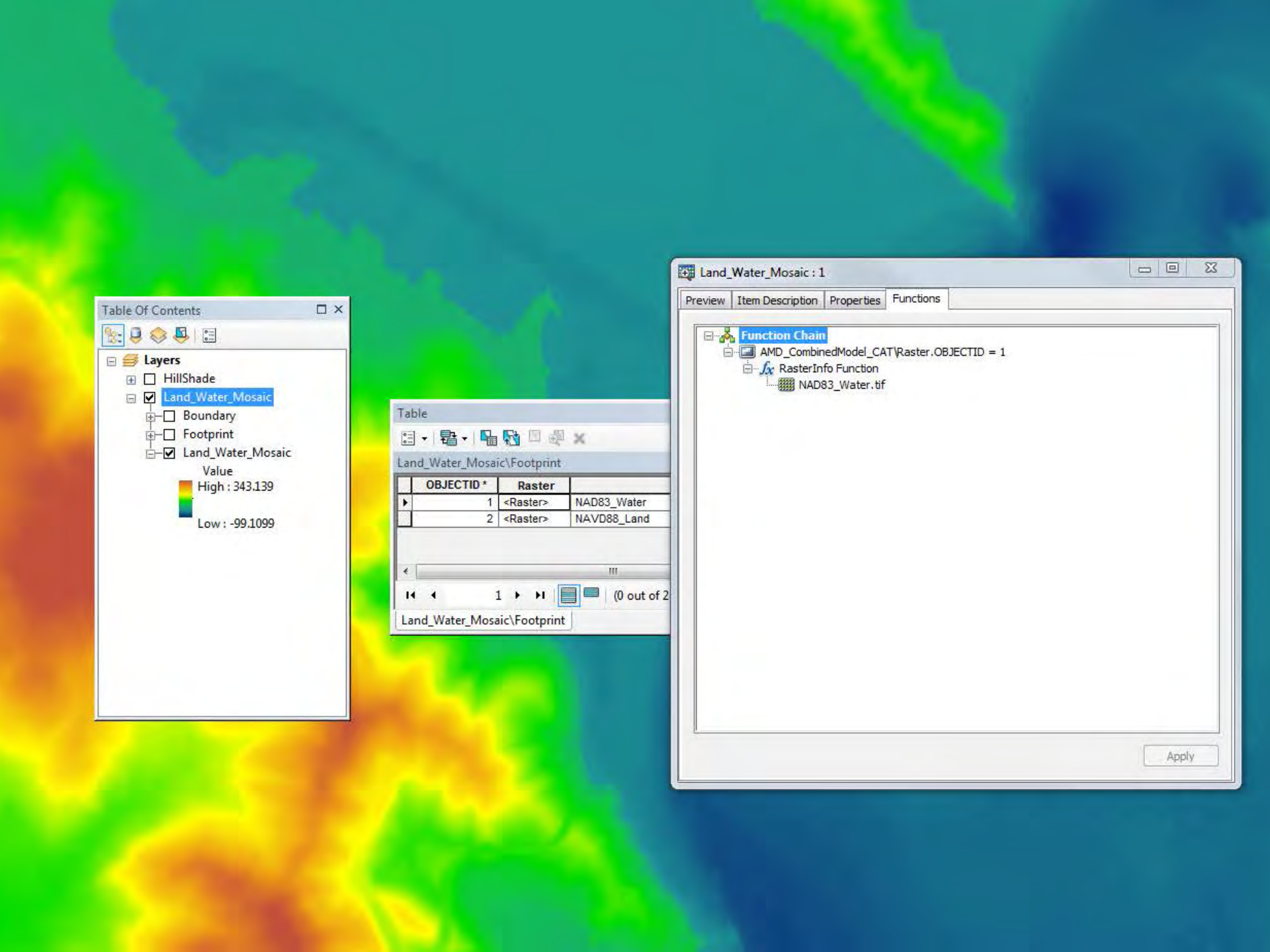
Preview
Item Description
Properties
Functions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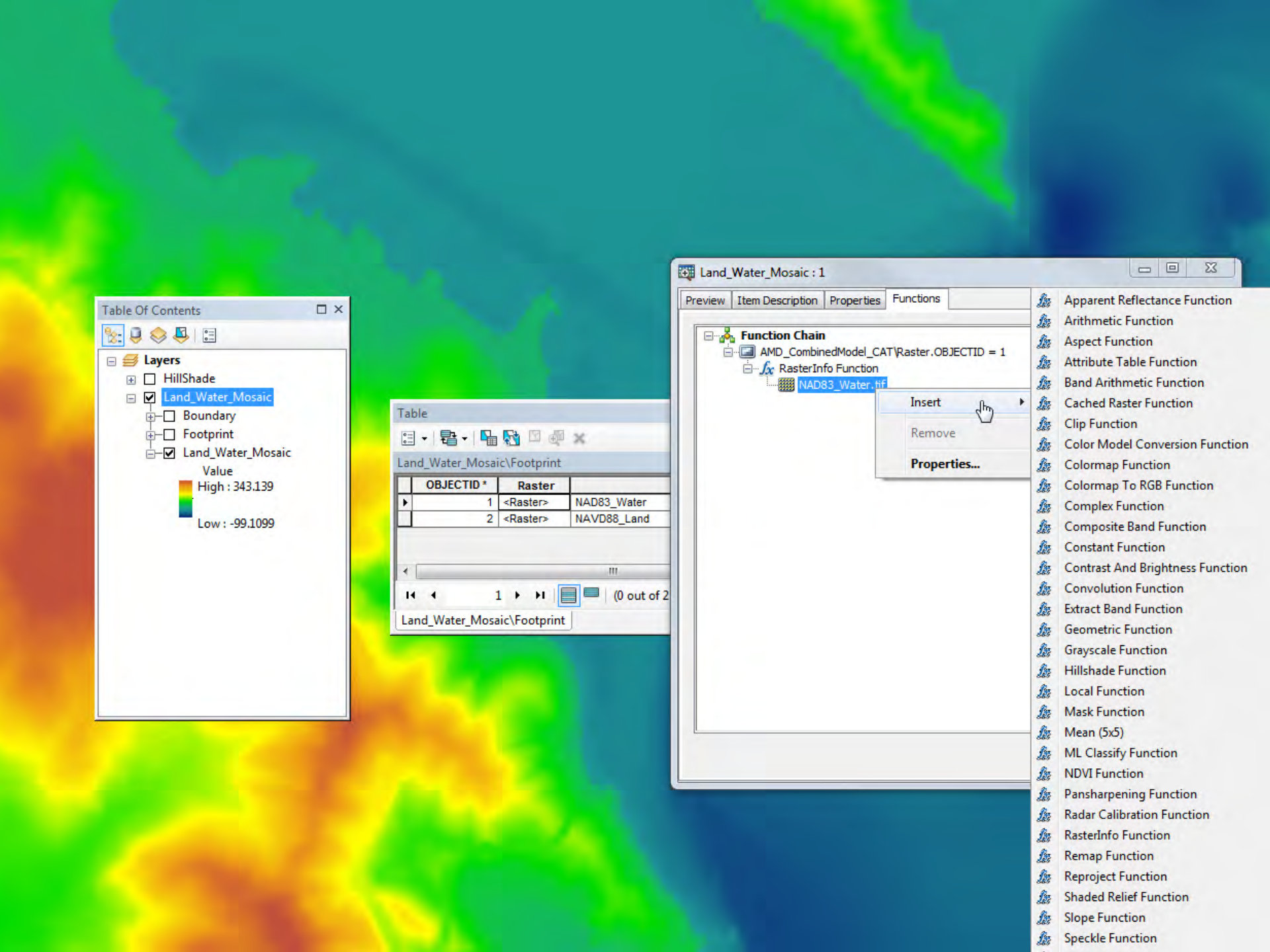
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RasterInfo Function
NAD83_Water.tif
Insert
Remove
Properties...
Apparent Reflectance Function
Arithmetic Function
Aspect Function
Attribute Table Function
Band Arithmetic Function
Cached Raster Function
Clip Function
Color Model Conversion Function
Colormap Function
Colormap To RGB Function
Complex Function
Composite Band Function
Constant Function
Contrast And Brightness Function
Convolution Function
Extract Band Function
Geometric Function
Grayscale Function
Hillshade Function
Local Function
Mask Function
Mean (5x5)
ML Classify Function
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RasterInfo Function
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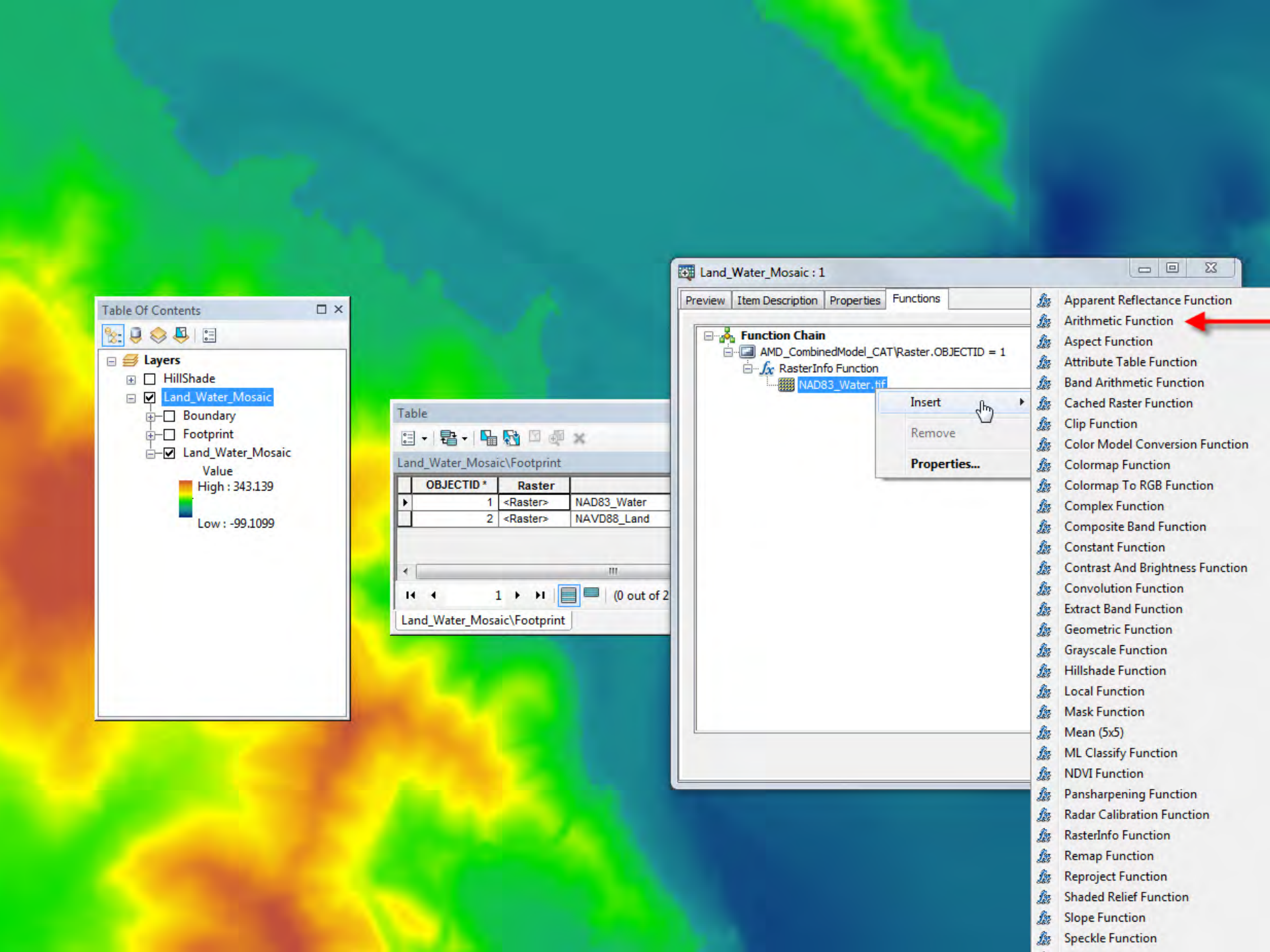
Reproject Function
Shaded Relief Function
Slope Function
Speckle Function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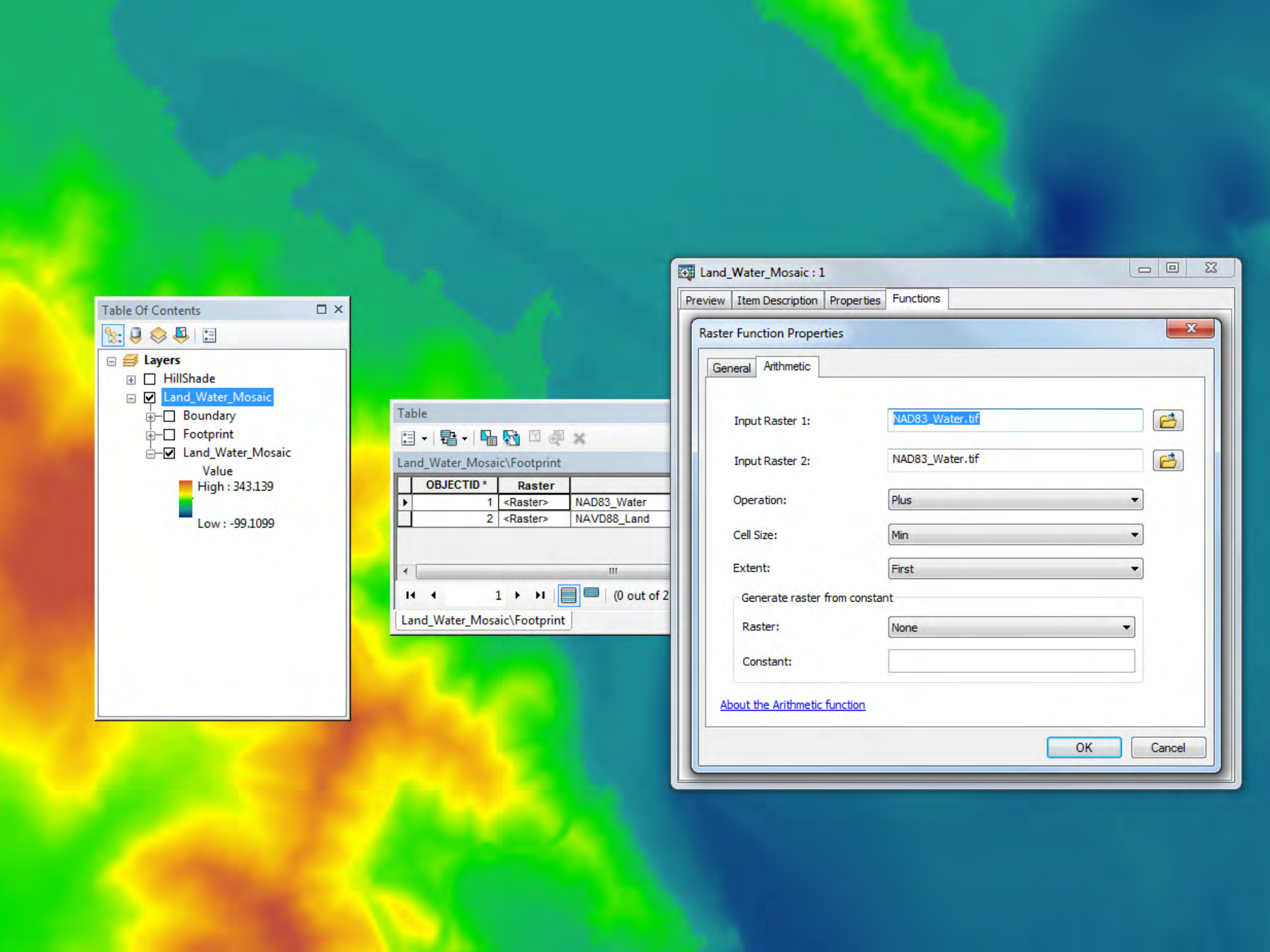
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Item Description
Properties
Functions
Raster Function Properties
General
Arithmetic
Input Raster 1:
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Input Raster 2:
NAD83_Water.tif
Operation:
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Cell Size:
Min
Extent:
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Raster:
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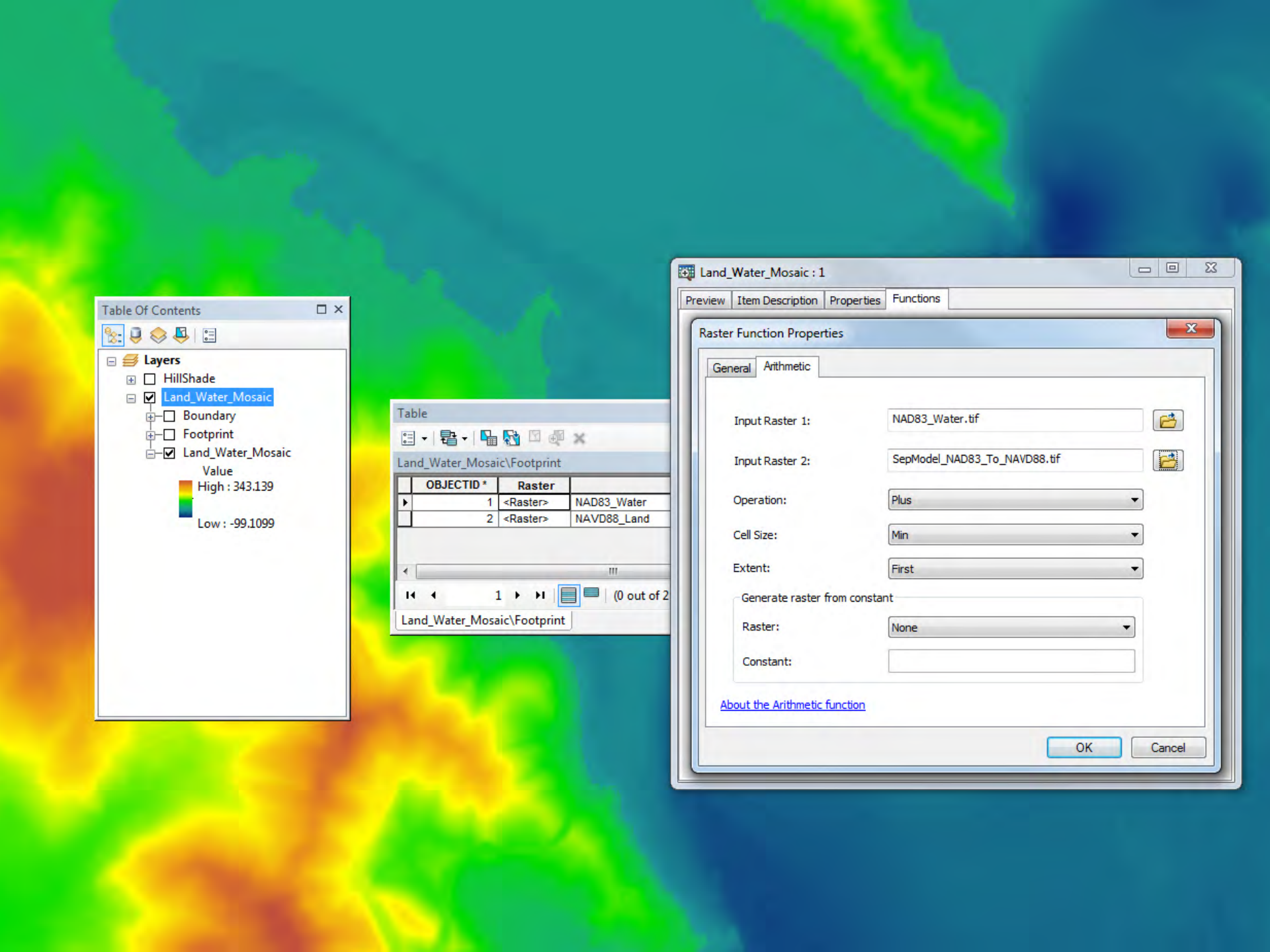
Constant:
About the Arithmetic function
OK
Cancel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Properties
Functions
Raster Function Properties
General
Arithmetic
Input Raster 1:
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Input Raster 2:
SepModel_NAD83_To_NAVD88.tif
Operation:
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Cell Size:
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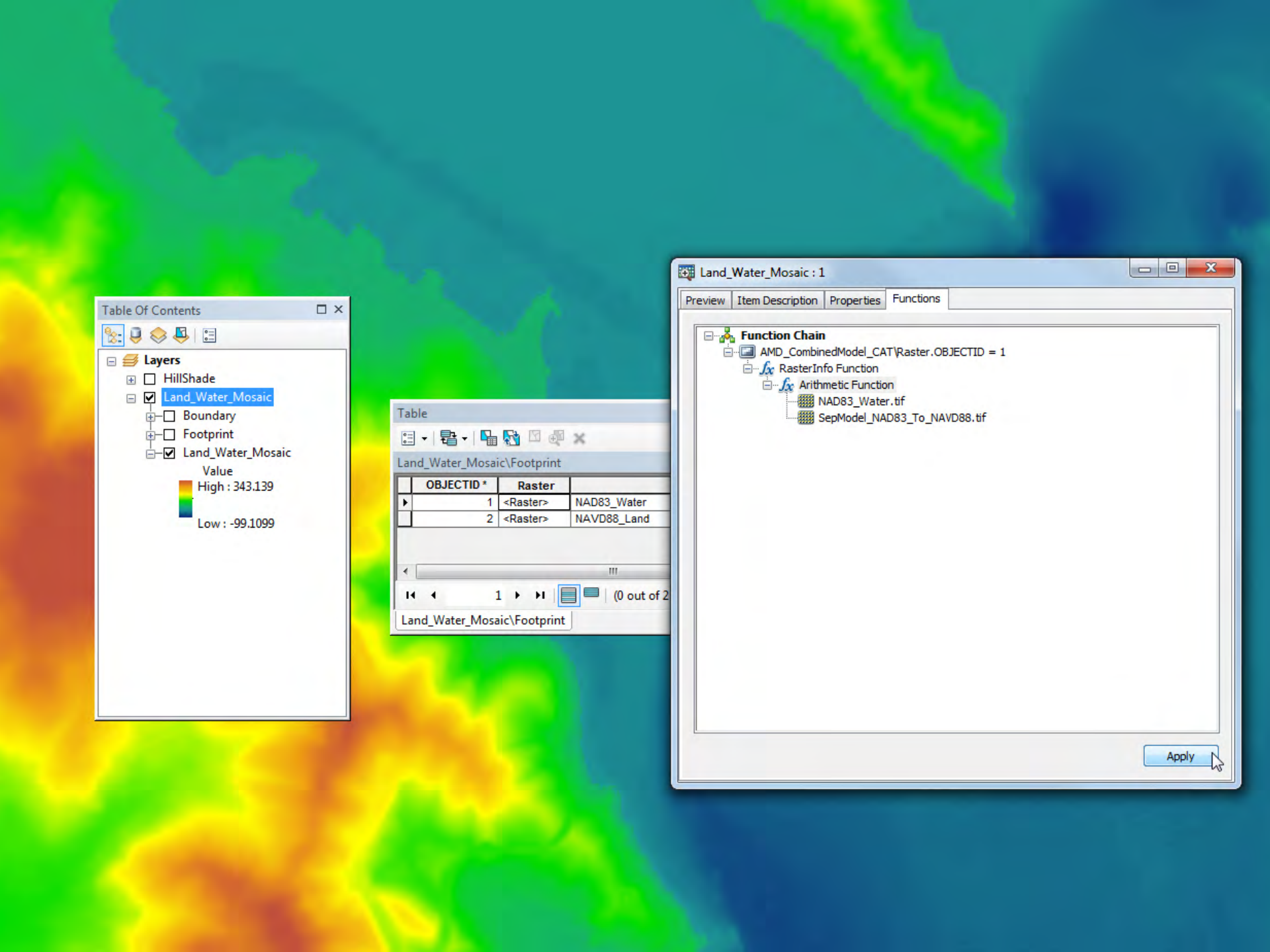
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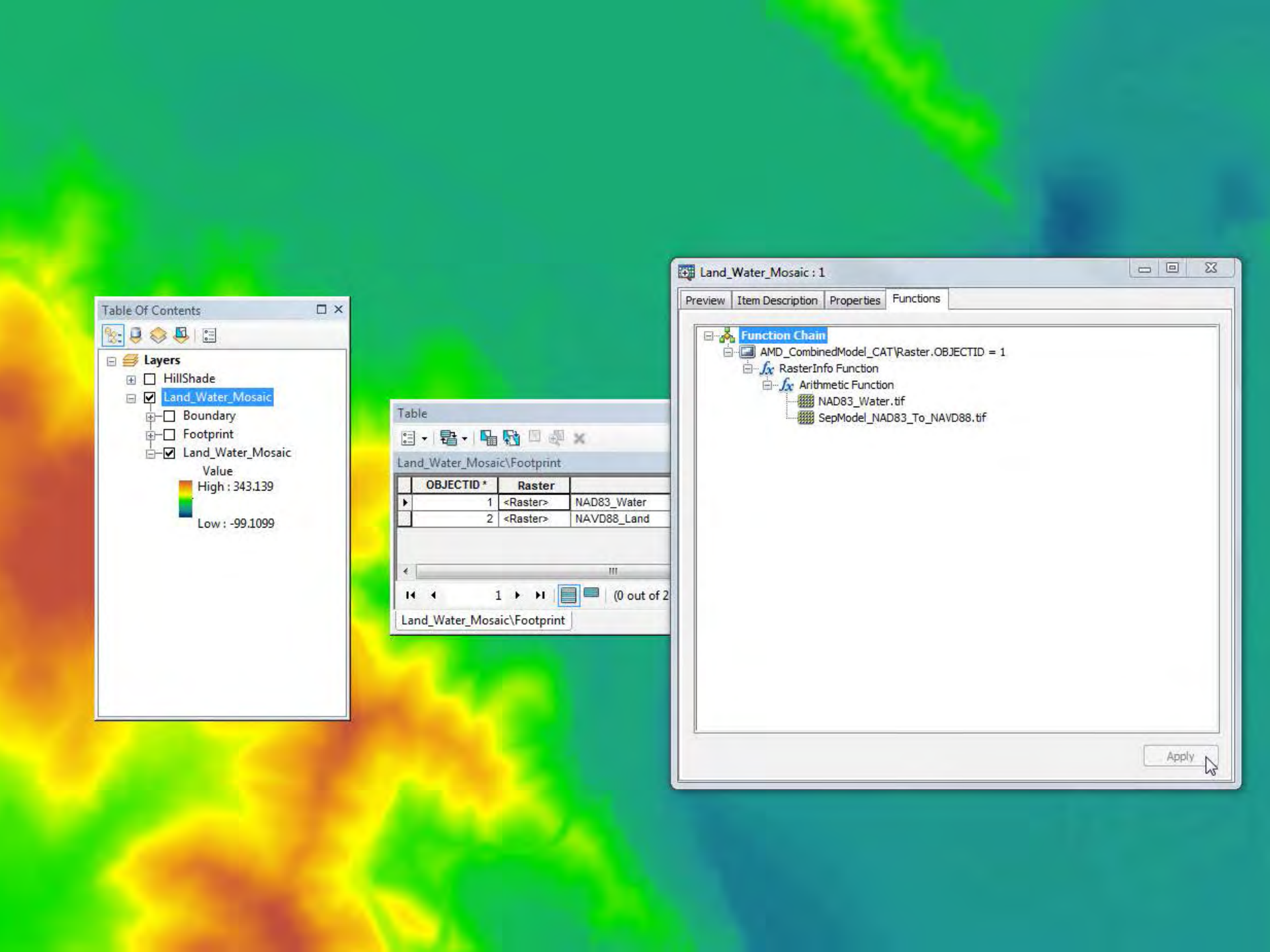
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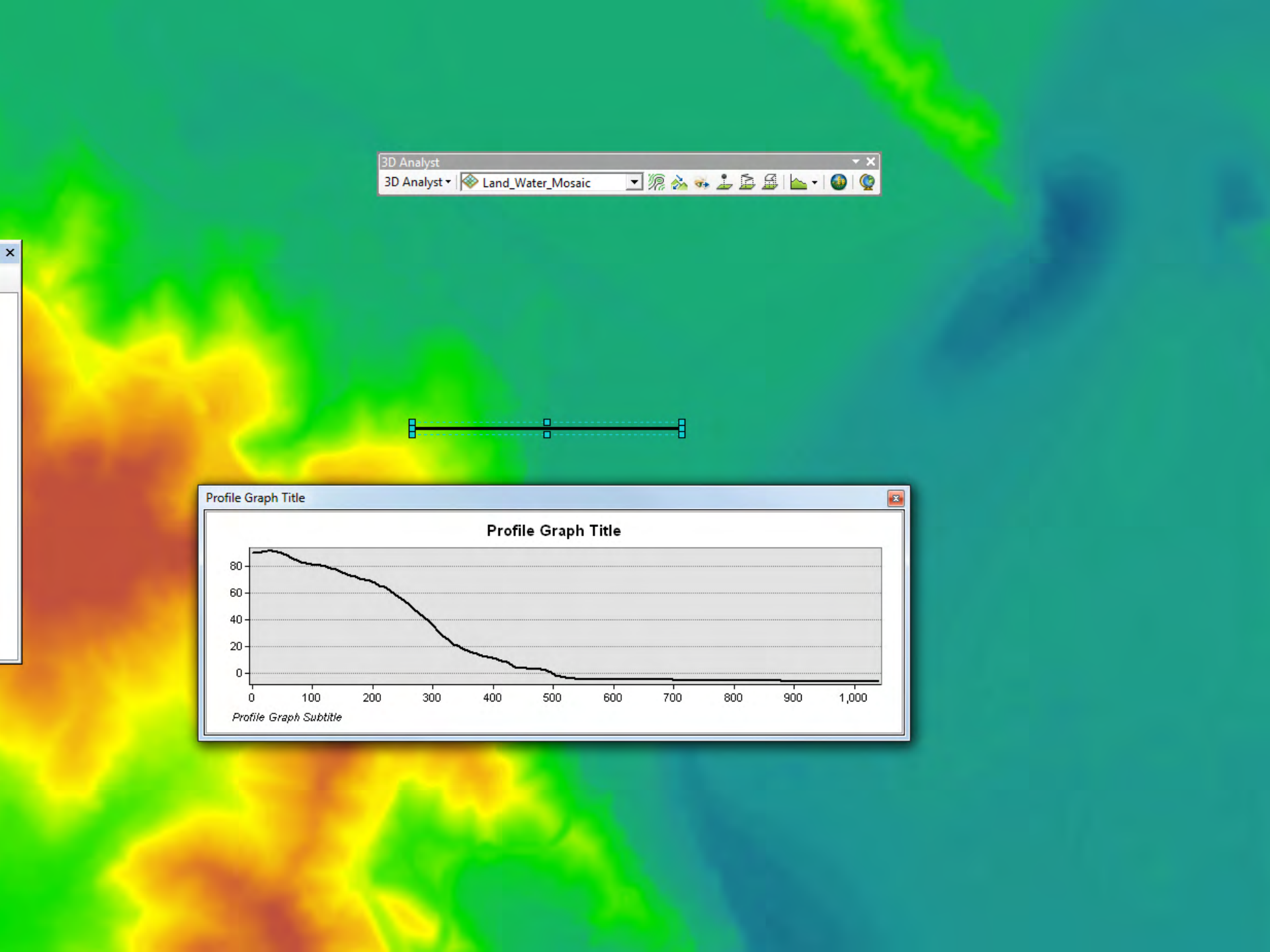
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3D Analyst
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Profile Graph Title
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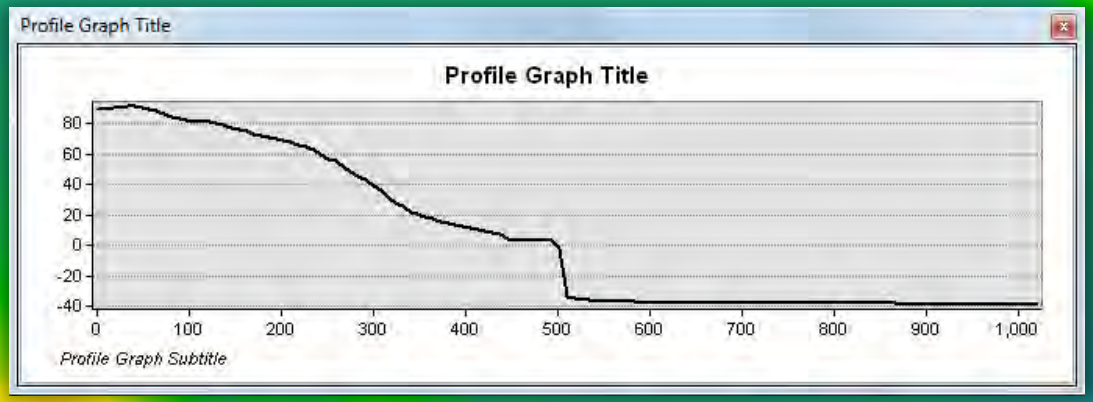
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Profile Graph Title
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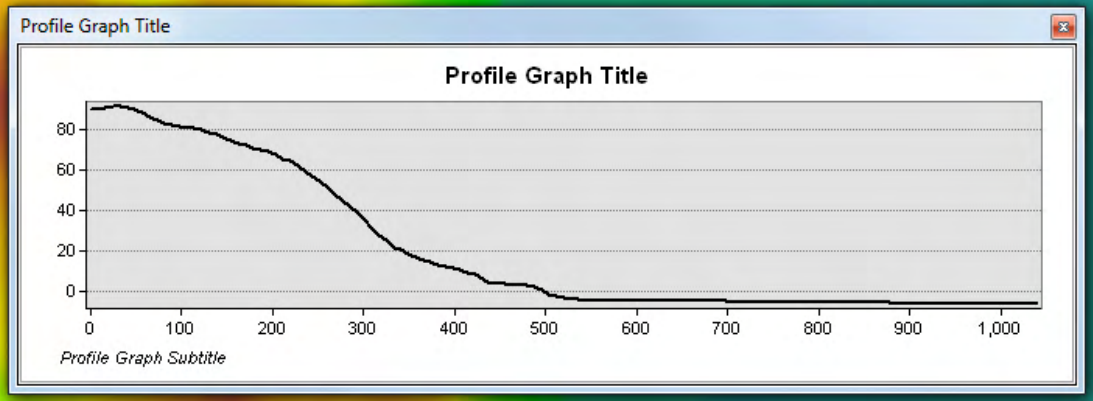
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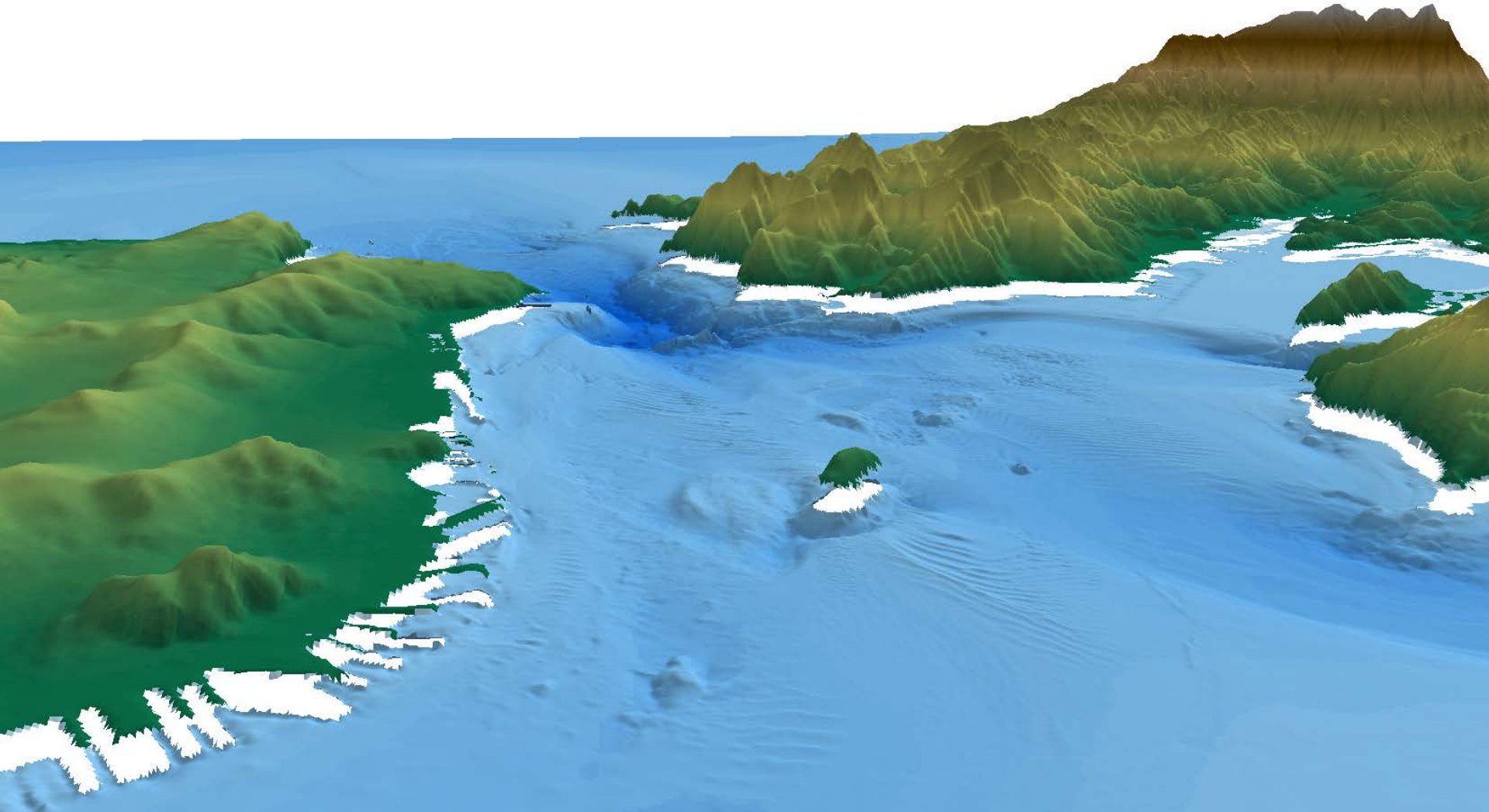
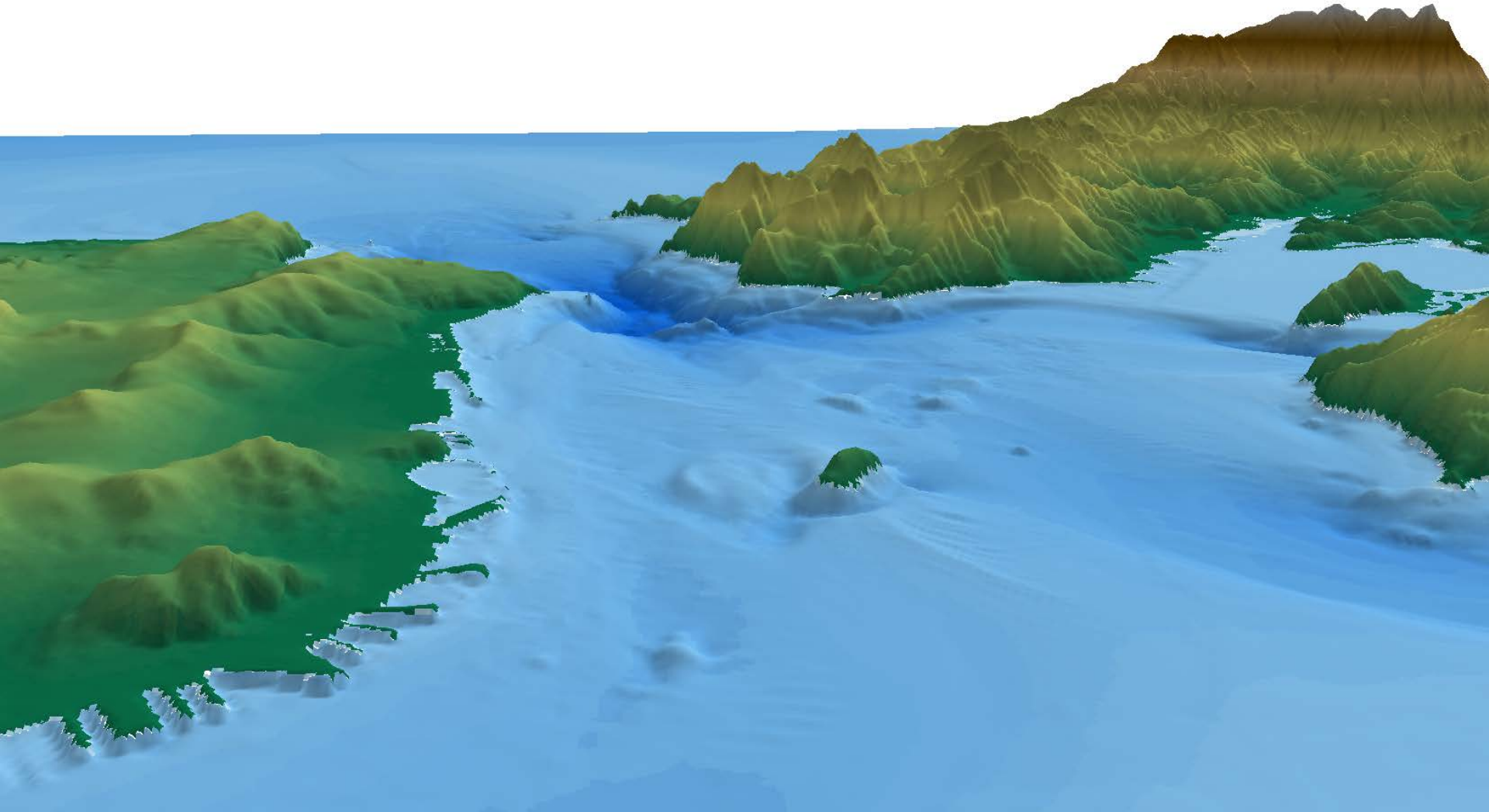
Land : NAVD 88
Water: NAD 83



Land : **NAVD 88**
Water: **NAVD 88**



Possible paths forward

- Easily extendable (local knowledge)
- Automated (metadata-driven)
- Crowd-sourced separation model data store
  - Cloud-based
  - Authoritative
  - Multi-resolution
  - Free

Closing thought

Always document vertical datum information in metadata

Understanding our world.