Historical Delta Elevation Model – Logic and Methods

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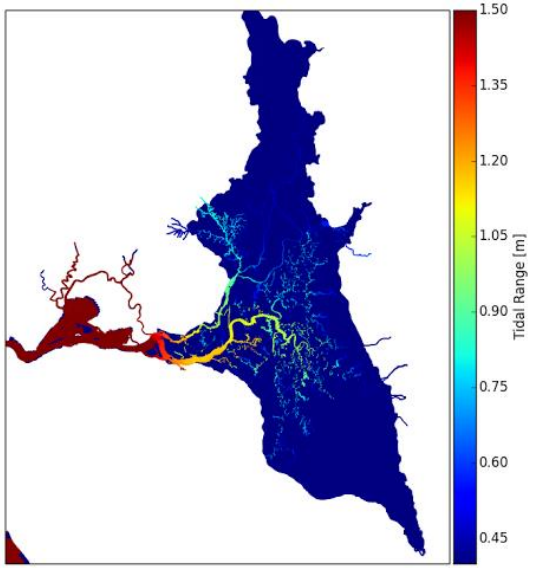
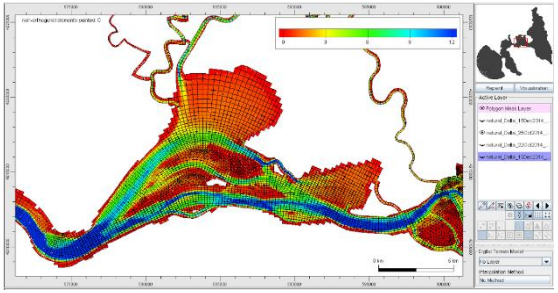
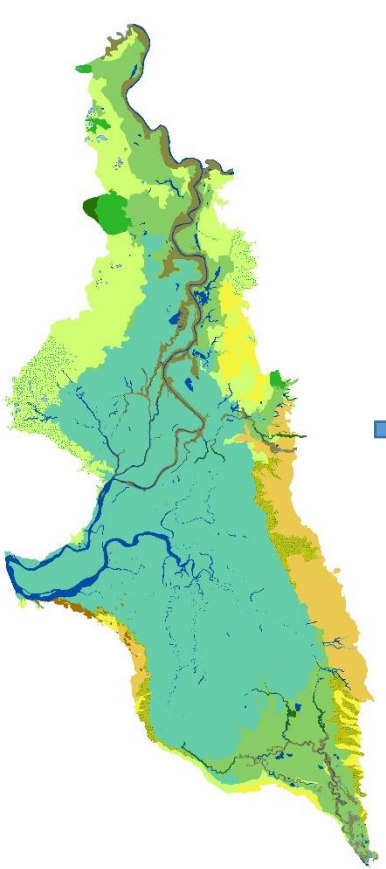
Overview

- **Goal**: Transform 2D data into a historical digital elevation model to gain insight to the natural Delta hydrology and hydrodynamics.
- **Applications**: Hydrodynamic changes, salinity intrusion, tidal marsh dynamics, estimated flood extents, visualizations



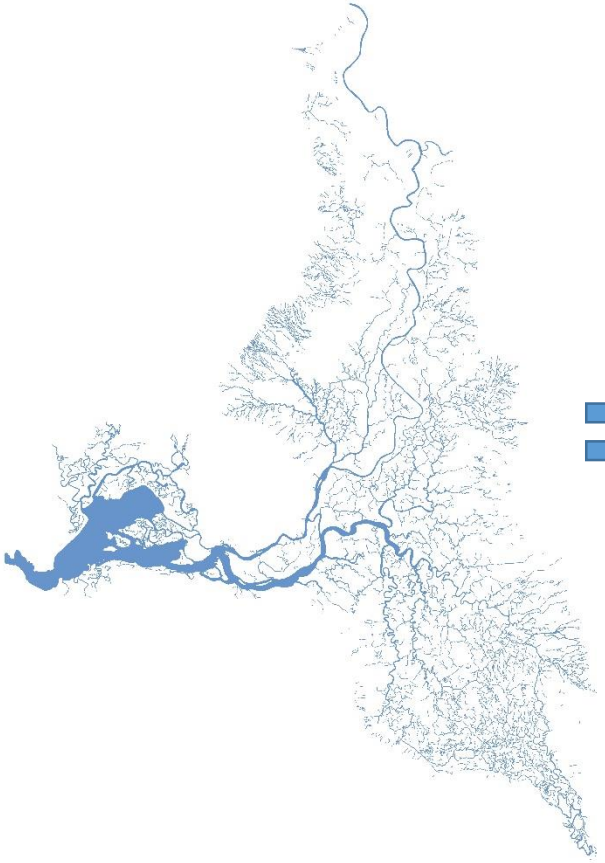


Big Picture



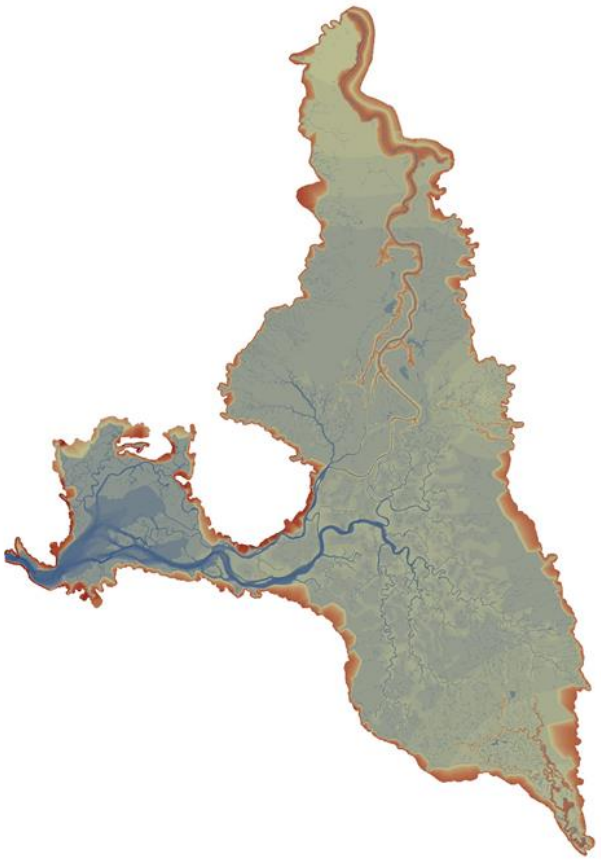
SFEI Historical Habitats

(Channels, tidal marshes, natural levees, etc)



Historical Bathymetry

(primary source depths, interpolation)



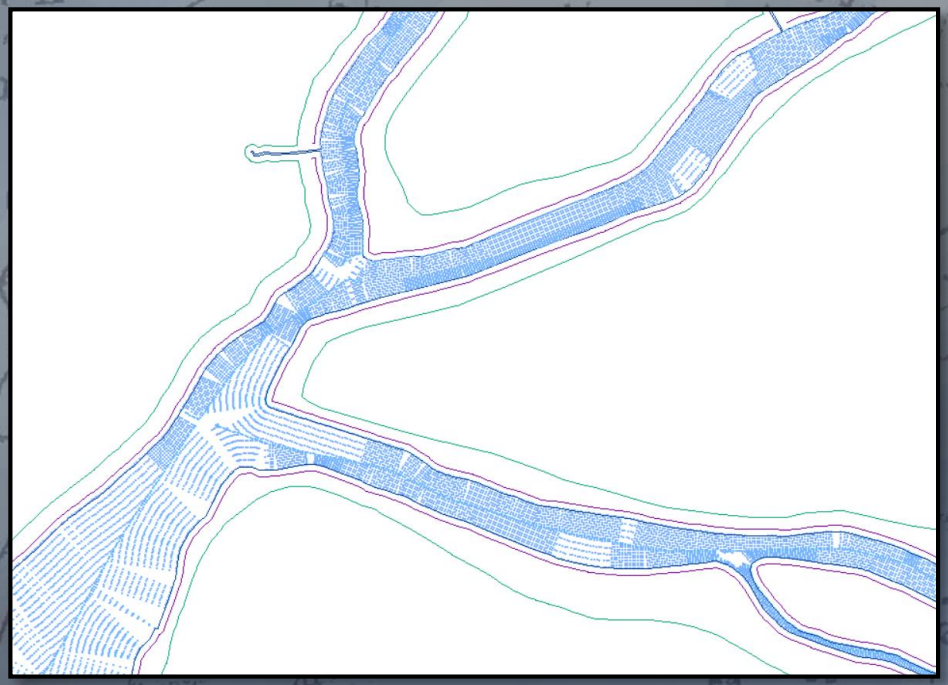
Historical Elevation Model

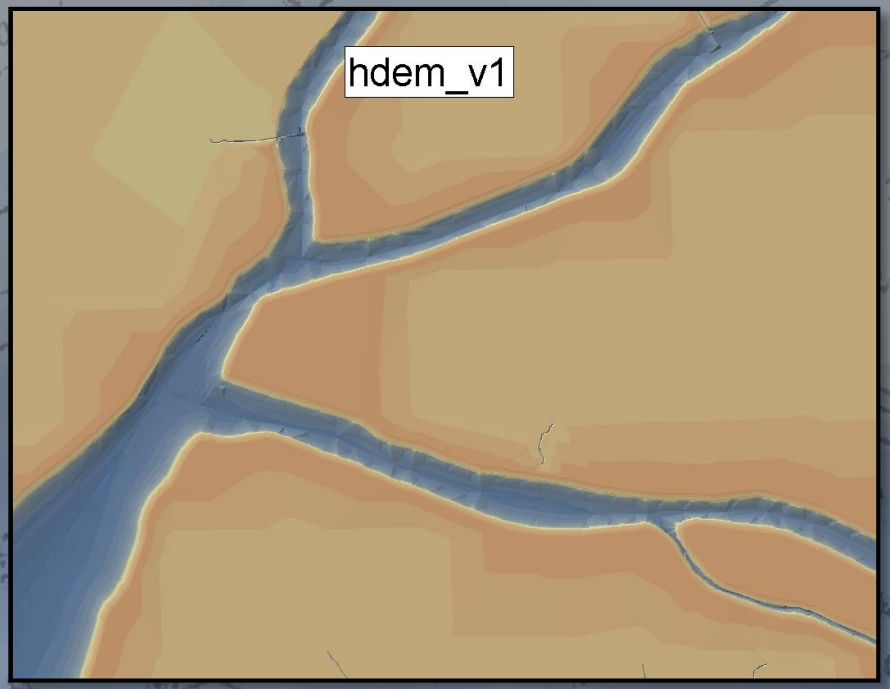
2D -> 3D

- Triangular irregular network (TIN)
- Vector-based surface morphology that is made by triangulating sets of vertices to create a network of triangles.

Pros	Cons
Takes many inputs (pts, lines, polys)	Use outside GIS world limited – often needs to be converted to raster
Flexible and editable	Sparse data can cause interpolation artifacts

TIN Flexibility



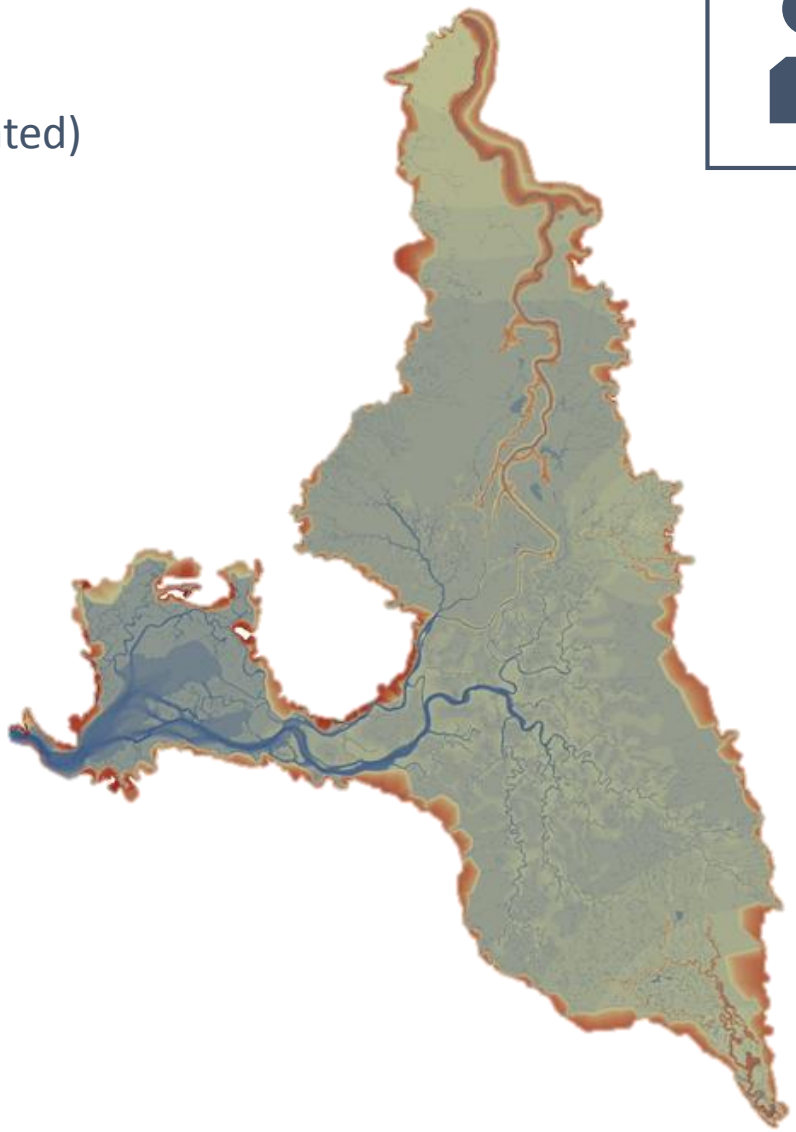


Cache – Steamboat – Sacramento confluence

- Preserves all the precision of the input data while simultaneously modeling the values between known points
- Higher resolution in areas where a surface is highly variable or where more detail is desired and a lower resolution in areas that are less variable

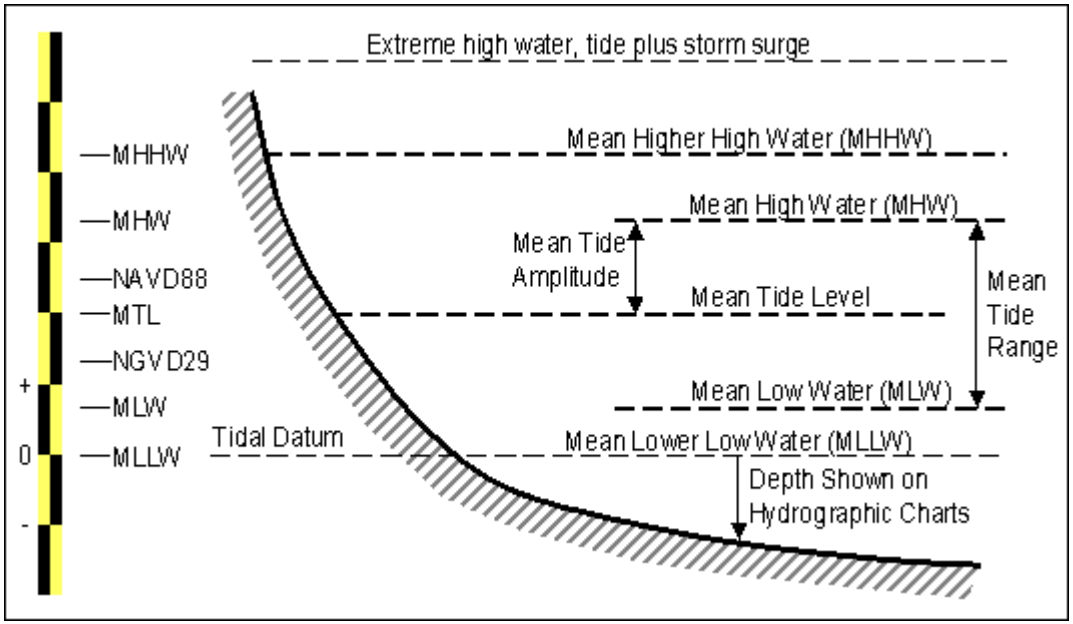
TIN Inputs

- Water Edge
- Bathymetry (interpolated)
- Thalweg
- Tidal Marshes
- Natural Levees
- Tidalsheds
- Tidal Ponds



line
point
polygon

Tidal and Geodetic Datums



Local Elevation

- MLLW or MHW

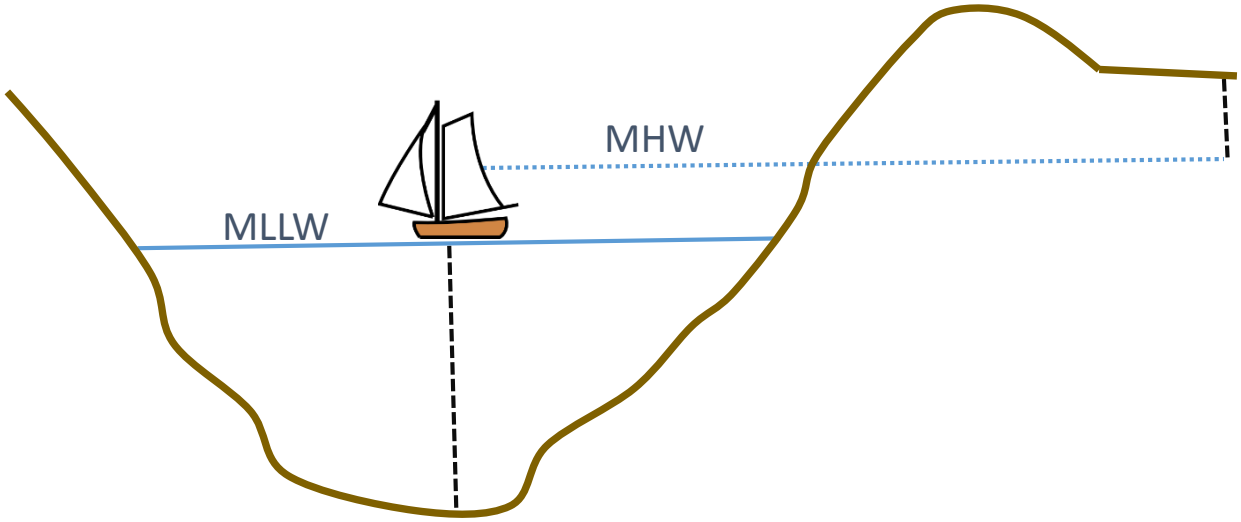
Conversion surface

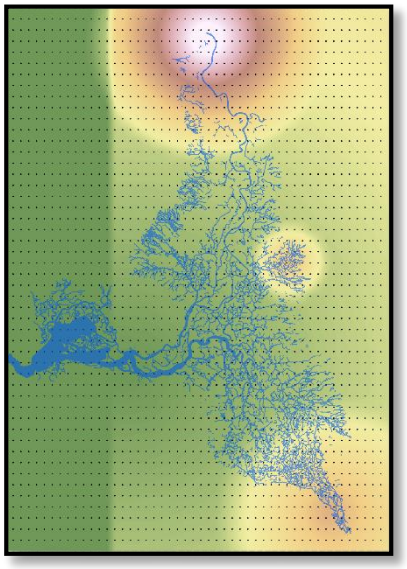
- Modeled values for tidal values throughout Delta

NAVD88

- All features need to have an elevation in NAVD88

Datum Conversion Surfaces





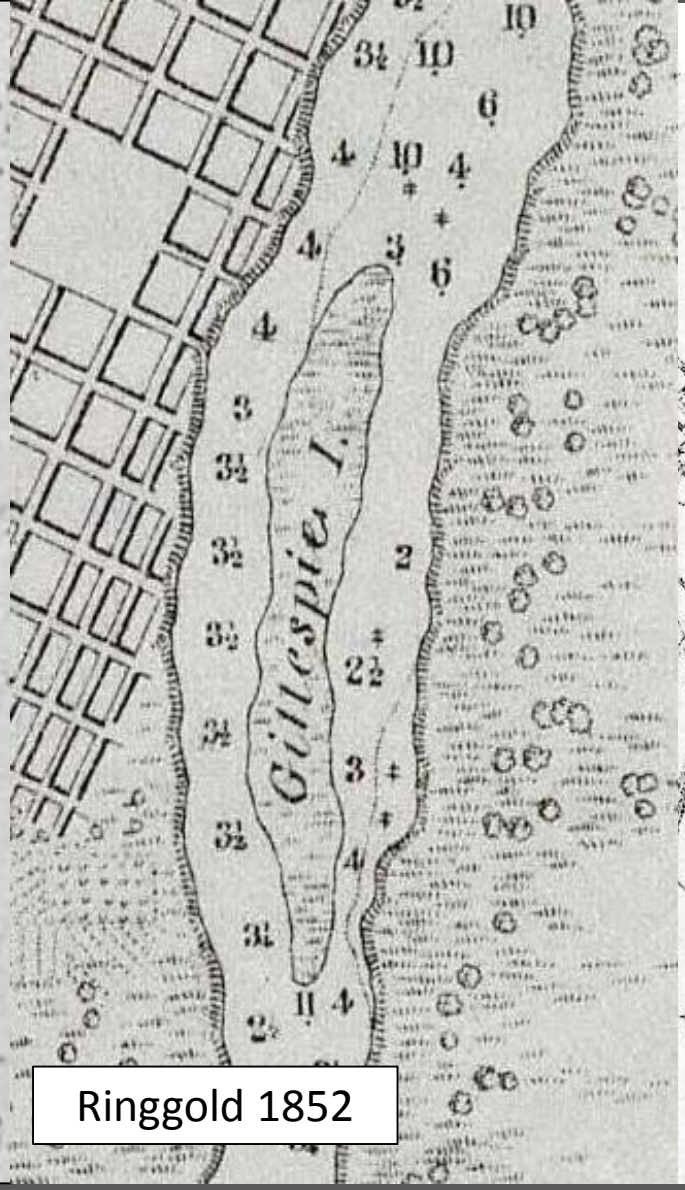
MHW surface

- Modeled historical MHW and MLLW layers
- Soundings and elevations adjusted from reference surface
- Values take from historical tidal observations

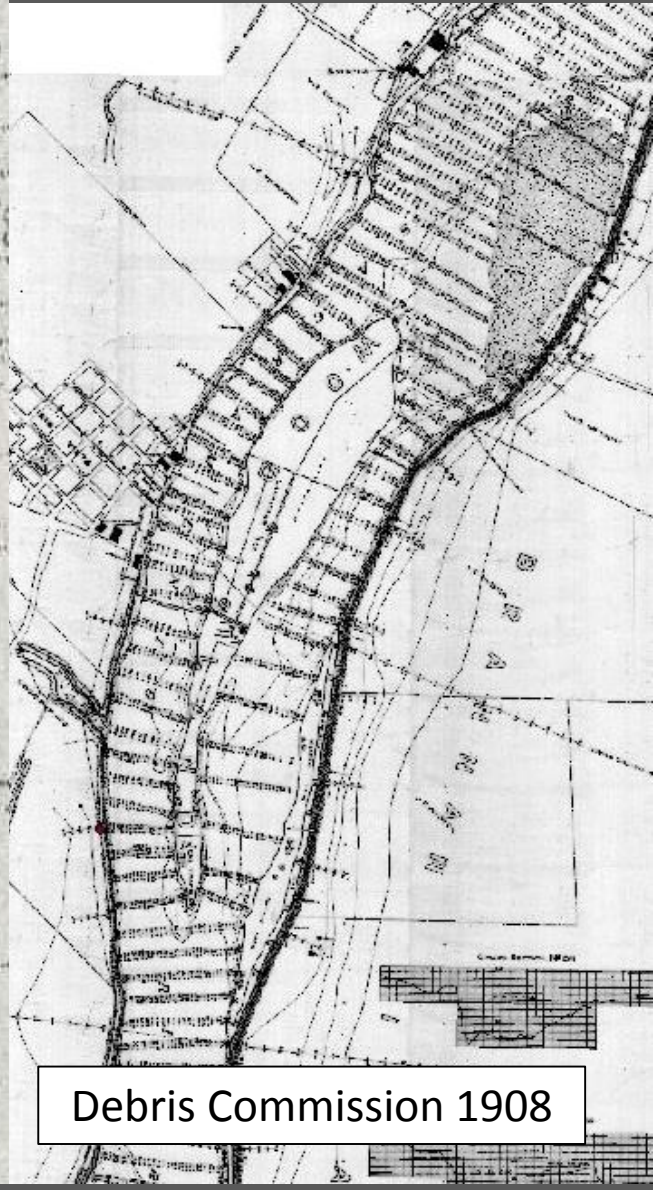
  "Water takes an hour longer getting to the head of Staten island travelling up the South Fork"

- Natural neighbors interpolation of point grid

Gibbes 1850



Ringgold 1852

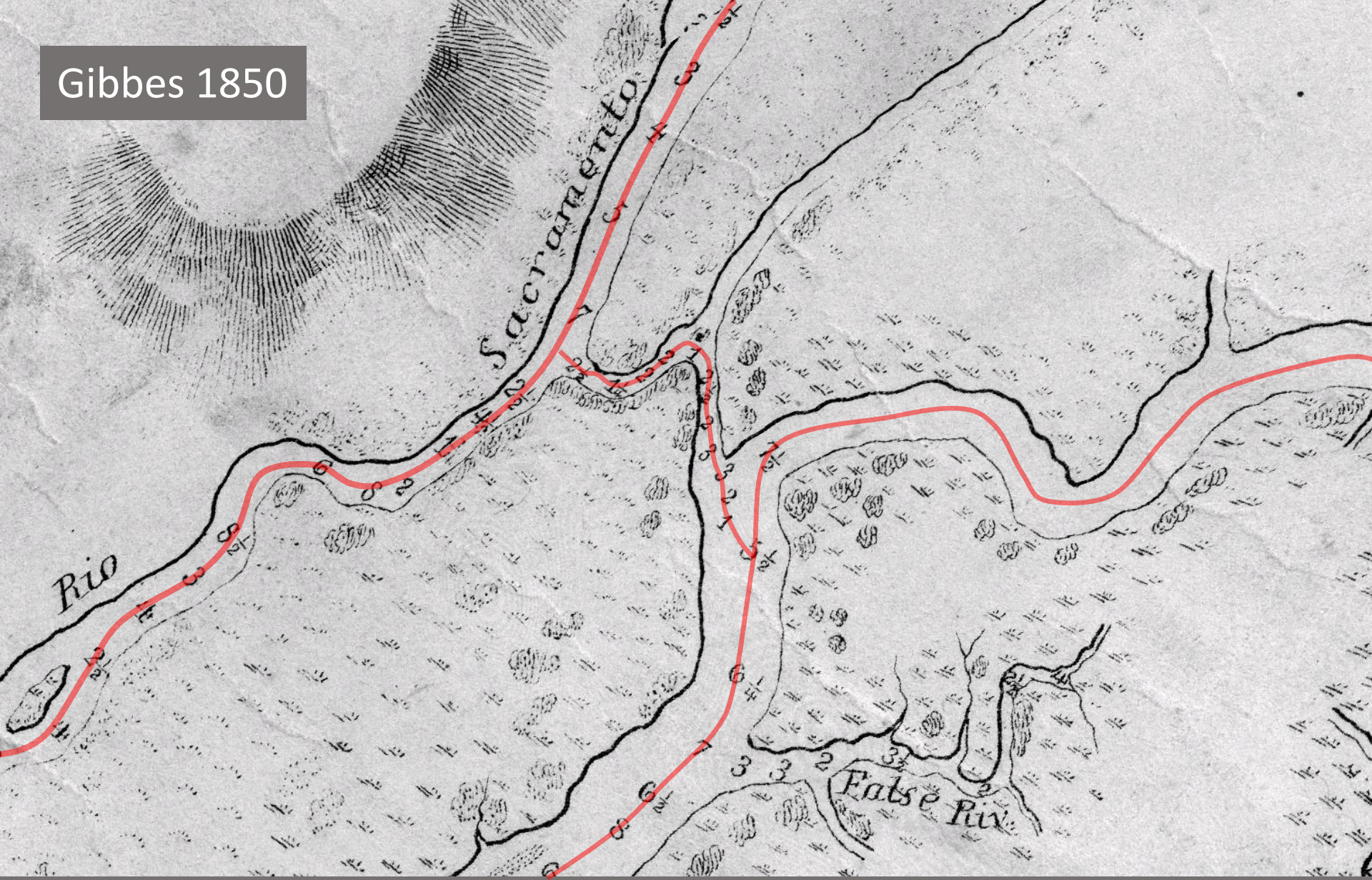


Debris Commission 1908

Historical Bathymetry Interpolation

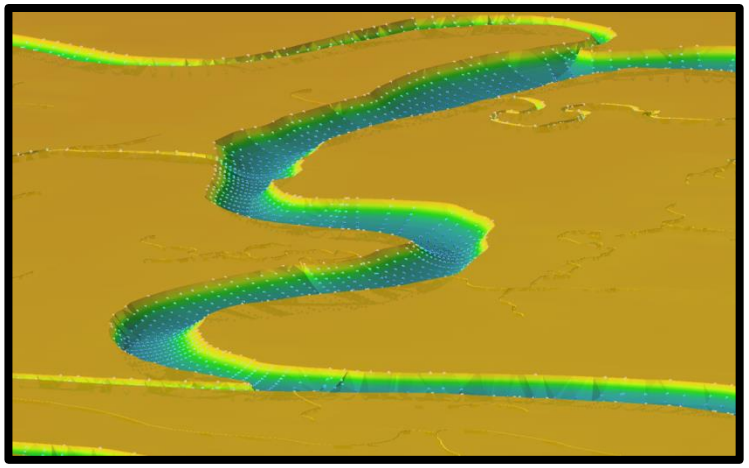
Spline - thalweg

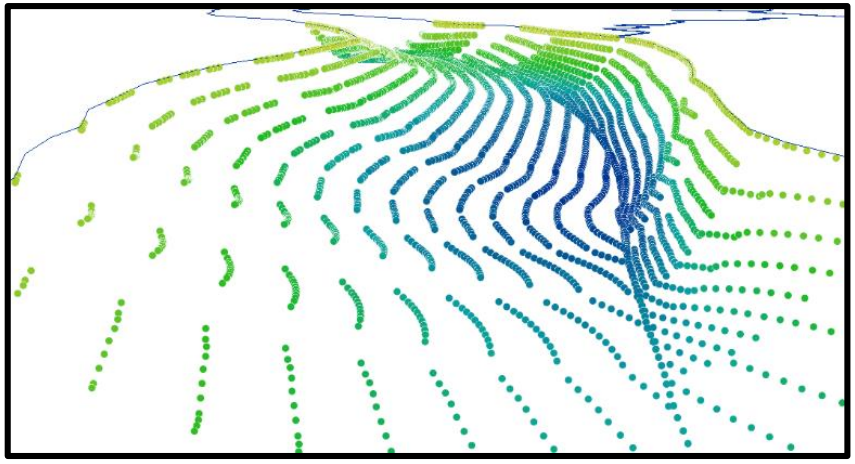
- R script - Cubic spline interpolation along thalweg
- Use: major channels with single depth (assumed deepest part of the channel)
- Python script – creates cross sections with elevations set using a parabola formula



Intermittent soundings – thalweg depth only

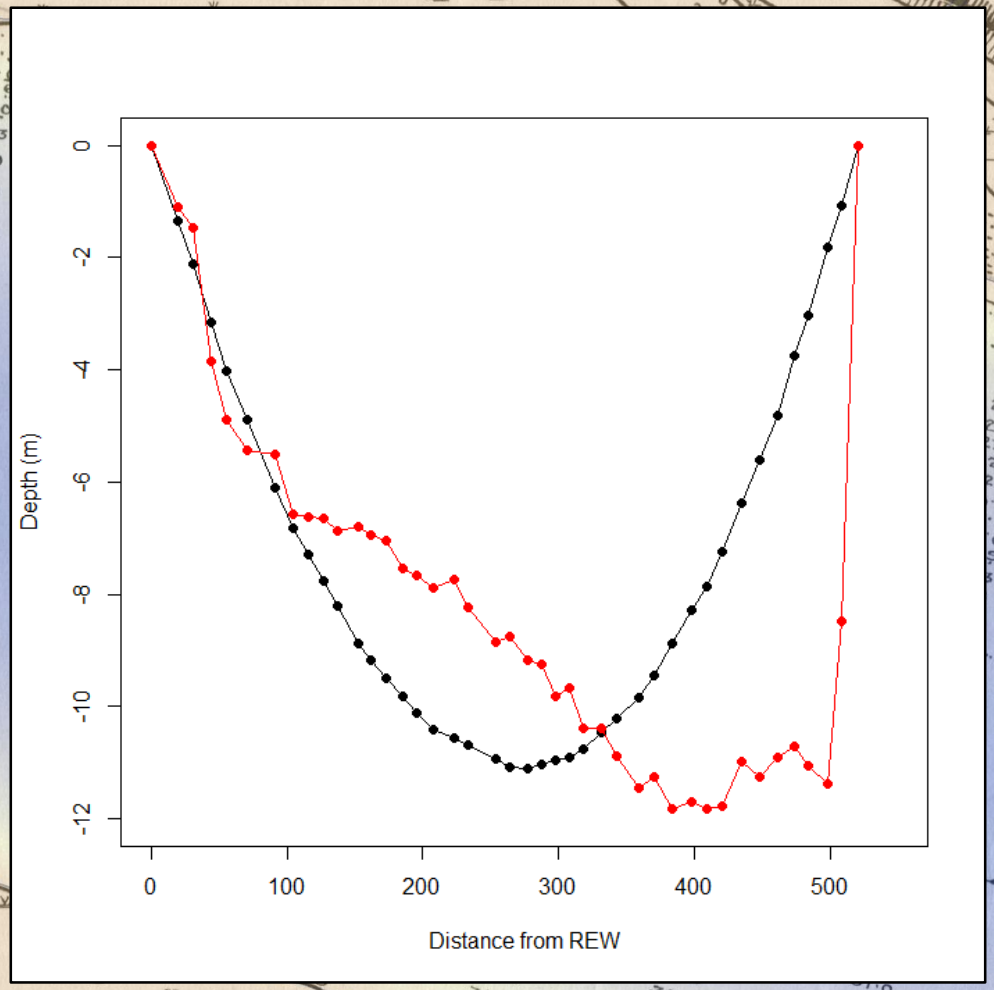
Parabolas





$$Depth_i = \frac{Bank_z - Thalweg_z}{Distance_{3d}{}^2} \times i^2 + Thalweg_z$$

Parabolic Channel Shape



Red: 1908 Debris Commission SH09 cross section

Depth Width Regression

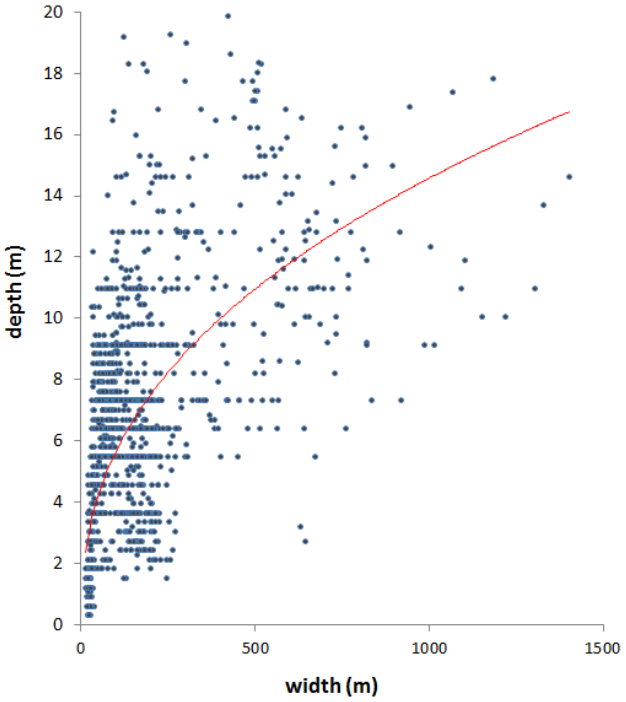
- Thalweg depth set using a regression equation using channel widths
- Channel structure set using an parabola shape
- Use: small channels with little or no historical soundings

all channels

channels with soundings

NUMBER OF SOUNDINGS	
Debris Commission	762
Gibbes 1850	199
Ringgold 1850 2a	97
Ringgold 1850 2b	426
TOTAL	1484

Extrapolating the depth of channels without sounding data based on their width

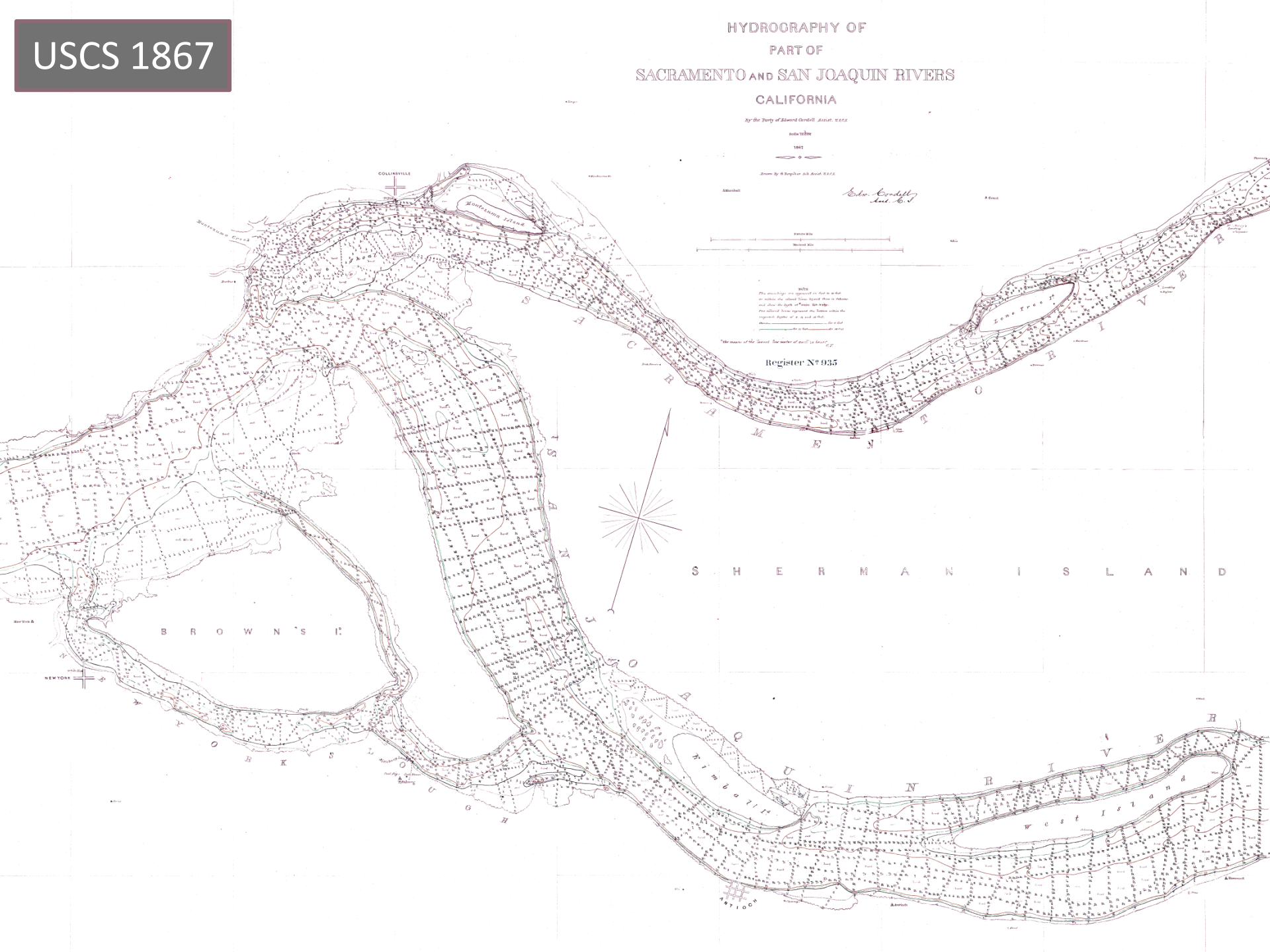


$$MLLW_{depth} = 0.8516 \times width^{0.411}$$

Topo to Raster

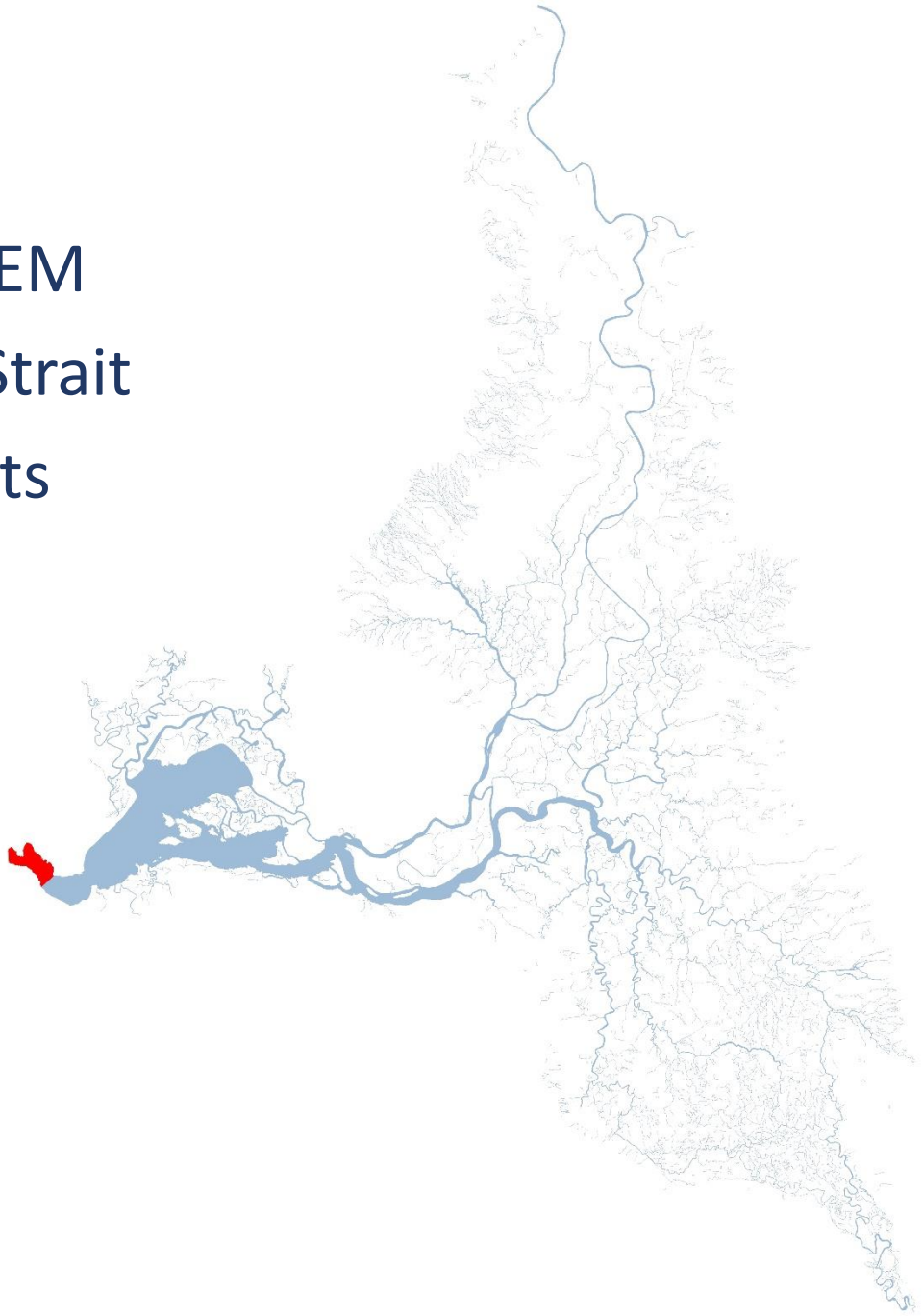
- ArcGIS tool - based on ANUDEM (Australia's continent-wide DEM)
- Interpolates a hydrologically correct raster surface from points and contours
- Used with dense data that has contour lines

USCS 1867

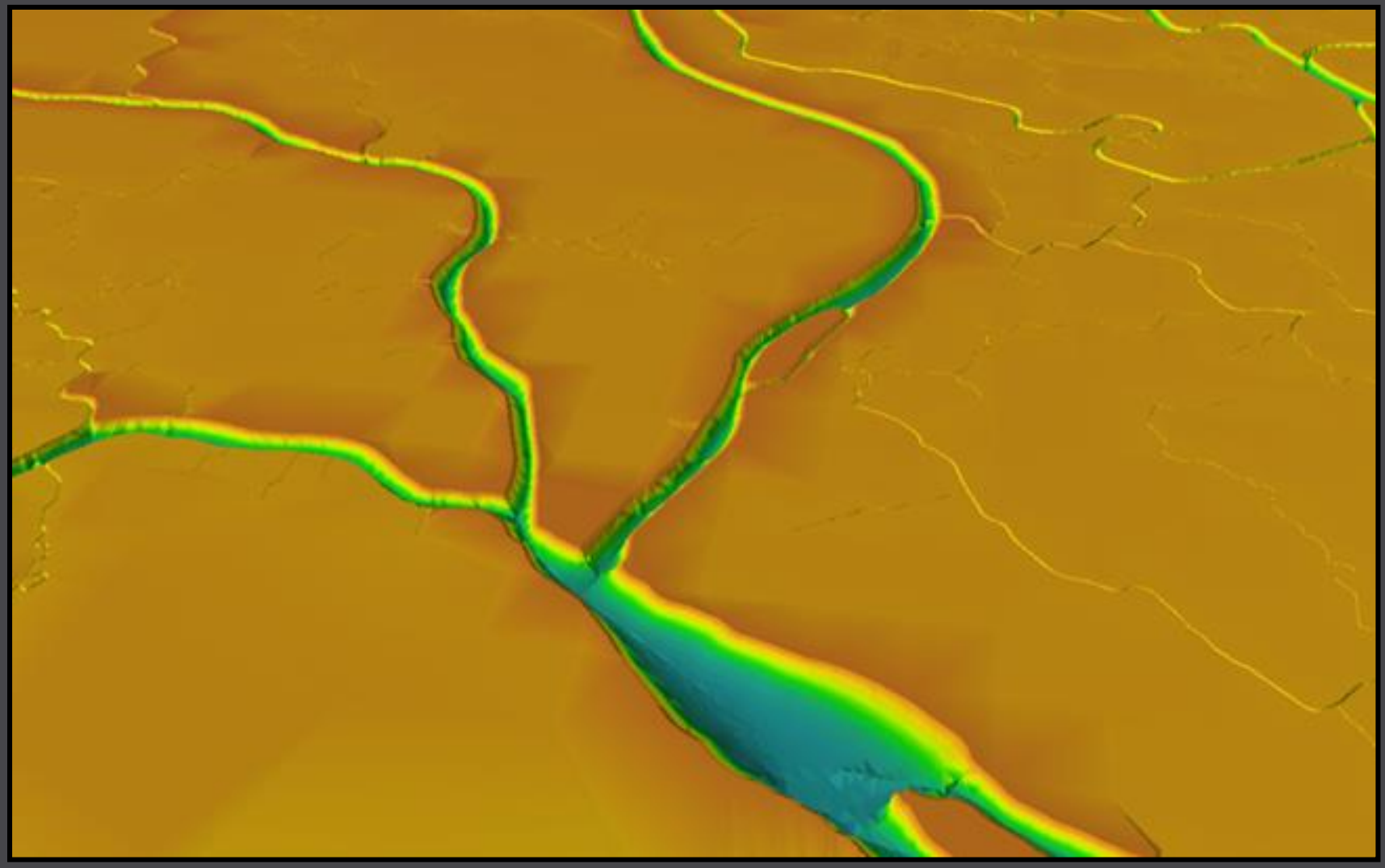

HYDROGRAPHY OF
PART OF
SACRAMENTO AND SAN JOAQUIN RIVERS
CALIFORNIA
Register № 935
COLLINSVILLE
Montezuma Island
SACRAMENTO RIVER
SHERMAN ISLAND
BROWN'S I.
NEW YORK
NEW YORK SLOUGH
SAN JOAQUIN RIVER
Kimball's
West Island
ANTIOCH

Modern DEM

- DWR 10m Bay – Delta DEM
- Transition at Carquinez Strait
- Values extracted as points

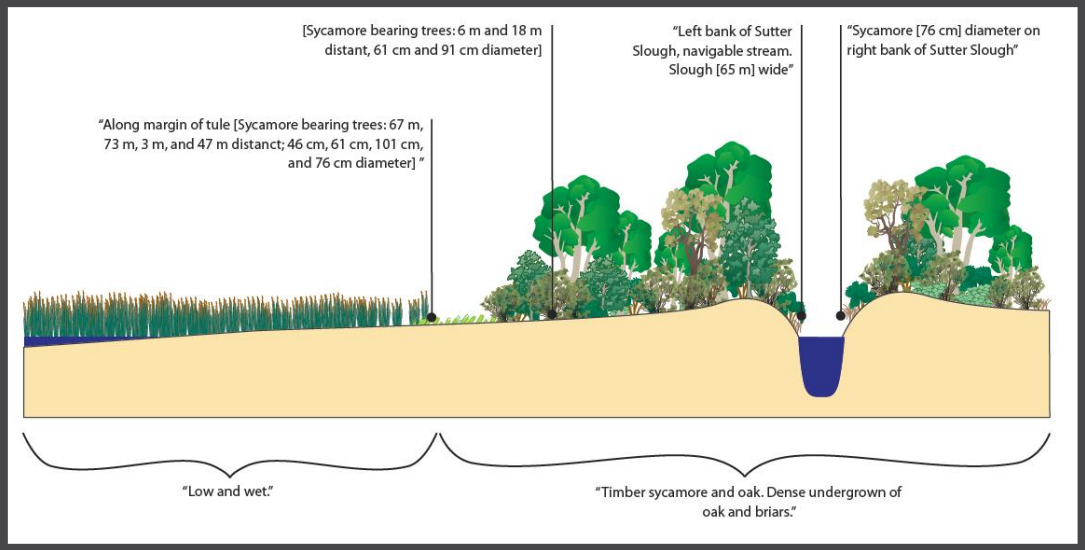


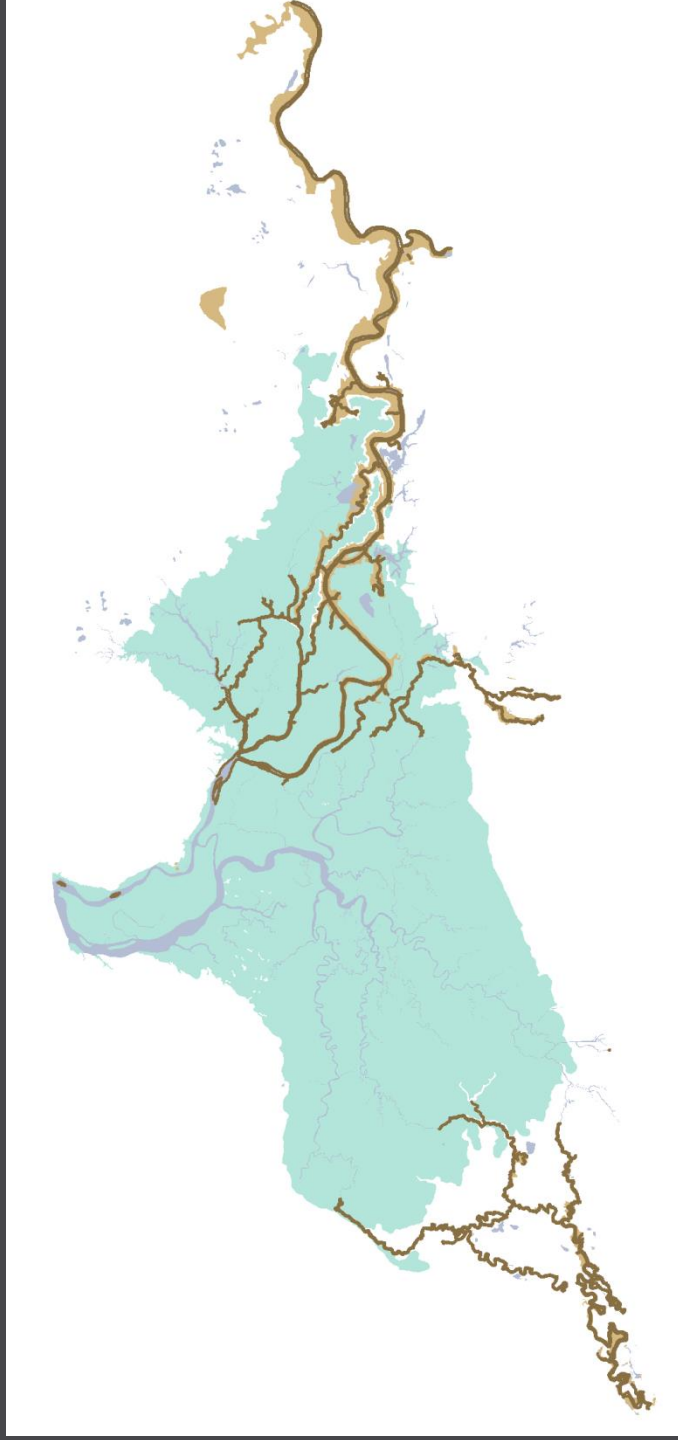
Putting it all together…

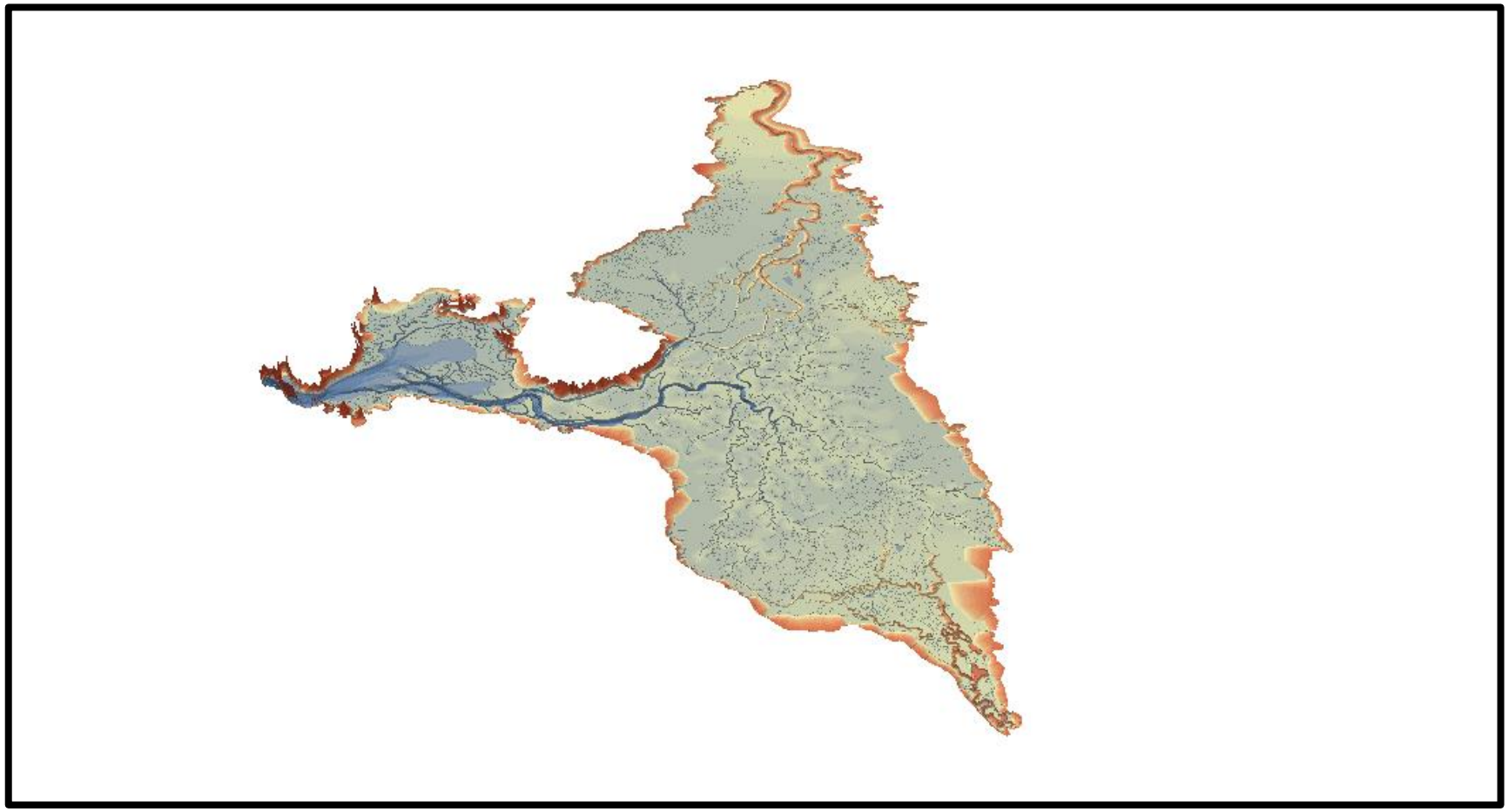


Natural levees

- Using natural levee crests and marsh elevation to capture height and basic side slope
- Setting where water can move and where it can’t on a tide



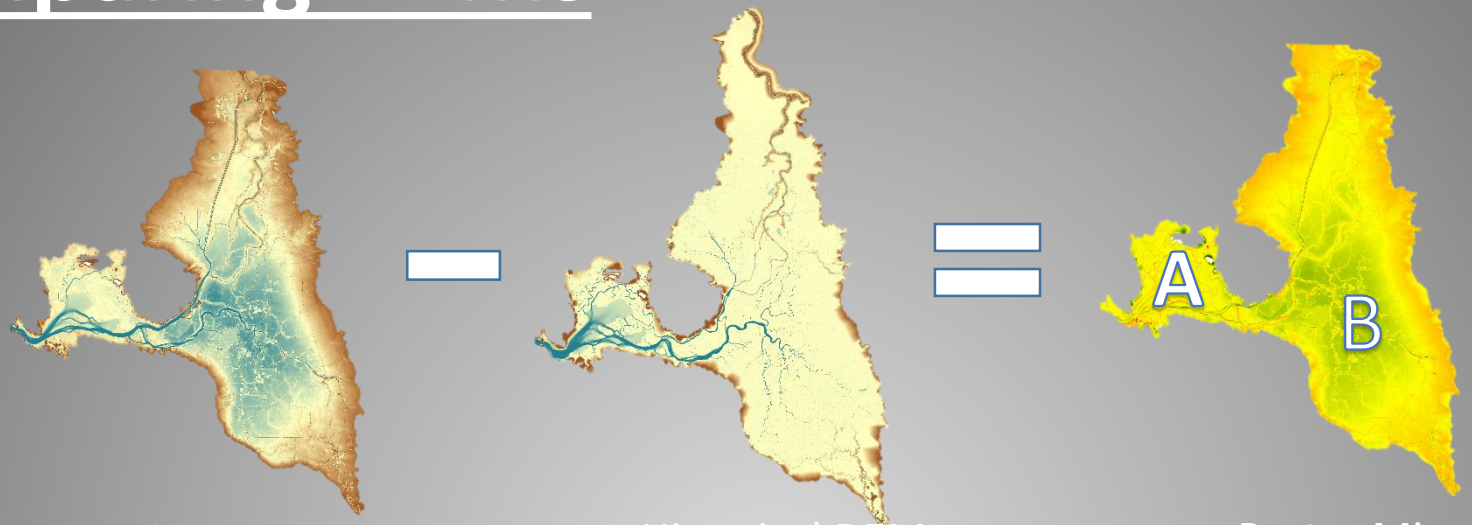




Historical DEM

1. Use the data that you have
2. Single method does not work
3. Elevation surface is flexible – iterative runs
4. Avoid excessive digitization
5. It's a model…..

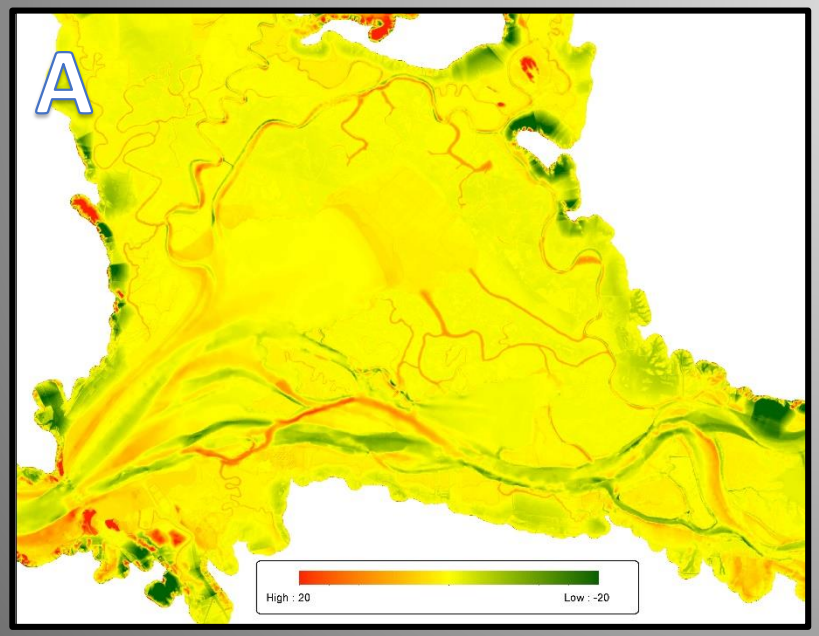
Comparing DEMs

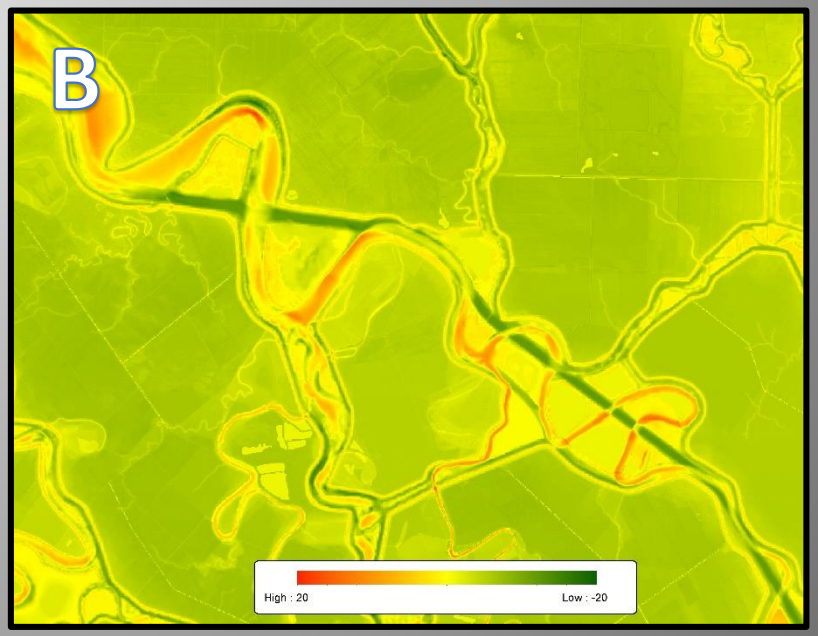


Modern 10m DWR

Historical DEM

Raster Minus





Demo

Before After Slider:

http://andybell.github.io/projects/hdem_slider.html