

Paleo Basemap to investigate Flooding Patterns and Geomorphic Change from the Bridge of the Gods Flood 550 Years Ago



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INTRODUCTION

We seek to create an accurate paleo-basemap to better understand the flood mechanics of the Bridge of the Gods Outburst Flood.

- The Bonneville Landslide dam, also known as the Bridge of the Gods, blocked the Columbia River about 550 years ago at the site of the modern Bonneville Dam, on the Washington-Oregon border.
- In ArcGIS, we fill in data holes and modern channels, and subtract modern structures, in an attempt to accurately represent the paleo-environment.

What evidence do we have for the Bridge of the Gods Outburst Flood?
What are the obstacles for creating an accurate paleo-basemap?

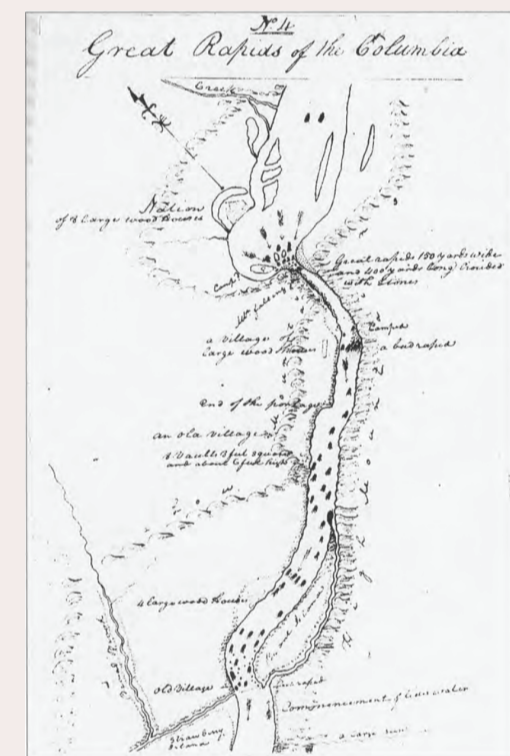
BACKGROUND

Indigenous Lore:

- According to the Klickitat Lore, the Bridge of the Gods (Bonneville Landslide) was created by the Chief of all Gods to join the lands North and South of the river.
- The dam's failure, thought to be a result of the violent dispute between the chief's sons, led to an outburst flood that drowned a forest and carved the Cascade rapids.
- Daniel Lee (1844): "The [Native Americans] say these falls are not ancient, and that their fathers voyaged without obstruction in their canoes as far as The Dalles."

Lewis and Clark Journals (1805):

- Noted the Cascade Rapids relationship to slide debris from Bonneville Landslide.
- Noted the submerged forest of the Columbia: "a number of stumps at some distance in the water."



Dating the drowned forest:

- Donald Lawrence:
 - Tree ring dating (1934): Trees killed before 1730 (later; AD 1562).
 - Radiocarbon dating (1958): results from two stumps estimated tree's death 670+/-300 yrs B.P. and 700+/-200 yrs B.P.
- Modern Findings:
 - Trees died between 1421-1447 (nine analyses from 3 trees).

Sediment Evidence:

- Images courtesy of Jim O'Connor



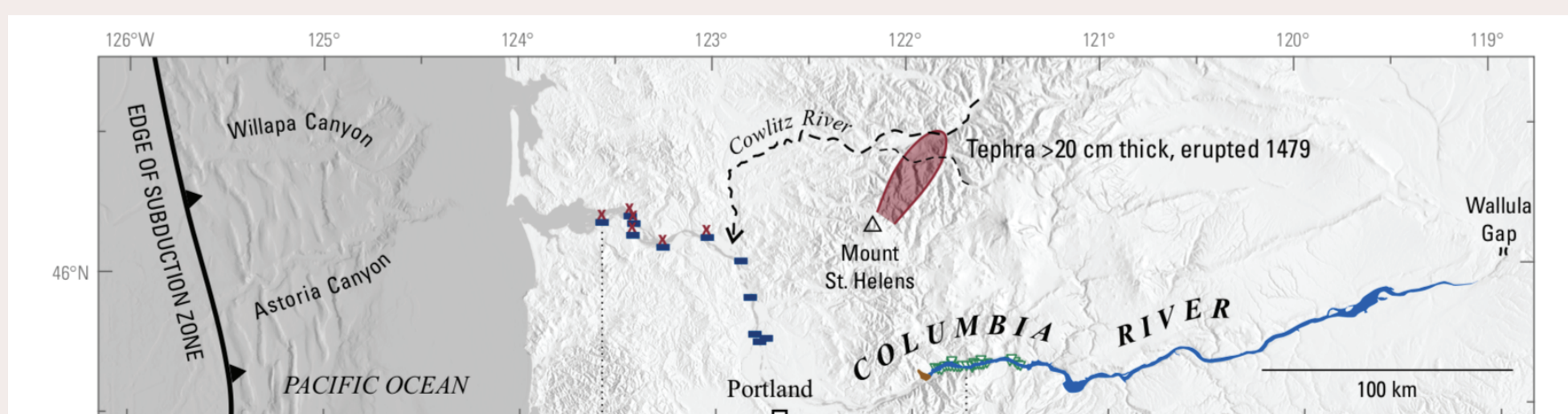
~100 km downstream of breach, Sauvie Island, OR



Hills above The Dalles (85 m asl)



Herman Creek delta into Lake of the Gods (35 m asl)

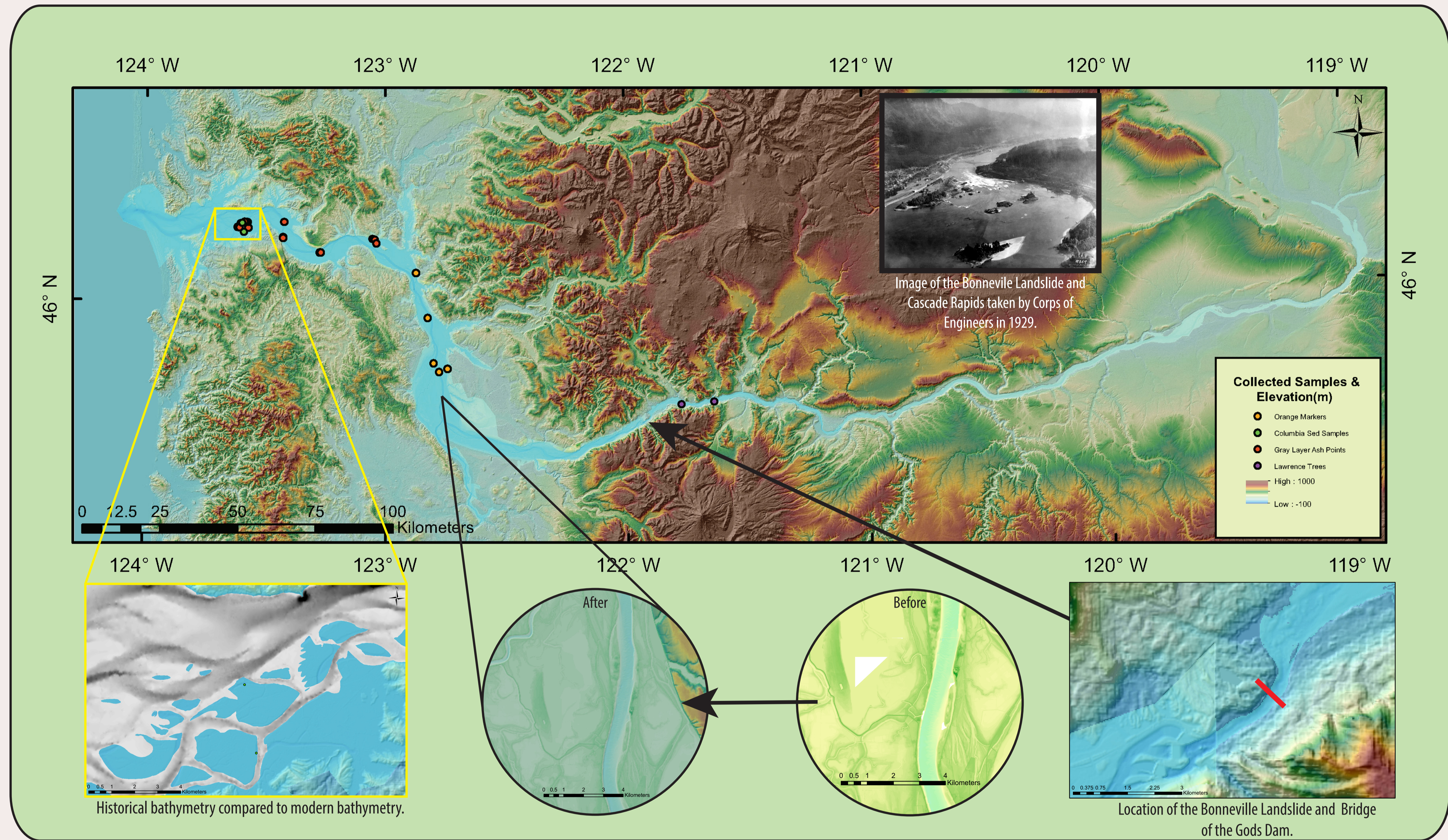


Flood deposits = coated plains and wetlands. Below the Cowlitz River they were later covered by waterflood ash derived from a 1479 eruption.

Bonneville landslide = impounded a lake in which forests were drowned, probably after 1425 and before 1450.

(Map courtesy of Brian Atwater)

PALEO-BASEMAP/RESULTS



METHODS

The paleo-DEM combines three data sets:

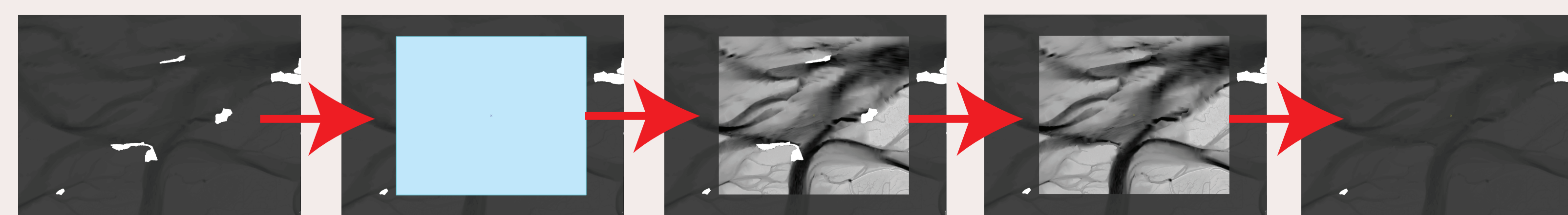
- Lower Columbia Digital Terrain Model with combined bathymetry/topographic data derived from bathymetry surveys and LiDAR (2010).
- Bathymetry of the Lower Columbia River with removed modern structures in Portland, validated by tide records from 1853 to 1876.
- Bathymetry upstream from the Bonneville Dam, merged with adjacent topography and derived from NOAA data.

Filling Void Workflow:

- Create new polygon shapefile
 - NAD_1983_UTM_Zone10 Projection
- Editor toolbar: Create Features
 - Draw rectangle around void, save/end edits
- Clip (Data Management Tool)
 - Input Raster: 'Raster DEM' b. Output Extent: 'Polygon Shapefile'
- Raster Calculator for clipped DEM
 - Con(IsNull(Raster), FocalStatistics(Raster, NbrCircle(100, "CELL"), "MEAN"), Raster)

Merging into one DEM:

- Mosaic to New Raster (Data Management Tool)
 - Pixel Type: 16_BIT_SIGNED b. Number of Bands: 1 c. Mosaic Operator: FIRST



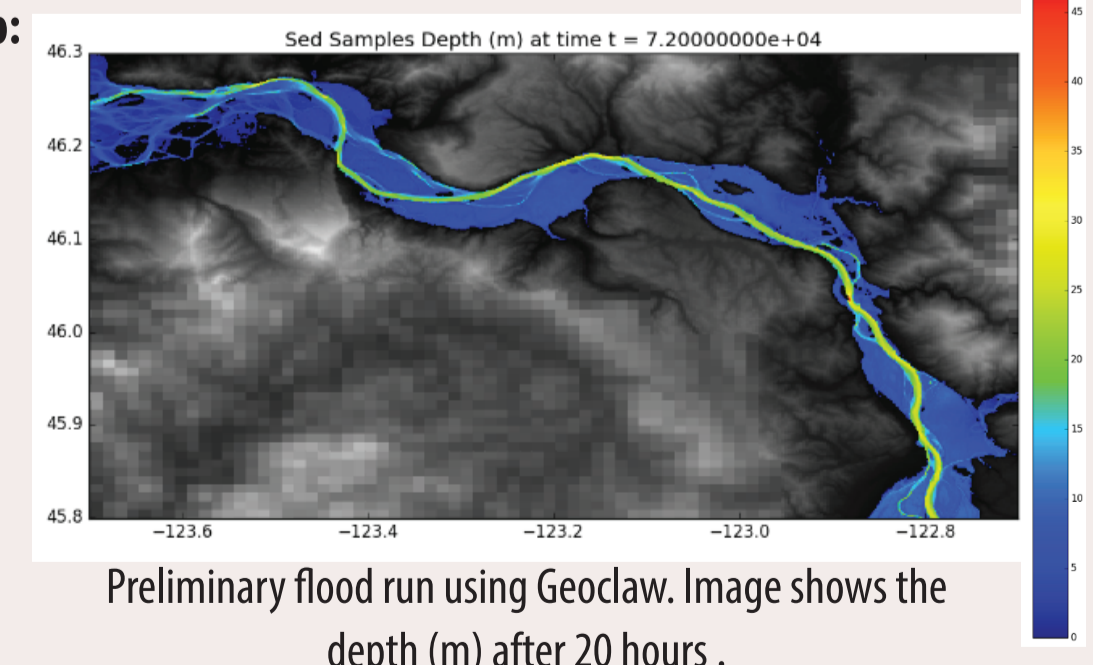
WHAT'S NEXT?

To Complete the Basemap:

- Update the Portland Basin with removed modern structures and combine the historic Lower Columbia River Bathymetry with adjacent topography.

After the Completion of the Basemap:

- Susannah Morey, my graduate student mentor, will run 2D numerical flood models on Geoclaw using the paleo-basemap to better understand the flood mechanics.
- The Geoclaw results will help a colleague, Elizabeth Davis, to determine potential sample sites for flood deposits.



REFERENCES

Canon C. 30-m resolution of the Dalles River using survey points from NOAA. Portland State University. Web. Lee, Daniel. 1806-1895. and Joseph H. Frost. Ten Years in Oregon. New York: Published for the authors. J. Collard, printer, 1844. 200-201. Lucas T. Helaire and Stefan A. Talke (2016) Modeling of Historic Columbia River Flood Impacts Based on Delft 3D Simulations. Portland State University. Web. O'Connor E., Pringle T., Reynolds D., and Yamaguchi K. (2018) Open access to Bridge of the Gods: A funding request to the Quaternary Research Center. pg. 1. O'Connor E. and Burns E. (2010) Cataclysm and controversy—Aspects of the geomorphology of the Columbia River Gorge. Field Guides. Sci. Lett. 238-239, 246. O'Connor E. (2004) The Evolving Landscape of the Columbia River Gorge: Lewis and Clark Cataclysm on the Columbia. Oregon Historical Society. Vol. 105, No. 3, 405-406. Patterson, Thomas. "Ancient Legend Lends Mystique to Gorge's Bridge of the Gods." The Seattle Times, The Seattle Times Company, 2 Dec. 2013. Portland District of the US Army Corps of Engineers (2010). Lower Columbia Digital Terrain model. Lower Columbia Estuary Partnership. Wetland Ecosystem Team. Historic Columbia River bathymetry derived from U.S. Coast and Geodetic Survey maps from 1868 to 1901. University of Washington. Web.