Visualizing Sea Level Rise Induced Migration Using Hexagonal Grids

Hoda Tahami, Bo Zhao, David J.Wrathall, Majid Farahani

Oregon State University

UCGIS 2018 Symposium and CaGIS AutoCarto

Outlines

- Background
- Objectives
- Methodology
- Application Development
- Future Enhancement
- Conclusion and Final reflections

Background

- Many sea level rise (SLR) assessments focus on populations presently inhabiting vulnerable coastal communities.
- Current maps demonstrate the area vulnerable to SLR.

- **Where is the destination of these potentially displaced persons? (Mathew Hauer 2017)**
- **What is the potential impacts on landlocked communities created by SLR-induced migration**

Objectives

- Interactively visualize the human migration through space and time

- Illustrate the scale of potential migration in/from the area

- Display how SLR-induced migration could affect both inland and coastal communities.

Data Preparation

Data:

- County-to-County migration data within the U.S (Hauer 2017)
- United States counties boundaries (www.census.gov)

Technical challenges:

- Simplifying the shapes of features
- Enhance user interaction, rendering performance and application scalability

Methodology

1. Simplifying the shape of features by using hexagons
2. Matching and transferring the migration records with administrative counties hexagons
3. Symbolizing the migration flow by arcs of varying weight based on migration flow rate
4. Connecting the centroid of the origin and destination of hexagons
5. Allowing the user to select either an origin or destination feature to display all flows in or out of the features

Hexagonal Grid

- ❑ Set hexagon gridlines along the US map.
- ❑ Apply an appropriate map projection
- ❑ Determine the appropriate hexagon size.

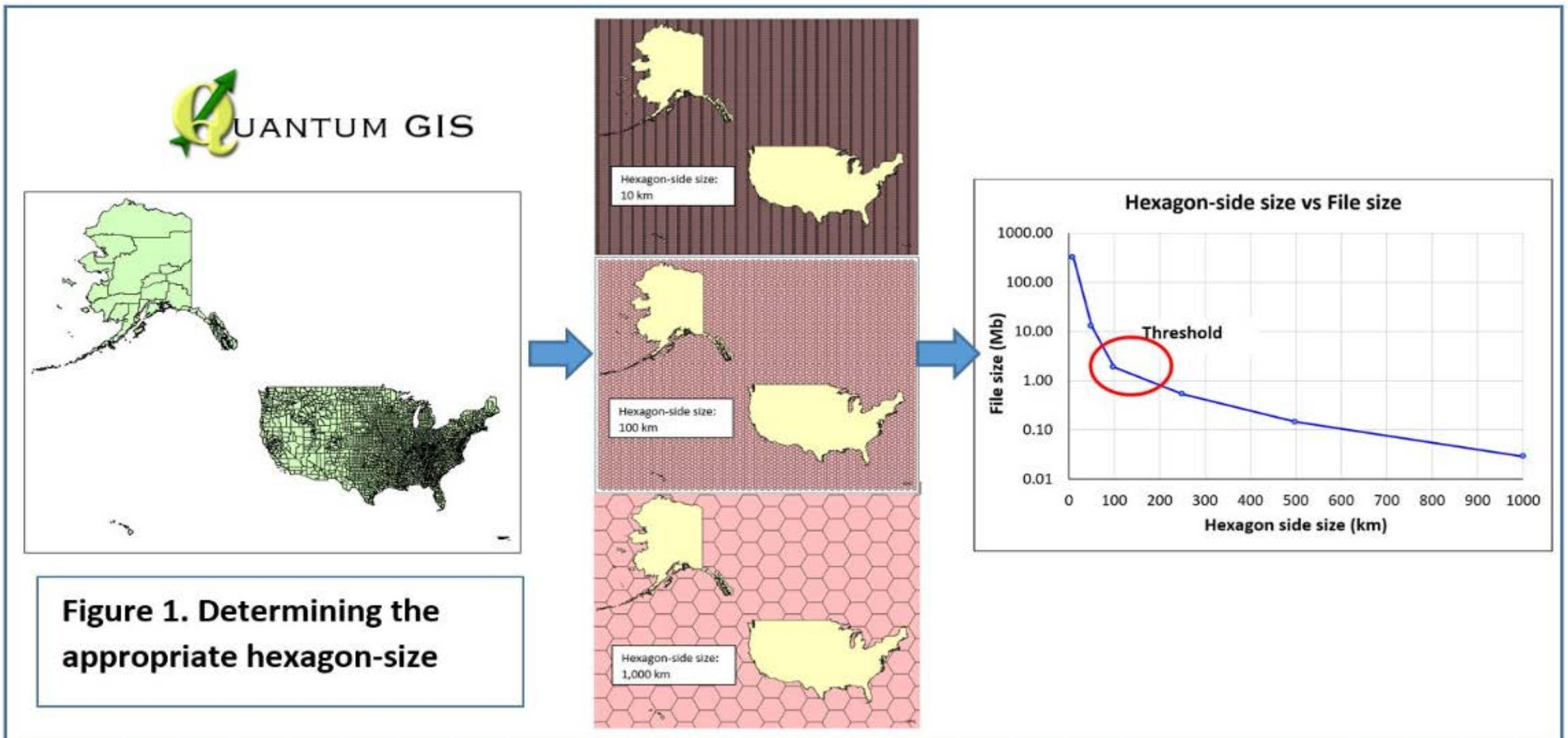


Figure 1. Determining the appropriate hexagon-size

Transfer of Migration Flows

- Source counties represented by hexagons were reduced to only coastal hexagons
- Since some hexagons covered more than one county, some flows had the same hexagon-origin and hexagon-target.

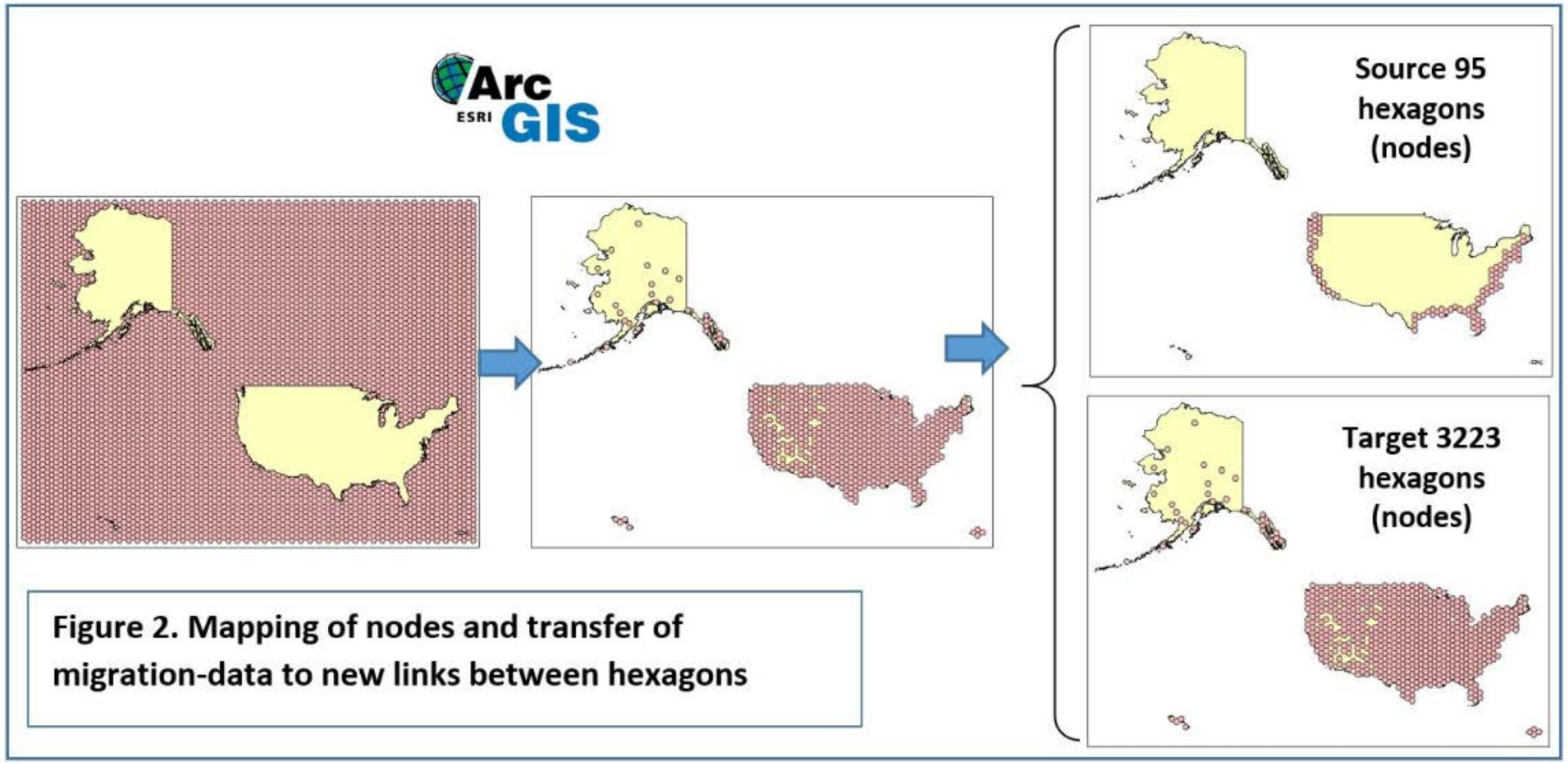


Figure 2. Mapping of nodes and transfer of migration-data to new links between hexagons

Reduction of Links (Migration Flows)

- ❑ Identify links with same source and target to merge migration flows
- ❑ Delete hexagons with zero migratory-flow
- ❑ Convert the map was into GeoJSON format and its attributes into CSV format.

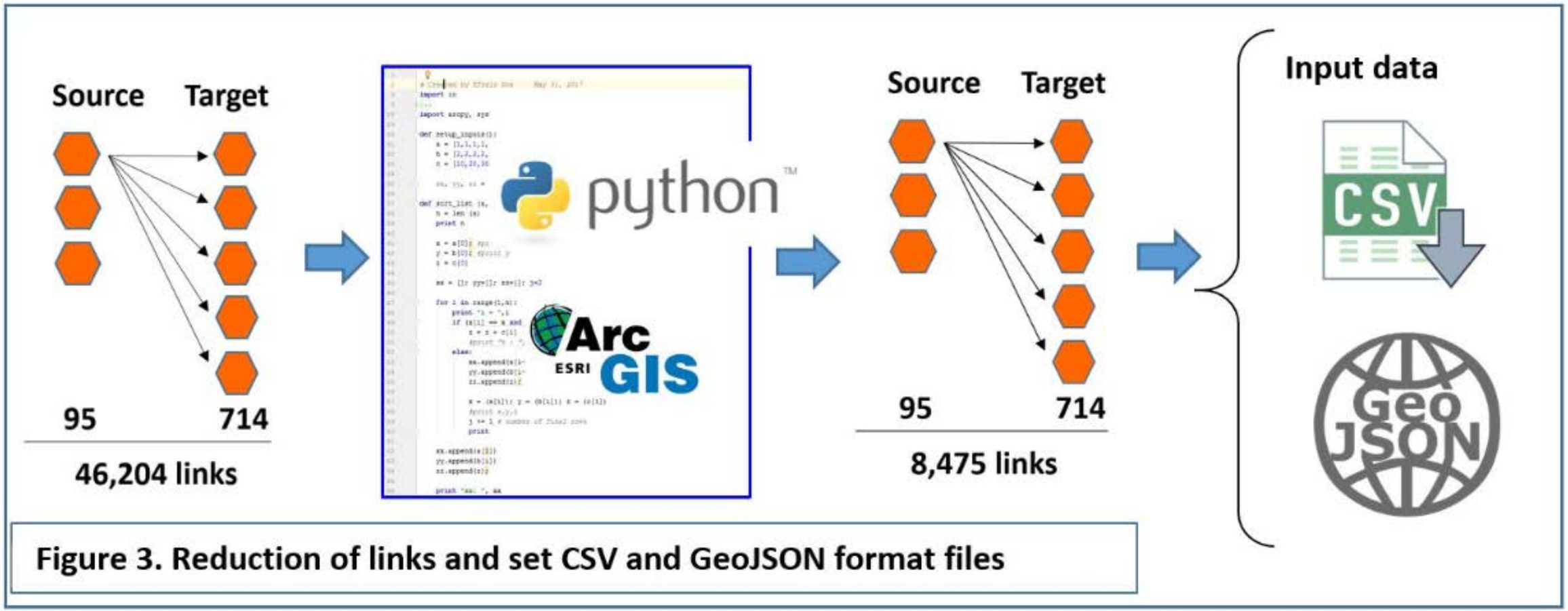


Figure 3. Reduction of links and set CSV and GeoJSON format files

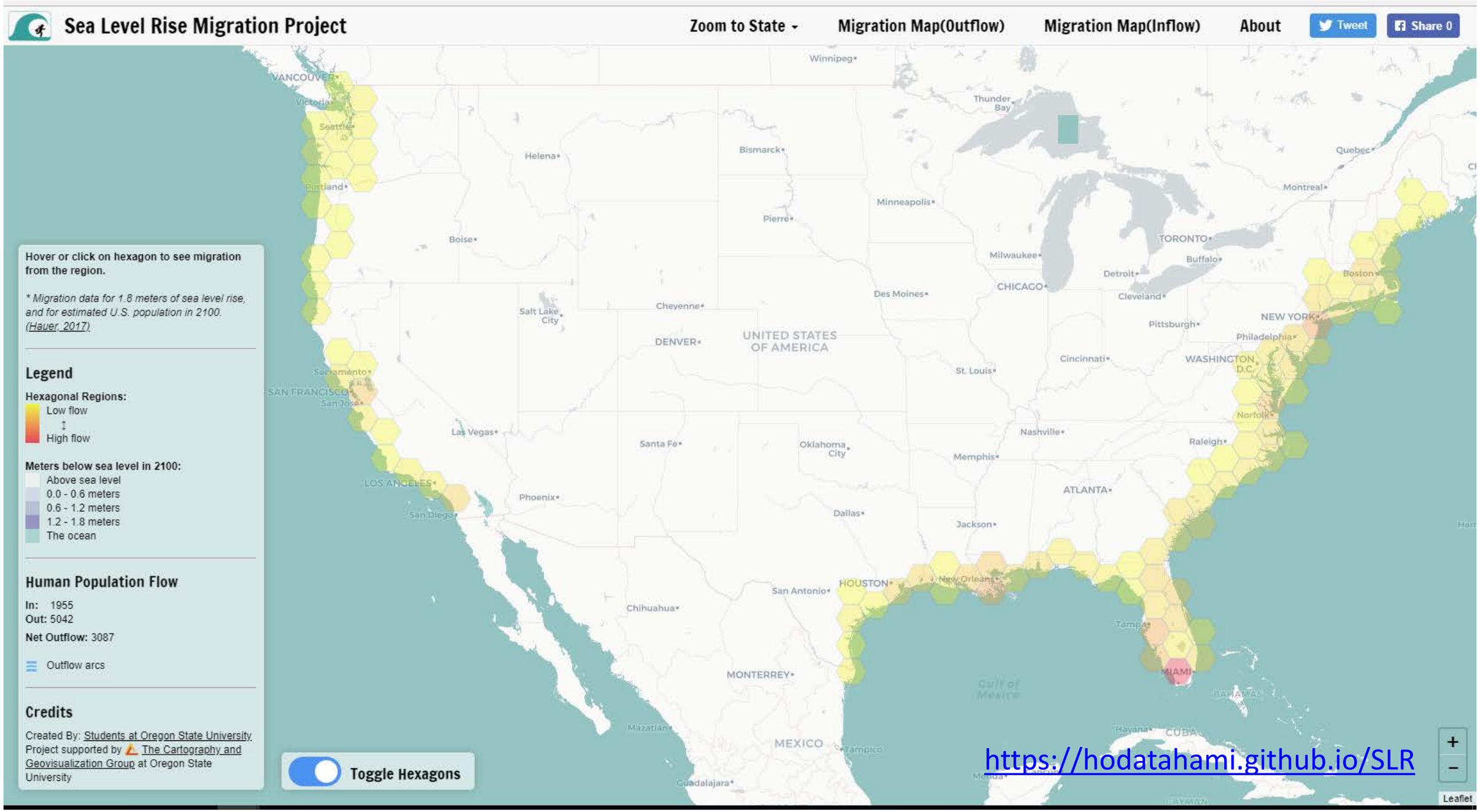
GeoVis Implementation

- Several libraries were used to produce the desired aesthetic, including: Bootstrap, D3, SpatialSankey, and Google Fonts.

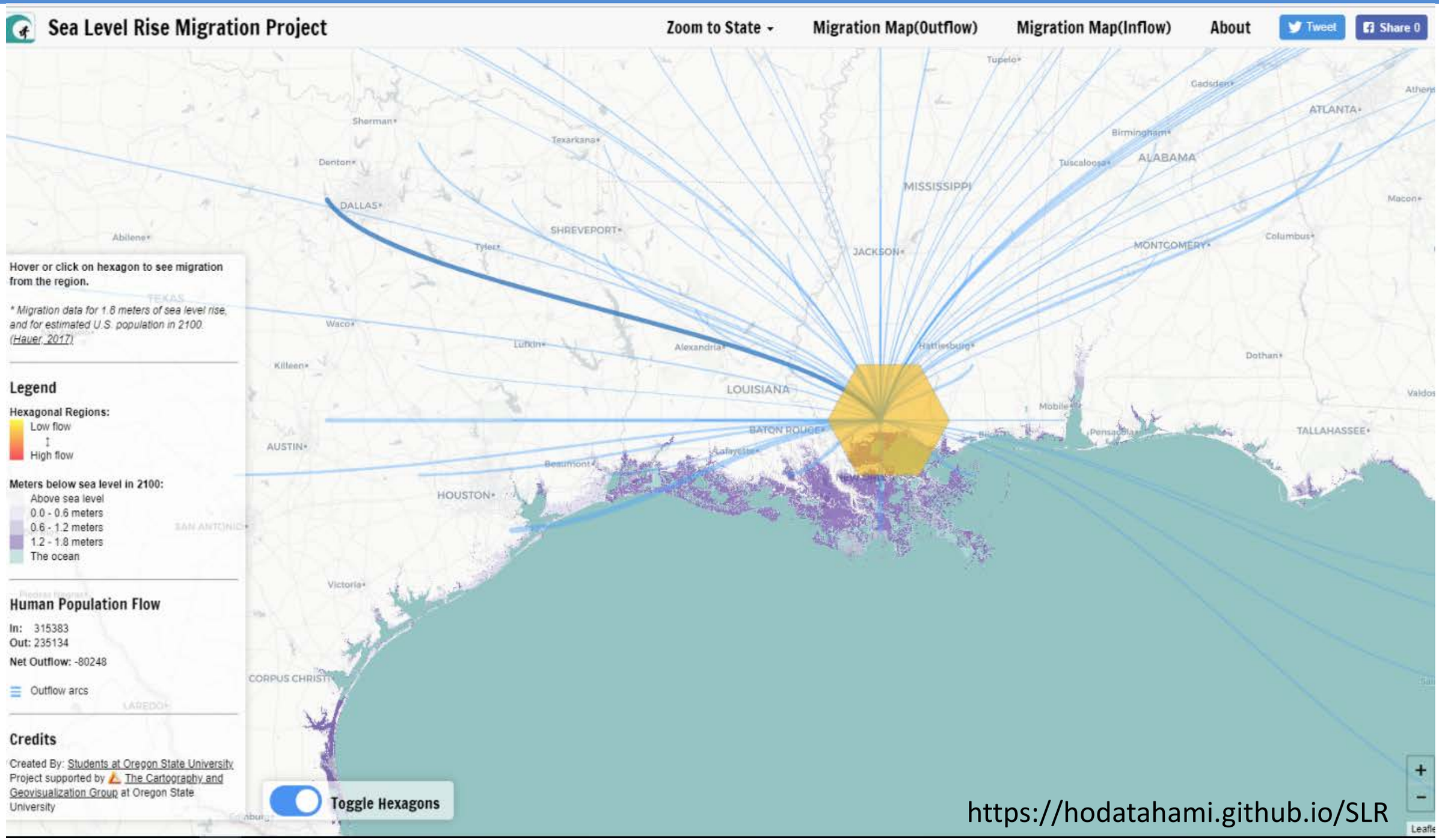
- Base map tile layers from CartoDB and Leaflet were used to produce our thematic map.

- The project is hosted on GitHub under an MIT license.

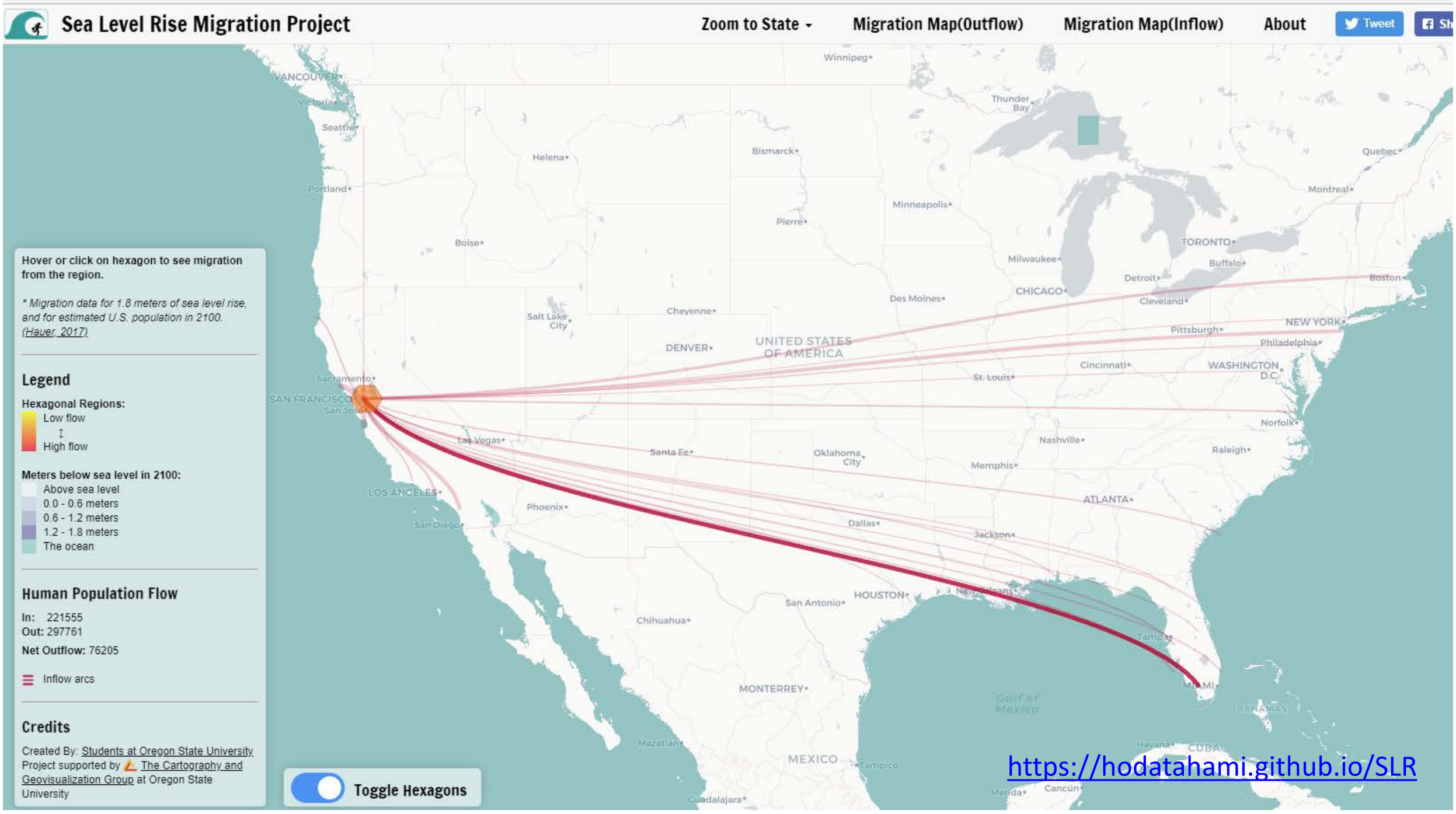
Hexagonal Grid over coastline



Migration Flow From Louisiana



Migration Flow To San Francisco



Future Enhancement

- Map projection and hexagon size
- Applying irregular hexagonal tessellations
- Representation of migration flows over time

Reference

- Hauer, M. E. (2017). Migration induced by sea-level rise could reshape the US population landscape. Nature Climate Change, (April). https://doi.org/10.1038/NCLIMATE3271

- Hauer, M. E., Evans, J. M., & Mishra, D. R. (2016). Millions projected to be at risk from sea-level rise in the continental United States. Nature Climate Change, 6(March), https://doi.org/10.1038/nclimate2961

- Zambotti, G. Guan, W. and Gest, J. (2015). Visualizing Human Migration Trhough Space and Time. ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences, II-4/W2, pp. 55–161.

Thank you