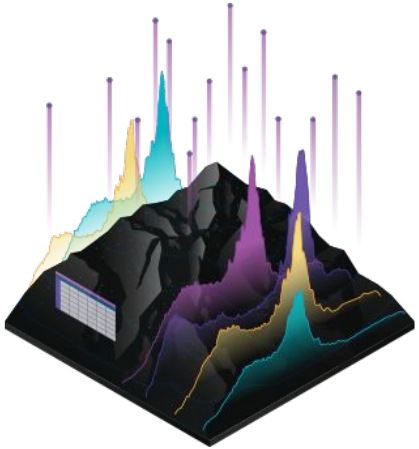
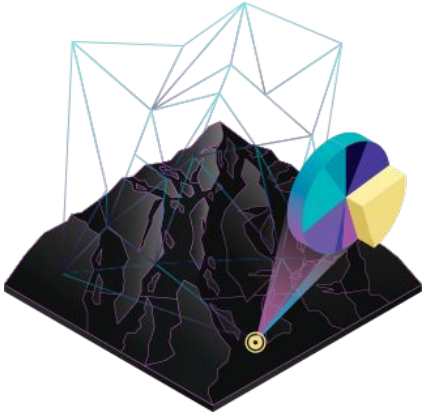




Geographical Information Systems

Isabel Heard
STAT 495

AGENDA

01 What is GIS?

02 Real Use Cases

03 Deep Learning Example

04 Trying Out The Software

05 Further Research

- Environmental Systems Research Institute
- Software company who created ArcGIS
- First used for land resource managers
- Now used broadly across many different commercial areas

What does GIS do?

Spatial system that creates, analyzes, and maps all types of data.

Connects data to a map software system

Display insights using geospatial techniques

CONNECT → BUILD → VISUALIZE → ANALYZE

Integrates location data with all types of descriptive information

Understand patterns, relationships, and geographic content

Who Uses GIS?

WALGREENS	• Gather current info about the spread of the flu • Help communities adjust resources accordingly
NATIONAL PARK SERVICE	• Search and rescue operations • Restoration and resource conservation planning
WORLD HEALTH ORGANIZATION	• Prevent health issues from escalating • Track the spread of diseases
STARBUCKS	• Use data to decide where to build new locations • Tracking population density, average income, traffic patterns, etc.
UBER	• Matching drivers to riders • Monitor and analyze traffic patterns

COVID-19 United States Cases by County Johns Hopkins University

States/Territories
Please select from list

County (or Equivalent)
Please select from list

Top 25 Confirmed Cases by County

3,710,586 confirmed
Los Angeles

1,552,197 confirmed
Miami-Dade

1,533,935 confirmed
Cook

1,530,296 confirmed
Maricopa

1,275,028 confirmed
Harris

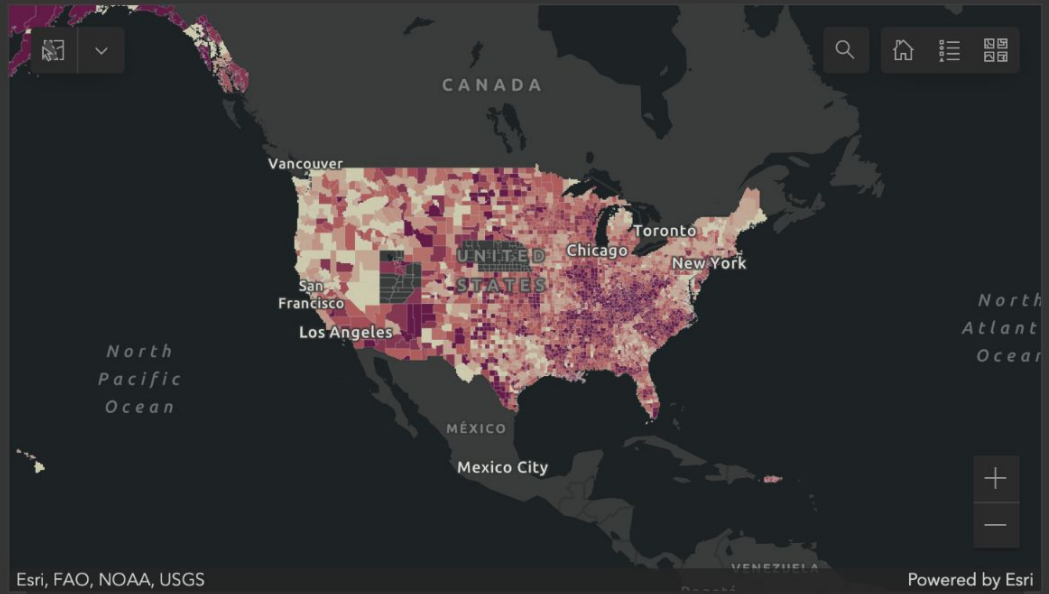
1,067,659 confirmed
San Diego

963,672 confirmed
Kings

904,779 confirmed
Queens

788,663 confirmed
Orange

JHU Ceased Updates at:



Confirmed by Pop

On March 10, 2023, the Johns Hopkins Coronavirus Resource Center will cease collecting and reporting of global COVID-19 data. For updated cases, deaths, and vaccine data please visit the

Top 20 Counties by Number of Deaths

35,545 deaths
Los Angeles

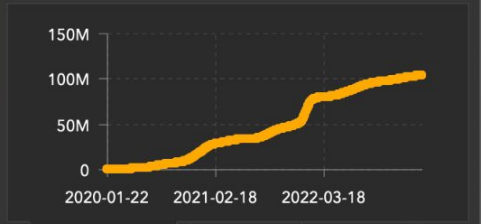
18,846 deaths
Maricopa

15,289 deaths
Cook

14,205 deaths
Kings

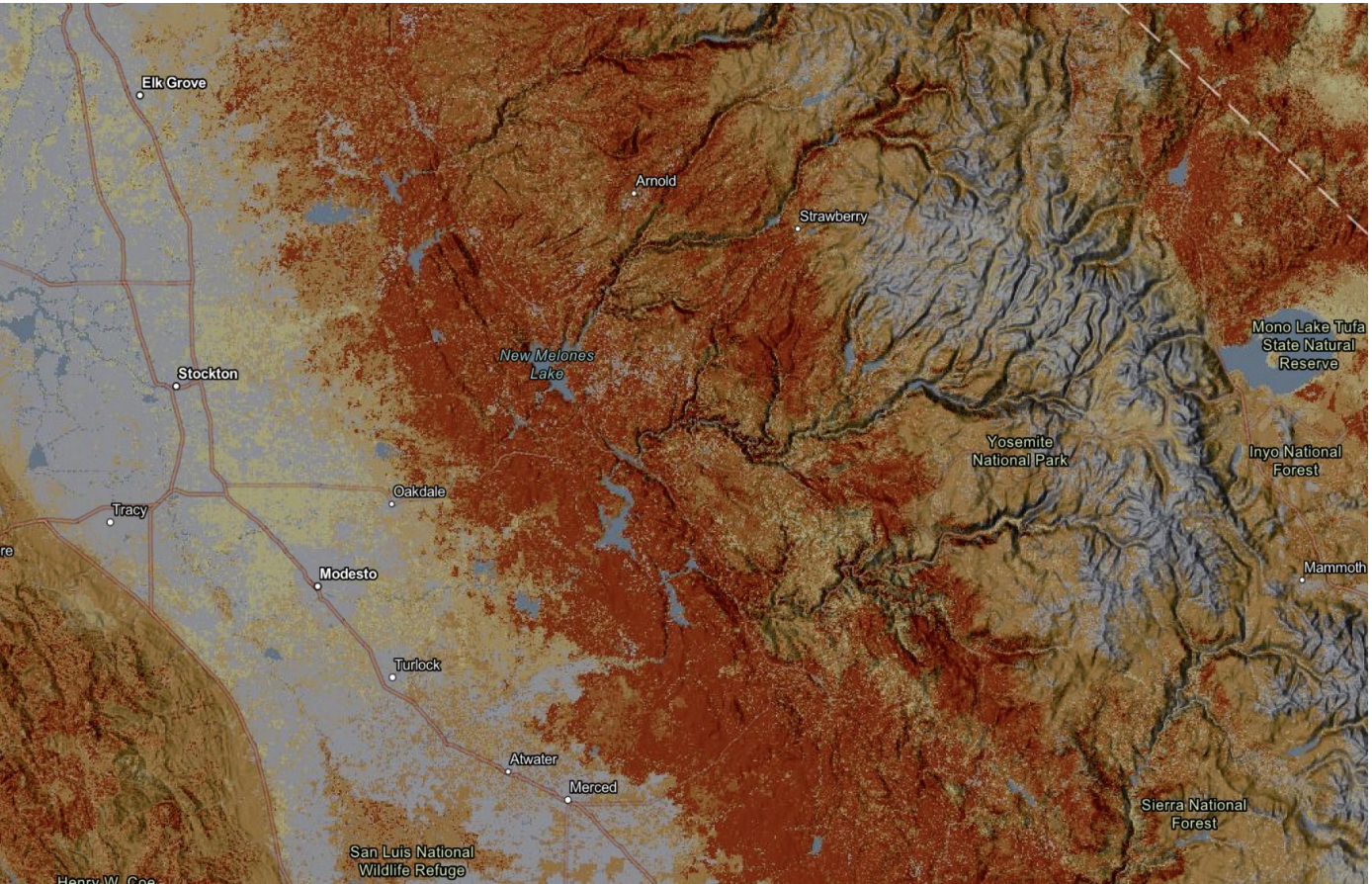
13,415 deaths
Queens

12,285 deaths
Miami-Dade



Confirmed | Deaths

Wildfire Hazard Potential



- US Forest Service shows wildfire hazard potential across the country
- Red zones being the areas most at risk
- Local decision makers can make more informed recommendations on how to allocate resources

How can this relate to data science?

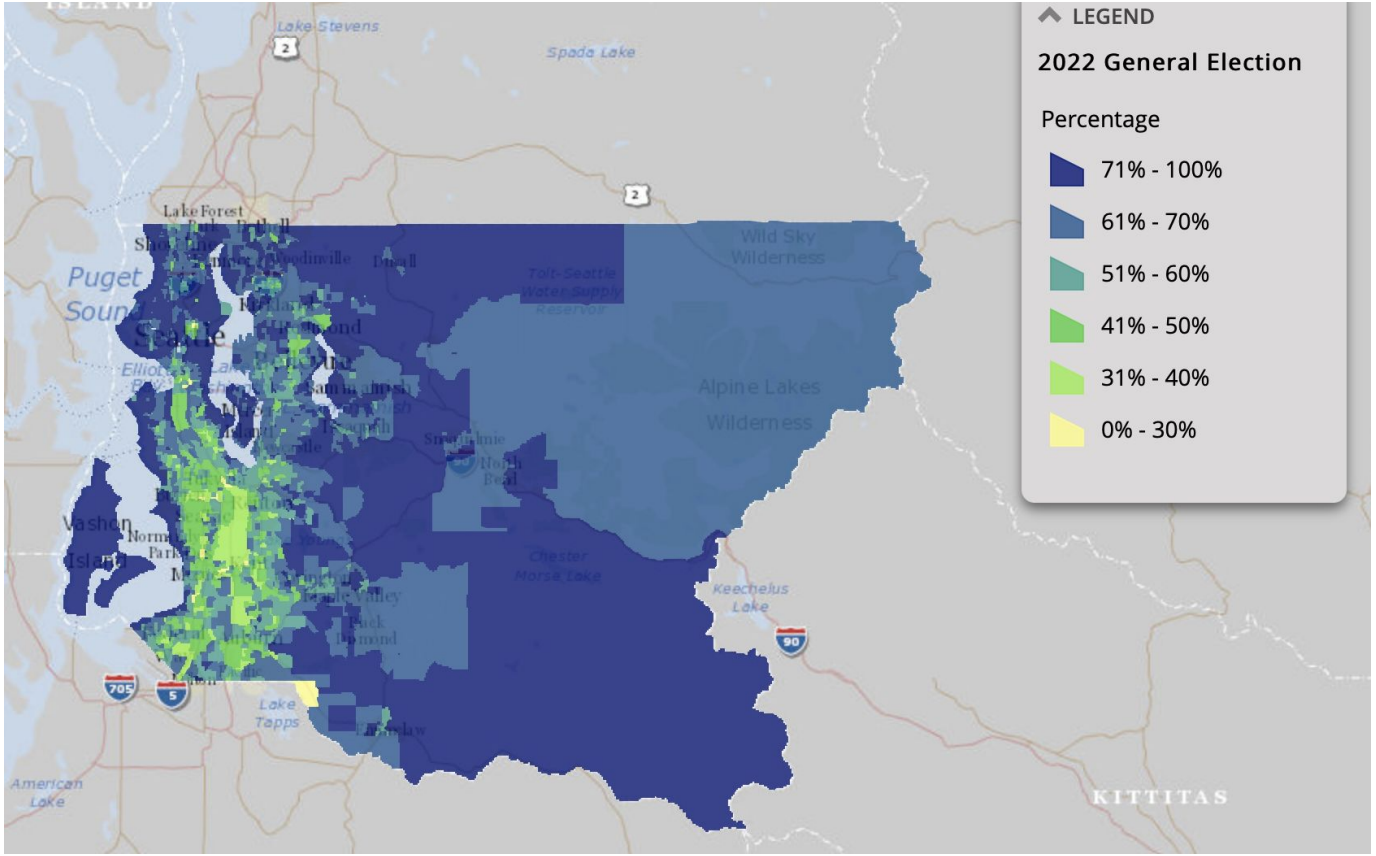
Spatial data science is where data science intersects with GIS.

01	**Data Engineering**	• Preparing data for analysis (GIS, R, Python) • Ex: Geoenrichment
02	**Data Exploration & Visualization**	• Exploring the raw data • Maps, charts, and animation (3D maps)
03	**Spatial Analysis**	• Modeling the geographic features of the data • Tells you where things are and how they relate to each other (pattern detection)
04	**ML & AI**	• Automate the process of updating maps • Model interaction over time • Location optimization
05	**Big Data Analytics**	• Large companies using GIS are using large volumes of data to draw conclusions
06	**Modeling & Scripting**	• Helps produce a repeatable workflow • Integrate Python to script workflows

King County

Real Use Cases for GIS

Visualizing Voter Turnout



Broadband Access

DIGITAL EQUITY / Access to High Speed Internet

Condition
Where the needs are greatest

Internet access to homes fosters community connectivity, economic and learning opportunity and quality of life improvements. In King County and most areas, internet speed can vary significantly depending on where you live and what you can afford.

Geography Level
County

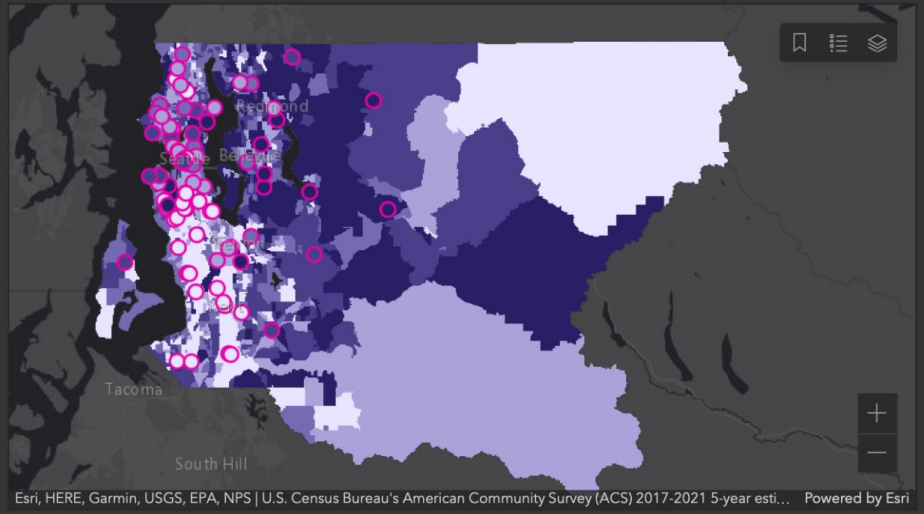
Geography Name
King County

Year
2018

Data Source: Internet (broadband) access from 2018 American Community Survey (ACS)

Terms of Use

King County



Actions
Our regional partners' investments

One way residents who have limited or no internet access can compensate is to connect to the internet via Public WiFi. This presentation shows King County regional public partners' investment in Public WiFi for citizen use.

Equity Score (Q1/Q5)
Average of Q1 = 82.9%

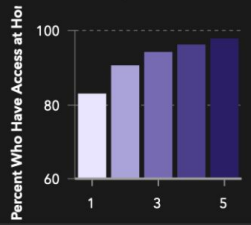
85%

Average of Q5 = 97.6%

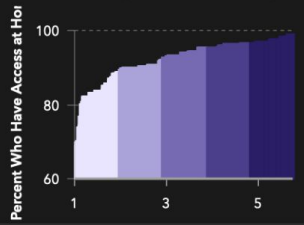
The Equity Goal is 100

Equity Score

Access by Quintile



Access by Block Group



Public WiFi Locations by

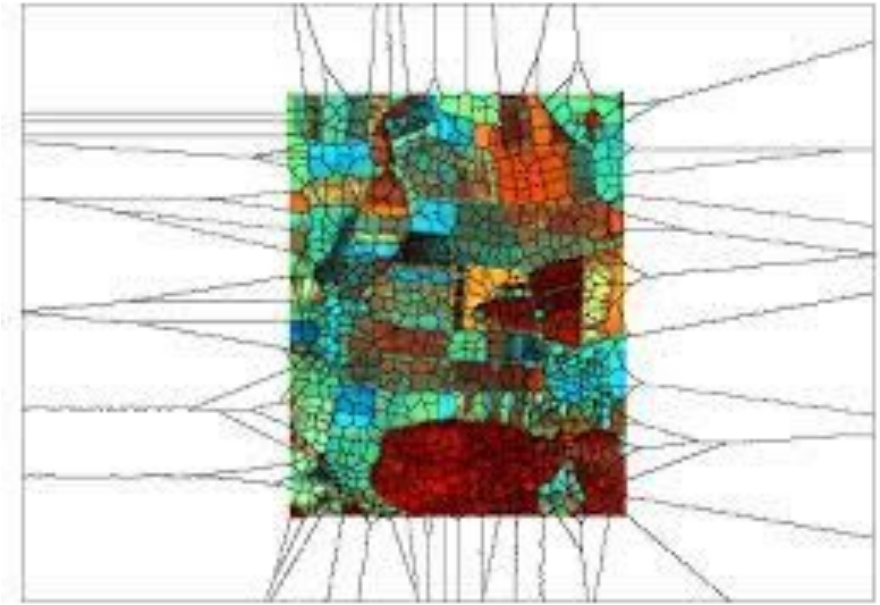
No data

High-Resolution Land Cover Mapping using Deep Learning

Objective of Project:

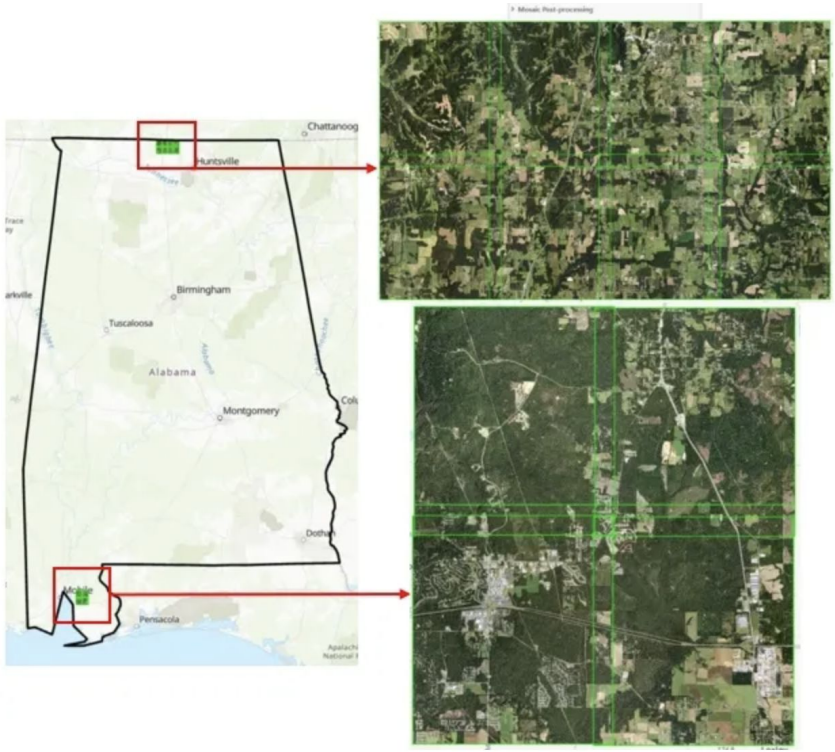
- Applying deep learning models to provide high resolution land cover in Alabama using Keras and ArcGIS
- Create a classified land cover map with 1-meter resolution
- Identify six land cover classes
    1. Buildings
    2. Roads/Parking lots
    3. Water
    4. Harvested/Open/Bare land
    5. Forest
    6. Planted crop land

Image Segmentation



- Dividing an image into multiple segments
- Assign a label to every pixel in an image
- Ideal for this project since each land cover class pixels share similar characteristics

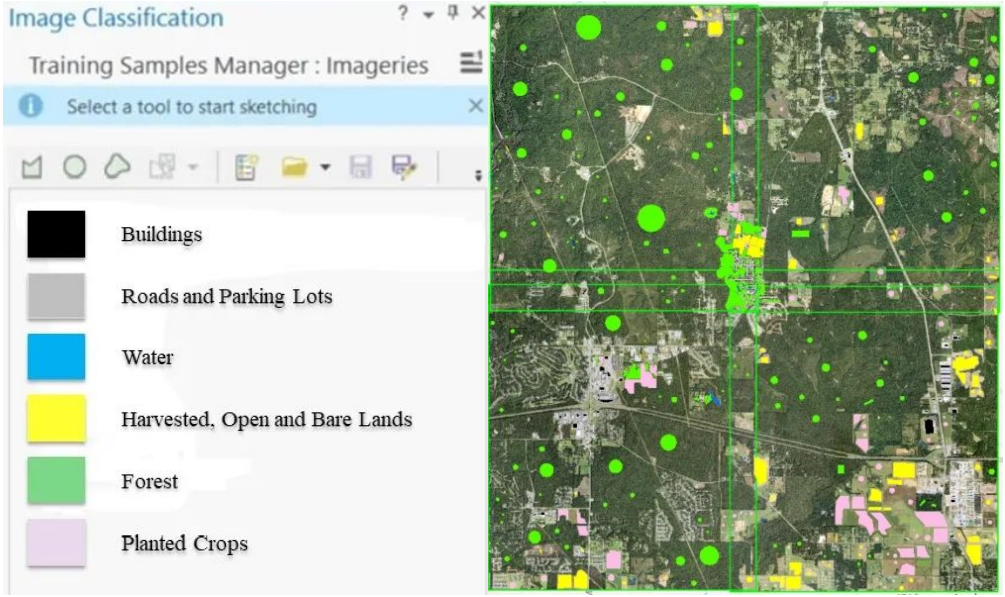
Data Sources Used for Project



- NAIP (National Agriculture Imagery Program) images
  - 8 images from the north
  - 8 images from the south
- Images are acquired at a one-meter ground sample distance
- Create a dataset in ArcGIS pro with images

Data Prep & Data Augmentation

- Increased the number of training data
- For each run of data augmentation, randomly select an area to create a new data point to train
- Merge newly generated data with existing land cover cases
- Normalize each band of NAIP image and shuffled training samples

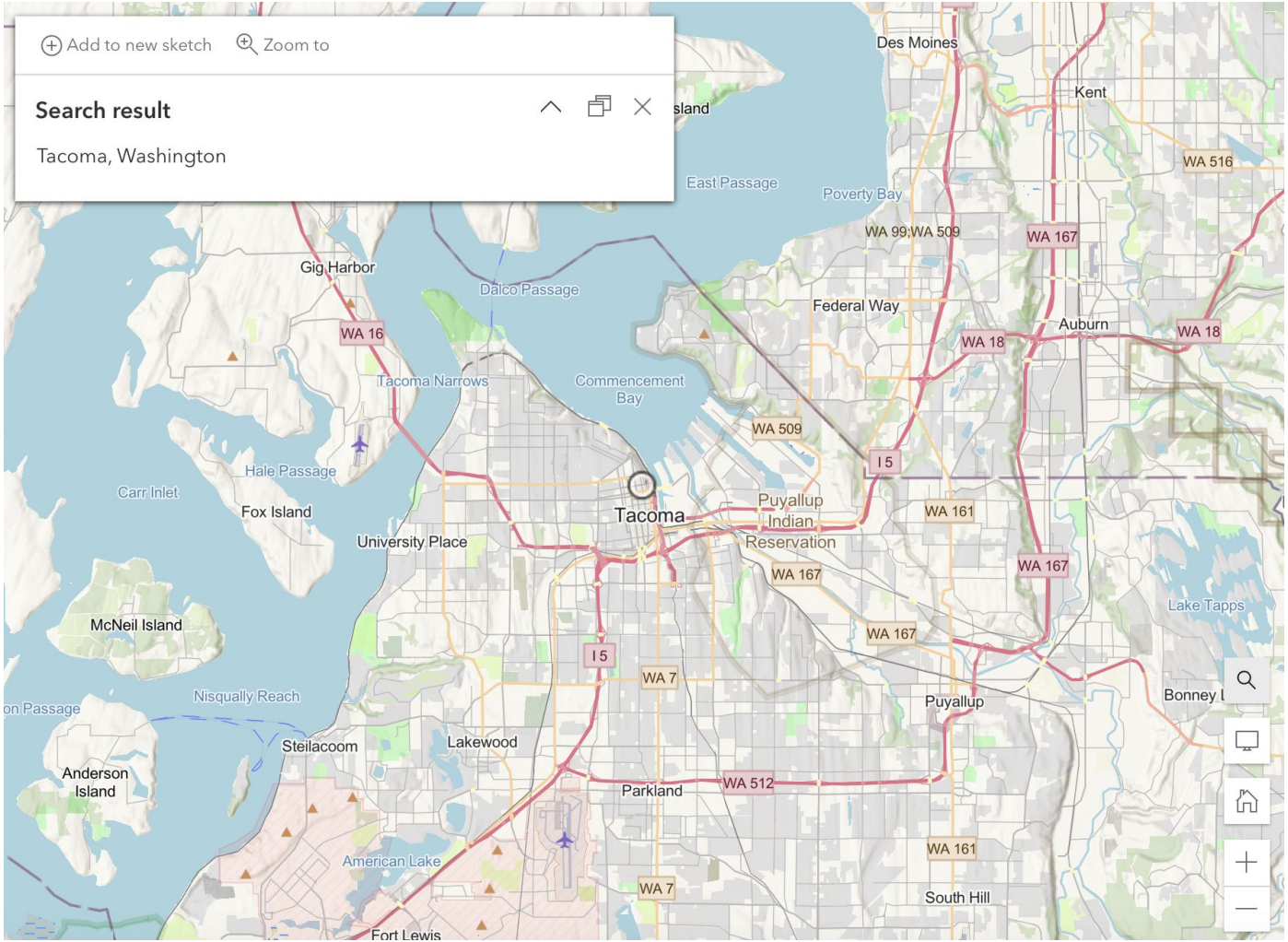


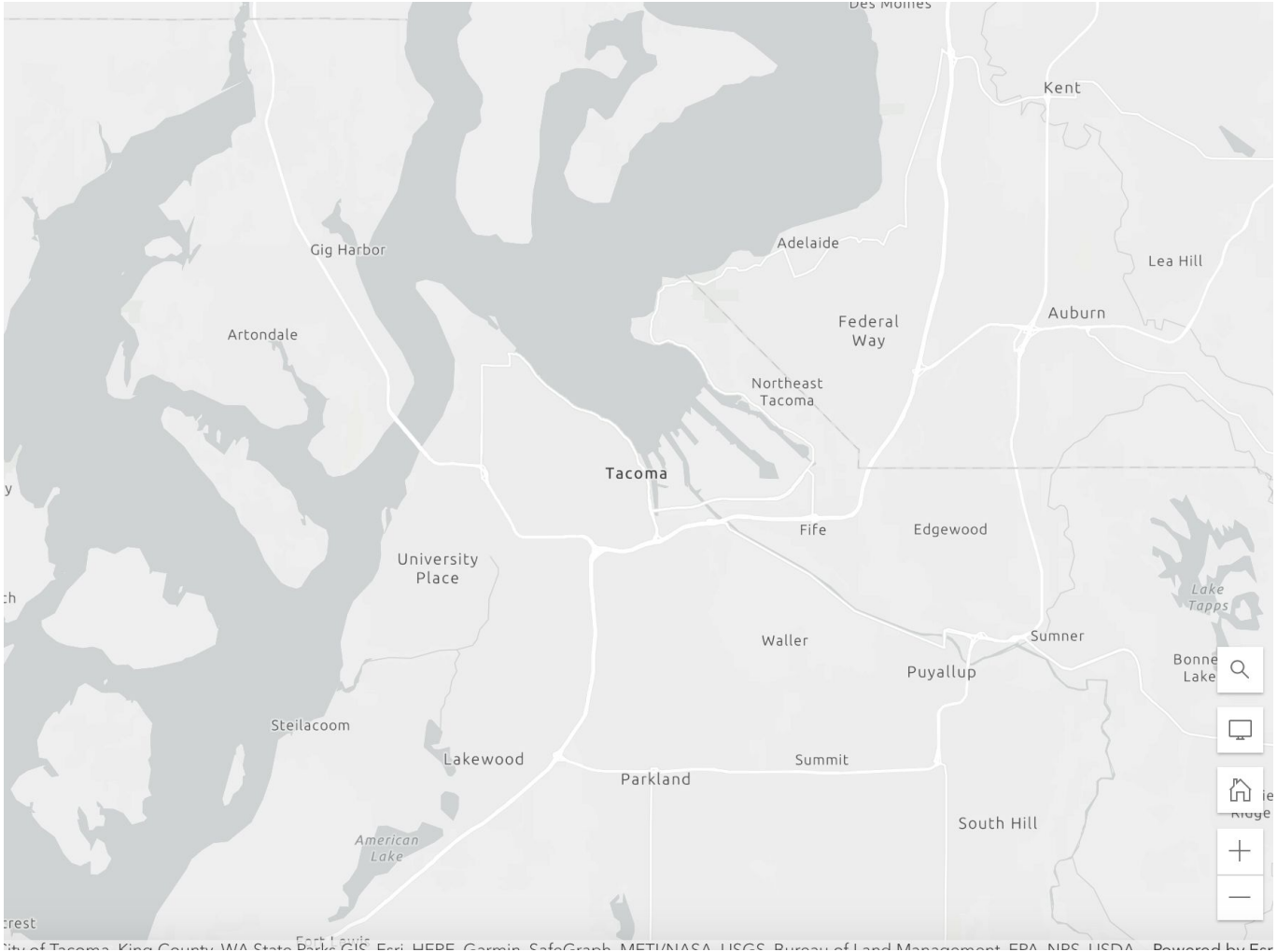
Modify & Train U-Net Model

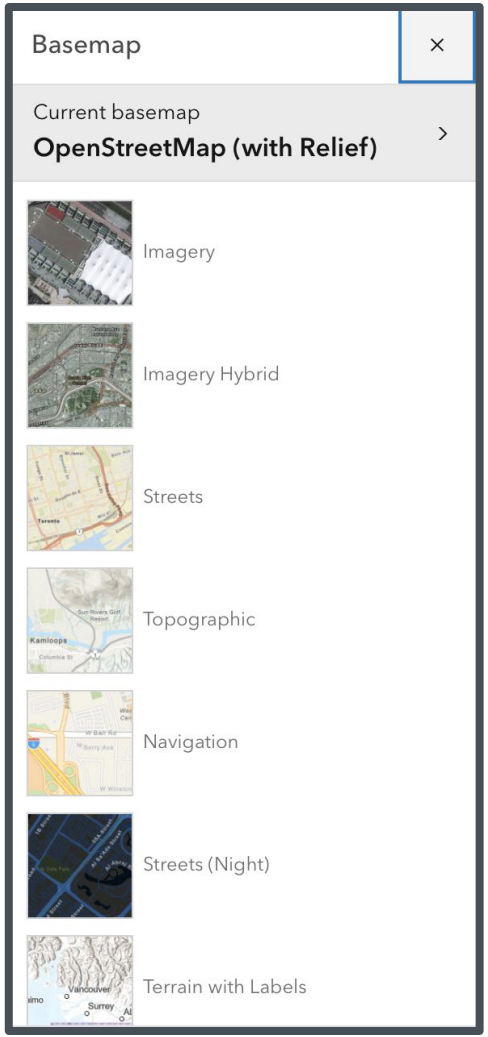
- Type of fully conventional network
  - Encoder, pre-trained classification network
  - Decoder, projects features learned by encoder onto the pixel space
- Since it is not feasible to label all cells in an image, need to write a loss function
  - Defines weight for each land cover class
- 90% calibration, 10% validation
- Ran model for 30 epochs
- Model stopped after 20 since validation loss did not improve significantly

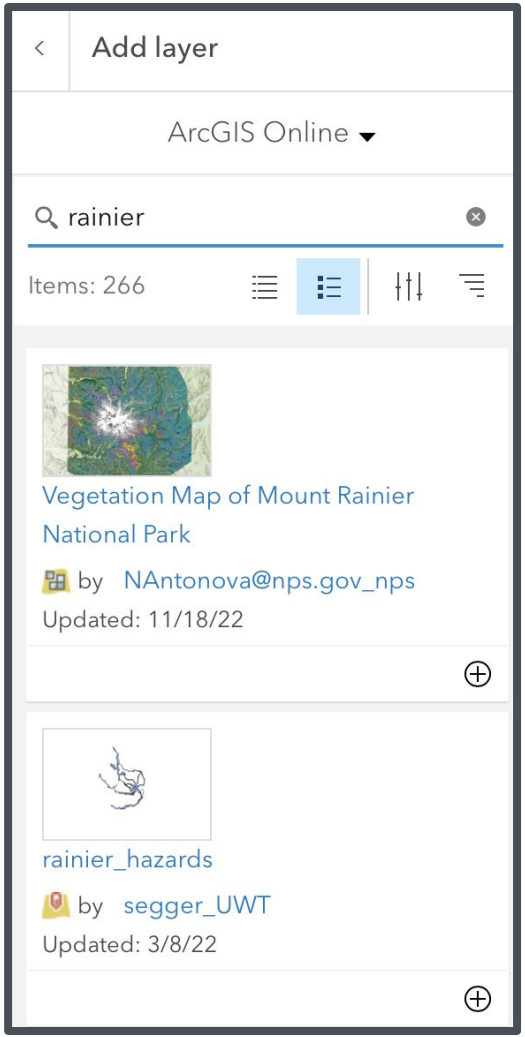
Class	Precision	Recall
Buildings	82.50	81.28
Roads	84.78	85.13
Waters	86.14	85.55
Harvested	90.38	91.88
Planted	89.05	88.19
Forest	91.46	92.65

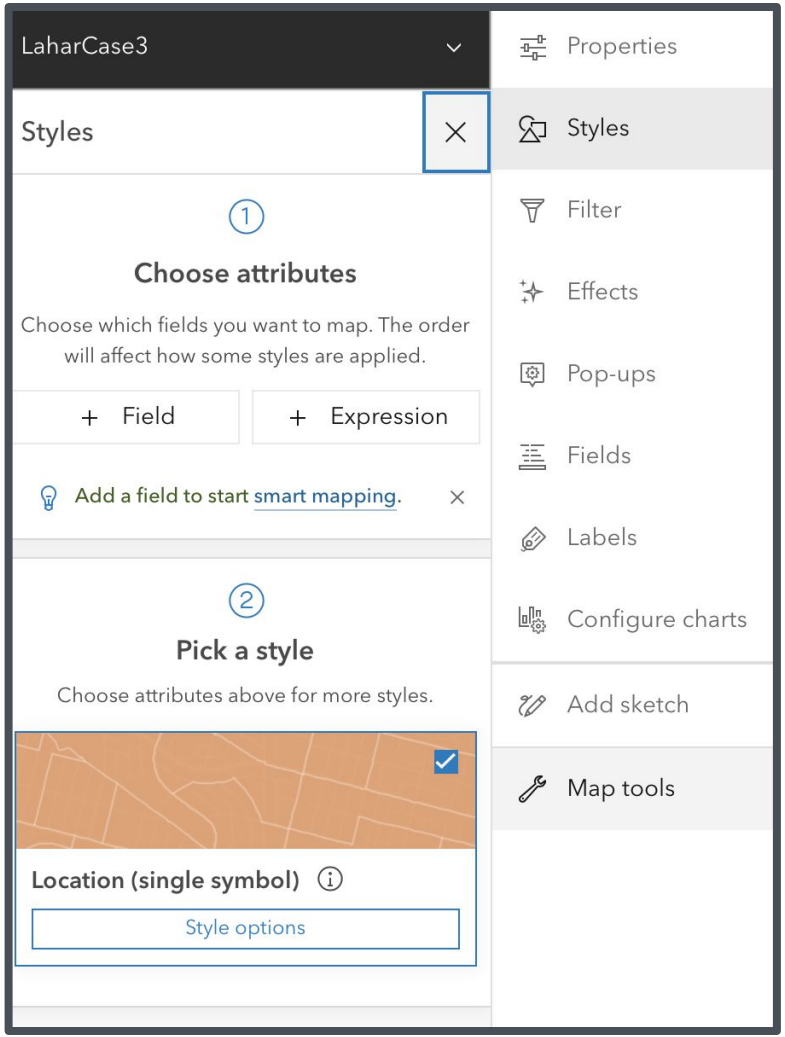
ArcGIS Implementation

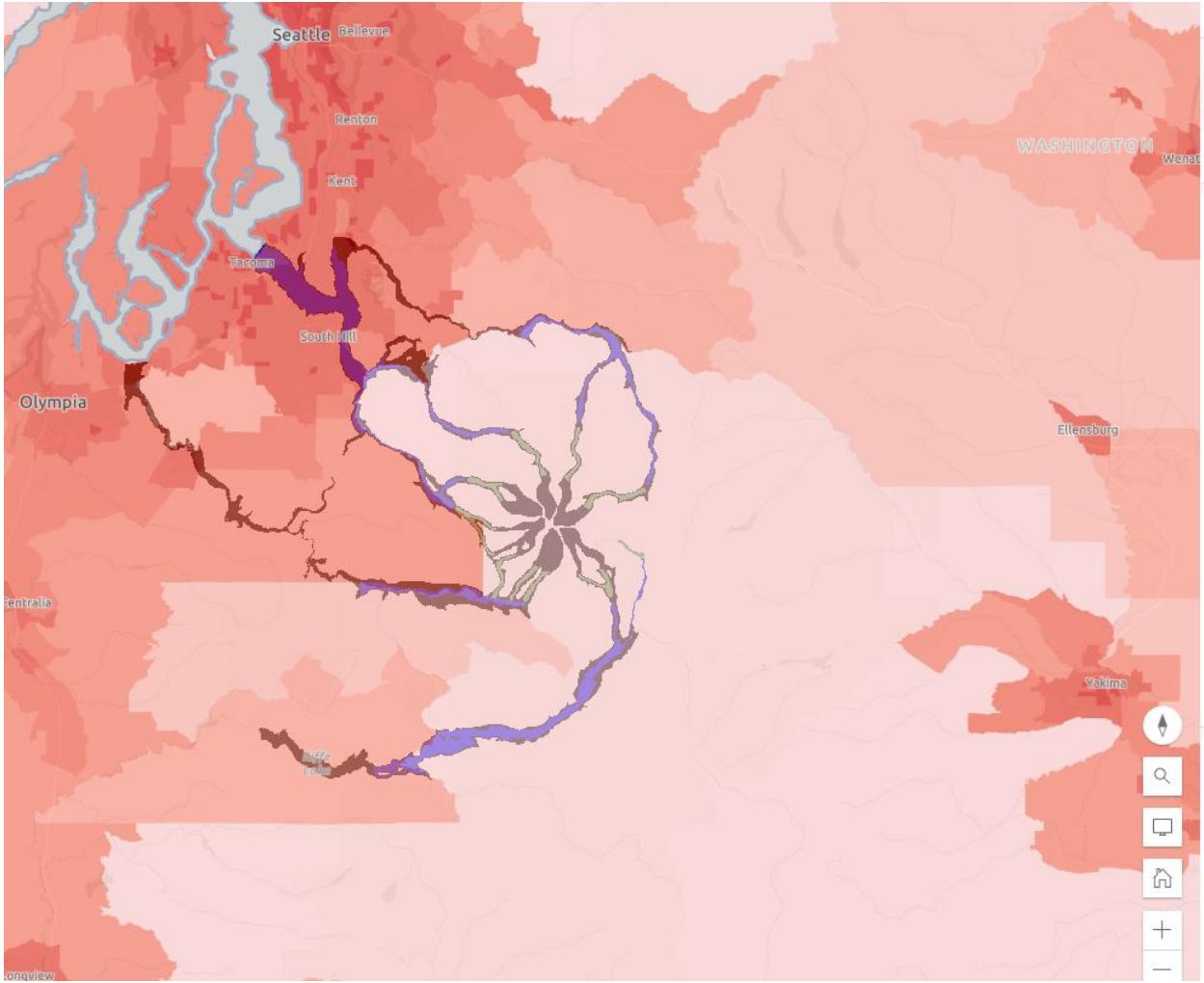

Add to new sketch
Zoom to
Search result
Tacoma, Washington
Des Moines
Kent
East Passage
Poverty Bay
WA 516
WA 99;WA 509
WA 167
Gig Harbor
Dalco Passage
Federal Way
Auburn
WA 18
WA 16
Tacoma Narrows
Commencement Bay
WA 509
I 5
Hale Passage
Carr Inlet
Fox Island
Tacoma
Puyallup Indian Reservation
WA 161
University Place
WA 167
Lake Tapps
McNeil Island
WA 7
Nisqually Reach
Puyallup
Steilacoom
Lakewood
Anderson Island
Parkland
WA 512
American Lake
South Hill
Fort Lewis


Des Moines
Kent
Gig Harbor
Adelaide
Lea Hill
Artondale
Federal Way
Auburn
Northeast Tacoma
Tacoma
Fife
Edgewood
University Place
Lake Tapps
Waller
Sumner
Puyallup
Bonney Lake
Steilacoom
Lakewood
Summit
Parkland
South Hill
American Lake


Basemap
Current basemap
OpenStreetMap (with Relief)
Imagery
Imagery Hybrid
Streets
Topographic
Navigation
Streets (Night)
Terrain with Labels


Add layer
ArcGIS Online
rainier
Items: 266
Vegetation Map of Mount Rainier National Park
by NAntonova@nps.gov_nps
Updated: 11/18/22
rainier_hazards
by segger_UWT
Updated: 3/8/22


LaharCase3
Styles
1
Choose attributes
Choose which fields you want to map. The order will affect how some styles are applied.
+ Field
+ Expression
Add a field to start smart mapping.
2
Pick a style
Choose attributes above for more styles.
Location (single symbol)
Style options
Properties
Styles
Filter
Effects
Pop-ups
Fields
Labels
Configure charts
Add sketch
Map tools



Properties

Use the selector above to switch between layers in the map.

Information

Symbology

Show in map legend

MHE_WA_PopulationDensity_tiles

People per Square Mile

- 5,000.1 and above
- 500.1 to 5,000
- 88.81 to 500
- 25.1 to 88.8 (US Density)
- 10.1 to 25
- 5.1 to 10
- 0 to 5

WA_sldl_Dissolve

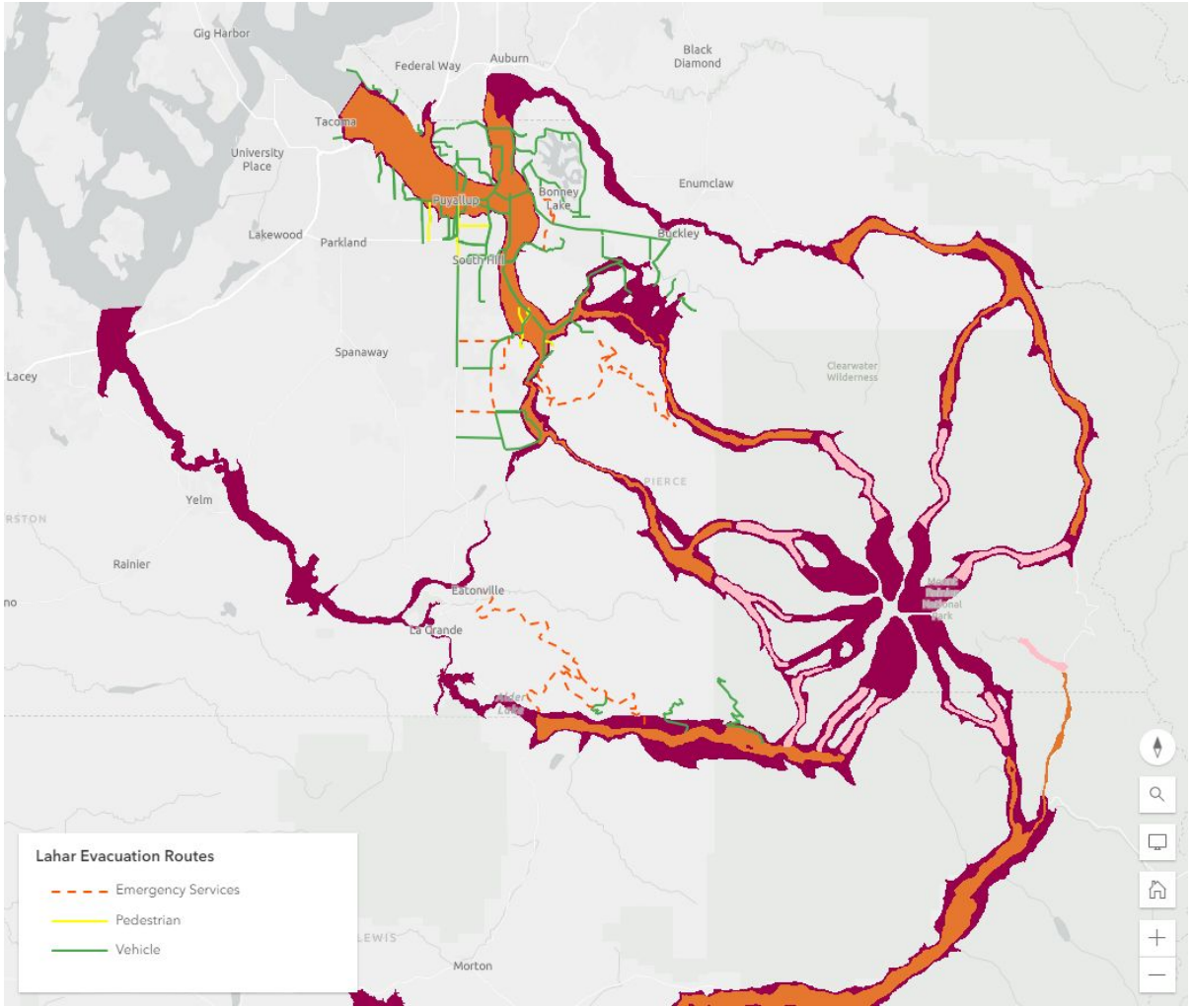
Appearance

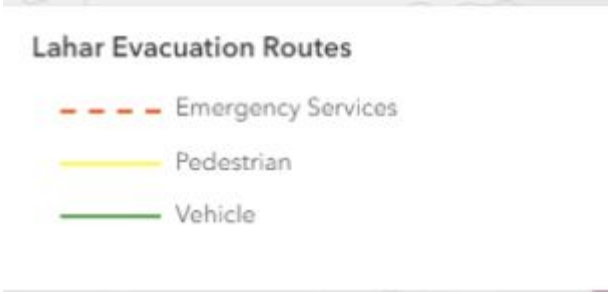
Blending

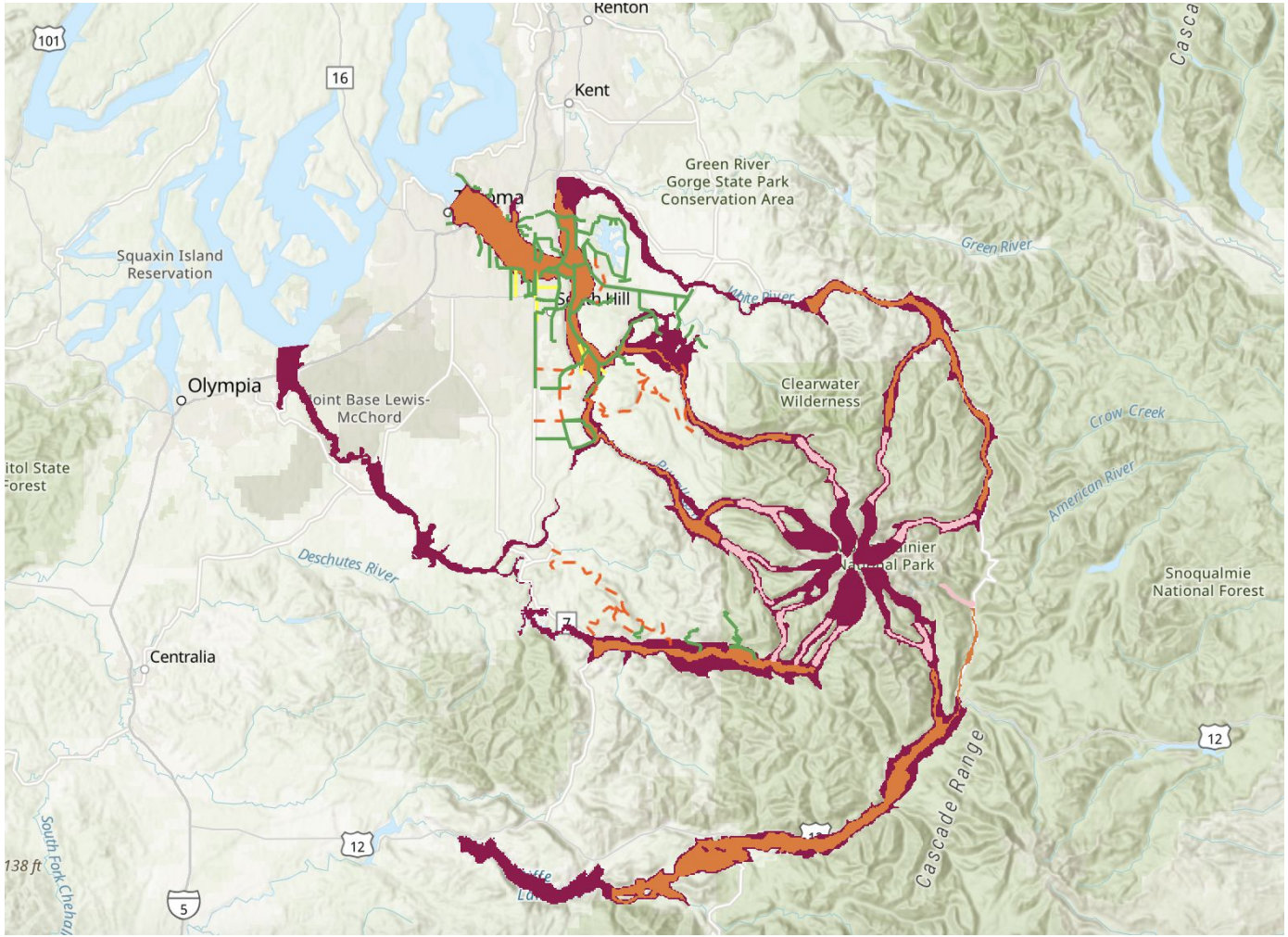
Normal

Transparency

37%

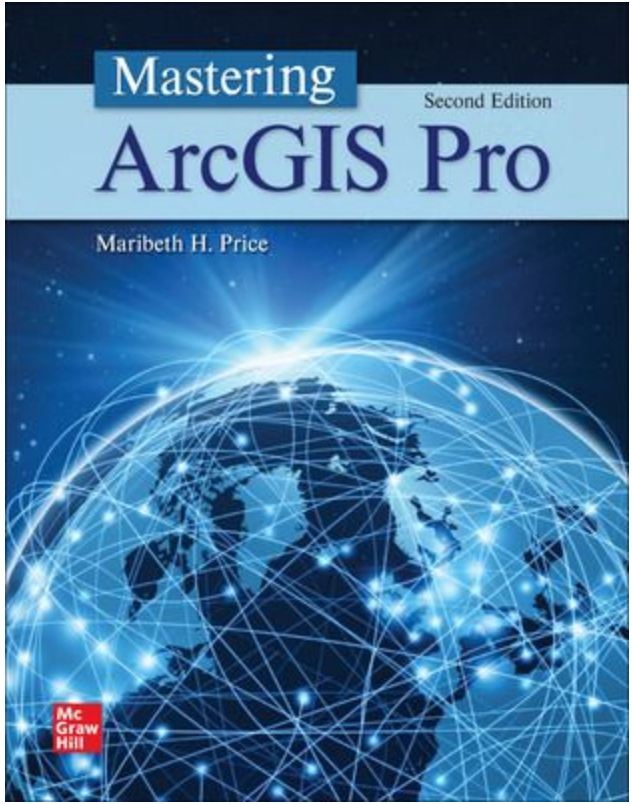

Gig Harbor
Federal Way
Auburn
Black Diamond
Tacoma
University Place
Puyallup
Bonney Lake
Enumclaw
Lakewood
Parkland
Buckley
South Hill
Spanaway
Lacey
Clearwater Wilderness
PIERCE
Yelm
Rainier
Eatonville
La Grande
LEWIS
Morton
Lahar Evacuation Routes
Emergency Services
Pedestrian
Vehicle


Lahar Evacuation Routes
Emergency Services
Pedestrian
Vehicle


Renton
Kent
Green River
Gorge State Park
Conservation Area
Squaxin Island
Reservation
Olympia
Clearwater
Wilderness
Deschutes River
Green River
Crow Creek
American River
Snoqualmie
National Forest
Centralia
Cascade Range
South Fork Chehalis
138 ft
101
16
7
12
5

Further Research

- Learn more about ArcGIS pro and how it works in connection with Python
- Create more maps that focus on the environment
- Figure out how to incorporate ML/deep learning into the models



Sources

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- https://www.arcgis.com/home/index.html
- https://www.esri.com/

Questions?