MUSA 6950

Final Project

Asian Elephants Migration Corridor Planner

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ELEPHANT
MIGRATION ROUTE PLANNER

Background & Context

Abnormal Migration Activity

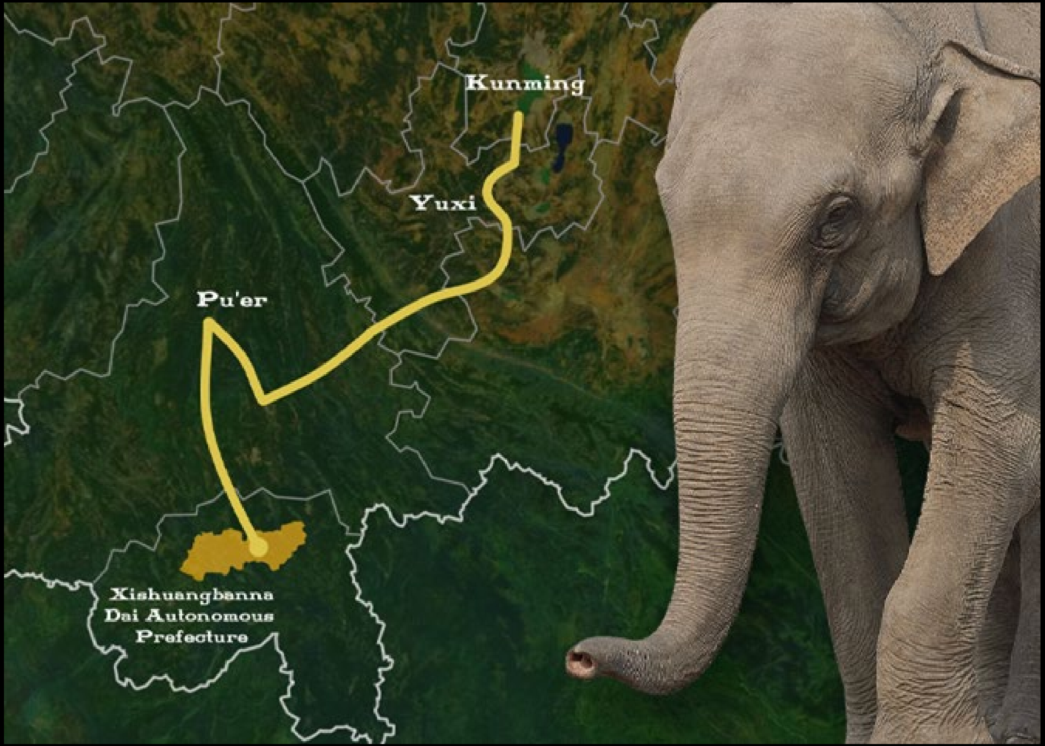
BBC

Home News Sport Business Innovation Culture Travel Earth Video Live

China elephants: 150,000 evacuated from path of trekking herd

One of China's wandering elephants has finally made it home. But problems exposed by the herd's journey aren't going away

Background & Context




The herd traveling from a nature reserve in Xishuangbanna to Yuxi, a city of 2.6 million people.

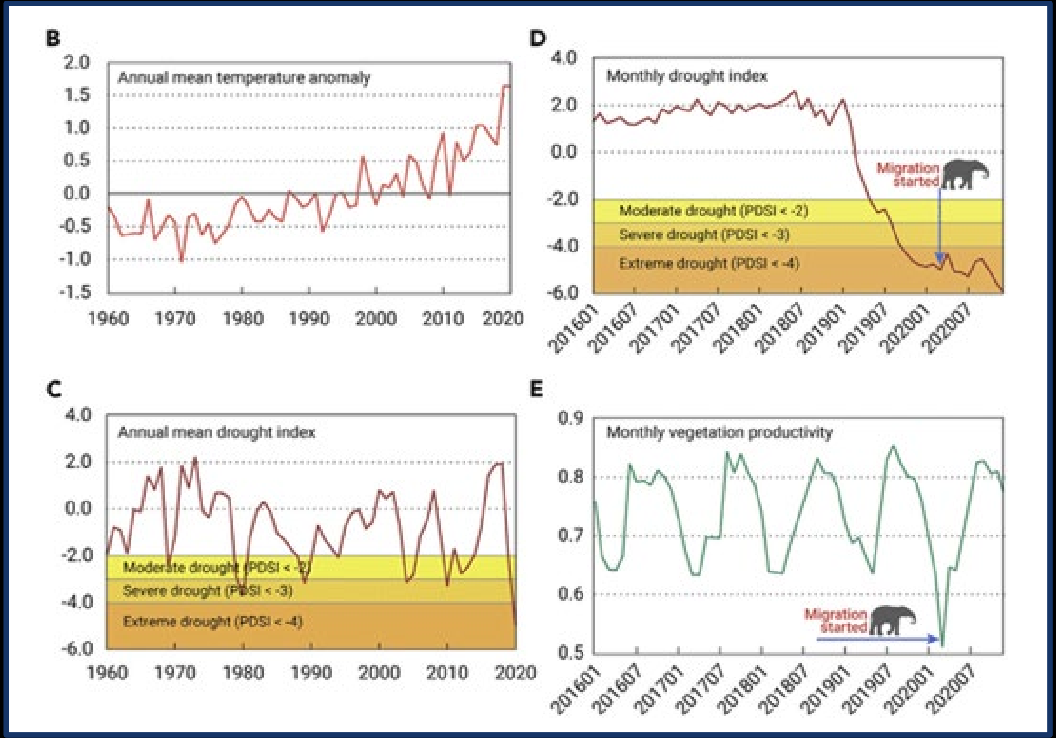
A government official shows the migration route of the elephants in Eshan County on May 28.

Background & Context

Significant Disruption：

- Between 2014 and 2020, the Yunnan government paid over **$26 million** in compensation for damage caused by elephants.
- From 2013 to 2019, **41 people** were trampled to death and **32 others** were injured by Asian elephants in Yunnan

Background & Context



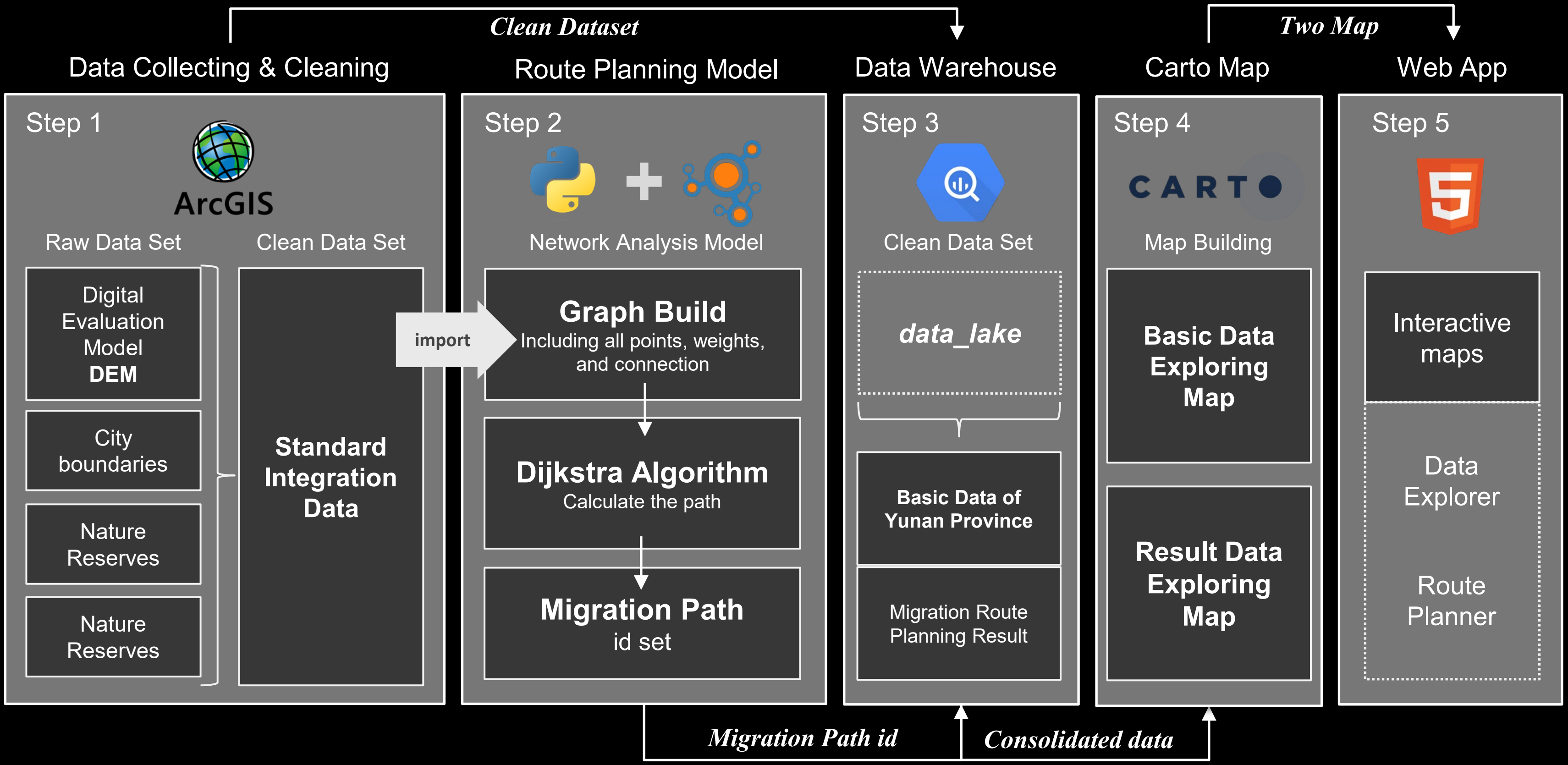
What is the **Reasons** behind it?

Population Growth?
Drought?
Temperature?
Food Resource?
……

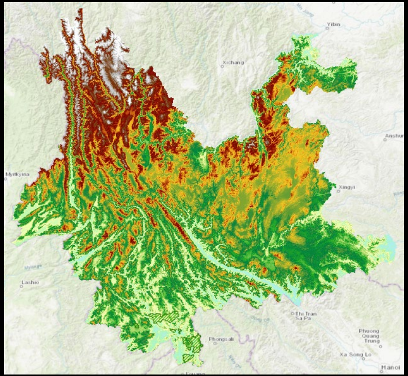
Background & Context

How should we choose the best **elephant migration routes** and set up **migration corridors** to protect both elephants and human property?

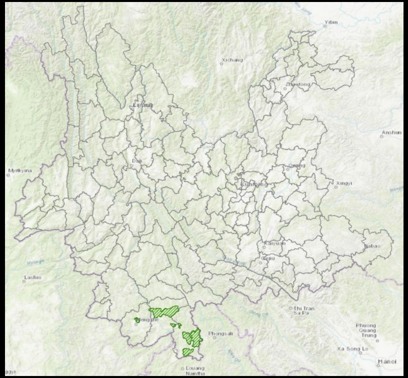
Model Framework



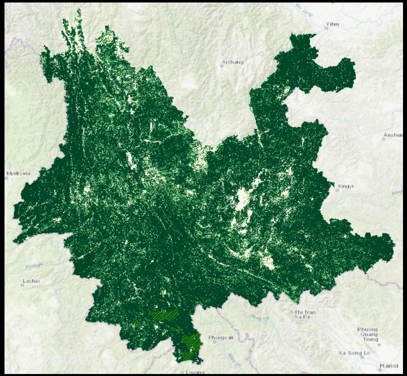
Data Collecting & Cleaning



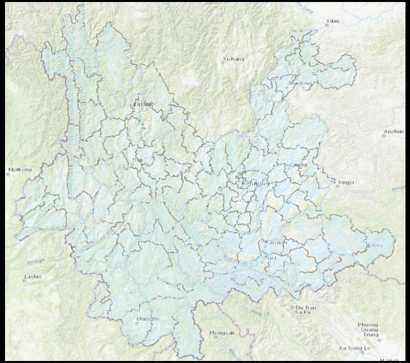
Digital Elevation Model (DEM)



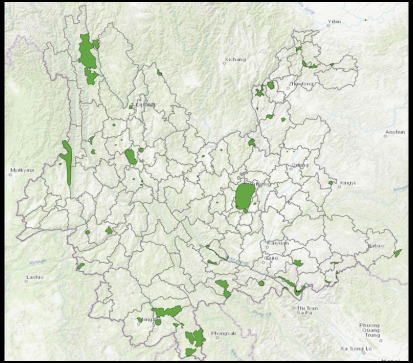
County Border



Forest Resource

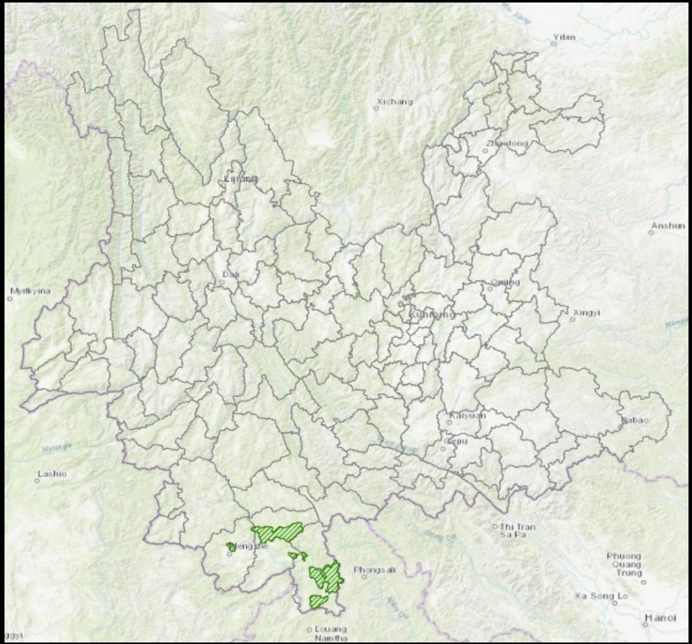


River System

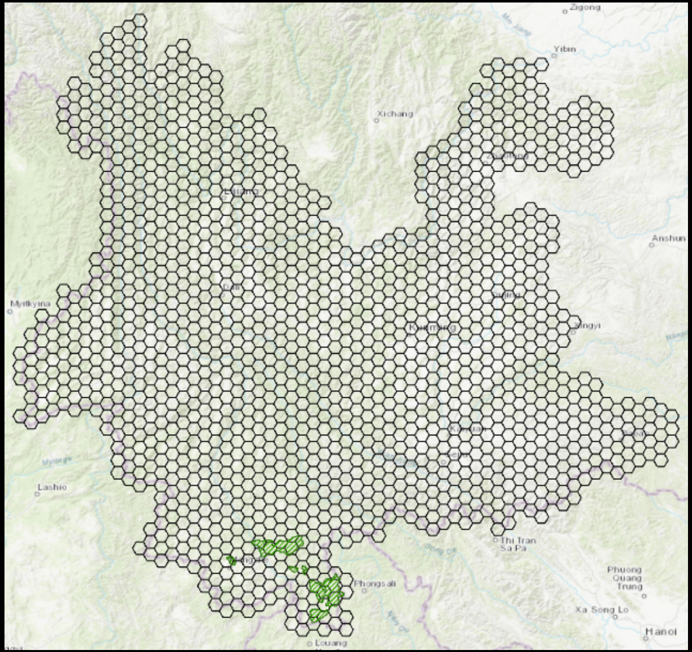


Existing Conservation Areas

Data Collecting & Cleaning

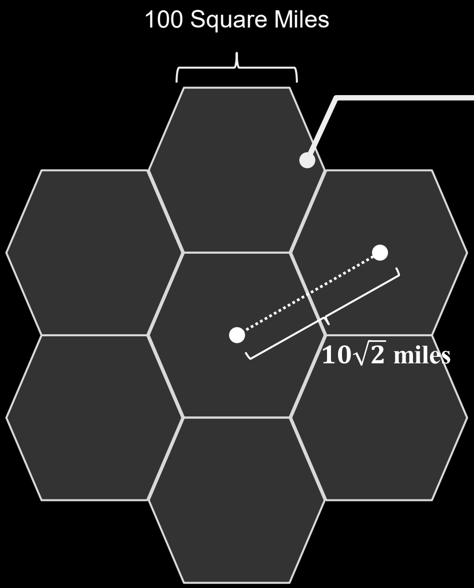


Original Raw Data



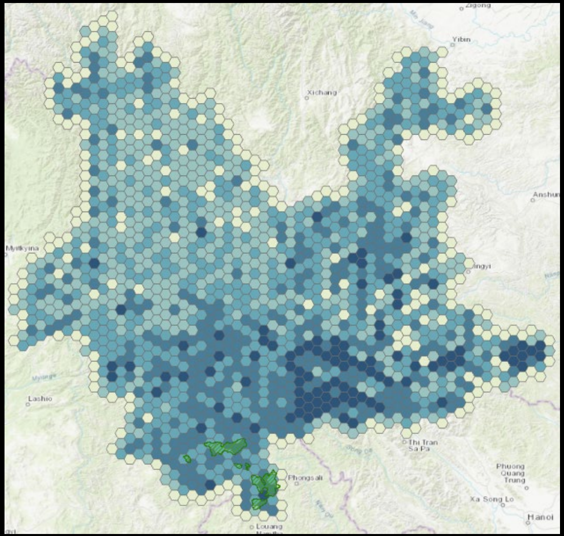
Converted Standard Data

Data Source

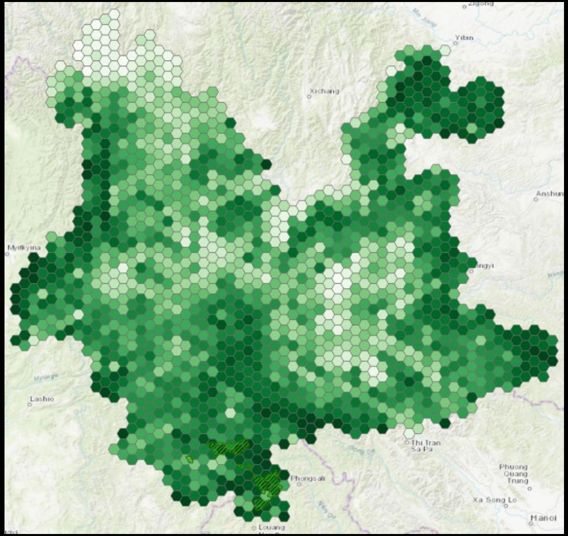


id	Forest_Area	Altitude	Water_Area	Population	Is_City	Is_Habitat
001	9000	2471	300	500	1	0
002	8000	2300	140	0	0	0
003	7560	2201	540	2000	1	0
004	6770	3210	270	2888	0	0
005	9290	2200	261	1000	0	1

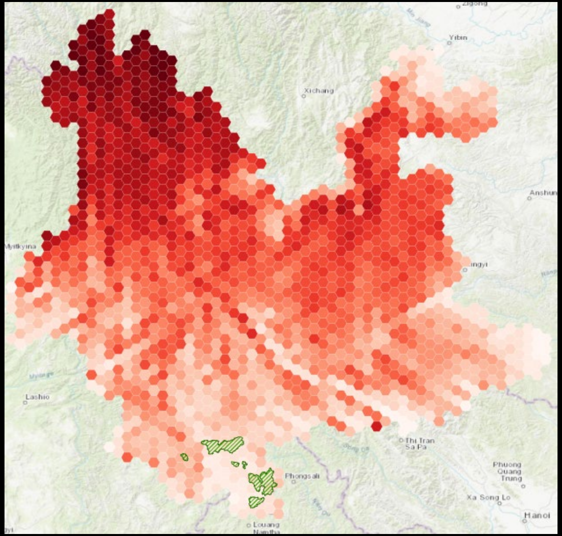
Data Collecting & Cleaning



Water Source

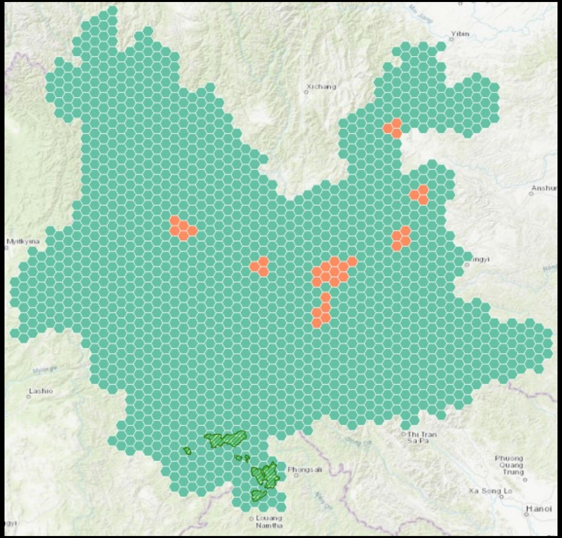


Forest & Food Source

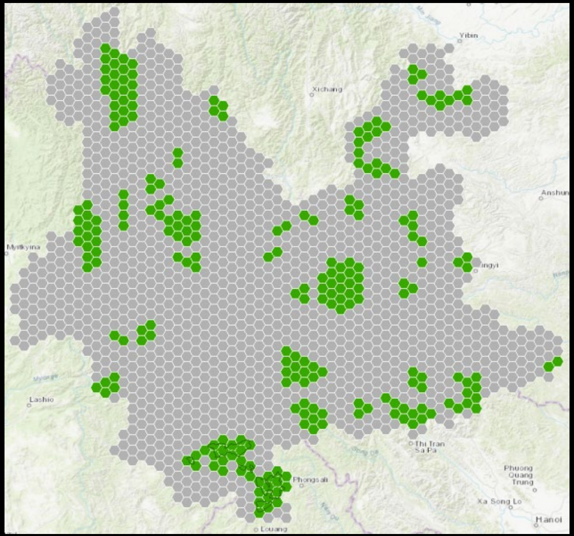


Altitude

Data Collecting & Cleaning



Is it a city?



Is it a habitat?

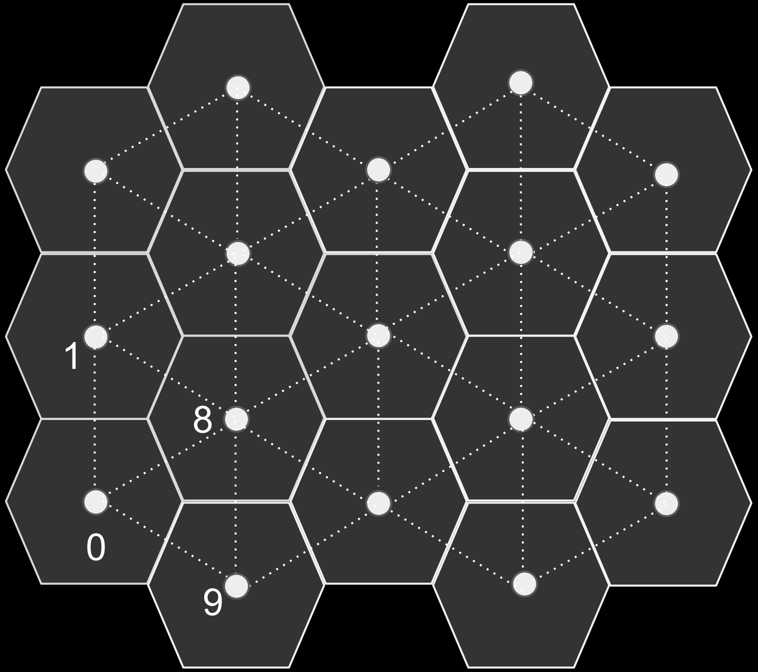
Algorithm design

Graph build

```python
def dijkstra_shortest_path(gdf, start_id, end_id):
    # Build a graph from GeoDataFrame
    graph = {}
    for index, row in gdf.iterrows():
        graph[row['id']] = {}
        for neighbor_index, neighbor_row in gdf.iterrows():
            if index != neighbor_index:
                distance = row['geometry'].distance(neighbor_row['geometry'])
                if distance <= 2000:  # 只连接距离小于等于 2000 米的邻居点
                    graph[row['id']][neighbor_row['id']] = distance
```

Origin **Point 0** Distance to **Point 1** Distance to **Point 2**

```
{0: {1: 18907.67976640627, 8: 19924.581230591983, 9:
18910.64278611532},
 1: {0: 18907.67976640627, 2: 18907.67976641894, 9:
19913.299319651444},
 2: {1: 18907.67976641894, 3: 18907.67976641602, 9:
18910.642786131157, 10: 19924.581230591983, 11:
18910.642786129818},
 3: {2: 18907.67976641602, 4: 18907.679766407855, 11:
19913.299319652375},
```



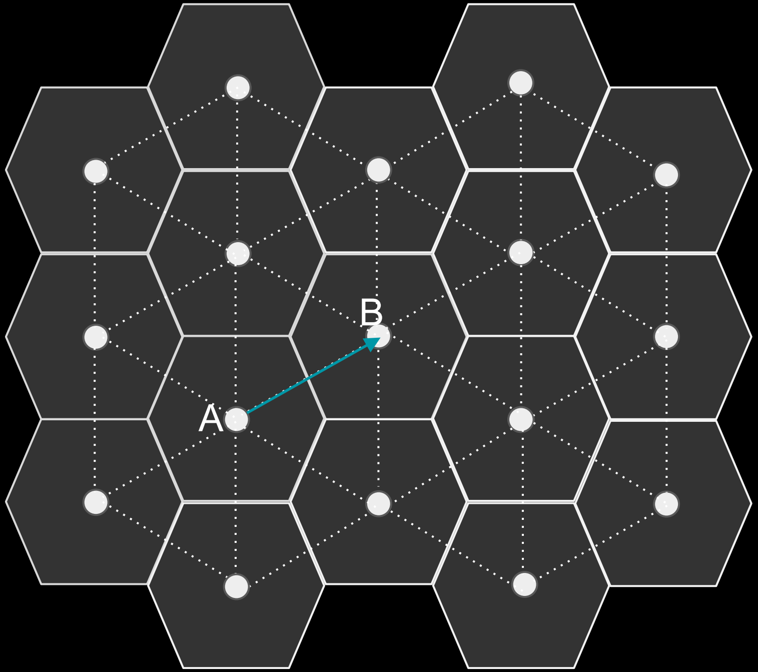
Algorithm design

So, when we do the simulation, how do we consider the **‘altitude’, ’river source’, and ‘forest source’?**

To move from Point A to Point B, the cost is:

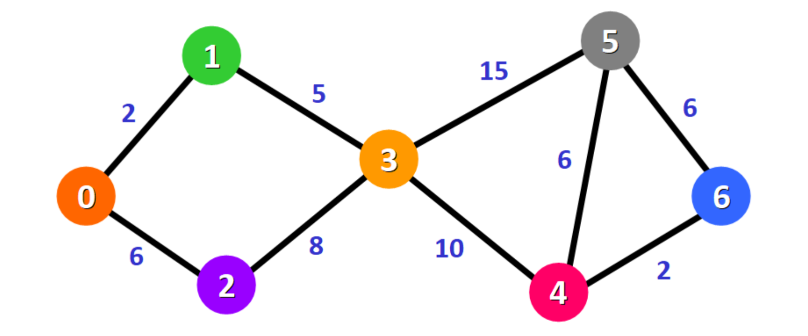
$$Cost = \alpha \cdot Distance - \beta \cdot Forest\ Source - \gamma \cdot River\ Length + \delta \cdot Average\ Altitude$$

$\alpha, \beta, \gamma, \delta$ are the weight we add to the attribute



Algorithm design

Dijkstra Algorithm

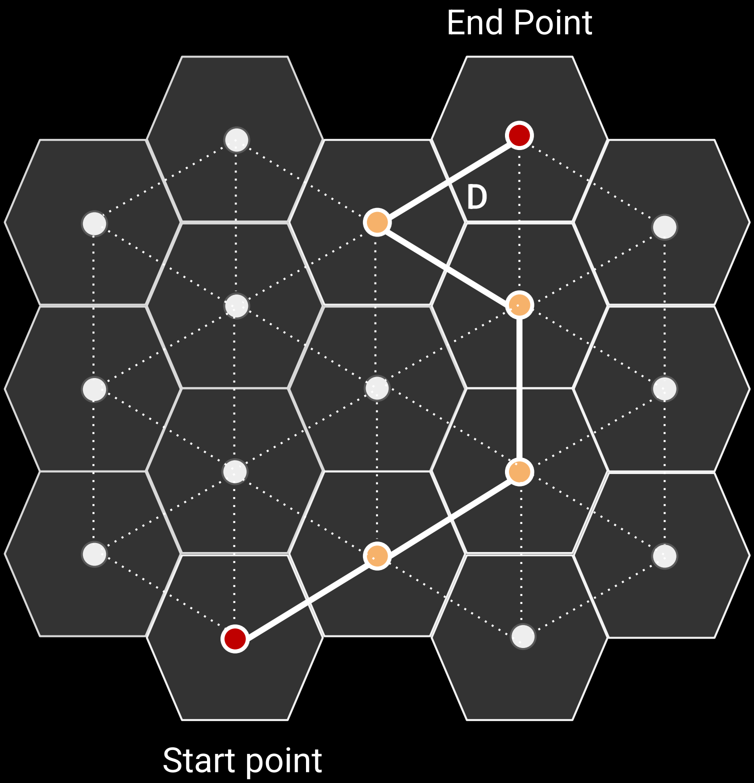


The algorithm will generate the shortest path from node 0 to all the other nodes in the graph.

Distance:

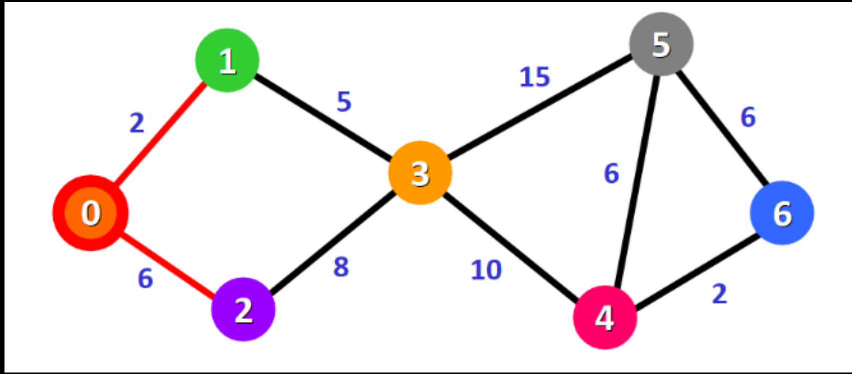
0: 0
1: ∞
2: ∞
3: ∞
4: ∞
5: ∞
6: ∞

Unvisited Nodes: {0, 1, 2, 3, 4, 5, 6}



Algorithm design

Dijkstra Algorithm

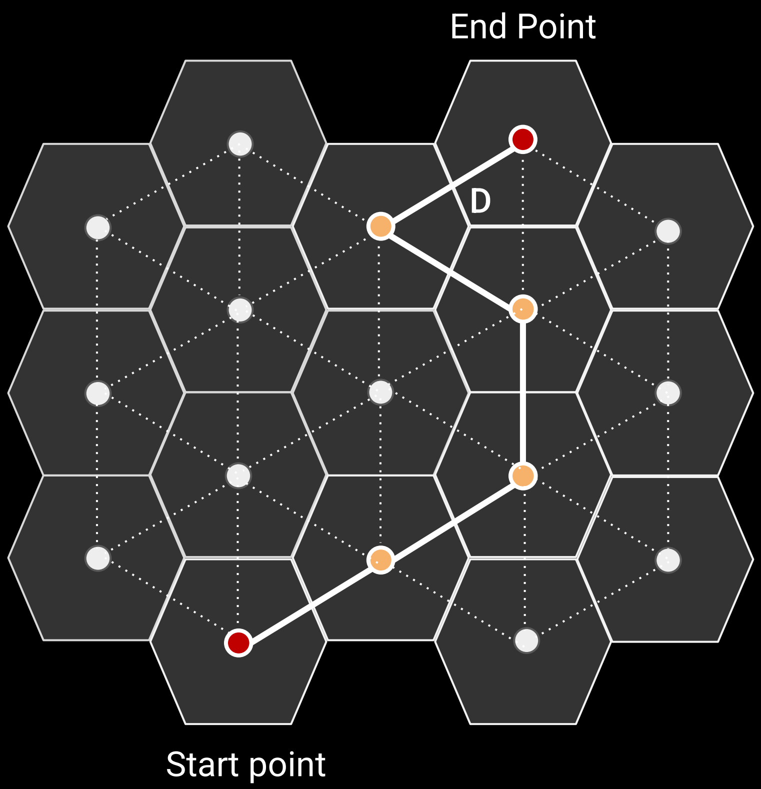


update the distances from node 0 to node 1 and node 2 with the weights of the edges that connect them to node 0 (the source node).

Distance:

0: 0
1: ~~∞~~ 2
2: ~~∞~~ 6
3: ∞
4: ∞
5: ∞
6: ∞

Unvisited Nodes: {~~0~~, ~~1~~, 2, 3, 4, 5, 6}

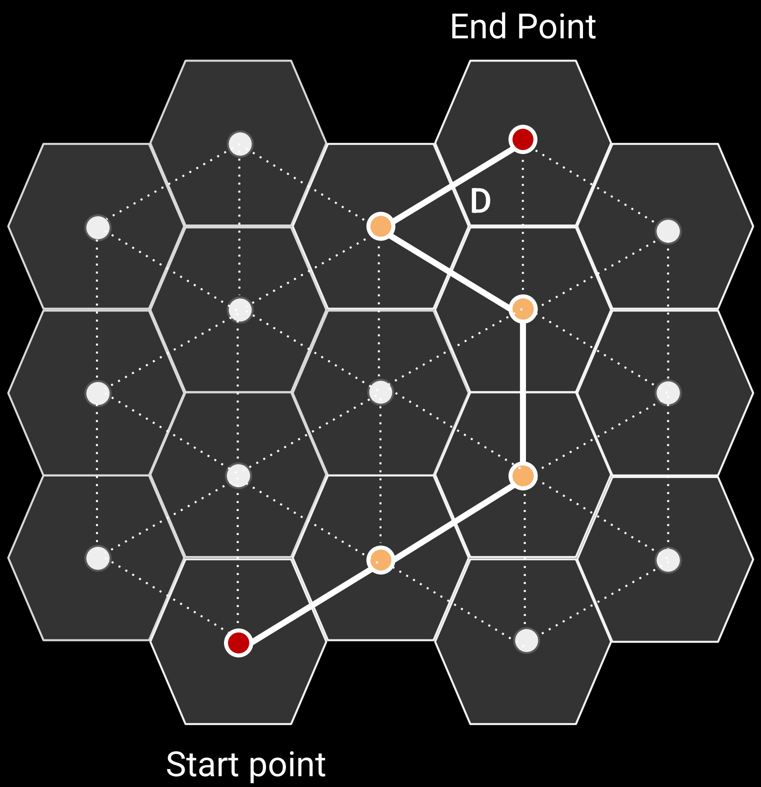


Algorithm design

As there are 1600 points in the geodata frame

Avg Calculation Time: **20min +…**

How to cut down the average calculation time?

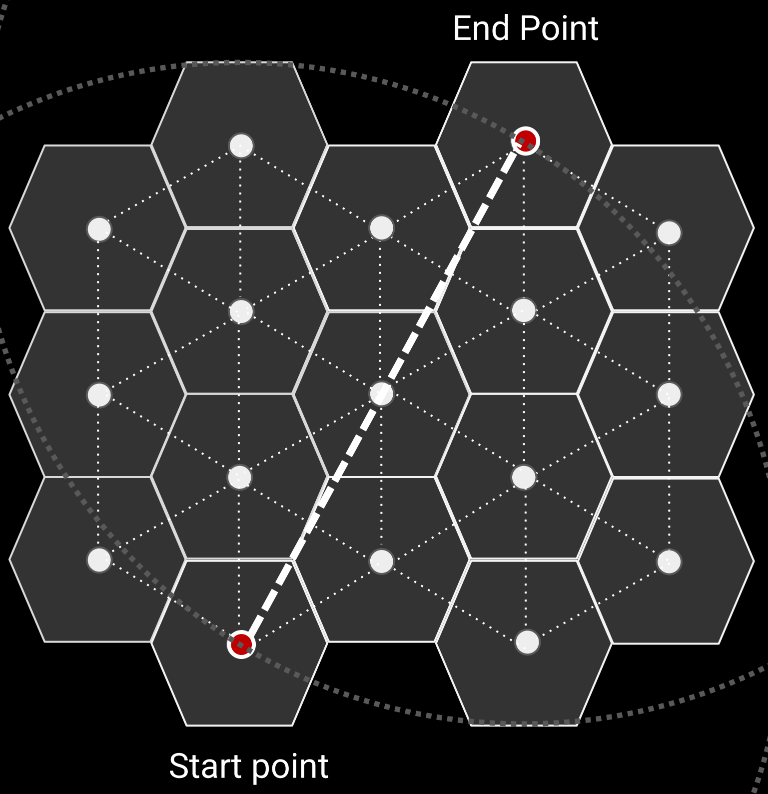


Algorithm design

Pruning

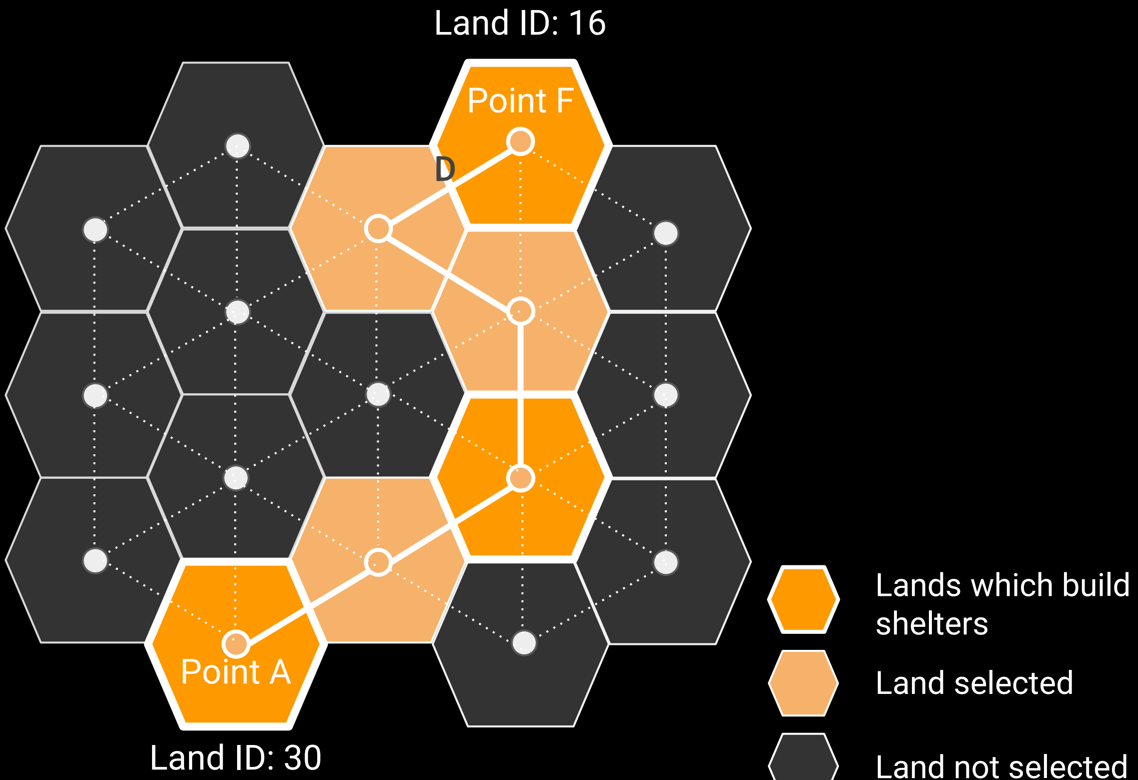
In this model, I will calculate the straight-line distance from the startpoint to the endpoint, and then consider only the points within this distance, slightly expanding the range (e.g., by an additional 10%) to ensure that potential optimal paths are not overlooked.

```
# caculate the distance of two points
line_distance = start_point.distance(end_point)

# search radius = 1.1* distance
search_radius = line_distance * 1.10

# filter the points within radius
mask = gdf['geometry'].apply(lambda x: x.distance(start_point) <= search_radius or
pruned_gdf = gdf[mask]
```



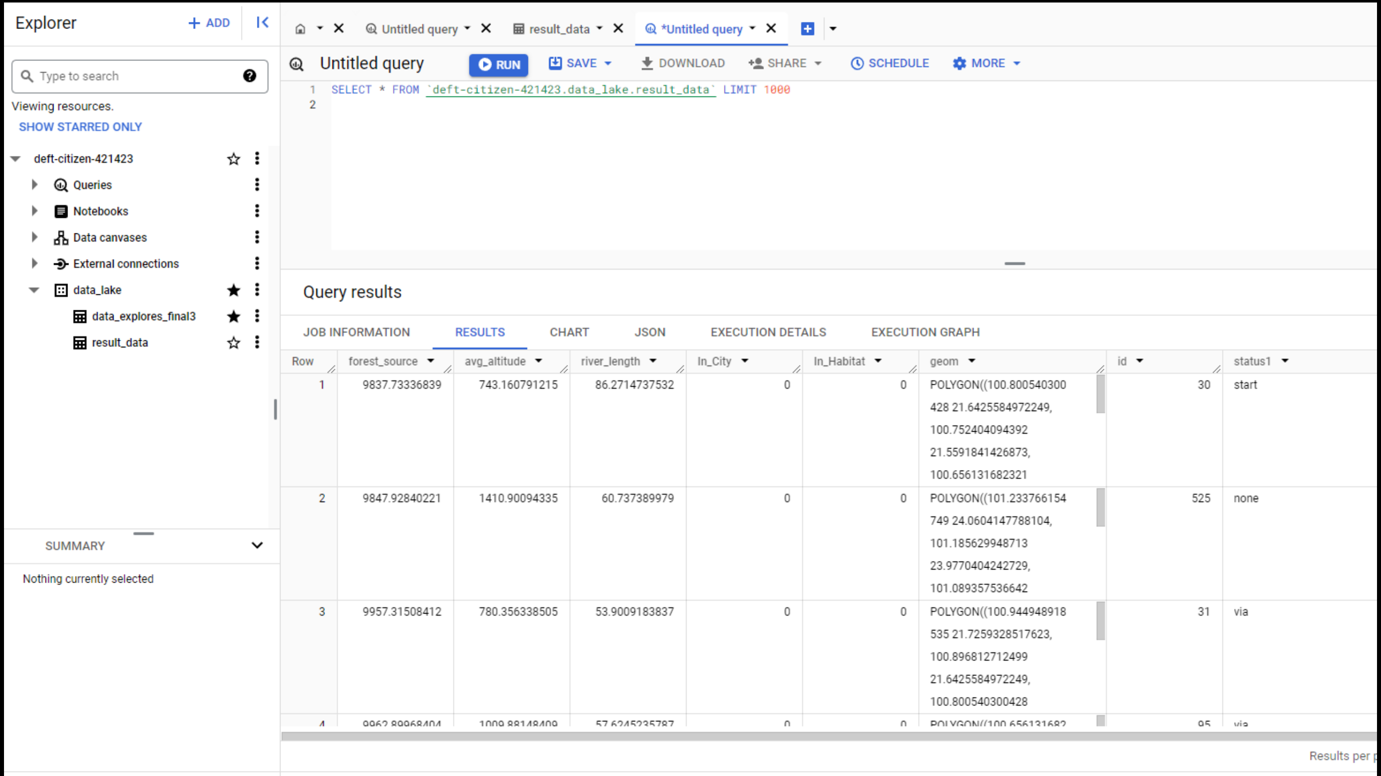
Algorithm design

```
Path IDs: [30, 44, 61, 79,
96, 95, 116, 143, 179, 180,
221, 222, 266, 267, 314,
315, 366, 367, 419, 420,
475, 476, 536, 537, 598,
599, 656]
```



Total Forest Area
Total River Area
Total Distance
Financial cost

BigQuery


Explorer
+ ADD
Type to search
Viewing resources.
SHOW STARRED ONLY
deft-citizen-421423
Queries
Notebooks
Data canvases
External connections
data_lake
data_explores_final3
result_data
SUMMARY
Nothing currently selected
Untitled query
result_data
*Untitled query
Untitled query
RUN
SAVE
DOWNLOAD
SHARE
SCHEDULE
MORE
SELECT * FROM `deft-citizen-421423.data_lake.result_data` LIMIT 1000
Query results
JOB INFORMATION
RESULTS
CHART
JSON
EXECUTION DETAILS
EXECUTION GRAPH
Row
forest_source
avg_altitude
river_length
In_City
In_Habitat
geom
id
status1
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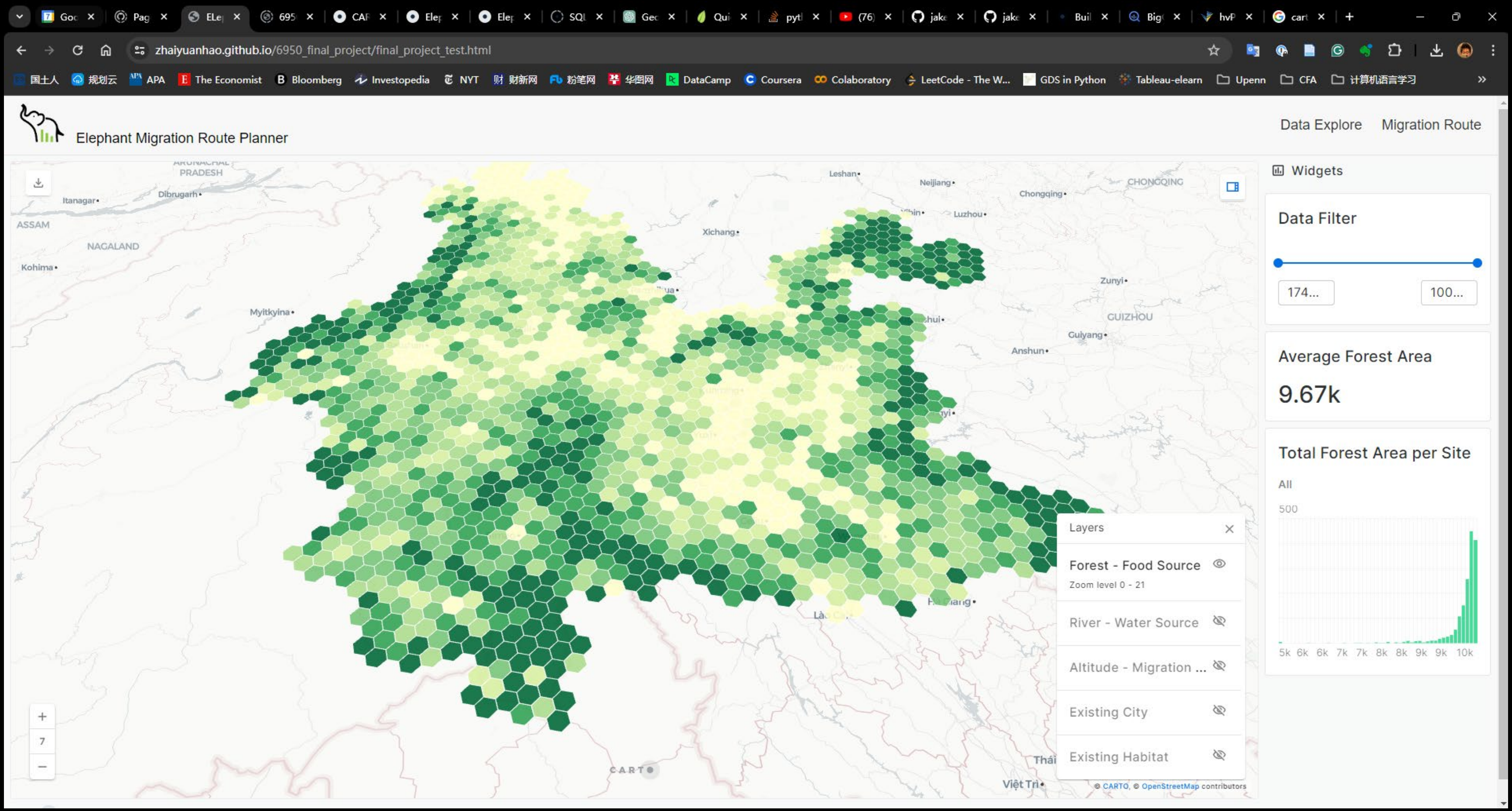
Results per


zhaiyuanhao.github.io/6950_final_project/final_project_test.html
Elephant Migration Route Planner
Data Explore
Migration Route
Widgets
Data Filter
174...
100...
Average Forest Area
9.67k
Total Forest Area per Site
All
500
5k 6k 6k 7k 7k 8k 8k 9k 9k 10k
Layers
Forest - Food Source
Zoom level 0 - 21
River - Water Source
Altitude - Migration ...
Existing City
Existing Habitat
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Reference

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