**Optimizing emergency responses: developing operations research tools for Flood response in Bangladesh**

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**Abstract:**

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# Introduction

# Method

## Data:

### Summary of the case study (present situation)

As of today (Aug 25, 2024), more than 500,000 people have taken refuge in around 3,500 shelters in the 11 flood-hit districts, where nearly 750 medical teams are on the ground to provide treatment (ReliefWeb 2024; Paul 2024). Most affected communities are from Feni, Noakhali and Khagracchari districts; 193,864 people are in 3170 shelters.

Challenges (Brainstormed with Riad):

1. Most Bangladesh Army base locations are NOT open-source
2. Emergency response in Bangladesh is often at community level (getting data at national level is almost impossible, partly due to security reasons)

Working on:

1. Collecting GIS map & .json/.shp files of flood impacted regions ++

**Some useful links (ref. everyone):**

1. <https://protirodh.net/flood> (you need to drag the map to the right). Note: view is different in Safari vs Chrome.
2. <http://biwta.port-log.net/live/Map.php>
3. Flood Forecasting & Warning Centre <http://www.ffwc.gov.bd>
4. Water level [data](https://ffwc.rimes.int/app/observed-water-level)

A map with many houses and red dots

Description automatically generated

**Figure 1 Affected regions in Bangladesh (Source: protirodh.net 2024)**

### Data needed for the optimization model

**Table 1 Metadata and database schema**

|  |  |  |  |
| --- | --- | --- | --- |
| *Category* |  | *Specifics* | *Data points/ type* |
| Affected region | Road Network Data | Traffic Data: Real-time or historical traffic patterns, congestion data, and road closures.  Accessibility: Information on road conditions, including roads that may be flooded or inaccessible. |  |
|  | **Shelters**: Locations of emergency shelters and their capacities.  Hospitals: Locations, capacities, and current status (operational or flooded).  Locations of communication towers, especially in areas with poor signal coverage. | Geolocation of shelters (& their capacity)  Note: Current occupancy in this shelters are location of demand points for our model. |
| Supplier |  | **Depots/Warehouses**: Locations of resource storage facilities. | Geolocation of depot |
| Resource Data | Resource Type: Types of resources available for distribution (e.g., food, water, medical supplies).  Stock Levels: Current stock levels of each resource at different locations.  Resource Requirements: Demand for resources at various locations. |  |
| Affected people (demand) |  |  |  |

Hypothetical table summarizing some of the GIS data elements, shown in *Table 2*. We may not be able to obtain or produce such precise information for our problem, but this can be a good starting point for our data collection.

Table 2 Hypothetical datatable (for our brainstorming), produced using ChatGPT

| **Data Type** | **Attributes** | **Example Values** |
| --- | --- | --- |
| **Road Network** | Road ID, Type, Condition, Traffic Level, Closure Status | R123, Highway, Good, High, Open |
| **Bridges** | Bridge ID, Location, Condition, Flood Risk | B456, (38.8977, -77.0365), Fair, High |
| **Elevation** | Location, Elevation (m) | (38.8977, -77.0365), 50 |
| **Flood Zones** | Zone ID, Flood Risk Level, Last Flooded Date | FZ789, High, 2024-08-20 |
| **Shelters** | Shelter ID, Location, Capacity, Occupancy | S101, (38.8977, -77.0365), 200, 150 |
| **Hospitals** | Hospital ID, Location, Status, Bed Capacity | H202, (38.8977, -77.0365), Operational, 100 |
| **Population Density** | Location, Density (people/km²) | (38.8977, -77.0365), 2000 |
| **Weather** | Location, Temperature (°C), Rainfall (mm), Wind Speed (km/h) | (38.8977, -77.0365), 25, 50, 10 |
| **Resource Stock** | Resource ID, Type, Location, Stock Level | R303, Water, Depot 1, 5000 liters |
| **Resource Requirement** | Location, Resource Type, Required Quantity | (38.8977, -77.0365), Food, 1000 kg |
| **Communication Towers** | Tower ID, Location, Signal Strength | C404, (38.8977, -77.0365), Strong |

### Dataset of our case-study

**Table 3 Dataset of flood-affected region**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  |  |  |  |  |
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|  |  |  |  |  |

Population density of Bangladesh [source link](https://www.kaggle.com/datasets/ahnaftahmid/bangladesh-geojson-adm2-64-districts-zillas/code); [link2](https://www.kaggle.com/datasets/ahnaftahmid/districts-of-bangladesh)

# Result & Discussion

The flood severity plot in Figure 2 is semi-hypothetical (I have manually put the severity after reading some local newspapers). Population density plot in Figure 3 (need to fix color++)

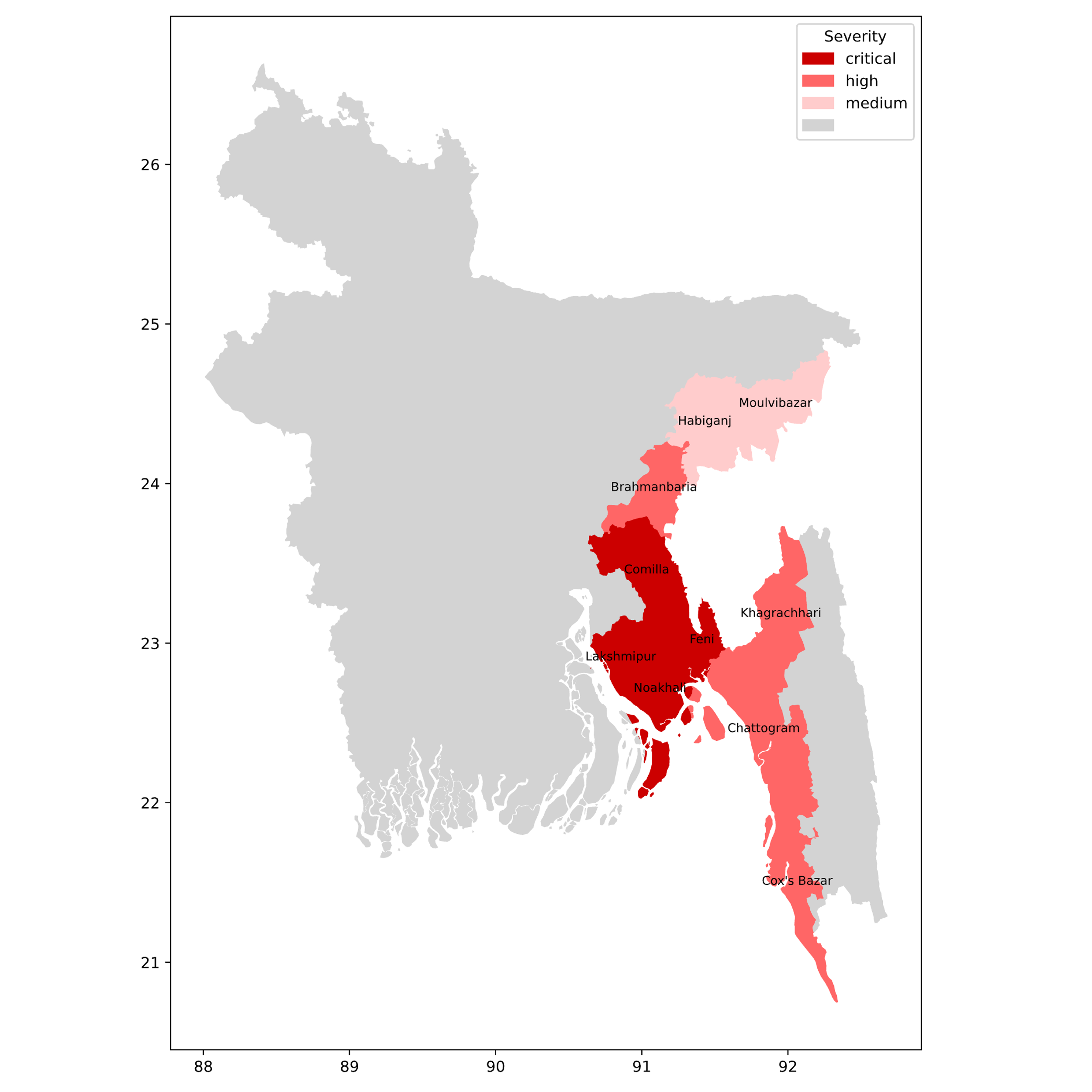


Figure Floor severity in affected districts

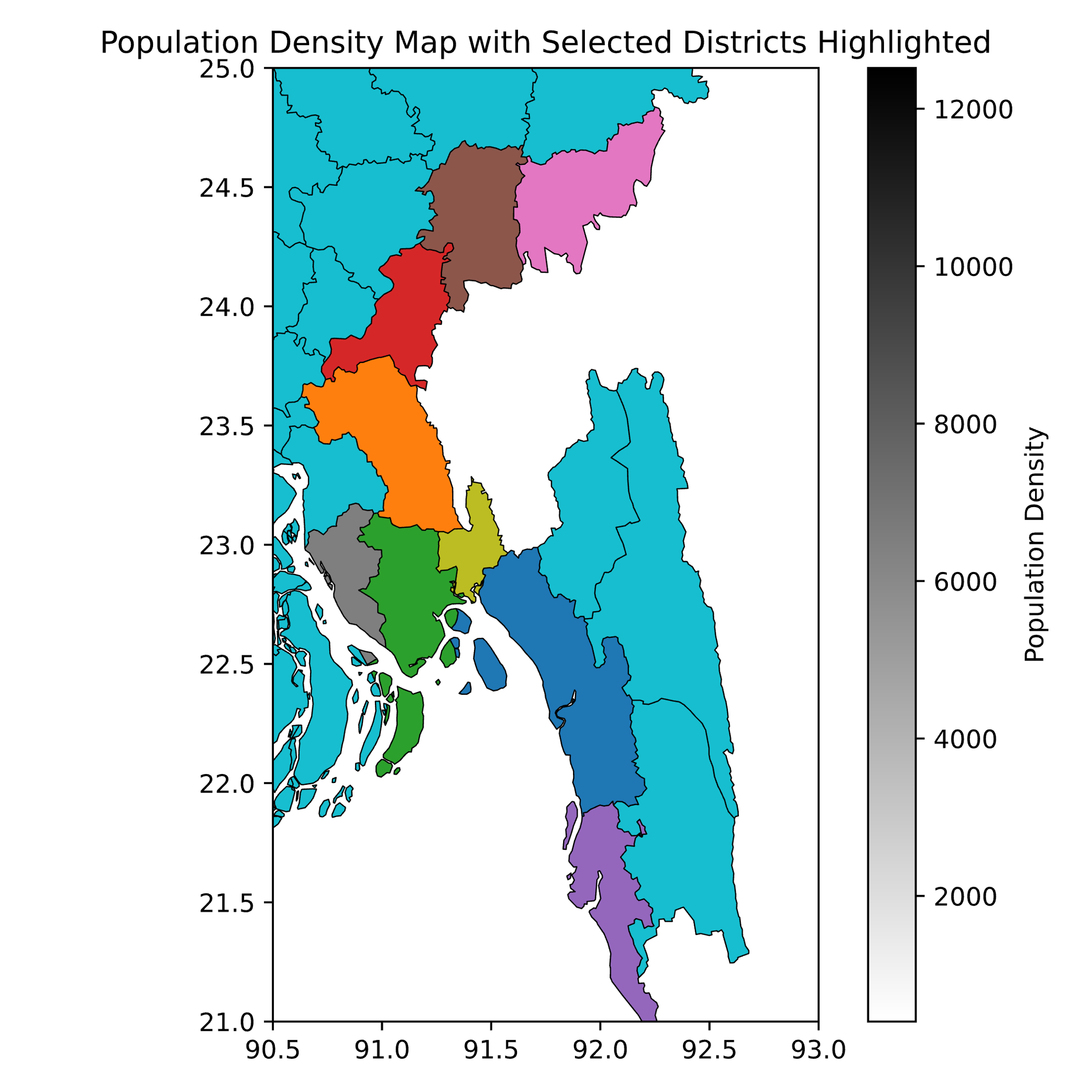


Figure 3 Population density

Tanmoy (Aiming to complete below tasks before Sep 01 meeting): +++

1. Feni (GIS map with shelter locations, population, severity)
2. Fix Fig3
3. POC
   1. math model and descriptive text of VRP-TW model
   2. brainstorm on DV, objective function
4. 1-2 idea brainstorming for webapp.
5. Optimized network (add one GIF for Github homepage)

# Conclusion

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**Supplementary resources**

<https://github.com/tanmoyie/Optimizing-flood-reponse-in-Bangladesh>

**Authors’ contribution**

***Md Mahbubar Rahman:*** original research idea, optimization model development, solution algorithm; ***Tanmoy Das:*** optimization model development, data curation and analysis; ***Riad Alam:*** Domain experience, data collection; ***Hafizur Rahman:*** model deployment, validation

**Reference**

Paul, Ruma. 2024. “Twenty Dead, 5 Million Affected in Bangladesh Floods.” Yahoo News. 2024. https://au.news.yahoo.com/twenty-dead-5-2-million-145537062.html.

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