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

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**Abstract:**
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# 1 INTRODUCTION

**Idea generation :**
Brainstormed (Mahbub & Tanmoy)

1. Collect data (GIS map, and
2. Information needed on depo, warehouse storage location (supply), affected area, and population (demand)
3. Build the conceptual and mathematical models
4. Column generation to solve the optimization problem

# 2 METHOD

## 2.1 Data:

### 2.1.1 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

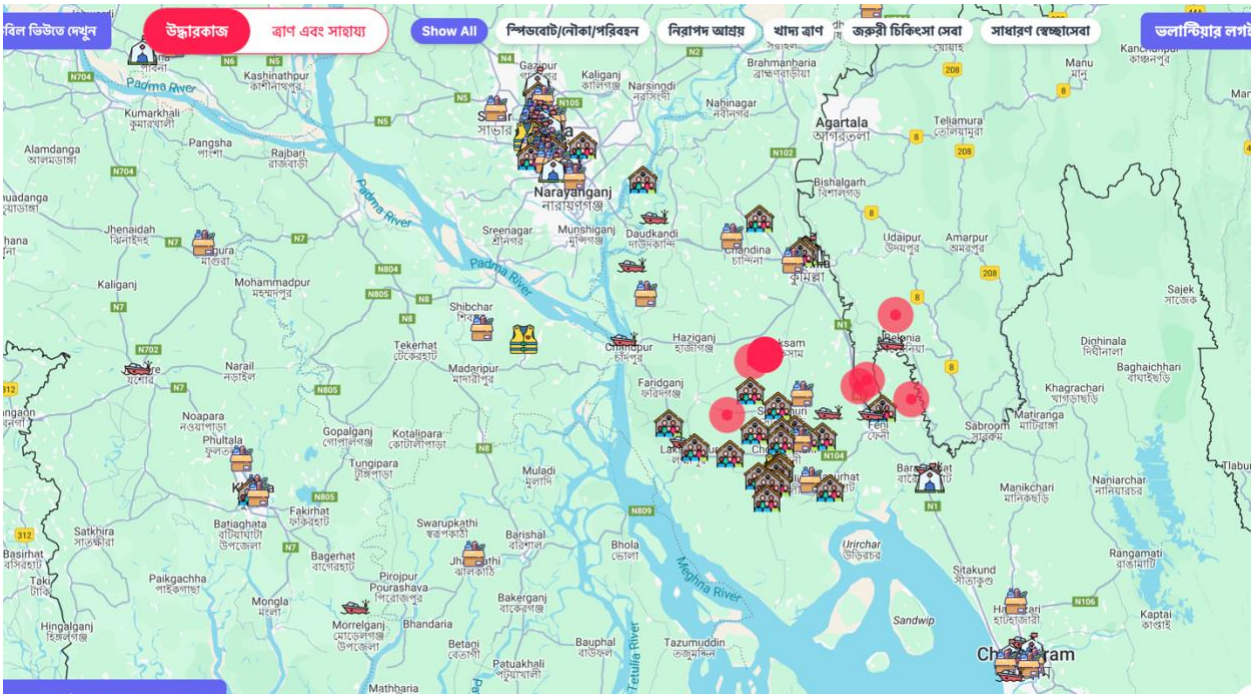


**Figure 1 Affected regions in Bangladesh (Source: protirodh.net 2024)**

### 2.1.2 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.<br>Accessibility: Information on road conditions, including roads that may be flooded or inaccessible. | |
| | | **Shelters**: Locations of emergency shelters and their capacities.<br>Hospitals: Locations, capacities, and current status (operational or flooded).<br>Locations of communication towers, especially in areas with poor signal coverage. | Geolocation of shelters (& their capacity)<br>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).<br>Stock Levels: Current stock levels of each resource at different locations.<br>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 |

| Data Type | Attributes | Example Values |
|---|---|---|
| **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 |

### 2.1.3 Dataset of our case-study

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

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## 3 RESULT & DISCUSSION

# 4 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

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