FLOOD MAPPING FOR BANGALORE

TEAM 9

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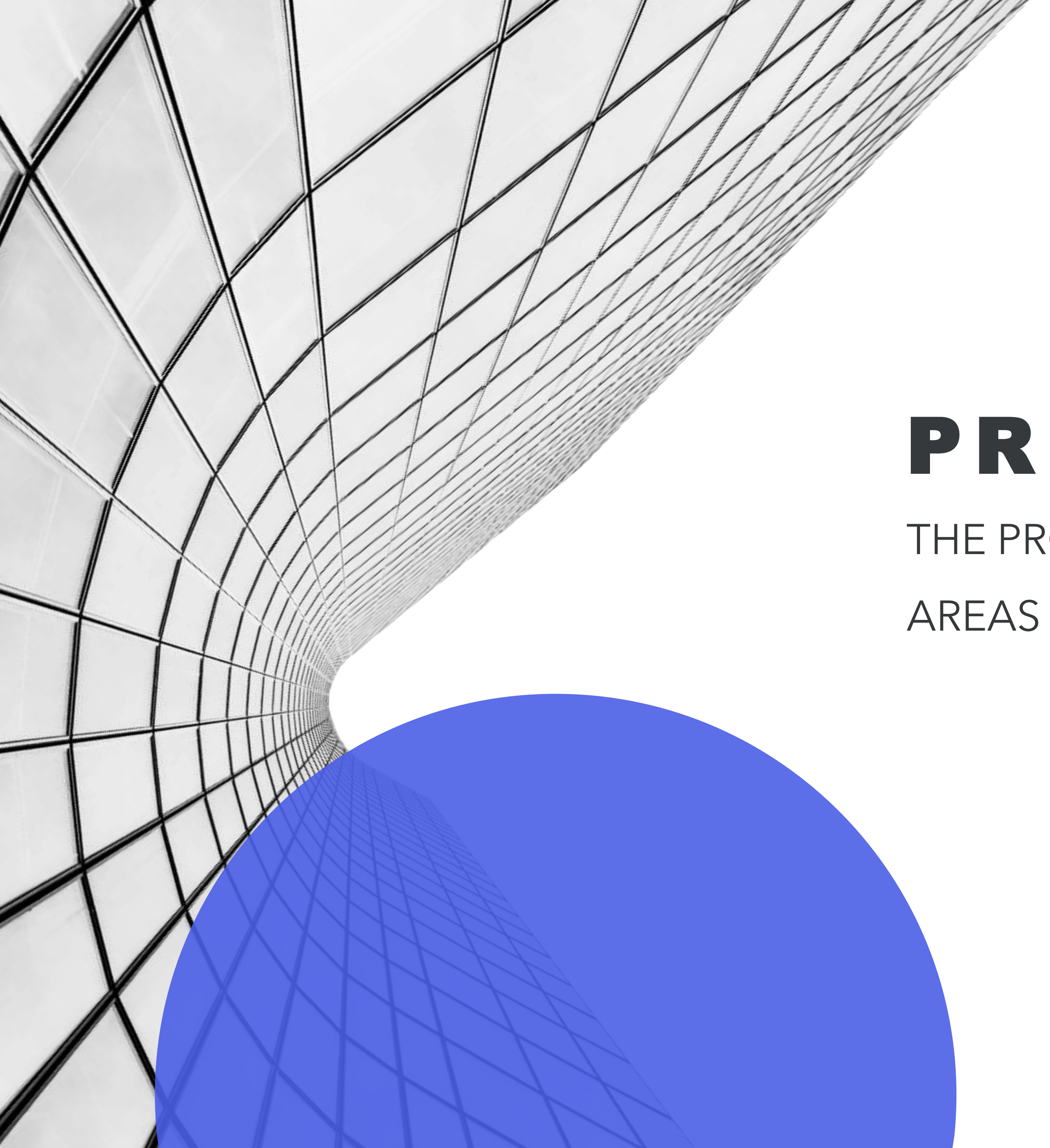
INTRODUCTION

This study focuses on developing flood hazard maps for Bengaluru's urban district, emphasizing the identification and analysis of flood-prone areas caused by different factors. Using Geographic Information System (GIS) techniques integrated with Multi-Criteria Decision Analysis (MCDA), the project evaluates key factors and combines them .

The approach aims to perform flood susceptibility mapping and identify regions based on their flood risk levels.

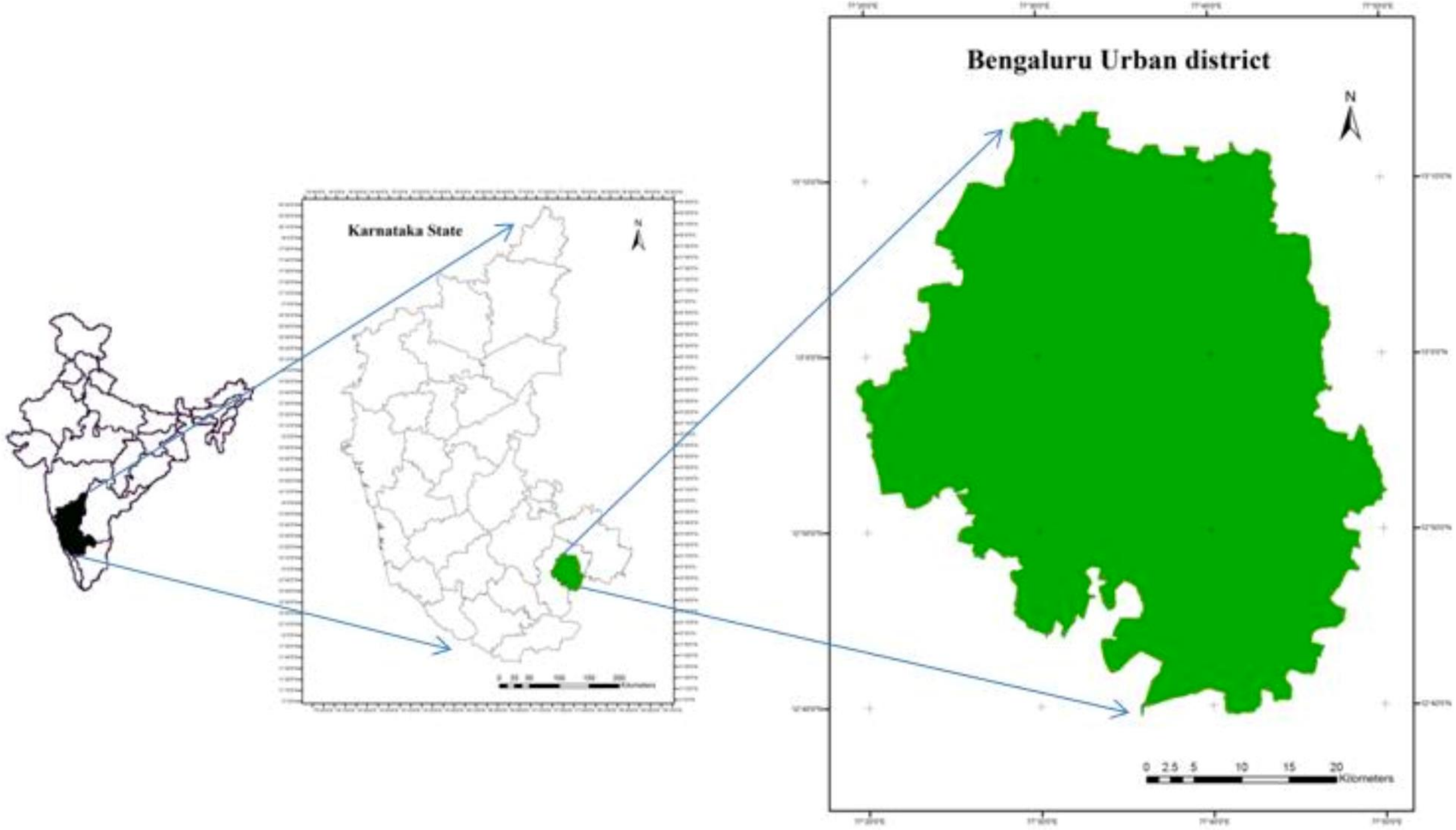


PRIMARY GOALS

THE PROJECT AIMS TO IDENTIFY FLOOD-PRONE AREAS IN BANGALORE

REGION OF INTEREST (ROI)

Fig. 1: Location of the study area



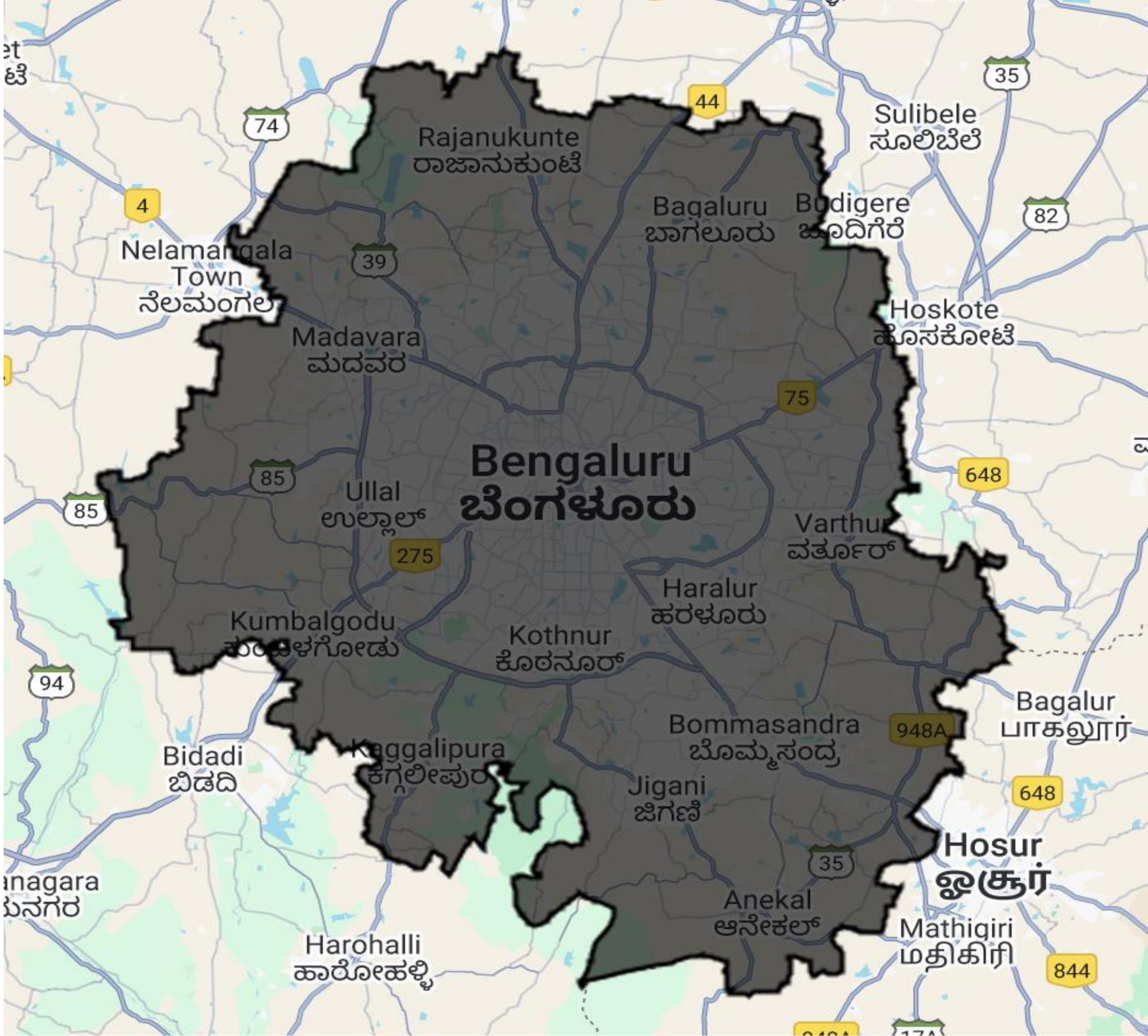
Ref : Taken from Rajeesh *et al.*: Urban flood hazard zonation in Bengaluru Urban District, India

REGION OF INTEREST:

BENGALURU URBAN DISTRICT

The shape file used here is "Bengaluru District Boundary" (.shp format) taken from KSRSAC has various Spatial Data collected from Departments.

[Shape file source]



IMPLEMENTATION

Methodology

- **Selection of Factors**

We considered four key factors influencing flood risk: NDVI (vegetation), elevation, distance from permanent water bodies, and TPI (topographic position index) for the region of interest.

- **Creation of Layers**

Separate layers were created for each factor using the datasets .

- **Scoring System**

The values in each layer were divided into 5 bands, assigning scores from 1 to 5.

Score 1 indicates low flood risk, and **score 5** indicates high flood risk

Each layer's values were mapped based on their contribution to flood risk.

- **Weighting the Factors**

  Each factor was assigned a weight depending on its importance in contributing to floods.

  For example, elevation may have more weight than NDVI due to its critical role in water accumulation.

- **Combining Scores**

  The scores from all layers were combined, applying their respective weights. This produced the final flood risk map, with areas categorized based on their overall scores.

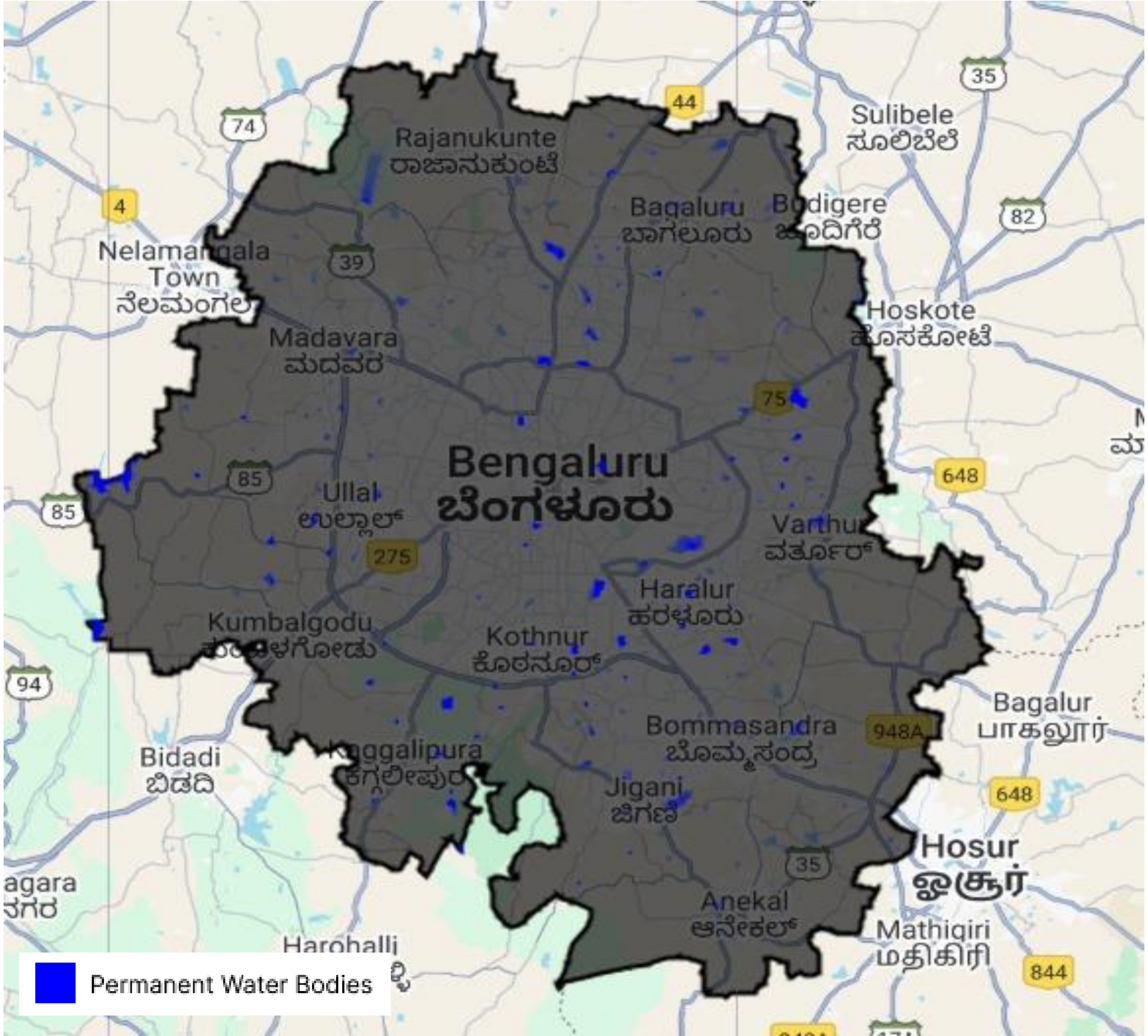
- **Final Flood Map**

The resulting map visually highlights regions with low to high flood risks, providing insights for flood management.

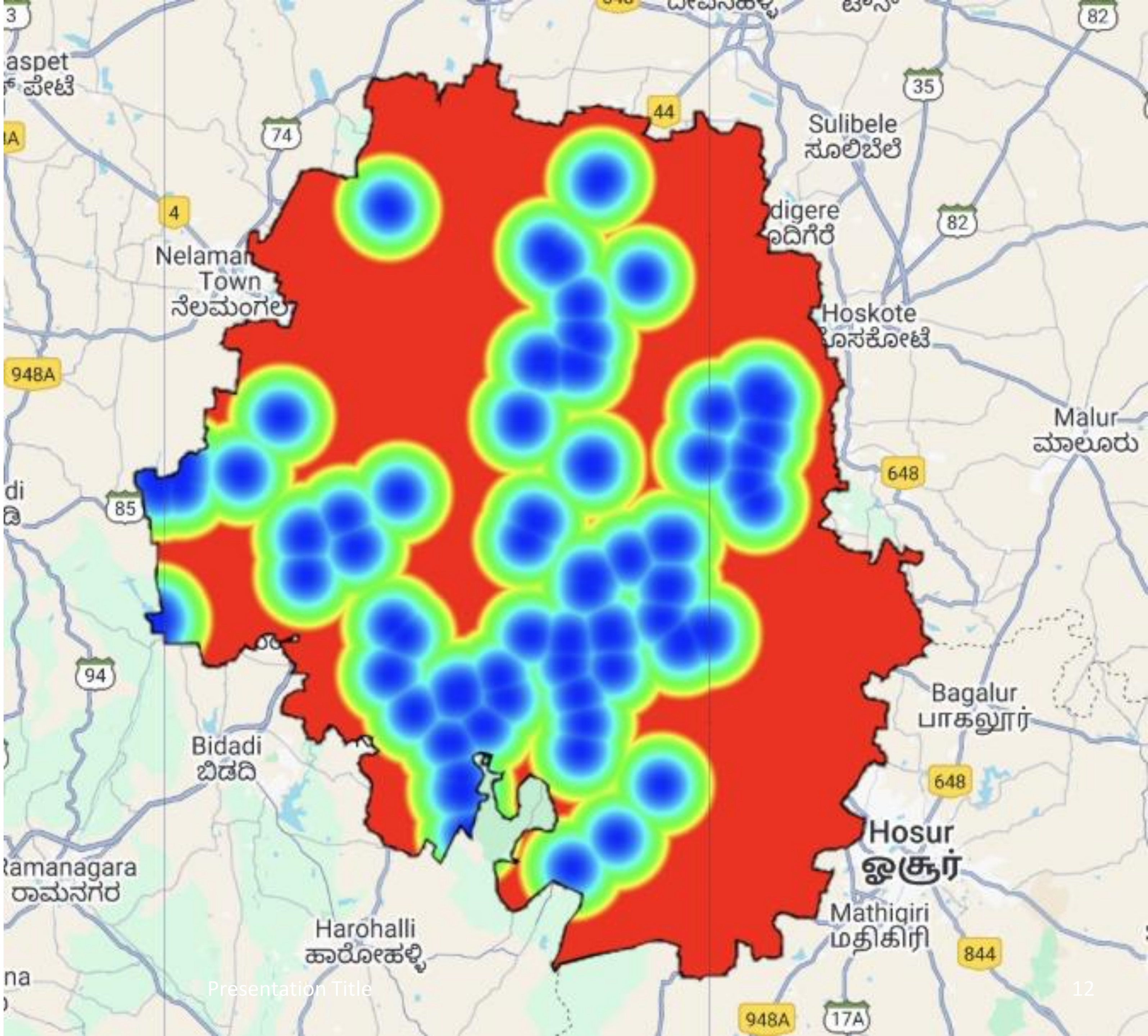
We divided the range into scale of 5 and assigned the colors accordingly.

- **Dataset Name**: **Global Surface Water Dataset (GSW)**:
- **Dataset**: `JRC/GSW1_3/GlobalSurfaceWater` Dataset
- **Resolution**: 30 meters.
- **Water Occurrence**: Identifies areas with water presence over time.
- **Permanent Water**: Extracts regions with high water occurrence (>60%), representing stable water bodies.
- **Why used**: This dataset provides historical water occurrence information derived from Landsat imagery, helping to understand the relationship between water bodies and flooding potential.

PERMANENT WATER



DISTANCE FROM PERMANENT WATER



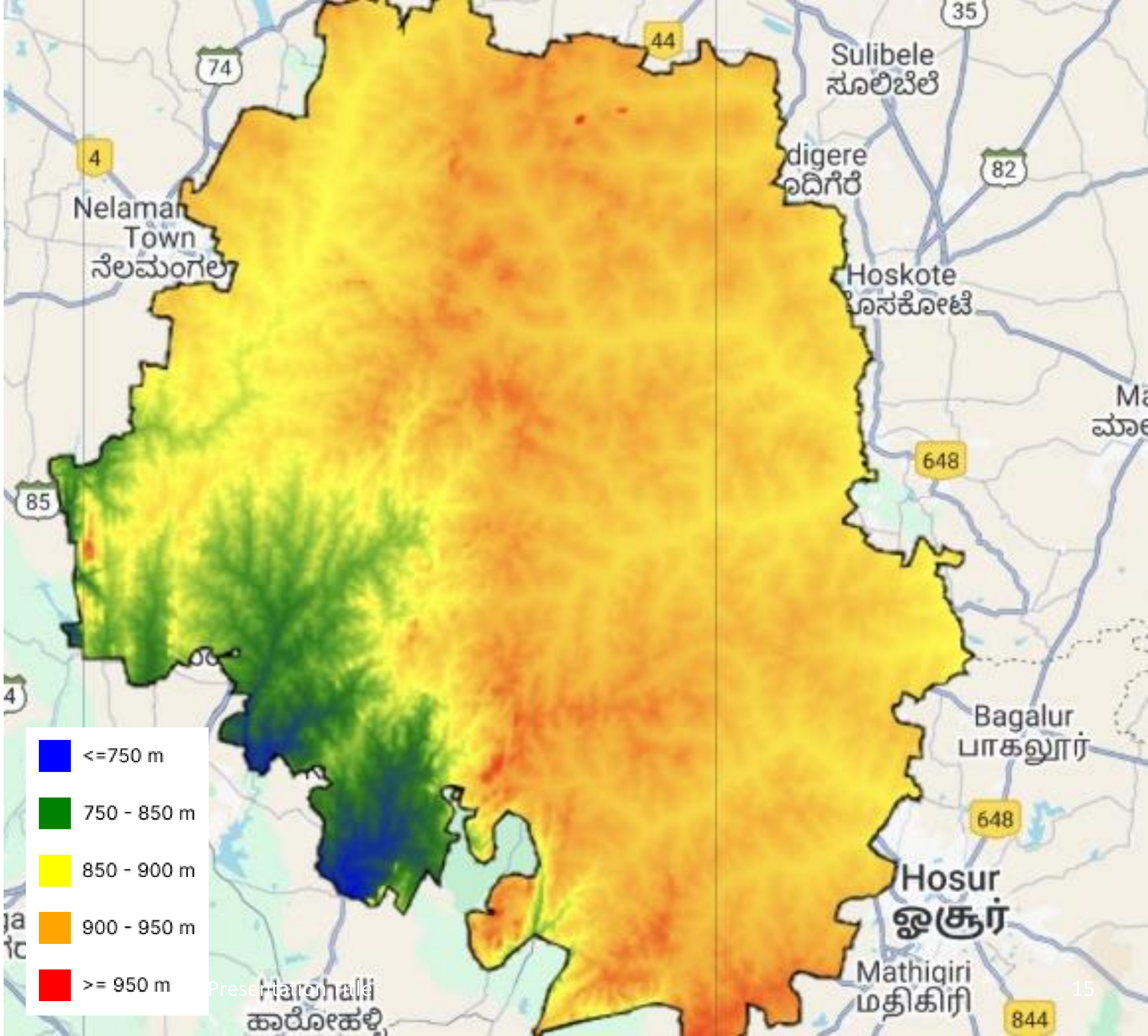
Greater distance from water bodies generally indicates lower flood risk, as areas farther from water sources are less likely to be impacted by rising water levels.
Closer proximity to water bodies increases flood risk, as areas near rivers, lakes, or other water bodies are more likely to experience flooding during heavy rainfall or storm surges.

DISTANCE FROM WATER BODIES (meters)	Category
> 0.75	1 (Low Risk)
0.25 - 0.75	2
0 – 0.25	3
-0.25 - 0	4
≤ - 0.75	5 (High Risk)

- **Dataset Name: SRTM DEM (Shuttle Radar Topography Mission Digital Elevation Model)**:
- **Dataset**: `USGS/SRTMGL1_003` Dataset
- **Resolution**: 30 meters.
- **Purpose**:
- Provides elevation data for flood risk analysis.
- Used to compute:
    - **Elevation** : Higher elevations are less flood-prone.
    - **TPI (Topographic Position Index)**: Quantifies terrain features like ridges and valleys, crucial for identifying flood-prone areas.
- Elevation and TPI are key for understanding runoff and potential water accumulation zones.
- **Why used**: High-resolution DEM helps in precise topographic and hydrological modeling for flood susceptibility

ELEVATION MAP

An elevation map shows the height of the land surface above sea level, using colours to represent different elevation levels. In flood mapping, elevation maps are crucial because they identify areas at risk of flooding, with lower elevations being more prone to water accumulation.

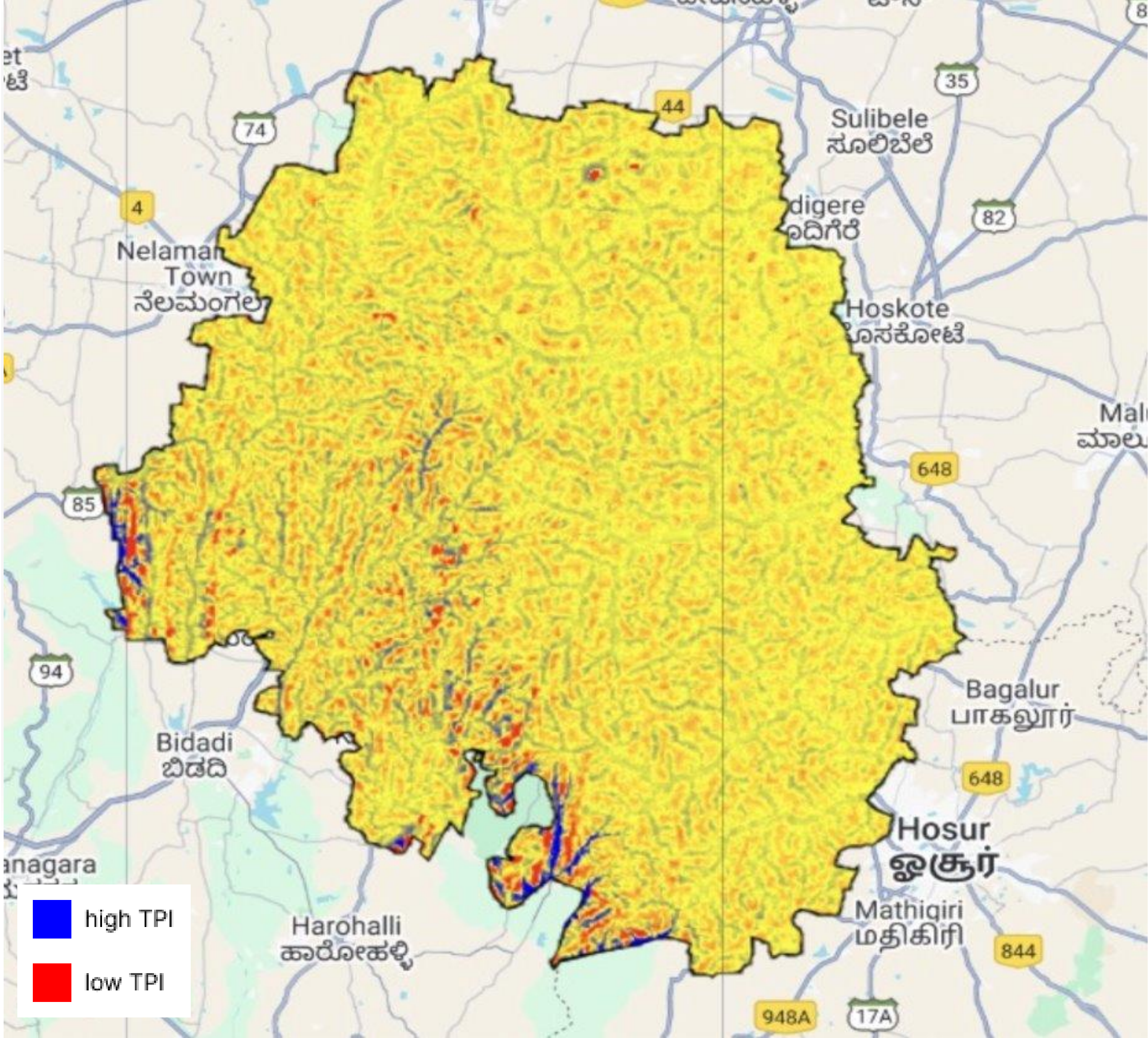


Higher elevated areas are less prone to flooding due to lower water retention and higher runoff, while lower elevations are more susceptible as they are closer to water bodies and prone to accumulation

Elevation Range (meters)	**Category**
> 950	1 (Low Risk)
900–950	2
850–900	3
800–850	4
≤ 800	5 (High Risk)

TPI

TPI (Topographic Position Index) measures the relative elevation of a location compared to its surroundings, indicating whether a point is a ridge, valley, or flat area. It helps in understanding the terrain's shape and its position within the landscape. In flood mapping, TPI is used to identify low-lying areas that are more susceptible to flooding, such as valleys or depressions, which tend to collect water.



Since we had positive and negative values for TPI, we normalized it.

- *Positive values for TPI* : Area is at higher elevation compared to neighbours
- *Negative value for TPI* : Area is at lower elevation compared to neighbours
- *Zero values for TPI* : Area is at same elevation

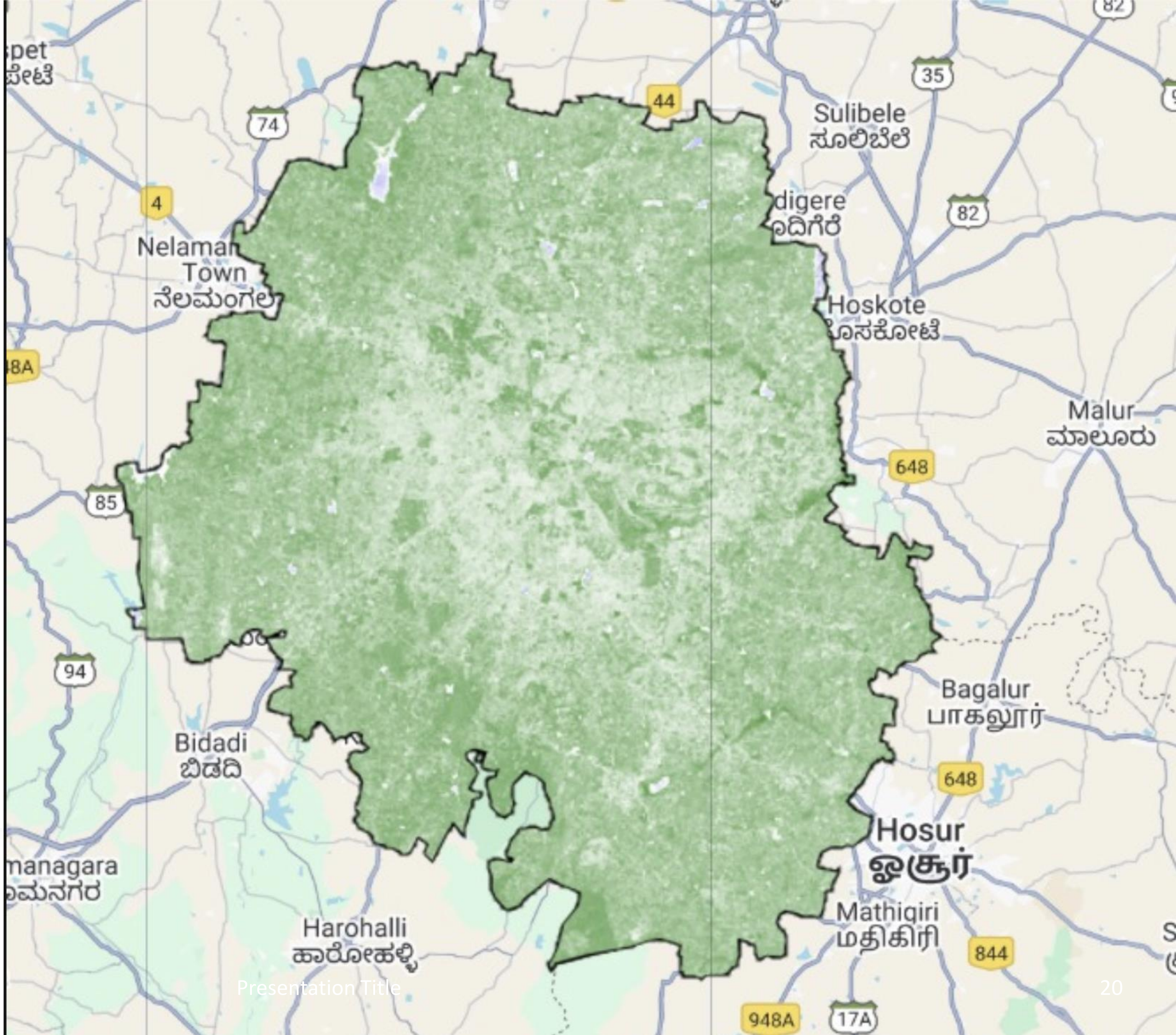
Higher TPI values (ridges and uplands) are less prone to flooding due to higher elevation and better drainage. Lower TPI values (valleys and depressions) are more prone to flooding due to lower elevation and water accumulation.

TPI	Category
> 0.75	1 (Low Risk)
0.25 - 0.75	2
0 – 0.25	3
-0.25 - 0	4
≤ -0.75	5 (High Risk)

- Dataset Name: **Landsat 8 Top-of-Atmosphere Reflectance**
- **Dataset**: `LANDSAT/LC08/C02/T1_TOA` Dataset
- **Resolution**: 30 meters.
- **Purpose**:
  - Used to calculate **NDVI (Normalized Difference Vegetation Index)** for vegetation health and land cover analysis.
  - NDVI is an essential factor in flood susceptibility as vegetation impacts runoff and infiltration.
- **Why used**: Landsat 8 provides multispectral imagery with sufficient resolution to study vegetation at a regional scale.

NDVI

NDVI (Normalized Difference Vegetation Index) is a measure of vegetation health and density, calculated using the difference between near-infrared and red light reflected by the Earth's surface. It tells us the presence and condition of vegetation, with higher values indicating dense, healthy vegetation.



Positive values for NDVI : Indicate the presence of vegetation, with higher values corresponding to denser and healthier vegetation.
Negative values for NDVI : Suggest non-vegetated surfaces such as water bodies, barren land, or urban areas.
Zero values for NDVI : Represent areas with minimal or no vegetation, often transitioning between vegetated and non-vegetated surfaces

Higher NDVI values reduces flood risk due to enhanced water absorption and infiltration.
Lower NDVI values lead to higher flood risk due to less water absorption and greater surface runoff.

NDVI VALUES	Category
> 0.75	1 (Low Risk)
0.25 - 0.75	2
0 – 0.25	3
-0.75 - 0	4
≤ 0.75	5 (High Risk)

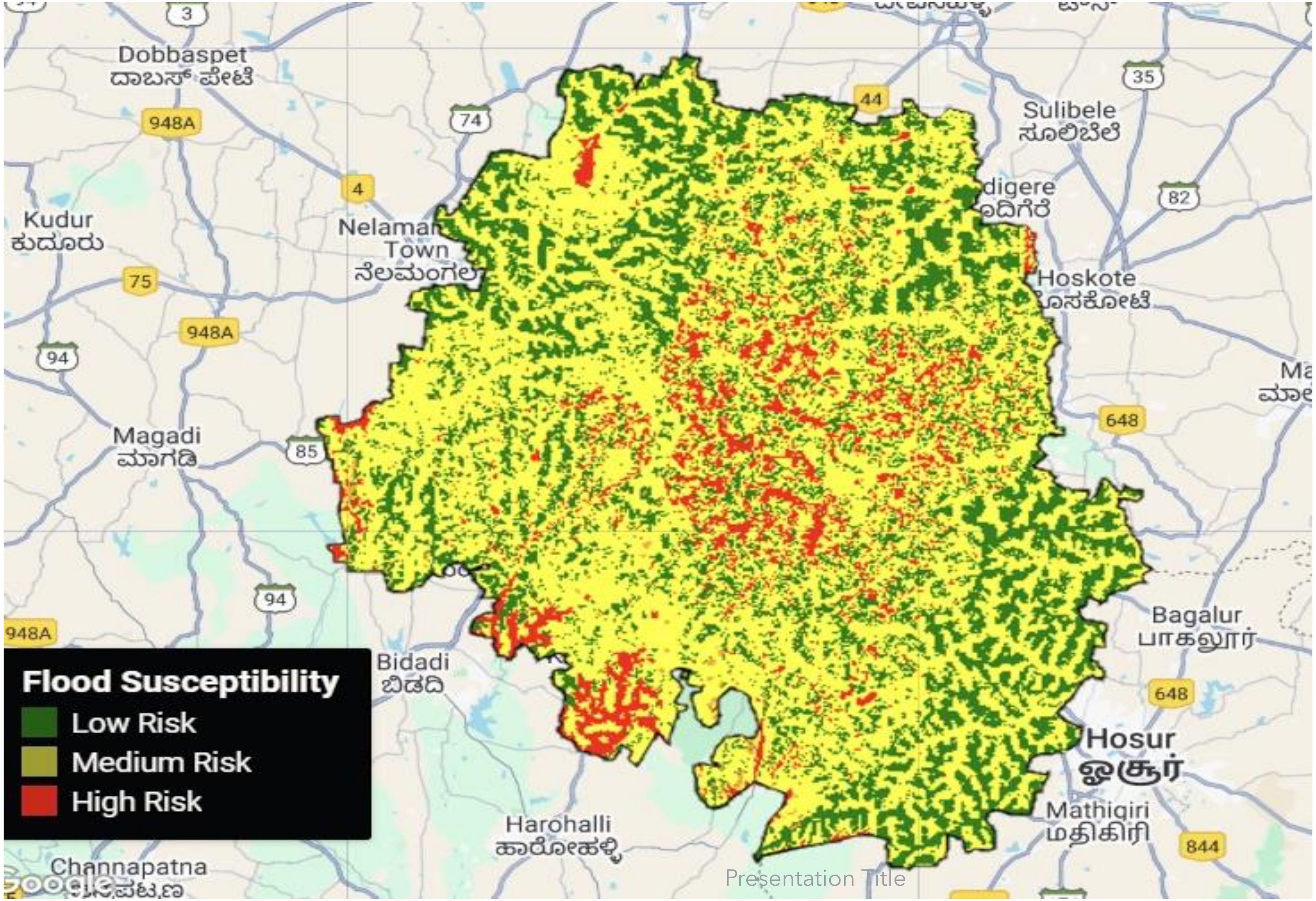
NOW WE ASSIGN WEIGHTS FOR EACH FACTOR

Factors	Weight
NDVI	0.15
Distance from permanent water	0.05
Elevation	0.30
TPI	0.50

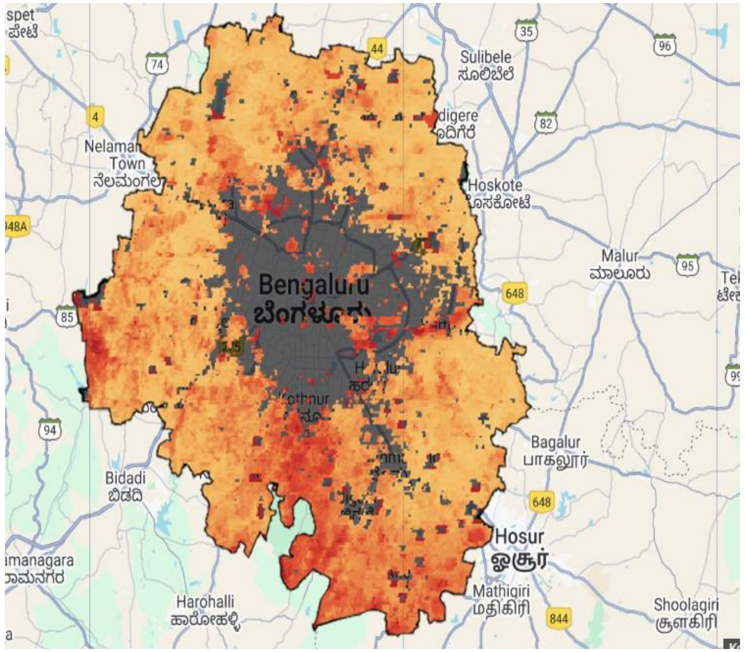
- Each layer score was multiplied by a weight indicating its relative importance:
- Weighted Score for a region = Layer Score × Weight of factor
- Final Flood Score = (NDVI_Score×NDVI_Weight)+ (TPI_Score×TPI_Weight)+ (Elevation_Score x Elevation_weight) + (Distance_from_water x Distance_weight).

- The resulting scores were normalized using min-max normalization to a scale of 1 to 5 , where 1= Low risk , 5= HIgh risk.
- ((weighted_score - min)/(max - min)) x 5

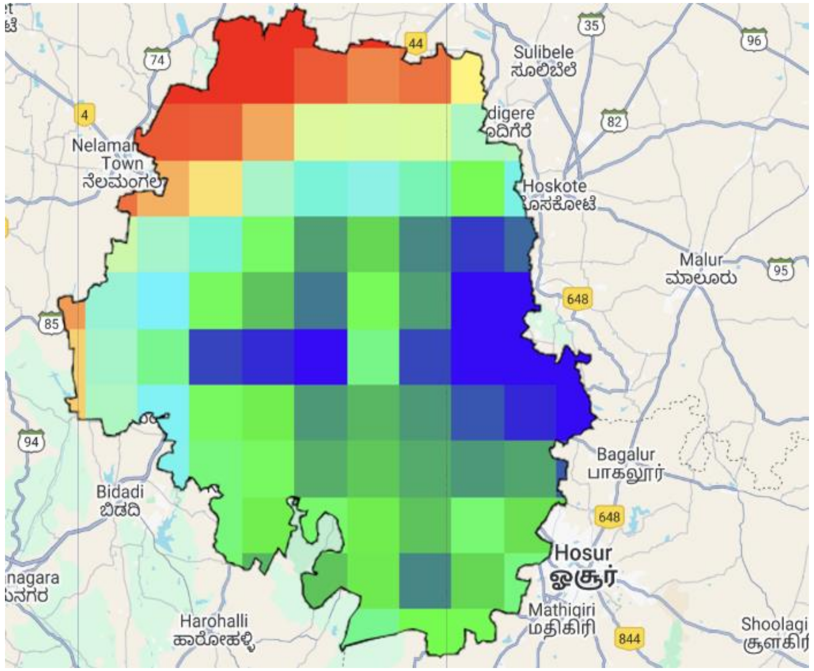
FLOOD MAPPING SHOWING RISK ZONES :



EXTRA ATTEMPTED FACTORS



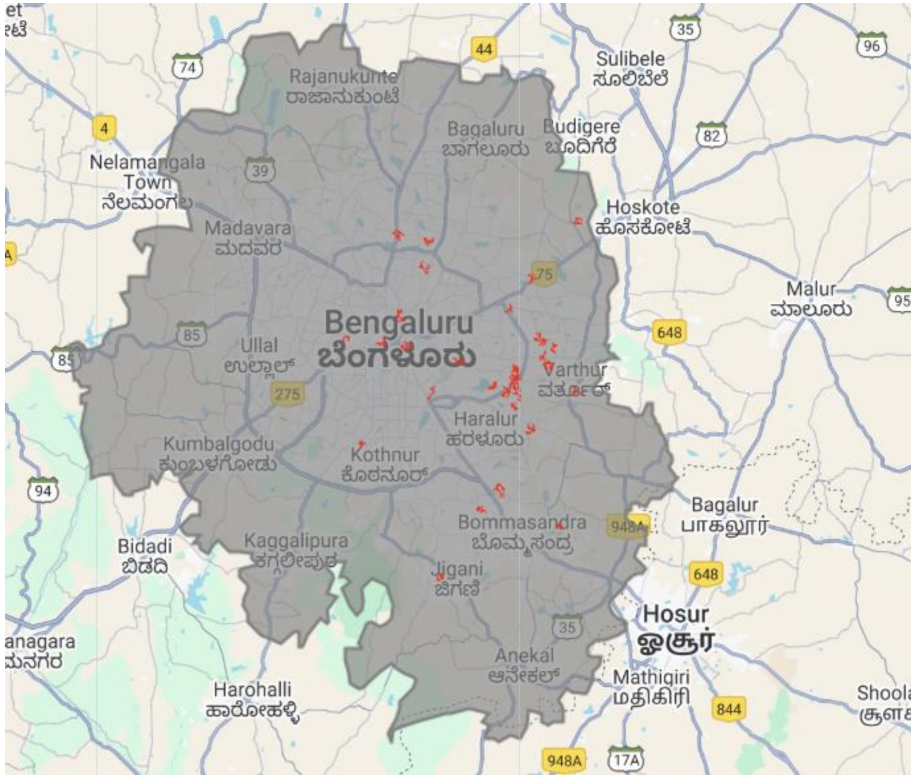
Soil carbon amount -
Soildgrids dataset



Precipitation -
Chirps-pentad dataset

RAIN MAP

We also tried to map the flooded area in Bangalore for the September 2022 floods by analyzing changes in radar backscatter values from Sentinel-1 images. We processed VH polarization data to create mosaics for pre-flood and post-flood periods, applied filtering to reduce noise, and computed the ratio of post-flood to pre-flood backscatter. Areas exceeding a threshold (1.25) were classified as potential flooded areas, while permanent water bodies and steep slopes were excluded to refine the mapping.



RESULT

The flood susceptibility mapping for Bangalore effectively highlights critical risk zones by integrating multi-criteria data such as NDVI, elevation, topographic position index (TPI) and proximity to water bodies. The final flood susceptibility map categorizes regions into low, medium, and high-risk areas, visually represented with an intuitive color-coded palette. Key findings indicate that areas with low elevation, poor vegetation cover, and close proximity to permanent water bodies are most vulnerable. This analysis provides actionable insights for urban planners and disaster management teams to prioritize high-risk zones for intervention, improve drainage systems, and develop adaptive strategies to mitigate future flood impacts.

THANK YOU

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