

Predictive Analysis and Mapping of Puddle Locations in Selected Area of Hanoi

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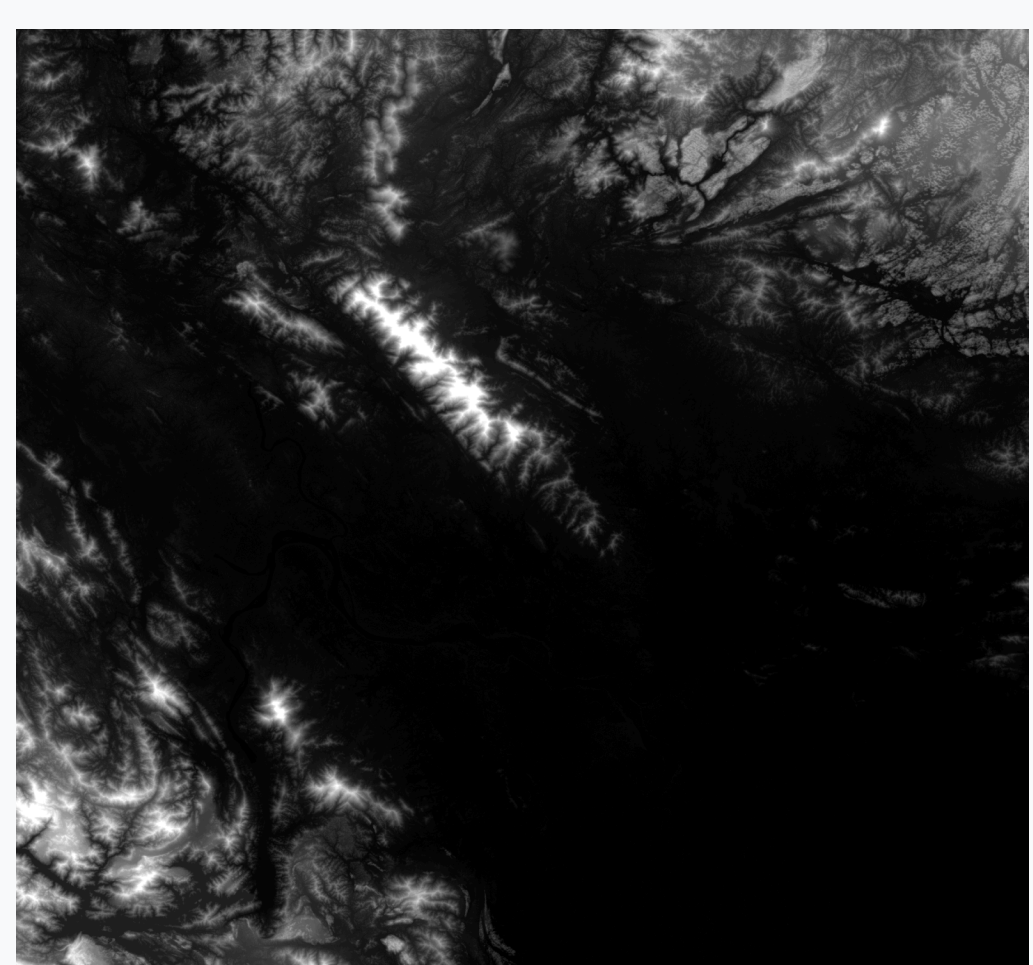
1. Introduction

To explain, Hanoi, Vietnam, is geographically lying in northern Vietnam's Red River Delta, a region influenced by both subtropical and monsoon patterns. Humidity frequently hovers above 70%, and in July and June, rainfall is heavy, sometimes flooding streets. In particular, massive puddles in Hanoi have been a problem in the society, creating delays in roads and school buses, also resulting in students coming late to school on heavy raining days. So, this project aims to predict possible puddle locations in a selected region of Hanoi to prevent traffic jams due to massive puddles.

2. Methodology

- Data selection & processing
- Extracting watershed basins using SAGA Next Gen Provider
- Calculating the sink depth using raster calculator
- Creating a flood map by combining the watershed basins and sink depth layers
- Checking the accuracy using HSDC and local news

3. Data Collection & Processing



Data Collection:

Shuttle Radar Topography Mission (SRTM GL1) Global 30m: obtained elevation data on a near-global scale to generate the most complete high-resolution digital topographic database of Earth.

Figure 1. SRTM GL1

- Selected Area - Hanoi, Vietnam. (WGS 84 (21.9546N, 105.0720E))

Data Processing:

Watershed Basins: Created by using SAGA Next Gen Provider to combine the following layers on Table 1.

Category	Input Data	SAGA Tool	Output
Pre-process	Raw DEM	Fill Sinks	Filled DEM, Flow Direction
Flow Analysis	Filled DEM	Flow Width and Specific Catchment Area	Flow Accumulation
Extraction	Filled DEM / Flow Direction / Flow Accumulation	Channel Network	Channel Network
Delineation	Channel Network / Filled DEM	Watershed Basins	2,065 Basins

Table 1. Watershed Basin Chart

Sink Depth: Subtracting the original layer (SRTM GL1) from the Filled DEM layer using the raster calculator results the sink depth of the selected area.

4. Preliminary Findings



Figure 2. Mapping of Puddle Locations

Our spatial analysis confirms that Hanoi's terrain is fundamentally predisposed to puddle formation. The city's elevation—dipping low to -5m—creates a vast, low-lying landscape where water naturally accumulates. The results also identifies 2,065 micro-watershed basins with sink depths varying up to 2m, particularly concentrated in the mid-to-low altitude urban zones. These closed depressions act as natural reservoirs; because they lack hydrological connectivity and are unsupported by adequate drainage infrastructure, they facilitate the persistent formation of puddles.

Topographic Summary:

- Total Micro-basins: 2,065
- Elevation Range: 990m to -5m
- Sink Depth: 0m to 2.0m
- Key Driver: Lack of hydrological connectivity in low-lying closed depressions, leading to high puddle risk.

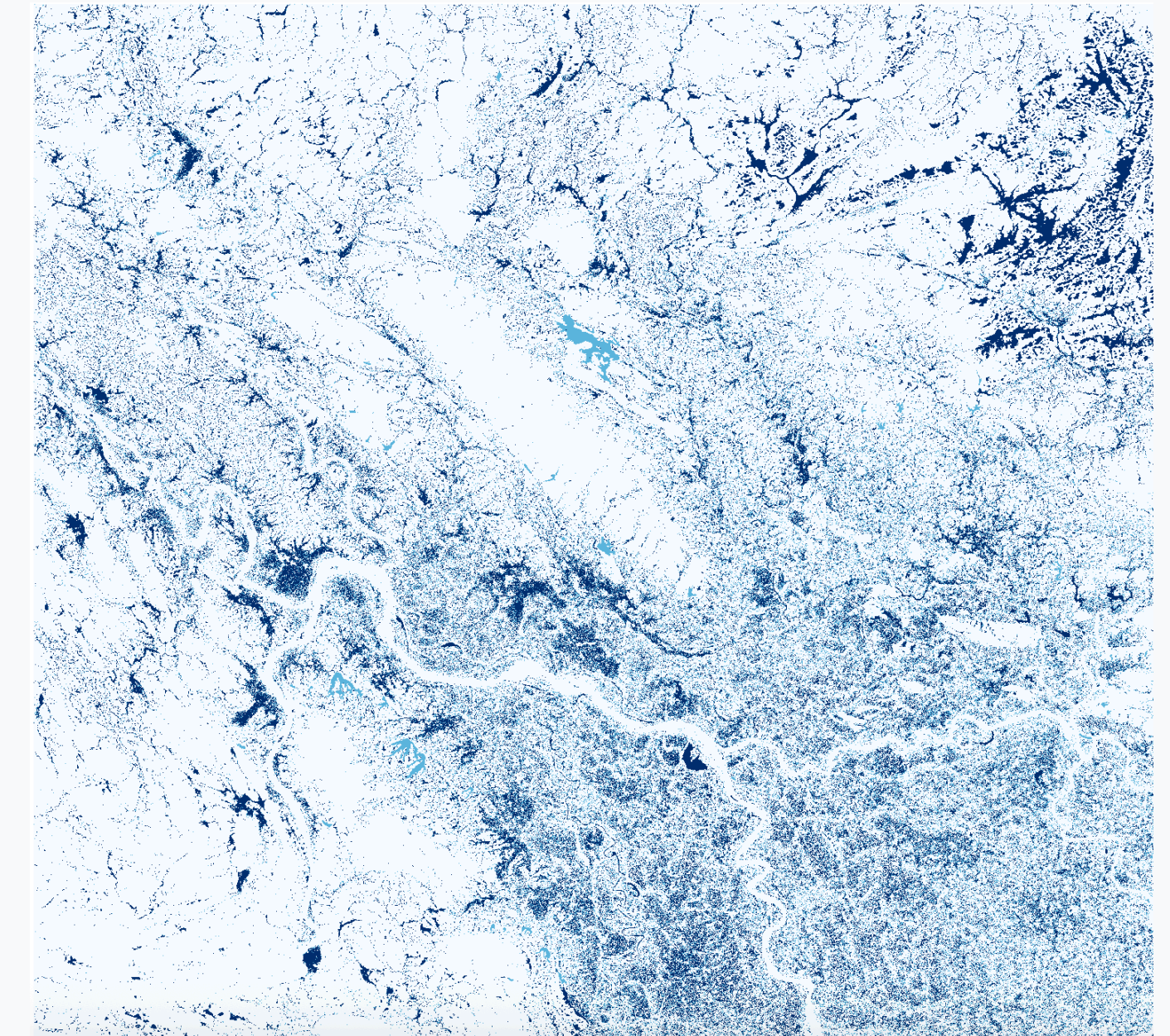


Figure 3. Sink Depth

5. Reliability/Limitations

The model demonstrates high reliability, with predicted sinks positively correlating with 12 major flood hotspots reported by HSDC and local news. While puddle formation involves complex hydrological factors, this study focused on large-scale topographic vulnerabilities. Although the 30m satellite resolution limits micro-pavement detail, the consistency with historical confirms the model's effectiveness as a predictive tool for urban flood-prone zones.

6. Conclusions

Hanoi's geography is naturally built for puddle formation. With its low elevation and 2.0m-deep sinks concentrated heavily along major roads and the city center, the terrain itself acts as a water trap. By pinpointing these high-risk hotspots, this project allows us to predict approximately where water will pool before the rain starts. Ultimately, these insights provide a roadmap to prevent the massive traffic congestion that paralyzes Hanoi during storm season.

