Climate Risk Assessment Report for Area of Interest in Ganganagar, Rajasthan and Amboori, Kerala

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Executive Summary

This report presents the detailed climate risk assessment for two locations***, Ganganagar in Rajasthan and Amboori in Kerala, focusing on flood and heatwave risks***. We have used ResSolv, a module of Resilience360 climate enterprise software suite to perform this analysis. ResSolv is an advanced AI-driven risk modeling solution built by Resilience AI. The analysis incorporates environmental and built-environment factors and datasets to generate vulnerability scores for each building and open-area in the identified area of interest (referred to as 'location' from here on)

1. Introduction

ResSolv based climate risk assessment identifies and quantifies the vulnerability of buildings in two locations—Ganganagar (Rajasthan) and Amboori (Kerala)—due to two types of climate risks, viz., heatwaves and flash floods. The assessment is conducted using a AI/ML based engine, which processes high-resolution satellite imageries and climate datasets, and thereby assigns risk scores..

Key objectives of this report:

- Provide a comprehensive risk profile of the location using map-view interface.
- Assign vulnerability scores to individual buildings for both heatwaves and flash floods.
- Present hyperlocal climate risk data[1] for both regions to assist in investment decisions and on-ground mitigation interventions.

2. Methodology

Our disaster risk model integrates nearly 20 datasets, The key factors influencing risk scores of the regions include:

- Roof typology to determine building vulnerability.
- Building area and structure characteristics
- Climate and environmental datasets, including temperature, slope, NDVI (Normalized Difference Vegetation Index), water bodies, rainfall data

[1] Climate risk data is an AI/ML-generated output. Validated risk record of the region is a paid effort and is not included in the report.

For each climate risk type, viz., heatwave and flash flood, a risk map is generated, showing the vulnerability of all detected buildings in the target region. The model outputs vulnerability scores on a scale of 1 to 5, along with corresponding risk percentages.

3. Climate Risk Assessment for Ganganagar, Rajasthan

3.1. Overview

- Location: Ganganagar, Rajasthan
- Total buildings assessed: 2,790
- Climate events assessed: Heatwaves, Flash Floods

RISK LEVEL	SCORE	HEATWAVE	FLOODS
		% OF STRUCTURES	% OF STRUCTURES
Very Low risk	1		
Low risk	2	1.4	
Moderate Risk	3	15.2	
High risk	4	**83.4**	7.4
Very high risk	5		**92.6**

- The majority of households face **moderate to high risk of heatwaves**, with 83.4% of buildings categorized under high risk (Score 4).
- A significant portion of the buildings (92.6%) are at **very high risk from flash floods**, highlighting the urgent need for flood mitigation strategies.

4. Climate Risk Assessment for Amboori, Kerala

4.1. Overview

- Location: Amboori, Kerala
- Total buildings assessed: 239
- Climate events assessed: Heatwaves, Flash Floods

RISK LEVEL	SCORE	HEATWAVE	FLOODS
		% OF STRUCTURES	% OF STRUCTURES
Very Low risk	1		
Low risk	2	**100**	
Moderate Risk	3		
High risk	4		5.5
Very high risk	5		**94.5**

- All buildings in Amboori fall into the **low-risk category for heatwaves**, indicating minimal concern for this climate event.
- Nearly all households (94.5%) are at **very high risk from flash floods**, making flood preparedness and management essential in this area.

5. Conclusion and Recommendations

Ganganagar, Rajasthan: The heatwave risk is significant, with most households facing moderate to high vulnerability. Immediate actions such as enhancing building insulation and increasing access to cooling centers are recommended. For flash floods, given the high risk to 92.6% of buildings, flood defense infrastructure, such as drainage systems and raised housing, should be prioritized.

Amboori, Kerala: While the heatwave risk is minimal, the flash flood risk is extremely high, affecting 94.5% of households. Urgent flood mitigation measures such as embankments, flood-resistant construction, and early warning systems are strongly recommended for this region.

6. Next Steps

Based on this assessment, it is crucial to generate a validated risk record and assess the value at risk of the region

Appendices

- Appendix A: Risk Maps for Ganganagar and Amboori
- Appendix B: Detailed Data Layers Used in the Model

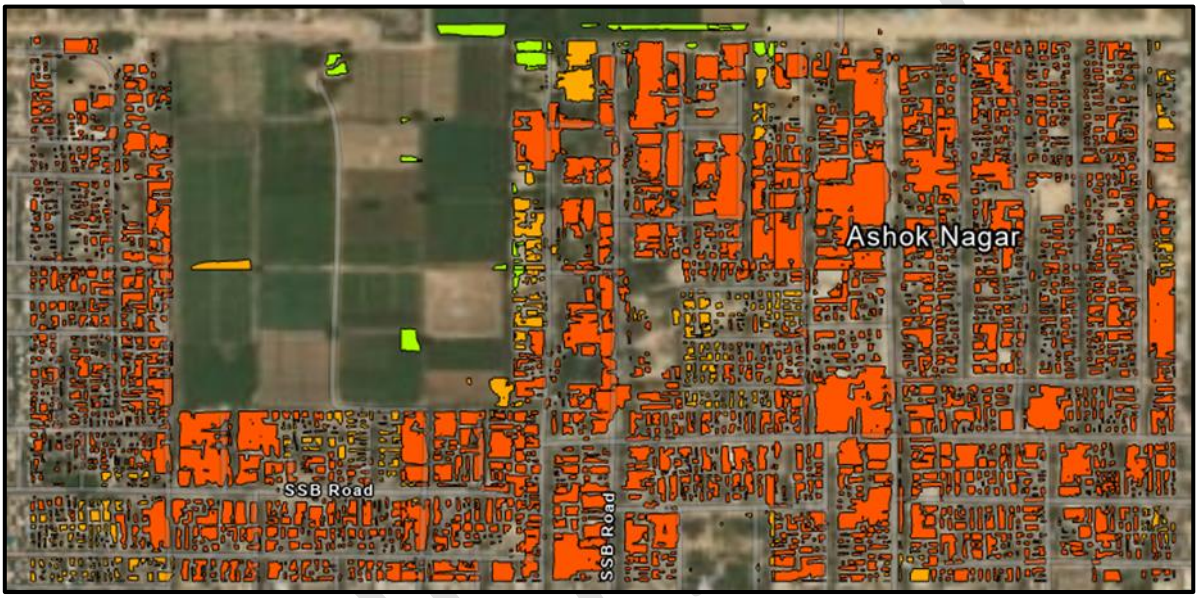
This report outlines the climate risks faced by Ganganagar and Amboori in a detailed, data-driven manner, providing a foundation for targeted interventions. We are confident that with the implementation of the suggested measures, Mahindra can significantly mitigate the climate risks in these regions.

Appendix A: Risk Maps for Ganganagar and Amboori

This appendix includes detailed risk maps generated for both locations, Ganganagar, Rajasthan, and Amboori, Kerala. These maps visualize the vulnerability scores for each household in the respective regions for the climate risks assessed: heatwaves and flash floods.

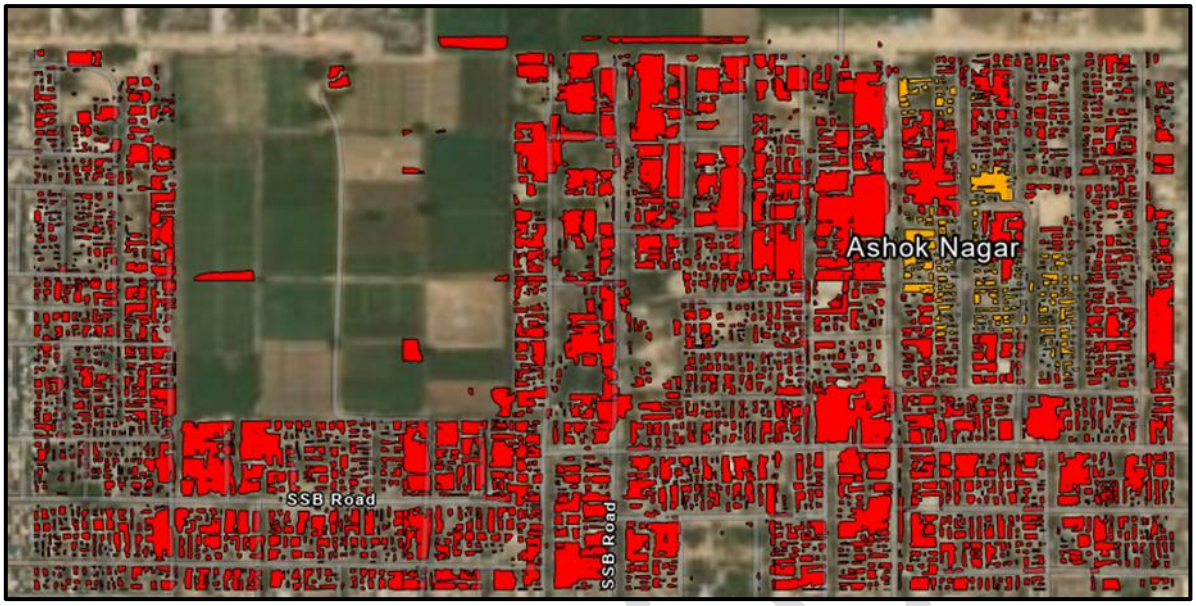
1. Risk Map for Ganganagar, Rajasthan

1.1. Heatwave Vulnerability Map



- Description: This map shows the heatwave risk distribution across **2,790** buildings in Ganganagar.
- Risk Scores:
  - Low Risk (Score 2): Highlighted in green.
  - Moderate Risk (Score 3): Highlighted in yellow.
  - High Risk (Score 4): Highlighted in orange.
- Observations: The majority of buildings are categorized under high risk (Score 4), especially in areas with dense infrastructure and poor ventilation.

1.2. Flash Flood Vulnerability Map



- Description: This map outlines the flood risk for the same 2,790 buildings in Ganganagar.
- Risk Scores:
    - Moderate Risk (Score 4): Highlighted in orange.
    - Very High Risk (Score 5): Highlighted in red.
- Observations: Significant portions of the town are at very high risk (Score 5) due to low elevation and proximity to water bodies, as identified by the hydrology layers.

2. Risk Map for Amboori, Kerala

2.1. Heatwave Vulnerability Map

- Description: This map displays the heatwave risk for **239** buildings in Amboori.
- Risk Scores:
    - Low Risk (Score 2): Highlighted in green.

- Observations: All buildings fall under low risk (Score 2) for heatwaves, suggesting minimal concern for this hazard in the region.

2.2. Flash Flood Vulnerability Map

- Description: This map indicates the flood risk distribution across the 239 buildings in Amboori.
- Risk Scores:
    - Moderate Risk (Score 4): Highlighted in orange.
    - Very High Risk (Score 5): Highlighted in red.
- Observations: Nearly all buildings are at very high risk (Score 5) for flash floods, particularly in low-lying areas near rivers and drainage channels.

Observations and Actionable Insights

- The maps highlight specific areas of vulnerability that require immediate intervention.
- Areas with high scores (4 and 5) for flash floods in both Ganganagar and Amboori should be prioritized for flood defense infrastructure and early warning systems.
- For heatwaves in Ganganagar, urban cooling strategies such as increased vegetation and improved building insulation are recommended.

Conclusion of Appendix A

The risk maps provide a visual representation of climate risks at the household level, offering actionable insights for targeted interventions. The maps complement the vulnerability scores in the main report, helping to identify the most at-risk regions and households.

Appendix B: Detailed Data Layers Used in the Model

This appendix provides an overview of the key data layers utilized in the climate risk model. Each layer plays a vital role in calculating the vulnerability of households to heatwaves and flash floods. Below are detailed descriptions of the main datasets and how they influence the model's output.

1. High-Resolution Satellite Imagery

Description:

High-resolution satellite imagery provides detailed, up-to-date visuals of the target locations, allowing the identification of individual buildings, road networks, and other key infrastructure. This data helps in mapping the exact locations and conditions of households, which are crucial for risk assessment.

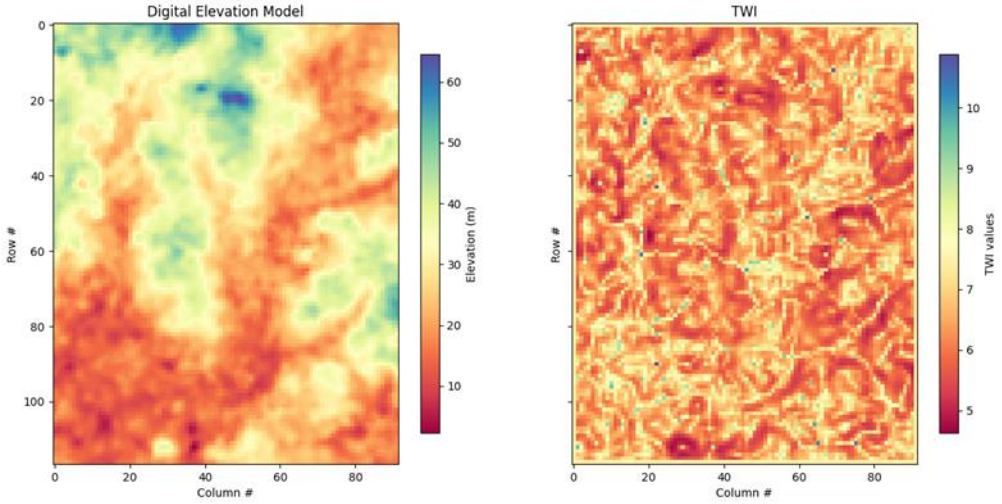
Impact on Results:

The high-resolution imagery enables accurate detection of buildings and their characteristics. For instance, roof typology, as observed in the satellite imagery, is given a higher weight in determining vulnerability. The imagery also allows the model to assess the density and layout of buildings, which can influence both heat retention during heatwaves and water runoff during floods.

2. Digital Elevation Model (DEM)

Description:

A Digital Elevation Model (DEM) represents the terrain's surface and topography, showing elevation changes and landform features.



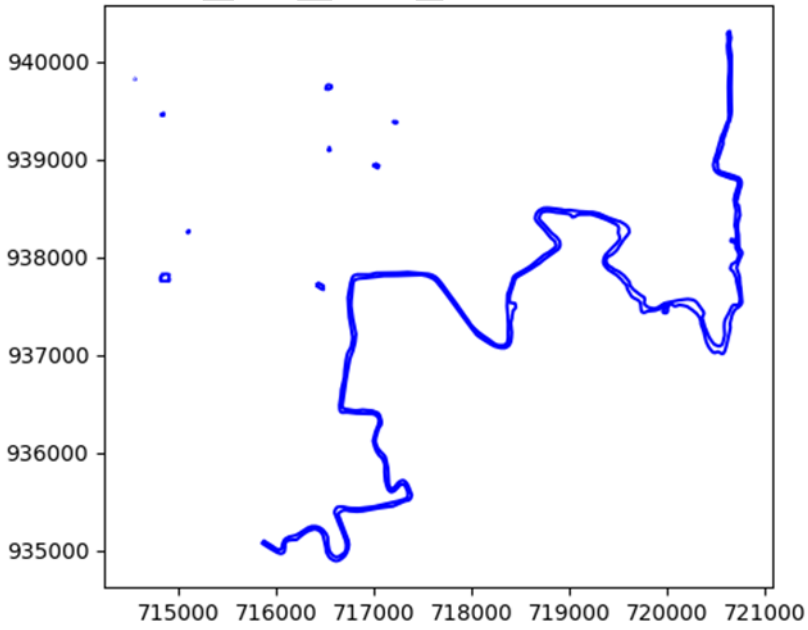
Impact on Results:

In flood-prone regions, lower elevation areas are typically at higher risk. In Ganganagar and Amboori, the DEM helps identify which households are situated in floodplains or on slopes prone to water runoff. It also influences heatwave risk by highlighting areas where topographic features might exacerbate heat accumulation.

3. Hydrology Layers

Description:

Hydrology layers provide information about water bodies (rivers, lakes, streams) and drainage patterns. They include data on the location, flow, and network of these water systems.



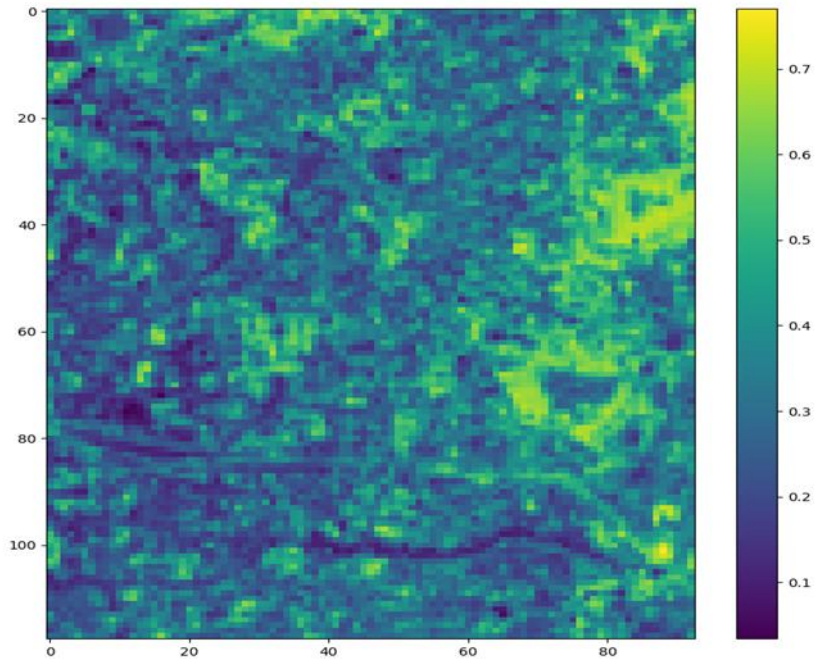
Impact on Results:

For flash flood risk, households closer to rivers or low-capacity drainage areas are assigned higher vulnerability scores. In Ganganagar, the hydrology layers help identify the areas at risk of river flooding, while in Amboori, the data is critical for assessing the risk from heavy rainfall-induced flooding.

4. Land Cover Data

Description:

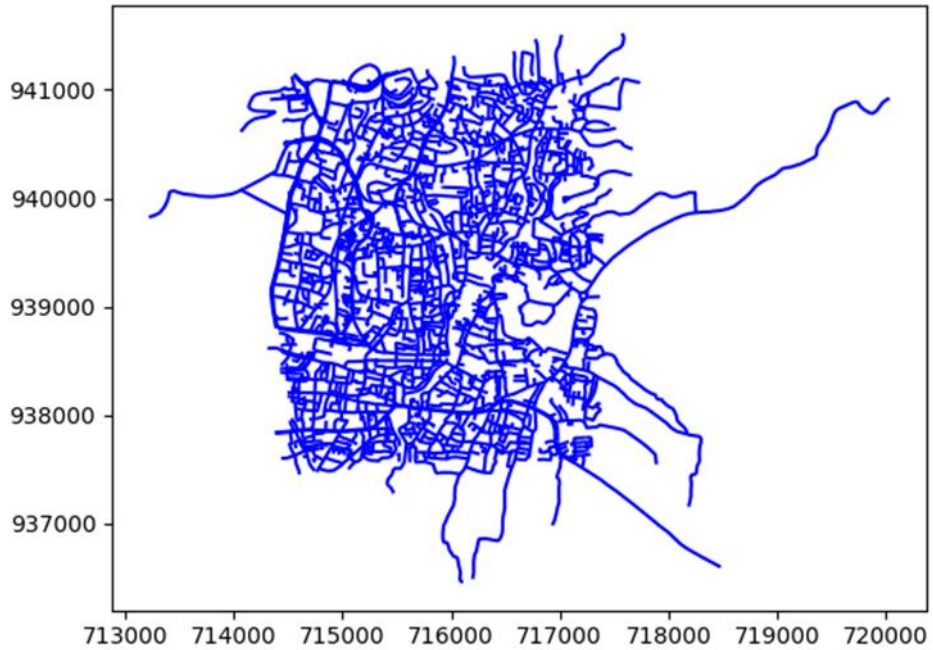
Land cover data categorizes the surface of the Earth into different types (e.g., vegetation, urban areas, water bodies, agricultural fields). It helps assess how land use affects climate risks.



Impact on Results:

In areas with high impervious surface ratios (such as urban zones), flood risks are typically higher due to reduced natural water absorption. Vegetation can mitigate the effects of heatwaves by cooling the surrounding environment. In Amboori, Kerala, areas with dense vegetation may have a lower heatwave risk, while impervious surfaces in Ganganagar, Rajasthan, could exacerbate both heat and flood risks.

5. Other Relevant Data



Temperature Data: Provides historical and current temperature records, essential for assessing heatwave risks. High temperatures combined with other environmental factors contribute to heat stress scores.

Road Networks: Proximity to major roads can affect flood risk, as roads with poor drainage can become channels for floodwaters. The presence of roads and infrastructure also influences urban heat island effects during heatwaves.

Apart from the above various other geo climatic parameters are also considered at the model backend for final risk calculation.

Conclusion of Appendix B

Each of these layers contributes to the accuracy and reliability of the climate risk model. By integrating high-resolution satellite imagery, DEMs, hydrology layers, land cover data, and other relevant datasets, the model is able to produce detailed and localized risk assessments for both heatwaves and flash floods. These insights guide intervention strategies to mitigate the identified risks in Ganganagar, Rajasthan, and Amboori, Kerala.