A Study on Flood Susceptibility Zones of Bengaluru Urban Using Geospatial and Analytical Hierarchy Process Techniques

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ABSTRACT
Conventional method of flood susceptibility requires historical data to map flood plain area, which requires a detailed survey and more expensive. Some of the data required for flood mapping is very difficult to obtain from ground measurements. The conventional methods have been reduced by geospatial techniques. Hence, in the present study an attempt has been made to assess the flood prone areas of Bengaluru urban by using geospatial and Analytical Hierarchy Process (AHP) techniques. The Bengaluru urban area is located in the southeast of Karnataka state and geographically lies between 12°49'5" N and 13°8'32" N latitude and 77°27'29" E and 77°47'2" E longitude and comprises three valleys namely Hebbal, Koramangala Challaghatta (KC) and Vrishabhavathi. The classified images of SRTM DEM 30 m resolution and Sentinel-2 10 m resolution data have been used to derive thematic maps. The causative factors such as precipitation, elevation, slope, drainage density, land use / land cover, topographic wetness index, distance from road and distance from river have been considered to derive the weights and then integrated using weighted overlay technique to prepare a flood susceptibility map. The results of the study showed that, the KC valley and Hebbal valley are more susceptible to high flood than Vrishabhavathi valley.

Keywords: RS, GIS, Analytical Hierarchy Process, Flood susceptibility

Introduction

Urban flooding is the major concern for the cities worldwide, especially rapid urbanising areas where the natural landscapes are altered with the impervious surfaces. These changes increase the surface runoff and lack in infiltration that can lead to frequent flooding events. Floods impact both socio-economic and environmental aspects of the affected area (Meyer et al.,2013). The climate change such as shift in precipitation patterns and extreme rainfall events elevate this challenges which further demands for the flood risk assessment monitoring and planning. Therefore, flood susceptibility mapping is essential in order to monitor and plan the areas vulnerable to flood. Moreover, it also provides a spatial insight on risks of flood at varying levels thereby, prioritising the levels of flood risk. Flood hazard management involves multiple authorities working to mitigate current and future vulnerabilities of human society to natural disasters (Malik et al.,2020). Identification and selection of flood causative factors such as slope, runoff patterns, drainage density, intensity of rainfall and surface roughness are determined based on their significant influence on flood (Abdel Hamid et al.2020). Saaty, 1980 created the AHP, which is recognized as a mathematical method for making multi-criteria decisions. The study focuses on flood susceptibility mapping using AHP, a multi-criteria decision making tool that systematically ranks and prioritises the factors contributing to the flood risk. Key causative factors includes rainfall, elevation, slope, drainage density, topographic wetness index, land use / land cover and distance from rivers and roads. Weightage and ranking are determined through an AHP pairwise comparison matrix, and these values are integrated with the basic input layers in Geographic Information System (GIS) software (Dung et al., 2022). Dwarakish et al.2024 used GIS and AHP to map flood hazard mapping with 95% accuracy, aiding flood management decisions.

Study Area

Bengaluru Urban is the most densely populated city which is geographically lies between 12°49'5" N and 13°8'32" N latitude and 77°27'29" E and 77°47'2" E longitude. The region is characterised by rapid urbanization which significantly influences the natural drainage system. Bengaluru urban comprises 3 major valleys namely; Hebbal (312.29 km^2) Koramangala-Challaghatta(KC) (290.43 km^2) and Vrishabhavathi (359.24 km^2) contributing to the drainage system and influencing flood patterns. Plate 1 shows the location map of the study area. The Hebbal and KC valley flows eastwards and confluence with Dakshina Pinakini river near Kadugodi plantation and Nagondanahalli, Bengaluru respectively. Vrishabhavathi valley flows southward and confluence with Arkavathi river near Ganalu, Kanakapura taluk, Ramanagara district. The average annual rainfall across Bengaluru Urban ranges from 479.22 mm (Krishnarajapura) to 889.52 mm (Kengeri).

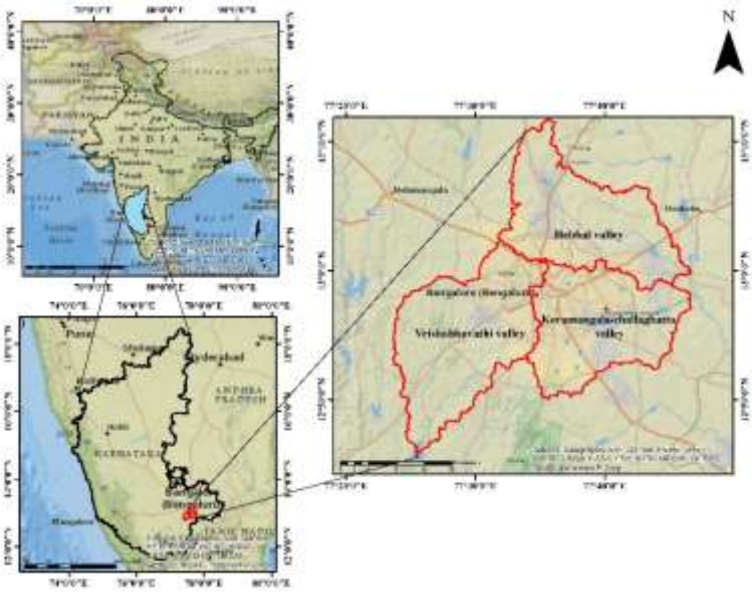


Plate 1 Location map of the study area

Data Products

In the present study, an attempt has been made to prepare flood susceptibility map using geospatial techniques and AHP method. The following data products are used in the present study. Table 1 shows the details of the data used in the present study.

Table 1 Data used in the present study

Sl No	Data	Source	Derived data
1	Daily Rainfall data (1980-2022)	Water Resources Development Organization (WRDO), Bengaluru	Precipitation Map
2	Sentinel 2 (10 m resolution)	ESRI	Land use / land cover Map
3	SRTM DEM (30 m resolution)	USGS Earth Explorer	Elevation, Slope, TWI, Drainage density Maps
4	River and Road networks	Open Street Map	Distance from river, Distance from road Maps

Methodology

The study employs a modern methodology to generate flood susceptibility map for Bengaluru urban area. Initially methodology involves in selecting 8 causative factors and constructing a pairwise comparison matrix using AHP, where relative importance for each factors are assigned. From the comparisons, weights of each parameters are derived. Subsequently, the flood susceptibility map is generated using reclassified flood causative factors. The datasets utilised and the procedures applied for determining weights and ranks through the AHP method are detailed below.

Datasets processing

The different thematic maps are derived by using the various data products obtained from different sources. The precipitation map is generated from rainfall data provided by the Water Resources Development Organization (WRDO), Bengaluru. This data is processed by integrating annual maximum rainfall values to visualize the spatial distribution of rainfall across the study area. The land use/land cover map prepared by supervised classification of Sentinel-2 satellite imagery (10 m resolution) has been obtained by ESRI. The satellite data is already processed to distinguish different land cover types such as vegetation, urban areas, barren land and water bodies, reducing the need for additional classification. The elevation, slope, topographic wetness index, and drainage density maps are generated using the Shuttle Radar Topography Mission (SRTM) 30 m Digital Elevation Model (DEM) from the USGS Earth Explorer platform. Elevation is directly extracted from the DEM, while the slope map is derived by calculating the change in elevation between neighbouring cells in the DEM. For TWI, the slope and contributing area are combined to identify areas likely to experience water accumulation. The drainage density map is created using the line density tool in ArcGIS, which computes the length of river networks relative to the surrounding area. Distance from river and distance from road maps are created using vector data of river and road networks obtained from open street map. The euclidean distance tool is applied to measure the distance of each point in the study area from the nearest river or road, producing maps that highlight proximity to these features. Fig. 1 shows the methodology followed for generating flood susceptibility map.

Flood causative factors

Topographic Wetness Index (TWI)

The Topographic Wetness Index (TWI) plays a key role in flood susceptibility within the catchment. It is calculated by using the eq. 1.

$$TWI = ln\left(\frac{\alpha}{\tan\beta}\right) \tag{1}$$

where, α = upslope contributing area and β = slope (topographic gradient).

Areas with higher TWI values are more prone to flooding as these zones tend to accumulate water due to topography. On the other hand, regions with lower TWI values are better equipped to drain water, reducing the flood risk. The spatial analysis of TWI highlights that high TWI areas, often located in flat or concave parts of the terrain, should be a primary focus for flood mitigation strategies, as they naturally serve as water accumulation points. Fig. 2 shows the Topographic wetness index map of the 3 valleys.

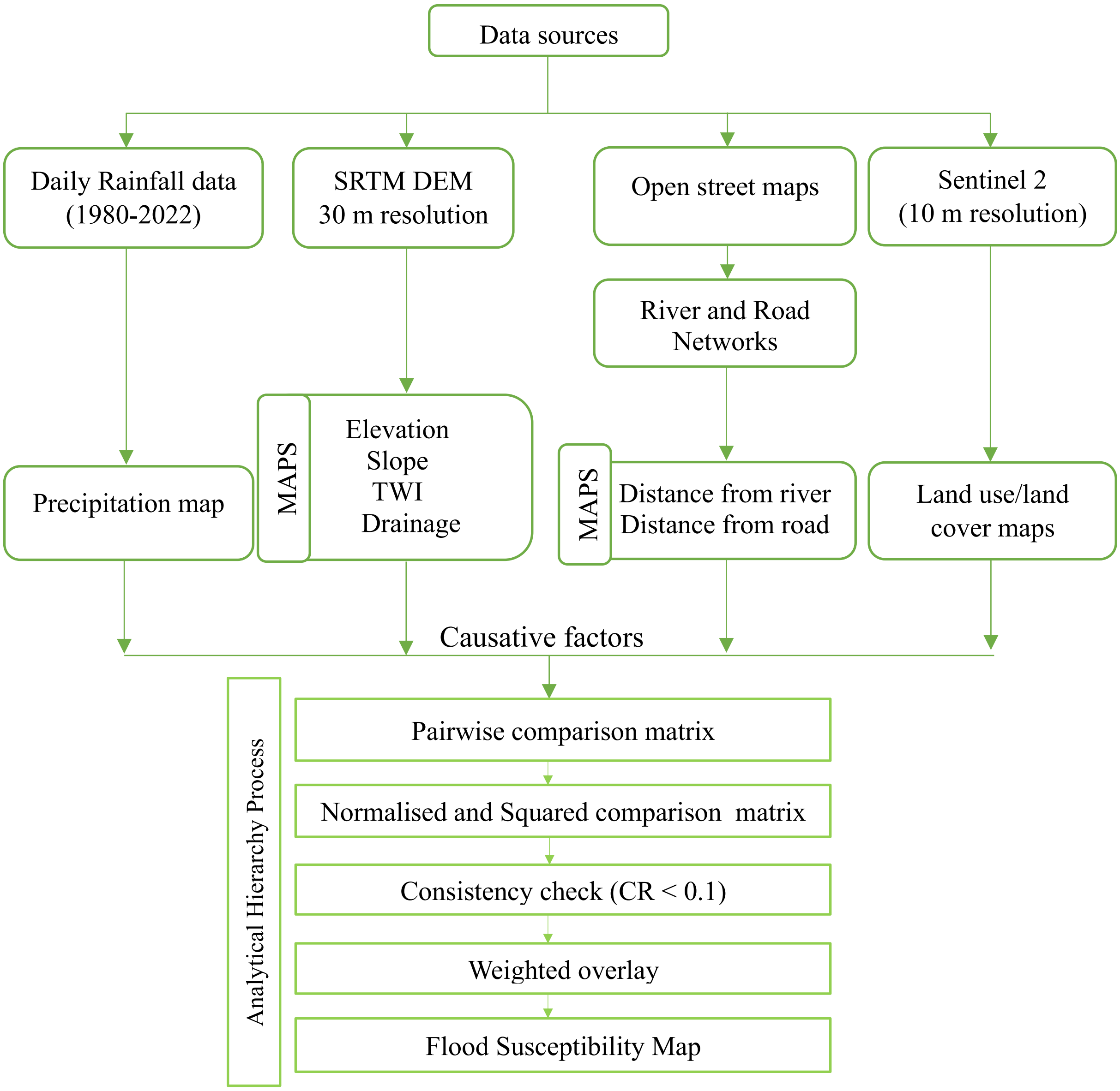


Fig. 1 Methodology for flood susceptibility mapping

Precipitation

Precipitation is a crucial factor influencing flood risk in the catchment. Areas receiving higher annual rainfall are more susceptible to floods due to the large volume of runoff generated during heavy rainfall. In contrast, regions experiencing lower rainfall are less susceptible. This variability in rainfall distribution requires a strategic approach to flood management, prioritizing areas with higher precipitation as they contribute significantly to surface water accumulation and flood potential. Fig. 3 shows the precipitation map of the 3 valleys.

Drainage Density

Drainage density, which refers to the length of the drainage network per unit area, directly impacts the catchment's ability to manage runoff. Regions with very high drainage density are more susceptible to flooding as the extensive network may become overwhelmed during intense rainfall events, leading to overflow. In contrast, areas with lower drainage density are less prone to floods, as they have a more limited capacity to convey water. Higher drainage density areas are particularly at high risk during peak flood conditions, emphasizing the need for effective runoff management systems in these zones. Fig. 4 shows the drainage density map of the 3 valleys.

Elevation

Elevation strongly affects flood susceptibility, with low-lying regions being at higher risk due to their tendency to collect water from higher elevations. These areas act as natural basins, making them more prone to flooding. Higher elevation zones experience less risk as water is more likely to flow away from these regions. Flood management strategies should thus concentrate on low-lying areas, where the potential for water accumulation and subsequent flooding is extreme. Fig. 5 shows the elevation map of the 3 valleys.

Slope

The slope of the terrain influences how quickly water moves across the landscape. Gentle slopes are more susceptible to flooding because they promote water stagnation and slower runoff, allowing for greater water accumulation. On the other hand, steeper slopes encourage rapid runoff, reducing the likelihood of local flooding but potentially increasing downstream flood risk. Proper management of runoff in flatter regions is essential to minimize the risk of flooding in these vulnerable areas. Fig. 6 shows the slope map of the 3 valleys.

Land use/Land cover (LU/LC)

Land use/land cover significantly determine flood susceptibility in the catchment. Built-up areas and water bodies are more susceptible due to their limited infiltration capacity and the high potential for surface runoff. Agricultural land also faces moderate flood risks, while forest areas have the lowest risk due to their high infiltration rates. This analysis highlights the importance of managing urban and built-up areas with adequate drainage infrastructure to mitigate flood risks. Fig. 7 shows the land use / land cover map of the 3 valleys.

Distance from River

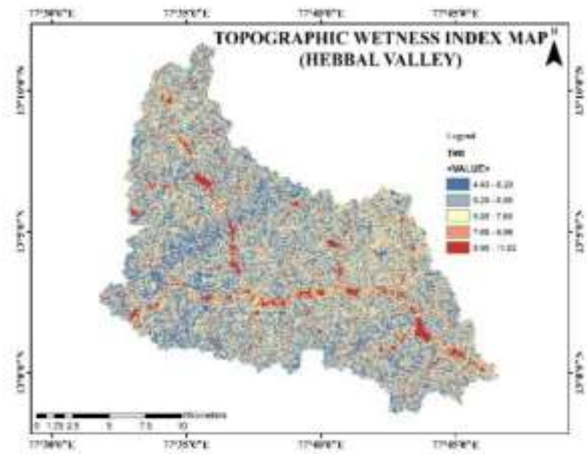
Proximity to the river is a critical factor in flood susceptibility. Areas located close to the river face a higher flood risk, especially during heavy rainfall when the river can overflow its banks. As the distance from the river increases, flood susceptibility decreases. This suggests that flood defense systems should be concentrated in areas near the river, where the potential for riverine flooding is extreme. Fig. 8 shows the distance from river map of the 3 valleys.

Distance from Road

The proximity to roads affects flood susceptibility, particularly in urbanized regions. Areas closer to roads tend to have higher flood risks due to poor drainage systems and the potential for water to accumulate along roadways. As distance from roads increases, the flood risk decreases. This emphasizes the need for improved drainage and flood prevention infrastructure along roads, particularly in areas with significant urban development. Fig. 9 shows the distance from road map of the 3 valleys.

Analytical Hierarchy process

In the present study, the weights of flood causative factors are determined by using AHP method (Saaty 1980, 1987 and 1990). The AHP is a multi-criteria decision making technique to address the studies involving multiple interrelated criteria's. The method begins by ranking the criteria hierarchically based on their relative importance which is determined using Saaty's(1980) comparative scale ranging from 1 to 9 (Table 2). A pairwise comparison matrix is prepared to assign the scale of relative importance for each factors (Table 3). The normalized pairwise comparison matrix is then created to standardize the values (Table 4). To validate the normalized matrix, a squared pairwise comparison matrix (Table 5) is constructed by multiplying pairwise comparison matrix by itself which provides a more robust approach for additional layer of verification for the consistency and weight distribution before proceeding to the final step of the analysis.



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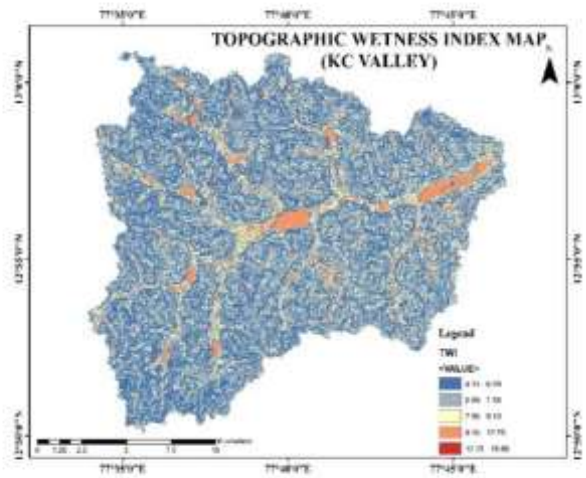

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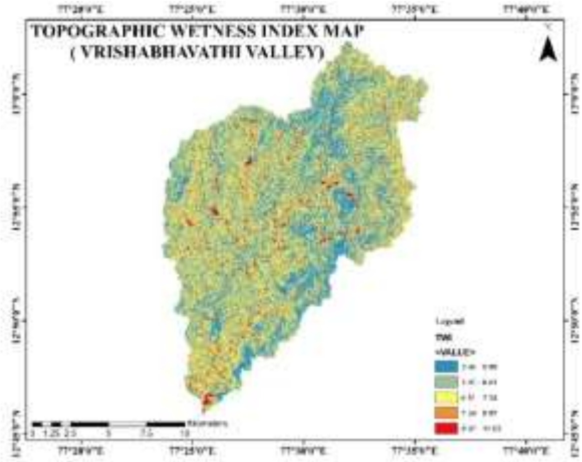

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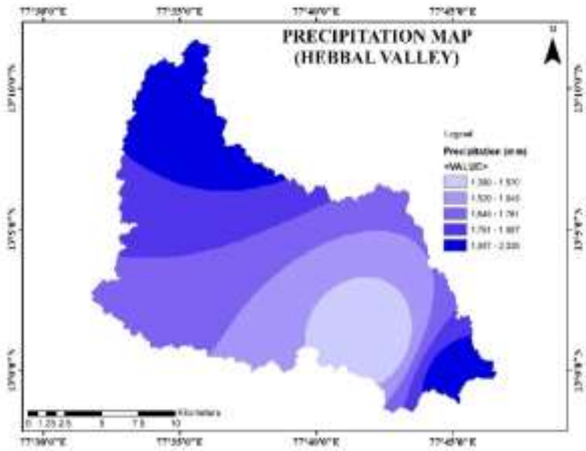
Fig. 2 Topographic Wetness Index Map (a) Hebbal valley (b) KC valley (c) Vrishabhavathi valley



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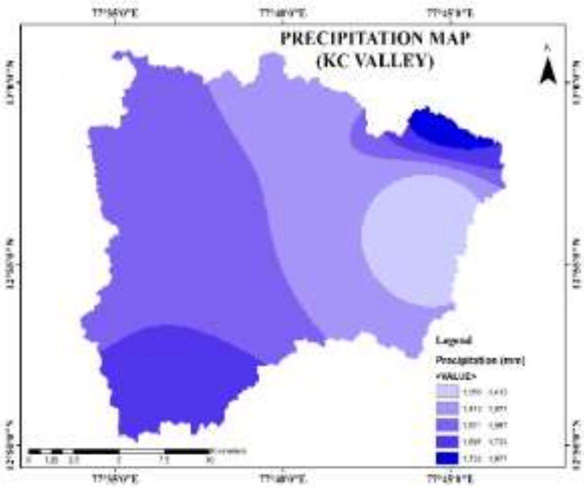

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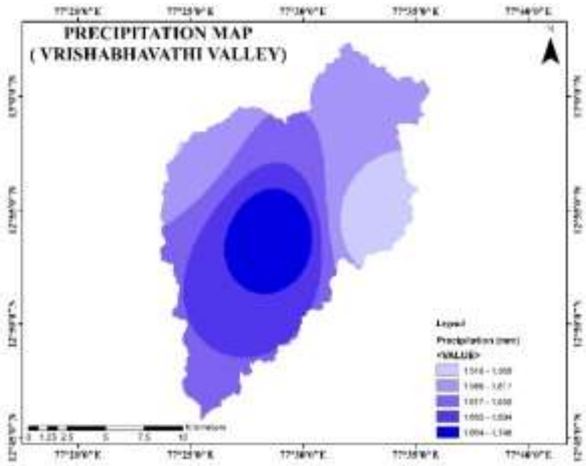

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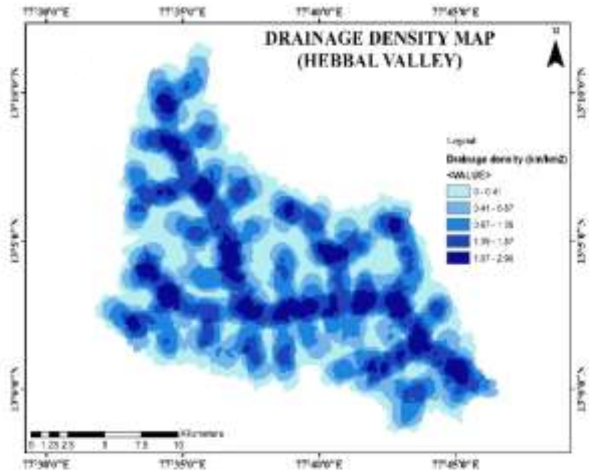
Fig. 3 Precipitation Map (a) Hebbal valley (b) KC valley (c) Vrishabhavathi valley



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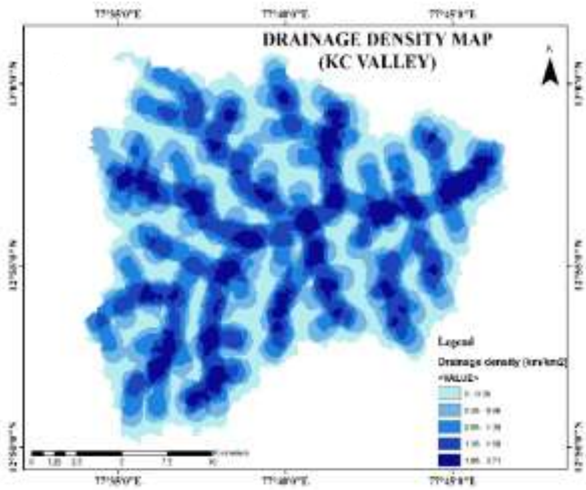

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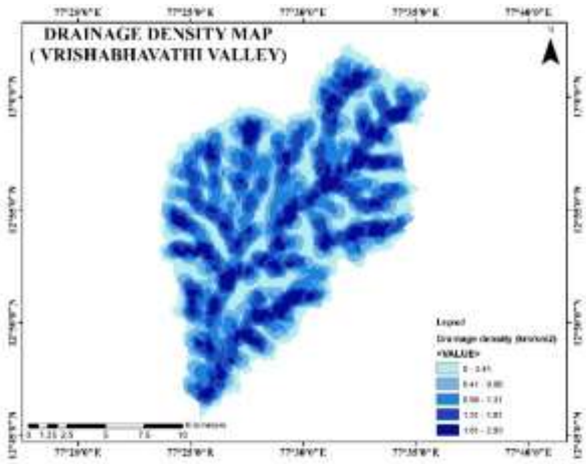

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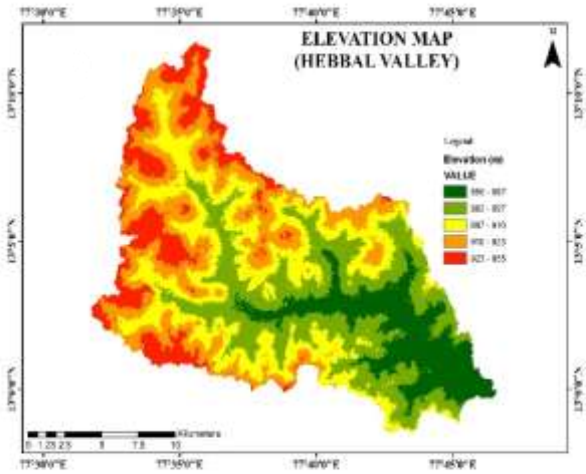
Fig. 4 Drainage Density Map (a) Hebbal valley (b) KC valley (c) Vrishabhavathi valley



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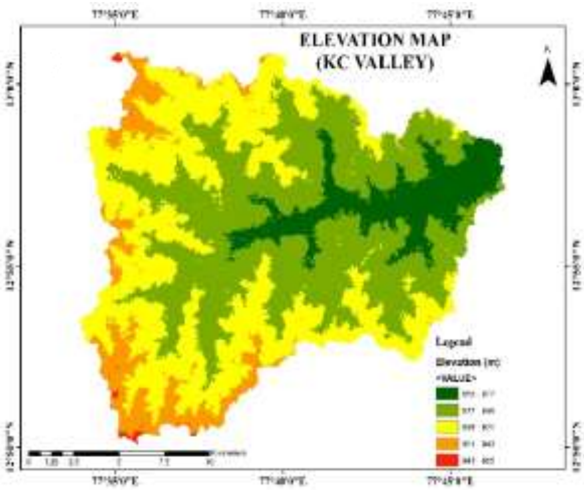

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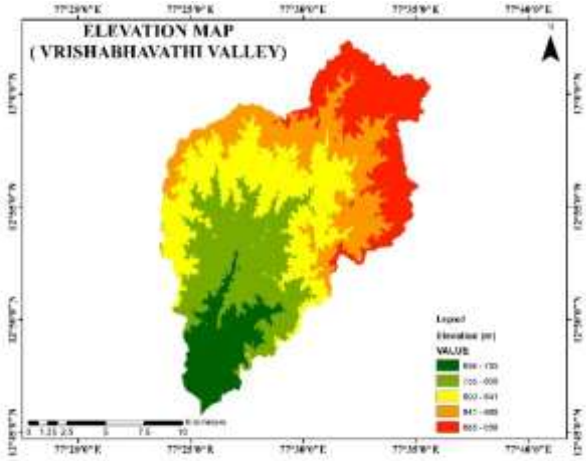

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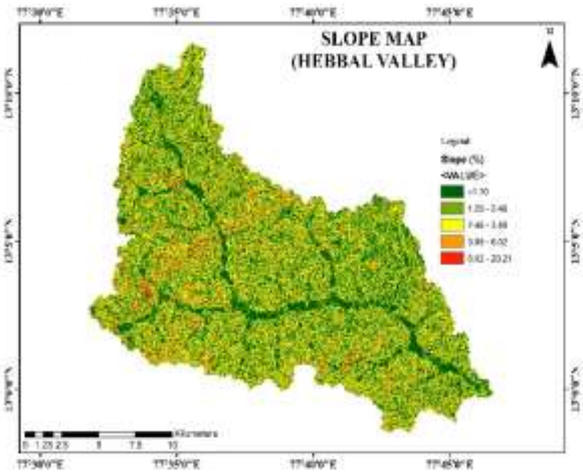
Fig. 5 Elevation Map (a) Hebbal valley (b) KC valley (c) Vrishabhavathi valley



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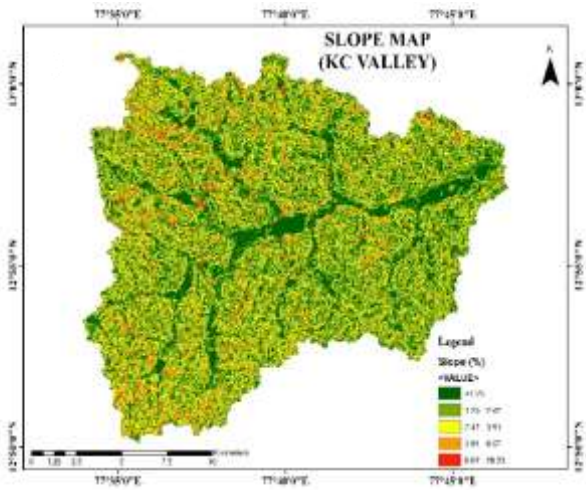

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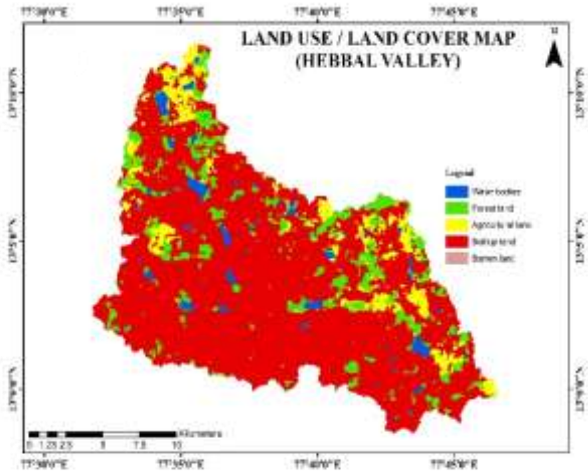
Fig. 6 Slope Map (a) Hebbal valley (b) KC valley (c) Vrishabhavathi valley



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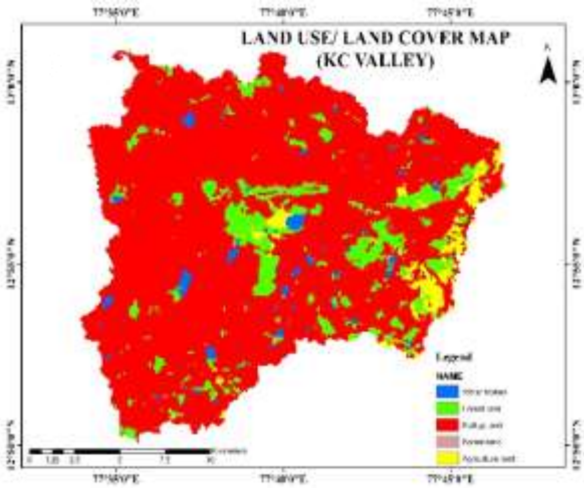

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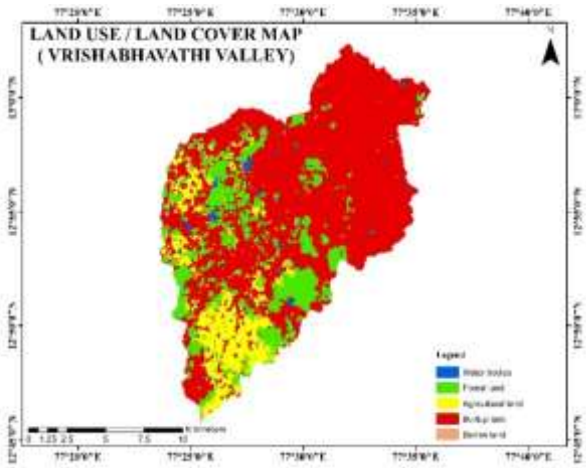

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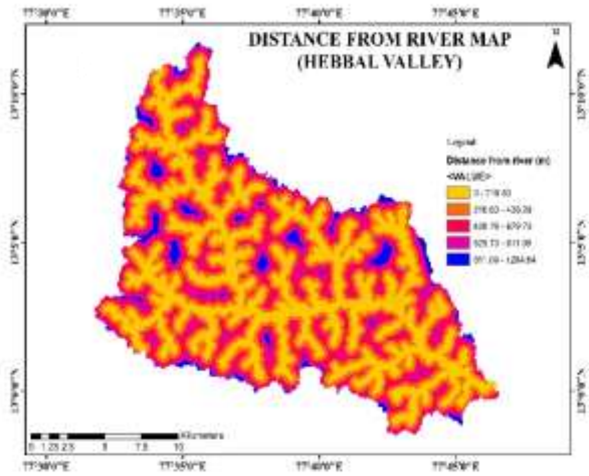
Fig. 7 Land use / land cover Map (a) Hebbal valley (b) KC valley (c) Vrishabhavathi valley



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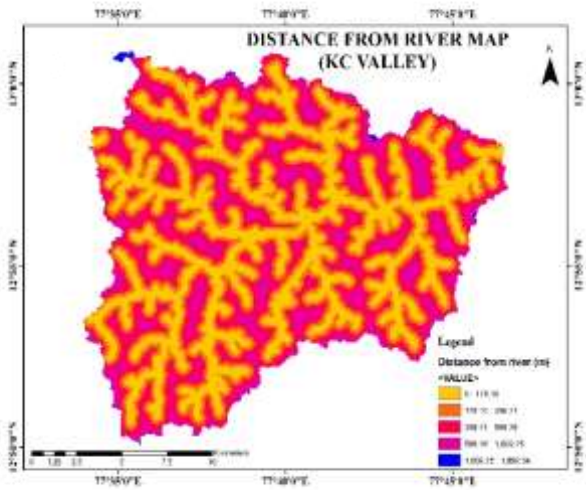

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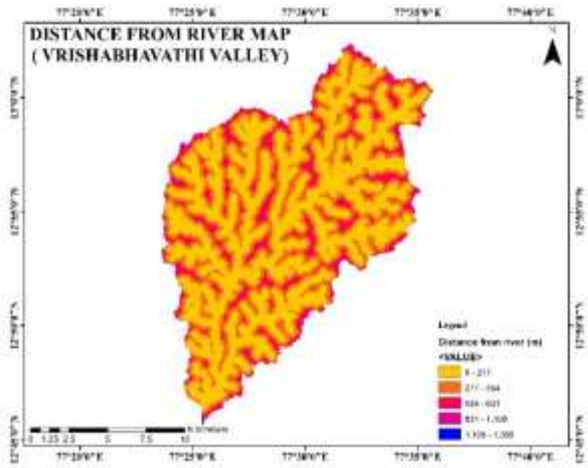

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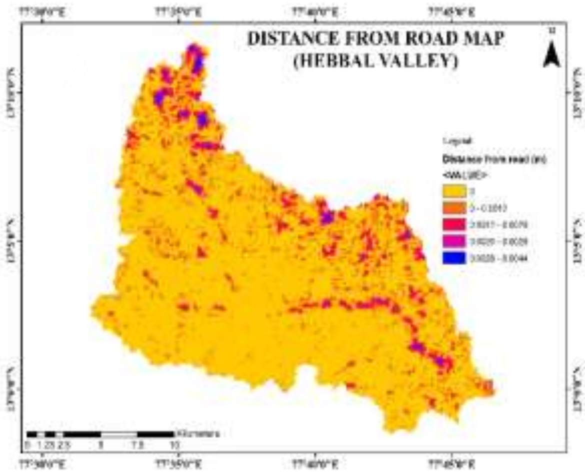
Fig. 8 Distance from river Map (a) Hebbal valley (b) KC valley (c) Vrishabhavathi valley



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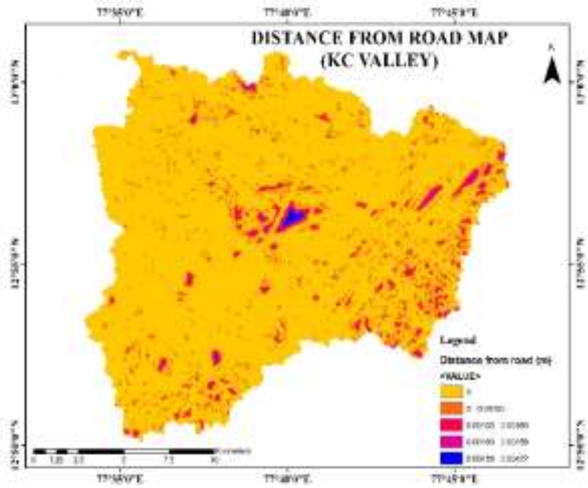

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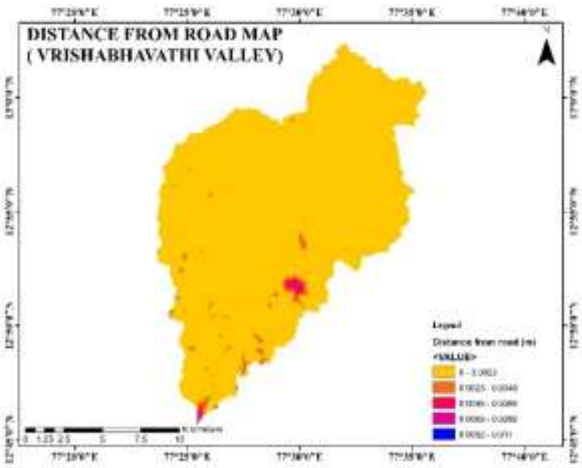

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Fig. 9 Distance from road Map (a) Hebbal valley (b)KC valley (c) Vrishabhavathi valley

Table 2 Saaty's scale (1980) of importance

Intensity of Importance (Absolute Scale)	Definition
1	Equal importance
3	Moderate importance of one over another
5	Essential or strong importance
7	Very strong importance
9	Extreme importance
2, 4, 6, 8	Intermediate values between the two adjacent judgments

Table 3 Pairwise comparison matrix

Factors	Precipitation	Elevation	Slope	Drainage density	LU/LC	TWI	Distance from Road	Distance from River
Precipitation	1	3	5	7	7	5	8	8
Elevation	0.33	1	3	5	5	3	6	6
Slope	0.2	0.33	1	3	3	2	5	5
Drainage density	0.14	0.2	0.33	1	3	2	4	4
LU/LC	0.14	0.2	0.33	0.33	1	2	4	4
TWI	0.2	0.33	0.5	0.5	0.5	1	3	3
Distance from Road	0.13	0.17	0.2	0.25	0.25	0.33	1	2
Distance from River	0.13	0.17	0.2	0.25	0.25	0.33	0.5	1

Table 4 Normalized pairwise comparison matrix

Factors	Precipitation	Elevation	Slope	Drainage density	LU/LC	TWI	Distance from Road	Distance from River	Criteria Weights
Precipitation	1	3	5	7	7	5	8	8	0.38
Elevation	0.33	1	3	5	5	3	6	6	0.21
Slope	0.2	0.33	1	3	3	2	5	5	0.13
Drainage density	0.14	0.2	0.33	1	3	2	4	4	0.10
LU/LC	0.14	0.2	0.33	0.33	1	2	4	4	0.07
TWI	0.2	0.33	0.5	0.5	0.5	1	3	3	0.06
Distance from Road	0.13	0.17	0.2	0.25	0.25	0.33	1	2	0.03
Distance from River	0.13	0.17	0.2	0.25	0.25	0.33	0.5	1	0.02

Table 5 Squared pairwise comparison matrix

Factors	Precipitation	Elevation	Slope	Drainage density	LU/LC	TWI	Distance from Road	Distance from River	Criteria Weights
Precipitation	8	12.11	23.35	118.5	38.67	80.68	109	138	0.35
Elevation	6.65	8	15.44	90.31	26.46	63.65	83.47	115.31	0.27
Slope	3.99	4.99	8	57.12	13.18	30.5	45.61	63.95	0.15
Drainage density	0.92	1.26	2.14	8	3.53	7.62	8.79	12.51	0.3
LU/LC	2.59	3.34	5.13	42.15	8	19.19	31.85	41.85	0.1
TWI	1.83	2.2	3.74	20.25	6.03	8	14.11	26.29	0.05
Distance from Road	0.99	1.29	2.17	9.41	3.5	5.97	8	13.43	0.03
Distance from River	0.58	0.95	1.49	6.36	2.37	4.8	6.12	8	0.02

Consistency ratio

Consistency ratio is calculated to ensure the reliability of the pairwise comparisons made in the AHP. The CR value of < 0.1 is the accepted threshold value and it is expressed as:

$$CR = \frac{CI}{RI} \quad (2)$$

where, CR = consistency ratio, CI = consistency index and RI = Random consistency index. Random index(RI) is referenced from the Saaty(1987) and is mentioned in the Table 6. In the present study, the RI value is 1.41 for 8 factors.

Table 6 Random Consistency Index (R.I) for n= 1,2, …..10

n	1	2	3	4	5	6	7	8	9	10
Random consistency index(R.I)	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Consistency index is calculated using the formula:

$$CI = \frac{\lambda_{max} - 1}{n-1} \quad (3)$$

where, λ_{max} is the maximum eigen value and n is the number of factors. In the study, the calculated λmax value is 8.75 for the normalized matrix and 8.95 for the squared matrix, with n=8. The consistency ratio of normalized and squared matrix is 0.08 and 0.09 respectively, which are less than 0.1. This indicates that the derived results are consistent. Since the squared matrix closely validates the normalized matrix, the normalized matrix is considered accurate and thus flood susceptibility map is generated using this weights.

Flood Susceptibility map

The flood susceptibility map is generated by overlying the influencing factors and their weights according to the AHP results (Table 7). Using ArcGIS, raster layers for each factor are reclassified and assigned their respective weights, integrating them into a single composite map.

Validation of model

The flood susceptibility map is validated using data obtained from the Karnataka State Remote Sensing Applications Centre (KSRSAC) and the Bruhat Bengaluru Mahanagara Palike (BBMP), Bengaluru. The vulnerable locations are identified by Karnataka State Natural Disaster Monitoring Centre (KSNDMC), Bengaluru and is published by BBMP. These sources provide information on flood vulnerable locations for Bengaluru urban which are overlaid onto the flood susceptibility map in ArcGIS. By comparing the vulnerable locations with high susceptibility areas identified in the map, the accuracy and reliability of the flood susceptibility is evaluated. This validation confirms the alignment between the modelled prediction map and the observed data ensuring the map's applicability for flood risk management.

Results and Discussion

Flood susceptibility map

The flood susceptibility map are generated for 3 major valleys of Bengaluru urban by using the AHP technique. Based on the weighted integration of flood causative factors, the flood zones of Hebbal valley, KC valley and Vrishabhavathi valley are classified into low, moderate and high susceptible zones which are represented in Plate 2, 3 and 4 respectively.

The analysis indicates that high flood susceptible zones account for 69 % of the area in the KC valley, 66 % in the Hebbal valley and 35 % in the Vrishabhavathi valley. These results emphasize the need for targeted flood management strategies particularly in regions with high susceptibility. The susceptible zone areas categorised into low, moderate and high are shown in Table 8, 9 and 10 respectively.

Table 7 Weightage of each factors and its classes in developing flood susceptibility map

Sl No	Causative Factor	Unit	Range	Class	Ratings	Weight (%)
1	TWI	Level	3.96 - 5.90	Very low	1	6
			5.90 - 6.49	Low	2	
			6.49 - 7.29	Moderate	3	
			7.29 - 8.93	High	4	
			8.93 - 11.03	Very high	5	
2	Precipitation	mm/year	1,518 - 1,564	Very low	1	38
			1,564 - 1,610	Low	2	
			1,610 - 1,656	Moderate	3	
			1,656 - 1,702	High	4	

			1,702 - 1,748	Very high	5	
3	Drainage density	m/km	0 - 0.57	Very low	1	9
			0.57- 1.15	Low	2	
			1.15 - 1.72	Moderate	3	
			1.72 - 2.3	High	4	
			2.3 - 2.87	Very high	5	
4	Elevation	m	694 – 755	Very high	5	21
			755 – 800	High	4	
			800 – 841	Moderate	3	
			841 – 885	Low	2	
			885 – 958	Very low	1	
5	Slope	%	<2.14	Very high	5	13
			2.14 - 3.92	High	4	
			3.92 - 6.06	Moderate	3	
			6.06 - 9.97	Low	2	
			9.97 - 30.28	Very low	1	
6	LU/LC	Level	Water bodies	Very high	5	7
			Agriculture Land	High	4	
			Built up Land	Moderate	3	
			Barren land	Low	2	
			Forest	Very low	1	
7	Distance from river	m	0 - 0.00931	Very high	5	2
			0.0093 - 0.019	High	4	
			0.019 - 0.028	Moderate	3	
			0.028 - 0.037	Low	2	
			0.037 - 0.047	Very low	1	
8	Distance from road	m	0 - 0.0023	Very high	5	3
			0.0023 - 0.0046	High	4	
			0.0046 - 0.0068	Moderate	3	
			0.0068 - 0.0091	Low	2	
			0.0091 - 0.011	Very low	1	

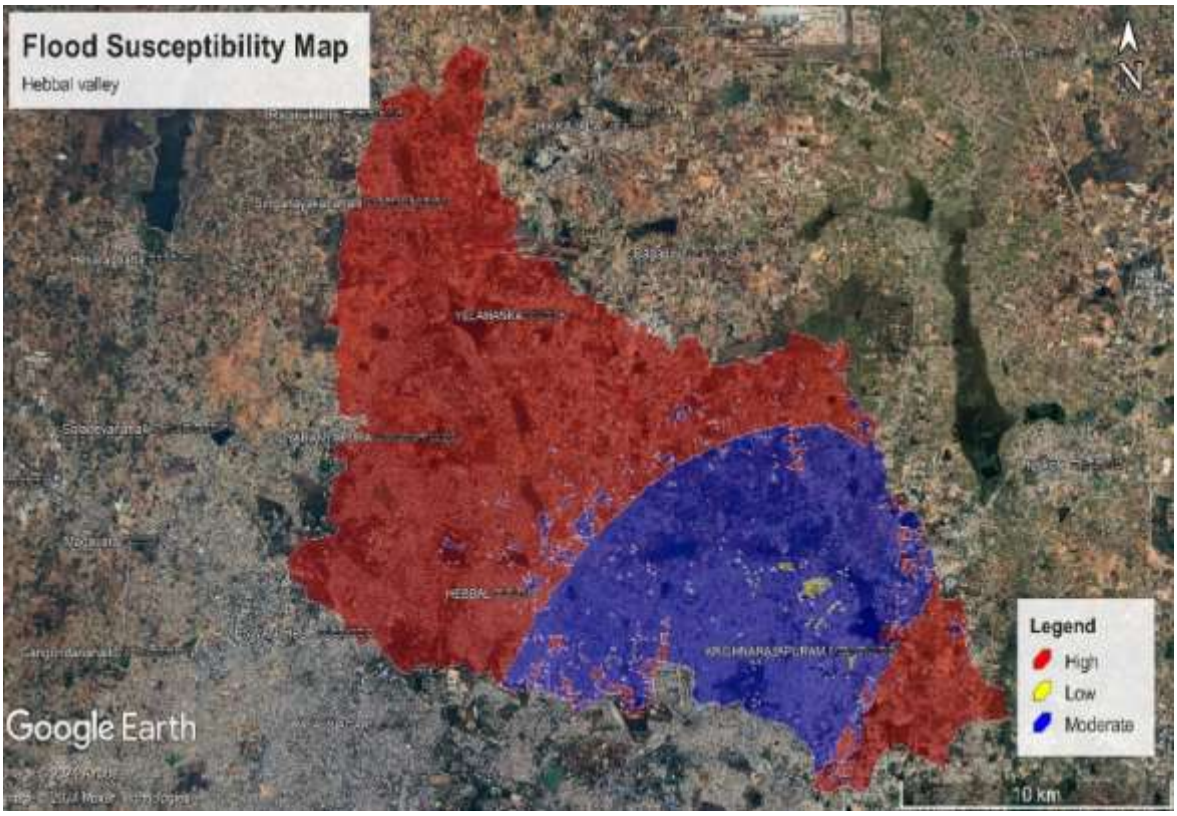

Plate 2 Flood Susceptibility map of Hebbal valley

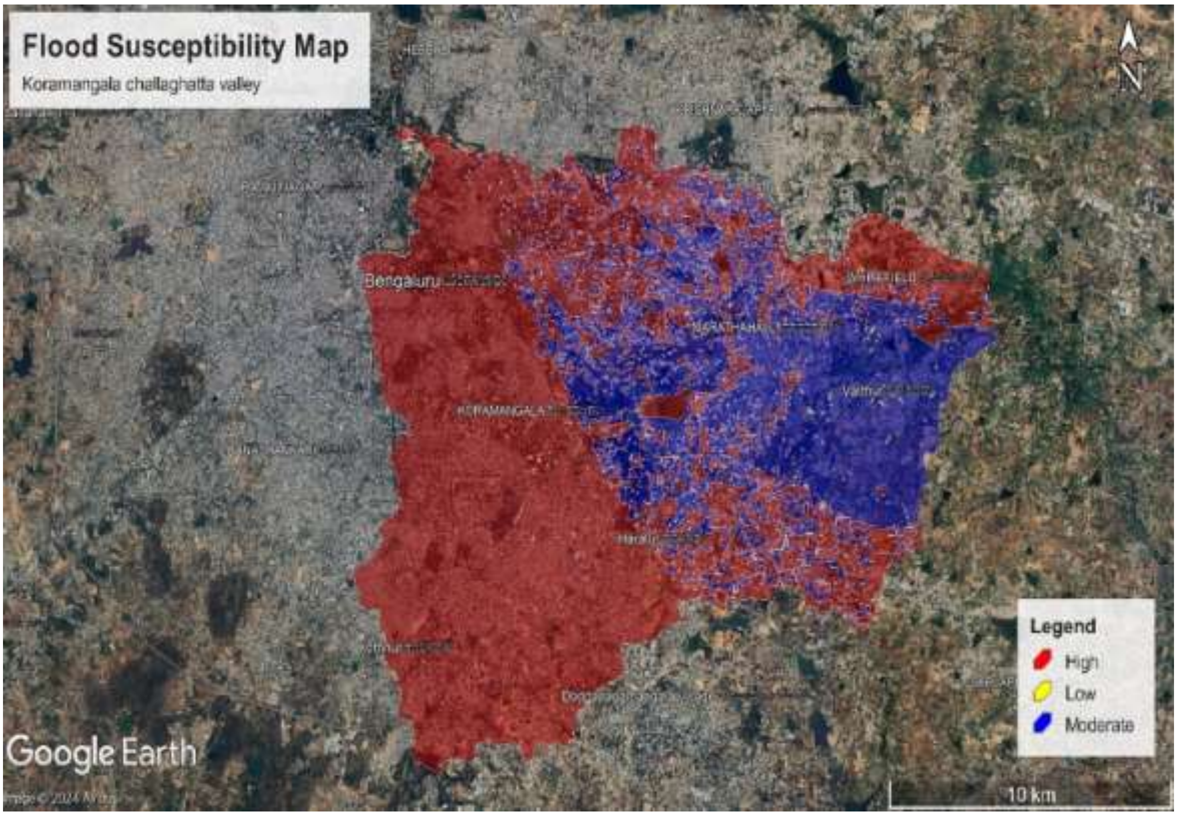

Plate 3 Flood Susceptibility map of KC valley

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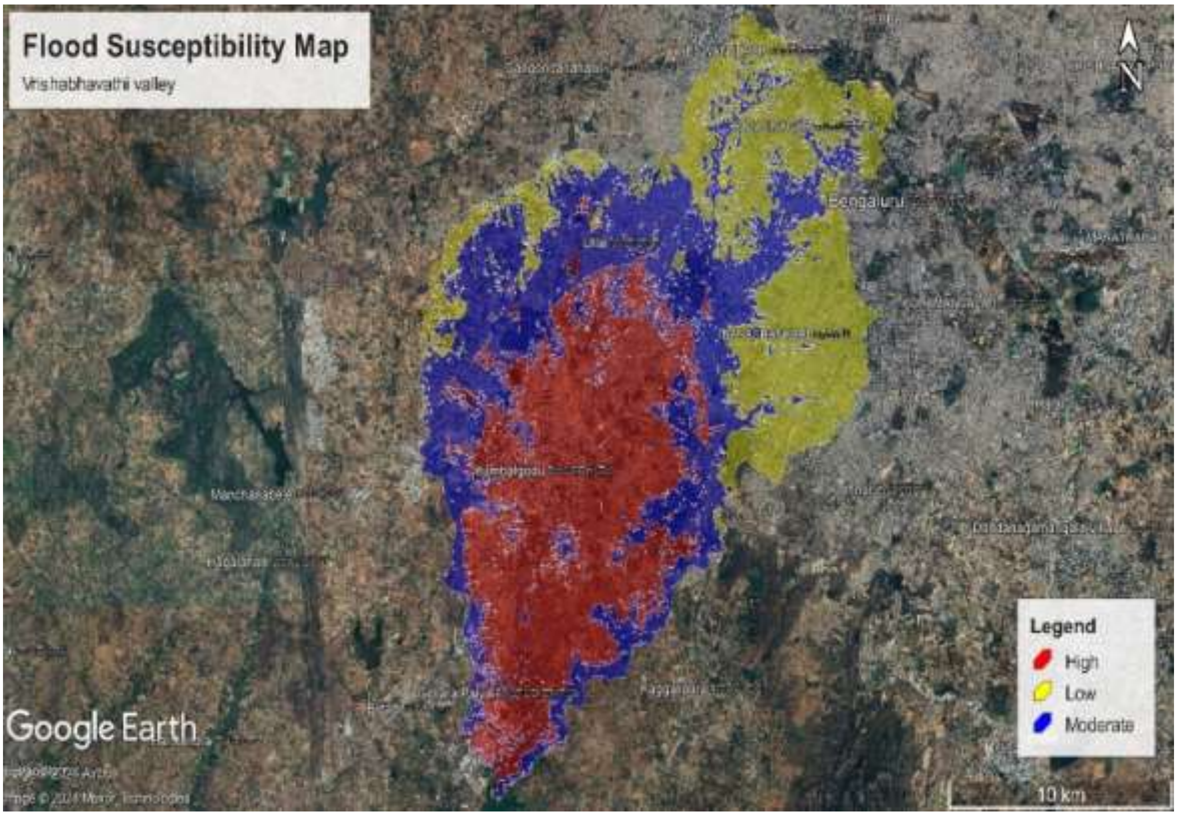

Plate 4 Flood Susceptibility map of Vrishabhavathi valley

Table 8 Susceptible zone areas of flood for Hebbal valley

Sl No	Flood Susceptibility	Area (km^2)	% of contribution	Flood Susceptible zone areas
1	Low	2.03	0	Kithaganur village, Margondanahalli, Battarahalli
2	Moderate	104.89	34	Kalyan nagar, Cheemasandra, Avalahalli, Banaswadi, Seegehalli, Krishnarajapuram, Baiyappanahalli, Dommasandra
3	High	205.37	66	Manyata Tech Park, Nagavara, Yelahanka, Hebbal, Kadugodi, Belathur, Thigalarapalya, Chikkabanahalli, Domsandra, Jakkur, Chikkasandra, Nagenahalli, Kodigehalli, Vidyaranyapura, Matthikere, Jalahalli, RT nagar

Table 9 Susceptible zone areas of flood for KC valley

Sl No	Flood Susceptibility	Area (km^2)	% of contribution	Flood Susceptible zone areas
1	Low	1.28	0	Thubarahalli, Ramagondanahalli, Siddapura
2	Moderate	89.53	31	Balagere, Gunjur palya, Varthur
3	High	199.62	69	Koramangala, Bellandur, Bommanahalli, JP nagar, HSR layout, BTM layout,

				Whitefield, Begur, Hulimavu, Nagondanahalli, Agara

Table 10 Susceptible zone areas of flood for Vrishabhavathi valley

Sl No	Flood Susceptibility	Area (km^2)	% of contribution	Flood Susceptible zone areas
1	Low	98.13	27	Rajajinagara, Malleshwaram, Basaveshwaranagara, Vijayanagara, Chamarajapete, Uttarahalli
2	Moderate	135.6	38	Ullal, Malathalli, Nagarbhavi, Annapurneshwari nagar, Bangalore University, Doddabalapura
3	High	125.51	35	RR Medical college, Kengeri, Kumbalagodu, Gollarapalya, Mysore road, Sheshagirihalli toll, Challegatta

Land use / land cover in the flood risk zones

Land use /land cover distribution significantly influences over the flood risk zones of the 3 major valleys. Fig. 10, 11 and 12 shows the category wise distribution of land use /land cover over the flood risk zones of Hebbal, KC valleys and Vrishabhavathi respectively, In all the three valleys builtup land is more susceptible to high flood, due to impervious surface and poor drainage system. However, agricultural land and forest land are in moderate risk zones due to their capability of infiltration and runoff control.

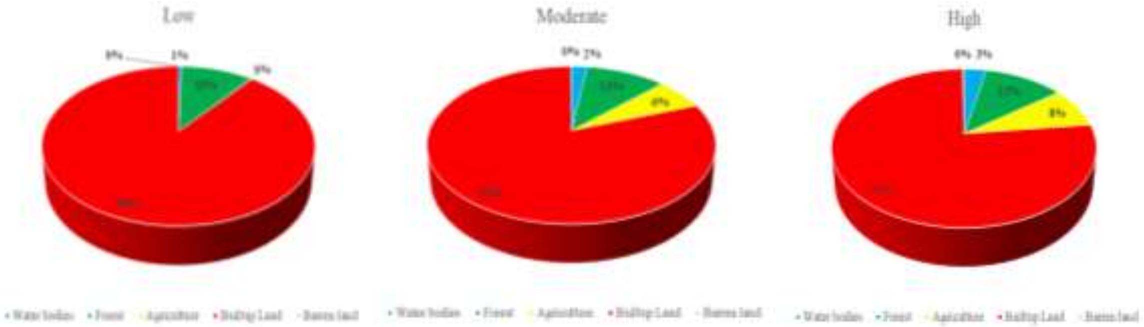

Fig. 10 Distribution of LU/LC across flood risk zones in Hebbal Valley

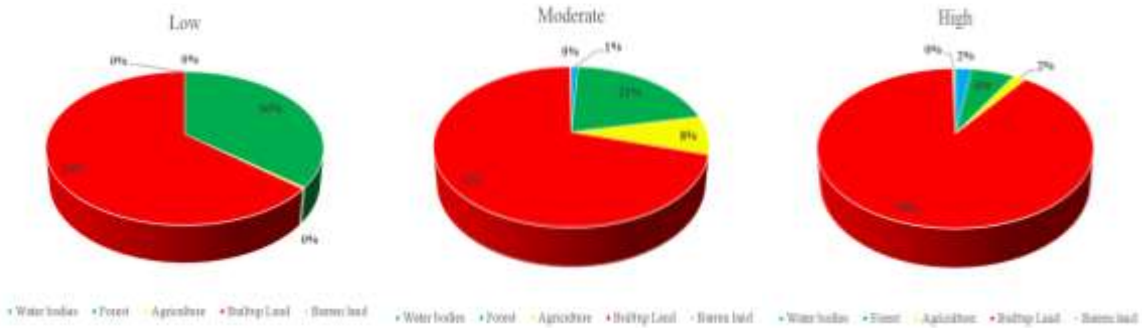

Fig. 11 Distribution of LU/LC across flood risk zones in KC Valley

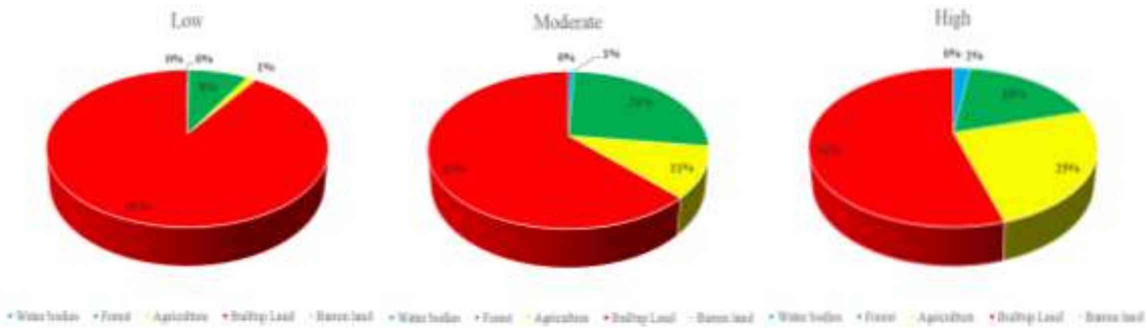

Fig. 12 Distribution of LU/LC across flood risk zones in Vrishabhavathi Valley

Validation

The flood susceptibility map can be verified for higher accuracy only if flood inventory maps are available. Unfortunately, the map is unavailable. However, the validation of flood susceptibility maps are performed using two independent datasets. The first validation utilizes the flood vulnerability zones identified by the KSNDMC, Bengaluru which is published by the BBMP, Bengaluru. The present study identified 217 locations out of 226 locations identified within the study area. The result indicates the significant alignment with the susceptibility zones. Within these locations, 40 % of them are covers in Vrishabhavathi valley which are classified as moderate to high flood risk zones and 100 % of them are in Hebbal and KC valley. This distribution depicts the reliability of the areas prone to flooding.

The second validation used the data from the KSRSAC, Bengaluru. Out of 200 flood prone location identified, 184 locations are within the study area. The analysis reveals that 100 % of the locations falls under moderate to high flood susceptibility in Hebbal and KC valleys, which indicates that these valleys are highly prone to flooding. In contrast, 96 % of the locations in Vrishabhavathi valley are classified on the edges of moderate to low susceptibility, suggesting relatively moderate flood vulnerability compared to other two valleys. This distribution highlights a distinct spatial variation in flood susceptibility among the valleys and depicts that final map has a good level of accuracy.

However, it is important to note that, the available vulnerable location data from both KSNDMC and KSRSAC affect only to Bengaluru Urban. While Hebbal and KC valleys are entirely located within urban boundaries, Vrishabhavathi valley lies partly in rural areas where vulnerable location data is not available. Therefore, the validation for Vrishabhavathi valley is limited to its urban segment only, and the analysis is based on the compromised availability of urban only datasets. Despite this, the overall spatial distribution of flood -prone areas highlights a good level of agreement with the susceptibility map indicating its reliability.

Conclusions

Flood susceptibility mapping is one of the most constructive methods that allows a reduction of flood hazard damage and assist planners, stakeholders and decision makers to have proper supervision over the flood prone areas, ensuing proper and socioeconomic development. AHP with geospatial Techniques have proved to be an alternative approach in identifying the flood susceptibility zones of Bengaluru urban area. For flood susceptibility mapping, eight causative factors which are major influencing the floods in the urban area have been employed along with Saaty's AHP techniques. The maximum weightage has been obtained to precipitation based on the scale of importance assigned to all the causative factors. Three flood susceptibility zones are mapped as low, moderate and high. The flood susceptibility zone shows 65

%, 69% and 34 % as high in Hebbal, KC and Vrishabhavathi valley respectively. Similarly, 33 %, 30 % and 37 % as moderate in Hebbal, KC and Vrishabhavathi and low susceptibility has been noticed only in Vrishabhavarthi valley with 27 %. Hence, the study has demonstrated the use of geospatial techniques along with AHP tools has proved to be an efficient tool to map the flood susceptibility and to recommend the mitigate measures due to urbanisation effect.

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