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Assessment of Urban Water Logging and Development of Stormwater Management Strategy for Gurdaspur City

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Abstract: Urban waterlogging is a common problem in cities during periods of heavy rainfall and can adversely affect transportation, residential areas, commercial activities, roads, and public infrastructure. Gurdaspur City in Punjab also experiences water accumulation at several locations during the rainy season, highlighting the need to examine the existing stormwater drainage conditions and the factors responsible for inadequate drainage. The present study focuses on assessing waterlogging conditions at selected locations in Gurdaspur City, identifying the major causes of the problem, and suggesting suitable measures for its reduction. A field-based assessment is carried out at selected waterlogging-prone locations using a grid-based data collection approach. Information such as approximate water depth, extent of the affected area, duration of water accumulation, rainfall conditions, drainage dimensions, drainage condition, blockage, silt deposition, and surrounding site characteristics is recorded. Local residents' observations are also considered to understand the frequency and effects of waterlogging. Based on the measured or estimated drainage dimensions, the carrying capacity of selected drains is evaluated using Manning's equation. Basic hydrological relationships are further used to estimate surface runoff and the approximate quantity of standing water at selected locations. The study is expected to identify major waterlogging-prone areas and determine the relative contribution of factors such as inadequate drainage capacity, blocked or silted drains, insufficient drainage inlets, low-lying locations, poor surface drainage, and increased runoff from built-up areas.

Keywords: Urban Waterlogging, Stormwater Drainage, Rainfall, Surface Runoff, Drainage Assessment, Waterlogging Hotspots, Manning's Equation, Gurdaspur City, Mitigation Measures

1.Introduction

Urban waterlogging is one of the major problems faced by cities during the rainy season. It occurs when the amount of rainwater reaching the ground surface becomes greater than the capacity of the drainage system to remove it. As a result, water starts accumulating on roads, streets, market areas and other low-lying locations. Even when water remains for a relatively short period, it can create difficulties for pedestrians and vehicles and can interrupt normal activities in the affected area.

The occurrence of waterlogging is influenced by several factors. Rainfall intensity and duration are important natural factors, while the condition and capacity of the existing drainage network play an important role in determining how quickly accumulated water can be removed.

Gurdaspur City in Punjab has several developed residential, commercial and road sections where stormwater drainage is important for maintaining normal conditions during the monsoon season. Waterlogging has been reported at different parts of the city following periods of heavy rainfall. The problem can affect traffic movement, local businesses, residential areas and public infrastructure. Therefore, examining the locations where water accumulates and understanding the condition of the nearby drainage system is important for identifying the factors responsible for the problem.

2.Literature Review

Urban waterlogging and rainfall-induced flooding have been studied extensively because of their effects on transportation, infrastructure, residential areas and economic activities. Previous research indicates that waterlogging is

generally not caused by rainfall alone. It is often the result of the interaction between rainfall characteristics, urban development, topography, drainage capacity and the maintenance condition of drainage infrastructure.

Singh, Nielsen and Greatrex (2023) conducted a systematic review of research on urban pluvial flooding in India. Their study examined 62 research articles to identify the major causes, impacts and mitigation approaches associated with rainfall-driven urban flooding. (ScienceDirect)Joe et al. (2025) investigated urban waterlogging vulnerability in Thoothukudi, Tamil Nadu. The researchers combined rainfall information, satellite-based observations and terrain characteristics to identify areas repeatedly affected by waterlogging. (ResearchGate)A recent review by Karmaksh, Sangwan and Kumar (2026) examined research trends related to urban water systems in Indian cities.

For Gurdaspur specifically, the Gurdaspur Local Planning Area Master Plan reports inadequate stormwater drainage infrastructure and recurring waterlogging during heavy rainfall. It identifies the Nabipur Cut drain as an important route for stormwater disposal and notes that silt deposition and inadequate drainage arrangements can reduce the effectiveness of the drainage system. The Master Plan therefore provides an important background for the present study and supports the need for a location-based assessment of waterlogging and drainage conditions within Gurdaspur City. (GMADA)

3.Aim and Objectives

* To identify major waterlogging-prone locations in Gurdaspur City.

* To assess the extent, depth and duration of waterlogging.

* To identify major factors responsible for waterlogging.

* To suggest practical measures for reducing waterlogging.

4.Study Area



Figure I: Location Points (Area I)

(a) Geographic location of corner points (Area I)

!. Jahaj chowk – Latitude - 32°02'29.10"N, longitude - 75°24'30.17"E

2. Hanuman chowk – Latitude - 32°02'17.43"N, Longitude - 75°24'19.08"E

3. Bhai Lalo chowk – Latitude - 32°02'05.57"N, Longitude -75°24'33.85"E

4. GT road to sangalpura road – Latitude - 32°02'28.15"N, Longitude- 75°24'59.47"E

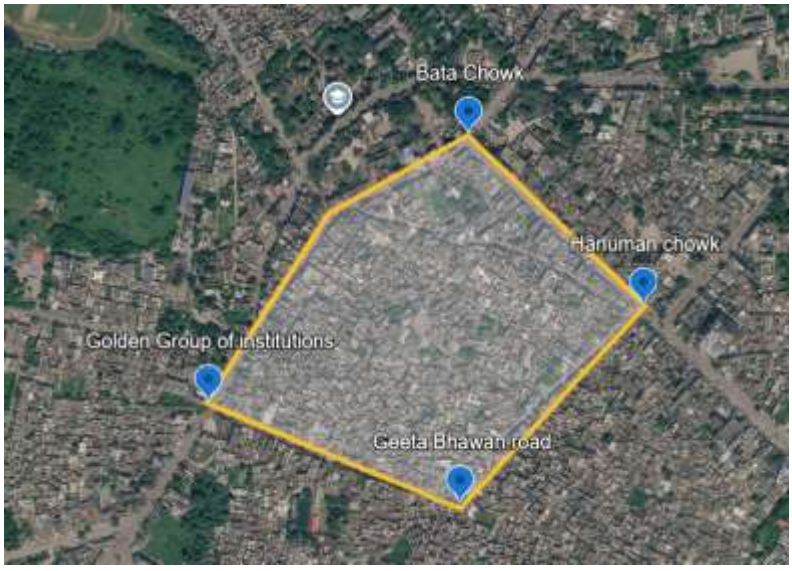


Figure II : Location Points (AreaII)

a) Geographic location of corner points (Area II)

1.Bata chowk – Latitude - 32°02'26.40"N, Longitude- 75°24'08.74"E

2.Golden group of institutions – Latitude- 32°02'13.85"N, Longitude- 75°23'54.36"E

3.Geeta Bhawan road – Latitude- 32°02'09.14"N, Longitude - 75°24'08.27"E

4.Hanuman chowk – Latitude - 32°02'18.40"N, Longitude- 75°24'18.40"E

5.Data collection

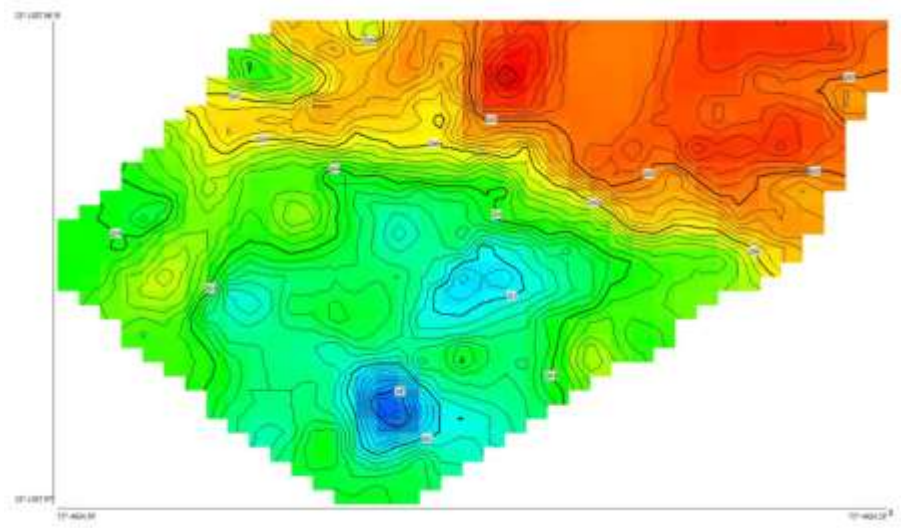


Figure III: Contour Map (Area I)

Profile(Longitude & Latitude)

S. No	Location / Point	Latitude (approx.)	Longitude (approx.)	Altitude (m, approx.)	Water Depth (cm, appro
1	Hanuman Chowk	32.0405	75.4052	265	15
2	Hanuman Chowk – nearby road	32.0409	75.406	264.5	17-18
3	Jahaj Chowk	32.0417	75.4072	264	22-24
4	Jahaj Chowk – approach road	32.0422	75.408	263.5	25-27
5	Mandi Road – Point 1	32.0428	75.409	264	20-22
6	Mandi Road – Point 2	32.0434	75.41	263.5	28-30
7	Near Castle Bakers	32.044	75.411	264	18-20
8	Castle Bakers – nearby junction	32.0445	75.412	263	30-32
9	Nearby low-lying area	32.0432	75.4128	262.5	35-37
10	Drainage outlet/low point	32.0423	75.4135	263	25-27

This contour map represents the elevation/topographic variation of the study area, with contour values ranging approximately from 258 m to 270 m.

* Highest elevation: about 270 m, mainly in the northern and northeastern parts (red/orange zones).

* Lowest elevation: about 258–260 m, concentrated in the south-central portion (dark blue zone). The green/cyan areas (262–265 m) represent intermediate elevations.

* Closely spaced contours indicate steeper slopes, particularly around the central–southern low-elevation zone and the transition toward the northern higher ground.The overall terrain shows a general rise toward the north/northeast and fall toward the south-central region.* For a waterlogging study, the low-elevation blue/cyan zones are important because they may act as natural water accumulation or drainage-convergence areas during heavy rainfall.

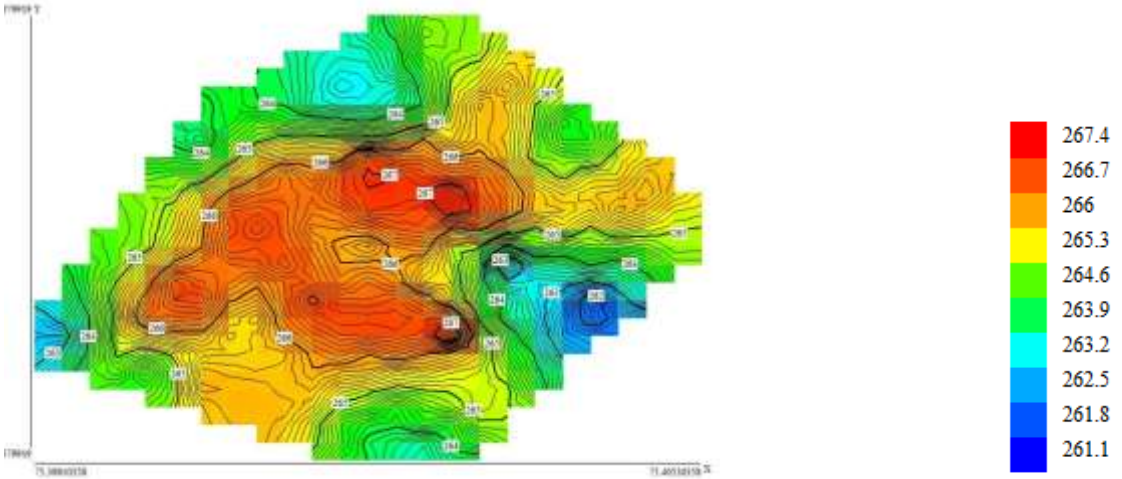


Figure IV: Contour Map (Area 2)

Profile (longitude & latitude)

Waterlogging & Elevation Assessment Data (10 Selected Locations)				
Location / Landmark	Longitude (°E)	Latitude (°N)	Altitude (m)	Waterlogging Depth (cm)
Golden Group of Institutions	75.39838	32.03717	262.505	30
Geeta Bhawan Road	75.40232	32.03591	263.281	25
Deep Depression Zone A	75.40159	32.04027	263.275	25
Mid Depression Zone	75.40187	32.04040	263.528	25
Mid-Western Slope	75.40085	32.03992	263.939	22
Western Boundary	75.40019	32.03961	264.146	20
Upper Central Depression	75.40212	32.04051	264.215	20
Bata Chowk / Northern Region	75.40242	32.04066	264.718	17
Northern Slope	75.40229	32.04060	264.958	15
Hanuman Chowk	75.40511	32.03846	265.038	15

The contour map represents the elevation variation of the study area, with contour values ranging approximately from 262 m to 267 m.

* Highest elevation: Around 267 m, mainly in the central portion of the study area, shown in red/orange.

* Lowest elevation: Around 262–263 m, mainly toward the eastern/southeastern and western edges, shown in blue/cyan. The closely spaced contour lines indicate areas of relatively steeper elevation change.

* The gradual change from the higher central region toward the lower boundary areas indicates the general direction of surface drainage. For a waterlogging study, the elevation zones (approximately 262–264 m) are particularly important because surface runoff may accumulate there, especially if drainage capacity is inadequate.

6.Proposed Solutions and Mitigation Measures for Waterlogging

1. Improvement of Drainage at Low-Elevation Points

Identify the lowest-elevation locations from the elevation and contour data and provide additional or larger storm-water inlets at these points, as these areas are more likely to accumulate runoff.

2. Increasing the Capacity of Existing Drains

Existing drains should be cleaned, desilted and upgraded where the observed water depth and waterlogging duration indicate inadequate drainage capacity.

3. Installation of Additional Storm-Water Inlets

Additional catch pits and storm-water inlets should be provided at locations experiencing greater water depth or prolonged waterlogging, particularly near low-lying road sections.

4. Correction of Local Road Depressions

Local depressions in the road surface should be identified and corrected .

5. Maintaining Adequate Road Gradient

Roads should be provided with an appropriate longitudinal slope toward designated drainage points to prevent the formation of isolated low spots where rainwater can accumulate.

6. Elevation-Based Drainage Planning

Drainage improvements should be prioritized using the elevation data. Locations with relatively lower elevation.

7.Conclusion

The assessment of urban water logging in Gurdaspur City indicates that stormwater-related problems are influenced by a combination of inadequate drainage capacity, increasing urbanization, expansion of impervious surfaces, obstruction and siltation of drainage channels, and insufficient connectivity within the existing stormwater network. The spatial assessment identifies vulnerable locations where the accumulation of runoff can adversely affect transportation, residential areas, and other urban activities during intense rainfall events.

The study demonstrates that improving the existing drainage network alone may not provide a sustainable solution to urban water logging. An integrated stormwater management approach is therefore required, combining drainage improvement and maintenance with decentralized measures such as rainwater harvesting.

8.References

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