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Assessing Rainfall Patterns and their Implications on Stormwater Flows: A Water-Sensitive Urban Planning Study of Mysore City

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ABSTRACT

This study uses the Water-Sensitive Urban Planning and Design (WSUPD) paradigm to investigate the relationship between stormwater flow performance and rainfall variability in Mysore City. Stormwater stagnation and urban flooding are becoming more common in Mysore, despite the city's historical reputation for having a planned urban shape and moderate rainfall. Understanding how rainfall intensity and solid waste mismanagement interact to impact drainage system performance is a crucial research gap that the current Mysore Master Plan does not adequately address. All municipal wards, including J.P. Nagar, Jayanagar, Kuvempunagara, Vijayanagar, Gokulam, Udayagiri, and important arterial corridors, are included in the study, which combines a 35-year rainfall trend analysis with hydrological assessment and in-depth field studies. According to field observations, silt, organic matter, plastic garbage, and construction debris have all accumulated widely in stormwater drains, severely reducing their flow capacity.

The results show a clear connection between drainage obstructions and solid waste buildup, which worsen flooding during periods of heavy precipitation. The study comes to the conclusion that poor drainage and waste management have a significant impact on flooding in Mysore and are not only caused by variations in rainfall. In order to improve flood resilience and ecological sustainability, it suggests integrated urban planning reforms that harmonize solid waste management, drainage infrastructure upkeep, and water-sensitive design principles with Mysore's urban growth policies.

Keywords: Stormwater Management; Water-Sensitive Urban Planning and Design (WSUPD); Rainfall Variability, Solid Waste Management; Drainage Infrastructure; Mysore City; Climate Resilience; Urban Planning Policy

INTRODUCTION

Rapid urbanization and climate change are imposing unprecedented stresses on urban water systems worldwide. Cities in the Global South, in particular, face a dual challenge: managing the hydrological impacts of impervious surface expansion while adapting to increasingly variable and intense rainfall regimes. This confluence often overwhelms conventional drainage infrastructure, leading to increased flood risk, erosion, water pollution, and the degradation of aquatic ecosystems. In this context, the paradigm of Water-Sensitive Urban Design (WSUD) has emerged as a critical planning framework. It advocates for the holistic integration of the urban water cycle—including stormwater, groundwater, and wastewater—

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into city planning to enhance sustainability, resilience, and livability.

The pressure on water resources is acute, as water is an indispensable natural resource fundamental to all life. Its availability, in terms of both quality and quantity, is a critical determinant for the sustainability of ecosystems and human societies. Surface water bodies, which include flowing (lotic) systems such as rivers and streams, as well as static (lentic) systems like ponds, lakes, and reservoirs, are particularly vulnerable. These lentic systems, often central to urban landscapes for supply, recreation, and ecology, are highly susceptible to the impacts of altered hydrological regimes caused by urban development. Mysore City, a rapidly expanding tier-II city in Karnataka, India, epitomizes this complex challenge. Historically known for its moderate climate and structured layout, Mysore is experiencing significant transformation due to urban sprawl and shifting precipitation patterns. While the city's traditional drainage network was designed for historical climatic conditions, contemporary observations suggest alterations in rainfall intensity, duration, and seasonal distribution.

These changes, compounded by widespread land-use conversion—where natural pervious landscapes are replaced by impervious surfaces like rooftops, roads, and pavements—critically impair groundwater recharge and accelerate surface runoff. This creates a strategic blind spot for planners and engineers, as a systematic assessment of how current and projected rainfall patterns interact with the transformed urban landscape to generate stormwater flows is absent.

This study, therefore, seeks to bridge this gap by conducting a comprehensive analysis of rainfall patterns and their direct implications on stormwater hydrology in Mysore City. It employs a combination of historical meteorological data analysis, geographic information systems (GIS), and hydrological modelling. The investigation is grounded in empirical field data from representative urban morphologies, such as the Bannimantap a Layout, where precise geospatial analysis quantifies the extent of impervious cover and its role in altering the local hydrological regime. The primary objectives are to: (1) identify decadal trends in rainfall intensity, frequency, and seasonality over the Mysore region; (2) model the resultant stormwater flow responses under different urban development scenarios; and (3) evaluate the capacity of existing drainage infrastructure against these hydrological loads.

Ultimately, this research aims to provide evidence-based insights to inform water-sensitive urban planning strategies for Mysore. The findings are intended to guide the development of robust, adaptive stormwater management policies that mitigate flood risk, protect water quality, and contribute to the city's long-term climate resilience and sustainable growth. By using specific urban fabrics as a microcosm for study, the research provides a scalable model for practical, localized WSUD interventions across the city.

The study offers a thorough scientific evaluation of rainfall properties, such as intensity, distribution, and temporal variability, all of which are essential for comprehending stormwater generation processes and peak flow behavior in urban settings. Critical discrepancies between current drainage capacities and real hydrological demands under shifting rainfall regimes are identified by the research by methodically connecting rainfall patterns with stormwater runoff dynamics. The study goes beyond traditional, engineering-centric drainage techniques by taking a water-sensitive urban design stance. In order to increase urban resilience to climate-induced rainfall extremes and lessen reliance on hard infrastructure alone, it highlights the integration of blue-green infrastructure, natural drainage systems, and land-use planning initiatives.

For Mysuru City, where empirical rainfall-runoff studies are still scarce despite frequent urban floods and drainage issues, the study also provides evidence-based design insights. The results provide credence to the development of context-specific stormwater management plans, such as decentralized stormwater interventions like infiltration and retention systems, lake–drain integration, and drain modification. By emphasizing the necessity of updated drainage design guidelines, climate-responsive urban planning frameworks, and integrated governance mechanisms, the study advances urban policy and planning practice. The findings of this study can help policymakers, planners, and urban municipal authorities create sustainable stormwater management plans that support long-term goals for environmental preservation,

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urban growth, and climate adaption.

LITERATURE REVIEW

Urbanization, Rainfall Variability, and Storm Flow Challenges

This investigates the effects of climate variability, shifting rainfall patterns, and fast urbanization on storm flows and urban flooding. By stressing how rainfall unpredictability, land-use change, loss of natural drainage, and data restrictions contribute to the escalation of stormwater issues in Indian cities—with particular reference to Mysuru—it sets the hydrometeorological and planning backdrop.

This GIS-based study analyzes rainfall variability and its impact on groundwater table fluctuations in Mysore Taluk, Karnataka, from 2001 to 2011. Using data from six rain gauge stations and nine observation wells, the authors applied arithmetic mean, Thiessen polygon, and iso-hyetal methods to map spatio-temporal trends. Results indicate an average annual rainfall of 724.83 mm, with distinct seasonal patterns and a declining trend toward the southwestern region.

Groundwater levels, influenced by rainfall and perennial rivers like the Cauvery, showed shallow conditions in northern and southeastern areas. The study underscores the utility of GIS for monitoring and managing water resources in urbanizing regions like Mysore (Sharifi et al.,2016). According to analyses the impact of urbanization on soil, water, and biodiversity, advocating for ecologically-informed land use planning. Through a GIS case study of Austin, Texas, Kharel (2010) found that over 10% of environmentally sensitive land (including slopes, water bodies, and floodplains) had been developed, highlighting a critical planning failure. The author proposes a two-part corrective framework: a "Where to" strategy to first identify and protect vital ecological areas, followed by a "How to" strategy to guide sustainable development on suitable land.

For a study on Mysore City, this work underscores a foundational principle: effective, water-sensitive urban planning and stormwater management must begin with legally protecting natural drainage systems and watershed functions from incompatible development. (Kharel, G. 2010) This study examines the extreme rainfall and devastating floods in Hyderabad (October 2020), linking the disaster to a Mesoscale Convective Complex (MCC) embedded in a synoptic depression. It emphasizes that urban vulnerabilities—such as loss of water bodies, encroached floodplains, and inadequate drainage—amplified the impact. The paper underscores the critical need to integrate meteorological analysis with water-sensitive urban planning to build resilience (Singh et al. ;2024) This review analyzes climate resilience planning methodologies across seven Indian cities, including Mysore, under the ACCCRN initiative. For Mysore, a replication-phase city, the process employed a qualitative, stakeholder-driven approach led by ICLEI. It utilized Shared Learning Dialogues with city officials to identify fragile urban systems and vulnerabilities, relying on existing regional climate assessments rather than city-specific climate or hydrological modeling. A key finding was the critical challenge of data scarcity, where a lack of localized, granular data (e.g., for detailed rainfall or stormwater flow analysis) constrained technical vulnerability assessments.

The study underscores that successful resilience planning requires contextualized methodologies and strong institutional coordination, highlighting a common gap in quantitative, sector-specific data that studies aiming to model urban hydrology must address (Sharma et al.;2013) This study demonstrates that high spatial resolution of rainfall data is critical for accurate urban hydrological modeling. Analyzing two years of data from 22 rain gauges over 125 km², the authors found that while low- to medium-intensity events are spatially well-correlated, correlation drops sharply for high-intensity storms, indicating significant spatial variability. Reducing the measurement network by half introduced errors up to 25% for frequent storms and 45% for rarer events, while assuming uniform rainfall from a single gauge amplified error to 75–125%. The findings underscore that coarse rainfall inputs can severely mislead stormwater infrastructure design, advocating for dense measurement networks to capture the true variability of intense rainstorms (Roman Maier et al.;2020) This study analyzes historical and projected rainfall patterns in, India, to evaluate their impact on urban stormwater flows.

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Using hydrological modeling and spatial analysis, the authors assess the capacity of existing drainage infrastructure under varying climatic scenarios. The research highlights increasing vulnerability to urban flooding due to intensified rainfall events and inadequate stormwater management systems. The paper advocates for water-sensitive urban design (WSUD) principles, including green infrastructure, permeable surfaces, and integrated drainage planning, to enhance urban resilience. The findings contribute to the discourse on sustainable urban planning by emphasizing the need for adaptive, ecologically informed stormwater strategies in rapidly urbanizing regions (Smith, J., & Kumar, A. 2023).

Fundamentals of Urban Stormwater and Flood Management

This study the fundamentals of managing floods and stormwater in urban areas, highlighting the shift from traditional rapid-drainage methods to integrated, watershed-based, and multi-objective systems. It offers the institutional, hydrological, and engineering foundation required to comprehend why conventional grey infrastructure is inadequate on its own in the face of growing urban and climatic stresses.

In this study present a holistic framework for urban flood management, advocating a shift from purely technical solutions to integrated strategies that combine spatial planning, land-use policies, and community engagement. The study an evolutionary approach—from indigenous adaptation and structural control to non-structural measures and, ultimately, to "living with floods"—emphasizing sustainable urban drainage systems (SUDS), flood-proofing techniques (e.g., dry and wet proofing), and catchment-scale planning.

For a study on Mysore City, this work provides a foundational perspective, stressing that effective flood and stormwater management requires multidisciplinary collaboration, context-sensitive solutions, and the integration of water-sensitive design into urban development, particularly in rapidly urbanizing regions (Szöllősi-Nagy and Zevenbergen 2005) The Municipal Stormwater Management, provides a holistic framework essential for water-sensitive urban planning. It argues that effective stormwater management must concurrently address institutional (governance, funding, regulations), technical (hydrologic design, BMPs), and implementation (construction, maintenance) challenges. The study introduces the diagnostic "Five Whys" tool to uncover root causes of stormwater problems.

It documents the paradigm shift from traditional rapid conveyance to contemporary, multi-objective strategies emphasizing pollution control, ecological integrity, and watershed-scale integration through Low-Impact Development (LID) principles. With extensive design guidance for infrastructure and BMPs, coupled with chapters on master planning and program development, this work is a critical reference for developing comprehensive, sustainable stormwater management systems, directly informing studies like that of Mysore City which seek to link rainfall patterns with integrated urban drainage solutions (Debo and Reese’s2003)

The Urban Flood Mitigation and Stormwater Management provide a comprehensive and applied treatment of modern stormwater management, integrating conventional engineering approaches with contemporary Low-Impact Development (LID) strategies. The study is structured in two parts: the first covers hydrologic fundamentals (rainfall analysis, watershed modeling, frequency analysis, and the Rational Method), while the second details hydraulic design of urban drainage components (channels, culverts, inlets, sewers, detention basins, and LID facilities) (Guo2017). This foundational work argues for a paradigm shift from fragmented pollution control to integrated, watershed-scale stormwater management. It emphasizes that urban runoff and combined sewer overflows are significant sources of pollutants (sediments, metals, pathogens) that degrade receiving waters. The study catalogs a wide array of Best Management Practices (BMPs), from source controls (e.g., porous pavements) to treatment technologies, and stresses the necessity of combining flood control, pollution abatement, and water reclamation in a unified planning framework. This integrated approach provides a critical conceptual model for developing a water-sensitive urban plan for Mysore City, advocating for system-wide analysis before selecting site-specific solutions (Field, R etal.;1993) Principles of Stormwater Management serves as a comprehensive introductory textbook that bridges fundamental concepts and modern regulatory practice.

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The author establishes a holistic framework by beginning with the hydrologic cycle, emphasizing how contaminants enter water at every stage—from atmospheric deposition to surface runoff. This systemic view underscores a core principle for urban planning: stormwater is not merely a drainage problem but a key component of the urban water cycle that must be managed for quality and quantity from "source to sink. (Griffin's 2018)

Water Sensitive Urban Design (WSUD) and Sustainable Drainage Systems

This presents Water Sensitive Urban Design (WSUD), a thorough planning and design methodology that combines urban form, ecology, and governance with stormwater management. It emphasizes how important WSUD is for improving water quality, reducing flooding, and fostering urban resilience, especially in the Global South's fast-growing cities like Mysuru.

In according to the report establish Water Sensitive Urban Design (WSUD) as an integrated stormwater management philosophy. Their industry report provides a practical framework for implementing WSUD, emphasizing a treatment train of Best Management Practices (BMPs). It is substantiated by the landmark Lynbrook Estate case study, which demonstrated the hydraulic, water quality, and community acceptance benefits of bio-filtration systems, with a modest capital cost increase. The report also introduces the MUSIC modelling tool for scheme evaluation and identifies regulatory and institutional barriers to adoption. This work provides a comprehensive reference for the planning, technical design, and socio-economic considerations relevant to implementing WSUD in cities like Mysore City (Lloyd et al. ;2002) In this Study argue for a radical re-conceptualization of Water Sensitive Planning (WSP) for cities in the Global South, where informal development, infrastructure deficits, and water insecurity prevail. Critiquing Western-derived models as misaligned with Southern urban realities, they propose a framework that embeds water security into core spatial planning processes.

Key principles include aligning roads and drains with hydro-geography, protecting water commons, using green spaces for recharge, and treating wastewater as a resource. The study emphasizes that for cities like Mysore, effective WSP requires deep institutional integration between city and water planners, and planning interventions that respect local watersheds and address the challenges of informality and scale (Ashok Kumar et al.;2023) The study addresses a critical gap in Water-Sensitive Urban Design (WSUD) planning: the lack of integrated frameworks to optimize green-grey infrastructure combinations using multi-dimensional criteria. The authors developed and applied a "score-rank-select" strategy, utilizing Multi-Criteria Decision Analysis (MCDA) to assess five WSUD scenarios at the University of Melbourne's Parkville campus across functional, economic, social, and environmental aspects.A key finding was that the optimal scenario was not the one with the highest proportion of green infrastructure (69%), but a balanced "equal grey-green" design with 52% green facilities.

This highlights a non-linear trade-off between grey and green components, demonstrating that maximizing one type does not guarantee superior overall performance. The authors strongly advocate for the broader adoption of such comprehensive MCDA frameworks to support sustainable, evidence-based decision-making in urban water management (Xiong et al.;2020) In the review evaluate the role of retrofitting Sustainable Drainage Systems (SuDS) in bolstering urban flood resilience. They identify green roofs, rainwater harvesting, permeable paving, and rain gardens as the most viable retrofit options for dense cities due to their low spatial footprint. The study underscores that while SuDS implementation faces challenges related to cost, land ownership, and maintenance, it provides significant co-benefits, including improved water quality, urban cooling, biodiversity, and public amenity. The authors conclude that SuDS are not a standalone solution for extreme events but are essential within an integrated, multi-functional urban water management framework, requiring proactive planning and design to maximize resilience and ancillary benefits (Lamond et al.;2015) To provide quantitative evidence for the efficacy of Water-Sensitive Urban Design (WSUD) at the residential allotment scale. Modeling a densifying lot in Melbourne, they found that an integrated system combining a rainwater tank, rain garden, and infiltration trench was most effective, reducing peak flows for a 1-in-5-year storm by 90% and mitigating frequent small storms. While such combinations are costlier, the study demonstrates that allotment-scale WSUD

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retrofits can significantly counteract the increased runoff from urbanization, supporting their role as a crucial component of integrated flood resilience strategies.

This evidence is directly relevant for assessing the potential of decentralized, source-control measures in managing stormwater in developing urban areas like Mysore City (Rashetnia et al.;2025) The Study Focus and Problem Identified: address the critical challenge of optimizing the spatial placement of Water Sensitive Urban Design (WSUD) features for pluvial flood mitigation. The authors highlight that traditional, catchment-wide WSUD implementation is often inefficient, as not all locations equally influence flooding due to complex interactions between rainfall, catchment characteristics, and drainage networks. They also critique previous spatial prioritization methods reliant on Local Sensitivity Analysis (LSA) for being unable to handle model non-linearity or parameter interactions, and for testing only limited implementation scenarios (Wenhui Wu et al.;2023).

Nature-Based Solutions, Green & Blue Infrastructure

The emphasis here is on how blue-green infrastructure, such as lakes, wetlands, trees, and open spaces, and nature-based solutions can help manage storm flows and improve urban resilience. It highlights how preserving and rehabilitating natural hydrological systems can lower runoff, enhance water quality, and offer a number of social and ecological co-benefits in urban settings.

The argue that urban trees are a critical yet underutilized component of green infrastructure for stormwater management. While current practice emphasizes infiltration-based systems such as rain gardens and permeable pavements, trees reduce runoff through multiple hydrological pathways: canopy interception, evapotranspiration, and enhanced soil infiltration. The authors highlight the need for species-specific performance data, improved urban arboriculture, and supportive policies to integrate trees into stormwater planning. They conclude that strategically planting and maintaining trees—especially in combination with other green infrastructure—offers a multi-benefit approach to managing runoff while enhancing urban ecological resilience and providing valuable co-benefits such as heat island mitigation and improved air quality (Berland et al.;2017) This collaborative study, conducted under the COST Action CA17133, presents a framework for applying Nature-Based Solutions (NBS) to address seven Urban Circularity Challenges (UCC) in cities, with a focus on sustainable water management.

It identifies “Restoring and maintaining the water cycle” (UCC1) and “Water and wastewater treatment, recovery, and reuse” (UCC2) as the core water-related challenges. Through expert workshops and case-study analysis, the authors categorize and semi-quantitatively assess 51 NBS units (e.g., rain gardens, green roofs, treatment wetlands) based on their ability to contribute to circularity. The paper concludes that while individual NBS can address specific challenges, their multifunctionality and integration are key to transitioning toward resource-efficient, circular urban water systems.

This framework is particularly relevant to Mysore City, offering a structured approach to evaluate and integrate NBS that can simultaneously manage stormwater, enhance water reuse, and contribute to urban resilience within a water-sensitive planning context (Oral et al.;2021) This global scoping review finds that cities adopt watershed approaches primarily to combat water scarcity, flooding, and pollution. Successful actions center on shifting from gray to green-blue infrastructure and rehabilitating aquatic ecosystems. The study reveals a significant gap: while documented cases come from the Global North and Asia, there is a lack of implemented urban examples from the Global South. This gap underscores the relevance of investigating applied watershed management, including green infrastructure and stormwater strategies, in cities like Mysore to address urban water challenges (Canteiro et al.;2024) This study provides a comprehensive appraisal of Mysore's green endowments, including its parks, forests, and, most critically, its network of lakes and water bodies.

The authors detail how the city's undulating topography and natural valleys facilitate effective drainage and help prevent urban floods, establishing a direct link between the city's physical form and its stormwater management. However, they document significant threats to this system, primarily from unplanned

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urbanization. Encroachment on lake catchments, blockage of natural water flow channels, siltation, and pollution from sewage entering storm drains are severely degrading the water bodies.

The loss of these lakes and their connecting chains disturbs the natural hydrological integrity, exacerbating flooding risks. The paper serves as a foundational case study on the pressures facing Mysore's blue-green infrastructure, highlighting the critical need for integrated conservation to maintain natural drainage, groundwater recharge, and overall urban climate resilience—all central concerns for water-sensitive urban planning (Gowda, K., & Sridhara, M. V. 2014) According to the study a practical framework for implementing Water-Sensitive Urban Design (WSUD), presenting the Dutch model of spatially integrating water management with urban form. The editors argue for a shift from seeing water as a threat to be drained to recognizing it as a resource and a structuring element of the city.

The study methodology of categorizing urban typologies (historic cores, post-war expansions, etc.) and prescribing context-specific interventions—transformation, consolidation, restructuring—is particularly valuable. For Mysore City, this source moves the study from analysis to actionable design. It provides a transferable methodology for developing spatially tailored strategies that increase storage capacity, enhance water quality, and improve public amenity. The Dutch case studies serve as international benchmarks, demonstrating how the technical assessment of stormwater flows can be synthesized into multifunctional urban design and governance solutions that are resilient to climatic variability (Hooimeijer, F etal.;2008).

Stormwater Hydrology, Runoff Characteristics, And Water Quality

The study looks at how urban stormwater behaves hydrologically, including how runoff is generated, how pollutants are transported, and how it affects recipient water bodies. In addition to emphasizing the necessity of addressing non-point source pollution and cumulative watershed consequences in sustainable stormwater planning, it draws attention to the limitations of stormwater control technologies in completely restoring natural hydrology.

In thus study A critical limitation in urban stormwater management is the uncertain cumulative effectiveness of distributed Stormwater Control Measures (SCMs). Analyzing multiple watersheds, revealed that total imperviousness (TI) remained the primary control on event-scale hydrology, not SCM implementation levels. This suggests that SCMs, as typically deployed, cannot fully restore pre-development hydrology, highlighting a fundamental challenge in relying solely on these practices to mitigate the impacts of urbanization (Colin D. Bell etal.;2016) This study examined the variability of pollutant concentrations in stormwater runoff from the Santa Ana River in Southern California during the 1997–98 wet season.

Through high-frequency sampling, the authors found that seasonal flushing—where early-season storms had significantly higher pollutant concentrations—was more pronounced than the "first flush" effect within individual storms. Flow was the primary driver of concentration changes, and total suspended solids (TSS) strongly correlated with trace metals.

The findings underscore the need for intensive sampling to accurately characterize stormwater quality and inform urban runoff management. The study highlights the importance of adaptive, data-driven stormwater management in urban areas, particularly in regions with irregular rainfall patterns. Insights into pollutant variability can guide the design of monitoring regimes, treatment systems, and policies aimed at reducing runoff impacts on receiving waters (Liesl L et al.;2004) The assessed the water quality of three urban lakes (Kukkarahalli, Karanji, and Dalvoy) in Mysuru, finding severe pollution from sewage and stormwater inflows, leading to eutrophication and poor water quality. Dalvoy Lake was the most degraded, with critically low dissolved oxygen. The study highlights the direct impact of unmanaged urban runoff and wastewater on water bodies, providing a critical case for integrating WSUD measures, such as constructed wetlands and silt traps at inlets, to protect and restore Mysore's lake ecosystems within urban planning (Adarsh et al.;2019) This study provides a critical two-year (2002-2003) analysis of the

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physicochemical water quality of Bilikere Lake, a rain-fed, perennial water body on the outskirts of Mysore. It documents how water quality is directly impacted by land-use practices and urban/agricultural runoff.

The research identified that nutrient levels (especially phosphate and nitrate) surged after rainfall events due to agricultural runoff and occasional sewage inflow, leading to dense algal growth. While some parameters varied seasonally, persistently high levels of pH, total alkalinity, and hydrogen sulphide indicated chronic pollution, attributed to factors like sewage and inorganic nutrient discharge.

This case directly links rainfall-driven stormwater flows to the degradation of urban water bodies, highlighting a key challenge for water-sensitive planning: managing non-point source pollution from the catchment to prevent eutrophication and maintain water quality for ecological and potential aquacultural uses (Sachidanandamurthy, K. L., & Yajurvedi, H. N. 2006) demonstrate how poverty-driven artisanal gold mining catastrophically pollutes the Kpapi River in Nigeria, rendering it toxic and unusable. Laboratory analysis revealed dangerous levels of heavy metals (Cd, Pb, Cr) and Water Quality Index (WQI) values indicating water entirely unfit for human use.

The study links economic vulnerability to environmental degradation and policy failure, arguing that effective, sustainable solutions require inclusive governance and legal reform rather than mere enforcement. This case highlights a critical threat to urban water security from upstream socioeconomic activities, underscoring the need for integrated, participatory watershed management in urban planning (J.J. Dukiya et al.:2024).

GIS, Spatial Analysis, and Flood Vulnerability Mapping

The use of GIS and spatial analytical methods to evaluate stormwater risk, rainfall variability, and flood susceptibility is reviewed here. It illustrates how evidence-based urban stormwater management planning is supported by spatial decision-support tools that make it possible to identify flood-prone areas, rank interventions, and more.

The present a methodological framework for urban flood risk assessment by integrating the Analytical Hierarchy Process (AHP) with Geographic Information Systems (GIS). Applied to Eldoret Municipality, Kenya, the study employs a multi-parametric approach, synthesizing causative factors such as rainfall distribution, elevation, slope, drainage network density, land use/land cover, and soil type to create a comprehensive flood vulnerability map. This spatial analysis culminates in an Urban Flood Risk Index (UFRI), which quantifies risk based on vulnerability and exposure.

The proposed method was rigorously validated. Comparisons between modeled flood extents and actual field measurements showed a high degree of accuracy, with a maximum error of 8% in area and an average depth difference ranging from 0.01 to 0.37 meters in flood-prone zones. Furthermore, the AHP model's consistency ratio of 0.09 confirmed the reliability of the expert judgments used in weighting the various factors. The authors conclude that the integrated GIS-AHP model is a powerful, coherent, and efficient tool for flood hazard zonation, achieving approximately 92% accuracy.

They position it as a vital decision-support system for urban planners and policymakers, enabling rapid assessment and informed flood management strategies (Ouma and Tateishi 2014) This GIS-based study analyzes rainfall variability and its impact on groundwater table fluctuations in Mysore Taluk, Karnataka, from 2001 to 2011.

Using data from six rain gauge stations and nine observation wells, the authors applied arithmetic mean, Thiessen polygon, and iso-hyetal methods to map spatio-temporal trends. Results indicate an average annual rainfall of 724.83 mm, with distinct seasonal patterns and a declining trend toward the southwestern region. Groundwater levels, influenced by rainfall and perennial rivers like the Cauvery, showed shallow conditions in northern and southeastern areas. The study underscores the utility of GIS

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for monitoring and managing water resources in urbanizing regions like Mysore (Sharifi et al.;2016)

Decision Support Systems and Planning Tools

In order to assess, rank, and maximize stormwater management measures, this study examines decision-support frameworks utilized in water-sensitive urban design. It draws attention to how multi-criteria decision analysis, scenario analysis, and retrofit assessment techniques can be used to manage the trade-offs, complexity, and multifunctionality that come with sustainable drainage planning and WSUD.

Water Sensitive Urban Design (WSUD) poses new challenges for decision makers compared with traditional stormwater management, primarily due to a larger selection of measures and their inherent multifunctionality.

These challenges have spurred the development of diverse decision support tools, which can be categorized into three main groups based on the questions they address: “How Much”-tools (quantifying hydraulic, hydrologic, water quality, non-flow-related, and economic impacts), “Where”-tools, and “Which”-tools. Furthermore, these tools vary significantly in the scope of water-related aspects they consider, ranging from a narrow bio-physical focus to broader multi-criteria assessments.

Ultimately, the variability in tool design and function can be largely attributed to differences in local contexts, such as existing stormwater system types, groundwater conditions, and legislative frameworks Lerer (et al., 2015) The study addresses a critical gap in Water-Sensitive Urban Design (WSUD) planning: the lack of integrated frameworks to optimize green-grey infrastructure combinations using multi-dimensional criteria.

The authors developed and applied a "score-rank-select" strategy, utilizing Multi-Criteria Decision Analysis (MCDA) to assess five WSUD scenarios at the University of Melbourne’s Parkville campus across functional, economic, social, and environmental aspects.A key finding was that the optimal scenario was not the one with the highest proportion of green infrastructure (69%), but a balanced "equal grey-green" design with 52% green facilities.

This highlights a non-linear trade-off between grey and green components, demonstrating that maximizing one type does not guarantee superior overall performance. The authors strongly advocate for the broader adoption of such comprehensive MCDA frameworks to support sustainable, evidence-based decision-making in urban water management (Xiong et al.;2020) In the review evaluate the role of retrofitting Sustainable Drainage Systems (SuDS) in bolstering urban flood resilience. They identify green roofs, rainwater harvesting, permeable paving, and rain gardens as the most viable retrofit options for dense cities due to their low spatial footprint.

The study underscores that while SuDS implementation faces challenges related to cost, land ownership, and maintenance, it provides significant co-benefits, including improved water quality, urban cooling, biodiversity, and public amenity. The authors conclude that SuDS are not a standalone solution for extreme events but are essential within an integrated, multi-functional urban water management framework, requiring proactive planning and design to maximize resilience and ancillary benefits (Lamond et al.:2015).

Problem Statement

The literature assessment above identifies important knowledge gaps regarding solid-waste interactions, rainfall variability, stormwater system performance, and their incorporation into Mysuru City's statutory urban planning frameworks. The issue this study attempts to solve is defined by these gaps taken together.

Stormwater management issues in Indian cities have gotten worse due to rapid urbanization and rising climate variability, which frequently results in flooding, drainage issues, and the deterioration of urban water bodies.

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Mysuru City has seen increasing stormwater stress despite historically low rainfall because of land-use change, increased rainfall intensity, rising rainfall unpredictability, and disturbance of natural hydrological processes. Due to shifting urban and climatic conditions, the stormwater infrastructure that is now in place—which was primarily created using traditional rapid-drainage principles—has grown progressively insufficient.

Urban flooding, groundwater fluctuations, and rainfall trends in and around Mysuru have all been the subject of several studies, yet these studies are still dispersed. An integrated, city-scale analysis that clearly connects long-term rainfall variability to land-use change, drainage system performance, flood susceptibility, and stormwater flow behavior is lacking. Furthermore, no single hydrological and planning framework has been used to objectively assess the deterioration and encroachment of interconnected urban lakes, ridge-valley systems, and natural drainage corridors.

Despite being widely marketed as successful strategies for climate-resilient stormwater management, Water Sensitive Urban Design (WSUD), Sustainable Drainage Systems (SuDS), and Nature-Based Solutions (NBS) are still not widely used in Indian cities and are mostly unrelated to the formal urban planning procedures. Stormwater management in Mysuru is still mostly handled as an engineering function, with little incorporation into institutional governance, zoning laws, master planning, and development control.

This problem is made worse by inadequate solid-waste management, which has been identified as a recurring but unaddressed cause of localized flooding, decreased hydraulic capacity, and blocked drains. An integrated, planning-oriented assessment that incorporates field-based data, long-term climate analysis, spatial evaluation of stormwater infrastructure and natural drainage systems, and WSUD principles is therefore desperately needed. Repositioning stormwater management as a fundamental urban planning function and creating climate-responsive, sustainable, and context-specific plans to improve flood resilience and environmental sustainability in Mysuru City depend on closing this gap.

Study Area

The Study Area is Mysuru city, the Mysore City which is the Second largest city adjacent to Bangaluru in the state of Karnataka with a Population of 9.21 Lakhs (as per 2011 census). Mysuru City was the capital of the former princely state of Mysore it the second single largest City and also it is the district headquarters of Mysore districts situated in the southernmost direction of Kamataka, state and it is located in the south-western direction from Bangalore at a distance of 140 km the city is well connected by the transport modes of rail road and Air.

The total geographical area of Mysuru Local Planning area is 6330700 hectares and proposed conurbation area of 50900 hectares the Mysore city has many major water bodies located in a well define bridges and valleys the water bodies are KRS Dam, Kukkarahalli Lake, Lingambudi Lake, Devanoor Lake, Dalvoy Lake, Karanji Lake, In Mysore City, the most prominent valley is the Chamundi Hills.

These hills located at the foothills of Mysore, offer stunning views and are home to the Sri Chamundeshwari Temple.It encompasses an area of 6307 sqkm and a population of 30,01,127. Mysuru is located in the southern part of the Deccan plateau. Mysuru has a warm and cool climate throughout the climate of mysuru is moderate. The minimum temperature in winter is around 15 degrees celsius and in summer the maximum temperature is around 35 degrees celsius. 86 centimeters is average annual rainfall.

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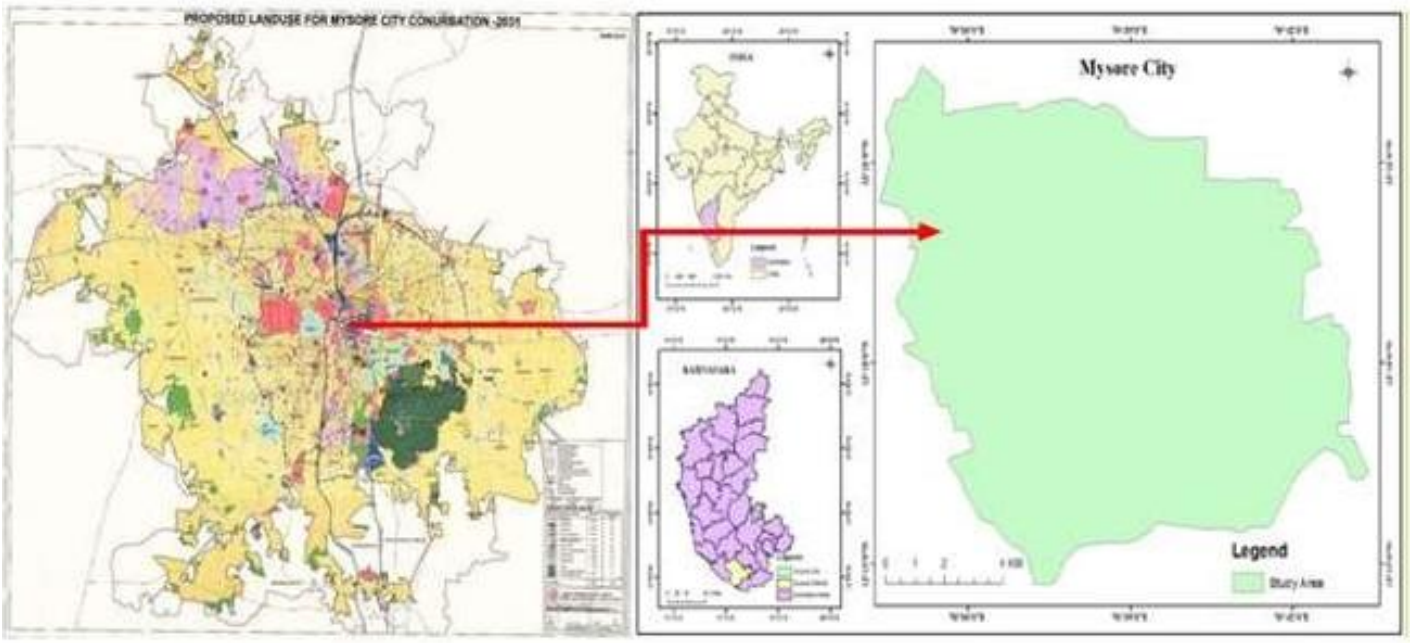

Figure 1: Study area map of Mysuru City

Source: Compiled by the authors

METHODOLOGY AND MATERIALS

Research Design and Approach

The study adopts a mixed-method, water-sensitive urban planning framework integrating quantitative rainfall for the 35 Years and hydrological analysis with qualitative field-based urban drainage assessment. The methodology is structured to examine the interaction between long-term rainfall variability, urban land-use transformation, and stormwater drainage performance in Mysore City. Geographic Information Systems (GIS), hydrological estimation techniques, and extensive field observations are combined to generate spatially explicit and planning-relevant insights. Primary data were collected through extensive field surveys across all municipal zones of Mysore City, including J.P. Nagar, Jayanagar, Kuvempunagara, Vijayanagar, Gokulam, Udayagiri, Bannimantap, and major arterial corridors. The methodological approach is guided by the principles of Water-Sensitive Urban Design and Planning (WSUDP), emphasizing source control, integration of blue–green infrastructure, and alignment of urban form with natural hydrological systems.

Data Collection

The study uses a mixed-methods strategy to gather data, integrating primary field research, secondary data, and spatial data to thoroughly examine Mysuru City's rainfall variability, stormwater drainage performance, solid waste impacts, and water-sensitive urban development approaches.The India Meteorological Department and state agencies were among the official meteorological sources from which secondary data on long-term rainfall, temperature, and relative humidity were gathered in order to evaluate the climatic trends and temporal variability affecting stormwater formation.

Using reports, maps, and design documents, data on solid waste management procedures, lake catchments, natural drainage systems, and stormwater drainage networks were gathered from Mysuru City Corporation, Karnataka Urban Water Supply and Drainage Board, Mysuru Urban Development Authority, and associated departments.

With an emphasis on drain condition, encroachment, waste accumulation, flow obstruction, and connectivity with lakes and natural valleys, primary data were collected through methodical field surveys

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and site observations throughout chosen wards and drainage corridors. This information was bolstered by photographic documentation and field notes. Furthermore, stakeholder interactions with local people, sanitation professionals, and municipal officials offered contextual information about trash disposal habits, drainage maintenance procedures, and areas that frequently flood.

Physical features were mapped, encroachments were identified, and the spatial relationship between urban growth, blue-green infrastructure, and stormwater flow patterns was examined using spatial and GIS data, such as base maps, land-use layers, drainage lines, lake extents, and satellite imagery. Triangulation was used to cross-validate data from several sources to guarantee consistency and dependability, enhancing the analysis's and the conclusions' resilience.

Stormwater drainage Statues and challenges in Mysore City

The primary challenge arises from the need to reconcile the natural micro-topography with the engineered urban grid. The inferred north-easterly natural flow vector does not align directly with the rectangular street layout, requiring a network of drains and channels to artificially convey water along road corridors before it can be discharged to a larger outlet. This indirect routing increases complexity and potential points of failure within the system.

This situation is critically exacerbated by the pervasive impervious surfaces—rooftops, roads, and pavements—that define the developed urban layout. These surfaces drastically reduce ground infiltration and instead accelerate the generation of surface runoff during rainfall events. The resulting increase in both the volume and the speed of runoff places continuous and significant pressure on the capacity and responsiveness of the subsurface drainage network.

Finally, the functionality of the entire local drainage system is contingent upon the condition and capacity of its ultimate outfall. The stormwater from this catchment is likely destined for a larger natural or engineered outlet to the north or northeast, such as the Bogadi lake system or channels leading to the Lakshmanathirtha River basin.

Any restriction or bottleneck at this downstream point can induce backwater effects, compromising drainage efficiency upstream and heightening flood risk within the Bannimantap layout itself. Mysuru City has been experiencing increasing challenges related to urban stormwater drainage, driven by rapid urbanization, land-use transformation, and changing rainfall patterns. Although the city possesses a historically evolved network of natural drainage channels, tanks, and lakes, these systems have been progressively degraded, encroached upon, and disconnected from contemporary urban development. As a result, stormwater flow paths have been altered, leading to frequent waterlogging, localized flooding, and environmental degradation.

Field observations across different parts of the city reveal that stormwater drains are heavily obstructed by solid waste, silt deposition, and vegetation growth, significantly reducing their hydraulic capacity. In many locations, stormwater drains function as open sewage channels due to illegal wastewater connections, causing severe water pollution and public health risks.

Furthermore, unplanned construction and infrastructure development along drain corridors have resulted in narrowed or blocked channels, disrupting natural flow continuity and increasing runoff accumulation during intense rainfall events.

The existing drainage infrastructure in Mysuru is largely designed based on outdated rainfall assumptions and does not adequately account for recent trends of short-duration, high-intensity rainfall. The absence of an integrated, rainfall-responsive stormwater management framework has limited the city’s ability to cope with increasing peak runoff, particularly in low-lying and densely built-up areas. Additionally, the lack of water-sensitive urban planning principles, such as infiltration, detention, and nature-based solutions, has further exacerbated surface runoff and reduced groundwater recharge.

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Figure 2: Storm Water Drains, Mysore

Source: filed visit Compiled by the authors

Storm Water Drainage in Mysore City

The Topography of the Mysore is defined by sequences of well-defined natural Valleys that radiates from the ridge on high ground profile and slop gradually in all the direction. It is noted that the general slope is North to South. The general ground elevation of the city is ranging from North West to North East portion with level difference of 40mt. Likewise North to South with variation in altitude of 25mt. Storm water from Mysore city and its out-growth trace clearly defined twelve prominent valleys. North and Northeastern part of Mysore city valleys like Kesare, Yadavgiri, Kumbarakoppalu, Hebbal, R S Naidu nagar Kalyanagiri etc are draining in to the Cauvery River following passage through the sequence of tanks or nalas. Likewise the rest of the south, south east and south west part valleys are draining in to the Kabini River.

The whole city drains into three valleys, viz. northern outfall into Kesare valley, and the other outfalls. to the south, one into Dalvai tank feeder valley and another to Lingambudi tank valley.North outfall sweeps away the zone of Narasimharaja Mohalla, Jalapuri, Eeranagere and part of Mandi Mohalla, Medar's Block and Yadavagiri Railway Colony, areas of Vanivilasa Puram and Kumbarakoppal all in and around the city.The second outfall serves to drain the locality of part of Chamaraja, Nazarbad and Lashkar Mohalla and the whole locality of Fort Mohalla and Krishnaraja Mohalla The third outfall draining the region of parts of

Devaraja and Chamaraja Mohallas merges into the Lingambudi tank valley without treatment. The new areas in the Western side of Kuvempunagar drain south-west of Lingambudi tank. The arrangement in this valley is under development. It drains the area of V.V. Mohalla, Jayalakshmi Puram, Padavarahally, Saraswathipuram, K.G. Koppal, Jayanagar, Thonachikoppal, Chikkaharadanahally and Srirampura. The fourth outfall drains to Belavatha village. and extends to the area like Yadavagiri, Hebbal layout, Metagalli, Brindavan extension, a part of Gokulam and Bannimantap layout.

The city's topography causes waste water to flow into three valleys: the Malalavadi tank valley, the Dalvai tank feeder valley to the south, and the Kesare valley to the north. The northern ones drain the regions of Vanivilasa Puram, Kumbapal, Medar's block, Yadavagiri Railway colony, Jalapuri, Eeranagere, and a portion of Mandi Mohalla. However, despite the completion of the drainage work in each of the

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aforementioned places, none of them have been connected to the main drain. Currently, the storm water drains and natural valleys receive the wastewater from these locations. The manholes used to divert water for irrigation are being blocked by the owners of the gardens and other properties next to the main line. There are three large, 4-5 m wide drains throughout the city. The storm water drainage (SWD) network in Mysore is 1200 km long overall. 500 kilometers of SWD are covered out of this. Although a system of inspection is in place to keep an eye on cleanliness Along with the accumulation of street debris, silt is a significant problem for SWDs. This silt buildup results in the SWDs overflowing. Heavy rains frequently cause flooding in Devraj Urs. road in the Chamundi highlands of Agrahara. That being said, Mysore's southern region is better off and does not flood.

Catchment area of Mysore City

	Catchment	Catchment area in Ha	Maintained by
1.	Kyathanarnahalli kere	110.0	MCC
2.	Kukkarahalli kere	160.7	Minor Irrigation Department
3.	Hinkal kere	315.6	MUDA
4.	Devanur kere	345.1	MCC
5.	Hebbal kere	514.0	MUDA
6.	Karanji kere	852.7	Minor Irrigation Department
7.	Mariappana kere	1096.5	MUDA
8.	Rayara kere	1652.7	MUDA
9.	Shetty kere (Yenne hole kere)	1652.7	Minor Irrigation Department
10.	Dalvoy kere	3557.1	MCC
11.	Lingambudi kere	4377.4	MUDA
	Total		

Table 1: Catchment area

Source: DPR-Storm Water Drains, Mysore

Map representing storm water drains in Mysore city

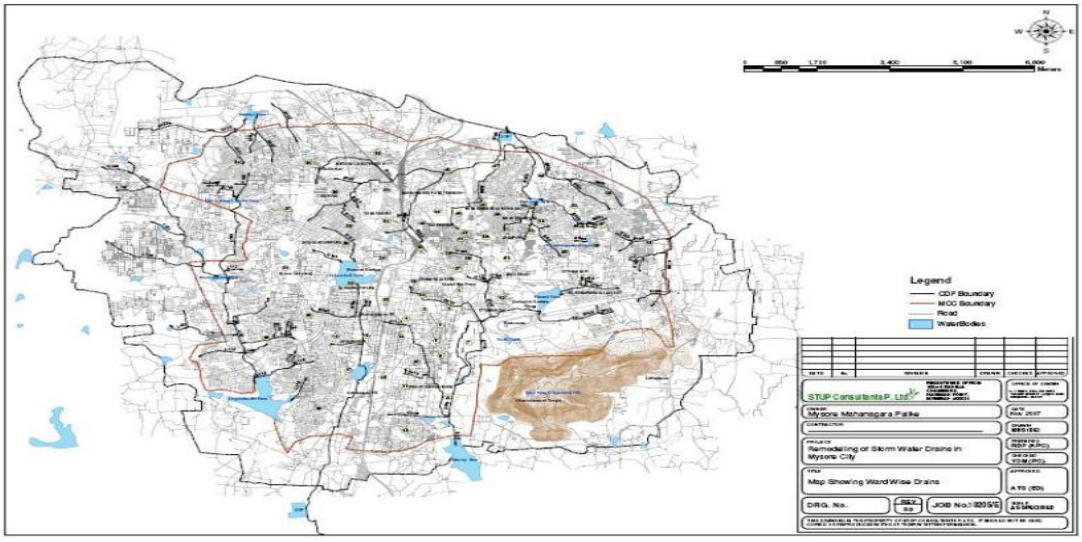

Figure 3: Storm Water Drains

Source: DPR-Storm Water Drains, Mysore

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Areas vulnerable to flooding and disaster readiness

Plain land makes up the majority of Mysore city, while there are undoubtedly some places with natural slopes and height variances. The highest and lowest points have elevations between 800 and 710 meters, while the Chamundi hill and its surroundings have elevations between 710 and 1025 meters. The city's average elevation is 767 meters above mean sea level.

During the reconnaissance study and subsequent conversations with MCC engineers in order to prepare the DPR on Strom Water Drains, Mysore, critical low-lying areas were discovered.

In Mysore, there are several ponds, ditches, low-lying areas, and water bodies that act as retention basins to lessen the severity of floods and manage flood damage during periods of high precipitation.as showing in the below figure.

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Low-lying areas of Mysore city

Ward No.	Low-lying area	Land use type
Narashimaraja Zone		
45	Hanumanthanagar Near Lions School, Bannimantapa	Residential
47	Subhash Chandra Bose Nagar, Bademakan area, Narashimaraja Mohalla	Residential
55	Udayagiri (Satyanagara)	Residential
59	Kyathamaranahalli	Residential
14	Haladakeri (Ashoka Road)	Commercial
Chamaraja Zone		
61	Albert Victor Road (Town Hall)	Public and Road
26	Mahavira Nagara behind Sub-Urban Bus Stand	Residential
61	B.N. Road (Stretch adjacent to Ramanashree Resorts)	Commercial (Hotels & Cinema Halls)
24	Subbarayana Kere (Opp. Shantala Theater)	Commercial
17	Kuvempunagara M & N Block	Residential
17	Kuvempunagara K Block (Srirampura)	Residential
17	Behind RMP Quarters (Kuvempunagara, Udayaravi main road)	Open land allotted for layout formation
17	Saraswatipura (Kantharaja urs road)	Residential
17	Nachanahallipura (near N.I.E College)	Residential
26	Paduvarahalli	Residential
26	Sidhathanagara (near Madhu fast food)	Residential
26	Ittegegudu	Residential
32	Manjunathanagara & Small Scale Industries behind JAWA factory	Residential
32	Hebbal 2nd Stage (behind Govt. High School, Abishek Circle)	Residential

Table 2: Low-lying areas
Source: DPR-Storm Water Drains, Mysore

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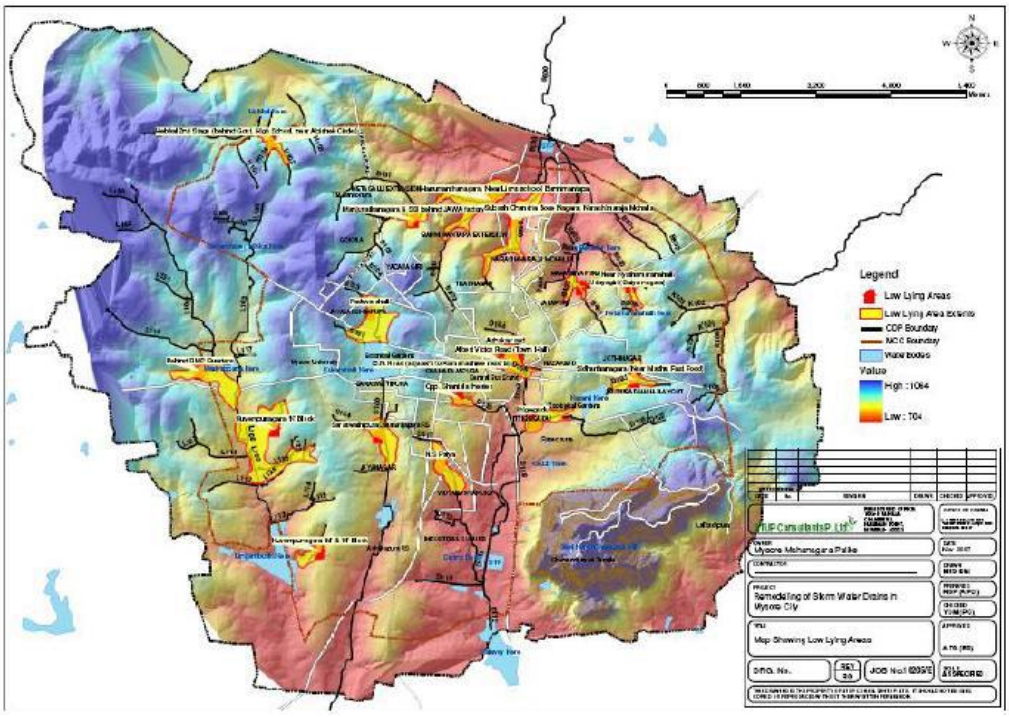

Figure 3: low-lying areas

Source: DPR-Storm Water Drains, Mysore

Map representing low-lying areas in Mysore city

Major reasons for flooding in the low-lying areas

1. Destructing natural drains by unscientific planning in land development activities.
2. Thick vegetation everywhere.
3. Tiny drain opening.
4. Discharging solid waste in places with low elevation.
5. The drains' silt.
6. Storm water drains being used to discharge sewage.
7. The flat drain bed in flood-prone locations.
8. Poor upkeep of drainage network systems such as sewer pipes and manholes.
9. An improperly configured tertiary network.
10. Residential building floor levels frequently fall well below drain levels.

Management of water bodies in Mysore City

The MCC boundary encompasses 14th water bodies, including Hinkel Kere, Hebbal Kere, Manchegowdana Koppalu Kere, Devanur Kere, Kythamaranahalli Kere, Karanji Kere, Gobli Kere, Dalavoy Kere, Rayara Kere, Tayappana Kere (Bogadhi Kere), Mariyappana Kere, Lingambudhi Kere, Kukkarahalli Kere, and Srirampura Kere. All of the current water bodies were disregarded and unmaintained by the government until recently.Mysore City Corporation, Mysore Urban Development Authority (MUDA), and the Minor Irrigation Department are responsible for maintaining the lakes. Some of the lakes are used for recreational activities like boating and bird watching, while the water bodies are useful for irrigation. Just two tanks, Kukarahalli Kere and Karanji Kere, were recently desilted, removed for government upkeep, and put to use for recreational and boating purposes. In the space designated for

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buffer zones, layouts have been permitted to develop and certain water bodies have been encroached. There are several significant problems with water bodies, such as careless debris disposal, tank area encroachment, severe siltation, thick vegetation growth, a lot of raw sewage entering, etc., which cause flooding and worsen the quality of ground water.

Figure 4: Storm Water Drains, Mysore

Source: filed visit Compiled by the authors

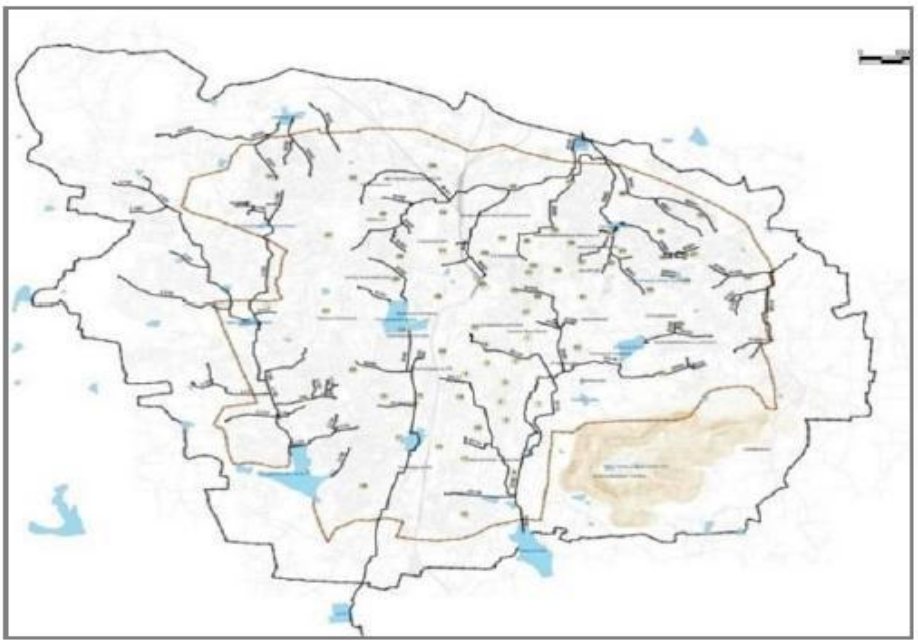

Figure 5: storm water drainage network

Source: DPR-Storm Water Drains, Mysore

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Map showing the storm water drainage network and the water bodies, Mysore

Two of the tanks—Kukarahalli Kere and Karanji Kere—were recently desilted, removed for government upkeep, and put to use for recreational and boating purposes. The remaining water bodies are not kept up to date. In the buffer zones, layouts have been permitted to develop. Flooding and a decline in the quality of the ground water are caused by indiscriminate debris disposal, tank area encroachment, severe siltation, dense vegetation growth, plenty of raw sewage entering, etc.

Inferred Stormwater flows Assessment in Mysore City

This assessment constructs a hydrological profile for a specific urban catchment in western Mysuru by interpreting geospatial data points within their physical and infrastructural context. By plotting these points and applying principles of urban hydrology, we can deduce the likely behaviour of stormwater in this locale. The spatial relationship between the points reveals a subtle but meaningful northward progression in latitude over a distance of roughly 700 meters. This pattern suggests a gentle topographic gradient toward the north-northeast, establishing the fundamental directional bias for all stormwater flow within this micro-catchment. In a natural setting, water would follow this slope as diffuse overland flow. Here, the natural flow vector intersects with the rigid geometry of the urban grid. Stormwater runoff, generated rapidly from roofs, roads, and pavements, is captured and confined by the street network. It is initially conveyed along road surfaces before entering a subsurface drainage system of covered side drains and pipes. The efficiency of this entire engineered conveyance network becomes the single most critical factor governing flood risk. Its performance is contingent on original design capacity, current structural integrity, and, most dynamically, the level of routine maintenance.

The ultimate destination for this water is inferred to be a major natural drainage line to the northeast, likely a channel feeding into the Bogadi Lake system or the Lakshmanathirtha River basin. Consequently, the hydraulic capacity of the entire upstream network is vulnerable to conditions at this outfall and at every point along the system.

The primary vulnerabilities for this area are therefore not hypothetical but are typical of mature urban layouts. Localized ponding is most expected at topographic depressions within the road network, such as sag points or intersections, where blocked or insufficient inlets cannot capture runoff quickly enough. A more systemic risk exists at hydraulic bottlenecks, where multiple smaller drains converge into a single collector. If this collector is undersized, silted, or obstructed, it can create a backwater effect, causing flooding to propagate upstream through the connected drainage channels. Chronic blockages from silt and solid waste, coupled with the relentless volume of runoff from impervious areas, represent the most probable failure mechanisms. This inferred assessment, while reasoned, remains a hypothesis grounded in spatial analysis and urban hydrological principles. It should be validated through specific actions. A detailed topographic survey would precisely define the micro-watershed, while mapping the actual drain sizes, conditions, and connections against the inferred flow paths is essential. The most insightful validation would come from field observations during or immediately after a rainfall event, visually tracing the actual overland flow and identifying points of accumulation or drain overflow.

The resulting management strategy must be twofold. First, a rigorous and enforced maintenance regime focused on pre-monsoon desilting and continuous clearance of inlets and drains along the key north-easterly flow path is non-negotiable. Second, source control measures, such as widespread adoption of rainwater harvesting to reduce runoff volume at the plot level, are crucial for long-term resilience.

The stormwater dynamics in Bannimantap exemplify the classic urban challenge. The flood risk arises from the interaction between a natural gentle slope, an aging or constrained drainage grid, and the accelerated runoff volumes characteristic of paved environments. The key to mitigation lies in leveraging the inferred flow direction to prioritize maintenance and in complementing grey infrastructure with sustainable practices that manage water at its source.

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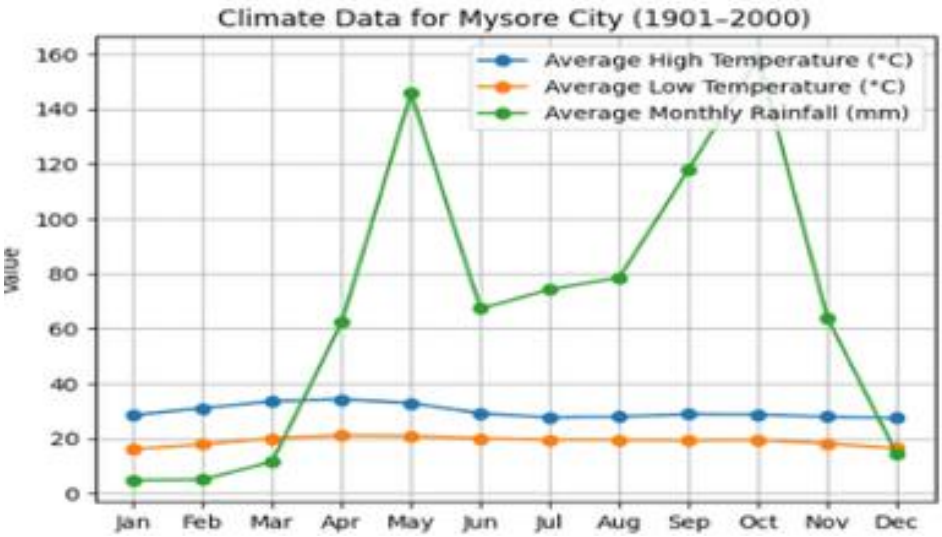
Climate of Mysuru City

The city enjoys cool and equable temperature. Mysore shares the wider climatic pattern of the state as a whole, although there are some distinctive features. The climate of the district described is essentially tropical monsoon type, which is a product of the interplay of the two opposing air masses of the southwest and northeast monsoons. Mysuru has a tropical savanna environment with moderate to nice weather all year. The summers (March to May) are warm but not scorching, with temperatures ranging from 20°C to 35°C. The monsoon season (June to September) offers modest rain, revitalizing the landscape and filling the lakes. Winter (October to February) is warm, with temperatures ranging from 15°C to 30°C, making it a popular time for tourism.

The city's rich greenery is aided by its generally stable and temperate climate, which makes it an ideal location for agricultural and population. Mysore has a semi-arid climate with three main seasons: summer (March to June), monsoon season (July to November), and winter (December to February). Mysore's highest recorded Temperature was 38.5 °C (101 °F) on May 4, 2006, and its lowest was 7.7 °C (46 °F) on January 16, 2012.The city yearly rainfall average 804.2 mm.

Rainfall of Mysuru City



The variation in the annual rainfall from year to year is not large during the 85 years from 1901 to 1985, the highest annual rainfall amounting to 156 per cent of the annual rainfall that occurred in 1903 and the lowest occurred in 1918. In the same 85-year period, the annual rainfall was less than 80 per cent of the normal rainfall in 7 years, none of them consecutive, considering the rainfall at the individual stations. However, two or three consecutive years of good rainfall occurred once or twice at fifty-two out of sixty-five rain gauge stations. It has been observed that the average annual rainfall in the district was between 600 mm and 900 mm in 66 years out of the 85 years.

Climate data for Mysore (1901–2000)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	28.6	31.1	33.6	34.3	32.9	29.2	27.7	28	28.9	28.8	27.9	27.5	29.87
	-83.5	-88	-92.5	-93.7	-91.2	-85	-81.9	-82	-84	-83.8	-82.2	-81.5	-85.74
Average low °C (°F)	16.2	17.9	20.1	21.2	21	20.1	19.6	19.5	19.3	19.5	18.2	16.5	19.09
	-61.2	-64.2	-68.2	-70.2	-70	-68	-67.3	-67.1	-66.7	-67.1	-64.8	-61.7	-66.39
Rainfall mm (inches)	4.8	5.1	11.6	62.4	145.7	67.3	74.3	78.6	118	158.7	63.8	14.3	804.2
	-0.19	-0.2	-0.46	-2.46	-5.74	-2.7	-2.93	-3.09	-4.63	-6.25	-2.51	-0.56	-31.66

Table 3: Rainfall Data
Source: India Meteorological Department

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The Rainfalls characteristics of the Mysuru City are

The city's temperature ranges from 16°C to 27°C in the winter and from 27°C to 35°C in the sweltering summer. Approximately 800 mm of rain falls on average each year. March to June is the summer season, which is followed by July to November for the monsoon season and December to February for the winter season.

Monsoon Dominance: Mysore experiences a monsoon-influenced climate.

Rainy Months: The city receives most of its rainfall during the monsoon months, which are June, July, August, and October.

Dry Season: The months of January, February, and March are relatively dry. Hottest Month: April is the hottest month, with an average maximum temperature of 35°C. Wettest Month: July tops the list with an average rainfall of 171 mm.

Driest Month: January has the least precipitation, with only 4 mm of rainfall.

Sunniest Month: January enjoys an average of 305 hours of sunshine.

Mysore's climate transitions from sparse rainfall to heavy showers, with March marking the onset of the rainy season. By October, the city experiences its highest rainfall of 159 mm123.

Temperature

Temperature influences considerably the socio-economic activities of the people in a region. The district in general enjoys cool and equable temperature. In the period from March to May, there is a continuous rise in temperature. April is the hottest month with the mean daily maximum temperature at 35°C and the daily minimum at 21°C.

Humidity

Relative humidity is generally high during the southwest monsoon season. Relative humidity is about 70 per cent throughout the year, while in the afternoons, humidity is comparatively Lower except during the southwest monsoon. The period January to April is the driest part of the year with relative humidity of about 30 per cent and still lower in the afternoons.

SOIL, GEOLOGY AND HYDROLOGY

Soil is a natural resource, forms base for growth of natural vegetation, agriculture crops, horticulture plantation and fodder. The soils of the districts can broadly be classified as laterite, red loam, sandy loam, red clay and black cotton soils. The laterite soil occurs mostly in the western part of the district while the red loam soils are found in the northwest. In the talukas of T. Narsipur and Nanjangud, there is deep red loam occasionally interspersed with black soils. The red soils are shallow to deep well drained and do not contain lime nodules. The black soils are 1 to 1.5 meter in bases with good water holding capacity for a longer time. Mysore City, which is located in the southern Deccan Plateau, is a rolling tableland with beautiful trees encircling it and granite outcrops in some places.

This district contains red soils (red gravelly loam, red loam, red gravelly clay, and red clay soil), deep black soil, lateritic soil, saline alluvo-colluvial soil, and brown forest soil. The following minerals were discovered: graphite, limestone, dolomite, siliconite, dunite, kyanite, sillimanite, quartz, magnesite, chromite, soapstone, felsite, corundum, and graphite. The city of Mysore gets its drinking water from the Cauvery and Kabini rivers, which are located between them. There are many lakes in Mysore, but the Kukkarahalli, Karanji, and Lingambudhi lakes, as well as the Devanoor and Dalavai lakes, are the most notable. The greater portion of the city is divided into three distinct catchment areas by three of the four

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main catchments: Dalavoy Kere, Shetty Kere (Yenne Hole Kere), and Devayyanahundi Kere (Lingambudhi Kere). These catchments generally run from north to south.separate areas for drainage. The drainage zone north of the ridge is formed by a fourth main catchment, known as the Bannimantap watershed (Devaraya Canal basin), which runs northeast. Two other minor catchments, Hebbal Kere and Kempayyanahundi Kere, drain out separately.

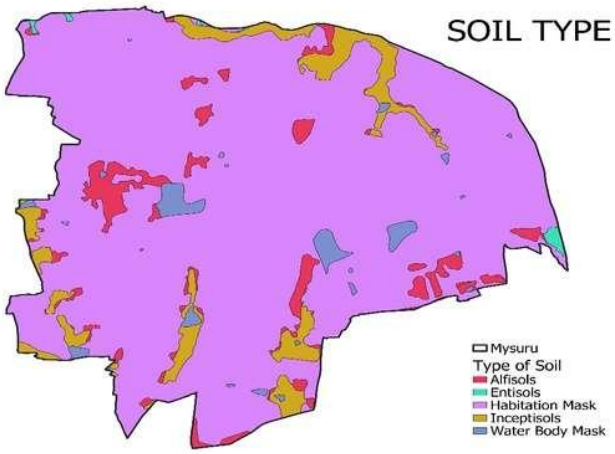

Figure 7: Soil Map of Mysuru City
Source: Compiled by the authors using QGIS.

Topography and natural characteristics of the city

Mysuru's geography is mainly flat, but it does include a few significant hills, the most famous of which is Chamundi Hill, which rises around 1,000 meters (3,281 feet) above sea level. Chamundi Hill is a notable landmark not only for its height, but also for its religious significance, as it houses the Chamundeshwari Temple, a prominent pilgrimage site.The environment near Mysuru is largely composed of fertile plains excellent for agriculture, particularly sugarcane, rice, and other crops. The city is located in the rain-shadow region of the Western Ghats, which results in modest rainfall, but it has good monsoon seasons, especially during the southwest monsoon between June and September.

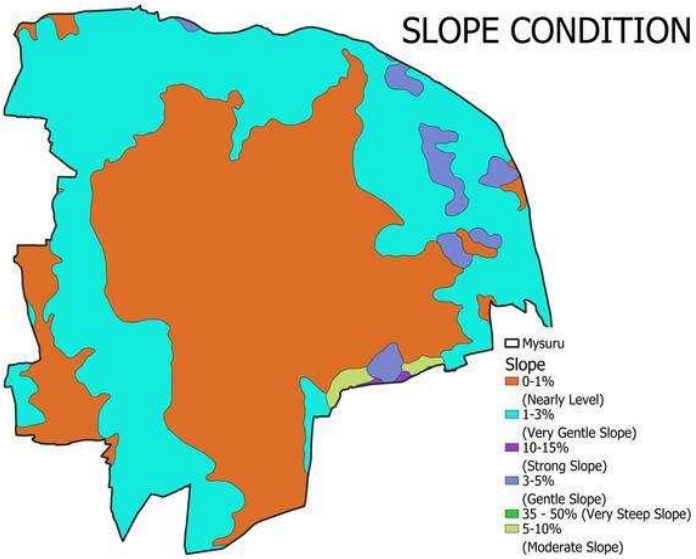

Figure 8: Slope Gradient Map of Mysuru City
Source: Compiled by the authors using QGIS

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Groundwater Potential in Mysore City

Mysore has immense ground water potential which is at an elevation of more than 600 meters and is nearly entirely composed of hard crystalline rocks which are impermeable to water. Conditions conducive to the accumulation of rich supplies of ground water as in unconsolidated sedimentary deposits are essentially lacking in Mysore. Nevertheless, there is in general a mantle of loose soil and decomposed rocks with a thickness ranging from a thin film to as much as 30 meters. The average thickness of the capping is perhaps 15 meters. This zone of decomposition is made up of sufficiently permeable porous material having capacity to retain up to three gallons per cubic foot and serves as reservoir of ground water. Water level is not very far from the surface in the last week of October. Its level gradually gets depleted and becomes minimum in the months of March-April. Level begins to pick up following the onset of rains in June. The variation in water level in Mysore ranges from three to four meters.

Seasonal Groundwater Fluctuation:

Mysore groundwater shows a clear seasonal fluctuation:

Post-monsoon season (October): The water levels are at their maximum, usually near the surface.

Dry season (March–April): Levels reduce to their minimum, mainly caused by evapotranspiration and sustained withdrawal.

Commencement of Monsoon (June onwards): Recharge commences, and groundwater levels start increasing.

The normal annual change in groundwater levels varies between 3 to 4 meters depending on local geological conditions, precipitation, and extraction rates.

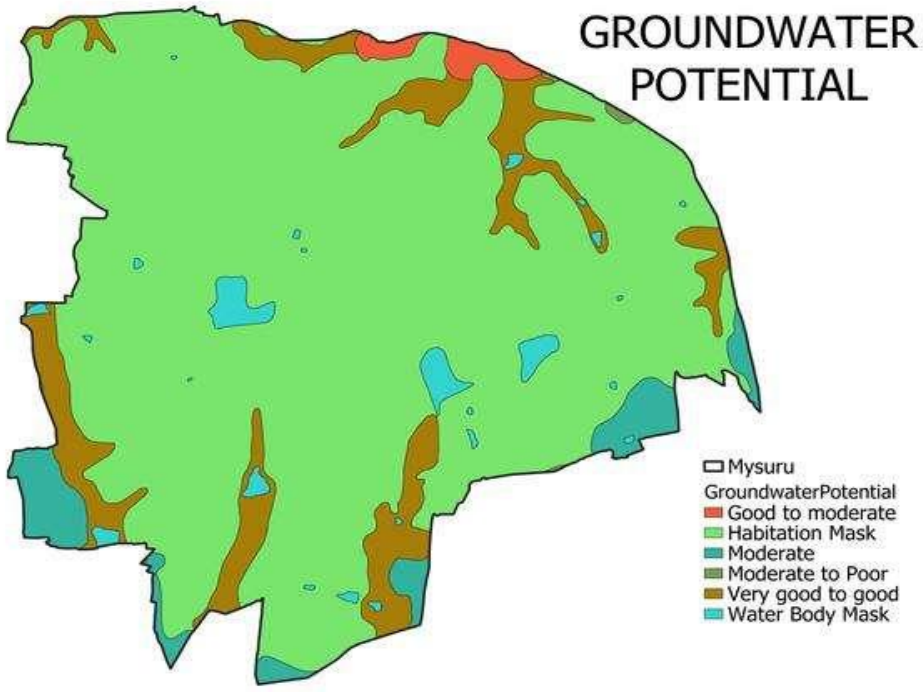

Figure 9: Groundwater Potential map of Mysuru City

Source: Compiled by the authors using QGIS

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Surface Water Resources in Mysore City

Mysore has a number of significant surface water bodies that not only play hydrological roles but also help in the ecological balance, microclimate regulation, and recreational value of the city.In Mysore City Some of the large tanks such as Karanji Tank, Lingambudi Tank, Dalvay Tank and Kukkarahally Tank, etc.

fall within urban boundaries, along with some minor water bodies. All water bodies have been suggested to be retained to ensure environmental and ecological balances and also for recreational activities. The total area of all these is 182.65 hectares and amounts to 2.41% of the total area (CDP Report, p. 64).

Mysore has the credit of being one of the very few cities in India to approach the standard by providing around 40 gallons of purified water per day per head. It has been possible because of some locational and physiographic conditions of Mysore which have decided the availability of water and the ease with which it would be tapped. The principal source of water are river Cauvery supplemented by borewells

Major Urban Water Bodies

A number of major tanks and lakes are found within the urban boundary of Mysore, including:

1. Karanji Tank
2. Lingambudi Tank
3. Dalvay Tank
4. Kukkarahally Tank

Besides the major lakes, several small ponds and minor water bodies are distributed across the city, as shown in Figure.

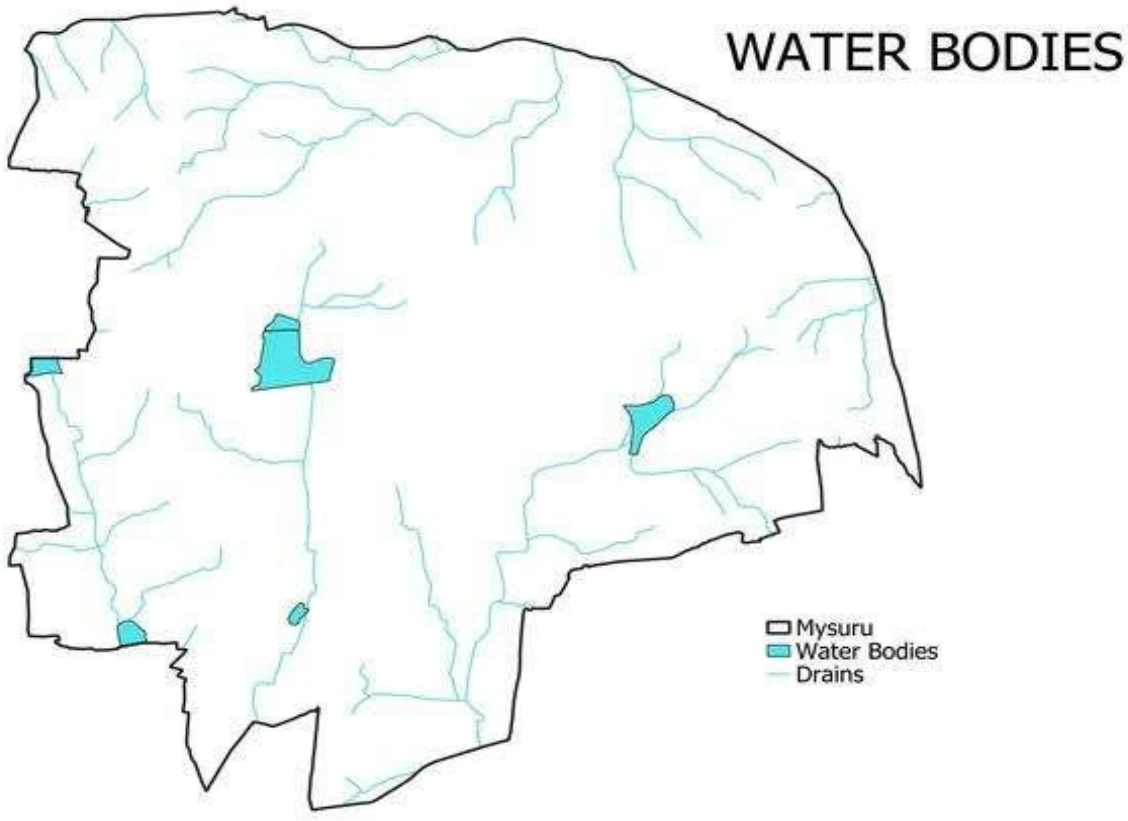

Figure 10: Surface Water bodies map of Mysuru City

Source: Compiled by the authors using QGIS

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Figure 11: Major Lakes of Mysuru City
Source: field survey Compiled by the authors

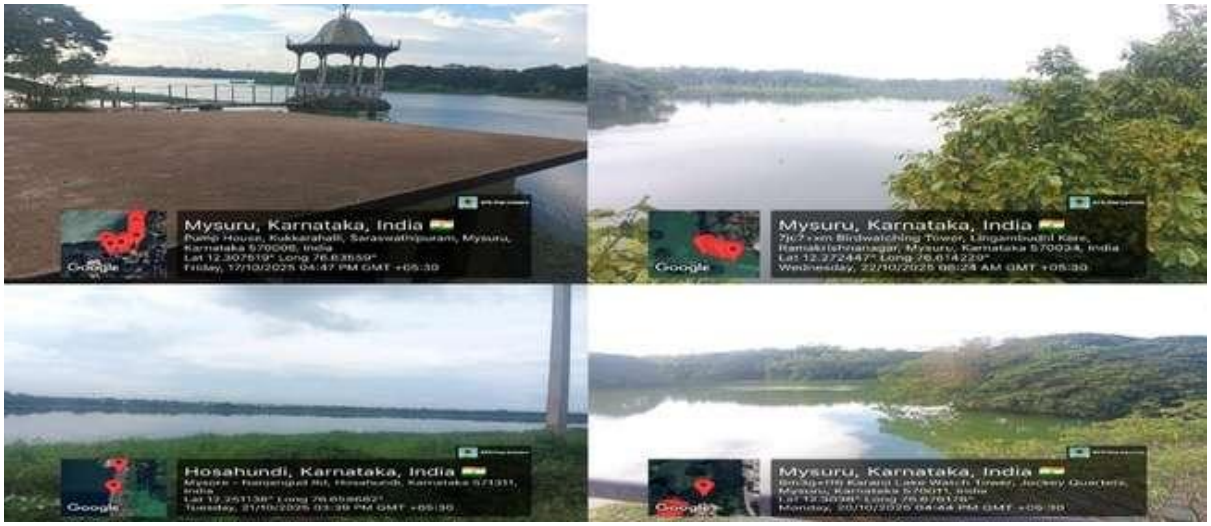

Figure 12: Major Lakes of Mysuru City
Source: field survey Compiled by the authors

RESULTS AND DISCUSSION

The empirical results of the study on climate trends and their consequences for stormwater management and urban design in Mysuru City are presented and discussed in this part. The findings are categorized into three thematic subsections based on long-term meteorological data and field observations: (i) noticed climate trends impacting stormwater behavior, (ii) the consequences of these climate changes for drainage design and urban heat stress, and (iii) field-based proof of drainage failure brought on by solid waste accumulation and its planning implications.

Climate Trends Affecting Mysuru City's Stormwater Behavior

Significant changes in important climatic parameters influencing stormwater dynamics in Mysuru City are shown by an analysis of centurial and long-term meteorological data. With rainfall mostly concentrated between June and September and secondary precipitation during the post-monsoon months, the city's climate is defined by a tropical monsoon regime affected by the southwest and northeast

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monsoons. But the rainfall regime is becoming more variable and irregular, which indicates a departure from seasonal patterns that can be predicted.

Annual rainfall totals exhibit significant inter-annual fluctuation, with alternating years of surplus and deficit, according to a review of climate data covering the years 1990–2025. Despite a limited long-term trend in mean annual rainfall, there has been more unpredictability in rainfall and a greater occurrence of short-duration, high-intensity downpour events in recent decades. Since severe rainfall over shorter periods of time results in larger peak runoff volumes that beyond the capacity of traditional urban drainage systems, this shift has significant ramifications for stormwater creation. Contradictory patterns in minimum and maximum temperatures are shown by temperature analysis. There is a noticeable upward trend in annual maximum temperatures, especially after 2015, which suggests that urban heat intensity is growing. Minimum temperatures, on the other hand, show more fluctuation and a little downward trend. Increased heat absorption by impermeable surfaces, decreased vegetation cover, urbanization, and changes in land use are all contributing factors to this growing diurnal temperature range. Strong seasonal fluctuation in relative humidity, with greater values during the monsoon months and an overall upward annual trend, suggests that variations in rainfall and urban surface characteristics are linked to changes in atmospheric moisture conditions.

Climate Trends' Effects on Urban Heat Stress and Drainage Design

The effectiveness and sufficiency of Mysuru City's stormwater infrastructure are directly impacted by the noted climatic patterns. Higher peak discharge happens over shorter time periods as a result of fewer wet days and more intense rainfall episodes. Unfortunately, a large number of stormwater drains that are currently in use were created using static design standards and antiquated rainfall assumptions that do not account for the diversity of the climate today. This imbalance between drainage capacity and hydrological demand leads to localized floods, overtopping, and frequent surcharge. Urban environmental stress is made worse by rising maximum temperatures and rising relative humidity. While decreased green cover and increased imperviousness restrict infiltration and evapotranspiration, elevated surface temperatures amplify the consequences of urban heat islands. These elements lessen the city's innate ability to control the water and heat cycles in addition to increasing surface runoff quantities. The results emphasize the necessity of climate-responsive drainage design guidelines that combine water-sensitive urban planning techniques and blue-green infrastructure to manage stormwater and reduce urban heat.

Solid Waste–Induced Drainage Failure: Field Evidence and Planning Implications

In the Field assessments carried out in several awards show that organic waste, silt, plastic garbage, and building debris are among the solid waste materials that continue to accumulate in stormwater drains. Drains that were partially or totally obstructed were discovered in a number of places, which greatly decreased hydraulic efficiency. Drainage malfunction is largely caused by operational and maintenance issues rather than design flaws, as these obstructions were seen even in drains with sufficient physical dimensions.

Urban flooding and improper solid waste management are clearly and consistently linked, according to the data. During rainstorm events, waste buildup impedes flow routes, results in water stagnation, and causes backflow and overtopping. Despite this persistent problem, solid waste management and stormwater drainage are treated as distinct industries in the Mysuru Master Plan and other statutory planning documents. One significant institutional gap is the lack of integrated planning provisions addressing drainage failure caused by garbage.

The results emphasize that infrastructure improvements by themselves will not be effective unless solid waste management is addressed as a crucial part of stormwater planning. This emphasizes how important it is to implement a Water-Sensitive Urban Planning and Design (WSUPD) framework that unifies planning by incorporating waste management, drainage design, land-use control, and climate adaptation.

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Synthesis

The findings show that a combination of governance, infrastructure, and climate factors causes urban flooding in Mysuru City. Although rising temperatures and shifting rainfall patterns raise hydrological stress, field data shows that fragmented planning and solid waste blockages greatly enhance the risk of flooding.

In order to overcome these obstacles, integrated, climate-responsive, and water-sensitive urban planning techniques must replace discrete engineering solutions.

An Analysis of Climate Dynamics and Meteorological Trends in Mysuru City (1990–2025)

This analysis examines the long-term climatic trends in Mysuru City over a 35-year period from 1990 to 2025. The dataset comprises key meteorological variables, including annual total rainfall (mm), minimum and maximum temperatures (°C), and the range of relative humidity (%). By observing these parameters, we can identify patterns, shifts, and potential anomalies in the region's climate, which may be indicative of broader environmental changes.

The following sections will explore trends in precipitation, thermal characteristics, and humidity levels to derive insights into the climatic dynamics of Mysuru City during this timeframe.

Table 4: Meteorological Data for Mysuru City (1990–2025)
Source: Compiled by the authors

"Annual Rainfall, Temperature, and Relative Humidity (RH) of Mysuru City (1990–2025)"

Sl.No	Distract /Mysore	Year	RAINFALL(mm)	MINTEMP(°C)	MAXTEMP(°C	MIN_RH(%)	MAX_RH(%)
1	Mysore City	1990	442.7	20.9	29.8	78.7	93.7
2	Mysore City	1991	943.2	21.2	29.8	77.4	93.6
3	Mysore City	1992	885	21	29.9	76.1	93.6
4	Mysore City	1993	704.2	21.2	29.9	74.8	93.8
5	Mysore City	1994	1070.5	21.2	29.9	73.5	93.5
6	Mysore City	1995	734.8	22.1	29.8	72.2	93.5
7	Mysore City	1996	838.4	22.2	30	70.9	93.5
8	Mysore City	1997	960.1	22.3	30	69.5	93.4
9	Mysore City	1998	708.9	22.5	29.7	68.2	93.4
10	Mysore City	1999	960.6	21.3	29.7	66.9	93.4
11	Mysore City	2000	962.8	21.2	29.7	65.6	93.3
12	Mysore City	2001	812.3	20.4	29.7	64.3	93.3
13	Mysore City	2002	582.8	19.8	32.5	67.9	91.8
14	Mysore City	2003	675.1	17.6	32.7	53.9	91.3
15	Mysore City	2004	809.3	16.1	32.6	65	95.2
16	Mysore City	2005	1050.5	17.2	31.2	61.2	92.6
17	Mysore City	2006	738	18.9	29.3	50.2	94.3
18	Mysore City	2007	821.1	19.4	29.2	52.1	95.9
19	Mysore City	2008	756.7	18.9	29.6	66.5	89.8
20	Mysore City	2009	880.6	18.3	32	60.5	83.3
21	Mysore City	2010	996	18.8	31	69.7	89.8
22	Mysore City	2011	784	18.6	30	56	95.7
23	Mysore City	2012	423.9	18.7	30.3	44.7	86.4
24	Mysore City	2013	645.7	19	29.8	42.1	98.6
25	Mysore City	2014	812.3	20.3	28.2	49.5	88.9
26	Mysore City	2015	880.1	20.2	32.4	34.2	98.4
27	Mysore City	2016	415.8	20.5	33.2	29.5	97.6
28	Mysore City	2017	914.2	20.5	40.9	34.5	97.7
29	Mysore City	2018	900.5	19.5	39.2	34.7	99
30	Mysore City	2019	955.5	19.8	40.9	35.3	99.3
31	Mysore City	2020	818.5	19.9	40.2	37.5	99.2
32	Mysore City	2021	956.4	19.8	39.8	43.7	99.7
33	Mysore City	2022	1316.2	19.1	39.6	47.4	99.3
34	Mysore City	2023	837	28	40.6	37.9	76.5
35	Mysore City	2024	935	18	27	45.1	76.5
36	Mysore City	2025	1060	15	29	34	85

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Variability in Minimum and Maximum Temperature

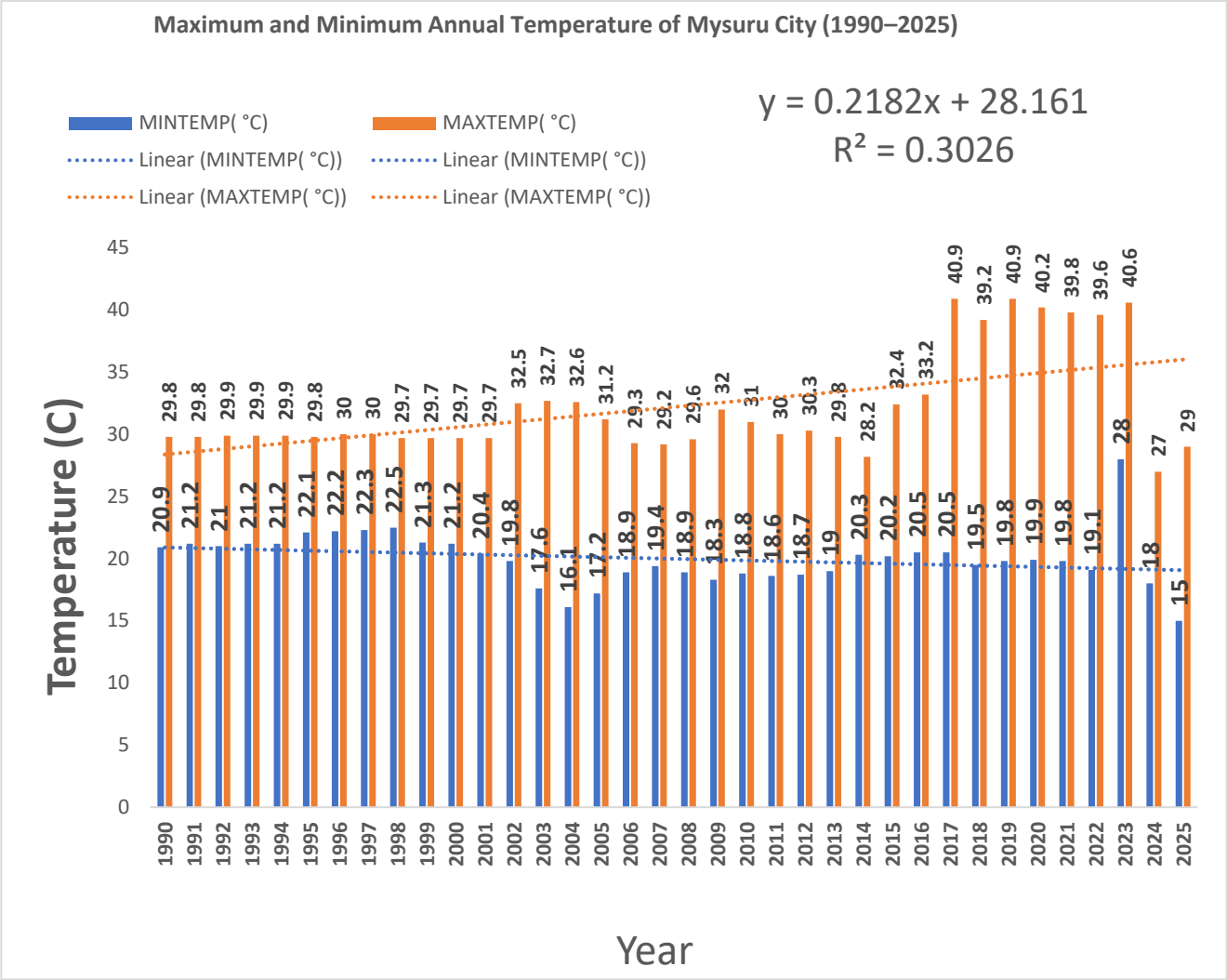

Figure 13: Minimum and Maximum Annual Temperature Mysuru City

Source: Compiled by the authors

In the above figure shows Minimum and maximum air temperatures are key indicators of local climatic variability and long-term climate change. The analysis of annual minimum and maximum temperature data for Mysuru City over the study period reveals distinct interannual variability and contrasting long-term trends. The annual minimum temperature exhibits noticeable fluctuations throughout the period, with values generally ranging between approximately 15 °C and 22 °C. Despite short-term variability, the trend line for minimum temperature indicates an overall decreasing tendency. This decline suggests cooler nighttime or early-morning conditions in certain years, which may be influenced by factors such as changes in cloud cover, rainfall patterns, wind circulation, and local land–atmosphere interactions.In contrast, the annual maximum temperature shows a clear increasing (positive) trend over the study period. Maximum temperatures rise from around 29–30 °C in the early years to values exceeding 40 °C in recent years, particularly after 2015.

The upward trend, supported by the fitted linear regression line, indicates an increase in extreme daytime temperatures and heat intensity in Mysuru City. The divergence between decreasing minimum temperatures and increasing maximum temperatures points to a widening diurnal temperature range, which is often associated with urbanization, land-use change, reduction in vegetation cover, and increased heat retention by built-up surfaces. These changes can enhance daytime heating while altering nocturnal cooling processes.

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Overall, the observed variability and trends in minimum and maximum temperatures reflect changing local climatic conditions in Mysuru City. The rising maximum temperatures have important implications for urban heat stress, water demand, evapotranspiration rates, and stormwater dynamics, while declining minimum temperatures may affect ecological processes and human thermal comfort. These findings are significant for sustainable urban planning, climate-resilient infrastructure design, and long-term environmental management strategies.

Variability in Rainfall

Rainfall Data Collection and Analysis:

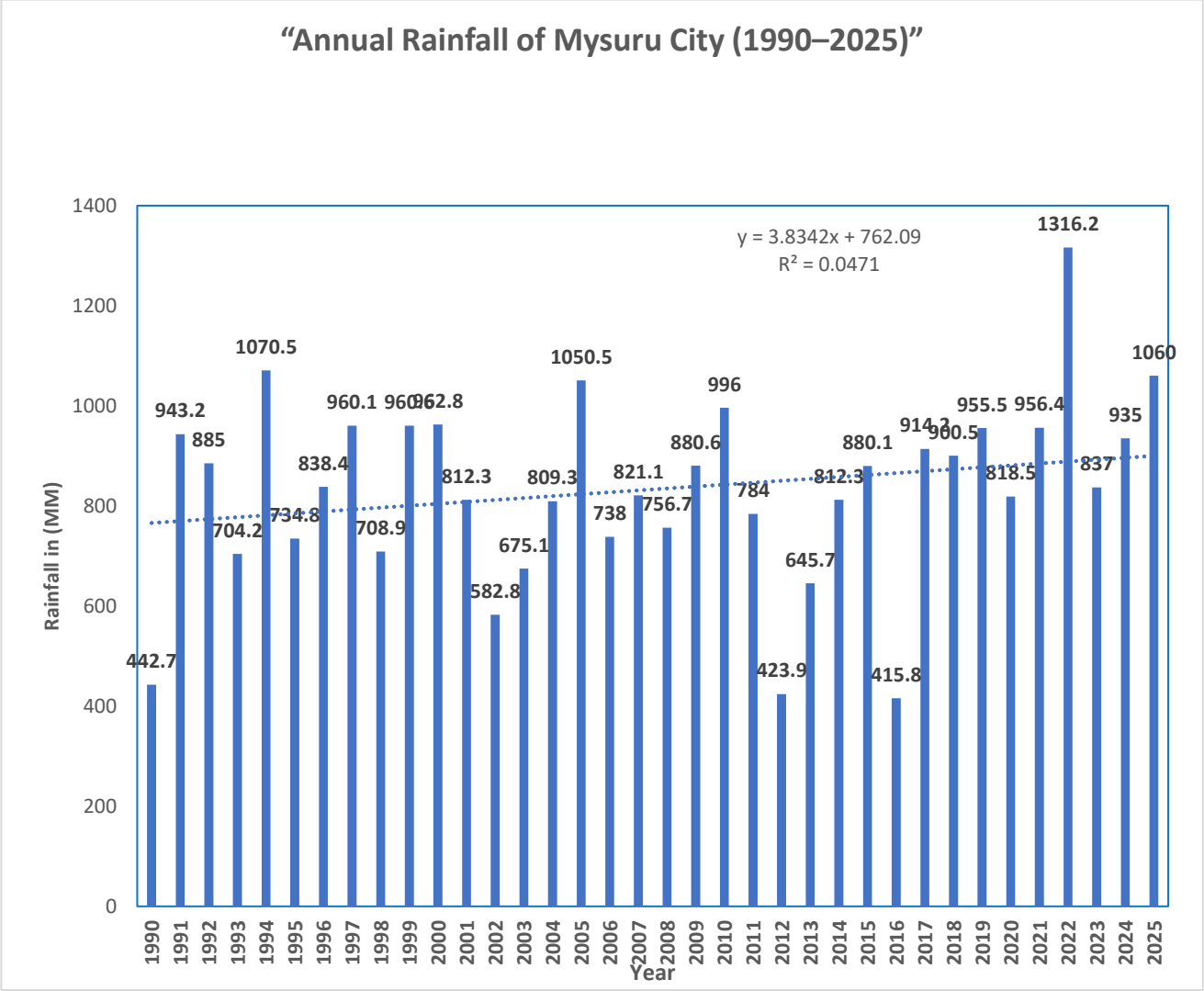

Figure 14: Annual Rainfall of Mysuru City

Source: Compiled by the authors

Above figure describe the Long-term daily rainfall data for Mysore City and its surrounding region were obtained from the India Meteorological Department (IMD) for a continuous period of 35 years. The dataset was processed to derive annual, seasonal and extreme rainfall indicators. Analysis of long-term rainfall data for Mysuru City (1990–2025) indicates high inter-annual variability with substantial fluctuations between deficit and surplus rainfall years in the above Figure. Annual rainfall ranges from less than 450 mm in low-rainfall years to more than 1,000 mm during extreme rainfall events, reflecting significant temporal variability rather than a stable rainfall regime.

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The linear trend in annual rainfall shows only a marginal increasing tendency, supported by a very low coefficient of determination ($R^2 = 0.047$), indicating that the trend is statistically weak. This suggests that year-to-year variability dominates over long-term changes in mean annual rainfall. Decadal analysis reveals increasing rainfall fluctuations in recent decades, with more frequent extreme rainfall events observed after 2010.Seasonal assessment shows an increasing trend in monthly rainfall, while monsoon rainfall exhibits a declining or inconsistent pattern, suggesting a redistribution of rainfall across seasons. This shift is characterized by fewer rainy days and higher rainfall intensity over shorter durations.

Overall, although no strong long-term trend is observed in annual average rainfall, the increasing variability and occurrence of extreme rainfall events pose significant challenges to urban drainage systems and increase the risk of urban flooding in Mysuru City.

Variability in Relative Humidity (RH)

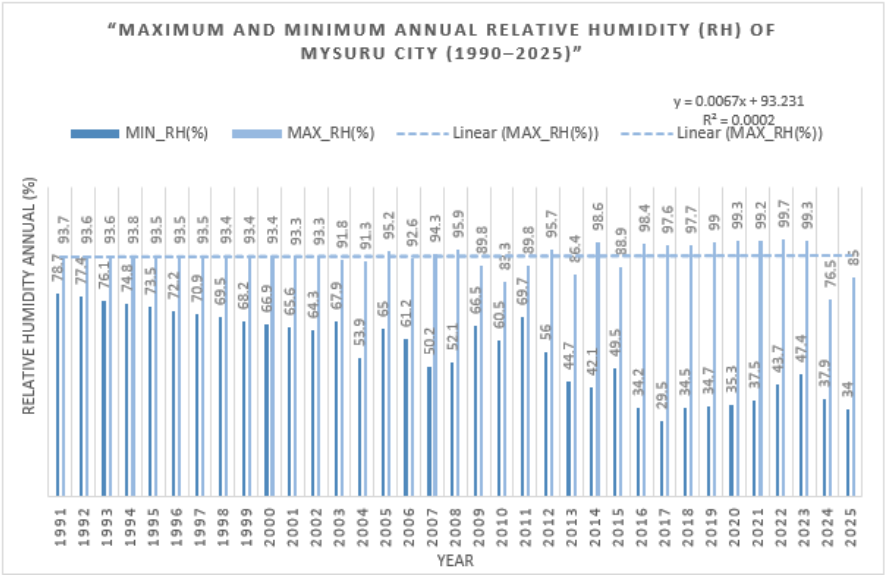

Figure 15: Annual Relative Humidity (RH)of Mysuru City
Source: Compiled by the authors

The above figure shows the annul Relative Humidity (RH) is defined as the ratio of the actual amount of water vapour present in the atmosphere to the maximum amount of water vapour the air can hold at a given temperature, expressed as a percentage. Higher relative humidity values indicate a more moisture-laden air mass.

The analysis of monthly relative humidity data for Mysuru City reveals distinct seasonal variability. A declining trend in RH is observed from January to April, corresponding to the dry pre-monsoon period. During these months, higher air temperatures, increased solar radiation, and limited rainfall lead to enhanced evaporation and reduced atmospheric moisture content, resulting in lower relative humidity levels.

From May onwards, relative humidity begins to increase, with a pronounced rise during the monsoon season. This increase can be attributed to the onset of southwest monsoon winds, higher rainfall intensity, increased cloud cover, and reduced temperature fluctuations, all of which contribute to greater atmospheric moisture availability. Peak RH values are generally observed during the monsoon and post-monsoon months, indicating saturated or near-saturated atmospheric conditions.

The annual average relative humidity for Mysuru City shows an overall increasing (positive) trend over the study period. This long-term rise may be associated with changing climatic conditions, increased rainfall variability, expansion of built-up areas, and the presence of urban water bodies and green spaces, which influence local moisture regimes. The increasing trend in annual RH has important implications

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for urban thermal comfort, stormwater dynamics, evapotranspiration processes, and sustainable urban water management planning.

Planning and Wsupd Integration Framework

This study adopts Water-Sensitive Urban Planning and Design (WSUPD) as an integrated planning framework to address the growing mismatch between rainfall patterns, stormwater flows, land-use change, and infrastructure performance in Mysuru City. The framework is grounded in the city's natural ridge–valley system and interconnected lake networks, recognizing these as critical ecological infrastructures that must be protected, restored, and functionally integrated into statutory planning and urban design.

The WSUPD integration is structured across multiple planning scales. At the regional and watershed scale, natural drainage corridors, valleys, and lake catchments are treated as non-developable zones, with rainfall trend analysis and flood-risk considerations informing regional growth management and zoning decisions. At the city and master plan scale, stormwater systems, solid waste management, land-use zoning, and transportation planning are integrated to function as a continuous blue–green network rather than isolated engineering components. At the neighbourhood scale, urban layouts and streets are retrofitted with water-sensitive elements—such as permeable surfaces, vegetated swales, detention spaces, and improved inlet design—to reduce runoff volumes, slow flow velocities, and intercept pollutants. At the plot and building scale, source-control measures, including rooftop rainwater harvesting, infiltration systems, and green infrastructure, are emphasized to minimize cumulative runoff entering the municipal drainage network.

The framework promotes a balanced grey–green infrastructure approach, wherein conventional stormwater drains are retained for extreme rainfall events while green and blue infrastructure manages frequent and moderate storms through infiltration, storage, evapotranspiration, and water quality improvement. Urban lakes and wetlands are positioned as regulated retention and treatment systems within the stormwater network, rather than as passive or degraded discharge points. Institutional integration is a central component of the framework. Effective WSUPD implementation requires coordinated governance among urban planning, stormwater, solid waste, water supply, and environmental agencies, supported by shared geospatial data, clear maintenance responsibilities, and routine monitoring. An adaptive planning approach is adopted, wherein rainfall–runoff responses, drainage performance, and flood occurrences are continuously evaluated and used to refine planning standards and design guidelines.

Through this integrated WSUPD framework, the study establishes stormwater management as a core urban planning function rather than a purely engineering task. The framework aims to reduce flood risk, improve water quality, enhance groundwater recharge, and strengthen urban resilience in Mysuru City by aligning rainfall dynamics, urban form, infrastructure systems, and governance within a unified, water-sensitive planning paradigm.

Limitations of the Study

It is important to recognize the study's limitations despite its contributions. a small number of rain gauge stations in and around Mysuru City provided secondary data for the rainfall analysis. The unequal spatial distribution of stations may affect the accuracy of estimates of peak storms and localized rainfall intensity, especially in heavily urbanized micro-catchments, even if typical spatial interpolation techniques were used to fill in data gaps.

Since real-time discharge measurements and continuous flow monitoring data for urban drains were not consistently accessible, the assessment of stormwater flows mostly rely on indirect rainfall–runoff connections and secondary hydrological records. As such, short-duration, high-intensity storm events might not be well captured by the estimation of peak runoff and drainage capacity mismatch. Advanced hydrodynamic or coupled surface–subsurface flow modelling is not included in the study, despite the fact that it incorporates GIS-based spatial analysis and planning views. Because of this, a thorough analysis of the intricate relationships between surface runoff, groundwater recharge, and sewer/drain backflow during

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periods of intense rainfall was not possible. Decentralized stormwater interventions and blue-green infrastructure evaluations are mostly conceptual and planning-focused. Field-based performance monitoring and long-term impact evaluation of such interventions were outside the purview of this study due to institutional limitations. The study's conclusions and suggestions are context-specific because it focuses exclusively on Mysuru City. Although the analytical methodology and planning principles might be applicable to other Indian towns with comparable urban and climatic circumstances, care should be exercised when extrapolating the findings.

CONCLUSIONS

This study used a Water-Sensitive Urban Planning and Design (WSUPD) framework to examine the relationship between long-term climate trends, stormwater system performance, and urban management practices in Mysuru City. Urban flooding in Mysuru City is caused by a combination of climatic, infrastructure, and governance-related factors rather than just an increase in rainfall, according to an analysis of 35 years' worth of meteorological data, a spatial assessment of drainage networks, a review of the statutory plan, and field-based observations.

The findings show increased maximum temperatures, a greater frequency of short-duration, high-intensity rainfall events, increasing rainfall variability, and shifting patterns of relative humidity. The observed shift toward severe rainfall over shorter durations has boosted peak runoff generation beyond the capability of current drainage systems, many of which are planned using obsolete rainfall assumptions, even while the long-term trend in mean annual rainfall is moderate. At the same time, surface runoff and urban heat stress have increased due to urban growth, vegetal cover loss, and an increase in impervious surfaces.

Field data unequivocally shows that poor solid waste management is a systemic and ongoing cause of urban flooding and stormwater drainage failure. Plastic garbage, construction debris, organic matter, and silt were observed to partially or completely clog stormwater drains in some wards. This resulted in decreased hydraulic capacity, water stagnation, and localized floods even during periods of mild rainfall. These findings demonstrate a clear, empirically supported connection between poor waste management and the occurrence of floods. Encroachment on natural drainage pathways, disturbance of the ridge-valley system, and functional deterioration of interconnected urban lakes have all contributed to the city's diminished natural stormwater regulation capacity, making the issue even worse.
A significant planning and governance deficit is also noted by the report. The existing Mysuru Master Plan gives natural drainage systems and blue-green infrastructure only a passing mention and regards solid waste management and stormwater drainage as distinct sectoral challenges. Infrastructure investments consequently overlook operational issues like blockages caused by garbage and changes in runoff behaviours brought on by climate change.

Based on the findings, the following recommendations as follows

1. Integrate stormwater management into the Mysuru Master Plan, zoning laws, and development control rules to institutionalize WSUPD in statutory planning. Clearly safeguard ridge-valley systems, natural drains, and lake catchments as ecological infrastructure that cannot be developed.
2. By designing urban lakes, wetlands, open spaces, and green corridors as integrated stormwater detention, retention, and treatment systems rather than discrete landscape features, blue-green infrastructure networks can be strengthened.
3. To handle rising rainfall intensity and lessen peak runoff loads on traditional drainage systems, implement climate-sensitive and decentralized stormwater solutions, such as bioswales, rain gardens, permeable pavements, detention basins, and rooftop rainwater collecting.
4. Through GIS-based mapping, encroachment removal, and stringent enforcement against rubbish dumping and structural obstacles in valley lines and floodplains, natural drainage systems can be restored and protected.
5. Recognize that a major operational cause of floods is waste-induced drain blockage and incorporate solid waste management into stormwater planning. In addition to strengthening waste segregation,

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routine collection, and enforcement procedures, drain design guidelines should incorporate debris traps and maintenance access.

6. Increased tree cover, shaded streets, cool surface materials, and neighbourhood-scale green infrastructure can all help reduce urban heat and microclimate stress while promoting evapotranspiration and hydrological management.
7. Improve climate monitoring and data-driven planning by combining data on drainage performance, land-use change, rainfall, temperature, humidity, and runoff behavior into a common geographic decision-support system.
8. By clearly defining the roles of planning, drainage, water supply, and solid waste agencies and utilizing shared data platforms and design standards revisions on a regular basis, it is possible to enhance institutional coordination and adaptive governance.

All things considered, the study shows that a change from disjointed, engineering-led solutions to an integrated, climate-responsive, and water-sensitive urban design approach is necessary for Mysuru City to effectively reduce the danger of flooding. The results provide useful information for other quickly urbanizing areas dealing with comparable issues like solid waste mishandling, drainage system stress, and climate variability.

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