

POLICY FRAMEWORK AND GOVERNANCE CHALLENGES IN URBAN DRAINAGE MANAGEMENT OF DELHI

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Abstract

Delhi's urban drainage management focuses on implementing a drainage master plan to address annual waterlogging, improve water management, and control encroachments. Urban drainage management is crucial for mitigating flood risks and enhancing climate resilience in rapidly developing megacities such as Delhi. The present study critically reviews the policy frameworks and governance structures that guide Delhi's urban drainage system, with a focus on institutional measures and regulatory mechanisms. It adopts a qualitative research methodology involving a comprehensive policy content analysis and semi-structured expert interviews. The research identifies key governance challenges, including institutional fragmentation, overlapping mandates, inadequate enforcement, and limited incorporation of climate adaptation measures. The analysis reveals that, despite the existence of numerous drainage-related policies and plans, there is a lack of an integrated and coherent governance framework, resulting in ineffective implementation and unsustainable urban water management. The paper advocates for strengthening institutional coordination, enhancing policy coherence, and embedding nature-based solutions within the regulatory framework to improve the resilience and functionality of Delhi's urban drainage infrastructure.

Keywords: Policy Framework; Urban drainage management; Delhi policies; urban drainage framework; Delhi drainage system.

1. INTRODUCTION

Delhi, the capital of India, is bisected by the Yamuna River, with most urban development concentrated on its western bank. Rapid urban expansion has increased impervious surfaces, while long-standing neglect of drainage infrastructure has placed severe pressure on the stormwater system (Roy et al., 2020). As a result, flooding and waterlogging have become recurring challenges during the monsoon season, posing risks to public safety, mobility, and public health (Marwal & Silva, 2023).

Urban drainage management plays a critical role in reducing flood vulnerability and enhancing climate resilience in Delhi. The city has an extensive drainage network of over 18,000 km, as shown in Figure 1. However, much of this infrastructure is outdated, poorly maintained, and uneven in performance. The

system was originally designed for lower rainfall intensities and lower population densities (S. Kumar et al., 2019). Under current climatic variability and rapid urbanisation, the existing capacity is frequently exceeded, leading to severe waterlogging and flood events (S. Kumar et al., 2022).

These challenges are further intensified by fragmented institutional arrangements. Multiple agencies are responsible for different components of stormwater and sewerage management (Sarkar & Choudhary, 2020). These agencies often operate with overlapping mandates and limited coordination. Such fragmentation contributes to delayed responses, inefficient maintenance, and recurring flooding in the city (Dutta et al., 2019; Sarkar & Choudhary, 2020).

To address these issues, the Delhi Drainage Master Plan 2025 proposes integrated, climate-resilient, and system-wide solutions (Khan et al., 2024). However, the translation of these policy visions into effective on-ground outcomes remains constrained by governance gaps and institutional disconnects (BASELINE REPORT: ENVIRONMENT Enabling Strategic Plan: Master Plan for Delhi 2041, n.d.; Sewerage Master Plan for Delhi 2031, n.d.).

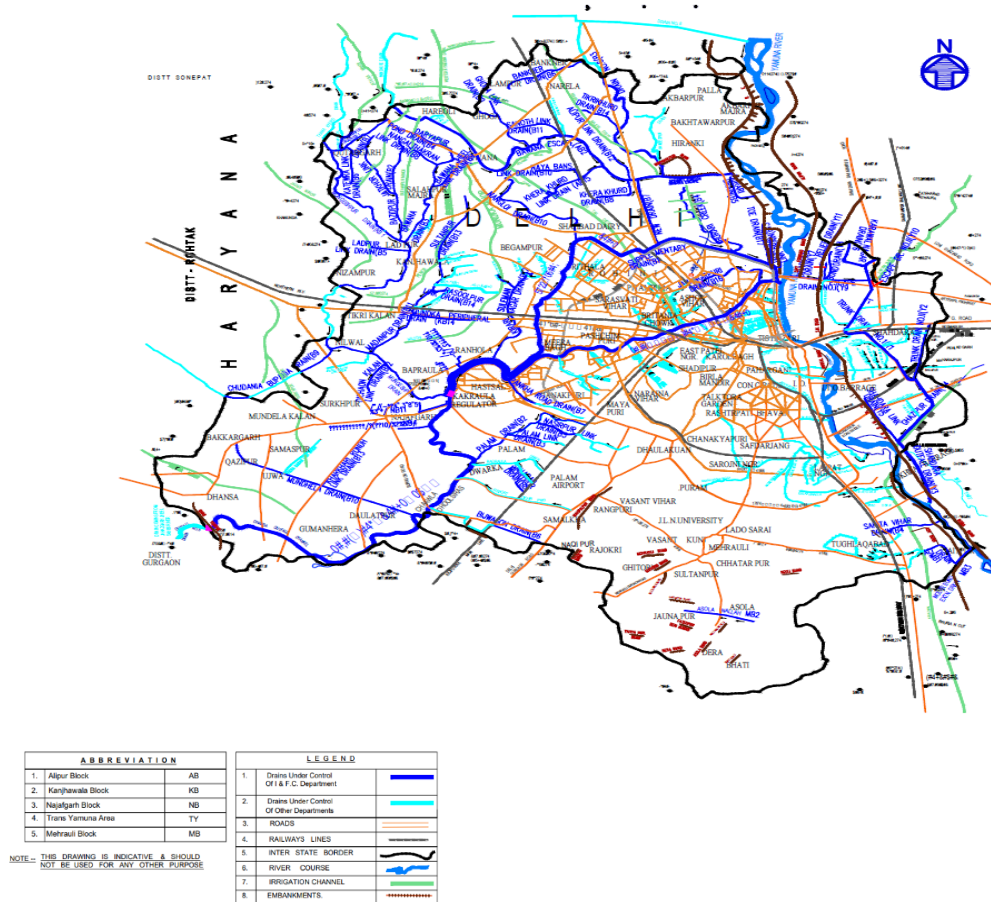


FIGURE 1 - THE MAP SHOWS DELHI'S DRAINAGE NETWORK
Source: Irrigation & Flood Control Department (IFC)

This study examines the fragmented policy framework and governance challenges in Delhi's urban drainage management. It analyses existing institutional arrangements and evaluates the effectiveness of current policies. The research further identifies key governance gaps related to coordination, enforcement, and institutional capacity that continue to hinder efficient and resilient stormwater management.

2. LITERATURE REVIEW: DRAINAGE MANAGEMENT POLICIES AND GOVERNANCE THEORIES

A mix of historical practices and contemporary policy frameworks shapes urban drainage management in Delhi. Key policy documents, including the Drainage Master Plan 2025 and the Sewerage Master Plan for Delhi 2031. These documents emphasise the modernisation of stormwater infrastructure and the integration of climate resilience. Similarly, the master plan for Delhi 2041 highlights sustainable urban water management as a strategic priority (Enabling Strategic Plan: Master Plan for Delhi 2041, n.d.). These policies reflect a shift from conventional drainage approaches towards more integrated and adaptive systems.

Existing literature underscores the importance of multi-level and multi-stakeholder institutional arrangements in urban water governance. Several studies argue that effective drainage management depends on coordination across agencies, policy coherence and active stakeholder participation. Theories of integrated governance further suggest that alignment between different governance scales is essential for managing complex urban flooding challenges (Ahmad et al., 2016). In addition, global frameworks such as the principles developed by the Organisation for Economic Co-operation and Development. It emphasises transparency, accountability, and stakeholder engagement as key components of resilient water systems.

However, much of the existing research remains focused on policy intentions and theoretical frameworks. There is limited critical examination of how these principles are implemented in practice, particularly in the context of Delhi. Issues such as institutional fragmentation, overlapping mandates, and weak coordination mechanisms are often acknowledged but not systematically analysed. This creates a gap between policy design and on-ground implementation.

This study addresses this gap by examining the institutional structure and governance processes underlying urban drainage management in Delhi. It focuses on coordination challenges, accountability mechanisms, and implementation constraints. By linking policy analysis with field-based evidence, the study provides a more grounded understanding of governance inefficiencies and their impact on urban flood management.

2.1. Institutional framework for drainage and flood management

2.1.1. Policy-making, planning, and regulatory agencies

Delhi's drainage and flood management system reflects a clear separation between policy formulation (Table 1) and on-ground execution (Table 2). Planning institutions define strategies and regulations. However, weak horizontal coordination among agencies leads to overlapping responsibilities, delayed responses and accountability gaps. Operational agencies function within fragmented jurisdictions, which results in inconsistent implementation and recurring flooding.

TABLE 1 - AGENCIES ARE PRIMARILY RESPONSIBLE FOR POLICY FORMULATION, MASTER PLANNING, REGULATION AND STRATEGIC OVERSIGHT.

No.	Agency	Primary Role in Drainage & Flood Management
1.	Ministry of housing and urban affairs (MoHUA)	National-level urban policy formulation, funding frameworks, and guidelines influencing drainage, stormwater management, and climate-resilient infrastructure.
2.	Delhi Development Authority (DDA)	Preparation and implementation of Master Plans (MPD- 2021, MPD-2041); zoning regulations affecting natural drains, floodplains, green buffers, and land use.
3.	Government of NCT of Delhi (GNCTD)	Overall policy direction, budget allocation, and coordination among state departments dealing with drainage and flood mitigation.
4.	Delhi Jal Board (DJB)	Policy and planning for sewerage, stormwater- sewer integration, wastewater treatment, and related infrastructure standards.
5.	Irrigation & Flood Control Department	Planning and regulation of flood control infrastructure, embankments, drains, pumping stations, and river-related flood mitigation.
6.	Central Water Commission (CWC)	Flood forecasting, hydrological data generation, river behaviour analysis and advisory role for flood management strategies.
7.	National Disaster Management Authority (NDMA)	National-level disaster management guidelines, including urban flood risk reduction and preparedness frameworks.
8.	Delhi Disaster Management Authority (DDMA)	State-level disaster preparedness, response planning, early warning coordination, and emergency protocols for floods.

TABLE 2 - AGENCIES ARE RESPONSIBLE FOR DAY-TO-DAY OPERATIONS, MAINTENANCE, DESILTING, EMERGENCY RESPONSE, AND INFRASTRUCTURE EXECUTION.

No.	Agency	On-Ground Responsibilities
1.	Municipal Corporation of Delhi (MCD)	Maintenance and desilting of minor drains, stormwater drains, roadside drains, ponds, and local waterlogging mitigation within its jurisdiction.
2.	New Delhi Municipal Council (NDMC)	Drainage maintenance, stormwater management, and flood response within the NDMC areas.
3.	Public Works Departments (PWD), Delhi	Maintenance of roadside drains, culverts, bridges and drainage linked to arterial roads and major infrastructure.
4.	Irrigation & Flood Control Department (IFCD)	Construction, operation, and maintenance of major drains, flood embankments, pumping stations, and river flood control structures.
5.	Delhi Jal Board (DJB)	Operation of sewer networks, pumping stations, treatment plants, and management of stormwater-sewer interactions during monsoons.
6.	Delhi Disaster Response Force (DDRF)	Emergency response, relief operations, and coordination during flood-related disasters.

Limited data sharing and weak knowledge management further constrain evidence-based decision-making. This reduces the effectiveness of system planning and long-term interventions (Kumar & Bhaduri, 2018). In addition, enforcement of drainage regulations remains weak due to inadequate monitoring and

limited technical capacity. This has led to encroachments on drainage channels and poor maintenance practices.

Climate adaptation is also insufficiently integrated into existing policies. As a result, the drainage system remains vulnerable to increasing rainfall variability and extreme weather events linked to climate change (Sarkar & Choudhary, 2020).

2.2. Failure of Urban Drainage Management: Delhi

Delhi, one of India's largest metropolitan regions, faces recurring urban flooding during the monsoon season. It represents a typical case of drainage failure in a rapidly urbanizing city (Rajasekar et al., 2022). Flooding persists despite investments in infrastructure, planning, and institutional mechanisms.

Several areas, including ITO, Minto Bridge, Najafgarh, Dwarka, South Extension, Lajpat Nagar, the Yamuna floodplains, and parts of East Delhi, experience severe waterlogging almost every year. These events disrupt traffic, damage infrastructure, and pose risks to public safety.

No single authority manages the entire drainage cycle, from stormwater generation to final discharge. The irrigation and flood control department manages major drains and flood control structures. The Municipal Corporation of Delhi handles local drains. The public works department is responsible for road drainage. The Delhi Jal Board manages sewerage, while the Delhi Development Authority oversees land-use planning.

This fragmented structure creates overlaps and gaps in responsibility. It often leads to blame shifting during flood events and weak accountability. Another major limitation is the poor integration of drainage planning with land use decisions (Chaudhuri et al., 2022). Although the master plan of Delhi identifies floodplains and drainage corridors, enforcement remains weak. Encroachments and unplanned development continue in critical areas (S. Kumar et al., 2022).

The most significant failure is diffused accountability. During flooding, responsibility is spread across multiple agencies. This creates public confusion and administrative delays. No single institution is held accountable for system-wide failure, which reduces incentives for long-term reform (Passi et al., n.d.-a; Rajasekar et al., 2022)

Table 3 presents a synthesis of SCOPUS- indexed studies on Delhi's urban drainage system. It has a strong emphasis on pollution dynamics, hydrological behaviour, urbanisation impacts, and climate-induced flooding. Most studies highlight that major drains, particularly the Najafgarh drain, fall into the Yamuna River. It functions primarily as a conduit for untreated wastewater rather than as an effective

stormwater infrastructure. The literature consistently identifies key challenges such as increasing surface runoff due to rapid urbanization, declining water quality, inadequate and outdated drainage design, and rising flood vulnerability under changing climate conditions. However, despite this extensive technical and environmental analysis, there is a notable lack of focus on institutional fragmentation, inter-agency coordination, and governance inefficiencies that significantly affect drainage planning and management in Delhi. This gap in the existing body of research highlights the need for an integrated institutional perspective, thereby forming the central research gap addressed in this study.

TABLE 3 – A SYNTHESIS OF THE LITERATURE REVIEW ON DELHI'S URBAN DRAINAGE SYSTEM

Author(s) & Year	Journal	DOI / Source	Study Focus	Methodology	Key Findings	Drainage Relevance
(Nehra & Singh, n.d.)	<i>Pollutant Transport Modelling in the Yamuna</i>	DOI: 10.3233/JCC230023	Drain pollution modelling	MATLAB simulation	Delhi contributes >50% pollution via drains	Establishes the link between drainage and river pollution
(Bhattacharya et al., 2015)	<i>Water Quality of Yamuna & Drains</i> (Environmental Monitoring & Assessment)	DOI: 10.1007/s10661-014-4146-2	Irrigation water quality	Field monitoring	High heavy metals & contamination	Shows the impact of drains on agriculture
(Vaid et al., 2022)	<i>Pollution Sources in Najafgarh Drain</i> (Environmental Science & Pollution Research)	DOI: 10.1007/s11356-022-21710-z	Pollution source tracking	Statistical + field study	Drain is the largest pollution contributor	Critical drainage pollution study
Vaid et al. (2025)	<i>Water Quality Trends across Land Use</i> (Environmental Monitoring & Assessment)	DOI: 10.1007/s10661-025-14624-z	LULC–water quality link	Statistical modelling	Urbanisation worsens drainage water quality	Connects land-use with drainage failure
(Vaid et al., 2024)	<i>Microplastics in Urban Drainage Channels</i> (Water Science & Technology)	DOI: 10.2166/wst.2024.181	Microplastic transport	Field sampling	Drains carry MPs to the Yamuna	Emerging drainage pollution issue
(Soni et al., 2014)	<i>Environmental Flow of the Yamuna</i>	Source: arXiv (Scopus-indexed references)	River flow & ecology	Hydrological analysis	50–60% flow needed for ecosystem health	Highlights drainage-flow imbalance
(Borsche & Klar, 2014)	<i>Urban Drainage Flood Modelling</i>		Sewer–surface interaction	Mathematical modelling	Flooding due to coupled drainage failure	Theoretical basis for urban flooding
(P. Kumar et al., 2022)	<i>Najafgarh Drain Water Quality Assessment</i>	SSRN / ICARI (indexed conference) (SSRN)	Drain pollution	Physicochemical analysis	Severe deterioration of water quality	Reinforces drainage pollution role

3. METHODOLOGY

This study adopts a mixed-method research approach to examine the policy framework and governance challenges in urban drainage management in Delhi. The research combines qualitative policy analysis with quantitative assessment of hydrological and institutional data. To provide a comprehensive understanding of systemic gaps. Secondary data is collected from statutory planning documents such as the Master Drainage Plan 1976 and the Master Plans of Delhi 2021 and 2041. Also, data collected from official reports of the Delhi Development Authority, the Municipal Corporation of Delhi, and the Irrigation and Flood Control Department, etc. National-level policy guidance documents issued by the national disaster management authority are also reviewed to evaluate alignment between local implementation and national urban flood management guidelines.

Primary data is gathered through 30 semi-structured professional interviews with planners, engineers, and administrative officials. These interviews are to understand institutional fragmentation, coordination challenges, accountability mechanisms, financial constraints, and operational bottlenecks. In addition, 120 questionnaire-based surveys are conducted with residents affected by urban flooding. These surveys are conducted to capture ground-level experiences, perceptions, and challenges faced during flood events. The interviews and surveys are conducted across multiple locations in Delhi. Primarily, the areas are focused on flood-prone areas that experience recurrent waterlogging.

Field surveys are carried out in these identified zones to document physical conditions, encroachments, drain capacity issues, and maintenance status. The collected data is analysed using content analysis for policy review and institutional mapping to identify jurisdiction overlaps and fragmentation. The study applies governance evaluation parameters, namely institutional clarity, coordination efficiency, implementation capacity, and resilience integration, to systematically assess the effectiveness of the existing framework. The methodological approach ultimately aims to identify structural governance gaps and propose an integrated, climate-responsive drainage management model for Delhi.

4. POLICY FRAMEWORK ANALYSIS

Delhi's urban drainage management involves multiple agencies, including the Municipal Corporation of Delhi (MCD), Delhi Development Authority (DDA), Public Works Department (PWD), Delhi Jal Board (DJB), and the Irrigation and Flood Control Department (IFC). Each agency holds separate but overlapping responsibilities. Related to drainage infrastructure planning, development, maintenance, and environmental regulation, which often leads to irregular governance(Singh & Tayal, 2022).

The Delhi Drainage Master Plan 2025 serves as an important policy outline. Consisting of climate-resilient infrastructure upgrades and integrated stormwater management strategies. Also, environmental

regulations and municipal development plans set parameters for land use and water pollution control. Which indirectly impacts drainage policy (Ahmad et al., 2016). The assessment reveals limited unity across these policies and institutional mandates (S. Kumar et al., 2022). Overlapping authorities generate uncertainties in responsibility. Whereas weak inter-agency coordination hampers unified drainage planning and effective enforcement (Marwal & Silva, 2023). Climate adaptation strategies are not reliably cohesive with core drainage policies, and this reduces the system's ability to respond to emerging hydrological risks. This irregular institutional and policy environment weakens the holistic and sustainable management of Delhi's urban drainage system. It requires governance reforms to clearer roles, enhanced coordination, and policy integration focused on resilience building.

4.1. Policies are applicable in Delhi:

Water policy (draft): This policy elaborates on developing a road map for managing the water resources in Delhi, with technical and administrative consideration aspects. Such as water supply norms and demand projections, water availability, wastewater recycling, institutional mechanisms, policy issues, and options, etc.

Delhi Water Septage Management Regulations 2018: These regulations provide norms and standards for the criteria for the issue of a license for transportation, collection, also disposal of septage. This takes into consideration technological applications in septage management, etc.

Master plan for Delhi (MDP): This plan promotes integrated water management, combining stormwater, wastewater, and rainwater reuse. It also emphasizes the blue-green infrastructure.

Drainage master plan for Delhi (2018): It provides the digital elevation models, GIS-based mapping for the drainage system of Delhi.

Yamuna action plan (phases I-III): This plan aims at watershed management, which impacts stormwater discharge and drainage quality into the river, Etc.

Master plan for Delhi (MDP): It promotes blue-green infrastructure. This integrates drainage, sewerage, and stormwater into urban design.

Drainage Improvement Projects/ Road Drainage Plans: This controls the upgradation of roadside storm drains and outfall connections. also redesigning the road level and slopes for improved runoff.

Local Drainage Maintenance Guidelines & Action Plans: It controls the maintenance of tertiary and secondary drains in residential and commercial zones. It also provides the other norms for drain clogging by solid waste, pre-monsoon desilting drives, etc.

Comprehensive Drainage & Sewerage Study: It is an integrated plan for linking sewerage and drainage. Highlighting institutional fragmentation issues.

Wetland and Waterbody Restoration Plan: This plan is for restoring and protecting wetlands connected to the drainage system. It also provides a study for enhancing stormwater retention and flood mitigation.

Urban Flood Resilience Studies: This study generates the hydrological and hydraulic modelling for flood risk mapping.

Table 4 show different agencies and departments' control over different policies, plans, or reports for drainage and water.

TABLE 4 – AGENCIES AND DEPARTMENTS CONTROL OVER DIFFERENT POLICIES, PLANS, OR REPORTS FOR DRAINAGE AND WATER.

No	Agency/department	Policy/plan/report	year
1.	Irrigation & flood control department (IFC),	Drainage master plan for Delhi (prepared by Delhi IIT)	2018
2.	Delhi Development Authority (DDA)	Master plan for Delhi (MDP)-2041	Draft 2021
3.	Public works departments (PWD), Delhi	Drainage improvement projects/ road drainage plans	Ongoing
4.	Municipal corporations (MCD, NDMC, etc.)	Local drainage maintenance guidelines & action plan	periodic
5.	Delhi Jal Board (DJB)	Delhi water policy (draft)	2019
6.	Delhi urban environment and infrastructure improvement project (DUEIIP)	comprehensive drainage and sewerage study	2001
7.	Yamuna action plan (I-III)	River pollution & drainage improvement program	ongoing
8.	Delhi Wetland Authority	Wetland and waterbody restoration plan	2020
9.	National Institute of Urban Affairs (NIUA)	Urban flood resilience studies	present

4.2. Administrative structures: Administrative structures of the above agencies/organisations:

The Irrigation and Flood Control Department (IFC), Delhi Development Authority (DDA), Municipal Corporation of Delhi (MCD), and New Delhi Municipal Council (NDMC) function as independent and parallel administrative institutions within Delhi's governance system. These agencies are not hierarchically linked, as illustrated in Figure 2 (a) (b), Figure 3 and Figure 4.

The IFC operates as a technical line department under the government of the National Capital Territory of Delhi. It is responsible for flood control, stormwater drainage, irrigation canals, embankments, and emergency flood management. Administratively, the department reports to the Delhi government through the concerned minister and the principal secretary, as shown in Figure 2(a). It does not fall under the authority of any urban local body or planning agency.

In contrast, the DDA is a statutory authority established under the Delhi Development Act, 1957. It functions under the central government, with the lieutenant governor serving as its chairperson, as shown in Figure 2 (b). The DDA is responsible for city-level planning, including preparation of the Master Plan of Delhi, land acquisition and disposal, and large-scale urban development. However, it does not exercise administrative control over the IFC, MCD, and NDMC.

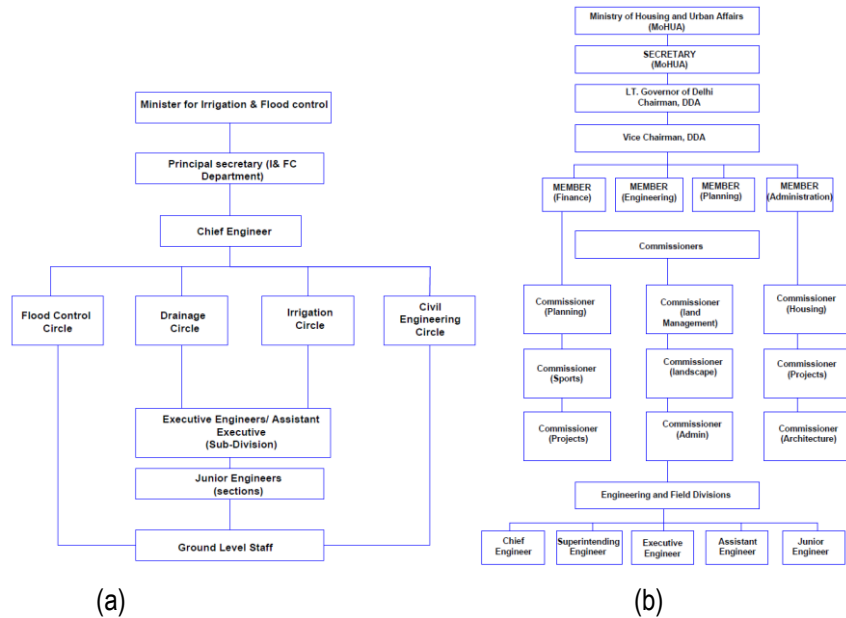


FIGURE 2 - FLOW CHART SHOWING THE ADMINISTRATIVE STRUCTURE OF THE (a) IRRIGATION AND FLOOD CONTROL DEPARTMENT (IFC) & (b) DELHI DEVELOPMENT AUTHORITY (DDA),
 Source: Authors, based on data collection

The Municipal Corporation of Delhi (MCD) is an urban local body constituted under the Delhi Municipal Corporation Act. It is responsible for a wide range of municipal services, including local roads, sanitation, solid waste management, public health, and primary education. The mcd functions through an elected council headed by the mayor, along with an executive municipal commissioner, as shown in fig 3. It operates as an interdependent body and is not subordinate to either the DDA or the IFC.

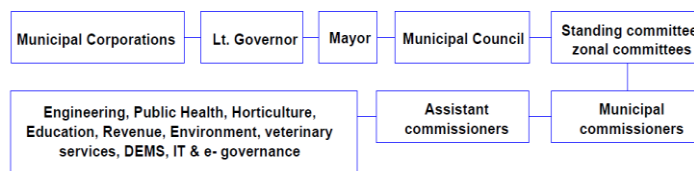


FIGURE 3. FLOW CHART SHOWING THE ADMINISTRATIVE STRUCTURE OF THE MCD,
 Source: Authors, based on data collection

The New Delhi Municipal Council (NDMC) is a separate statutory authority established under the NDMC Act, 1994. It governs the New Delhi area and reports directly to the central government rather than to the

Delhi government or the MCD, as shown in Figure 4. Although these institutions coordinate during project implementation, such coordination remains largely functional and limited in scope.

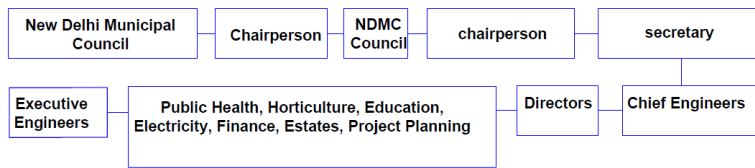


FIGURE 4 - FLOW CHART SHOWING THE ADMINISTRATIVE STRUCTURE OF THE NDMC
Source: Authors, based on data collection

The public works department (PWD), Delhi Urban Environment and infrastructure improvement project (DUEIIP), Delhi Jal Board (DJB), Delhi Wetland Authority (DWA), and the national institute of urban affairs (NIUA) operate as separate and parallel institutions within India’s urban governance framework as shown in Fig. 5, Fig 6, Fig 7, Fig 8. these organizations are not administratively interconnected. However, they may coordinate for specific projects or policy inputs.

The PWD, Government of the NCT of Delhi, functions as a line department under the administrative control of the Delhi government. It reports through the concerned minister and the principal secretary, as shown in fig 5. The department is responsible for the planning, construction, and maintenance of public infrastructure. It includes roads, bridges, flyovers, and government buildings. It does not report to, nor does it exercise administrative control over, the DJB, DUEIIP, DWA, or NIUA.

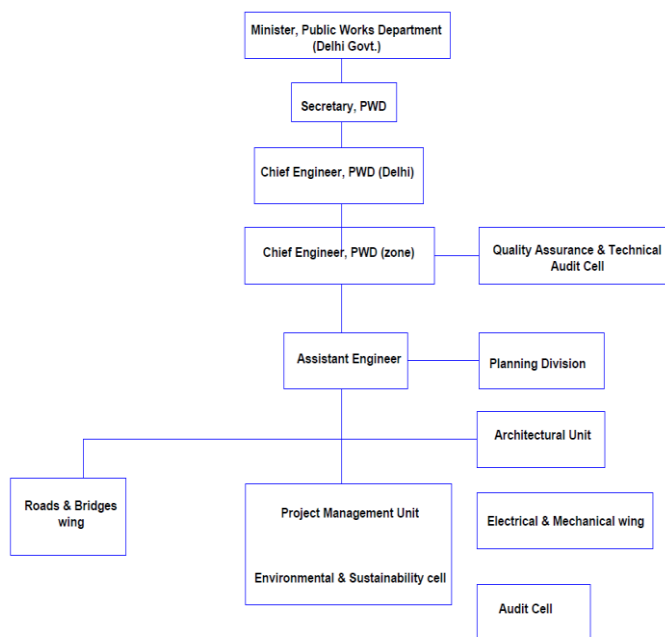


FIGURE 5 - FLOW CHART SHOWING THE ADMINISTRATIVE STRUCTURE OF THE PUBLIC WORKS DEPARTMENT (PWD), DELHI,
Source: Authors, based on data collection

The DUEIIP is a project-based institutional arrangement established by the government of the NCT of Delhi to implement environmental and infrastructure improvement initiatives. It is governed by a steering committee and executed through a dedicated project management unit, as shown in Figure 6(a). DUEIIP does not function as a permanent department or statutory authority. It also does not exercise administrative control over the PWD, DJB, DWA, or NIUA.

The Delhi Jal Board is a statutory body constituted under the Delhi Water Board Act. It operates independently under its own governing board. It is headed by the minister for water, as shown in Figure 6 (b). The DJB is the nodal agency responsible for water supply, sewerage, and wastewater management in Delhi. It is not subordinate to any other agency.

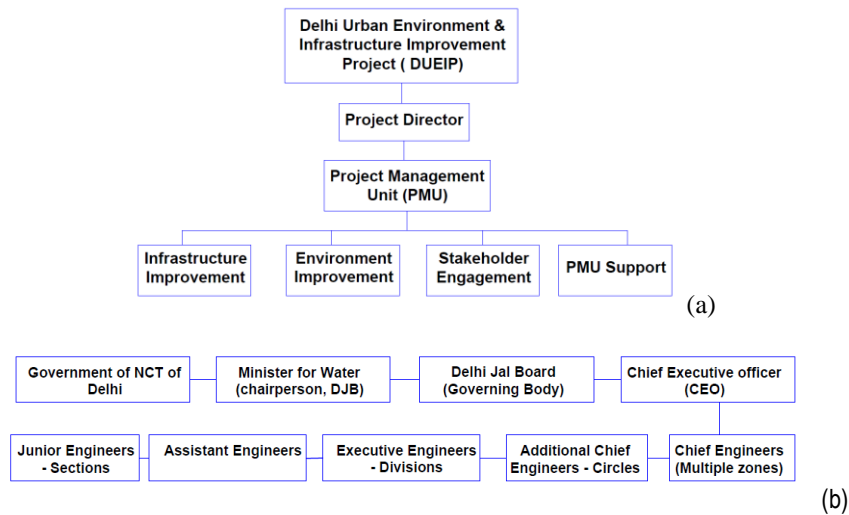


FIGURE 6. FLOW CHART SHOWING THE ADMINISTRATIVE STRUCTURE OF THE (a)DELHI URBAN ENVIRONMENT AND INFRASTRUCTURE IMPROVEMENT PROJECT (DUEIIP), (b) DELHI JAL BOARD (DJB)
Source: Authors, based on data collection

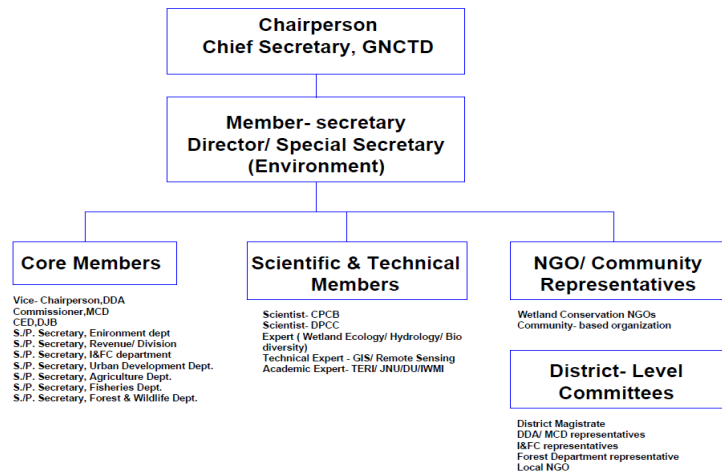


FIGURE 7 - FLOW CHART SHOWING THE ADMINISTRATIVE STRUCTURE OF THE DELHI WETLAND AUTHORITY
Source: Authors, based on data collection

The Delhi Wetland Authority is a statutory authority established under the Wetlands (Conservation and Management) Rules, 2017. It functions under the Department of Environment, GNCTD, with the Lieutenant Governor or Chief Secretary as chairperson as shown in Figure 7. Its role is regulatory and conservation-oriented, focusing on the protection and management of notified wetlands. It does not implement infrastructure works or report to PWD, DJB, or NIUA.

The National Institute of Urban Affairs (NIUA) is an autonomous national-level research and capacity-building institution under the Ministry of Housing and Urban Affairs as shown in Figure 8. It provides policy research, advisory support, and training to governments and urban local bodies across the country, including Delhi. It has no administrative control over any Delhi department or authority.

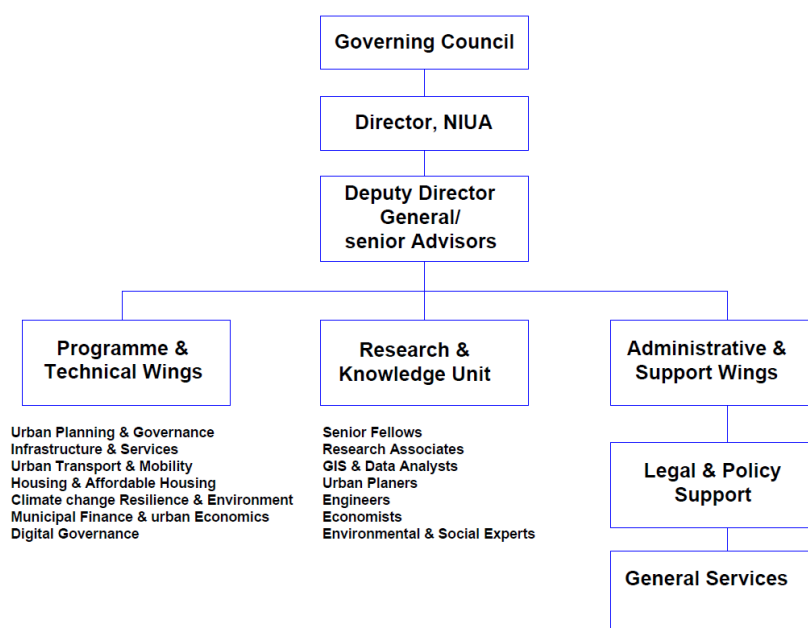


FIGURE 8. FLOW CHART SHOWING THE ADMINISTRATIVE STRUCTURE OF THE NATIONAL INSTITUTE OF URBAN AFFAIRS (NIUA)

Source: Authors, based on data collection

The above entities differ in legal status, reporting authority, and functional mandate. They may collaborate through committees, studies, or project coordination mechanisms, but they remain institutionally independent and non-hierarchical.

4.3. Institutional reporting mechanism and coordination

In Delhi, water and flood management operate through horizontal coordination rather than a unified command structure. Key agencies, including PWD, DUEIIP, DJB, DWA, NIUA, IFC, DDA, MCD, and NDMC, function as independent institutions with different reporting authorities. Their alignment occurs

through government oversight, statutory committees, and project-based coordination, rather than through hierarchical control.

For flood management, the Irrigation and Flood Control Department (IFC) acts as the nodal technical agency under the Government of the National Capital Territory of Delhi. During the monsoon, it leads flood preparedness and coordinates with other agencies. These include the PWD for roads, culverts, and bridges; the MCD and NDMC for desilting of local drains and sanitation; the DJB for sewer overflow prevention and pumping operations; and the DDA for floodplain and land-related issues. Each agency operates within its own mandate while following directions issued by the Delhi Government, the Chief Secretary, or the Lieutenant Governor during emergencies (NATIONAL CAPITAL REGION PLANNING BOARD Ministry of Urban Development, Government of India Functional Plan on Drainage for National Capital Region DRAINAGE, 2016).

In water supply and sewerage management, the Delhi Jal Board (DJB) serves as the lead statutory authority. It manages water treatment plants, sewer networks, and sewage treatment facilities. However, it relies on coordination with other agencies. It works with the PWD for road restoration after pipeline works, with the MCD and NDMC for local connections and grievance redressal, and with the IFC for sewer outfalls and pumping stations linked to stormwater drains. Such coordination occurs through interdepartmental meetings chaired by senior officials, rather than through the administrative hierarchy.

The Delhi Wetland Authority (DWA) plays a regulatory and conservation role. It focuses on wetlands, floodplains, and water bodies that support flood buffering and groundwater recharge. The authority does not execute infrastructure projects. Instead, it issues approvals and directions that must be followed by agencies such as the DDA, DJB, IFC, MCD, and PWD when projects affect notified wetlands.

The Delhi Development Authority (DDA) contributes primarily through planning and land management. Its role is significant in areas such as the Yamuna floodplain and other large land parcels. Although it does not directly manage drainage, its land-use decisions, zoning regulations, and riverfront development projects influence urban hydrology. Coordination with agencies such as the IFC, DJB, and DWA occurs through planning approvals, court directives, and high-level committees. The DDA reports to the central government, not to the Delhi government.

The Municipal Corporation of Delhi (MCD) and the New Delhi Municipal Council (NDMC) are responsible for local-level drainage and flood response. Their functions include desilting minor drains, managing waterlogging, maintaining ponds, and handling street-level emergencies. During the monsoon, they coordinate with the IFC and DJB through joint action plans, control rooms, and emergency mechanisms. However, both bodies remain accountable to their respective governance structures.

The Public Works Department (PWD) contributes indirectly by maintaining road drainage systems, culverts, and related infrastructure. It coordinates with the IFC and DJB, where road networks intersect with drainage or sewer systems.

The Delhi Urban Environment and Infrastructure Improvement Project (DUEIIP) operate as a project-based coordination platform. It brings multiple agencies together under a steering committee and supports integrated planning through a project management unit. However, it does not exercise administrative control over participating departments.

The National Institute of Urban Affairs (NIUA) plays a supportive role. It contributes through research, policy advisory, data analysis, and capacity-building initiatives. It is not involved in direct implementation or operational management.

Overall, coordination among these institutions is achieved through interdepartmental mechanisms, statutory mandates, emergency directives, and policy or judicial interventions. However, the absence of a unified command structure often limits efficiency and weakens accountability across the system.

5. GOVERNANCE CHALLENGES

5.1. *Institutional Division and Overlapping Mandates*

The drainage governance system in the National Capital Territory of Delhi reflects a divisional institutional structure. Multiple agencies, including the Municipal Corporation of Delhi (MCD), Delhi Jal Board (DJB), and Public Works Department (PWD), share responsibilities for planning, construction, and maintenance of drainage infrastructure (Prakash, 2018). Each agency operates within its own mandate and administrative framework.

This fragmented arrangement often leads to overlapping responsibilities and jurisdictional ambiguities. As a result, coordination becomes difficult, decision-making is delayed, and accountability remains unclear. These issues directly affect the efficiency and resilience of the drainage system (Redesigning Delhi's Green with Water Landscape & Environment Planning Department Delhi Development Authority, 2015; Shekhar & Sarkar, n.d.).

The current structure has evolved, leading to a complex and dense institutional landscape. In many cases, agencies follow inconsistent or conflicting rules and norms. This further reduces their overall effectiveness and weakens the governance of urban drainage in Delhi.

5.2. Enforcement Gaps and Capacity Issues

Weak enforcement of drainage regulations remains a major challenge. Limited monitoring mechanisms, inadequate technical capacity, and resource constraints hinder proper maintenance and compliance with standards. These limitations also contribute to illegal encroachments on drainage channels.

Capacity gaps extend beyond infrastructure. They affect data management, stakeholder engagement, and operational oversight (Passi et al., n.d.-b). As a result, adaptive management is weak, and responses to flooding risks are often delayed.

Political influence and administrative bottlenecks further weaken enforcement. This increases the vulnerability of the drainage system (Gosain et al., n.d.). In addition, implementing agencies often lack adequate funding, trained personnel, and essential equipment. The continued failure to enforce regulations reduces system efficiency and erodes public trust in governance institutions.

5.3. Insufficient public awareness and participation

Community-level engagement in drainage and flood management in Delhi remains limited. There are no effective mechanisms for local monitoring of drains or structured public participation. This is even though communities directly influence and experience the performance of the drainage system (Singh & Tayal, 2022).

In many unauthorised colonies and informal settlements, solid waste, plastics, and construction debris are frequently disposed of into open drains. This contributes to clogging and reduces drainage capacity. Figure 9 shows that drainage and sewerage infrastructure in Delhi is unevenly distributed. Areas with the highest population density, particularly unauthorised colonies, remain the least served.

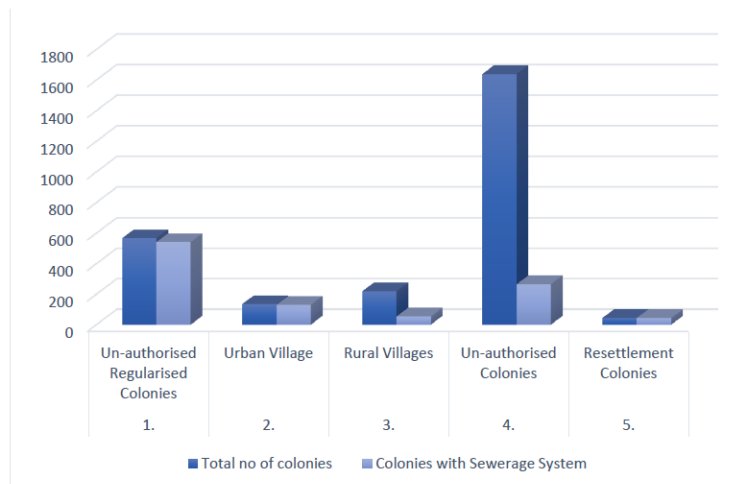


FIGURE 9 - STATUS OF SEWERAGE IN UNPLANNED COLONIES. Source: Economic Survey of Delhi 2019

As a result, these areas face persistent local flooding and waterlogging. In addition, there is no formal platform for citizen feedback or reporting of drainage issues to authorities (Roy et al., 2020). This lack of engagement weakens accountability and limits timely intervention.

Overall, the absence of community participation reflects a weak sense of shared responsibility between government agencies and residents, which further undermines effective drainage management.

5.4. Outdated design standards

Delhi's drainage network was designed decades ago, based on historical rainfall patterns and population levels that no longer reflect current conditions. Although the Drainage Master Plan (2018) recommends updated intensity–duration–frequency (IDF) curves, their adoption and enforcement remain limited.

The existing system relies on conventional approaches that prioritise rapid disposal of stormwater through concrete channels (Parveen et al., 2023). It gives little attention to sustainable practices such as permeable pavements, rain gardens, and detention ponds.

In addition, there is weak integration between new urban development and existing drainage infrastructure. This lack of synchronisation further reduces system efficiency and increases the risk of urban flooding (Rohit et al., n.d.).

6. COMPARATIVE ANALYSIS

A comparative study will help Delhi evaluate the national insights and improve decision-making and policy formulation. Globally, these cases establish how policy framework and governance challenges in urban drainage management are undertaken in different contexts, offering lessons applicable to Delhi, as shown in Table 5:

TABLE 5 – COMPARATIVE ANALYSIS

City/Region	Institutional Setup	Key Governance Challenges	Policy & Practice Highlights	Lessons for Delhi
Singapore	The Centralised authority, that is Public Utilities Board (PUB), manages all water sectors.	It helps balance rapid urban growth with water sustainability.	Integrated water management combining grey and green infrastructure; strong regulatory enforcement.	Centralised governance and integrated planning aid coherent policy implementation.
Rotterdam, Netherlands	Rotterdam has multi-level governance with clear agency mandates.	Climate change adaptation, integration, and stakeholder collaboration.	Adaptive flood risk management; digital monitoring; nature-based solutions.	Coordination across agencies and climate mainstreaming is critical.
Santiago de Cali, Colombia	Multi-institutional coordination with international support.	Funding, socio-ecological resilience, inclusive governance	Pilot projects using sustainable urban drainage systems (SUDS) and stakeholder engagement	Inclusive expertise and socio-ecological focus enhance project success

Eastern Europe (Belarus, Russia, Ukraine)	Multiple fragmented agencies with weak enforcement	Lack of regulation enforcement and strategic foresight	Challenges in embedding sustainable drainage in policies	Need for clear regulation, stakeholder integration, and enforcement mechanisms
Copenhagen, Denmark	Strong institutional framework with community involvement	Maintaining stakeholder engagement and climate adaptation	SUDS embedded in policy; digital real-time management; participatory governance	Stakeholder engagement and innovative tech support adaptive drainage management

Source: Authors, based on data collection

These Global cases demonstrate that incapacitating division and governance deficiencies are crucial. For establishing resilient and adaptive urban drainage systems capable of addressing climate and urbanization challenges. The effective urban drainage governance depends on either centralised or well-coordinated institutional structures. Also, it depends on enforcement capacity, stakeholder engagement, and integration of climate resilience and nature-based solutions.

7. DISCUSSIONS

Governance challenges such as institutional division, overlapping mandates, and weak enforcement have significantly reduced the effectiveness of Delhi’s drainage system. These issues lead to poor coordination, delayed infrastructure upgrades, and inadequate maintenance. As a result, flooding and waterlogging occur frequently during the monsoon season.

The absence of integrated climate resilience measures further weakens the system. It limits the capacity to respond to increasing rainfall variability and extreme weather events associated with climate change.

Globally, successful urban drainage governance models emphasise integrated institutional frameworks, clear allocation of responsibilities, and strong stakeholder collaboration. Cities such as Singapore and Rotterdam follow unified water governance approaches. These models promote inter-agency coordination and incorporate nature-based solutions into planning and policy frameworks. They also prioritise transparency, accountability, and adaptive management.

In comparison, Delhi’s governance framework lacks these integrated features. Adopting similar principles could strengthen institutional convergence, improve enforcement capacity, and promote sustainable practices. This would enhance the resilience and operational efficiency of the city’s drainage system.

8. RECOMMENDATIONS

8.1. Institutional Coordination and Policy Integration

- To address the governance division, creating a unified canopy agency could streamline responsibilities.
- Also, improve coordination among existing agencies.

- Developing a combined regulatory agenda that clearly defines roles, mandates, and accountability mechanisms is essential.
- Enhancing inter-agency communication through integrated platforms and regular coordination can substitute for cooperative planning and implementation.
- Ensuring that drainage policies are coherent and effectively enforced.

8.2. *Emphasis on Climate Resilience and Nature-Based Solutions*

- Combining climate resilience into the policy framework requires mainstreaming adaptive measures.
- Such as flexible infrastructure designs, early warning systems, and real-time monitoring.
- Nature-based solutions, including green corridors, rain gardens, and permeable pavements, should be prioritised.
- To enhance stormwater absorption, reduce flood intensity, and improve urban ecological health.
- These measures not only mitigate flood risks but also contribute to biodiversity conservation and climate adaptation.

Instigating these reforms will build a resilient, efficient, and sustainable drainage system. Which can support Delhi's urban growth and climate change challenges.

9. CONCLUSIONS

This study demonstrates that Delhi's recurring drainage and flood problems are not only technical in nature but also rooted in governance failures. Despite investments in policy initiatives such as the Delhi Drainage Master Plan 2025 and the proposed long-term drainage renewal programme, flooding and waterlogging continue to disrupt daily life across the city. The effectiveness of the drainage system is reduced by ageing infrastructure, unclear institutional responsibilities, overlapping mandates, and weak enforcement. Multiple agencies operate in isolation and often respond reactively during monsoon events rather than through coordinated and preventive action.

The findings indicate that improving drainage resilience in Delhi requires a shift from fragmented, project-based interventions to an integrated governance approach. There is a need to clearly define institutional roles, strengthen coordination mechanisms, and build long-term administrative capacity. Drainage planning should be treated as a city-wide, climate-sensitive system rather than a collection of isolated infrastructure components. The integration of nature-based solutions, climate adaptation strategies, and sustainable urban design can reduce flood risks while providing environmental co-benefits. In addition, the use of real-time monitoring systems, shared data platforms, and decision-support tools can support proactive and accountable management.

Based on these findings, a more effective administrative framework would involve the creation of a single nodal authority for drainage and flood management. This authority should have statutory powers for planning, coordination, and monitoring. It should bring together key agencies, including the Irrigation and Flood Control Department, Public Works Department, Delhi Jal Board, municipal bodies, Delhi Development Authority, and disaster management agencies, within a unified framework, as illustrated in Figure 10. Clear functional divisions—such as planning and design, asset maintenance, enforcement, emergency response, and community engagement—should be formally defined. At the same time, routine operations can remain decentralised at the municipal level. Regular inter-agency coordination, shared financial mechanisms for cross-jurisdictional infrastructure, and performance-based accountability systems would help address existing institutional gaps and improve overall system efficiency.

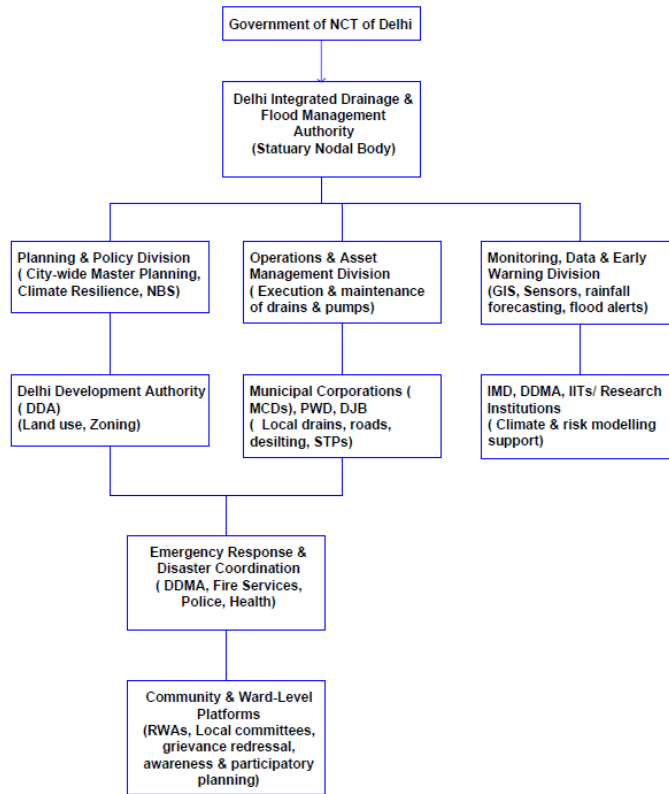


FIGURE 10 - SUGGESTIVE ADMINISTRATION STRUCTURE FOR DELHI
Source: Authors, based on data collection

Future research should examine how recently proposed reforms are implemented on the ground. Whether they lead to meaningful improvements in coordination and service delivery. Greater attention is also needed on stakeholder and community engagement, particularly in flood-prone and informal settlements, to ensure that drainage solutions are socially inclusive.

REFERENCES

- Ahmad, S., Avtar, R., Sethi, M., & Surjan, A. (2016). Delhi's land cover change in post transit era. *Cities*, 50, 111–118. <https://doi.org/10.1016/j.cities.2015.09.003>
- BASELINE REPORT: ENVIRONMENT (n.d.) *Enabling Strategic Plan: Master Plan for Delhi 2041*.
- Bhattacharya, A., Dey, P., Gola, D., Mishra, A., Malik, A., & Patel, N. (2015). Assessment of Yamuna and associated drains used for irrigation in rural and peri-urban settings of Delhi NCR. *Environmental Monitoring and Assessment*, 187(1). <https://doi.org/10.1007/s10661-014-4146-2>
- Borsche, R., & Klar, A. (2014). *Flooding in urban drainage systems: Coupling hyperbolic conservation laws for sewer systems and surface flow*. <https://doi.org/10.1002/fld.3957>
- Chaudhuri, G., Mainali, K. P., & Mishra, N. B. (2022). Analyzing the dynamics of urbanization in Delhi National Capital Region in India using satellite image time-series analysis. *Environment and Planning B: Urban Analytics and City Science*, 49(1), 368–384. <https://doi.org/10.1177/23998083211007868>
- Dutta, D., Rahman, A., Paul, S. K., & Kundu, A. (2019). Changing pattern of urban landscape and its effect on land surface temperature in and around Delhi. *Environmental Monitoring and Assessment*, 191(9). <https://doi.org/10.1007/s10661-019-7645-3>
- Enabling Strategic Plan: Master Plan for Delhi 2041*. (n.d.).
- Gosain, A. K., Khosa, R., Chahar, B. R., Kaushal, D. R., & Dhanya, C. T. (n.d.). *Contributors to the Study • IIT Delhi Faculty*.
- Khan, Z., Mohsin, M., Ali, S. A., Vashishtha, D., Husain, M., Parveen, A., Shamim, S. K., Parvin, F., Anjum, R., Jawaid, S., Khanam, Z., & Ahmad, A. (2024). Comparing the Performance of Machine Learning Algorithms for Groundwater Mapping in Delhi. *Journal of the Indian Society of Remote Sensing*, 52(1), 17–39. <https://doi.org/10.1007/s12524-023-01789-8>
- Kumar, B., & Bhaduri, S. (2018). Disaster risk in the urban villages of Delhi. *International Journal of Disaster Risk Reduction*, 31, 1309–1325. <https://doi.org/10.1016/j.ijdrr.2018.04.022>
- Kumar, P., Kumar, V., . P., Saini, S., & Yadav, A. (2022). Monitoring and Assessment of Water Quality of Najafgarh Drain and Its Sub Drains. *International Journal of Science and Research (IJSR)*, 11(7), 897–905. <https://doi.org/10.21275/sr22715215106>
- Kumar, S., Agarwal, A., Ganapathy, A., Villuri, V. G. K., Pasupuleti, S., Kumar, D., Kaushal, D. R., Gosain, A. K., & Sivakumar, B. (2022). Impact of climate change on stormwater drainage in urban areas. *Stochastic Environmental Research and Risk Assessment*, 36(1), 77–96. <https://doi.org/10.1007/s00477-021-02105-x>
- Kumar, S., Kaushal, D. R., & Gosain, A. K. (2019). Evaluation of evolutionary algorithms for the optimization of storm water drainage network for an urbanized area. *Acta Geophysica*, 67(1), 149–165. <https://doi.org/10.1007/s11600-018-00240-8>
- Marwal, A., & Silva, E. A. (2023). Exploring residential built-up form typologies in Delhi: a grid-based clustering approach towards sustainable urbanisation. *Npj Urban Sustainability*, 3(1). <https://doi.org/10.1038/s42949-023-00112-1>
- NATIONAL CAPITAL REGION PLANNING BOARD (2016) *Ministry of Urban Development, Government of India Functional Plan on Drainage for National Capital Region DRAINAGE*.
- Nehra, V., & Singh, S. K. (n.d.). *ASSESSMENT OF WATER QUALITY OF NAJAFGARH DRAIN AND ITS IMPACT ON RIVER YAMUNA MASTER OF TECHNOLOGY in ENVIRONMENTAL ENGINEERING*.

- Parveen, N., Siddiqui, L., Siddiqui, M. A., Sarif, M. N., Islam, M. S., Khan, S., Khanam, N., Mohibul, S., & Shariq, M. (2023). Monitoring built-up area expansion led by industrial transformation in Delhi using geospatial techniques. *Environmental Science and Pollution Research*, 30(49), 106936–106950. <https://doi.org/10.1007/s11356-022-23221-3>
- Passi, A., Goswami, T., Agrawal, T., & Singh, G. (n.d.-a). Urban Drainage Management: Evaluating Drainage Infrastructure and Flood Resilience in Delhi city. In *International Journal of Humanities Social Science and Management (IJHSSM)* (Vol. 4, Number 3). Retrieved www.ijhssm.org
- Passi, A., Goswami, T., Agrawal, T., & Singh, G. (n.d.-b). Urban Drainage Management: Evaluating Drainage Infrastructure and Flood Resilience in Delhi city. In *International Journal of Humanities Social Science and Management (IJHSSM)* (Vol. 4, Number 3). Retrieved www.ijhssm.org
- Prakash, B. (2018). Writing in from the periphery: Partition narratives from Rurban Delhi. *Journal of Postcolonial Writing*, 54(3), 307–319. <https://doi.org/10.1080/17449855.2018.1461985>
- Rajasekar, U., Shankar, V., Thool, P., Dutta, M., Bhaire, M., Pahwa, D., Singh Rawat, D., Bhanot, B., Katar, T., & Shukla, P. (2022). Capacity Building for Disaster Risk Management (DRM) and the Global Facility for Disaster Reduction and Recovery (GFDRR). In *European Union-South Asia. EUSAR*.
- Redesigning Delhi's Green with Water Landscape & Environment Planning Department Delhi Development Authority*. (2015).
- Rohit, M., Patole, M., Head, B., & Negi, M. M. (n.d.). *Realtime Monitoring & Source Tracking Water Pollution in Najafgarh Drain Before & During COVID-19 Outbreak with FOREMS A Case Study by PTESPL*. Retrieved www.ijert.org
- Roy, S. Sen, Rahman, A., Ahmed, S., Shahfahad, & Ahmad, I. A. (2020). Alarming groundwater depletion in the Delhi Metropolitan Region: a long-term assessment. *Environmental Monitoring and Assessment*, 192(10). <https://doi.org/10.1007/s10661-020-08585-8>
- Sarkar, U. D., & Choudhary, B. K. (2020). Reconfiguring urban waterscape: Water Kiosks in Delhi as a new governance model. *Journal of Water Sanitation and Hygiene for Development*, 10(4), 996–1011. <https://doi.org/10.2166/washdev.2020.152>
- Shekhar, S., & Sarkar, A. (n.d.). *Hydrogeological characterization and assessment of groundwater quality in shallow aquifers in vicinity of Najafgarh drain of NCT Delhi*.
- Singh, S., & Tayal, S. (2022). Managing food at urban level through water–energy–food nexus in India: A way towards holistic sustainable development. *Environment, Development and Sustainability*, 24(3), 3640–3658. <https://doi.org/10.1007/s10668-021-01580-0>
- Soni, V., Shekhar, S., & Singh, D. (2014). Environmental flow for the Yamuna river in Delhi as an example of monsoon rivers in India. *Current Science*, 106:4.
- Vaid, M., Sarma, K., & Gupta, A. (2024). Urban drainage channels as a pathway for microplastics in riverine systems: A case study of Delhi, India. *Water Science and Technology*, 90(2), 563–577. <https://doi.org/10.2166/wst.2024.181>
- Vaid, M., Sarma, K., Kala, P., & Gupta, A. (2022). The plight of Najafgarh drain in NCT of Delhi, India: assessment of the sources, statistical water quality evaluation, and fate of water pollutants. *Environmental Science and Pollution Research*, 29(60), 90580–90600. <https://doi.org/10.1007/s11356-022-21710-z>