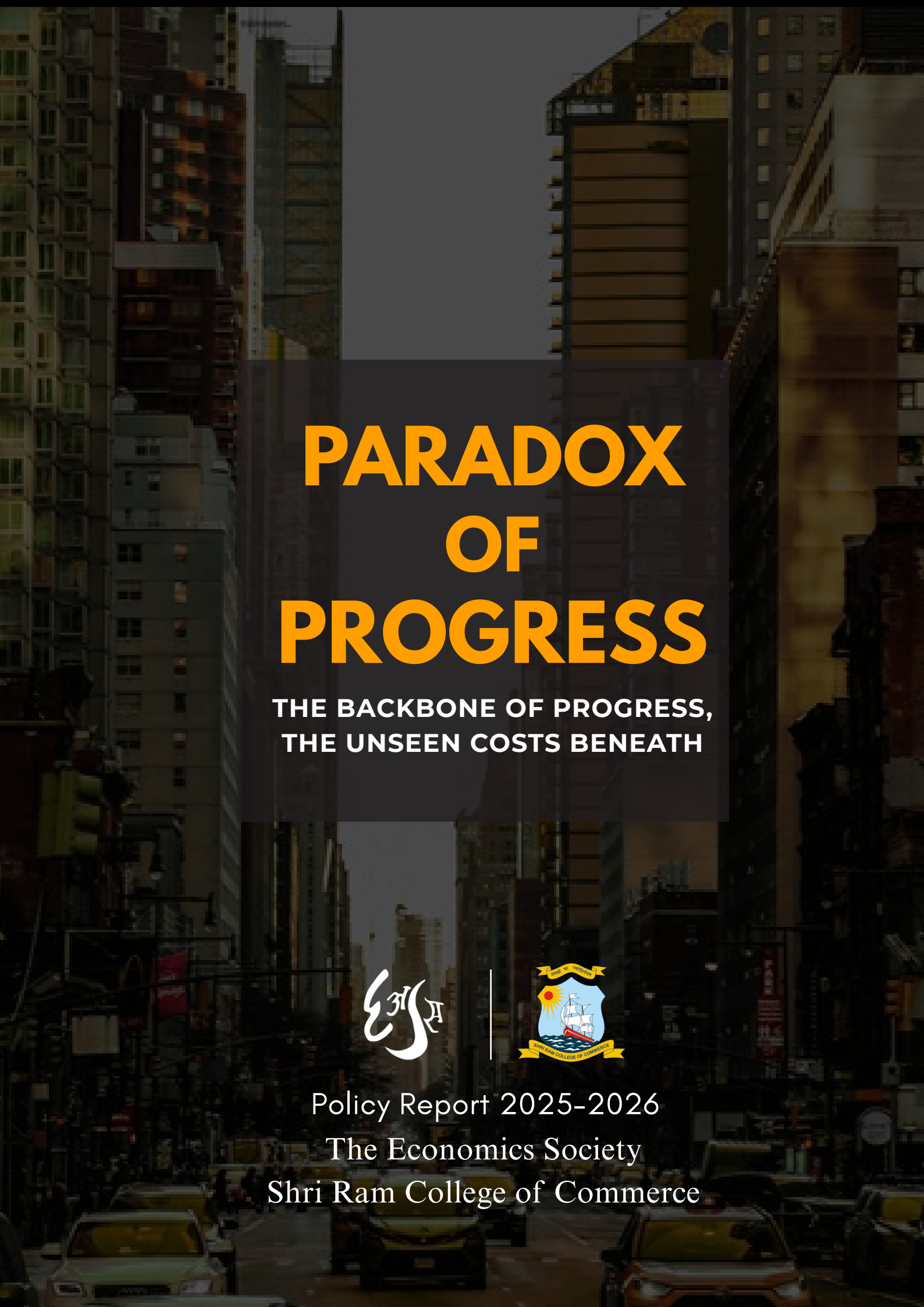


PARADOX OF PROGRESS

THE BACKBONE OF PROGRESS, THE UNSEEN COSTS BENEATH

Policy Report 2025-2026

The Economics Society

Shri Ram College of Commerce

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EXECUTIVE SUMMARY

The growth experienced by India has been unlike anything seen before. In just the past decade, investment in infrastructure development in the country has increased sixfold, reaching ₹11.21 lakh crore in 2025-26 from ₹2 lakh crore in 2014-15. Projects such as Bharat Mala, Sagarmala, PM Gati Shakti, and Smart Cities Mission have completely changed the state of the country's infrastructure since 1947. The vision of Viksit Bharat put forth by the Government for the development of the country until 2047 places infrastructure development at its core. However, in the midst of all this, there has been a 2021 flash flood in Chamoli, a 2022 collapse of the Morbi bridge, a 2015 flood in Chennai, displacing more than 1.8 million people, and a flood in Punjab in 2025, destroying over 3,00,000 acres of land, along with 1,400 villages being inundated. None of these incidents occurred without infrastructure failures, but rather were caused by them as well.

The thesis of this report is that infrastructure investments in India, undertaken with speed and scale but without adequate ecological assessment, institutional accountability, and maintenance strategies, are creating long-term vulnerabilities that undermine the very economic and social benefits they are meant to deliver. This argument can be supported with evidence from centuries of investments in various sectors. Colonisation efforts in railways drained resources and stifled local industries while creating an illusion of connectivity; Five-Year Plans built steel factories and dams that displaced tribal populations and destroyed river systems without adequate compensation; and contemporary highway investments are merely continuing this tradition in the Himalayas, Western Ghats, and coastal regions, where unscientific slope cutting, wetland encroachment, and forest clearance are converting what were meant to be development corridors into disaster corridors. The Char Dham highway project in Uttarakhand, for instance, caused hundreds of landslides due to vertical cutting in some of the most unstable geology in the world, with the Supreme Court's High-Powered Committee confirming that the project's widening had directly increased landslide risks. What is most pertinent to note is that this project was divided into 53 segments of less than 100 km precisely to avoid the threshold for a full Environmental Impact Assessment.

In other words, environmental regulations in India are not only not enforced but also structurally flawed in their enforcement. The EIA process, overseen by the Ministry of Environment, Forest, and Climate Change under the Environment Protection Act, involves a series of steps: screening, public consultation, impact assessment, and compliance monitoring. In practice, EIAs have been undertaken on a desk study basis rather than through field surveys, and public consultations have been undertaken in English in regions where the public does not understand the language.

Further, with insufficient notice periods, post-facto clearances have been mooted for institutionalisation, and state pollution control boards, which are meant to carry out monitoring of compliance, remain understaffed and underfunded. The result is evident in project after project: the Vizhinjam port project has led to coastal erosion and impacts on fishermen livelihoods not captured in the EIA prediction; the POSCO Paradip port project's EIA has not captured impacts on coastal areas and livelihoods; and Himalayan hydropower projects, individually examined, have cumulatively created a new geography of cascading risk, as exemplified in the catastrophe in 2021 when the Tapovan-Vishnugad and Rishi Ganga hydropower projects were destroyed in the Chamoli floods, along with hundreds of workers.

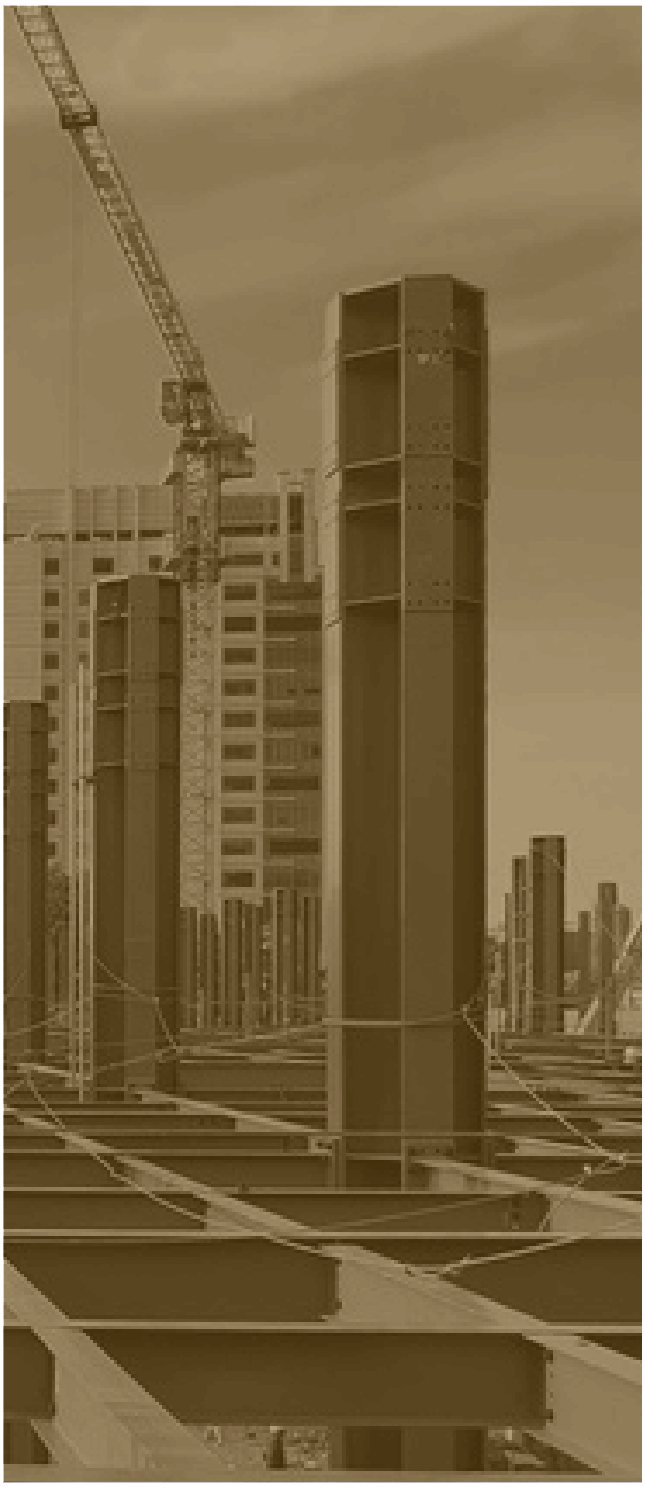
The picture with respect to infrastructure in cities is equally worrying. The Jawaharlal Nehru National Urban Renewal Mission, initiated with an outlay of Rs. 1 lakh crore in 2005, was audited by the Comptroller and Auditor General, which revealed housing completion rates at a tiny fraction of what was planned, with governance reforms superficially or not at all implemented. The Smart Cities Mission has revealed that cities with better administration have extracted a disproportionate share of funds from the Centre as well as private investors, while cities with weaker administrations have been left with half-finished projects and no institutional framework for operations and maintenance. AMRUT, with its many achievements with respect to tap water connections as well as sewerage, has to operate in an environment that generates 72,368 million litres of sewage per day, but has the treatment capacity for less than half of that. In Delhi, which has grown from an original 201 square kilometres at independence to its present 1,467 square kilometres, the destruction of wetlands and the transformation of the Sahibi River into the Najafgarh drain, now the largest contributor of pollution into the Yamuna, highlights the infrastructure created to solve one problem that has resulted in creating a new one. The floods in Chennai in 2015 were no anomaly in climate patterns; they were the expected outcome of a city that has seen its wetlands shrink from 80 per cent of the area in the 1980s to a mere 15 per cent by 2015.

Common to all these failures is the institutional thread that prefers new construction to maintenance of existing assets, and tangible outputs to sustainable outcomes. The Ministry of Road Transport and Highways spends about 1 per cent of its budget on maintaining a highway system that now exceeds 1.46 lakh kilometres in length.

The bridge collapses in Bihar – over a dozen in one month in 2024 – were no anomaly in geological phenomena; they were the expected outcome of decades of non-maintenance, shallow foundations, and the artificial removal of desilting from bridge pillars ahead of the monsoon. This latter practice actually removes the very silt that holds the pillars in place. The National Infrastructure Pipeline, which accounts for over 13,000 projects and ₹185 lakh crores in planned investment across the country, has a project completion rate of only 20 per cent. Private sector participation in these projects is at only 11 per cent of the pipeline, when it should be at over 21 per cent.

The delay between announcement and delivery is no accident; it is the result of structural weaknesses in land acquisition strategies, environmental clearances, contracts, and inter-agency coordination that no dashboard can replace.

What this report ultimately reveals is that progress and vulnerability in India are not opposite. The highway that connects a remote rural area to a regional market also destabilises the slope above it. The dam that irrigates a drought-prone plain also submerges a forest community's way of life. The port that reduces logistics costs also causes erosion that displaces a fishing village. These effects are not the inevitable outcomes of development; they are the outcomes of development without sufficient geoscience integration, without cumulative environmental assessment, without maintenance obligations, and without the meaningful participation of communities that suffer the greatest consequences. India has the institutional foundation in place – the PM's GIS platform, the GSI's geological mapping capability, the NITI Aayog's performance monitoring system, and an EIA system that, with sufficient investment, has the potential to act as a true risk filter – to build differently.



PURPOSE OF WRITING

The report was written to examine an apparent contradiction that lies at the very heart of current Indian development policy: that the infrastructure currently being developed to drive development is, in a quantifiable and regular number of instances, in fact driving disaster. India is investing in roads, highways, ports, dams, urbanisation, and border connectivity in a manner and scale that is unprecedented in the post-independence history of India. Capital expenditure is up almost six times over the past decade. Bharatmala, Sagarmala, PM Gati Shakti, Smart City, and Viksit Bharat are programs that encapsulate a national vision of infrastructure as a driver of a ₹5 trillion economy and a developed India by 2047. This is a legitimate vision, and connectivity gains are a very real outcome of this vision.

Yet in the same decade, India has seen the 2021 Chamoli disaster, in which years of tunnelling and blasting in the Himalayas heightened a glacial flood that caused hundreds of deaths and destroyed two major hydroelectric projects; the 2022 Morbi bridge disaster, in which a privatised heritage structure collapsed due to neglected maintenance and the absence of safety management, causing over 130 deaths; the 2015 Chennai floods, in which a city that had replaced 80 percent of its wetlands with concrete could not even manage to absorb a single monsoon event, causing the displacement of 1.8 million people.

This was followed by the 2025 Punjab floods, in which embankments were breached, drains were blocked, and reservoir management was mismanaged to cause the destruction of over 3,00,000 acres of agricultural land in all 23 districts of Punjab. In all these disasters, the role of infrastructure was not just as a passive victim. It was an active contributor to the scale of the disaster.

The purpose of this report is to record and demonstrate this relationship with evidence, to historicise it from colonial public infrastructure to the Five-Year Plans and then to the present, to analyse the institutional mechanisms through which it is perpetuated – fragmented environmental clearances, maintenance under-investment, local institutional weaknesses, and the structural exclusion of vulnerable communities from planning and distribution – and to demonstrate that India's infrastructure ambitions and India's ecological and social resilience are not necessarily in conflict, but are made to be in conflict through the current ways in which decisions are made to develop. The report is not opposed to building. It is in favour of building, but building in ways that recognise the true cost of what is built, to whom it is built, and what it is built upon.

The intended audience is students of public policy, institutional planners, and anyone seeking to understand why a country that is building faster and spending more than at any point in its history continues to produce infrastructure failures that are both preventable and politically predictable.

The report draws on official budgetary data, parliamentary audits, geological assessments, disaster case studies, and the lived consequences of policy decisions in Uttarakhand, Bihar, Punjab, Chennai, Delhi, and Himachal Pradesh to build an argument that is empirical rather than ideological: that progress, as currently measured and delivered, is producing its own paradox.



OVERVIEW

The report begins with a discussion of infrastructure development in the broader context of the evolution of human history, from the grid-planned cities and irrigation canals of the Harappan civilisation and Mesopotamia to the Roman roads and the Industrial Revolution's impact on the landscape and work patterns. The point is made that, across the board, every period in history has seen infrastructure as both a means of power and welfare, and the trade-off between connectivity and ecological damage, as well as the balance between the interests of the state and the interests of the community, is not new to India.
It is, however, new to the urgency with which it is being posed. India is then examined in greater detail, beginning with the colonial era. The investments made by the British in terms of infrastructure, such as railways, ports, canals, and the Public Works Department established by Lord Dalhousie in 1855, were viewed not as an effort at modernisation, but as one of extraction.

Railways were created not to link the countryside to the marketplaces but instead to transport raw resources to the ports. Roads, which did not contribute to the income of the colonial administration, were not built with adequate financial support. Canal building in Punjab and the Gangetic region enhanced agricultural output, yet it resulted in issues such as waterlogging, salinity, and the removal of pastoral societies. The impact of imbalances in investment, maintenance, and mapping in the development of infrastructure, which is biased towards coasts, while ignoring the interiors has been seen as a hurdle in the way of independent India since 1947. These years after independence are viewed in light of the Five-Year Plans, starting from the conservative and agricultural-first Plan to the Nehru-Mahalanobis Plan for heavy industry in the Second Plan, up to the Ninth Plan and the Golden Quadrilateral Project as preparation for the Bharatmala project.

Each planning period is judged in terms of what it accomplished and at what cost: the construction of steel plants at Bhilai, Rourkela, and Durgapur created industrial infrastructure at the cost of tribal displacement across Odisha, Madhya Pradesh, Chhattisgarh, and Jharkhand. The NHDP created cost savings in logistics and travel times, but also cost overruns and environmental bypasses.

The key part of the report's analysis is its exploration of how infrastructure decisions convert natural hazards into human disasters. It does this through six in-depth case studies. In Uttarakhand, the construction of the Char Dham highway project and the rise of Himalayan hydropower schemes illustrate how hasty infrastructure construction in geologically unstable terrain, without proper environmental impact assessments, unscientific cutting and erosion of slopes, and cumulative river basin stress, converts infrastructure projects like highway construction and clean energy schemes like hydropower into landslide and flood triggers.

In Bihar, the collapse of numerous bridges in 2024 indicates the results of a state growing faster than its capacity, where corruption in construction materials and the foundation depths leads to damage to facilities that provide a means of livelihood and flood safety for rural communities. In Punjab, the 2025 floods exemplify the situation wherein embankment repair work has been deferred, drainage has been prevented, and reservoir management in inter-state regions has failed. In Chennai and Delhi, the report highlights the consequences of urban growth, whereby wetlands, water bodies, and natural drainage routes are covered with impervious surfaces, causing heavy rainfall during monsoons to result in devastating floods, especially in North Chennai and Delhi's unorganised regions.

The last sections review the existing institutional framework for infrastructure development, which includes the National Infrastructure Pipeline, PM Gati Shakti, the EIA process, NHAI, AMRUT, the Smart Cities Mission, JNNURM, the Border Roads Organisation, the Geological Survey of India, and the ministries of Road Transport, Housing and Urban Affairs, Rural Development, and Ports and Shipping. These are reviewed in terms of their actual and potential positive and negative aspects. The Geological Survey of India has covered 98.5 per cent of India's mappable land, but geoscience data are not always considered before construction begins. PM Gati Shakti speeds up clearances, but there may be fewer chances for environmental impact assessments.

The Smart Cities Mission has provided Integrated Command and control centres in 100 cities, but investments were made in already well-governed urban bodies while leaving the rest in the lurch. AMRUT has provided crores of households with access to piped water and sewerage, but in a nation that treats less than half of its daily sewage generation.

It should be pointed out, according to the report, that the resources, the information, and the funding needed to make India do things differently have been established. What is needed is not slower construction but criteria that would allow us to define success in terms other than kilometres of infrastructure constructed, dollars disbursed, and wetlands destroyed or mountains destabilised. The paradox of development is not a necessary outcome; it is a policy decision.

METHODOLOGY

Qualitative research approaches are utilised for this report regarding the effects of economic development and climate-resilient infrastructures in India. Specifically, this research paper examines the manner in which India constructs its infrastructure systems in response to its fast-developing economy amidst threats posed by climate change disasters like floods, landslides, and others.

During the course of research, this paper adopts a case study research method and helps us appreciate the interaction among national policies, institutions, and developmental interests vis-à-vis climate change adaptation measures. During the conduct of this research paper, the study makes extensive use of secondary data, including policy papers, research articles, and literature on climate change policies and adaptation measures in India, as well as infrastructure development in India. Therefore, secondary data is extensively used for drawing conclusions from this research study.

Finally, a policy analysis methodology is applied to assess the following aspects: infrastructure development, adaptation to climate change, and sustainability.

Methodology implies the use of thematic analysis that identifies important themes that arise from different sources on the issues of resilience and sustainability, risk management, and economic development.

Such methodology will allow revealing how India responds to its problems related to development and environmental conditions through the use of different approaches.

To conclude, the research will be based on the concept of the paradox of development. This approach deals with the conflict between high rates of infrastructure development and increasing climate change. This issue will help assess whether India pursues the path of sustainable development or increases the existing problems of climate change.

INTRODUCTION

Overview of Infrastructure Development in India

From time immemorial, we have seen history being built, quite literally, from the stones and bricks of the Indus Valley to the concrete of today's cities; the story of human progress has been built on infrastructure. Every generation has built its own unique memorial, which exists from the stone cities of the Harappan civilisation until the modern expressways that connect all of India.

The process of infrastructure development involves systematic infrastructure improvements that expand essential facilities and services to create better economic and social conditions for a specific area.

Early Civilisations

Human civilisations throughout history have pursued their essential goal of constructing their basic social and economic systems to create better future outcomes. This pattern of behaviour leads people to develop new technological systems that create better infrastructural elements and establish improved social structures. Human development has always depended on the way people modify their natural surroundings, from the beginning of river valley civilisations until today.

The Harappan Civilisation: The Indus Valley Civilisation, which existed from 2600 to 1900 BCE, represents one of the oldest civilisations that developed during that time period.

The cities of Harappa, Mohenjo-Daro, and Dholavira developed a rectangular grid system, which enabled street intersections to create right-angle junctions. The entire settlement used bricks, which followed a standardised ratio for construction work. The system used advanced water management technologies together with a full drainage network, which connected all residential areas to its sanitation system. Harappan cities established their most creative urban design element through the construction of elevated platforms, which safeguarded their cities from water inundation. The urban design of both Mohenjo-Daro and Harappa featured massive artificial platforms that elevated the complete city area above its adjacent floodplains.

Early Mesopotamia: The Mesopotamian Civilisation, which is also known as the cradle of civilisation, came into existence around 3500 BCE. It developed irrigation-based agriculture as it thrived between the Euphrates and the Tigris rivers. Contrary to the quiet and predictable Nile, these rivers were irregular in flow and prone to sudden flooding, which compelled the societies in Mesopotamia to develop elaborate irrigation canals, embankments, and water control systems. The development is characterised by the rise of cities like Ur and Uruk, which had temples, administrative buildings, and defensive walls made mostly of mud bricks. On the other hand, the rise of Mesopotamia was not characterised by the absence of challenges.

For example, the process of irrigation, which was intensive, was a tedious process that needed central planning and maintenance. The use of mud bricks in the construction meant that erosion would occur. Additionally, irrigation led to the salinisation of the soil over very long periods, which caused the productivity of the land to decrease.

Ancient Egypt: The Ancient Egyptian Civilisation began to develop on the banks of the Nile River around 3100 BCE. The development pattern of the civilisation occurred naturally according to the sequence that the Nile River followed with regard to the flood cycle. The people used basin irrigation methods together with their expertise in mathematics and surveying to build large stone structures. Engineers developed tombs, pyramids, and temples through their advanced engineering methods and organised worker systems.

The Roman Empire: It began with the Roman Republic in 509 BCE and achieved great heights as an empire from 27 BCE. Widespread use of the Roman concrete made it possible to produce lasting buildings such as amphitheatres, baths, bridges, and other structures. The extensive network of roads and aqueducts supported trade activities and military operations and provided urban water distribution throughout extensive territories. The Romans developed their city planning system through grid street patterns, which included sewage systems and public baths to create organised public spaces and infrastructure systems.

The Medieval Period

The medieval period marked one of the major transformations in the development and construction of infrastructure. The major reason for this transformation during this era was the establishment of various empires and trading platforms. During this period, rulers were primarily focused on the development of infrastructure such as roads, forts, irrigation systems, cities, monuments, etc. However, this period is marked by various adverse factors as well.

The main purpose of the infrastructure development projects in this period was to cater to the state power and the elite interests, not the welfare of the people in general.
Such practices, like coercion and forced labour, and imposition of high taxes, were used for the construction of forts, cities, palaces, and religious structures, which caused economic crises due to the diverted attention of the peasants and artisans towards construction instead of tilling fields.

It was a period of development and construction projects for irrigation systems such as canals and dams, which helped to improve agricultural output and raise revenue.

This led to yet another change in the natural water system, culminating in a disruption of the ecology of the area. Apart from that, the unmanaged canal system also led to issues like waterlogging and salinisation of the soil. The system, designed like the one above, only favoured the elite who had land. The small farmers were somehow disadvantaged.

Additionally, another aspect that characterised this period was the militarisation of the infrastructure. The infrastructure developed during this period was meant to support the movement of a huge number of soldiers during a war. This implies that the other kinds of infrastructure developed during this period were not sufficient. For example, the infrastructure that emerged during the period was not sufficient regarding rural connectivity.

In other words, it may be said that while the development of infrastructure during the medieval period was remarkable, there was also a sense of exploitation and economic inequality similar to what exists presently.

The Industrial Revolution and the Western Model

When we discuss changes in the 'Western model', what is really being referred to is a narrative that is as much cultural and psychological as it is economic. At the core of it is the Industrial Revolution, a phenomenon that was so transformative that it not only changed how goods were produced but how people thought about these things in the first place.

The Industrial Revolution, which started in late eighteenth-century Britain, was a defining era in the history of mankind. Most notable is how technology developed from isolated beginnings to pervade all aspects of life. While steam technology, as seen in James Watt's improvements to the steam engine, enabled greater productivity, it also changed the pace of human life from cyclical seasons of country living to the relentless pace of a factory working day.

While the mechanised looms and spinning jennies popularised advances in the productivity of textile factories, they remained icons of a modern world where productivity was the only king.

It was not just technological in its dimensions but also spatial and social. Places such as Manchester and Birmingham, previously ordinary market towns, grew exponentially in size as people changed the nature of their lived experiences from cottage villages in the countryside to the factory districts. The rapid urbanisation represented in the boomtowns of the industrial revolution era was at once the source of economic wonder and caution: the sites of technological progress and economic advancement, yet the scenes of squalid housing conditions, pollution, and health vulnerability. In technological advancement in the stages of production, the industrial revolution demanded sociological adaptation.

The early transport revolution was another story involving infrastructure that had far-reaching effects. Canals dug through the English landscape and early railroads connecting towns were unprecedented in their scale and speed. Transport costs fell dramatically in the span of decades, while the relative cost of moving freight compared to producer prices declined by an enormous amount. These innovations formed the backbone of many Western economies and became a template other nations sought to emulate.

Moreover, in Western Europe and eventually North American countries, the notion that industrialisation equated with the concept of 'progress' gained currency.

Indeed, political theorists, economists, and politicians went about propagating tales about the absolute equivalence that could be drawn between the concepts of 'manufacturing,' 'capital accumulation,' and 'technological advancement' and 'economic maturity.' Works by David Landes, seminal in the list of economic histories, accept the norm that industrialisation is the crucible of modernisation, but not just in the sense of technological advancement, but even in the sense of the values it implanted in society.

However, it was within this Western model of progress that there existed a paradox of sorts, for it was an offer of untold wealth and materialistic prosperity, yet it was also the guarantor of inequality, of disruption, as the rapid mechanisation of everything from the workforce to the family units highlighted the dichotomy between the haves and the have-nots. What was initially perceived as the ultimate in progress had become, in the lives of the people, a multifaceted mosaic of prosperity and disruption that would forever be the hallmark of the Western model of growth and development, shaping the ultimate assessments of the term in the world today.

Emergence of Sustainable Development

The term "sustainable development" has emerged as an important and popular concept today, but how did it emerge in the first place? It originated to counter the Western model of development that dominated much of the 20th century, when humans were at the crossroads of choosing between "growth at all costs" and "growth that lasts". People started to understand during the 1960s and 70s that human progress brought destruction to natural environments.

o The UN Conference on the Human Environment, which took place in Stockholm in 1972, marked the first global recognition of sustainable development as its main concept. The United Nations Environment Programme was established to create environmental awareness among people throughout the world. The Brundtland Report, which scientists titled "Our Common Future", stands as a fundamental sustainable development milestone because it demonstrated how development directly depends on environmental factors. The document established sustainable development as a form of development that enables current needs to be fulfilled while future generations maintain their ability to meet their own needs. The document identified three essential elements for sustainable development, which included economic sustainability, environmental sustainability, and social sustainability. The Earth Summit, which took place in 1992, built its main principles on this concept. World leaders gathered at the event to officially implement sustainable development and to sign important climate change and biodiversity treaties.

United Nations Environment Programme (UNEP)

The major agenda for the creation of the UNEP was the promotion of international cooperation towards environmental problems and the coordination of international efforts aimed at protecting the environment. One of the most critical milestones related to sustainable development was the issuance of the Brundtland Report in 1987.

The report, though officially known as "Our Common Future," focused on the significant relationship existing between the environment and sustainable practices and development pointers. The relevant definition of sustainable development provided here is the one usually widely accepted and refers to “development which meets the needs of the present without compromising the ability of future generations to meet their own needs.” We were first introduced to the three pillars of sustainable development, which are interlinked, namely economic sustainability, environmental sustainability, and social sustainability.

This concept of what is meant by sustainable development helped provide the foundation upon which the 1992 United Nations Conference on Environment and Development was held. It is also known as the Earth Summit. This is the turning point as we now concentrate on global policy-making.

The Indian Context

In the case of India, the development of its infrastructure has never been purely a technical issue but has also remained deeply embedded in history, political ideology, and social values. Indeed, from the ancient cities and settlements to India’s modern-day mega-projects, its development has remained an unending dialogue between the nation-state, its economic ambitions, and social justice and equity. This development has, of course, remained far removed from the Western-style infusion of private capital, which was the hallmark of its development path.

Historically, infrastructure development during the colonial era was carried out with a specific objective. Infrastructure projects such as railways, ports, and roads were constructed with the aim of providing connectivity for the extraction and transportation of resources from the hinterland to the ports, but they did not provide any significant connectivity. The development of the rail routes connected vast areas across the country and had a lasting impact, but it was affected by factors that caused regional imbalances. The legacy of colonial times had a considerable impact on the development across post-independence India, where the country had to use its infrastructure for development purposes.

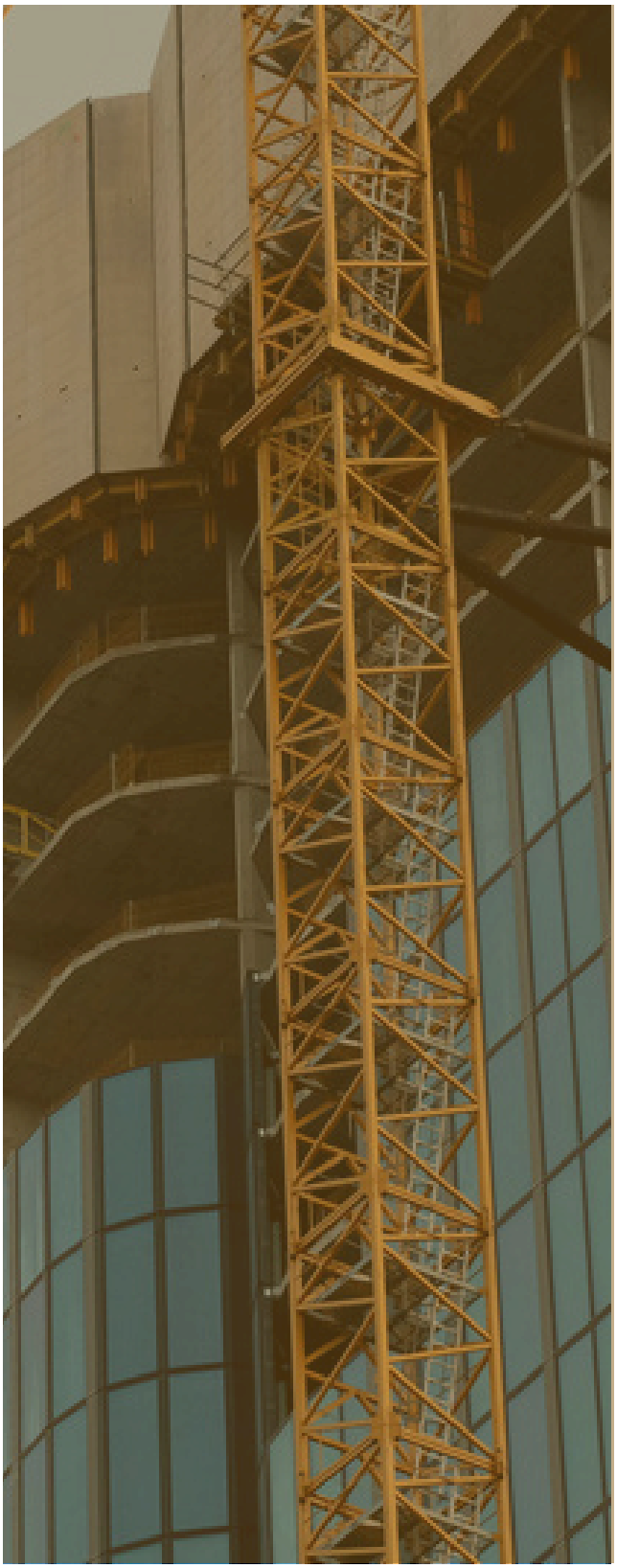
The period after 1947 saw infrastructure assuming pride of place in the vision of the modern and self-sufficient Indian state. The building of large dams, steel plants, power schemes, and public sector enterprises was emphasised, manifesting an exemplar of confidence in the power of scientific rationality and the role of the state. The Five-Year Plans established infrastructure as an essential input in the process of industrialisation and transformation, focusing attention on heavy industry, energy, and transport. Though the strategy helped to build an initial industrial and infrastructural base, signs of weakness began to manifest.

The last half-century of the twentieth century witnessed a transition. The Green Revolution increased irrigation, rural electrification, and rural roads substantially. This improved agricultural productivity remarkably but also widened geographical and environmental inequalities.

Economic liberalisation post-1991 brought dramatic change to the landscape of infrastructure with liberalisation policies and privatisation policies for sectors like telecommunication, power, and roads. Public-private partnerships and liberalisation policies have increased growth but have also increased debates about sustainability.

The current era is characterised by the launch of schemes such as the Bharatmala, Sagarmala, and Smart City Mission, which point to the desire to connect infrastructure development with logistics efficiency and city management. At the same time, the country's development challenges, including its pace of urbanisation, resilience to global warming, and inequalities, have made it more pertinent to adopt principles related to sustainable development.

Consequently, infrastructure development in the Indian setting also acts as an introduction and a mirror of the larger development programme that the nation embraces. This serves to expose the changes and shifts, for instance, from a control setting to a setting focused on the development of capacity, and from growth-focused settings to a setting focused on sustainability. But the important message is that infrastructure development is definitely a tool for economic growth, and a powerful influencer of the definition of progress.



TIME

INFRASTRUCTURE HISTORY:

2600-1900 BCE HARAPPAN CIVILISATION

1

Grid-planned cities (Harappa, Mohenjo-Daro, Dholavira) with standardised bricks, covered drains, and elevated platforms that guarded against seasonal flooding.



3500 BCE EARLY MESOPOTAMIA

2

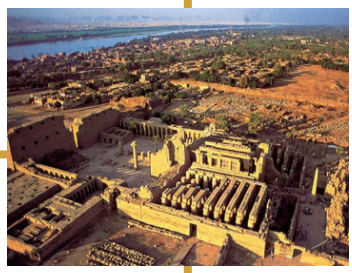
Irrigation canals, embankments, and flood-control systems built between the Tigris and Euphrates. Cities like Ur and Uruk featured temples and defensive mud-brick walls.



3100 BCE ANCIENT EGYPT

3

Basin irrigation along the Nile combined with advanced surveying to construct pyramids, temples, and tombs, monuments of organised state engineering.



509 BCE-476 CE ROMAN EMPIRE

4

Roman concrete enabled aqueducts, roads, amphitheatres, and baths. Grid-planned cities with sewage systems formed a template for urban infrastructure across two continents.



700-1526 CE MEDIEVAL INDIA

5

Forts, canals, cities, and religious monuments built under successive empires; irrigation (e.g. Western Yamuna Canal by Firoz Shah Tughlaq) raised agricultural output and revenue.



LINE

INDIA AND THE WORLD



6

INDUSTRIAL REVOLUTION 1760-1840

Steam-powered mills, canals, and early railways in Britain transformed production and transport, providing the model that other nations, including colonial India, sought to adopt.



7

EAST INDIA COMPANY 1613 onward

EIC establishes trading posts at Surat, Calcutta, Madras, and Bombay; military engineers begin forts and coastal infrastructure to secure commercial and military control.



8

FIRST INDIAN RAILWAY 1853

Bombay to Thane line (34 km) opens; railways rapidly expand to link resource-rich interiors to port cities, primarily to move raw materials and troops, not to serve local populations.



9

PUBLIC WORKS DEPARTMENT 1855

Lord Dalhousie formalises the PWD, centralising roads, canals, and buildings under civilian control; the Ganga Canal (Proby Cautley, 1854) irrigates large tracts of western UP.



10

FIRST FIVE YEAR PLAN 1951-1956

Prioritises agriculture, irrigation, and flood control; major multipurpose river valley projects like Bhakra-Nangal, Damodar Valley, Hirakud become symbols of the new nation-state.

TIME

INFRASTRUCTURE HISTORY:

1956-1961 SECOND FIVE YEAR PLAN

11

Heavy industry drive: Bhilai, Rourkela, Durgapur steel plants built with Soviet and European cooperation; railways and thermal power expanded to support industrial growth.



1960s and 70s GREEN REVOLUTION AND BRO

12

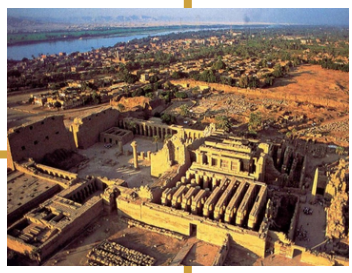
HYV seeds, canal irrigation, and rural electrification boost food output; BRO (formed 7 May 1960) builds strategic border roads in the north and northeast, linking remote terrain to India.



1991 ECONOMIC LIBERALISATION

13

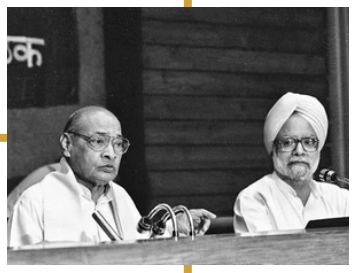
Reforms open telecom, power, and roads to private capital; PPP models emerge; JNNURM (2005) channels investment into urban infrastructure and governance reform in 65 cities.



1999 onward GOLDEN QUADRILATERAL/NHDP

14

Ninth Plan launches India's largest highway programme, connecting Delhi, Mumbai, Chennai, and Kolkata with four-lane highways; NHAI was created to implement and manage NHDP.



2015 (ongoing) BHARTMALA AND SAGARMALA

15

Bharatmala targets ~65,000 km of new highways to improve freight corridors; Sagarmala focuses on port-led development, modernising 12 major ports and coastal economic zones.



LINE

INDIA AND THE WORLD

16

PM GATI SHAKTI — 2021

Integrated GIS-based platform synchronising roads, railways, ports, airports, and logistics to eliminate siloed planning; building the architecture for multimodal connectivity.

17

SMART CITIES MISSION — 2015 (ongoing)

100 cities receive funding for digital infrastructure, smart mobility, and urban services; part of a wider push linking infrastructure investment to livability and climate resilience.

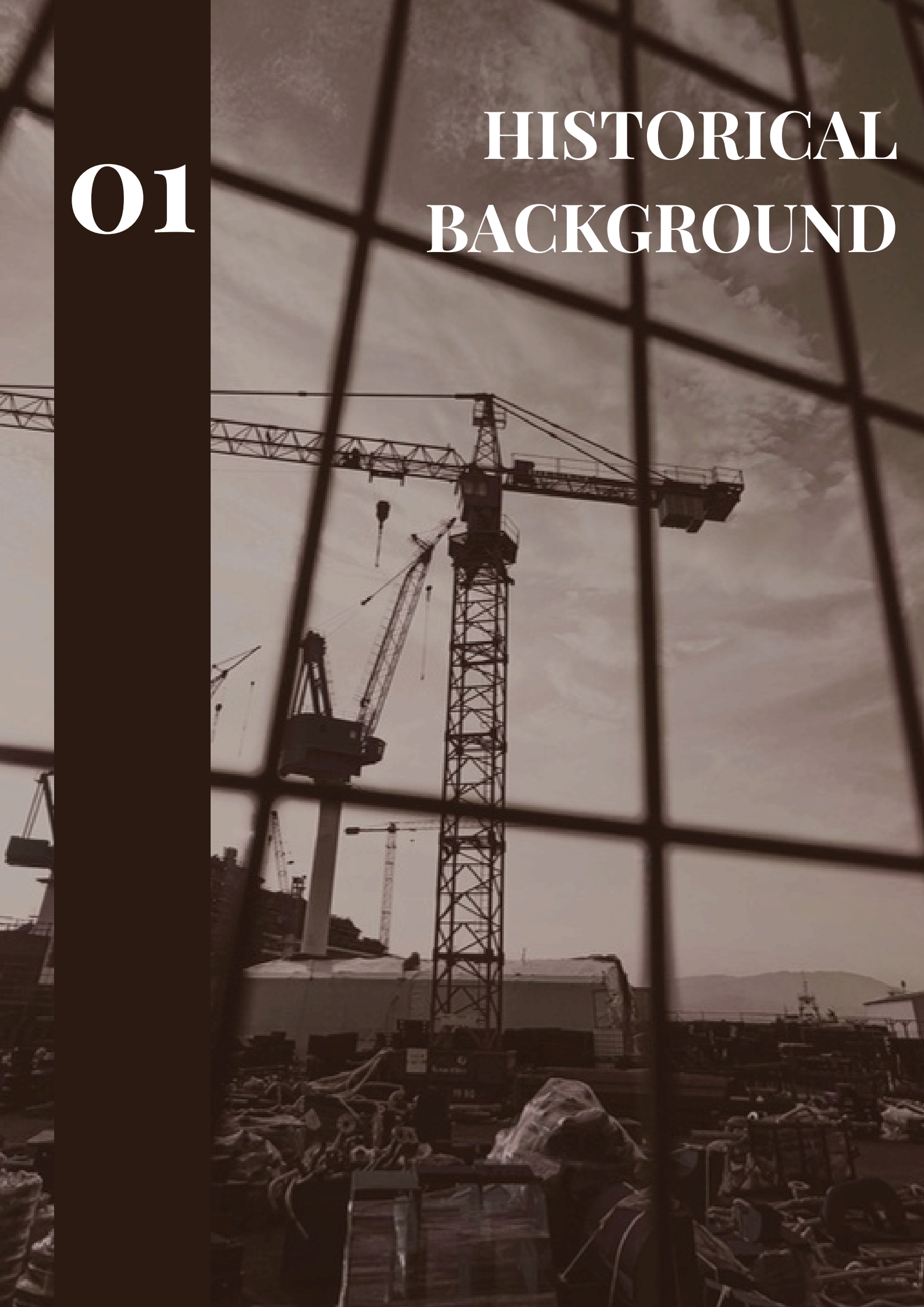
18

VIKSIT BHARAT 2047 — Target Year

Vision of a developed India by the centenary of independence.

01

HISTORICAL BACKGROUND



HISTORICAL BACKGROUND

Research-based Public Works by the British

Era of the East India Company:

The earliest construction works can be traced back to the advent of the British East India Company, when Sir Thomas Aldworth secured a grant from Mughal Emperor Jahangir and established the first factory at Surat in 1613. It became the first major trading hub for the British in India. The company established multiple trading posts, including the important port cities of Calcutta (Kolkata), Madras (Chennai), and Bombay (Mumbai). Development was initiated in coastal regions to facilitate trade and military control. The company's transformation from a trading corporation to a colonial power began with the British victory in the Battle of Plassey in 1757. The EIC brought in many infrastructure projects like ports, railways, and roads under the supervision of the military engineers, as provincial public works came under the purview of the Engineering Department of the army. It also began to construct military roads and forts to solidify its control over the expanding empire.

Formation of the Public Works Department:

The Public Works Department was established by Governor-General Lord Dalhousie in 1855. As the colonial rule spread, the need for a more organised civilian infrastructure increased. As a result, the formalisation and creation of the PWD came into the picture under the control of Lord Dalhousie.

This distinct department relieved the military from the construction aspect and centralised the supervision of infrastructure projects across different provinces. The Public Works Department was in charge of public works, including roads, canals, and buildings such as courthouses, post offices, administrative buildings, and drainage, which were carried out extensively across different provinces. The rationale behind the colonial public works was not just about modernisation; it was very much connected to imperial control, as improved infrastructure meant more revenue collection, easy movement of troops, and goods. The economic geography was being reshaped in this manner.

Railways:

Pack animals and small sailing vessels on navigable rivers were the common systems of long-distance transportation of cargo till the mid-nineteenth century. Large trains of pack animals were driven by the nomadic Banjaras on roads that connected western India with eastern and northern India. For short-distance trade and travel, the common means of transportation were palanquins, small river crafts, and bullock carts. The older systems of long-distance trade used a lot of labour and time. The railways replaced this system without much resistance. The Indian railway system is considered to be the most significant contribution of the British to Indian infrastructure. Between 1860 and 1940, total route miles increased from 838 to 41,852.

Their motive was clear- import raw material from India and export the cheaply manufactured finished products from Britain. The extensive network was meant to prioritise the movement of military troops instead of increasing domestic connectivity. During independence, the system lacked standardisation, diversification, accessibility, and regional balance.

Roadways:

While railways received substantial investment, the road infrastructure remained underdeveloped due to neglect and recurring maintenance costs. There was little attention paid by the government to the roads. While the total road length increased, it did so at a pace much slower than that of the railways. The length of metalled roads per 1,000 persons in 1931 was only 0.4. As a point of reference, the ratio was over 1.5 in British Ceylon (Sri Lanka) and Malaya (Malaysia).

The road network was spread over approximately 400,000 kilometres, but covered only about 40% of British India. Most roads connected administrative centres, military installations, and commercial hubs, increasing convenience for administrative purposes. Roads became inaccessible during monsoons, disrupting village economies and increasing rural distress. No attention was paid to rural connectivity and accessibility.

There were three reasons for this biased treatment of roads. Firstly, road building was claimed to be an expensive affair in India due to the terrain, the rivers, and the high repair costs because of the monsoons. Secondly, roads did not generate any monetary return for the government, while the railways did.

Thirdly, the ones who were pushing the government to invest in modern transportation were the groups that wanted railways or other cheaper modes of long-distance trade.

Ports:

One of the main features of colonial public works under the British was the expansion of the main ports, along with other maritime infrastructure. The British transformed main port-cities like Bombay (Mumbai), Calcutta (now Kolkata), and Madras (now Chennai) into major export and import hubs. Such ports were instrumental in the export of raw materials such as cotton, jute, opium, agricultural produce, and minerals from India to Britain and in the import of British manufactured goods into India.

The colonial ports were also turned into industrialisation centres for the urban growth of the colonies. Major investments were made to develop port infrastructure to serve the economic interests of the British. While international shipping connections were established, facilities for domestic trade received minimal attention.

Prominent port cities like Bombay, Madras, and Calcutta became the main shipping hubs and saw the construction of urban infrastructure such as docks, customs houses, and storage facilities. These cities also received development for facilities like sanitation and education. Rural areas, where most Indians lived, remained underdeveloped and impoverished.

These coastal port cities became the essential naval and military bases, housed the European administrators and merchants, and were under the control of the British, who found it more comfortable to manage these cities than the remote interior regions. Therefore, ports became the centres of power and governance.

By 1947, one of the most conspicuous legacies of colonial rule was the development of infrastructure, including ports, canals, railways, and urban waterworks. The British left behind these infrastructural assets as a network of interlinked public works built for governance, commerce, and control.
This infrastructure created the facilities that changed India's agrarian landscape and the transport geography to a significant extent. It modernised the irrigation system, connected different areas, promoted urbanisation, and established different institutions.

However, the progress was accompanied by a price, in terms of social reordering, ecological disruption, regional inequalities, colonial exploitation, economic drain, and long-term distortions. The very infrastructure that supported modernisation also supported colonial domination.

Canal vs Railways Argument

Two prominent systems shaped British colonial infrastructure in India: canals and railways, both of which had their own priorities and limitations. Canals were mostly built to help farmers and respond to problems, like famines. On the other hand, railways were built for a very different purpose.

They were not primarily meant to benefit Indians but for the interests of the British Empire. The rail network made it easier to transport raw materials from villages to ports, so they could be shipped to Britain. It also helped the government to move troops quickly across the country and maintain stronger control over the empire. This difference not only changed the geography of the economy but also made regional differences worse, which led to India's long-term uneven development.

Canals:

Initially, the primary motive for canal construction was the search for revenue. Early efforts began in 1817 and were centred on the redevelopment of previous Mughal works. The British regarded canal irrigation as a remedy for the recurring famines in India. According to the merchants of Manchester, they were necessary for the development and exploitation of Indian resources. The supposed intent of canals was mainly agrarian stabilisation and local relief in frequently famine-struck areas like Bengal, Madras, and Punjab. However, canals were mainly meant for agricultural improvement and fostering Britain’s industrial ventures. By the late nineteenth century, 43,800 miles of canal construction had been completed.

Important Projects: Proby Cautley's Ganga Canal (1842–1854) irrigated large tracts of western Uttar Pradesh and was intended as an anti-famine and stabilisation effort for agriculture in that area.

The Western Yamuna Canal, originally built by Firoz Shah Tughlaq much earlier, was revived in the early 1800s by British engineers for the agricultural development of Haryana.

The Punjab Canal Colonies were developed as agricultural colonies in semi-arid areas, increasing the productivity of the region as a wheat-producing zone.

Impact: With canal irrigation, waste and pasture lands were turned into croplands of high yield and thus made taxable. The colonial administrations considered this a tool of revenue extraction. It indeed did increase the agricultural output and state receipts.

Rural employment rose as agricultural productivity increased and food security emerged. Stable and consistent agricultural output facilitated the collection of taxes for the colonial government.

Limitations: It created a geographic imbalance as the emphasis was on plains and fertile areas, ignoring tribal terrain, semi-dry areas, and hilly topographies. Dry zones in need of irrigation were left untouched, whereas well-irrigated productive land became a target for canal development to secure returns on investment.

Improper drainage, waterlogging, salinisation, and malaria outbreaks were, quite often, locally reported as the unplanned consequences of situations where there was a lack of proper engineering and maintenance.

Siltation, leakages, and lack of proper maintenance reduced long-term effectiveness.

The construction of canals proved too expensive as it was hard to connect far-off and remote villages.

Railways:

After the 1850s, there was a rapid expansion of railways. Besides the railways being a means of moving troops and administration, they were also instrumental in transporting raw materials and agricultural products from the interiors to the ports for export. Most of the building works were funded by private British companies that were usually supported by government guarantees. The railway was meant to transport raw materials like cotton, jute, and opium from the countryside to the port cities. It facilitated government supervision and increased efficiency in exports. The first railway line opened from Bombay to Thane (34 km) in 1853 and was a symbolic beginning of colonial railway development. Railway tracks were established to link resource-rich areas with the coastal cities to avoid going through the rural interior, therefore reducing the cost and time of transportation.

Important Projects: The East Indian Railway (1850s–1870s) connected Calcutta to Delhi via Allahabad and facilitated the movements of troops and raw material.

The Great Indian Peninsula Railway connected Bombay to the Deccan region, where cotton was grown.

The Southern Mahratta Railway connected Madras Presidency to Karnataka's interior.

The Assam Bengal Railway was created to transport tea and timber from the Northeastern region to the ports.

Impact: A standardised and even transportation system facilitated efficient administrative control and quick troop transportation.

Transportation facilities to ports not only sped up the flow of exportable commodities but also made urbanisation possible around the junctions and port nodes. Port cities like Bombay, Calcutta, and Madras saw an increase in urbanisation.

Limitations: Little attention was given to rural connectivity, leaving dry, hilly, and tribal parts of India without access to easy transportation.

The Railway Guarantee system caused Indian taxpayers to lose money, for the profit of British investors. The Indian industry was suppressed as local engineering and manufacturing were neglected.

The rail-enabled cheap imports also dismantled the local manufacturers (handicrafts and textiles) of many regions, and this is the de-industrialisation side of the colonial trade story.

Comparative Analysis:

Canal and railway development in India exhibits a sharp contrast in the British colonial infrastructure strategy, each representing a different logic and yielding different results. The main canal systems, like the Ganga Canal and Punjab's irrigation systems, were aimed at stabilising food production, preventing famines, and generating land revenue through planned irrigation. Although they had drawbacks like limited reach and inadequate maintenance, they benefited particular regions and supported rural livelihoods. By connecting resource-rich interior regions to coastal ports, railways such as the East Indian Railway and the Great Indian Peninsula Railway led to resource extraction and exploitation.

Railways boosted urbanisation and established a national transportation network.

Geographical Coverage: Railroads had the ability to cross a variety of lands, whereas it was not possible for transport by waterways. Rivers and canals follow nature or historically engineered watercourses. The building of canals was very much dependent on nature-friendly factors like mild slopes, rivers that flow all year long, and vast stretches of fertile plains. The Ganga-Yamuna Doab, the Punjab plains, and the Cauvery delta were well-endowed with these features, making them very suitable for the development of extensive canal networks. Nevertheless, the very dependence on geography turned out to be the greatest weakness of the canal system. In the Deccan Plateau, Western Ghats, Thar Desert, or hilly and forested regions of the northeast, canals were out of the question. Railways, however, were equipped with many more features to deal with and hence, could overcome the physical barriers of India's varied terrain. By means of tunnels, bridges, and embankments, railway tracks went through mountains, plateaus, forests, and dry zones, and thus, brought the areas together that canals could never. Consequently, while canals still had a limited regional scope, railways became the only means that could integrate the entire subcontinent into one economic and administrative space.

Speed and Reliability: Canals transported goods at a slow speed that depended on the supply of water in the canal system.

It was not unusual that in the dry seasons, many canals became unsuitable for navigation, and in the silting periods, they had to be cleared extensively. Besides these, their operation could be disrupted by floods, breaches, or irregular water supply, and so on. Due to technological improvements in engines and tracks, railways were able to provide transport services that were continuous, reliable, and very fast to a great extent. Thus, they became very useful indeed for the colonial administration, which was able to move troops quickly during revolts, transport grains during famines, and shift raw materials like cotton, jute, and coal to port cities. The pace at which railways worked made it one of the most effective methods of political control and economic extraction.

Economic and Market Integration: The role of railways was dominant when it came to economic integration and market transformation. Canals did have a positive effect on Indian agriculture through the expansion of irrigation and stabilising crop output; however, they mainly contributed to localised and regional growth only. For instance, the canal colonies in Punjab raised the production of wheat and cotton and led to the making of new agricultural settlements, but these advantages stayed in the particular regions only. On the contrary, railways connected the rural interiors straight to export-driven port cities such as Bombay, Calcutta, and Madras. The railway system created two opposing effects because it connected different markets, yet it caused Indian handicraft industries to collapse through its distribution of inexpensive British goods.

The railways created a modern transport system for India, which created a greater need for colonial trade systems, while the canals of India helped maintain agricultural systems and their associated regional economic activity. The canals required continuous operational work because they needed regular desilting, maintenance of embankments, and control of water flow. The British shifted their funding and operational focus towards railways and ports, which resulted in many canal systems falling into disrepair or becoming forbidden access points. The railway system maintained its good operational state because workers performed consistent maintenance tasks on the system. The institutional backing of railways enabled their infrastructure system to expand through upgrades, while they maintained operations at unprofitable levels because their strategic importance outweighed their economic value.

Social Impact: The two systems had different and contrasting social impacts. Canals contributed to the expansion of cultivation and, in some areas, they lessened the problem of drought; thus, they were of great help to the farming communities. On the other hand, canal colonisation pushed out local pastoral groups and changed the traditional water rights, which resulted in land being trapped in the hands of loyal colonists and elites. Railways made mobility, labour migration, and urban employment possible, but also aggravated the economic inequality, spread of epidemics, and the extraction of Indian wealth for the British benefit. Consequently, they both were means of development and control simultaneously.

Colonial powers achieved stronger control and created greater regional economic disparities through railway construction, while canal systems provided more benefits to the Indian people. Canals provided better infrastructure for equitable development and system resilience, but railways functioned as the primary tool of imperial control. Agricultural stability benefited from the construction of canals, which offered lower costs and higher energy efficiency to farmers. Railways provided greater speed and geographical flexibility, while enabling political and economic systems to connect over wide areas. The historical development of railways showed better results because they fulfilled British Empire requirements for fast troop movements, resource extraction, export connections, and territorial control. The canals versus railways debate serves as an example of the Paradox of Progress because canals provide better social sustainability and local advantages, but railways become the choice through their ability to create political and economic power.

The British colonial infrastructure system remains in poor condition because it fails to maintain existing facilities and its refusal to support local development. The British authorities started many projects to establish their control over resources, while disregarding any need for sustainable operations that would last beyond their immediate objectives. India faced difficulties in managing its post-independence infrastructure because neglect and poor maintenance had resulted in infrastructure systems that lacked essential elements.

GSI India

The GSI is a Government of India agency launched on March 4, 1851. It was founded by Sir Thomas Oldham in Kolkata, West Bengal, where it is headquartered. He brought its scope from coal exploration and locating coal deposits for railways to mapping the geological landscape of India. The primary objectives of this organisation include conducting geological surveys and studies in India. It is one of the oldest organisations in the world related to surveys, and the second oldest survey organisation in India after the Survey of India (founded in 1767), which conducts geological studies and surveys. The GSI currently comes under the Ministry of Mines and is responsible for creating and updating India's geoscience information, mineral assessments, and providing scientific expertise, which would help in policy making and the development of the nation.

Recently, GSI has been moving towards the digitisation and centralisation of geoscientific data to provide wider access to the masses. A major institutional initiative taken under this is the National Geoscience Data Repository (NGDR), a Ministry GSI-led online platform that is intended to host exploration and geoscience datasets for policymakers, industry, and researchers. The NGDR portal was publicly launched in late 2023.

GSI’s systematic geological mapping programme (SGM) has covered a huge area of India's mappable land. (Around 98.52%) making it a significant achievement for the geological framework and reflecting continuing updates and re-mapping efforts.

These mapping products are the backbone of mineral exploration, groundwater studies, environmental assessment and infrastructure siting.

GSI's Role in Infrastructure Planning

GSI provides foundational geoscience inputs that are used for the purpose of siting and designing dams, tunnels, roads, bridges, and working on urban areas with assessment of seismic zonation, slope stability, and groundwater. It is useful in hazard assessments, and the mineral inventories are used by ministries, state governments, and engineers to reduce the overall geological risk. The resulting data aims to improve evidence-based decision-making across infrastructure and mining sectors.

Some of the functions performed by GSI:

- **Supplying geoscientific and objective information:** GSI is the source of geological and geoscientific information, and it regularly updates the national geoscientific data and information base through field surveys and technology. This information is stored in the National Geoscience Data Repository, which is an important source for different stakeholders in the government and industry sectors. The information helps in making decisions for policy-making and commercial and socio-economic needs.
- **Systematic Geological Mapping (SGM):** The most important geological mapping project is conducted by the Geological Survey of India. GSI has mapped 98.52% of the total mappable area of India, and it has also prepared the geological map of India.
- **Mineral resource assessment:** GSI performs ground, aerial, and marine surveys to assess the mineral resources of the country. These mineral resource assessment projects investigate ferrous and non-ferrous minerals, precious metals and minerals, and industrial and fertiliser minerals. It also performs fundamental and interdisciplinary geological research, which includes geological mapping and groundwater studies.

GSI's role in the development of Infrastructure:

- **Site Investigation and Planning:** The GSI conducts various geological investigations before finalising any infrastructure projects like bridges, roads, and so on. This will help the engineers understand the nature of rocks, soil, and groundwater, and also make the site safe and secure from any mishap.
- **Disaster Risk Management:** GSI analyses and assesses landslides, earthquakes, and floods. This data is very useful for constructing roads, buildings, highways, and so on, in a safe location, which will minimise the risk of any natural disaster.
- **Sustainable Development:** GSI plays a crucial role in making the infrastructure projects environmentally sustainable by assessing the terrain stability and ecosystem before the construction of infrastructure projects.
- **Mineral and Resource Mapping:** The development of infrastructure is based on the availability of raw materials like coal, iron ore, limestone, and so on.

GSI undertakes the job of identifying these resources and hence helps in the development of industries like cement, steel, and power.

- **Hydrological Studies:** GSI investigates the availability and quality of groundwater, which is essential for assessing the development of agricultural and water supply schemes. This study will ensure that the development work is economical and sustainable.

Criticisms and Gaps:

- **Outdated and incomplete mapping:** The extent of mapping that has been carried out in India is extremely outdated, with some of it having been carried out several decades ago. Urban development, construction of dams, and climate change-related slope movements mean that many areas need either updated mapping or more detailed hazard mapping.
- **Data access, coordination, and application issues:** It has been suggested that geoscience products are not necessarily brought into project planning early enough or made operationally available to local planners and implementing agencies.
- **Resource and capacity constraints:** Manpower-intensive geoscience and the need for funding and real-time geotechnical monitoring infrastructure are limited and do not allow for continuous hazard monitoring and warning.

These issues have been apparent in recent high-profile Himalayan events, such as road expansion and large pilgrimage highway projects, which have been identified by studies, reporting increased landslides and slope failures. This clearly shows that a lack of coordination between infrastructure implementation and geoscience hazard assessment can lead to more negative than positive results.

The First Five-Year Plan (1951–1956)

Introduction

India's First Five-Year Plan was launched at a time when the country was struggling with the aftermath of independence and Partition. The economic status of the country presented several challenges in the form of very low per-capita income, almost no industrial capacity, and a critical food supply problem that was made worse by the Bengal Famine of 1943 and the mass migration of people in 1947. Under these circumstances, the planners adopted a growth strategy that was heavily influenced by the Harrod-Domar model, which suggested that the main factors determining economic growth were the rate of savings and the productivity of capital.

Objective

The Plan put more priority on consistent and controllable growth instead of daring industrial leapfrogging, which is a combination of the weak economy and the new government's limited capacity. The capital buildup was treated by the planners as a process that would take time. They emphasised domestic savings, capital productivity improvements, and investment in the sectors having an immediate and wider impact. The highest objectives included stabilisation of consumption, control of prices, and restoration of trust.

Besides, the plan had the point that not just physical capital formation would drive the development, but also institutional reforms like land reorganisation, better extension services, and expansion of cooperative credit that would eventually lead to the rural production structures.

Implementation

At the beginning of the 1950s, the percentage of India's labour force working in agriculture was around 70%, so the planners focused mainly on the primary sector. They considered food self-sufficiency not only an economic necessity but also a factor in political and social stability. A lot of money was set aside for irrigation, soil conservation, hydropower, and flood control, and the construction of multipurpose river valley projects; that is, Bhakra-Nangal, Damodar Valley, and Hirakud was aimed at feeding and finally regulating the rivers' flow of water. The Plan also provided support for the rehabilitation of landless and refugee farmers who had lost their property during Partition. This sectoral strategy was premised on the understanding that only a flourishing primary sector would result in rural prosperity and food security.

Impact

The First Five-Year Plan's political logic, which guided through its very design and implementation, is one of the least-examined yet most fundamental aspects of the Plan. India of 1951 was not just a poor country with a slow-developing economy; it was a recently liberated, strongly divided political entity trying to prove the legitimacy, power, and unity of a new democratic government.

The rulers took over a country that had extremely poor rural areas, very rigid social classes, severe food shortages, the consequences of partition, the move of large numbers of refugees, and the colonial-based forms of administration instead of development-oriented ones still exist. When such a country was concerned, economic planning was the main road to political building. It was a strategic step for the people in India's predominantly rural areas, where the state's credibility was to be established.

Thus, the allocation of funds towards the development of communities, small irrigation projects, state or local credit institutions, and agriculture-related services for the rural sector has fulfilled twofold objectives: these were the means of economic modernisation, and at the same time, they were the means of political integration. The new government, through these programmes, not only communicated but also brought its power and rule to the doorstep of those rural areas that had previously been cut off from the structure of formal governance, thus changing their status from subjects to citizens. Local governance institutions (panchayats) were revived, and participation was nurtured, particularly in terms of national development; this was a project with the dual nature of being ideological as well as developmental.

Shifting to this line of thought, the First Plan's over-cautiousness was indeed not an ideological retreat but a very astute political re-timing. The leadership consciously refrained from radical changes in the structure, massive industrialisation programs, or land reforms, which could incite fighting and result in the destabilisation of an already weak government or food shortages.

Rather, the immediate objective was to lay the groundwork of a nation-state, to make the bureaucracy, which was already slow in coming, educated to the public, and finally to gain the confidence of the people in democracy.

The Nehru–Mahalanobis Model and the Second Five-Year Plan (1956–1961)

Introduction

Indian planners in the mid-1950s reached the conclusion that agricultural recovery needed to proceed alongside other development initiatives to address the nation's structural underdevelopment problem. The Jawaharlal Nehru–Prasanta Chandra Mahalanobis strategy proposed prioritising heavy industry and capital goods production to build a self-sustaining industrial base and reduce import dependence. The system used Soviet planning models as its foundation because it believed that investments in steel and machinery, mining, and public sector enterprises would create more sustainable growth than spending on present-day consumption goods. The state emerged as the primary developer of projects during the Second Five-Year Plan because private capital lacked sufficient resources and infrastructure to support these initiatives. The approach accepted immediate consumption limits to enable industrial development and future production increases.

Implementation

The Plan led to the building of three major steel plants in the public sector at Bhilai, Rourkela, and Durgapur, all of which were constructed with international cooperation. The projects were the first signs of India's industrial power and were very necessary for steel production, the main material for modern production and infrastructure. The railways received a complete overhaul with the double purpose of improving not only the goods transport but also the national connectivity, and so supporting migration, commerce, and administrative integration. The public investments led to the expansion of the power sector in the form of thermal and hydroelectric projects, while the newly strengthened Atomic Energy Commission planned to build the nuclear power capacity for the long-term strategic security of the country. Overall budget allocations showed the new priorities: the industry and mining took the largest share; transport and communication got a significant increase; and agriculture's relative share decreased. This pattern of planning marked a decisive turn for India to a state-led, industrialising economy.

Achievements and Challenges

The Second Plan achieved great success in building up India's heavy industrial capacity and enlarging state-run enterprises. The primary sectors of steel, machine tools, and electrical equipment gained a lot as the country became less dependent on imports and reached a certain level of technology in some industries. The upgrading of infrastructure brought about the movement of goods and also helped to form a national market. At the same time, the plan also posed a great deal of difficulties. The large manufacturing projects were very expensive and thus used up funds that could have been spent on labour-intensive industries or on agricultural modernisation. The balance of payments situation worsened drastically due to large-scale machine imports.

Inefficient administration and management in state-run firms resulted in low productivity and, consequently, prolonged investment payback periods. The rural population did not gain in the same proportion as the whole country did, thus making the situation in different regions more unequal. These contradictions made it possible for the more complex economic debates of the sixties and seventies to take place about the planning efficiency, the power of the state, and the policy concerning industry.

Impact

The Five-Year Plans, which India initiated as its first large-scale development programmes, established an intricate link between government-sponsored industrial growth and the traditional lifestyles of indigenous tribal peoples who inhabited forest areas. The projects that aimed to build capital and develop infrastructure for national progress continuously invaded indigenous territories, thus forcing indigenous communities to abandon their ecological and cultural practices to support economic growth. The economy experienced benefits from industrialisation and resource extraction; however, the communities that lacked political power underwent social, environmental, and cultural destruction. Research conducted in Odisha, Madhya Pradesh, Chhattisgarh, and Jharkhand demonstrates that displacement destroyed access to essential resources such as forests and rivers and agricultural fields, which led to the breakdown of mixed subsistence systems and forced multiple households into dangerous wage work.

The compensation package, together with the resettlement process, resulted in inadequate support because the available land consisted of barren areas and divided sections, and people faced challenges in reaching shared community resources. Displacement from their homes caused people to lose physical possessions, which resulted in the breakdown of kinship ties, religious practices, and community-based governance systems.

The environmental degradation created additional problems, which compounded existing issues. The construction of reservoirs together with deforestation activities and changes in river flow patterns led to decreased biodiversity and diminished forest resources, reduced soil fertility, and impaired groundwater recharge capacity, which created nutritional shortfalls and income uncertainties and market dependency for existing vulnerable groups. Droughts and floods, which occurred more frequently, created greater long-term ecological and economic risks. The rehabilitation projects, which promised to deliver electricity, irrigation, and industrial development, actually increased social inequality.

BRO India

Introduction

BRO is a road construction executive force in India that provides support to the Indian Armed Forces by ensuring connectivity in strategically important and difficult terrains. It was established on 7th May, 1960, to secure India's borders and develop infrastructure in remote areas of the north and north-east states of the country.

Before 2015, the BRO was funded by the Ministry of Surface Transport under the Ministry of Road Transport and Highways in order to ensure smoother operations; it has now been completely shifted, and it currently comes under the Ministry of Defence. BRO develops and maintains road networks in India's border areas and friendly neighbouring countries. This includes the operation of infrastructure in 19 states and three union territories, including Andaman and Nicobar Islands, and neighbouring countries such as Afghanistan, Bhutan, Myanmar, Tajikistan, and Sri Lanka. The engineering efforts of BRO have helped facilitate the logistics of troops as well as connectivity, and it has also contributed significantly to disaster relief and reconstruction efforts. However, the technical and environmental difficulties of working in mountain ranges are significant.

The roles of BRO can be divided into two, namely, peacetime roles and wartime roles, which are as follows:

Peacetime roles:

During peacetime, the major role of BRO comprises working on socio-economic development by developing and maintaining day-to-day operational road infrastructure. It also focuses on relief and rebuilding tasks during natural disasters like landslides, floods, earthquakes, etc.

Wartime roles:

These include developing and maintaining the roads in the troop deployment sector so that their presence is maintained efficiently there.

They also work on maintaining the transport lines and developing new ones, as well as repairing the existing damaged lines. Some of these projects implement some of the development programs of the Indian government in other foreign countries, such as Tajikistan, Afghanistan, Myanmar, and Bhutan. Their major projects include the Delaram-Zaranj Highway in Afghanistan, which was completed and delivered to the Afghan government in 2008. They also include the renovation of the Farkhor and Ayni air bases in Tajikistan. The BRO was also involved in the reconstruction activities of the Tsunami in Tamil Nadu in 2004, the Kashmir earthquake in 2005, and the flash floods in Ladakh in 2010.

BRO's role in the development of infrastructure:

1) Building Strategic Roads and Highways: BRO undertakes road construction in border and remote regions to ensure all-weather connectivity and thus, improve the development in those areas.

2) Development of Tunnels and Mountain Infrastructure: BRO, by providing a rapid means of deliveries to border areas and facilitating rapid troop movement, develops infrastructure that supports the Indian Army.

3) Develops Defence and Strategic Infrastructure: BRO, by providing a quick supply of deliveries to border areas and enabling faster troop movement, develops infrastructure that supports the Indian Army.

4) Maintenance of Roads in Disaster-Prone Areas: BRO repairs and maintains essential infrastructure that was affected by landslides.

floods, earthquakes, and so on. The activities of BRO facilitate a robust transport system that supports uninterrupted connectivity even in adverse environments.

5) **Combining Modern Engineering and Construction Technology:** BRO employs cutting-edge technology and creative approaches to develop climate-resistant infrastructure that supports even in high-altitude environments.

Criticisms of BRO:

Over the past decade, trends have been identified that show how rapid road expansion, extensive slope cutting, blasting, and insufficient environmental clearance have contributed to increased landslide incidents, loss of natural drainage, deforestation, and local slope instability.

Unscientific slope cutting:

Studies carried out on the Char Dham routes have shown a large number of landslides caused by unscientific slope cutting and road construction. It is recommended that more slope-friendly designs, the latest methods of slope stabilisation, and stronger ecological norms be followed.

Environmental concerns:

The National Green Tribunal has highlighted projects that have been implemented without a proper Environmental Impact Assessment and forest clearance in ecologically sensitive zones. This has resulted in an aggravation of the disaster risks.

Need for modern engineering solutions:

There is a need for a shift from aggressive cut-and-fill methods to full EIA implementation and real-time monitoring, and nature-based slope protection to reduce long-term disaster risk.

Ninth Five-Year Plan

The Ninth Five-Year Plan, which India released in 1997, seemed to many to be a nudge at stabilisation into a grander growth age. Planners desired to do more than stabilise the economy after the painful yet needed macroeconomic reforms of 1991; they were able to take the economy forward in a manner that they could affect ordinary people.

The theme of the plan, “Growth with Social Justice and Equity”, was not just a slogan, but a political decision to attempt to reconcile much quicker growth with the reduction of poverty. The most evident outcome of that decision was the unambiguous change in the way the state perceived infrastructure: no longer a rather basic support system, it turned into an on-the-nose driver of national productivity and connectivity.

The Ninth Plan allocated huge resources to power, irrigation, and most importantly, roads and transport, which is an indication that the state has realised that better connectivity is the key to unlock the markets, occupations and services.

NHDP

The roads swept to the middle of that talk. The National Highway Development Project (NHDP) was an idea thought up during the Ninth Plan and was inaugurated to function as a transformational programme.

one that is bold and unashamedly national in its scope. The best known of them was the Golden Quadrilateral, a proposal to connect Delhi, Mumbai, Chennai and Kolkata to new four-lane highways with the North-South and East-West corridors, and preferred port road links. All these interventions were aimed at weaving India's big cities and economic centres in a network of freight and passenger movement that was faster and cheaper. Planners at the time estimated that the NHDP would entail upgrading a number of thousands of kilometres of highways and injecting tens of thousands of crores worth of investment into the transport network; the project became the largest highway programme India had ever attempted.

Just as that scale was a win and a pain, on the positive side, the existence of better highways literally reduced the travel time between big cities and lowered the logistics expenses incurred by businesses, which, when economic scientists explain the productivity gains of the 2000s, can be cited. However, even the magnitude of the programme revealed the inadequacies of the Indian delivery systems. There was cost inflation, time slippage and uneven performance; and some periods were brisk, some slower, the timeline was pushed, and the bill was increased more than originally estimated. These are not minor bookkeeping issues; delays and cost overruns alter beneficiaries, redistribute local economic calculations, and heighten the political pressure to hastily build on the site instead of ensuring a prudent location choice or environmental studies.

To summarise, NHDP demonstrated that a national stimulus for the infrastructure can provide substantial social good, yet it depends solely on whether its governance, technical and ecological protection can keep up with its scale.

A more in-depth examination of the implementation of the NHDP shows the institutional learning that was carried out. A statutory body called the National Highways Authority of India (NHAI) was charged with the implementation of the NHDP, and with time, the programme has developed into multiple phases with mixed financing sources: central funds, market borrowings, state contribution and more and more, the private financing models.

This mix revealed two things simultaneously: the state was serious about establishing the connective infrastructure at the national level, and at the same time, it became more open to the invitation to the participation of the private sector in large, capital-intensive projects.

That financing-delivery experiment with initial public-private deals on toll roads and expressways aided in establishing the policy template upon which subsequent efforts (Bharatmala, PM-Gati Shakti) will be based. It also raised good debates that were well-known concerning accountability, maintenance and whether speed had indeed started to push good environmental practice out.

The joint achievement of the Ninth Plan and NHDP is a paradox: the infrastructure turned out to be the core of the concept of national development, whereas the planning and delivery procedures were not always established to handle all the outcomes that such massive projects give. Bridges and highways could indeed make markets smaller and smaller, but they also changed the appearance of the country and local economies; they made heroes and new losers. Whereas coverage and connectivity were rightly the initial point of concern, the latter policy discussion is one that this report picks up on; it must pose other tougher questions: are projects being chosen with long-term ecological resilience in mind? Do the institutions that create and sustain them have the technical, social, and environmental imprudences that ensue ready?

The story of the Ninth Plan is thus two teachings: infrastructure is very, very important in its growth, and so are the machinery and methods of its construction.

The achievements of the NHDP and its failures as a party became the guide to future decisions of India, looking back at the same decade. Subsequent programmes and changes of institutions, new financing devices, increased utilisation of PPPs, and combined master plans tried to increase the benefits and cover the flaws revealed in the application. However, there is the underlying conflict: how to achieve large-scale, quick growth in infrastructure and yet avoid the establishment of environmental or social liabilities in the long term.

It is that tension which lies at the very core of our report, The Paradox of Progress: projects which make us richer by one measurement can make us poorer by another unless we redraw the manner in which decisions are made, the manner in which risks are evaluated and by what means communities are given meaningful attention to the consequences of projects which impact them.

Jawaharlal Nehru National Urban Renewal Mission

JNNURM was introduced in December 2005. Fundamentally, JNNURM consisted of two sub-missions (Urban Infrastructure and Governance (UIG) and Basic Services to the Urban Poor (BSUP). The programme came up with approximately 65 mission cities, and it sought to ensure rapid investments in water, sanitation, sewage, urban transport and housing of the poor and also to drive governance reforms in the Urban Local Bodies (ULBs). The initial figure of the Mission by the central government was ambitious- about [?]1 lakh crore within a period of seven years, and the Centre was supposed to contribute half of that figure (later revised). The area was vast and the purpose obvious: to connect finance, infrastructure and institutional reform in order to make cities plan and provide basic services.

On paper, the pipeline was spectacular: hundreds of projects passed in cities, big-ticket sub-missions, new institutions, special-purpose vehicles and state nodal agencies to implement projects. As a matter of fact, they turned out to be uneven and disappointing.

The performance audit led by the Comptroller and Auditor General (CAG) revealed that most of the targets were well below expectations, core infrastructure and housing completion were low, funds were being released slowly, and governance reforms were not entrenched in most states. The CAG found that the goals of the Mission were compromised by several structural problems, lack of state and city-level planning, fund releases, poor contract management, and insufficient monitoring.

In simple terms, there were numerous promises of lots of money, numerous projects were passed, and very little was done to finish those projects in time, and very few cities experienced an effective and long-lasting positive effect on local governance beyond the lifespan of the funds. As an example, a very small percentage of housing projects that were supposed to be done for the urban poor had been developed by 2011-12, and this failure jeopardised the equity assurance of the Mission.

The causes of the failures were not one-sided. Several interacting issues, such as audits and academic assessments:

- **Inadequate project design:** Several project appraisal reports (DPRs) were reported without proper surveys and land surveys, and these subsequently demanded revisions and relocation. This implied that budgets and timetables were wishful thinking and not plausible plans.
- **Loopholes in the flow of finance and fiscal ownership:** The Centre failed to release the entire committed amounts in full time, and some states failed to release their matching portions in time. This intermittent funding trend halted productivity and smashed schedules.
- **Weak local capacity:** In most states, the implementation and accountability were weak since Urban Local Bodies were usually the nominal implementing agencies but lacked trained staff, financial controls, and regular elections. The CAG has come across poor internal controls and monitoring several times.
- **Reforms were generally superficial:** JNNURM pegged central grants on governance reform, which in most instances was selectively adopted or hurriedly done in check-box fashion (such as in property tax reform, municipal accounting, or regularisation of staff). Infrastructure projects could not be sustained without a real institutional change.
- **Equity gaps:** Provision of housing and basic services to the urban poor was part of the priorities stated in the Mission, though there were pathetic completion rates of housing. The idea of incorporating the urban poor in planned urban development was easily lost in implementation.

TIME

FIVE YEA

1951-1956 PLAN I

Bhakra-Nangal, Damodar Valley, Hirakud dams; irrigation, flood control, hydropower. Community development blocks and rural roads prioritised for political integration. Large dam construction displaces communities; resettlement packages inadequate.

1



1956-1961 PLAN II

Nehru-Mahalanobis model builds Bhilai, Rourkela, Durgapur steel plants; overhauls railways; expands thermal/hydro power; strengthens Atomic Energy Commission. Displaces tribal communities in Odisha, MP, Jharkhand for steel/mining.

2



1961-1966 PLAN III

Machine tools, fertilisers, defence industries expand; power generation targets raised; HYV research lays Green Revolution base. 1962 and 1965 wars divert resources; Plan III fails targets; drought and food crisis expose over-reliance on industry.

3



1969-1974 PLAN IV

Canal irrigation, rural electrification, and feeder roads expanded for HYV farming; fertiliser plants and storage built in Punjab-Haryana. Regional inequality deepens; waterlogging and soil salinisation rise; small farmers largely excluded.

4



1974-1979 PLAN V

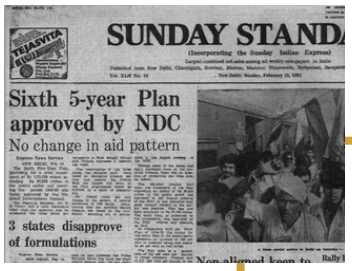
Thermal power expands post-oil shock; Minimum Needs Programme funds rural roads, water, schools; plan ends early amid political instability. Emergency-era forced resettlement; coal expansion drives deforestation in Jharkhand and Chhattisgarh.

5



LINE

R PLANS


SUNDAY STAND

Sixth 5-year Plan approved by NDC

No change in aid pattern

3 states disapprove of formulations

6

PLAN VI 1980-1985

National Rural Employment Programme creates wage jobs via infrastructure; roads and power expand. Narmada projects launch amid controversy, with Sardar Sarovar Dam displacing Adivasi communities and sparking the Narmada Bachao Andolan.


INDIAN EXPRES

Plan envisages 5pc annual growth rate

No gap in resources

No raise in funds for public sector

ENLF agrees to

7

PLAN VII 1985-1990

Telecom modernisation begins (STD network, PCOs); power sector reforms attempted; Jawahar Rozgar Yojana links village infrastructure to rural wage employment at scale. Power sector losses mount; fiscal deficit escalates.



8

PLAN VIII 1992-1997

Private sector opened to telecom and power; NHPC and state electricity boards restructured; port privatisation begins; focus shifts toward human development indicators. Reform pace uneven; power sector privatisation and rural infrastructure investment stall.



9

PLAN IX 1997-2002

Golden Quadrilateral and N-S/E-W corridors conceived; NHAI created; Pradhan Mantri Gram Sadak Yojana launched for all-weather rural roads; power sector reforms accelerated. NHDP suffers cost overruns and timeline slippage.



10

PLAN X 2002-2007

JNNURM (2005) channels ₹1 lakh crore into 65 cities for water, sanitation, urban transport, and housing; SEZs and port-led industrial corridors gain traction. CAG audit finds poor project completion; housing for urban poor barely delivered.

TIMELINE

FIVE YEAR PLANS

2007-2012 PLAN XI

NIP concept emerges; freight corridors approved; RGGVY expands rural electrification; infrastructure spend target raised to 9% of GDP. Land acquisition bottlenecks stall projects; EIA bypasses in Himalayan roads worsen landslide and flood risk.

2012-2017 PLAN XII

Bharatmala, Sagarmala, Smart Cities Mission launched; renewable targets set; last Five-Year Plan before NITI Aayog replaced Planning Commission (2015). Char Dham highway linked to Himalayan landslides due to unscientific BRO slope cutting.

11



12





02 ANALYSIS OF DEVELOPMENT

ANALYSIS OF DEVELOPMENT

The government's vision and approach to the development of infrastructure in India

The Viksit Bharat Initiative

The Viksit Bharat is an ideal representation of the Indian government's ambitious dream of changing India into a developed and successful country by the centenary year of the country's independence, i.e., by 2047. To achieve and fulfil the Viksit Bharat dream, the Indian Ministry of Road Transport and Highways plans to develop 50,000 km of highways in the coming 10 to 12 years by spending over Rs. 20 lakh crore.

Under this plan for multi-modal connectivity under the PM Gatishakti National Masterplan, the government aims to create India's infrastructure revolution worth ₹100 trillion to build the physical foundation of Viksit Bharat. This involves improving infrastructure such as India's ports, airports, roads, etc. This effort is led by both government and private sector contributions. PM GatiShakti is a visionary and path-breaking strategy for leading economic growth and development in India. This effort to promote development follows 7 engines of growth: Railways, Roads, Ports, Waterways, Airports, Mass Transport, and Logistics Infrastructure. The projects on these 7 engines in the "National Infrastructure Pipeline" will be aligned with the PM GatiShakti framework. This will help raise productivity and accelerate economic growth and development.

This plan has been formulated in the form of a Digital Master Planning tool in association with the BISAG-N (Bhaskaracharya National Institute for Space Applications and Geoinformatics). The main features of the plan include the allocation of ₹20 trillion for the development of 50,000 km of Express Highway, a budget of ₹2 trillion for port infrastructure, and a budget ranging from ₹10 trillion to ₹12 trillion for the improvement of the railway network. All these areas aim to improve the level of connectivity in the country, further promoting economic growth and the increased standards of living in India. For the accomplishment of the vision for Viksit Bharat, the government has initiated programs such as PM Gati Shakti, Bharatmala, Sagarmala, Smart City, UDAN, National Infrastructure Pipeline, etc., with the intention of increasing the rate of infrastructural improvements in the country.

Strategies for Infrastructural Development

India has set goals to achieve a $5 trillion economy. To support and achieve this, the government launched the National Infrastructure Pipeline, besides other initiatives such as 'Make in India' and the production-linked incentives scheme to enhance the growth in the infrastructure sector.

The National Monetisation Plan: It was the first asset monetisation initiative, launched for 2022-25. It had a target to raise Rs 6 lakh crore from core central government assets.

The government achieved an asset monetisation of around Rs 5.65 lakh crore, 94 per cent of the objective of Rs 6 lakh crore under NMP 1.0.

Finance Minister announced the second asset monetisation plan for 2025-30, targeting Rs 10 lakh crore in new investments. This initiative will help the government to reinvest capital to drive infrastructure growth in the country. In 2025-26, the National Highways Authority of India (NHAI) will be the major contributor to the NMP, followed by power, railways, and coal and mining.

Support to States for Infrastructure: This was proposed by the Union Finance Minister, with an outlay of Rs. 1.5 lakh crore in the 2025-2026 Union Budget for 50-year interest-free loans to states for capital expenditure and incentives for reforms. The intent behind this initiative is to enable and encourage states to undertake large infrastructure investments in roads, urban infrastructure, social infrastructure, etc., without the immediate burden and tension of interest payments. Many of the gaps in infrastructure, such as roads, sanitation, water supply, and city planning, are not at the central level but rather at the state and municipal levels. Offering interest-free loans for a longer period of time to states will give them a chance to invest without putting pressure on their current budgets.

Urban Challenge Fund: It is an initiative to boost municipal infrastructure, improve governance, and accelerate urban planning. With Rs 10,000 crore earmarked for 2025-26, the fund is set to address land and development challenges, promote social infrastructure, and facilitate the expansion of urban corridors and smart cities through themes like "Cities as Growth Hubs", "Creative Redevelopment of Cities", and "Water and Sanitation". The purpose of the programme is to encourage states and urban local bodies (ULBs) to come up with good-quality, eco-friendly, and scalable urban infrastructure projects, in which the focus would be on those sectors that need an upfront investment, such as water supply, sewerage, sanitation, urban transport, and redevelopment.

Data-driven infrastructure mapping: One of the main aspects of the Gati Shakti programme is the use of leading-edge technologies, for example, GIS and data analytics, which will revolutionise the entire infrastructure planning process. The data-driven method allows decisions to be made in real time, thus reducing duplication of work.

Recycling capital: NMP was launched by the government as a structured roadmap to monetise brownfield (existing and revenue-generating) assets of the central ministries. The objective is to unlock value from public investments made in infrastructure and tap long-term private capital for further infrastructure creation. Monetisation under NMP does not imply an outright sale of asset ownership. It is about transferring revenue rights or operation rights for a specified period under contracts to private or institutional investors, while the government retains ownership.

The idea of capital recycling here is that by monetising existing brownfield assets like toll roads, transmission lines, rail assets, pipelines, etc., the government raises funds, which can then be reused to finance new greenfield infrastructure projects, thus reducing the burden of fresh public borrowing. Asset recycling enables creation through monetisation; in other words, mature assets with stable revenue are less risky for investors, and the proceeds from them are recycled to invest in new infrastructure, thus providing a sustainable financing path.

Budgetary Allocations

Allocation for capital expenditure is looking higher than ever, with the highest allocation of Rs 11.21 lakh crore in the budget for FY2026. Over the past decade, India's growth in infrastructure has been rapid, with capital expenditure increasing from Rs 2 lakh crore in 2014-15 to 11.21 lakh crore in 2025-26, almost a six times jump to the 'Viksit Bharat' ambition. The capital expenditure will continue to maintain its current level of 3.1 per cent of GDP throughout the Union Budget period of 2025-26. The government plans to execute its capital expenditure approval of Rs 15.48 lakh crore, which represents 4.3 per cent of the country's gross domestic product.

- **Roads:** The Union Budget 2025-26 allocated Rs 2.87 lakh crore to the Ministry of Road Transport and Highways (MoRTH), which represents a 3 per cent increase from its previous budget of Rs 2.78 lakh crore(BE).
- The National Highways Authority of India received a funding allocation of Rs 1.87 lakh crore, which represents an 11 per cent increase from its previous funding of Rs 1.68 lakh crore(BE) in 2024-25.
- **Railways:** The Union Government has allocated Rs. 2.652 lakh crores to Indian Railways. The figure is quite comparable to last year.
- **Airports:** The Ministry of Civil Aviation received Rs 2400 crore, which amounts to 9.7 per cent less than the revised financial estimate for the 2024-25 fiscal year. The Regional Connectivity Scheme will receive funding of Rs 540 crore. A new version of the Ude Desh ka Aam Nagrik (UDAN) scheme will be launched to establish regional connections to 120 new destinations, which will serve 40 crore passengers over the next decade.
- **Ports and Shipping:** The Ministry of Ports, Shipping, and Waterways (MoPSW) received an allocation of Rs 3471 crore according to the budget estimate. The allocation has an increase of 46.02 per cent over the budget estimate of Rs 2377 crore, made for FY 2024-25. The Maritime Development Fund, which has a total corpus of Rs 25000 crore, will be created to provide long-term financing support, with the government funding up to 49 per cent of the total amount. This fund allocation is part of a broader vision to give a boost to India’s maritime industry.

Other measures proposed in the budget include subsidising shipbuilding, the acquisition of ships, shipbuilding clusters, etc.

Involvement of the Private Sector in Infrastructure Development

India is at a moment when the country's appetite for roads, rails, metros, ports, and airports is enormous. That arrangement, called Public-Private Partnership (PPP), has been central to India's recent growth story: large highways, station redevelopments, waste-management systems, and even hospitals and student hostels now carry private names and private financing. Some of that has worked, but some of it has failed spectacularly. The question here is simple: are we using PPP to make durable, sustainable progress or to accelerate short-term gains that later become liabilities?

When budgets are tight and demand is enormous, PPP is attractive. It leverages private capital to build assets the public needs now. The PPP Authority, along with various government schemes (such as the Viability Gap Funding or VGF Scheme), has enabled the approval of numerous PPP projects, such as hospitals, student hostels, waste treatment plants, redeveloping railway stations, etc., with support from the central government to finance such projects, making them bankable. The VGF portal shows lists and approvals of such projects, indicating the larger scale at which PPP projects are being encouraged, as mentioned above.

Types of PPP

- **BOT (Build-Operate-Transfer):** A contractor funds, builds, and operates a project for the concession period, then transfers it. Toll roads are often BOT projects.

- **O&M (Operation & Maintenance):** a private firm operates or maintains a government asset for a contract period.

- **HAM (Hybrid Annuity Model):** the government pays a substantial up-front share (reducing private sector financing risk) while the private partner builds and operates the project.

These forms are flexible, and that is why they're widely used. The government PPP portal lists active VGF-backed projects and details of recent PPP approvals across sectors, showing the mechanics in practice. Some of them are listed below:

- Development/upgradation of the existing District Hospital to a Medical College at Giridih, Khunti, Dhanbad, Deoghar, and Jamtara in the State of Jharkhand via a PPP.
- Development of Medical College and Hospital at Namsai in Arunachal Pradesh through the Aspirational District Program in PPP mode through DBFOT.

Advantages

PPP brings three practical benefits to a cash-constrained state:

- Private capital opens up projects that the state cannot fund alone.

- Well-chosen private firms can accomplish complex technical tasks more rapidly.
- Also, contracts can be formulated that will help in sharing certain types of risk between the state and the private sector.

In many instances, PPP has achieved "real public value" with quick roads, revamped stations, and new municipal services where they would not have been possible otherwise.

Disadvantages

The difficulty with PPPs is that, in cases where public safety, ecology, and well-being do not coincide with profit maximisation, things go awry. The problem is a systemic one: a company is designed, by charter, to create a return, while a country has a systemic imperative to safeguard safety, ecology, and well-being.

Two such examples are:

• **Vivekananda flyover (Kolkata, 2016):** The collapse of a flyover during its construction caused the demise of many people in Kolkata in 2016. This incident highlighted how a civic infrastructure can turn into a disaster due to the lapse of sufficient time for completion of work and the failures of a contractor. Many issues of design weaknesses, and the contractor was blamed for the failure.

• **Morbi suspension bridge (Gujarat, 2022):** In October 2022, a suspension bridge used by pedestrians broke, resulting in over a hundred fatalities. Apparently, major issues about maintenance and permits were identified, and cases against the managers were filed.

The episode highlighted that handing assets to non-state bodies (trusts, concessionaires) without robust maintenance oversight can be deadly.

These tragedies are not proof that PPPs are inherently bad, but they are stark evidence that where the state does not keep a tight regulatory and supervisory hand, the private partner's incentives (cut costs, maximise revenue) may result in compromised safety or deferred maintenance.

Policy and contractual fixes

If PPP is to remain central to India's infrastructure strategy, these are the fixes that will reduce this "paradox" of continuing development without harming the environment and maintaining the existing infrastructure:

- Mandate robust and independent EIA and cumulative impact assessments within bid documents. If bidders are required to show their environmental plan, then as early as bid time (and not later), ecological costs will be internalised.

- Shorten and simplify accountability chains: Ensure inclusion of clear and enforceable maintenance clauses and escalations/penalties for lack of maintenance in contracts. Accountability for roles and names should be traceable during the entire period of the project.

- Construct a public-private performance dashboard. PPP performance data (safety incidents, environmental compliance records, maintenance records) must be available in real-time and will be accessible on a central portal. Citizens will be able to access information regarding the organisation they deal with to establish if they are compliant.

- Development of viability support (VGF) measures and risk sharing to encourage long-term stewardship. If part of public support depends on meeting long-term environmental and maintenance objectives, then private investors will be encouraged to act in a positive manner.

Bharatmala

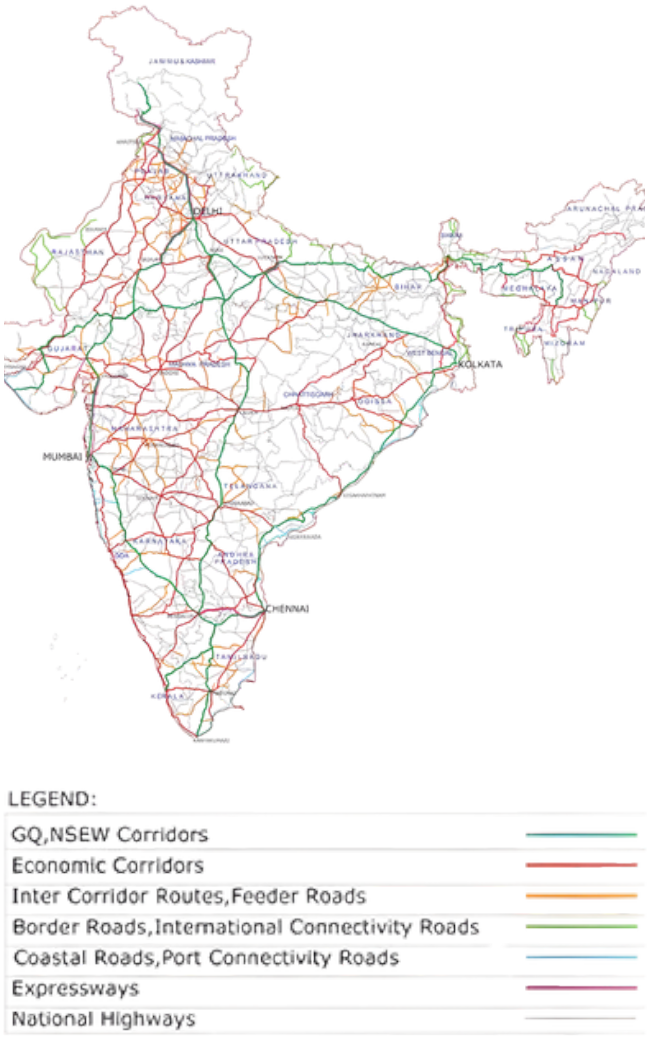
Bharatmala Pariyojana, also commonly referred to as The Indian Garland Project, is an Indian infrastructure project undertaken by the Government of India. The proposed mega project was first proposed and introduced by the Union Minister of Road Transport and highways by the name, Shri Nitin Gadkari, in the year 2015. The project was approved by the Cabinet Committee on Economic Affairs and was subsequently initiated by the Government of India as an umbrella programme of the highway sector in October 2017. This project is under the head of the Ministry of Road Transport and Highways (MoRTH). It is designed to connect 550 District Headquarters (out of the present 300) and could significantly boost our economy, as this will reduce logistics costs and travel time and would also help in industrial growth, as it will improve connectivity between production and consumption centres. Apart from this, millions of jobs will also be created because of it.

Some of the key components of its contribution to economic growth are:

- **Reduces costs and time:** This project reduces travel time and freight costs for both people and goods. This is done by building expressways and economic corridors, and it also leads to making businesses more competitive.

- **Enhances supply chains:** It helps in creating connectivity between major production and consumption centres through efficient trade routes and thus, strengthens the entire supply chain and supports indigenous manufacturing.

- **Boosts international trade:** International trade development occurs through the construction of international border roads and international connectivity routes, which enable trade with neighbouring countries. It originates from the border between Gujarat and Rajasthan, flowing through Punjab, Jammu and Kashmir, Himachal Pradesh, Uttarakhand, parts of Uttar Pradesh, Bihar, and West Bengal, and through the northeastern states of Sikkim, Assam, Arunachal Pradesh, Manipur, and Mizoram. Under this project, special attention has been given to enhancing connectivity in northeastern states. With such developments, there is a prospect for better trade relations with neighbouring countries like Bangladesh, Bhutan, Nepal, and Myanmar.



Source: Bharatmala E-Book, Ministry of Road Transport and Highways

This will entail an estimated investment of ₹10.63 lakh crore-US$130 billion in the committed new highways, which is the highest ever outlay for any government road construction scheme as of March 2022. The initial amount was kept as ₹5.35 lakh crore for Phase-1 of 34,800 km, but because of numerous delays, the project has been extended till 2027-28, and the total investment has also gone up substantially. As of mid-2025, around 19,826 km to 20,770 km of roads were said to be completed under Bharatmala Pariyojana. Still, most of it is under construction, and the total target is to develop 34,800 km of new highways. Till now, tenders worth approximately ₹8.54 lakh crore have been awarded.

Scheme	Length (km)	Cost (Rs. Cr.)
Economic Corridors	9,000	1,20,000
Inter-corridors and Feeder Roads	6,000	80,000
National Corridor Efficiency Improvement	5,000	1,00,000
Border and International Connectivity Roads	2,000	25,000
Coastal and Port Connectivity Roads	2,000	20,000
Expressways	800	40,000
Subtotal	**24,800**	**3,85,000**
Ongoing Projects, including NHDP*	10,000	1,50,000
Total	**34,800**	**5,35,000**

Source: Ministry of Road Transport and Highways

Scope

The Bharatmala Project is a venture that is in the form of an umbrella scheme that comprises various projects. The projects that are under this umbrella are as follows.

1. **Road and highway network upgradation:** According to this programme, it encompasses thousands of kilometres of roadways, including national highways, economic corridors, and feeder and intercorridor routes, which link major manufacturing centres, ports, and agricultural regions. Assisting in enhancing trade and economic development. This project contains 2 phases. The former includes 9,000 km of economic corridors, 6,000 km of feeder routes, 5,000 km of border roads, and 2,000 km of international connection routes as part of the National Corridors Efficiency program and 2,000 km of roads and 800km of expressways to connect to the coast and ports. In addition to this, there are also 10,000 km of NHDP roads. Therefore, Phase 1 will contain approximately 34800km of roads.
2. **Border and International connectivity roads:** Phase 1 of the Bharatmala entails the development of about 2000 km of new border roads to support its infrastructural growth. They are concerned with providing better connectivity to the international borders as well as contributing to the connectivity between India and its neighbours. They focus on enhancing road connectivity with the international borders and also help in linking India with its neighbouring countries. It also strengthens national security by improving access for defence forces and border management agencies. It also helps to increase cross-border trade and tourism, particularly with neighbouring nations like Nepal, Bhutan, Bangladesh, and Myanmar.
3. **Coastal & Port Connectivity Roads:** This segment of Bharatmala seeks to enhance port to coastal and the rest of the country connectivity. Its major aim is to enable the easy passage of commodities from ports to manufacturing and consumption hubs. It also benefits in the form of increased coastal tourism and trade, particularly in regions along India's 7,500 km-long coastline. Apart from that, it also facilitates the Sagarmala Project, which is a government scheme that works on port-led development.
4. **Greenfield Expressways Access:** This section of Bharatmala deals with developing a new generation of expressways from ground zero. These will be referred to as greenfield projects since they are built on virgin land. Their prime objective is to minimise road travel time and traffic congestion on the roads and link major economic and industrial centres with high-speed, safe, and efficient roads. Example: the Delhi Vadodara Expressway.
5. **Logistics Efficiency:** Aiming to reduce the overall logistics costs from the current estimated 18% to as low as 6-8% of the GDP. It also targets to optimise the movement of people and goods and improve India's Logistics Performance Index (LPI). A major component under this is the development of 35 Multimodal Logistics Parks (MMLPs) at strategic locations in order to make efficient cargo handling and distribution through a hub and spoke model. These parks are designed for seamless integration across different modes of transport like road, rail, and waterways.

Corridors

Economic Corridors: An economic corridor is a geographical area or route that connects major economic hubs with the required infrastructure and helps in increasing trade and growth. These corridors consist of transport links like roads, railways, and ports. They tend to facilitate the movement of goods, people, and capital. Their goal is to essentially lower transportation costs and stimulate economic activity. Economic corridors in Bharatmala are highway stretches that link high-production clusters, consumption centres, ports, industrial parks, and other high-growth centres. They are constructed to link factories, mines, ports, and inland logistics centres so that people and freight can travel more smoothly with ease. Under Bharatmala Phase I, approximately 26,200 km of Economic Corridors have been identified. Of this, approximately 9,000 km were to be undertaken in Phase I for execution.

Some of the Economic Corridors include:

- Mumbai–Kolkata
- Mumbai–Kanyakumari
- Amritsar–Jamnagar
- Kharagpur–Siliguri

National Corridors: A national corridor refers to an extensive infrastructure system that links industrial and transportation networks across multiple states to establish nationwide movement. National Corridors represent the primary highway systems that operate throughout India. The National Corridors Efficiency Improvement program under Bharatmala aims to enhance vital highway systems through three main activities, which include reducing traffic congestion, implementing system upgrades, building additional capacity and establishing better logistics management. The project requires multiple infrastructures to achieve its goal through street lane widening, new bypass construction, city ring road development, and high-level corridor construction and choke point elimination. The first phase of the project includes efficiency improvement work for 5000 kilometres of national corridor routes.

Golden Quadrilateral: The Golden Quadrilateral is the most popular national corridor in India, as perceived by the people. The network links four Indian metropolitan cities: Delhi, Mumbai, Kolkata, and Chennai. This has a total of approximately 5,846 km and carries the highest traffic in the entire country, with freight and passenger. This forms the backbone of the national highway system.

North South Corridor: This route begins in Srinagar and passes through many cities until it reaches Kanyakumari, the southernmost point of India. The distance is around 4000 kilometres and traverses through Delhi, Hyderabad, and Salem.

East-West Corridor: The route of the East-West Corridor is from Silchar, in Assam, which is on the northeast, to Porbandar, in Gujarat, which is on the western side. The route is able to cover a distance of 3300 kilometers, and it links the eastern and western parts of the country via the major freight transport routes. Apart from this, there are several industrial corridors as well.

An industrial corridor aims to create an area with a group of manufacturing firms or another industry. They are created in areas that have pre-existing infrastructure, such as ports, highways and railroads.

Infrastructure development corridors are a link between rural areas and urban growth. In the 21st century, industrial corridors are often viewed as opportunities for jobs and economic development in a region.

Other Related Road Construction Projects

- **NHIDCL:** The entity currently functions as a Schedule A Public Sector Undertaking. The organisation established itself as a whole government entity on the 18th of July 2014 by the registration of the entity under the Companies Act 2013. The modern infrastructure development project, which NHIDCl represents, serves as a vital solution to enhance connectivity throughout the most difficult and strategically important parts of India. The corporation functions under the authority of the Ministry of Road Transport and Highways to fulfil its main mission, which involves enhancing national highway systems throughout the country. The organisation focuses on developing border areas which constitute international boundaries between India and its neighbouring nations. The organisation executes various functions, which include national highway promotion, surveying, designing, constructing, operating, and maintaining national highways, tunnels, logistics centres, and other infrastructure facilities.
- **CRIF:** The Central Road and Infrastructure Fund (CRIF) is the major body which controls various infrastructure, including Transport, which includes Roads, Bridges, Ports, Shipyards, Waterways, Airports, Railways, etc. The law takes effect through the CRIF Act of 2000, which amended the Finance Act of 2019. The main objective of the Central Road Fund (CRF) is to finance the development and maintenance of roads. The organisation receives its main financial resources from a tax imposed on diesel and petrol sales. The organisation funds both road development and road maintenance, along with the construction of railway bridges.
- **NHDP:** The National Highways Development Project (NHDP) is a major initiative towards qualitative and quantitative enhancement of National Highways, involving development and 4/6 lining of about 13,150 km of road at a cost of over Rs. 54,000 crore (at 1998-99 prices). The primary objective behind it was to improve, expand, and improve the national highway network and make it an international standard. Apart from the nearly 14,000 km of highways being developed under NHDP and other projects, the Government has announced 4-laning and development of another 10,000 km of National Highway stretches.

Sagarmala

The Sagarmala programme aims to reduce the logistics cost of trade and EXIM transactions through developing the efficiency of ports, hinterland connections, and coastal shipping, besides moving down India's unreasonably high logistics burden. The initiative is conceptually in line with the Pradhan Mantri Gati Shakti National Master Plan that foresees integrated multimodal connectivity for reducing both transit times and inventory and transaction costs for exporters and importers.

Scale and Targets

Being rolled out since 2015, the programme has ever since been conceptualised and strategised to be the national flagship programme and includes close to 839 projects that pertain to the development of ports, port connectivity, coastal shipping, inland waterways, port-driven industrialisation, and coastal area development. The total investment planned in this area is around ₹5.8 lakh crores.

To be specific regarding the implementation aspect, more than 260 projects have been completed under the initiative, marking an investment of more than ₹1.4 lakh crore, aside from the massive number that are under implementation or under the planning phase. Modernisation of ports is solely responsible for more than 230 projects and close to ₹3 lakh crore in investment plans that focus on enhancing capacity and efficiency in major or non-major ports. Simultaneously, around 280 connectivity projects in the roads, rail, or multimodal segments of more than ₹2 lakh Crore aims at minimising the logistics hurdles in the hinterland and the port regions.

Central Initiatives

Sagarmala's foundation comprises two intertwined policy shifts: port modernisation (capacity expansion, efficiency upgrading, and the establishment of new ports) and port-centred connectivity (linking through rail and roads to the hinterland, building multimodal terminals, and reducing integration with inland waterways).

The modernisation of ports is directly aimed at the provision of more berths, the complete mechanisation of handling of cargo, and the entry of private terminal operators into the ecosystem of public ports; on the other hand, the connectivity projects will focus on cutting down pre-berthing detention and truck turnaround by extending rail sidings, setting up dedicated freight corridors, and creating linkages for coastal shipping.

The reasoning behind joining port capacity with hinterland throughput is theoretically valid, but at the same time, it poses huge complexities in the implementation aspect, as the performance of ports improves only through simultaneous investment by different departments and agencies.

In reality, the execution involves coordination issues (Indian Railways, NHAI, Major Ports, state governments, IWAI), multi-agency financing structures (PPP, central/state budgets, port trusts), and intricate land-acquisition processes, thus making holistic delivery slower than single-agency projects.

Coastal Economic Zones and Community Measures

The programme has gone beyond just building physical connections and ports to integrating the coastal industrial areas by linking up the Special Economic Zones (SEZs) with the ports, planning the Sagarmala Industrial Port Cities (SIPCs), and carrying out such projects as building up fisheries infrastructure and providing skills training that promote coastal livelihoods.

The idea is to make the ports' supply chain benefits internal by creating demand anchors nearby, thereby shortening the last-mile logistics, and clustering the manufacturing to export intensively.

Community programmes that are complementary to the economic development programmes are seen as a way to balance the macroeconomic gains with local inclusion. But on the other hand, the enormous investments involved and the focus of the authorities on port-led industrialisation pose a danger of uneven development, in which benefits are not only concentrated in the same areas but also in the same social classes.
This can happen unless there is strict monitoring and enforcement of land-use, resettlement, and local employment targets.

Data Review

Key indicators presented in aggregate for the program include port cargo handling capacity, average turnaround time, coastal cargo volumes, and inland waterway traffic. According to official reports, the capacity handled by major ports has expanded from the range of 800-870 MTPA in the mid-2010s to the range of 1,630-1,629 MTPA as of 2023-24, the average turnaround time has reduced from about 93-96 hours as of 2013-14 to about 48 hours as of 2023-24, and coastal cargo tonnage as well as inland waterways have experienced high percentage increases. Even though these types of major statistics are certainly important to monitor to track overall trends as well as note improvements, relying on capacity, as in the above case, might not accurately represent the true progress by overstating the efficiency of the operations, as the capacity handled by the ports is not necessarily the same as the usage, and the trend of declining turnaround times might not be the same in other ports or even categories of cargo. Hence, a thorough assessment necessitates the availability of port-level throughput, berth productivity, container dwell times, shifts in modal share, and private terminal performance data by commodity and seasonality to substantiate the claims made in aggregates.

Critique of Data Quality

Programme dashboards and press briefings that aggregate project counts and investment values are the means through which official monitoring of Sagarmala is conducted, thereby revealing its methods to some extent.
However, the use of such methodologies has its drawbacks and thus complicates the situation with respect to independent assessment. One of the major points of contention is that there are different numbers presented by various authorities when it comes to counting projects and finishing; this is evident, for example, in the public releases that show 272, 277, or 280 projects completed on different dates.

These lags in reporting, reclassifications of projects, or including/excluding state-level works are some of the reasons why such inconsistencies arise. The second limitation stems from the fact that aggregate investment commitments do not only present the difference between committed, sanctioned and actually disbursed funds; tracking financing flow requires tri-partite reconciliation across central allocations, state contributions and private investment certifications, which is very complicated. To fully understand what is going on in the ports and the hinterland in terms of capacity, one has to look at oral and written reports. Without port-level utilisation and container dwell-time data, it is difficult to attribute export competitiveness improvements directly to Sagarmala interventions.

Finally, claims on employment and export targets are typically modelled projections rather than ex post measured outcomes; such modelled estimates require assumptions about multiplier effects and demand elasticities that are rarely published in full, limiting reproducibility and auditability.

Comparative Outcomes 2014–2024

The major port capacity in India has increased significantly, average ship waiting times have fallen by nearly three-fourths, from about 93-96 hours to 48-50 hours, and inland waterway cargo has surged from roughly 18 million tonnes to over 140 million tonnes. These trends are in tune with the response of an integrated infrastructure thrust: more berths, mechanised handling, improved road-rail connectivity, and multimodal terminals that have come up, along with improvements in efficiency related to higher berth productivity and reduced pre-berthing delays, thus signalling broad efficiency gains.

However, it would be methodologically incorrect to attribute these improvements solely to Sagarmala. Several other concurrent reforms and market forces also transformed the logistics environment, such as customs digitalisation, the rollout of Goods and Services Tax, expansion of private terminal operations, rail initiatives such as the Dedicated Freight Corridor, global shipping cycles, and firm-level investment decisions. Aggregate capacity growth may be a reflection of private funding and trade demand, while faster turnaround times could be from both new infrastructure and system-wide operational modernisation.

Concerns

A major policy issue is the trend towards allocating investments primarily to the capital-intensive port modernisation and connectivity, which takes up the bulk of the reported expenditures and pulls money away from the more innovative and smaller-scale projects. The focus on big undertakings may lead to a reduction of available funds for community resilience, ecological protection, and local business support; furthermore, it could be a factor in increasing the differences among the regions if the large investments are made in already well-off coastal nodes. One of the main points of concern in the project delivery is speed: there are still a few hundred projects under implementation that belong to the identified pipeline, which counts approximately 839, so the progress of completion raises questions regarding the institutional capacity, land acquisition difficulties, and financial hurdles.

The opportunity cost of capital and the continuous maintenance burden after the completion also need to be addressed; the projects that are heavy on investment entail huge sunk costs and constant operations and maintenance (O&M) liabilities that have to be financed without the risk of impairing the budgets for the social sector.

Smart Cities Mission

The Smart Cities Mission attempted to revolutionise urban governance and infrastructure in 100 selected cities by combining area-based redevelopment and technological interventions.

The model was heavily supported by the use of special purpose vehicles (SPVs), which helped to centralise project implementation and draw in various funding sources, central grants, state/ULB contributions, and private co-funding, to pay for projects in the sectors of mobility, water, urban public spaces, digital governance, and energy efficiency.

The mission's dual strategy, which is area-based development for visible centripetal change and pan-city interventions for systemic upgrades, was designed to show urban renewal models that could be replicated and scaled across the whole urban system of India. Besides, the usage of SPVs by the best of the institutions aimed to make project delivery professional and to get rid of some bureaucratic inertia, but at the same time, it raised questions concerning governance related to transparency, local accountability, and continuity of leadership.

Progress Metrics

According to government reports, the Mission is expected to have done a total of about 8,066–8,075 projects in terms of work orders by the year 2024–25, and the Government's expenditure on these projects is anticipated to be around ₹1.64 lakh crore, with the completion percentages reported to be in the range of low-to-mid 90s (approximately 7,300–7,600 completed projects depending on cut-off dates).

The releases from the Centre indicate that the Centre's allocation (approximately ₹47,000–47,652 crore) has been almost fully utilised and that there has been a significant amount of state and private co-funding, which has resulted in the total investment reported being significantly more than the central outlay. The noted operational successes include the setting up of Integrated Command and Control Centres (ICCCs) in 100 cities, the placement of thousands of CCTV cameras, the distribution of solar street lights running into lakhs, and the installation of intelligent transport management systems in several urban locations. These indicators of process and output are quite appropriate for keeping track of the project delivery in real-time, but will still need the support of the outcome metrics to conclude if the projects have indeed led to inclusive urban welfare gains.

Methodology

The mission's innovative city-engagement approach gave the power to the local governments of each city to give a set of projects priority according to their local needs, and SPVs were meant to be the source of fast-track governance.

Those cities that had capable ULBs and strong admin were the ones that very quickly benefited from the decentralised system; however, at the same time, it did create a situation where some municipalities were very weak and couldn't cope with the planning and execution of complex public works or even attract private partners. The monitoring was mainly done through SPV reports and a central dashboard that shows the project status and financial disbursement updates; although this does allow for the real-time tracking of implementation, it is, however, also less effective in terms of qualitative outcomes and distributional equity. Questions like the transferability of the central funds, the exact amount of private investment and the differences in O&M arrangements from one city to another are not always visible in the public dashboards, making rigorous external evaluations difficult.

Spatial Equity

Data collected through observation indicates that the benefits derived from the Smart Cities Mission have not been distributed evenly: cities that were rich, capable and had good administration extorted a large part of the funds invested in the private and public segments with high visibility, while the other urban centres in particularly poor states just managed to keep the projects going. The area-based projects, which were dominating the whole mission, have, on one hand, supported the creation of landmark developments, but on the other hand, they have restricted the benefits to the city's core, where essential services for the poor have been left out.

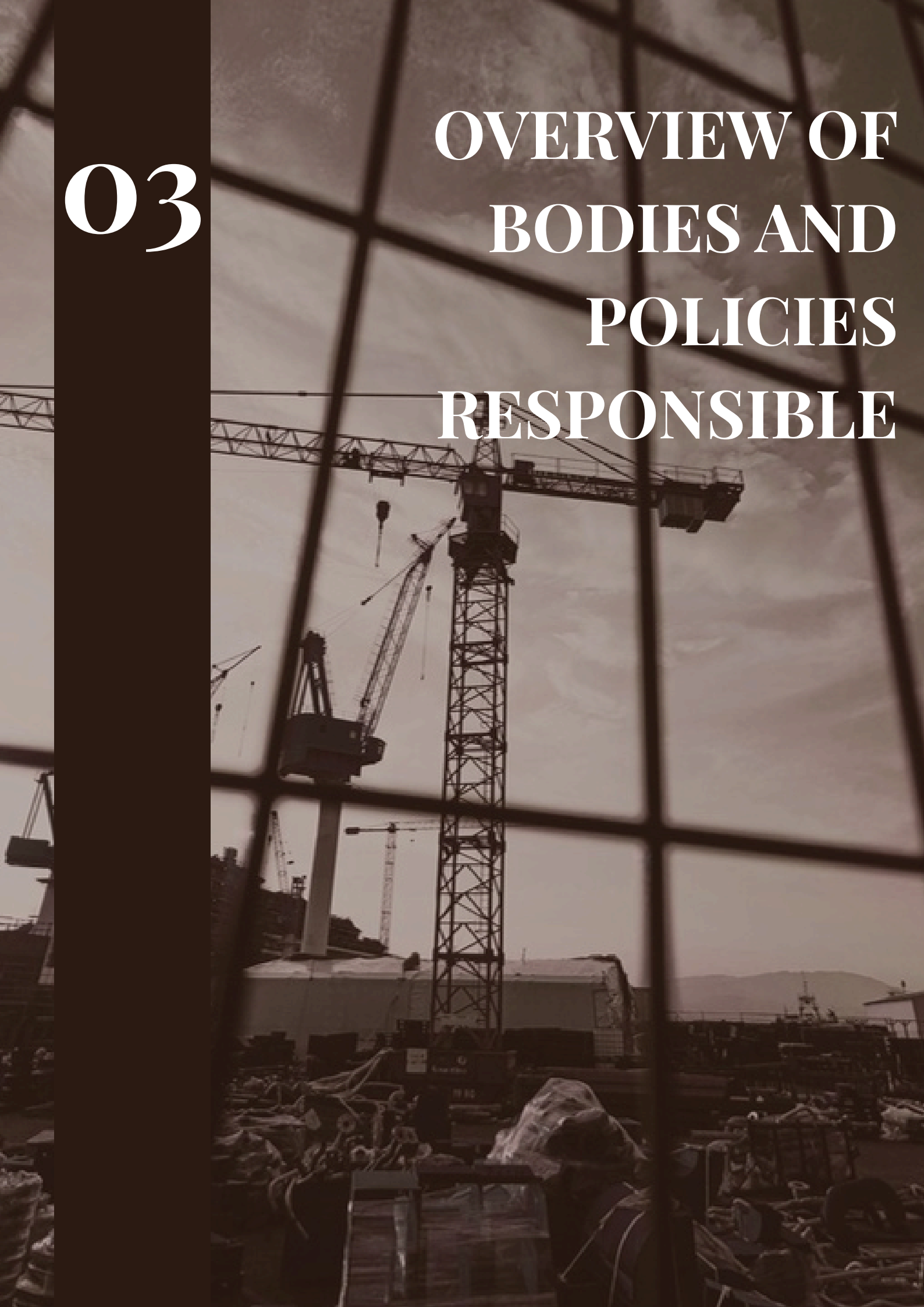
Furthermore, the technical side of the project, like the Integrated Command and Control Centres (ICCCs) and AI-powered traffic management, has often resulted in the urban poor not getting the priority they deserve because of the focus on efficiency rather than basics for the poor, like access to housing, water, sanitation and livelihoods for the informal sector. This scenario points out that the Smart Cities Mission was able to bring about urban capital projects, but its redistribution effect was somewhat ambivalent and subject to local governance capacity, as well as institutions for the welfare of the poor being in place.

Strengths and Weaknesses

The monitoring architecture for the mission (central dashboards, SPV periodic reports, and parliamentary questions) strongly traces the project counts and financial flows but is weak on beneficiary-level outcomes and third-party verification. Different ministry releases and the lagged reporting cycles indicate the necessity for standardised cut-off dates, independent project audits, and household-level surveys to verify service delivery achievements. The reports of the Standing Committee and independent evaluations have pointed out matters like the constant changes in SPV leadership, post-project constraints in O&M financing, and the little progress in the institutionalisation of pan-city solutions. In order to increase accountability, the mission should undergo regular impact measurement by way of household surveys, urban mobility studies, air and water quality metrics, and it should also provide open data on O&M budgets and contract terms.

03

OVERVIEW OF BODIES AND POLICIES RESPONSIBLE



OVERVIEW OF POLICIES AND BODIES RESPONSIBLE

PM Gati Shakti

The Vision

In 2021, the Government of India introduced the PM Gati Shakti-National Master Plan. The Gati Shakti philosophy is a straightforward yet radical one: all infrastructure ministries are to be planned in a coordinated way, rather than individually. It is facilitated by a digital GIS-based platform which lays over 1400+ layers of information of forest land, railway routes, power lines, water bodies, economic zones, demographic clusters, seismic zones, among others.

When these layers are combined, a highway-building ministry will be able to detect instantly whether it is going to cross a wildlife crossing, an irrigation canal, or a state project-in-progress.
The preconceived notion is that development must be faster, cheaper and more sustainable if the right people know the right data at the right time.

Working

It is coordinated through the Gati Shakti GIS platform, through the Network Planning Group or NPG. In every project that any ministry intends to undertake on such a magnitude, they look at the project under a variety of parameters, such as feasibility, ecology, financial optimisation, and long-term national corridors.

This virtual backbone makes the development of the infrastructure more proactive and not reactive. That is, instead of installing power lines once the new railway line has been built, they would be installed parallel to each other and would make relocation worth crores less expensive.

This is diffused throughout the infrastructure of roadways, rails, ports, aviation, power and telecom, where one is interested in making sure all these develop together as opposed to separately. Connectivity is being achieved by aligning highways with fibre conduits, maximising freight against rail and port utilisation, enhancing the air connectivity in the areas and harmonising the power grids and renewables. Doing so results in speed, efficiency and maximisation.

Effect on the Ease of Doing Business

Before Gati Shakti, logistics in India were estimated to be around 13-14% of the GDP, which is much higher than global standards. Under multimodal integration, this should be reduced to 8-9% to have an opportunity of competing with the Indian products.

The manufacturers are not facing the slowness of the freight movement, unpredictable transit times, and lack of planning of the industrial clusters.

Reduction in logistics efficiency has already been reported in the states of Gujarat, Maharashtra, and UP after they switched to a data framework as a part of Gati Shakti.

Sustainability of the Environment and Climate Sensitivity

The Gati Shakti makes it possible to directly include in the planning interface Eco-Sensitive Zones, forest boundaries, wildlife corridors, watershed lines, and landslide-prone areas.

This means that:

- A tiger movement route is opposed to a road alignment during the planning phase.
- Before the real construction starts, a railway line that has to pass through the floodplain could be diverted.
- Projects in the Himalayas are best improved with regard to the geotechnical scrutiny.

The planning initiative of embedding environmental intelligence would be directed towards ecologically blind growth.

That does sound ideal on paper. And in other instances, it is even working. An example is the Jogighopa MMLP in Assam, which is under PM Gati Shakti in order to integrate the road, rail, and water networks along the Brahmaputra River. Equally, the Pune-Bengaluru Expressway and the Mandi-Dabwali-Panipat Corridor are suggested to reduce the time taken to travel and to increase the efficiency of freight transportation. Such projects demonstrate that coordination and sharing of data can even make infrastructure more efficient.

However, when you take a closer look at those things, especially from an environmental or social point of view, the plot is not flawless, either. Yes, Gati Shakti has actually made it easy to coordinate faster and approvals smoother, but that speed comes with its issues. More expedited clearances may imply less time to conduct adequate environmental analyses or engage in community consultations.

The Challenges Ahead

Nonetheless, there are some grave challenges to the initiative. Most state departments rely on disjointed offline data, which consequently brings data inconsistency.

1. Land acquisition is also rather a slow and politicised process.
2. The unavailability of the portals in the local planning bodies is a digital barrier to the use of the portals.
3. The terrain of Himalayan and the Northeast requires extremely special alignment studies.
4. However, through regular training and coordination of the state, the difficulties can be solved.

EIA

Environmental Impact Assessment (EIA) is intended to act as a proactive safety net. It is a procedure wherein one looks into the future of the possible effects of a given project on the environment, the people and the economy and then helps to identify ways in which they can be prevented or minimised.

Basically, it is a procedure that involves simple yet basic questions: what will occur as a result of this project happening, how small or large an impact it may be, what kind of damage may be avoided, and how it may be mitigated.

EIA in India

The EIA system in India is under the Environment (Protection) Act and is managed by the Ministry of Environment, Forest and Climate Change (MoEFCC). The routine process seems to be as follows: screening, scoping, baseline data gathering, impact prediction, drafting an EIA report and mitigation plans, public consultation (hearings), and ultimately a decision-making process and eventual monitoring and compliance. Ideally, the process would be a cyclic process which would start with proper planning, then an evaluation of viability and consequences. This is coupled by seeking the opinions of stakeholders prior to the decisions, and the whole process is carefully followed, and the experience is incorporated back into the planning process. Those steps and institutional checks that are expected to follow are summarised in the very portal of the ministry.

Where EIA succeeds

There are actual teeth in EIA when it is properly done. It has the power to suspend or reprocess those projects that would cover crucial habitats, put a strain on means of livelihood or drain the local water supply. The overall theme of the EIA is not to impede development but rather to force the projects to be redesigned in such a way that the benefits are not drawn out of the ecosystems and human lives.

Progressive development, but at high expense; EIA is the instrument that is intended to render such hidden expenses transparent in front of it, metamorphosing into tragedies.

Where EIA fails in India

Regrettably, the Indian EIA process is often undermined by its promise due to several reasons which are closely connected:

- Shallow analysis and ineffective fieldwork: most of the EIAs are not done on a desk-to-desk basis or shallow sampling, but rather through effective fieldwork. It results in the bad prediction of impact and bad mitigation plans. A typical example is the POSCO (Paradip) captive port EIA.

- There is no consideration of cumulative and cascading effects: Projects are often evaluated in isolation, and not within a greater context of projects. Cumulative coastal effects and sediment dynamics were missed over and over again in the POSCO and other marine/port EIAs.

- Public participation is a procedural but not a substantive process: Public hearings are supposed to consider local perspectives and knowledge to be part of the process. Nonetheless, the involvement of the public at the hearings is usually hasty, technical reports are accessible in English only, and the results of supporters are not shared with society. This poses a problem concerning the legitimacy of decisions and covers actual social costs.

The draft EIA reforms, as proposed in 2020, were criticised in terms of lessening the involvement of the people and the time requirements to respond to the feedback.

- **Regulatory dilution and post-facto clearance:** A more frightening twist has been towards "regularise-after-the-fact" strategies: the project begins working and only asks to be cleared afterwards. Critics have submitted that the EIA 2020 draft had institutionalised such post facto clearances and other dilutions and encouraged non-compliance instead of discouraging such. When the clearance procedures are transformed into an ex-post paperwork process, the role of EIA as a preventive measure will be compromised.

- **Shortages of capacity and enforcement**: The monitoring agencies (state pollution control boards, MoEF offices in the targeted areas) tend to be understaffed and underfunded, though the reports on EIA may be thorough and honest. Poor monitoring, absence of enforcement of terms, and absence of disclosure of the status of compliance to the masses imply that mitigation plans are usually on paper promises.

POSCO (Paradip, Odisha)

The planned captive port and steel plant attracted a great amount of attention due to the lack of sufficient examination of cumulative effects, livelihoods, coastal processes, and turtle nesting areas in the EIA process. The independent evaluations (by CSE and others) highlighted the way in which the loopholes in field-based inquiries and lack of cumulative impact evaluation may conceal major damages to society and the environment- damages which had to be experienced through further mobilisation and legal actions.

Vizhinjam Port (Kerala)

A much more current case on the coast exemplifies the controversial nature of EIAs. Erosion and loss of livelihood were something not anticipated in the beaches, and when breakwater and dredging activities commenced, there were warnings raised by both the local fishing communities and scientists. Proponents cited modelling and validation by institutes, and local residents cited the damage to the coast and loss of homes through erosion. Vizhinjam also demonstrates the multidimensionality of coastal processes, the insufficiency of EIAs for small projects to comprehend the processes of the shoreline, as well as the immediate anthropogenic effects in cases where there is a discrepancy between the models and reality.

The report states that infrastructure projects may be a source of temporary mobility or capacity, but have long-term ecological and vulnerable community costs. By institutional mechanisms of procedure shortcuts, watering down of regulations, and lax enforcement of laws, the weakening of EIA is the institutional mechanism that transforms progress into damage. Once EIA is another feature of the box-ticking process, instead of a serious point of decision making, the projects that should not have been allowed to proceed, and the contradiction gains new momentum: short-term benefits, long-term costs.

Reforms

To make EIA correspond to the narrative of responsible progress, the following reforms are necessary:

- **Be cumulative and regional assessments compulsory:** For clusters of projects (ports + industries + coastal tourism; multiple hydropower projects within one watershed). System-level stress is not seen by EIAs one at a time.

- **Abolish the post-facto clearance system:** Revise the language of legislation in such a way that projects cannot occur without previous clear clearance, publicly verified, and permanent amnesty periods.

- **Enhance civic engagement in practice, not procedure:** Provide EIA summaries in native tongues, lengthening of the period of public notice, publishing of hearing feedback and monitoring accessible, and independent facilitators of disadvantaged groups.

- **Increase monitoring and enforcement competence:** Properly fund and staff SPCBs and MoEF regional offices; design third-party, citizen accessible compliance monitoring systems to ensure that citizens are able to track compliance with mitigation measures.

National Infrastructure Pipeline

Overview:

The National Infrastructure Pipeline (NIP) FY 2019-25 is a state programme that intends to bring the citizens the infrastructure of the world, to enhance their lifestyle and comfort. It would allow the government to write long-term financing tools, such as the Development Finance Institutions (DFIs). Before NIP, there was no single scheme of planned infrastructure investments at the governmental level and on a project-by-project basis, which would allow policymakers, investors and project developers to coordinate their activities. The dissemination of the information regarding planned projects was among ministries, state governments and local bodies, which complicated the determination of the investable opportunities, the prioritisation of project preparation and the mobilisation of long-term funding. The NIP was developed by a High-Level Task Force, which was constituted under the chairmanship of Atanu Chakraborty, Secretary, Department of Economic Affairs (DEA), Ministry of Finance. It is a move towards the realisation of the grand target of India becoming a USD 5 trillion economy. It entails both brownfield projects (development of an existing project) and greenfield projects (development of a new project). The project cost of over Rs 100 crore will include economic and social infrastructure development of the centre, state, and local bodies. It is aimed at giving it a shot to generate jobs in other sectors and to make it more inclusive. In order to fund infrastructure more, the India Investment Grid (IIG) was introduced in order to serve as the active supervisor of the projects, introduce necessary changes, and address any possible concerns. The NIP is a financial viability joint funding model. The capital expenditure was to be distributed between the Centre, States and the private sector.

This share was initially aimed at about 39%, 39%, and 22%, respectively, and there is a heavy focus on the appeal to the investment of the private ones.

Projects and Investments

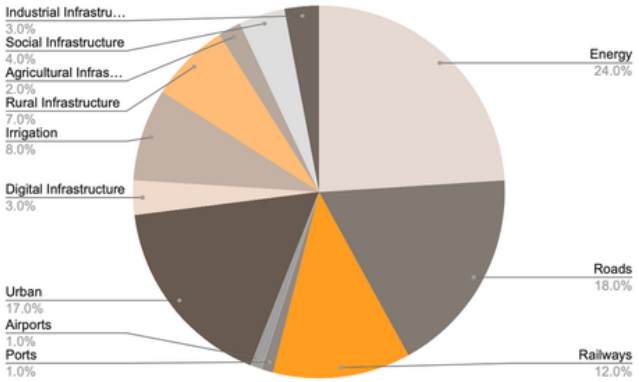
- **Initial Projections:** NIP had earlier estimated a cumulative projected capital outlay of Rs. 111 lakh crore in FY 2020-2025. In order to supplement the growth process, numerous programmes were initiated, including the PM Gati Shakti portal, National Single Window system and the National Monetisation Programme. Initially, approximately 6835 economic and social infrastructure projects were initiated. Energy (24%), Roads (18%), Urban Infrastructure (17%), and Railways (12%) sectors constitute a share of about 71% of the estimated capex. The Centre (39%) and state (40%) will have an equal portion of implementation of NIP, and the last category is the private sector (21%).

- **Status as at September 2011:** There are 36 projects with a 40 per cent value of the total capex of Rs 111 lakh crore under implementation, 30 per cent value of 36 projects under conceptualisation and development of 22 lakh crore value of projects. Projects with a value of 11 lakh crore (10%) do not have information concerning the project status.

- **Coverage Growth:** In 2022, the Ministry of Finance (MoF) informed the media that the projects are covered in the NIP, and they have been increased to 9,335, with an estimated investment of close to Rs. 108 lakh crore in these projects.

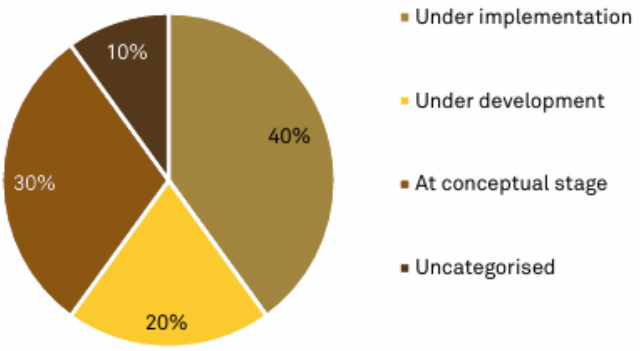
According to official reports by the Finance Ministry, as of late 2023, NIP had claimed to have captured a total of more than 9,288 projects with a total outlay of Rs. 108.88 lakh crore to 2020-25.

Sector-wise break-up of capital expenditure of Rs 111 lakh crore during fiscals 2020-2025



Source: Report of the Task Force, Department of Economic Affairs, Ministry of Finance, Government of India

Stage of Implementation



Source: Report of the Task Force, Department of Economic Affairs, Ministry of Finance, Government of India

Critical Assessment

- Local infrastructure negligence: The pipeline focuses on relatively bigger projects, and therefore, it overestimates the importance and quantity of smaller, local projects capable of better social returns per rupee.

Thus, it creates a misleading impression of what the technical definition of infrastructure growth is like at the grassroots level.

- **Disproportionate Investments:** 85 per cent of the huge investments of the NIP are redirected to four high-priority sectors, namely transport, energy, real estate and water management. Approximately 60 per cent of NIP investments are absorbed in 6 distinct sub-sectors, namely roads, railways, metro systems, renewable and non-renewable energy and transmission lines. The major sectors, except real estate, have major investments concentrated on 3-4 states geographically.

- **Weak Monitoring:** Initially, it was planned to be done in the form of frequent reviews and corrections; however, ground-level implementation has been rather inhomogeneous. And without a robust monitoring system (not only displaying projects on a dashboard), there is also the jeopardy of quality and compliance with specifications like materials and services to maintain the infrastructure over the following years. Several analysts have indicated that India lacks institutions of adequate strength on the subject of dispute-resolution, contract-enforcement, and independent audit of project completion and quality, especially on PPP and projects led by the private sector. This loose system of governance is shaking the credibility of NIP: the announcements of mega-projects can continue increasing; however, the actual performance, quality, and maintenance can be backsliding.

- **Low rate of completion:** Land acquisition, environment clearances, process delays and cost overruns are some of the most significant aspects that inhibit the smooth completion of a project. Long gestation and low returns projected make projects economically unfeasible, and this creates a threat to the stakeholders, both the public and the private. By March 2025, the NIP had covered 13,000 projects costing a total of Rs. 185 trillion, almost fifty per cent of which is in the transport sector. Nevertheless, the key problem still is implementation, with projects being completed at a rate of 20% to date, and 45% of projects are in progress.

- **Environmental Implications:** NIP is criticised for being too focused on grey infrastructure and not climate-resilient, low-carbon alternatives. There has been an analysis of inadequacy in the integration of climate resilience, environmental protection, and green infrastructure. Big infrastructure has a longer lifespan, but when these facilities are not built with climate resiliency in mind, they will become orphaned resources in the future, particularly when climate change strikes in the form of floods, droughts, heat, and overstrained resources.

- **Low participation of the Private Sector:** The participation of the Private sector is still low, with less than 1 per cent share. The NIP projects are mostly implemented by Government entities. The NIP pipeline has a marginal share of 11% in the Public-Private Partnership.

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Key Objectives:

Atal Mission for Rejuvenation and Urban Transformation (AMRUT) came into action on 25 June 2015. It was geared towards making the life of the urban population in the urban cities across India better through addressing the primary shortages that were crippling the urban cities, mainly in water supply, sanitation, and urban facilities. The mission acknowledged that there were many urban localities which were lacking the basic infrastructural facilities like piped water supply, proper sewerage, proper drainage, green open spaces, and well-planned water-management systems. The Mission reached 500 of the chosen cities and towns, which also included the state/UT capitals, large industrial towns, and tourist towns. The central government funds it and allocates the funds to the States and UTs depending on the population of the cities and the number of towns.

The mission has five city areas of concentration:

- Water supply
- Sewerage/septage management
- Water drainage
- Parks and green open spaces
- Urban transport Non-motorised transport.

The demand to build urban infrastructure continued to grow, and hence, the government resolved to reinitiate the mission as AMRUT 2.0, which was approved in October 2021, with a broader ambition.

The indicative outlay on AMRUT 2.0 totals ₹2,99, 000. As part of AMRUT 2.0, the Ministry of Housing and Urban Affairs (MoHUA) created the Jal Hi AMRIT initiative to stimulate the efficient operation of sewage plants by the states and UTs. It aims at providing a universal water supply by connecting houses to tap connections in all 4,378 statutory towns. The other goal is 100 per cent coverage of residential sewerage/ septage management in 500 AMRUT cities and 2.68 crore tap connections and 2.64 crore sewerage connections to bring out the desired results.

The main areas of interest within AMRUT 2.0:

- To introduce 100 per cent household tap water connection in statutory towns.
- To design septage management systems in 500 AMRUT cities to serve the whole population.
- To promote the use of treated wastewater in gardening, agriculture and industries.
- To guarantee the revitalisation of water bodies and groundwater recharge.
- The creation of City Water Balance Plans (CWBP) to make good use of water.

Progress:

In July 2025, the Ministry of Housing and Urban Affairs (MoHUA) had indicated that 4,065 projects worth Rs 77,317.40 crore were completed out of the total 8,205 projects, and 4,410 projects worth Rs 1.05 lakh crore were in the process of floating tender or preparation of detailed project report (DPR). Approximately half of the sanctioned projects are connected with the management of water supply, sewerage and septage.

The mission has had a series of achievements and notable successes over the almost decade of its operation, which depict its scope and objectives. Among the most important are the most important figures and the outcomes:

- It has been able to offer 2.03 crore tap connections and 1.50 crore sewer connections. There are 14,828 AMRUT and AMRUT 2.0-sanctioned projects worth Rs 2,73,649 crore. The physical completion of works estimated to be approximately Rs 112,368 crore has been done.
- The urban parks built have increased to approximately 2,994, which cover approximately 6,869 acres.
- The water body rejuvenation has also been impressive: water bodies rejuvenated have been over 544, with a total of 9 511 acres.
- On the aspect of environmental/energy, through the mission, 99 lakh LED streetlights have been installed, which, among other things, saved huge amounts of energy and reduced CO2 emissions as a constituent of the sustainability element.

The mission also permitted both the traditional projects through the government and also the ability to participate by the private sector, public-private partnerships (PPPs) in the big cities, and mapping of urban-solution start-ups to create innovative water and sanitation solutions, leading to a hybrid model of citizen infrastructure and market-oriented innovation. In a nutshell, AMRUT has achieved absolute success in the sense that it has managed to introduce a total transformation of urban water and sewage infrastructural systems in all of urban India.

Challenges:

This has evolved despite the immense improvements, with approximately 200000 deaths being caused by the absence of water, sanitation, and hygiene services each year, and approximately 31 per cent of urban Indian households have no piped water,r and 67 per cent of urban households have no pipe sewerage systems.

Infrastructure Growth with AMRUT does not necessarily ensure ecological sustainability and long-term sustainability. The interventions pose a risk to the formation of new environmental problems if they are not handled, followed, and planned in relation to ecology. A few of the problems are the following:

Water resource strain: A report by NITI Aayog estimates that the groundwater of approximately 21 leading cities will run dry by 2030, leaving 40 per cent of the Indian population without drinking water. Under the central fund allocation division, some 35,250 crore is allocated to water supply, out of a paltry 3,900 crore to the rejuvenation of water bodies, green spaces, and parks. This disparity in funding reflects that such ecological projects as recharge, waterbody health, and green infrastructure are not as important as supply infrastructure.

Slow waste being treated: In 2020-21, India generated about 72,368 MLD of sewage, but the treating plant capacity added is only about 31,841 MLD. This demonstrates that a massive fraction of wastewater remains untreated, and this is counterproductive to the gains of laying new sewer networks under AMRUT.

Disproportional service: Water and sewerage projects are still in suspension or half implemented after the approval. An example of this is that in small towns with AMRUT 2.0, the wards served are very few, and those remaining are not supplied with water.

In Nepanagar, Madhya Pradesh, 11 wards of the 24 planned wards in the town have been kept, reaching out to only 34.35 crore worth of projects. During the second stage of AMRUT, states and union territories (UTs) had two years to develop and approve their State Water Action Plans (SWAPs). To date, the funds out of the Rs. 66,750 crore funds that had been earmarked, amounting to Rs. 63,976.77 crore, have been given approvals. Some of the states, like Arunachal Pradesh, Chhattisgarh, Delhi, and Haryana, are said to have over 90 per cent of their funds yet to pass through, and they are yet to complete their SWOPs.

Bharatmala

Bharatmala Pariyojana, also known as the Garland Project, is an infrastructure project that looks after the development of highways and roads in India. It was launched by the Government of India to help in the development by producing economic corridors, national corridors, border roads and feeder routes. It aims to improve logistics and strengthen trade across states as well as international borders.

Objective

The logistics cost in India has always been high because of inefficient road connectivity and overdependence on a few routes.

The Bharatmala project, through its corridor development strategy, plans to lower logistics costs by connecting production sites, ports, markets, and industrial sites. Thus, it essentially:

- Reduces Cost and Time
- Strengthens supply chain
- Boosts International Trade

Current status:

An economic corridor is a geographical area or route that connects major economic hubs with the required infrastructure and helps in increasing trade and growth.

Some of the Economic Corridors include:

- Mumbai–Kolkata
- Mumbai–Kanyakumari
- Amritsar–Jamnagar
- Kharagpur–Siliguri
- Raipur–Visakhapatnam

National Industrial Corridor Development Programme (NICDP)

NICDP is the National Industrial Corridor Development Programme. This is an infrastructure project started by the Indian Government to develop futuristic industrial cities known as ‘Smart Cities’ across India. These Smart Cities would have infrastructure supporting manufacturing and economic growth. This programme aims to make India competitive in the international market, attract investments, generate high employment opportunities, and lead to socio-economic development. The program is being implemented through the National Industrial Corridor Development Corporation (NICDC) in collaboration with state governments.

Vision and Objectives

The main objective of NICDP is to enhance India's manufacturing sector, which is currently 17% of GDP, so with NICDP, it is aimed at reaching 25% by 2030. This all will be possible only by building a national network of industrial and logistics corridors that will greatly enhance exports, and with this, the exports are aimed at reaching $2 trillion by 2030.

Apart from this, 12 greenfield smart industrial cities across 6 major industrial corridors have been planned to be built. They will provide world-class utilities and help in connectivity and building a business-friendly environment.

Key Industrial Corridors under NICDP

Delhi-Mumbai Industrial Corridor: This corridor extends over 1,500 km in 7 states. It will be a large investment zone with 6 greenfield industrial cities. The investment in this is approximately $100 billion.

Chennai-Bengaluru Industrial Corridor: This corridor is spread over Tamil Nadu, Karnataka, and Andhra Pradesh and has a crucial focus on auto, electronics, and heavy engineering.

Amritsar-Kolkata Industrial Corridor: This corridor will increase the development of the eastern region industries, such as textiles and agro-processing, making them develop to a greater extent.

East Coast Economic Corridor: This corridor assists in increasing India's coastal export capacities and also decreases logistics costs to a greater extent. This corridor's logistics are expected to decrease costs by 30% and increase India's port traffic.

Bengaluru-Mumbai Industrial Corridor: This corridor increases connectivity between two large industrial centres and supports industries such as IT, textiles, and engineering goods. It plans to assist the manufacturing sector's efficiency and decrease costs by 20%.

Impact on infrastructure

Logistics and transport development: The NICDP supports the development of over 100 smart cities and equips them with efficient transport systems and digital infrastructure. The key focus here is to reduce logistics costs and make it less costly.

Plug-and-play industrial parks: These are the new industrial parks that are being developed under this programme. They are perfect for investment, as these offer ready-to-use infrastructure, enabling businesses to start operations almost immediately and reduce red tape and other government compliance.

Digitalisation and 'Industry 4.0': By leveraging technologies such as Internet of Things (IoT), automation, and data analytics, the NICDP has been working on "Industry 4.0" that aims to facilitate industrial zones, resulting in efficiency. Therefore, lead time in manufacturing and productivity improvement by 15-20%

Multi-modal Connectivity

This involves the integration of rail, road, port, and airport networks to cut logistics costs, and it has been put into effect with the main objective of reducing the cost of both time and money.

The Pradhan Mantri Gram Sadak Yojana (PMGSY)

It is a rural infrastructure scheme that was initiated by the Government of India with the aim of improving all-weather road connectivity in all underdeveloped as well as unconnected areas. This is an important poverty alleviation strategy.

PMGSY aims to integrate remote habitations with mainstream economic and social systems. This is done by establishing sustainable rural road networks. This programme emphasises high uniform technical standards and encourages state-level policy planning for effective long-term management.

Objective

The primary aim of PMGSY is to enhance and develop the existing rural road networks. This includes Major Rural Links (MRL) with a national target to improve 50,000 km of roads in the States and Union Territories. The improved connectivity through PMGSY helps rural areas by connecting them to major services and facilities such as:

- Gramin Agricultural Markets
- Higher Secondary Schools
- Primary & Community Health Centres/Hospitals

The above-mentioned connectivity helps directly in enhancing socio-economic mobility and rural development.

Planning and Selection of Roads

The road planning process in PMGSY is a multi-step process that is part of the District Rural Roads Plan (DRRP).

The DRRPs keep updating the existing road lists and connectivity gaps. The roads are selected through a scoring system-based evaluation mechanism. This is leading to a Comprehensive Upgradation-cum-Consolidation Priority List (CUCPL), and this is done for each district.

Quality control under PMGSY:

A three-tier quality control mechanism is adopted for this:

Programme Implementation Unit (PIU): This is the first-tier unit and is responsible for site supervision and also ensures that the materials and manpower used in construction are according to the specifications. This is a very important unit in the entire process of implementation.

State Quality Monitors (SQM): This, being the second tier, is looked after by the State Government and plays a key role in periodic inspections. Unless they are properly implemented, the work may flow in any direction.

National Quality Monitors (NQM): This is the third tier, and its major work is to perform random inspections on any specific date and provide feedback about the quality control systems. This gives us the actual idea about the quality, as these are done on completely random dates.

National Highway Authority of India (NHAI)

On paper, the work of NHAI appears to be a success story: a mobile world, faster economic interchange, and connectivity.

Directly behind the shining tarmac is another truth. The highways that are cheered because they are helping to bridge distances are literally becoming mute spectators to environmental degradation and systemic displacement, as well as environmental vulnerability on a long-term basis.

The story of their own development is always unfolding to a certain extent, and the cost they impose on the environment and societies is hardly ever paid.

Highways vs. Ecology

Highways traverse forests, wetlands, delicate landscapes, and conventional habitats. The NHAI sustainability reports themselves identify some of the more prevalent environmental risks of road expansion as cutting down roadside trees, interference with the regional drainage systems, slope cutting in the hilly or mountainous regions, destruction of agricultural land, and negative impact on the water resources. The expansion of highways in Kerala, led by NHAI, caused severe ecological and safety disturbances: wetlands and paddy fields were expropriated, the drainage was disrupted, roadside walls collapsed, and other sections were prone to flooding and collapse during monsoons. The latter is not an isolated occurrence; the same trends have been witnessed in several locations.

The most obvious example is the case of the Himalayas, as per the Char Dham Highway Project, which was majorly constructed under the supervision of NHAI (or central coordination). An amalgamation of unscientific hill-cutting, forest deforestation, and expansion into dangerous slopes has been continually blamed as the cause of landslides slope failures, and ecological disintegration in places that were already geologically precarious. This has been discussed in the case study on Uttarakhand. It has been reported that more than 50,000 trees had been uprooted in some areas, and millions of cubic metres of soil had been moved about by the earth movements.

The absence of forests and natural slope-stabilising vegetation resulted in the landslides and rockfalls, and in some of the tragic incidents as a result of rain, even moderate rain, resulting in the loss of human lives. In addition to this, numerous large-scale highway plans have attempted to evade the environmental scrutiny required: the Char Dham scheme was formally separated into discrete segments (less than 100 km each) to prevent the actual commencement of a full Environmental Impact Assessment (EIA), despite the scheme actually being an 889-km stretch of highway expansion. This sleight-of-hand bureaucracy compromised environmental protection and facilitated rapid tracking of constructions in sensitive areas.

When Highways Fail

Highway cuts have caused landslides, frequent road closures, destruction of livelihoods and houses, and displacement due to slopes that have been destabilised. Areas that were once covered by forests lose biodiversity, the ability to hold soil and water, and are prone to flooding, soil erosion, and chronic degradation. Standing wetlands and farmlands are engulfed by concrete corridors, shrinking natural floodplains, cutting down ground water recharge and driving local agrarian communities away.

Roads constructed in either strategic areas or remote areas, which are usually situated on hills or coastlines, could be a disaster area in the future when hit by the monsoons. The NH-66 along Kerala's coast or the bypasses using paddy fields and wetlands demonstrate how inappropriate blanket highway templates are, where they are not locally adapted to the environment.

In this way, the infrastructures constructed to facilitate this so-called development tend to undermine the ecological bases, which need to be strong enough in the long term to enable resilience, which is a characteristic of the so-called paradox of progress.

Institutional and Policy Weaknesses.

The issues are partially compounded by the general scramble to be constructed: targets, deadlines, and visible deliverables (kilometres laid, expressways made operational) and less so on site-sensitive planning, terrain-sensitive design, and follow-up. The environmental risk (such as slope cutting and disruption of drainage) is recognised by NHAI even in the places where it happens, but in reality, the long-term ecological protection is not followed.

In hilly or humid areas, a standardised road-design pattern appropriate to a plain is used without alteration. Slope stabilisation is not done, drainage rationale is disregarded, and landslides or floods are considered expected externalities, not structural failures. This model, based on a template, disregards the intense geographic variation in India. There is also an accountability gap. Fragments of projects are also created to circumvent legal protection (such as EIA).

With a highway constructed, the two components (social and environmental) are neglected in terms of maintenance. Long-term monitoring and mitigation rarely consider local communities that are usually displaced or disrupted.

Pattern Rather than the Exception.

In Kerala, following the development of a national highway, it was reported that there occurred recurrent floods, damage to the roads in a few months after the construction and the collapse of the protective side-walls to safeguard the highway. Wetlands and paddy fields were destroyed locally.

In the Himalayas, the Char Dham, which was constructed to bridge great religious places of worship, has already turned fertile slopes into unstable landslides. Thousands of cubic metres of soil movement, deforestation, and recurrent slope failures have been reported soon after the road cut of road projects.

According to experts, the traditional formula of building access roads wide enough to expand when necessary just does not work in areas with mountains, where the slope, drainage, seismicity, and rainfall demand terrain-sensitive design.

NITI Aayog

In 2015, NITI Aayog was established to replace the previous Planning Commission. The reason was simple: India is highly diverse, both geographically and culturally; coupled with its economic background, it could not rely on a single model.

NITI Aayog was supposed to be more adaptable, more cooperative, and more fact-finding. Instead of dictating from the centre, it would consult with states, making adjustments in policies to local realities.
Ideally, such a change was logical: what would be effective in Kerala would not be useful in Uttar Pradesh; what can be useful in a coastal district would not work in a dry area. The framework of NITI Aayog was to accommodate such regional differences and yet provide the country with a vision.

The Aspirational Districts Programme (ADP)

The NITI Aayog flagship programme is the Aspirational Districts Programme (ADP), which was initiated in January 2018. It focuses on 112 underdeveloped districts in India, where adequacy in several aspects, including health, education, infrastructure, agriculture, water resources, skill development, and financial inclusion, is low.

The programme works under the specific model: each district is monthly rated with the progress based on 49 indicators under five themes: Health & Nutrition; Education; Agriculture and Water Resources; Financial Inclusion and Skill Development; Basic Infrastructure.

During its initial years, a lot of districts that were under ADP posted impressive returns. As an example, dozens of districts increased the indicators of maternal and infant health, school infrastructure (drinking water, sanitation) and agricultural productivity. The fact that the focus was on the delta change improvement rather than the previous state made even the most backward districts look like they were improving.

Strengths: What NITI Aayog Does Right.

NITI Aayog can react to events in a shorter time, and provide policy guidance to suit situations, and consider the diversity on a state level, as opposed to the old centralised top-down Five-Year Plans.

The open dashboard provided by the ADP and the regular rankings bring about transparency. Districts are aware that they are being scrutinised; poor performance is created.

The system incentivises districts and states to produce real results by monitoring real indicators, such as the nutrition of children, school infrastructure, and simple infrastructure. Districts will compete against each other; higher-performing districts can become examples to others.

Limitations: where NITI Aayog fails.

NITI Aayog does not assign funds directly; unlike the Planning Commission, it does not have direct authority. It is able to recommend and advise, but the application lies in individual ministries and the state bureaucracy. This hinders its ability to implement long-term, structural change of policy in all sectors.

Dependence on quantitative measurements, not qualitative performance: The ranking scheme used by ADP is too reliant on quantifiable, easily measured measures (such as the number of schools that have toilets, immunisation rates,

and road accessibility), which may not be related to quality or sustainability.

Lack of care over environmental or social externalities: Sustainability of the environment, ecological fragility, or resource scarcity and limitations (pollution, degradation, and ecological disturbance) are not adequately factored into the official system of ADP. Due to this, the gains of development may be achieved at the expense of ecology, the process that echoes the identical paradox.

Ground-level coordination/capacity: Under the ADP, many districts have poor coordination capacity, insufficient personnel training, uncoordinated between ministries, and scarce technical means to use short-term solutions, and this is not sustainable for long-term transformation.

Risk of symbolic wins on structural change: Policy success will be evaluated by dashboards and rankings, which will create incentives to focus on the easy-to-measure wins. This can result in a checkbox development: a school facility is recorded as complete, yet the quality of the education, long-term repairs, community participation, and the less quantifiable and more difficult side can all be bypassed.

Ministry of Housing and Urban Affairs

Overview:

MoHUA is the topmost national body that deals with urban development, housing policy, and the liaison with other ministries, state governments and the urban local entities. It offers both financial and technical support to States and Urban Local Bodies to supply water, sewerage, and transport services. MoHUA is at the forefront in identifying the course of urbanisation of India in terms of infrastructure, housing, sanitation and urban governance. It oversees significant urban legislation and regulatory structures, including the legislation on urban real estate, metropolitan development, and municipal governance.

The MoHUA has initiated some major schemes to facilitate infrastructure development as follows:

- **National Mission on Sustainable Habitat (NMSH) 2021-30**.

It has the goal to promote low-carbon urban development and climate change resilience as part of the national planning on climate change in India. It is in tandem with the SDGs and the Paris Agreement. It pays attention to sustainable buildings, clean transportation, urban city planning that is climate-conscious, and waste management, as well as enhancing inclusivity and resiliency to disasters.

- **National Heritage City Development and Augmentation Yojana (HRIDAY).**

The Ministry of Tourism launched it in 2015 to maintain the heritage character and ensure the growth of cities in selected cities. The plan has put four key areas, namely Physical Infrastructure, Institutional Infrastructure, Economic Infrastructure, and Social Infrastructure, to rejuvenate and re-energise the soul of heritage cities.

- **North Eastern Region Urban Development Programme (NERUDP):** It was introduced in the capital of Agartala, Aizawl, Gangtok and Kohima to develop urban infrastructure in the North-Eastern states. It was concentrated on better water supply, sewerage, sanitation and solid waste management.

Through such schemes, the MoHUA intends to ensure inclusive, sustainable and resilient urban development in India through incorporating infrastructure development, environmental sustainability, heritage conservation and regional balance by equipping Indian cities with the challenges of rapid urbanisation, climate change and disparate regional development, as well as increasing the quality of life of the citizens of India.

Budgetary Allocation:

In the FY 2025-26, the Ministry has obtained a budget of Rs 96,777 crore, which is 52 times more than the revised budget of 2024-25. This represents 1.9 per cent of the total spending of the central government and 0.3 per cent of the GDP. Urban development is one of the six areas of transformative reforms that have been prioritised by Finance Minister Nirmala Sitharaman to enhance the growth trajectory of India. This goes hand in hand with the government still laying emphasis on inclusivity and sustainable cities. An urban challenge fund (UCF) of Rs 1 lakh crore has been allocated a budget of Rs 10,000 crores.

The UCF also targets to create cities as a growth centre, and also, to promote creative redevelopment of cities, and to carry out water and sanitation projects.

Limitations and Structural Weaknesses:

- **Unintended development:** Master plans are fundamental in the control of urbanisation. They are the tools that assist in controlling and directing the current and upcoming use of land, growth and development of cities. The report published by Niti Aayog in 2021 concluded that Urban Planning Capacity in India shows that of the 7,933 urban towns, 28% (2216) of urban towns in total had approved master plans in 2021, and of these, 65% did not include issues such as climate resilience in their plans. Lack of master plans will result in a disorderly development and construction, traffic congestion, floods, and sprawl. The Urban Local Bodies are those that are supposed to operate under MoHUA and implement their plans, and in many cases, they lack sufficient funding, technical skills, and even coordination with other planning bodies.

- **Ecological Neglect:** Rapid Urban water supply expansion, piped system, and expansion of built-up areas have exerted a lot of strain on the available natural resources, including water bodies, groundwater aquifers, local water drainage, and ecosystems.

Many Indian cities have already attained water scarcity, low water management capabilities, and depleted aquifers. The situation with the sanitation, sewage treatment, and wastewater management in most cities remains too unsatisfactory, regardless of any new infrastructure-related initiatives, to satisfy the increasing population. As a result of releasing untreated or semi-treated wastewater and inefficient drainage, pollution, flooding, and health hazards to people occur. The urban growth that comes with demand for housing, roads, and construction via MoHUAs programs implies much building, concrete, and in most cases, with little or no regard to the green infrastructure, ecological balance and climate resiliency, thus increasing the urban heat-island effect, reducing natural recharge zones and destroying the environment. The focus on urban planning is still often under such a growth-oriented focus, which is usually infrastructure-first, ecology-later.

- **Failure to consider the long-term sustainability:** The schemes tend to focus more on the physical development of infrastructure as opposed to long-term spatial and environmental planning. Indicatively, fast-tracked development pursued under PMAY-U and the Smart Cities Mission has at times been followed by rapid construction, without the corresponding planning of drainage and sewage, and the creation of a green infrastructure, resulting in waterlogging and environmental harm. In cities such as Gurugram, Hyderabad and Bengaluru, with less strict building standards, Large-scale construction works are accepted, which in turn intrude into wetlands and lakebeds, leading to frequent urban flooding. Whereas MoHUA enhances ease of doing business by simplifying building approvals, critics opine that the process has led to a compromise of environmental and planning protection that leads to unsustainability.

Ministry of Road, Transport, and Highways

Overview:

Ministry of Road, Transport, and Highways (MoRTH) is the ministry that is the most significant in the Indian infrastructural development. It is a central government department that deals with planning, construction, maintenance and street safety of the national highways. The second-largest road network in the world is that of India, 6.3 million kilometres. The road network comprises: National Highways, State Highways and other roads like district, urban and rural roads. The ministry intends to link the national corridors, border regions and economic centres through projects such as Bharatmala Pariyojana, Setu Bharatam, National Highways Development Project (NHDP) and PM Gati Shakti and form an integrated and time-saving road network.

The ministry takes control over the primary roads that provide the linkage of the Indian land and the configuration of the Indian network.

This interconnects the cities and villages of India, making movement, trade, business and economic integration easy. Therefore, MoRTH plays a central role in infrastructural development and modernisation of India, which is mostly stimulated by the infrastructure sector.

Progress:

The Ministry of Road Transport and Highways (MoRTH) has also played a role in the spur in developing infrastructure in India by registering 12,349 km in the year 2023-24. The National Highway (NH) network was extended by 60 per cent, where 91,287 km in 2014 have become 1.46 lakh km at present.

Compared to the rate of 12.1 km/day in 2014-15, construction speed rose to 33.8 km/day in 2023-24, which is 2.8 times higher. By March 31, 2025, India will have over 63 lakh km of road network, comprising National Highways being 1,46,204km, State Highways being 1,79,535km and 60,19,723km of other roads.

It has been working faster on 923 current road projects, most of which have been exceeding their initial deadlines. It is aimed to achieve at least half of them by March 2026 using quicker clearances, faster land acquisition and releasing central funds on time.

It has implemented a rigorous system of monitoring whereby top-level reviews are done monthly to make sure that the timelines are fulfilled.

The MoRTH has developed a long-term framework, the National Highway Vision 2047 and infrastructure.

According to this vision:

- Every individual should be able to access high-speed corridors within 100-150km.
- India is willing to become among the top G20 countries in terms of the density of high-speed corridors.
- Reasonable accessibility to the National highways in the undeveloped parts of the region.
- International passenger facilities.
- Reduction in the percentage of logistic cost to GDP.

Major Projects:

- **Atal tunnel:** It is the longest highway tunnel in the world, with a height of more than 10,000 feet, and this tunnel was inaugurated on 3 October 2020. The tunnel saves not only 46 km of road route between the cities of Manali and Leh but also saves time by a rough of 4 to 5 hours.

- **Delhi-Mumbai Expressway:** The highway links key economic hubs in Delhi, Uttar Pradesh, Haryana, Rajasthan, Madhya Pradesh, Gujarat and Maharashtra. The effect has seen the distance between Delhi and Jawaharlal Nehru Port Trust being cut by approximately 180 km and a cut in the time of travel by up to 50 per cent to the linked destinations.

- **Char-dham Mahamarg Vikas Pariyojana:** The Ministry has embarked on the Improvement Program of connectivity of Char-Dham (Kedarnath, Badrinath, Yamunotri and Gangotri) in Uttarakhand. The programme will comprise the development of 825 km of NHs, which will cost approximately Rs 12,595 crore in total.

Areas of Consideration:

New roads are being constructed at an unprecedented and impressive rate, but at the same time, some problems, such as maintenance, environmental sustainability and local resilience, are usually overlooked.

Imbalance in construction and maintenance: The NITI Aayog and various other committees have proposed that the focus of the maintenance of the available roads should be given precedence over the construction of new ones. According to the Parliamentary Standing Committee on Transport (2023), the Ministry had been allocated 1% of its total budget to the maintenance of the highways, which amounted to Rs 2,600 crore, which is insufficient relative to the large network of highways. The life-time and sustainability of the network are influenced by the disequilibrium between maintenance and construction because it raises the cost of maintenance.

Ecological costs: In addition, construction of highways has caused massive deforestation and soil degradation as well as loss of biodiversity in ecologically sensitive regions such as the Western Ghats and the Northeast.

Both the Centre for Science and Environment (CSE) and NITI Aayog have raised concerns that a large number of projects are not subjected to the necessary environmental impact assessment, that is, speed and completion are taken into account rather than ensuring the ecological balance is maintained.

The Centre of Science and Environment (CSE) estimates that nearly 54,000 hectares of forest area were diverted to the construction of roads in 20152023 which impacted delicate ecosystems and raised the chances of catastrophes. The Supreme Court High-Powered Committee tasked in 2022 said that the widening of Himalayan highways had been overdone, and this was worsening the landslide danger, compromising the long-term sustainability.

Unsustainable growth trends: The intensive highway networks lead to the introduction of more vehicle traffic, leading to increased carbon emissions, air pollution, noise pollution, and environmental degradation.

The larger the number of roads constructed, the larger the number of vehicles will be visible on the roads through the "induced demand" effect, and thus causes pollution unless a major investment is made in green transport, public transportation and regulating it.

Highway development results in the improvement of such aspects as full integration, accessibility, mobility, integration of the country, economic development and the efficiency of logistics. But, environmental cost, ecological destruction, social displacement, land-resource depreciation, pollution escalation, inequity and social burden are also part of these advances. Roads are not made of concrete; roads slice through the ecosystems, modify land use, and disintegrate communities. The growth of infrastructure is combined with rapidity most of the time, with the goal of being seen and expanded, rather than sustainable, environmentally friendly, maintenance in the long run, resilience to climate change, and social justice.

To move forward in a sustainable way, the MoRTH would need to shift the vision towards long-term durability, safety, and being ecologically friendly and see to it that the roads of India not only provide a route to connectivity, but also provide a path to resilience and sustainability.

The Ministry of Rural Development

The Ministry of Rural Development is a branch of the Government of India. This branch plays a key role in the socio-economic development of rural parts of India. The main focus of this ministry is on special rural grants for health and education, piped filtered drinking water programs, public and affordable housing programs, public work programs and grants for rural roads and infrastructure. It also provides special grants to rural local bodies.

Objective and schemes:

Its primary goal is to ensure the growth of people in rural areas and make their lives better by providing them with the right opportunities.

Key schemes:

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA): This scheme guarantees wage employment for 100 days of the year in rural areas, with a main focus on vulnerable groups and community empowerment.

Pradhan Mantri Awas Yojana-Gramin (PMAY-G): This scheme aims to provide housing for the rural poor.

Pradhan Mantri Gram Sadak Yojana (PMGSY): This works on providing all-weather road connectivity in rural areas.

Deendayal Antyodaya Yojana-National Rural Livelihoods Mission (DAY-NRLM): This focuses on poverty reduction through means like self-help groups (SHG) mainly for women.
National Social Assistance Programme (NSAP): Provides social security to the poor and vulnerable people in rural areas who have been affected by this issue on a significant level.

Relationship with infrastructure:
Pradhan Mantri Gram Sadak Yojana (PMGSY): Through this scheme, the government builds and maintains all-weather roads connecting rural areas to markets, schools, and hospitals.

Pradhan Mantri Awas Yojana–Gramin (PMAY-G): This scheme, it provides affordable housing for rural families and makes their development suitable.

Livelihood Infrastructure: under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), it creates durable rural assets such as ponds, check dams, and various irrigation canals, aiming to make growth easy and faster.

Infrastructure Bond

Introduction

The very first step in the long-term development plan of fast-growing economies is infrastructure financing. It is thus the case that the countries make more and more physical assets like roads, bridges, power stations, and urban buildings.

Thus, the need for capital that is both large and long-term becomes very acute. The traditional banking systems, which are mainly based on short-term deposits, are unable to provide such capital in a sustainable way due to their structural limitations. Hence, special financial instruments and institutions have come to the forefront to fill the gap between the greater demand for infrastructure and available long-term funding. Infrastructure Bonds and Infrastructure Debt Funds (IDFs) are two of the major accolades of modern infrastructure finance that help mobilise and direct both domestic and international capital towards indispensable development projects.

Infrastructure Bonds

Infrastructure bonds are considered debt instruments of long-term maturity that are meant to provide funds for the construction of public-utility projects with long delays before they start receiving revenue. Bond maturity usually ranges between 15 and 30 years, which is an indication of slowly filling up revenue cycles of big infrastructure projects like highways, metro rail systems, power plants, ports, bridges, or social infrastructure facilities. The cash flow from such projects is predictable, but also gradual. These seek gradual, long-term returns to cover their liabilities.

In India and many other developing countries, a large part of the infrastructure bond funding goes to transportation projects.

More than one-third of the total bond deployment usually goes to roads, highways, rail infrastructure, and bridges. This is because the projects' huge scale and immediate socio-economic impact are the main reasons for this. On the other hand, in the global market, the energy and utility sectors attract the largest share of infrastructure debt because they have stable revenue streams and require high capital investments. Infrastructure bonds provide a significant amount of money to social infrastructure care, such as health facilities, educational institutions, and welfare-oriented projects. To some extent, these projects might not always bring in the strongest direct financial returns, but their societal impact and long-term benefits are enough to justify government-backed financing. The limited issuance and regulated nature of infrastructure bonds reflect the necessity of fiscal prudence, long-term planning, and the safeguarding of investor interests in sectors that are of national importance.

On the part of investors, infrastructure bonds present a predictable return through their coupon-based model and have historically had very low default rates. But they also entail a long-duration risk. In fact, over the course of a decade, interest rate changes can wipe out the value of the bond, and thus the investor should be ready for the secondary market to have relatively low liquidity. The governance risk is still there. The inefficiency of the authorities, the malpractice of contractors, and the delay can all lead to the low performance of the project and thus indirectly affect the investors' confidence. It is thus imperative to build up the transparency and the discipline of execution in order to keep trust in the infrastructure bonds market.

Infrastructure Debt Funds

Infrastructure Debt Funds (IDFs) were presented as a structured solution to one of the key issues in infrastructure finance, the asset–liability mismatch. Banks, as a rule, resort to short-term deposits for funding long-term infrastructure loans, thereby causing systemic stress and liquidity problems. The Indian administration admitted the insufficiency of this model and, in the 2011–12 Union Budget, introduced the IDF framework, which was to become the cornerstone of a new financial setup intended to attract long-term capital, both domestic and international, for infrastructural purposes. The framework was put into practice during the Twelfth Five-Year Plan (2012–2017) with the first IDFs set up in 2013.
IDFs can function through two main regulatory routes:

1. **IDF–NBFC (Non-Banking Financial Company)**

IDF–NBFCs, which are regulated by the Reserve Bank of India (RBI), are able to attract long-term funds through bond issues in either rupees or foreign currencies, and these bonds usually have a maturity of at least five years.

They are mainly concentrated on providing funds for completed infrastructure projects, the projects that have reached at least one year of commercial operation, thus making it easier for the investors to take the risk.

2. IDF–Mutual Funds (IDF–MF)

The Securities and Exchange Board of India (SEBI) supervises IDF-MFs, giving them more operational flexibility. They do not need to reach their maturity dates and can invest in a larger variety of infrastructure-related debt instruments. They can back infrastructure projects which are dynamic or of a smaller scale, like the ones with changing or developing project structures. Their mutual-fund model permits participation of a broad spectrum of investors, with retail and domestic institutions included, but the main focus remains on institutional investors.

A significant advantage of the IDF mechanism is that it can free up the capital of banks. When IDFs refinance operating projects, banks recover the money that they had lent for a long period and can invest the capital in new infrastructure or other priority projects.

This up-cycling of credit capacity enlarges the overall financing pool that is available without increasing government spending.

Benefits

Both infrastructure bonds and IDFs contribute significantly to the creation of a stable, long-term ecosystem for infrastructure development. Key benefits include:

- Long-term financing matches the lifespan of infrastructure assets, thereby reducing refinancing pressures.
- Attraction of institutional investors, when their long-term liabilities align naturally with infrastructure cash flows.
- Reduced burden on the banking sector, which allows banks to focus on underwriting and short to medium-term credit needs.
- Better financial discipline is ensured by regulated environments, which promote sound capital adequacy, transparency, and governance.
- Increased access to the global capital markets, particularly through the foreign currency issuances and ECBs.
- Continuity of projects, such as refinancing and capital rotation, ensures that there are no bottlenecks or stops in projects.
- These benefits make infrastructure debt instruments one of the most efficient means of scaling up the country's infrastructure, while maintaining financial stability.

Challenges

- Although it is a very effective tool, the infrastructure debt ecosystem faces the following structural challenges:
- Lack of secondary market liquidity makes long-term assets difficult to sell before maturity.
- Interest rate and inflation risks, which impact the long-duration bond valuation.
- Uncertainty in regulations and policies, particularly in tariff-based industries such as energy or transport.
- Project governance issues, such as delays, cost overruns, or inefficient procurement systems.
- Execution and operational risks, particularly in PPP (Public-Private Partnership) models, where there could be misaligned incentives among the stakeholders.

Improvement in these areas would require collective efforts in improving project governance, regulatory consistency, risk-sharing mechanisms, and transparency. Upgradation-cum-Consolidation Priority List (CUCPL), and it's done for each district. This ensures a structured and transparent allocation of resources.

Ministry of Ports, Shipping and Waterways

Overview

The entirety of India's maritime transport system falls under the control of the Ministry of Ports, Shipping and Waterways (MoPSW). It is responsible for a lot of things, like major ports, regulations of shipping, coastal transport, and inland waterway transport. The activities of the Ministry include managing cargo, modernising ports, planning logistics and ensuring maritime safety.

The Sagarmala Programme, which was established in 2015 to encourage development by the ports, is the core of the efforts by the Ministry. The programme is expanding the port capacity, enhancing the multimodal connectivity, and developing the industrial areas around ports. The four parameters of port modernisation, connectivity enhancement, port-linked industrialisation, and coastal community development are directing the 839 identified projects valued at around ₹5.8 lakh crore, of which more than 270 are complete.

These measures envisage that, with the modern cargo vessels, the transport costs are coming down, coastal areas are getting more employment, and the inland waterway and coastal shipping volumes are increasing.

The major ports are getting increasingly ready with their infrastructure to handle larger and more specialised cargo, which in turn is speeding up the logistics and making it more efficient.

It is recognised that there are still some matters regarding tariff determination, working conditions, and accountability to the public, but the model has been able to address the issues of under-investment, which were typical of the domestic ports, and has also ensured that the management of the domestic ports is at par with international standards.

Sustainability has emerged as one of the most important issues. The Harit Sagar scheme challenges the ports to transition to low-carbon operations through the use of hydrogen bunkering, shore power, electric cargo handling equipment, renewable energy plants, and green fuel fleets. The financial rewards are designed to encourage the operators to work with the environmentally friendly fuel and logistics solutions. Some of the ports have already started using solar power systems, electric cranes, and hydrogen-based solutions as their methods of energy efficiency and adherence to the global green shipping standards.

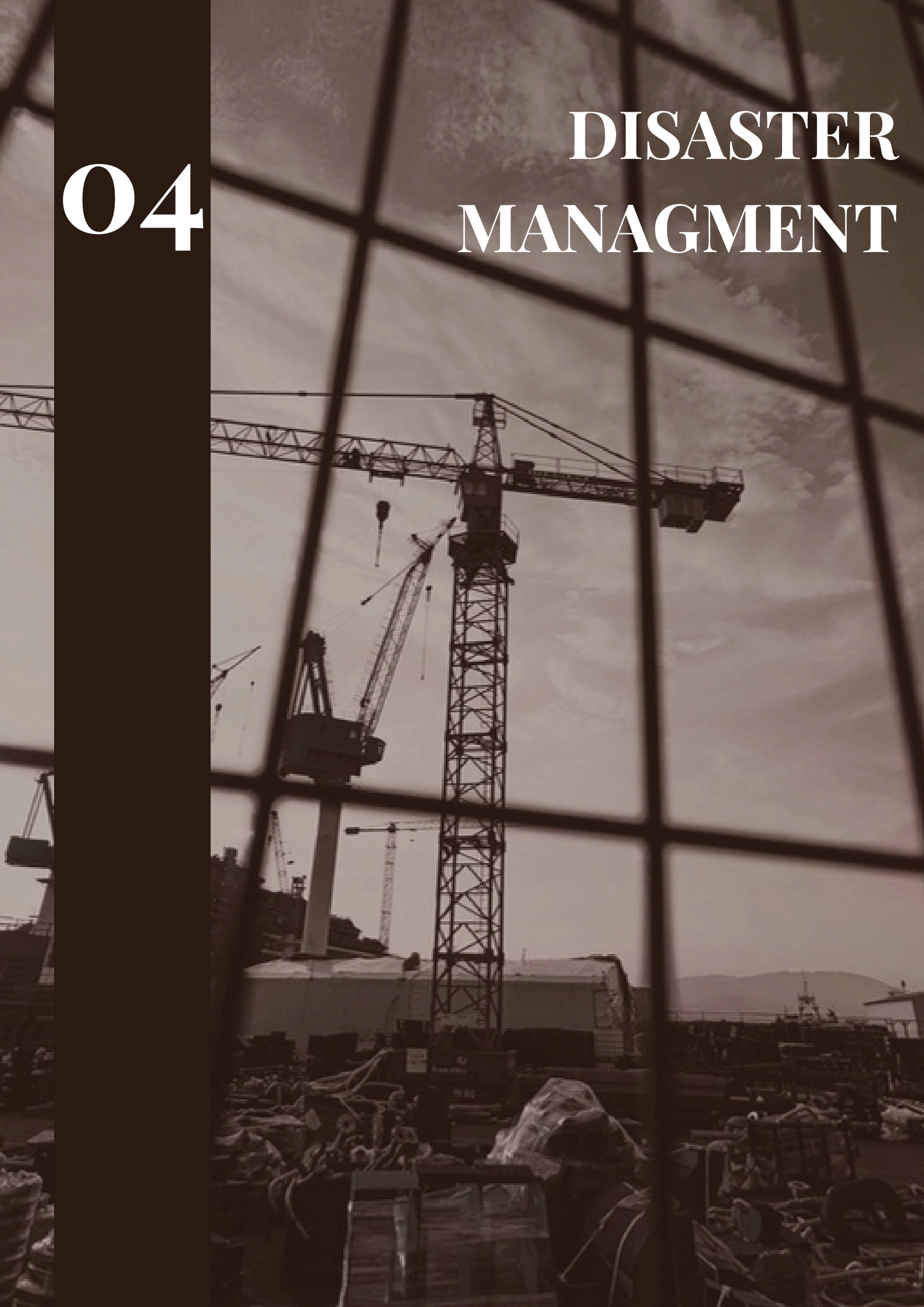
Export-oriented investments are being drawn towards the industrial zones established around ports, and the logistics efficiency has been a big factor in the reduction of freight costs for the major industries. Better multimodal connectivity, along with increased cargo handling capacity, supports ports in the management of growing trade and also in gaining global competitiveness. However, there are still many enormous challenges to face.

The participation of the private sector has its good sides but also raises through-equity concerns for the smaller users and port labour, while industrial extension could lead to coastal communities being disrupted unless security measures are put in place. The development of major infrastructure projects is very hard to avoid facing the issues of delays, complex regulations, and a lack of funds. Besides that, going green requires huge investments and consistent long-term policy support.

In spite of that, the MoPSW's integrated reform plan is about the combination of modernisation, private participation, digital governance, and sustainability, which places the country's ports in a position to change into trade, manufacturing, and green logistics hubs that are fully integrated. Realising this vision will depend on balanced governance, sustained infrastructure investment, and inclusive policies that harmonise commercial growth with environmental and social responsibility.

04

DISASTER MANAGMENT



DISASTER MANAGEMENT

When Development Becomes the Trigger: How Infrastructure Choices Turn Hazards into Disasters

This part evaluates the exerted effect of large infrastructure projects, which should enhance growth and connectivity, on increasing the risk of disasters under circumstances when ecological, geological, and hydrological consequences are poorly managed. Through the study of repetitive planning and implementation in various sectors, it brings out how development decisions in themselves tend to become the determinants of environmental vulnerability and disaster implications.

Roads and Railways

Our transport map is being redefined by big national schemes such as Bharatmala or multi-modal schemes under PM Gati Shakti. Greater speed of connection is an actual advantage: the markets become open, travelling time is reduced, and freight transportation becomes more efficient. However, when the decisions of alignment, route clearances or approvals are rushed without giving proper attention to ecological and hydrological considerations, it can prove to be catastrophic. The Char Dham roads of Uttarakhand are the archetype of the mountainous one: to reduce pilgrim time and make roads narrower, enormous hill-cutting and clearing of trees took place in a landscape vulnerable to geology, heightening the danger of landslides and slope failures.

The fact that the Himalaya are some of the youngest and most unstable mountain systems in the whole world is what made locals and experts raise the alarm; in that case, the common plain-land road designs are not applicable.

Similarly, any suggestion that a rail line should run through an ecologically sensitive area is met with a response of recurrent disagreement since the tracks do not represent a straight line on a map: they cut habitat, alter drainage, and in most cases demand substantial civil engineering. The Hubballi-Ankola railway project (Western Ghats) has had serious, well-documented objections from wildlife boards and conservationists owing to the possibility of enormous loss of forest and biodiversity. The last activities of the state wildlife boards indicate that the ecological stakes are high and the approvals are disputed.

Urban Projects

The story is replicated in cities with different textures. Unless the planners consider hydrology, metro lines, flyovers and massive built footprints can destroy the local drainage systems and lake catchments. The recurring floods in Bengaluru are now generally explained by the experts and judges as being the result of the encroachment on the lakes, blocked rajakaluves (natural storm channels), disappearance of the tree cover and paving of pervious surfaces, rather than unusual rainfall.

Some articles and research reports record how the network of lakes created in Bangalore was destroyed over the decades, making the city unable to receive abundant rainfall and transforming storms into catastrophes.

The Sahibi/Najafgarh scenario is different since it involves the same dynamic: a natural storm-channel engineered into a drain, which is fed by changes in land-use upstream, which drives sewage and loses its buffer capacity against the environment. The Najafgarh stretch is officially and in the media reportedly constantly polluted, silted and virtually ecologically dead in most of its length; and authorities have been forced to make massive de-silting and rejuvenation operations to get even basic flow rates of water.

Hydropower and Dams

The hydropower is commonly referred to as clean, and in the energy accounting, hydropower can be low-carbon, but the process of constructing a dam, excavation and diversion of mountain rivers is not environmentally neutral. The most tragic example of this is the Chamoli (2021) disaster. A huge rock-ice fall created a disastrous surge in February 2021, demolishing the Tapovan-Vishnugad (under-construction) and damaging Rishi Ganga and other projects, which led to the conclusion that landscape susceptibility to geological changes in the area was increased by decades of tunnelling, blasting, slope destabilisation around hydropower projects, and increased the magnitude of the disaster (ICIMOD and others).

The flood itself did not occur in a vacuum; infrastructure activities and the overall effects caused the terrain to become more susceptible, and the impacts of these activities were exacerbated.

A second, more ancient, but well-documented example of infrastructure changing geophysics is the Koyna area. The 1967 Koyna earthquake (around the Koyna dam in Maharashtra) has been commonly referred to in reservoir-induced seismicity literature: the seismic swarm that happened following reservoir fill-up is a lesson learned, evidence-based warning that large water bodies can alter stress regimes down the line, and cause earthquakes in already pre-conditioned areas

Structural Failures

Not all disasters are purely ecological issues; there are those that are failures in governance that are compounded by a lack of technical control. The collapse of the Morbi suspension bridge (Gujarat) in 2022 was an eye-opener regarding the fact that a tourist attraction can be turned into a tragedy through the use of renovation shortcuts, insufficient testing, poor choice of contracting decisions, and ineffective maintenance. Inspections discovered damaged cables, improper retrofitting (replacement of flexible planks with aluminium decking), and no load testing or official sign-off prior to opening again. This is a strong warning message: despite a limited environmental footprint of an infrastructure, the risks are created by ineffective implementation and ineffective governance after the construction works.

Patterns which repeat and repeat:

In all types of projects, several execution patterns are found repeatedly:

- **Fast-tracking/fragmentation:** Sometimes projects are divided into a large number of small packages to prevent the eliciting of more intense environmental assessments or to speed up approvals. This fragmented method conceals the build-up effects.
- **Metric-based approach to delivery:** The only difference that can be counted in measuring success tends to be based on visible results (kilometres constructed, megawatts approved) and not durability, resilience, or ecological well-being. Dashboards incentivise short-term measurable victories.
- **Weak cumulative evaluation:** Numerous statutory EIAs are based on single project assessments; there are limited legal mechanisms that mandate landscape or basin-based cumulative impact assessment in situations where numerous interconnected projects are clustered in a single geophysical environment.
- **Uneven citizen involvement and implementation:** Public hearings are at times more formal, and the monitoring of post-clearance is intermittent; in the case of poor local administration or institutional competency, maintenance and compliance are lost.

In places where such patterns are paired with unstable geographies, young mountains, coastal wetlands, and networked systems of lakes, the outcome is predictable: infrastructure that exacerbates the hazards that it is meant to mitigate.

Disaster Management and Policy

In case the goal of infrastructure policy is truly to make society safer and more prosperous, then three changes are necessary:

1. **A shift towards piecemeal EIA to compulsory cumulative and landscape-scale analyses:** This is so that several projects on a basin or corridor are considered jointly, and indicators of long-term ecological resilience are put in place.

2. **Incorporate ecological indicators in success dashboards:** kilometres and megawatts are not the only success metrics that should be added to success dashboards, but wetlands conserved, groundwater recharge maintained, slope-stability indices and biodiversity baselines are all ecological metrics that are readable in a success dashboard.

3. **Enforce post-construction stewardship:** Obligatory load testing, maintenance budgets (long-term), external audit, and actual empowered local control to ensure that projects are not opened and neglected.

Impact of Climate Change, Which Pressures the Existing Infrastructure

Introduction

Climate change, as one of the most topical issues of the century, is one of the most significant aspects that influences infrastructure and public assets.

The numerous risky impacts of climate, such as extreme weather and temperature, increasing sea levels and frequency of disasters such as floods, have endangered the infrastructure, government properties and transport systems.

The infrastructure is made up of the water systems, the electricity grids, the roads, bridges, etc. It is the foundation of contemporary society. The impact on these assets when the risks associated with climate occur leads to misfortunes to the population, financial loss, a decrease in the growth rate, and damage to the security of the public.

Climate Change and the Relationship Between Infrastructure and Public Assets

1. **Transportation Infrastructure:** Transport networks are impacted and at risk directly by extreme heat, heavy rains and floods, and an increase in the sea level. The high-risk factors are due to roads, railways, bridges, and ports.

2. **Phenomenon of heat stress:** When there is extreme high temperatures (that are caused by climatic changes), there is a new phenomenon that has been observed, and which causes the pavements (asphalt) to be softened, which leads to the phenomenon being known as rutting, i.e. permanent deformation of rail tracks, and even the steel bridge components to expand or buckle due to this.

3. **Erosion and Submergence:** Everything causes damage to the infrastructure in one way or another: heavy rain, flooding, storm events.

As an example, water-logging and high-pressure floods lead to washing out and submergence of roads and rails, and they also badly erode them. In other instances, they may even cause instability of foundations (mostly of bridges), rupture of tunnels and drains.

4. **Coastal hazards:** With the rising sea level, Coastal roads, ports, rail lines and other transport assets are now susceptible to storm surge and permanent inundation. This greatly decreases the viability of the infrastructure in the coastal regions.

Economic Viewpoint

India has transport assets valued at USD 400 billion that are highly vulnerable to climate-related risks. Other than that, there is repeated damage, which raises maintenance and repair expenses in the long run.
Other impacts of infrastructure adversities include disrupted supply chains and low connectivity. This has a dire impact on commerce, manufacturing, and movement.

Consequently, it is a severe challenge to the economic development of our nation due to the susceptibility of transport infrastructure in the context of climate change.

Thus, meeting these challenges requires large-scale investment to improve and adjust accordingly. Cities in India are projected to require over 2.4 trillion dollars by the year 2050 to construct low-carbon and climate-resilient infrastructure. To be able to survive increased heat, floods, a rise in sea level, and other climatic issues.

In the absence of such an implementation, there would be a potential possibility of an increase in the economic losses of flooding, heat stress, and climate-related disruptions.

Social Impact

1. **Violation of Essential Services:** Not only did the economy in general suffer, but infrastructure failure also had a devastating effect on the lives of many people due to curtailed access to hospitals, schools, emergency services, and water supply systems, which one needs. The destruction of school structures and road systems affects the education system and leads to high losses in learning. It is more so in the case of children in rural areas. Heat waves are responsible not only for increasing hospitalisation but also for straining power infrastructure. All this contributes to power outages, which will decrease the operation of cooling systems and medical equipment.

2. **Loss of Livelihoods:** Many people also rely on transport either directly or indirectly. Transport networks comprise a vital aspect of the movement of people within and out of one location to another in search of opportunities, and a vital aspect that enables agriculture, tourism, transport services, manufacturing, fishing, trade and so on. It also causes loss of work to the wage earners because of broken roads and halted transport. This makes them seek alternative means of earning a living to take care of the family. Being the economic growth contributor in our country, MSMEs are also harmed.

Mostly, as supply chain disruptions impact small businesses and places of production the most.

3. **Migration and Displacement:** When sea levels and coastal erosion increase, whole territories might become uninhabitable as a result of collapses and landslides. With the infrastructure turning insecure or unusable, families of the Coastal communities have to migrate forever. The Mountain and hill communities are experiencing landslides on a regular basis due to the disruption of slope stability caused by the construction of roads and other construction. The migrants to cities in rural areas consist of a loss of infrastructure and means of livelihood, thereby placing strain on the already strained urban development.

Impact of Urbanisation and Tourism

Catalysts of Development

Urbanisation and Tourism both contribute to economic growth, but they also lead to environmental degradation due to rapid development.

Tourism: The tourism industry is regarded as a growing industry by the World Bank Group, which currently accounts for more than 10 per cent of global GDP. The tourism industry has grown in recent years, with millions of tourists visiting India. The Union Budget 2025-26 allocated ₹2541.06 crore to improve infrastructure, skill development, and travel facilitation, as it generates 5 per cent of India's GDP.

The rapid growth of tourism in India serves as one of the main elements which has brought about substantial environmental decline. The phenomenon exists across various geographical regions, including the Himalayan ranges, coastal areas, desert environments, islands, and densely forested territories. The population expansion in these areas creates demands that exceed their ability to support additional residents according to the current capacity limits.

The hill stations of Manali, Leh, Mussoorie, Shimla, and Nainital are the vacation destinations of tourists all over India for their natural beauty and serene environment. Currently, the infrastructure at these places is insufficient to meet the needs of visitors, and the visitors are exceeding the capacity of the water supply, sewage treatment, and disposal systems. Building hotels and resorts on unstable slopes and in valley areas that are prone to floods is putting the local environment at risk of landslides and collapses, not only during earthquakes but also during heavy rainfall. The construction of luxury hotels and road networks requires the cutting down of trees, resulting in deforestation and soil erosion, which leads to the creation of unstable infrastructures.

Besides that, in the coastal areas such as Goa and the Andaman and Nicobar Islands, the unregulated construction of modern beachfront villas is causing the suffocation of sand dunes, mangroves, and coral reefs, which are the natural protectors of the coastlines against storms and erosion. Besides the above, the marine pollution comes from untreated sewage, plastic waste, motorboats, and cruise tourism is causing the degradation of water, which in turn is leading to the loss of biodiversity in the seas. Badly managed tourism, instead of being an industry that is harmless, is the main reason for environmental degradation, resource depletion, and infrastructural failure. It will continue to be so if short-term profit and expansion are given priority over long-term sustainability.

Urbanisation: India, the world's second most populous country, has seen a period of rapid urban development in its recent history. The country's urban population is expected to reach 600 million by 2030, according to the World Bank. The link between urbanisation and economic development has major implications for India, a developing country. Urbanisation promotes the development of better infrastructure, transport systems, and communication systems, which facilitate the smooth operation of business activities. The process of urban development bears positive effects on society; however, it bears adverse effects on the environment of the planet.

The unplanned nature of urban development in India has created excessive demands on both city infrastructure systems and natural ecosystems, which have exceeded the city's ability to support its increasing population through sustainable environmental methods.

The demand for housing, transport, water, sanitation, electricity, and waste management shoots up as a large number of people migrate to urban cities, but planning and investment hardly match the numbers.

To expand infrastructure, wetlands, lakes, river floodplains, forests, and agricultural lands are being occupied. This removal of natural buffers reduces space for groundwater recharge and takes away the land's ability to absorb heavy rainfall, thus contributing to urban flooding, which can be seen in Mumbai (2005), Chennai (2015) and recurring in Delhi and Bengaluru. The older drainage systems blocked by silt, plastic, and construction debris are unable to absorb heavy monsoon downpours. The primary cause of traffic jams, air pollution, and bridge and flyover deterioration results from increased vehicle traffic. The slums are made in areas such as riverbeds, garbage sites, and steep embankments; therefore, the inhabitants are most prone to the effects of floods, landslides, and toxic contamination.

The rivers function as disease carriers because untreated sewage and industrial waste materials are dumped into them. The construction sites are major sources of dust and particles that create air pollution problems. In the end, urbanisation that is not environmentally friendly and beyond the capacity of infrastructure not only causes inconveniences but is a deliberate way of turning cities into areas that are more vulnerable to disasters.

Large-scale Development Projects

Paradoxically, the same development projects that are often lauded for their economic growth potential can also raise the risk of disasters simply by causing changes in land use, influencing water resources, and even disrupting natural ecosystems. Projects like dams, highways, hydropower facilities, and urban development needs to be pondered upon in terms of how they affect the environment and not just the nature around it, but the people living in the vicinity, too.

As these projects are the primary sources of environmental risks, some of their instances are explained below:

1. **Highways and Hydroelectric Energy Programmes:** The Himalayan States of India, namely Uttarakhand, Jammu and Kashmir, Himachal Pradesh, and the northeast, have been at the forefront of the fast arrival of major developmental work calling for the increased construction of tunnels, roads, ropeways, and hydroelectric dams. Border Roads Organisation (BRO) has been facing the challenge of tree-felling and slope stability while trying to extend the national highway. The Char Dham Pariyojana project, which is worth billions of dollars, is doing road widening work all along 889 kilometres in Uttarakhand. The road widening project has put the removal of 6000 deodar trees, which grow on steep slopes, as one of its requirements. Experts have said that tree removal will lead to slope destabilisation and, therefore, more frequent and severe landslide events. The Supreme Court has recognised that the present ecological crisis is spreading over all the areas of the Himalayan range and is no longer confined to a few isolated spots. There are two major hazards that Himalayan dams are exposed to, both of which stem from intense earthquakes and floods caused by glacial overflow.

Cloudburst event locations had hydropower facilities in the vicinity that were running at the time. The 2023 glacial lake outburst flood at Lhonak Lake in Sikkim has heavily affected the Mangan, Gangtok, Pakyong, and Namchi districts. As a result of this, the Chungthang dam upstream was breached, which is the most important element of the major hydropower plant in the region, and the breach was caused by the flood moving upstream from its location. The events that were just closely followed in the period between 1 January 2024 and 31 July 2024 in Himachal Pradesh indicated the incidence of seven such events in seven distinct locations. Seven locations of cloudburst events had hydropower facilities in the area, four of which were operational during the time.

The recent 2023 glacial lake outburst flood in Lhonak Lake, Sikkim, has severely impacted the Mangan, Gangtok, Pakyong and Namchi districts. Due to this, the Chungthang dam upstream was overtopped or flooded, which is the most critical component of the major hydropower plant in the area, and the overtopping occurred because of the upstream movement of the flood at its location.

2. **Dams:** The Dam Safety Act (DSA) of India is not adequately doing risk-conscious decision-making, and this has been the main factor that leads to the irregularities in the legal front of the matter, as well as in the working front of the matter. An example of ecological damage by large development projects is the Tehri Dam in Uttarakhand. The project was to provide irrigation water and hydroelectric power to the users.

The project developed into a situation which caused severe harm to both environmental and social aspects of the region. The dam construction team selected a site which existed within the Himalayan lower regions that possessed high environmental sensitivity and biodiversity. The construction of the dam caused widespread forest land destruction, which resulted in dangerous ecological effects because it submerged large areas of natural habitat. The dam construction activities caused both land erosion and the destruction of agricultural fields.

3. **Tunnel Collapses:** In the last ten years, tunnels in Himachal Pradesh, Meghalaya, and Sikkim have been the scene of at least 15 collapses. Incidents involving tunnels reveal the gravity of issues pertaining to planning, management, and regulatory supervision of this sector. In the case of the Silkyara tunnel collapse in Uttarakhand, 41 workers were trapped for 17 days, which is a testament to the systematic failure and lack of preparedness for such catastrophic events.

Tourism Failures

The Kedarnath Floods: The 2013 Uttarakhand calamity is a clear example of how unchecked development combined with excessive religious tourism can provide the perfect conditions for natural events to become human disasters. The valleys like Kedarnath, Mandakini, and Alaknanda were hit by heavy rain and cloudburst in June 2013, which led to flash floods and devastating landslides.

Hydropower plants coming up in the mountain area lead to the mountains being destroyed with the aid of tunnels and blasting techniques. The floodwaters entered the region with extreme power, which caused a chain of subsequent events resulting in the demolition of houses, roads, and villages. More than nine million people were impacted by the flash floods. The greatest devastation of the catastrophe was experienced in the five districts of Bageshwar, Chamoli, Pithoragarh, Rudraprayag, and Uttarkashi. According to the State Government's report dated 09 May 2014, 169 people lost their lives, and more than 4, 021 people who were missing were presumed to be dead. The disaster is essentially a result of humans utilising construction activities in an unregulated manner by building along riversides, while at the same time deforestation and slope modifications created conditions that intensified the disaster.

Cloudburst in Leh: During August 2010, the town of Leh in Ladakh witnessed an unexpected cloudburst event. The flash floods, along with the mudslides, took more than 200 lives, and besides that, many people got injured. Leh has always been an ecologically balanced desert settlement. However, the continual tourist inflow has now pushed up the pace of construction in the local area. The construction of the lodging facilities took place on the natural paths of water drainage as well as on flood-prone areas that were still subject to environmental assessments. The town lacked a contemporary drainage system that could manage heavy rains because its climate pattern involves extremely low rainfall throughout the year.

The cloudburst event caused large volumes of water to move through river channels, which had dried up because of construction work and land development. The disaster demonstrated that developing tourist sites without understanding the local geography increases the potential risks to visitors. A single extreme weather event can transform into a disaster when both infrastructure systems and land use patterns fail to match the existing environmental conditions of fragile ecosystems.

Degradation of Goa: Even though Goa is known globally as a tourist heaven, its environment and infrastructure have been severely harmed by tourism development that has been largely unregulated for decades. Every year, uncontrolled tourism brings more and more visitors to towns where there are no proper facilities for waste management, water, and sanitation. Rivers and coastal waters get polluted as untreated sewage is dumped, which leads to beach pollution and the killing of the marine environment. This issue has been making local residents concerned about their environment for a long time. Developers have removed the mangroves and the sand dunes, which are the natural protection against erosion, just to build beaches, shacks, and commercial properties. The coastal zone has suffered from increased erosion at the same time, sea level rise and cyclone activity have also become more frequent. The constant tourism-led urban expansion has caused a shortage of water, the problem of waste, and the breakdown of ecosystems, all of which are examples of how good regulation can keep the environment and the infrastructure safe from damage.

Excess tourism in Ladakh: In the last three to four years, there has been a tremendous growth in the popularity of the Ladakh tourist destination. Hotels and guesthouse construction boom has taken place in the region as the cold desert has no adequate supply of water, although it is acute with water shortages. There are waste management problems in the whole region that lead to the contamination of both rivers and the areas by plastic and sewage wastes. New accommodation buildings, along with road widening, which is not properly planned and controlled, have caused devastating destruction to sensitive mountain habitats, a factor that has contributed to the high chances of landslides and soil erosion. The concrete buildings are replacing the traditional mud-brick houses, which are constructed in accordance with the climate, and these have negative impacts on the environmental conditions of the region.

Infrastructure Development and Disaster Vulnerability

The core of contemporary development studies is the comprehension of the interplay between infrastructure and disaster risk, particularly as the frequency and severity of climate-related disasters increase and urbanisation exerts more pressure on delicate areas. The connection is intrinsically bi-directional: on one hand, the infrastructure that is well-designed and properly managed can greatly reduce the natural hazards, whereas, on the other hand, the infrastructure that is poorly built, badly located, or not maintained at all can actually increase the magnitude of destruction.

This interaction is particularly notable in the case of poor countries, where the development hardly keeps up with the enactment of regulations or the provision of environmental protection. The literature on disaster risk reduction states that the infrastructure is not only of great economic importance, but it also plays a major role in determining the physical resilience of communities, the speed of recovery, and the social inequalities in the aftermath of disasters. To sum up, infrastructure is the first line of defence against hazards, and when it is managed poorly, it becomes the biggest vulnerability factor.

Resilience

Resilience has a major aspect, which is the ability of infrastructure to absorb shocks and at least partly keep up the essential operations. This is the case when hazards are purposely or accidentally considered in the design of the infrastructure. Buildings and structures, originally made for economic and/or civic purposes, are still able to play a major role in disaster resilience when durability is incorporated into the engineering. Seismic-resistant roads, flood-proof bridges, and wind-blown communication towers are all examples of infrastructure that serve a double cause, that is, providing usual services during normal times and acting as structural mitigators in crises. This indirect resilience is particularly important in areas where disaster-resilient infrastructure is not possible because of high costs.

The second type of resilience comes from disaster-resilient infrastructure.

These crying-out-for-help structures are the essence of disaster management strategy and include tsunami barriers, drainage systems that accept heavy rains, unstable slopes made stable through engineering, and built-out cyclone-safe areas in coastal zones. Not only does this specialised infrastructure protect human life and property to a certain extent, but it also influences public perception of risks, encouraging migration and shaping communities' attitudes towards risk. The areas that are exposed to the hazards are transformed over time by the investment in protective measures to become more hospitable and economically active.

One more time, the infrastructure that is commonly undervalued is nonetheless one of the three main pillars of resilience supporting the response and recovery systems. The frameworks of health facilities that can endure quakes, the communications network for emergencies with redundancy measures, the routes for evacuation that are already mapped digitally, and the storage of supplies that are essential for the population are all decentralised. These systems together enable very fast recovery after a calamity has struck. They guarantee that the different emergency services, such as medical care, rescue operations, and the flow of information, will not be disrupted. This is what separates the cases of short disruption from the ones with a long-lasting negative impact on development. The overall picture is that the infrastructural resilience categories are the operational backbone of disaster management, determining the way societies not only experience disasters but also their after-effects. The concept of resilience spans across and also interacts with the trajectories of long-term development. The steady failure of infrastructure under continual stress has been described by researchers as “reverse development”, a phenomenon where the gains in development made over the years are reversed in just a matter of hours. The situation in places where the rate of infrastructure growth is very high but the regulations are weak—this is the case in rapidly expanding peri-urban settlements in South Asia, Latin America, and Sub-Saharan Africa- is that the lack of hazard-resilient planning makes such areas very susceptible to getting back to worse, not to say, the worst, positions. Critical assets such as hospitals, major highways, industrial corridors, and housing stock often suffer irreversible damage, thus pushing poor people further into poverty. The economic cost of constantly rebuilding infrastructure takes away public resources that could have been used for the financing of long-term development priorities and, thus, keeps some regions trapped in the cycle of recovery instead of progressing.

Cost Burdens and Long-Term Pressures

The financial cost associated with disaster-prone infrastructure continues to be a challenge for governments. Spending a significant amount of money on the periodic repair of damaged roads, bridges, embankments, and power lines due to seasonal floods and storms consumes a substantial amount of the country’s and state’s budget. In most disaster-prone areas, the effects of disasters are always constant rather than intermittent, and hence the cost of maintenance becomes a constant rather than an intermittent cost.

The cost of mitigation may have reduced vulnerability, such as the strengthening of river embankments, the relocation of settlements away from flood-prone areas, and the retrofitting of essential buildings; however, the cost of not doing so continues to rise. Some of the disasters, such as major earthquakes and volcanic eruptions, are not entirely avoidable, but most of the climate-related disasters can be greatly mitigated by proper design, material selection, and planning. The lack of funding in disaster resilience, therefore, creates a cost structure where each disaster makes the next one even more vulnerable. As a result, a series of disasters takes place where each disaster is more destructive than the previous one.

Vulnerability

The selection of sites is an important element that contributes to the susceptibility of the infrastructure. It is a discriminatory and avoidable risk to locate the infrastructure in sites that are susceptible to hazards, such as hills that are prone to landslides, riverbanks that are unstable, flood plains, and coastal areas that are susceptible to storm surges. The rationale for the selection of the sites may be land scarcity, economic necessity, tourism incentives, or political apathy; however, in all these cases, the impact is so limited that the life of the infrastructure has already been shortened by the hazard before it even happens.

Furthermore, ill-conceived reclamation of already vulnerable land can often worsen the problem, particularly if the forests are cleared, drainage altered, or soil disturbed.

There is also another aspect of vulnerability, which is the nature of the interdependence of infrastructure systems.

The modern economy stands on a chain of networks that are so interlinked that one fault can lead to a complete blackout of all systems: power grids that are linked to communication networks, water systems that are dependent on electricity, and hospitals that depend on both digital and transport infrastructures. Thus, the failure of one piece of infrastructure can trigger a series of failures across various networks and turn a single disruption into a total breakdown of the system. However, the infrastructures that support the provision of services are the most vulnerable to cascading failures of this sort. Moreover, studies indicate that when one node fails, the availability of the service is reduced so quickly that the impact on the community is increased and the recovery is delayed.

A third and crucial characteristic of vulnerability is the different impacts that come to the marginalised. The indigenous peoples, forest inhabitants, scheduled tribes, migrants, and all those considered economically weaker are the ones to suffer the most due to the failure of infrastructure. These people usually live in places that are prone to hazards, like the edges of forests, riverbanks, or areas that are not very valuable, because they have been pushed out of the planned urban spaces. The houses and community assets of these people are seldom designed to endure the disasters that strike them, since poverty and the absence of institutional help prevent it.

The poor suffer the most in terms of increased mortality and prolonged recovery time as they live without the public infrastructure, which is needed for their survival: stormwater drains, evacuation roads, and healthcare centres.

Strong, inclusive infrastructure, therefore, becomes not merely a means of resilience but also a means of social protection.

Infrastructure in Social Inclusion and Minority Vulnerability

An important aspect of the socio-political distribution of risk concerning infrastructure and disaster vulnerability is seldom recognised. Through their situation, minority groups such as tribal people, forest dwellers, coastal fishing castes, migrant workers, and economically underprivileged households are the ones who have the greatest risk of exposure to natural disasters. This is not the case because of randomness, but rather it has historical reasons rooted in land exclusion, colonial forest policies, and unequal urban planning, among others. The infrastructure failure brings about these groups suffering more in terms of death, displacement, and loss of means of subsistence. Their rehabilitation is also prolonged because of the lack of financial resources, no political support, and poor access to government aid programs.

If infrastructure development is done with a wider perspective, it can change the unequal situation.

The building of all-weather roads will make it possible for remote tribal villages to have better access to hospitals; flood-resistant housing will secure the people of low income who have settled on river embankments and islands; decentralised solar grids will provide continuous power where the centralised systems have failed; and resilient water systems will control the spread of diseases in disaster-prone areas.

However, inclusive infrastructure is not common, and the projects of development consider the industrial or urban needs first and only then the social welfare. In other cases, it is the infrastructure that is supposed to assist the indigenous communities in the first place that ends up pushing the communities away from the sensitive environmental areas without offering them any form of protection. This creates a situation where the communities that are supposed to benefit from the infrastructure that is designed to enhance the resilience of the communities are instead left as a vulnerable group due to the displacement that comes with development.

It is through the recognition of the vertical that the attention of disaster research is shifted from the technical to the social justice aspect.

05

GAPS IN POLICY



GAPS IN POLICY

1. The Fragmentation Paradox

One of the biggest tensions within India's environmental governance framework is not necessarily about the lack of regulations, but how such regulations are designed and implemented. One such trend that has been observed is that large infrastructure projects are being segmented and split into smaller parts, which are individually assessed for environmental clearance. Perhaps one of the better examples of this is the expansion project of the Char Dham Highway. This project spans 889 kilometres and is clearly a project that has environmental implications on a cumulative scale. However, it is divided into 53 parts, none of which individually exceed the threshold that would call for an Environmental Impact Assessment.

One of the biggest problems that this creates is that it leads to a conceptual problem that questions the relationship between thresholds and environmental reality. Environmental systems are continuous and interconnected. Rivers do not recognise segmented boundaries. In fact, environmental impacts are cumulative. However, environmental regulations are based on thresholds. When a project is segmented in such a way that it meets threshold requirements rather than environmental boundaries, it creates a problem.

The end result is not necessarily a transgression of the rule itself but rather a limitation in the scope of the rule's ability to fully capture the situation. Each segment may be individually assessed and appears to be well within the bounds of the rule. In fact, the technical documentation of each segment may clearly demonstrate compliance with the established guidelines. Nevertheless, the cumulative result of the system as a whole is not always fully apparent in the segmented process of analysis. Deforestation in each segment may equate to significant deforestation in the overall system. Slope cutting in each segment may equate to significant geological destabilisation in the overall system. Drainage changes in each segment may equate to significant hydrological destabilisation in the overall system.

This creates a significant analytical dynamic between procedural and substantive adequacy in the rule itself. A system may be procedurally adequate in terms of the overall results while being substantively inadequate in terms of the overall analysis of cumulative impact.

The implications are not limited to the initial stage of clearance. Environmental monitoring systems are generally developed based on the approved project parameters. Similarly, mitigation measures are also generally linked to the identified impacts. When these impacts are assessed in isolation, the mitigation also remains in isolation. The consultation process with the local community also depends on the nature of the intervention. The community can be more easily consulted if the intervention can be presented as a whole rather than in parts, especially if the impacts

are not explicitly presented.

From a policy point of view, the above discussion implies that the development in environmental governance might call for greater importance to be attached to the cumulative impact assessment at the landscape or basin scales. This would not replace the need to conduct project-level EIAs; rather, it would complement these with the aim of ensuring that the impacts at the system level are also taken into account in the decision-making process. The aim here is not to add to the regulatory burden; rather, it is to ensure that the level at which impacts are assessed corresponds to the level at which environmental processes are operating.

2. The Maintenance Inversion

Typically, infrastructure systems are measured in terms of indicators that focus on infrastructure expansion, such as kilometres built, projects sanctioned, or capacity added. However, this may inadvertently lead to a secondary effect wherein, in comparison, maintenance is given relatively lesser attention. This can be seen as a concept of maintenance inversion, wherein more attention is given to developing new infrastructure than to maintaining existing infrastructure.

At a fundamental level, this is a result of a combination of factors related to incentives and infrastructure visibility. New infrastructure has outcomes that are easily communicated. It can be inaugurated, reported on, and linked to easily quantifiable milestones. Maintenance, on the other hand, has outcomes that are, by their very nature, less visible. Success is measured by continued success and a lack of failure, both of which are harder to quantify in terms of easily communicated indicators of success.

This is not to say that maintenance is not considered, but perhaps it is not as prominent in performance measures. A look at budgetary allocations can also give some insight into this imbalance. The Parliamentary Standing Committee on Transport has pointed out that only a small part of the total budget is set aside for maintaining an extensive network of national highways. The concern is not just how much is being put into it, but perhaps what it implies in terms of how infrastructure is conceptualised.

If one conceptualises infrastructure as an asset for long-term production, then maintenance is clearly crucial for sustaining it. If one conceptualises it as an attribute of production, then maintenance is not as prominent. These conceptualisations can coexist in one system, but it is perhaps the one reflected in performance measures and incentives that has greater influence.

The temporal aspect of the problem is clearly illustrated in the context of the failure of bridges. Physical structures tend to decay over time. Moreover, the signs of such decay can be detected through physical assessments. Such problems can be addressed through maintenance operations conducted in advance. However, in the absence of such maintenance operations, the situation may arise where the structure is no longer fit for use and has to be reconstructed. This would naturally require higher costs.

The formulation of policies such as the Bihar State Bridge Maintenance Policy of 2025 can be seen as an indication of the shift in focus toward the importance of maintenance. However, the relatively recent formulation of such policies can be seen as an indication of the lack of institutionalisation of maintenance in the past.

This can be seen as an issue of incentive structure rather than a lack of desire for maintenance. Incentive structures can be made more effective by incorporating the importance of maintenance in the overall assessment of the situation. This would involve the recognition of maintenance as an investment rather than an expense.

3. Limits of Output-Based Measurement

In the status quo, we see that infrastructure governance in India is characterised by extensive data collection and monitoring systems. However, depending on the types of metrics that are prioritised, both perception and behaviour can be influenced. A notable challenge with this is the focus placed on output-based metrics. These metrics measure what is being built and delivered, in contrast to outcome-based metrics, which measure how the infrastructure is actually functioning. This can be understood through the concept of "metric capture". Measurement systems tend to incentivise such behaviours in actors that optimise in favour of what is being measured. This means that when outputs such as project counts, financial outlays, or physical infrastructure units are emphasised, administrative efforts will be inclined to respond to such an assessment system, which is a rational response to the structure of evaluation, rather than a deviation from it.

For instance, we would like to highlight the Smart Cities Mission, which sees the use of metrics such as the number of Integrated Command and Control Centres, CCTV cameras, or solar streetlights installed, that are tangible and verifiable in nature. While such metrics are absolutely needed in assessing implementation, they fail to assess direct improvements in broader outcomes such as accessibility, inclusivity, or quality of life. As a result, what ends up happening is that a particular system is able to perform well on output indicators while leaving behind outcome aspects.

The same can be seen in other programmes such as AMRUT. For example, the expansion of infrastructure in the form of an increase in tap connections stands as an important achievement; however, the relationship between the expansion of infrastructure and the delivery of services also involves variables like the reliability of the infrastructure, the water pressure and quality, and the utilisation of the treatment capacity. When such aspects are not given equal importance in evaluation frameworks, the assessments stand incomplete and biased.

Further, this issue becomes more complex at the aggregate level, where programmes like Sagarmala involve a large number of projects in different sectors and regions. Variations in the number of projects completed as per different sources give an indication of the challenges in maintaining consistency in definitions. What this highlights is that even output tracking can be limited in providing true reflections if the underlying definitions

are themselves are not standardised.

The broader implication is that measurement frameworks would need to be evolved to accommodate different variables in the assessment of the infrastructure development schemes. Outputs would continue to remain relevant, but it would be necessary to ensure that the outputs are supplemented by a framework that would include variables like functionality, equity, and sustainability. This may not be possible by discarding the existing framework, but by evolving a framework that would be more in tune with the experience of the infrastructure users.

4. Underrepresentation of Natural Capital

Another significant aspect in the development of infrastructure is the valuation of the ecosystem. For example, in the development of infrastructure, the ecosystem services provided by wetlands, forests, and river systems are significant in the development of infrastructure. Some ecosystem services include flood control, water storage, and the prevention of erosion. However, the ecosystem services are not fully integrated into the economic decisions made.

What this creates is a form of "ecological debt", where natural systems are altered or removed for development and yet the immediate benefits of infrastructure are recorded and valued without the loss of ecological services being systematically accounted for in the same framework. As a result, decisions taken may end up being based on incomplete assessments of costs and benefits.

For instance, if we look at the case of Chennai, it is clear that the development process in the areas where the wetlands were located is significant and has been beneficial when viewed from the perspective of economic development. However, the end result of the process is that the city of Chennai became more vulnerable in terms of flooding in the event of extreme rainfall, and hence, the cost incurred in the process can be viewed as the deferred decisions.

Similarly, when a river system is developed and transformed for infrastructure, this may change its ecological functions. This may, in turn, require further investment over time in restoration and in creating artificial infrastructure that replicates services that were previously provided by the now-destroyed natural systems.

The key analytical point that we aim to highlight here is not that development and ecological preservation are mutually exclusive, but the fact that they are interdependent. Infrastructure performance does indeed find itself dependent on the stability of underlying ecological systems. When these systems are not accounted for, the efficiency of development decisions ends up being overstated.

The concept of incorporating natural capital in infrastructure development is a complex issue, and it is both conceptually and technically challenging. However, it is of critical importance in the context of sustainability and must be addressed.

5. Coordination Constraints

The institutional structure of India's infrastructure governance is marked by a multiplicity of institutions that cut across sectors, administrative levels, and jurisdictional mandates. On the one hand, this multiplicity can be seen as a reflection of capacity rather than weakness. Different institutions possess specialised knowledge and administrative experience in different parts of the infrastructure development process. But the complexity of India's infrastructure governance does not arise from the multiplicity of institutions. It arises from the nature of the interaction between institutions. Infrastructure outcomes are not the result of standalone interventions. They are the result of interdependent systems where the performance of one component is dependent on the performance of other components.

This gives rise to a structural coordination challenge. In a multi-actor system, every institution has a set boundary or mandate in which it operates and is measured by its own set of performance indicators. This leads to optimisation in that boundary. Roads are constructed optimally by one agency, drainage channels are maintained by another, and the water system is managed by a third. Within that boundary, the institutions may be performing well technically. However, the outcomes that are most important may not be within the accountability framework of the institutions that manage the system.

The result is not necessarily dysfunction, but rather a kind of partial optimisation. Each of the institutions can evidence its competence in its own sphere of action. However, the system as a whole can deliver suboptimal results because of the lack of active management of interdependencies. This is an important distinction. The problem is not that there is no effort and no expertise. It is that there is no management of interdependencies towards common objectives.

The waterlogging problem in Delhi is a good example of this problem in concrete terms. It is managed by multiple agencies that are responsible for various parts of it. Some parts are managed by the Public Works Department. Other parts are managed by various city governments. Other parts are managed by other agencies that might be responsible for highways or water systems. Each of these agencies might be functioning perfectly within its own sphere. However, waterlogging is not caused by any of these parts. Waterlogging is caused by how they all work together.

However, in the event of heavy rainfall, the interaction between the various components becomes crucial. A well-designed drain could still not perform if the water flow upstream is too high for the drain to handle. In addition, the design of the road affects the runoff, which in turn affects the drain's performance. All this requires coordination that goes beyond the sharing of information. In the absence of institutional arrangements for coordination, the process is not anticipatory but reactive.

At the national level, the Sagarmala Programme is a program that illustrates the same principles. The program seeks to enhance the efficiency of the port by

integrating it with the railway, highway, and water transport infrastructure. In conceptual terms, it recognises the port efficiency as a system attribute. A port's efficiency is not only a function of the port's operations but also depends on the connectivity to the hinterland.

However, the framework of institutions through which this integration has to be achieved is characterised by sector-specific accountability. Indian Railways, highway organisations, port trusts, and state governments all follow their own systems of administration, financial cycles, and performance management. They are each separately responsible for their respective parts of the integrated whole. Yet, no one is fully responsible for the integrated whole. This is a problem of coordination, where delays in one part of the system could adversely impact the entire system, even though each institution is separately accountable.

Interventions like PM Gati Shakti are a significant move towards addressing this problem. By developing a shared digital infrastructure for infrastructure planning, this intervention improves visibility for all ministries, reducing the possibility of duplicatory or conflicting infrastructure projects. It facilitates better spatial coordination and more informed decision-making in the planning stage itself.

But coordination is not simply a problem of information. It is also a problem of incentives and authority. Even when all organisations have equal information, incentives may differ since each institution may be separately accountable for its own performance. Therefore, for coordination to be effective, incentives may need to be aligned, and in some instances, authority structures may be required.

In this sense, the challenge of institutional multiplicity is not purely administrative. It is fundamentally about governance design. It involves determining how responsibilities are structured, how accountability is assigned, and how collective outcomes are prioritised within a system of specialised actors. Addressing this gap requires moving from a model of parallel competence to one of coordinated interdependence, where system-level performance becomes an explicit objective rather than an emergent by-product.

6. The Intersection of Development and Vulnerability

The policy domain of infrastructure development and that of disaster vulnerability are usually treated separately. One is related to economic growth, connectivity, and productivity, while the other is related to disaster vulnerability. However, empirical evidence indicates that they are related in a way that is more integrated than this division indicates. This is because infrastructure development can influence the spatial distribution of vulnerability in ways that are not immediately apparent, but that become important over time. One such way is displacement. Large-scale infrastructure developments such as dams, highway construction, industrial corridors, and urban expansion usually involve land acquisition. This usually results in displacement, especially among communities that lack the

political and economic strength to resist such displacement. These communities usually end up in new locations that are not randomly distributed. These locations are usually in areas that are of less economic value within the framework of such planning, which is usually associated with areas of higher environmental vulnerability.

This sets a pattern wherein development processes are a contributing factor to the spatial concentration of vulnerable populations in geographies that are prone to risks. Riverbanks, floodplains, steep slopes, and peripheral urban areas are resettlement areas since they are not subject to conflict in formal development plans. In this manner, these areas become more prone to risks like floods, landslides, and infrastructure failures.

The implications of displacement are not just physical in nature. There is a likelihood that a displaced population will be separated from their support systems and will be forced to rely on external support systems that may not be evenly distributed. A population that previously lived in harmony with its ecological systems may be resettled in areas where these systems are absent.

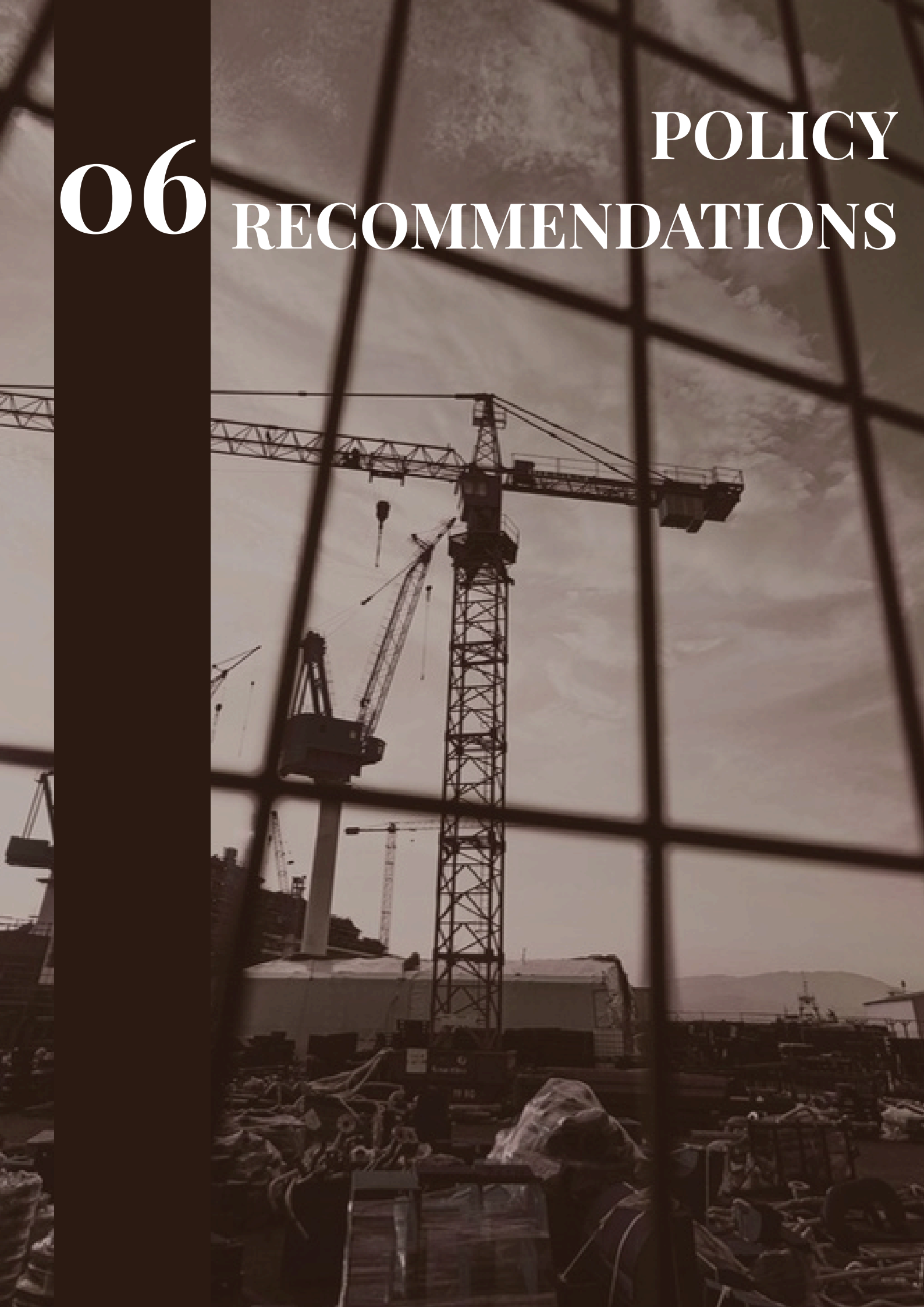
There are also historical cases of dam development and industrial growth that provide examples of the processes that influence resilience structures, whether they be social or ecological in nature. Although the development processes contribute to the overall economic growth of a nation, they may also influence the resilience structures at a local level. Knowledge structures that may have helped mitigate environmental risks in the past may be lost in the process of displacement.

Resettlement schemes in urban areas add another dimension to the analysis of the processes that influence resilience structures in the context of a disaster response or development growth. In the context of a disaster response, there may be a need to provide rehabilitation for the affected areas in an urban environment, leading to the resettlement of informal settlements in the area.

The recognition of the link between development and vulnerability implies the necessity of more integrated approaches in the planning process. Infrastructures can be assessed not only in terms of their economic benefits but also in terms of the spatial distribution of risk. This would include secondary and long-term effects, such as the areas where the displaced populations would end up settling and the changes in the level of risk they would be exposed to.

This does not imply that the development of infrastructure should be limited in any way. It simply implies the necessity of managing the wider impacts of such development. By incorporating vulnerability assessments in the project and planning process, it becomes possible to minimise the secondary impacts and achieve more balanced results.

06 POLICY RECOMMENDATIONS



POLICY RECCOMENDATIONS

1. Mandate for Strategic Environmental Assessment (SEA)

The "Fragmentation Paradox" that has been identified in the report, as seen in the case of the Char Dham Highway project, reveals a structural incompatibility between the scale at which the environment operates and the scale at which the governance mechanisms assess it. This incompatibility cannot be seen as a procedural incompatibility; it has to be seen as an epistemological incompatibility, a way of understanding the environment that is fundamentally at odds with the way in which the environment actually functions or behaves. Environmental Impact Assessment in India has traditionally been seen in a framework that assumes projects, interventions, and areas of impact are bounded or discrete entities. Such a framework assumes that the impact of the environment will be localised, linear, and separable. However, the environment in the Himalayan orogenic belt, or in most ecological systems, cannot be seen as linear or separable.

If an 889-kilometre-long project is broken down into dozens of administratively independent parts, each assessed in isolation from the others, the result is not just an incomplete evaluation; rather, the very object of evaluation changes. The reality of the system, with its hydrological interdependence, slope stability interactions, biodiversity corridors, and sediment flows, ceases to exist in the field of view of the regulator. In its place are left a series of technically correct micro-evaluations that add up to a whole unable to capture the very system they are intended to regulate. The problem, in other words, is not with the implementation of the Environmental Impact Assessment; rather, the problem lies with the very framework not being designed to capture cumulative effects.

This calls for a shift to Strategic Environmental Assessment as a foundational rather than secondary instrument. Strategic Environmental Assessment differs from Environmental Impact Assessment in its scope, as it addresses policies, plans, and programmes rather than individual projects. Strategic Environmental Assessment can accommodate the evaluation of cumulative, indirect, and long-term effects prior to decisions on individual projects. It thus fundamentally alters the temporal and spatial scope of environmental regulation.

One of the essential elements of this process would be the institutionalising of Bioregional Carrying Capacity Audits. This would involve the reconceptualising of the landscape in terms of thresholds of disturbance rather than simply as a passive background to development. By bringing together the tools of high-resolution topographical mapping, hydrological modelling, and ecological network analysis, it would be possible to develop what might be referred to as a Cumulative Load Threshold for any particular region. This would provide a scientifically grounded ceiling on the level of intensity of any

development. It is also significant that this would not be project-specific but would relate to ecological boundaries such as watersheds and forest corridors.

In terms of the operationalising of such a system, there would be a requirement for the development of a National SEA Secretariat with technical and regulatory power. This would involve the synthesis of geospatial data sets, climatic projections, and ecological data in the production of region-specific strategic assessments. Project approvals would then be dependent not only on the localised impact criteria but also on the region-specific criteria. This would involve the development of a two-tiered system of assessment.

The proposal also raises the possibility of a rethinking of legal doctrine. The ability to think of ecosystems as entities that have intrinsic integrity, rather than aggregates of exploitable resources, would open the door to the development of a law that protects the functionality of the system. Granting legal status to river basins, forest landscapes, or mountain systems would not be merely symbolic. It would be a way to challenge the cumulative harm, even if the action itself were legal.

On a more profound level, this recommendation aims to ensure that the governance process is more closely in tune with the ontology of the systems that it seeks to govern. In other words, the development of infrastructure in sensitive ecological zones is not simply a matter of engineering or economic feasibility. It is a process of engaging with complex adaptive systems in which feedback loops, thresholds, and tipping points are the dominant factors in the long-term prognosis of the systems. By incorporating the landscape-scale intelligence into the very early stages of decision-making processes, the state can avoid the buildup of what might be referred to as deferred disaster risk. This is the process in which the short-term benefits of connectivity or capacity are negated by the long-term failure of systems in the form of landslides, floods, and other ecological disasters. Strategic Environmental Assessment is not an additional layer of process; it is a recalibration of the way in which environmental risk is conceived and managed.

2. Institutionalising Lifecycle Jurisprudence

The “Maintenance Inversion” that the report reveals is a form of temporal inversion in infrastructure governance, in which the moment of creation takes precedence over the duration of functionality. This means that infrastructure development is seen as a singular event rather than a process.

This inversion has its roots in the politics of visibility. New infrastructure development produces a visible sign of progress, whereas maintenance produces a lack of failure, which is less visible and less politically rewarding in the end. This leads to a pattern in which infrastructure is allowed to deteriorate to the point that it needs to be rebuilt, effectively going through the cycle of visible investment again. This is not just a matter of inefficiency but also a degradation in asset value.

To achieve this, a fundamental change in the

conceptualisation of infrastructure in public finance and administrative accountability is necessary. This change has been captured by the introduction of a Lifecycle Integrity Framework. Here, infrastructure is conceptualised as a long-term asset that has value over a long period of time, provided that it continues to perform over this period. This, in turn, calls for the incorporation of lifecycle cost analysis in the approval of all projects. Instead of approving projects on the basis of capital costs, it would be necessary to factor in projected costs of maintenance, rehabilitation, and, in due course, decommissioning over a given period of time.

One of the main institutional innovations in this framework is the Automated Maintenance Sinking Fund. This fund is to be established at the time of project approval, where a portion of the total lifecycle cost is invested. What is more, this fund is to be ring-fenced, meaning that it is not to be used for anything else. This ensures that it is not subject to yearly fluctuations in the budget. By having this fund in place, it effectively translates into a contractual obligation for maintenance, rather than a discretionary one.

With advancements in sensor technology and data analytics, Dynamic Structural Health Monitoring can be implemented. This can monitor stress, vibration, and degradation of materials in real time. This can help in predictive maintenance rather than reactive repair. This information can also be used to create a National Asset Health Dashboard.

It is also important that any technological solution is accompanied by a shift in incentives for administration. Performance incentives for public officials need to be revised to reflect asset condition rather than asset creation. Asset Condition Index and Mean Time Between Failures can be used as performance measures. This can shift accountability from project delivery to asset functionality.

The concept of lifecycle jurisprudence is not just limited to financial and technical issues. It is also imbued with a commitment to the idea that infrastructure obligations do not end upon completion. This has important implications for contractual agreements, regulatory capabilities, and audit processes. Contracts need to include maintenance standards and responsibilities with the same level of precision as they do for construction. Regulatory bodies need to have capabilities to monitor and ensure standards, and audits need to assess not just financial performance but also functional performance.

With this recommendation, there is an attempt to move from a cycle of build and neglect to one of value preservation. The advantages of such an effort are both financial and social. Not only is there an improvement in efficiency and safety, but there is also an attempt to ensure that public expenditures align with the principle of intergenerational equity. In other words, public expenditures undertaken in one generation need to be able to serve future generations without unduly burdening them.

3. Transition to Multidimensional Outcome-Based Governance

The next policy recommendation focuses on metric capture, which we use to represent the

idea that the choice of indicators affects not only how the performance of infrastructure is measured but also how it is produced, which can be recognised as a subtle yet pervasive distortion in our governance systems. In the context of infrastructure governance, the emphasis on metrics lying on output rather than outcomes can drive the production of measurable artefacts rather than the creation of value and delivery of meaningful change. This is particularly the case where indicators such as 'kilometres constructed' or 'projects delivered' are easily quantifiable.

The problem lies not with the existence of metrics but with their scope and orientation. This is the case because output metrics face an inherent limitation when it comes to their ability to capture the quality, accessibility, and functionality of infrastructure. As a result, what ends up happening is that systems which seem to perform well on paper actually encounter failures when it comes to delivering substantive benefits in practice. The result is a divergence between administrative performance and the lived experience.

This is the very challenge that a transition to Multidimensional Outcome-Based Governance seeks to address by redefining the very basis of what is used to evaluate our infrastructure. Under this, the emphasis of the assessments conducted lies in making sure that projects are able to deliver functional outcomes rather than merely physical outputs. This requires the development of composite indicators that integrate multiple dimensions of performance.

For instance, a water supply project would be evaluated not only on the number of connections that have been provided through the project, but also on other social parameters like reliability, water quality, and equitable distribution. These parameters can then be combined into a weighted index that is a reflection of the overall service performance. The goal achieved through the same is that indices now see a shift in focus from "infrastructure as an object" to "infrastructure as a service".

Further, an important innovation within this framework is the concept of periodic Lived Experience Audits. What these audits involve is the systematic collection of user feedback to gain first-hand insights into the actual functionality of the infrastructure in order to assess it in a more grounded and effective way. We acknowledge the limitations of this particular framework when it comes to its feasibility and authenticity of user feedback, and to mitigate these challenges, we propose linking a portion of contractor payments to user-verified outcomes. What this creates is a direct incentive for ensuring that infrastructure works as intended by introducing an element of accountability that extends beyond formal compliance. Moreover, the periodicity or recurrence of these audits would help ensure that this assessment does not remain limited to a one-time activity, but an ongoing process that allows for more monitoring and adjustments to be made as per the needs of the hour.

Moving on to another critical component under this framework, we propose the standardisation of definitions and data systems, the need for which is deeply felt and discussed in the status quo.

Inconsistent definitions of project completion or operational status end up undermining the reliability of monitoring frameworks, and a lack of lifecycle tracking by data systems ends up creating a "build-and-forget" bias. Building a comprehensive, national-level lexicon would provide a common set of definitions and help ensure that data is comparable across programmes and over time. Another necessity in ensuring the effective implementation of this particular component is to make sure that this lexicon is integrated with all digital platforms and state and national-level systems to enhance transparency and reduce ambiguity.

At a conceptual level, what this recommendation involves is a shift from merely enumerating to evaluating. It recognises that infrastructure is valuable not because it exists but because it performs a function. By better aligning metrics with outcomes, governance systems can more effectively and comprehensively capture the complexity of development and ensure that investments translate into tangible improvements in quality of life, which is the very purpose for the creation of infrastructure in the first place.

4. Integration of Natural Capital

The exclusion of natural capital from infrastructure accounting is a significant gap in current policy frameworks. Natural systems are known to provide crucial services such as flood regulation, water purification, and climate moderation; however, these services are often treated as externalities and are not considered in cost-benefit analyses.

What this creates is a systematic bias in favour of built infrastructure, wherein the benefits of development are quantified, but the costs of ecological loss are not, and decision-making tends to be based on incomplete information. This can then lead to outcomes that appear economically viable but are actually environmentally and socially unsustainable.

Our recommendation of integrating Natural Capital Accounting seeks to address this very imbalance by assigning economic value to ecological services. What this involves is the quantification of the various benefits provided by natural systems and their very needed incorporation into project evaluations. For example, the flood buffering capacity of wetlands can be valued in terms of the cost of what equivalent engineered solutions would take.

The internalisation of these values into the system creates a more accurate representation of the trade-offs involved in development decisions. It also provides planners and developers a basis for comparing alternative approaches, including nature-based solutions. In many cases, it may turn out to be that preserving or restoring natural systems is more cost-effective than the construction of artificial infrastructure.

Furthermore, we introduce the concept of grey-green hybridity, which builds on this by promoting the integration of engineered and natural systems. Rather than viewing them as substitutes, we use this approach to recognise their complementary natures, which leads to enhanced resilience and reduced long-term

costs. For instance, urban drainage systems could be designed to work in conjunction with natural water bodies and permeable surfaces.

The challenge we face with the implementation of this recommendation is the fact that it requires changes in both methodologies and institutional practices, which is a massive undertaking in all respects, whether political, financial, or social. This also means that cost-benefit analyses must incorporate ecological valuation, and that regulatory frameworks must, in turn, mandate such analyses, especially for major projects. Additionally, capacity building is needed to develop the expertise that is required for such ecological assessment and valuation.

By adopting this idea of natural systems being integral components of infrastructure, we move towards aligning economic and environmental objectives, and in shifting the focus from short-term gains to long-term sustainability, which would help ensure that development does not undermine the very systems on which it depends.

5. Information Sharing to System-Level Accountability

The challenge of coordination in infrastructure governance can be defined as a problem of information asymmetry or administrative fragmentation. Although these definitions are not far from the truth, they are not complete. The problem with infrastructure governance is not just that institutions are not informed about each other's activities; rather, the problem lies in the nature of the governance architecture, where power, incentives, and accountabilities are not aligned with the systemic nature of infrastructure outcomes. Infrastructure outcomes are inherently interdependent. Land use planning informs transport networks, waste management informs drainage networks, hinterland connectivity informs port services, and multiple agencies are involved in urban services due to the interdependent nature of these services. However, the nature of the institutions through which these services are delivered is largely sectoral, with each agency optimising its own performance rather than optimising the performance of the infrastructure service as a whole.

This creates a situation that may be referred to as the structural accountability gap. Agencies can evidence compliance, efficiency, and even excellence in their own domains, but may not be effective overall as a system because the relationships between the domains are not clearly governed. In such a system, problems that emerge as a result of interaction effects cannot be clearly attributed to any of the institutions. This creates a diffusion of accountability where the outcomes are collectively created but individually disavowed.

Interventions such as data sharing and integrated dashboards have been implemented in an effort to overcome this challenge. While such efforts are significant advances in the field, they can be seen as being primarily information-centric and not authority-centric. While visibility is an improvement over the prior situation, visibility alone does not overcome the

problem of coordination unless there is an incentive structure that can drive alignment between the institutions. In other words, the availability of information does not automatically imply alignment.

The concept of Trans-Institutional Outcome Authorities is seen to be a response to this misalignment. These are not seen as additional layers of bureaucracy, but rather integrative governance structures designed around a particular system-level outcome. They are distinguished from traditional agencies, where a sectoral mandate is used to establish authority, by a functional goal such as urban flood resiliency, multimodal logistics efficiency, or regional water security. Their jurisdiction is thus not defined by sector, but by the scope of the particular outcome for which they are established to deliver.

The distinctive characteristic of Trans-Institutional Outcome Authorities is that authority is aligned with responsibility. For a system-level outcome to be meaningfully governed, there must be a body that has both the authority to coordinate action across agencies and the ability to enforce action that optimises the system as a whole. This thus requires a reconfiguration of existing relationships within the system, where agencies continue to maintain their technical role but within a framework of shared responsibility. This is where the Trans-Institutional Outcome Authority plays its role.

An important aspect of this framework has to do with the redefinition of the authority's performance measures. Common administrative measures include sector-based outputs, such as the number of kilometres of road constructed or the volume of cargo moved. Although important in a particular domain, such measures do not address system-wide performance. For example, the efficiency of a logistics system is not a function of the capacity of the ports or the length of the highways, but a function of the synchrony of the different parts of the system, including customs, rail, and last-mile delivery. Defining the authority's performance in terms of system-wide measures, such as total system transit or cost per unit of movement, provides a common goal that goes beyond the institutional boundaries.

This alignment of incentives has important behavioural consequences. When institutions are incentivised in a manner that reflects a common outcome, the internal decision processes of the institutions also begin to take into account the interdependencies of the system. This leads to a governance framework that shifts from parallel optimisation to coordinated optimisation.

Another important dimension is temporal coordination. Infrastructure systems often involve projects with different timelines, where delays in one component can undermine the effectiveness of others. A system-level authority can sequence investments and operations to ensure that interdependent components are synchronised. This reduces the risk of partial functionality, where individual assets are completed but cannot deliver their intended benefits due to missing links in the system.

At a broader theoretical level, this

recommendation aligns with the concept of polycentric governance. Polycentric systems are characterised by multiple centres of decision-making that operate with a degree of autonomy while being linked through mechanisms of coordination and mutual adjustment. Such systems are particularly suited to complex environments where no single authority can possess complete information or control. By combining decentralised expertise with centralised coordination, polycentric governance can achieve both flexibility and coherence.

However, for this to be effective, linkages between institutions are necessary. In the absence of such linkages, decentralisation could lead to fragmentation. The role of the Trans-Institutional Outcome Authority is to provide the linkages by providing a focal point for coordination without undermining the functional specialisation of the various agencies. In this sense, it neither adds nor subtracts institutions but merely reconfigures their relationship with respect to outcome objectives.

At the heart of this recommendation is a shift in logic in the way in which we govern infrastructure, namely, from a sectoral logic to a systemic logic.

In this sense, it is recognised that infrastructure outcomes are not pre-existing attributes but rather emergent properties of systems, and it is only by governing in a way that is aligned to this concept of systems that it becomes possible to transcend the coordination challenges which currently undermine the effectiveness of infrastructure policy.

6. Spatial Justice Mandate

The relationship between infrastructure development and vulnerability represents one such dimension of policy. The assessment of infrastructure development is generally based on its economic benefits, connectivity, and growth. The assessment is often conducted in such a way that it ignores the issue of spatial redistribution. Development is not only an issue of creating assets; it is also an issue of creating space. Creating space, it affects different populations in different ways.

One such factor is the issue of displacement. Infrastructure development is generally associated with the acquisition of land. In this regard, it is often necessary for such projects to relocate populations. The assessment of such an issue is generally based on its economic effects. The displaced populations are generally provided with compensation for the land they lose. The displaced populations are often provided with new locations that are not only economically less productive but also environmentally vulnerable. The new locations include floodplains, unstable slopes, and peri-urban areas. The issue creates new patterns of vulnerability. The new patterns of vulnerability include an increased level of risk in response to environmental issues. The populations who were displaced in the first place are now exposed to new issues.

This is not coincidental but is rather the result of underlying dynamics in the process of valuing the land and the priorities of the plans. Land that is deemed suitable for the development of high-value infrastructure is likely the land that is perceived to have the lowest level of risk and the highest level of

economic potential. Land that is prone to risk and lacks infrastructure is likely the land that is available for resettlement. This is the structural connection between development and vulnerability and the process of building infrastructure that generates new forms of risk distribution.

The Spatial Justice and Resilience Mandate is aimed at addressing this connection between vulnerability and development through the integration of vulnerability considerations into the core of the infrastructure planning process. This is in contrast with the traditional process of displacement management and response, where displacement is considered secondary and dealt with in the later stages of the project approval process. A major tool in the Spatial Justice and Resilience Mandate is the Pre-emptive Vulnerability Mapping process. This is the process of evaluating the hazard profile of the resettlement location through the use of indicators such as flood frequency and risk of landslides.

This establishes a normative principle in planning, which is that development should not worsen the risk profile of the affected populations. Though this seems obvious, it is actually a big step from how things are done now. The focus is not on compensation but on equivalence. The establishment of thresholds for risks is now being used as a criterion for resettlement. The focus is no longer on economic substitution but on environmental and social continuity.

The concept of Resilience Titling is an extension of this idea. The idea is to redefine what is meant by resettlement. The focus is on providing houses, but not just houses. The focus is on houses based on physical properties. The properties include size and quality. However, it is not just the houses by themselves that contribute to resilience. It is the environment in which they are located. The environment includes drainage systems, transportation networks, healthcare services, and social services.

Resilience Titling therefore links the allocation of housing with a range of environmental and infrastructural assurances. This may include elevation above flood levels, access to emergency services, and connection to urban infrastructure. By codifying such assurances in the resettlement policy, the government is able to ensure that the resettled populations are not only provided with housing but also protected.

To achieve this mandate, there is a need for a significant level of integration between various domains of planning. This would involve the integration of hazard mapping with social impact assessment and infrastructure planning in order to develop a comprehensive understanding of the situation. This would require the cooperation of various agencies involved in the management of the environment, urban development, disaster management, and social welfare. It would also require the development of data systems that can support such integration.

The legal framework has a vital role to play in the implementation of these principles. Without legal frameworks, the principles of vulnerability might not be legally binding. It can provide a framework for the minimum

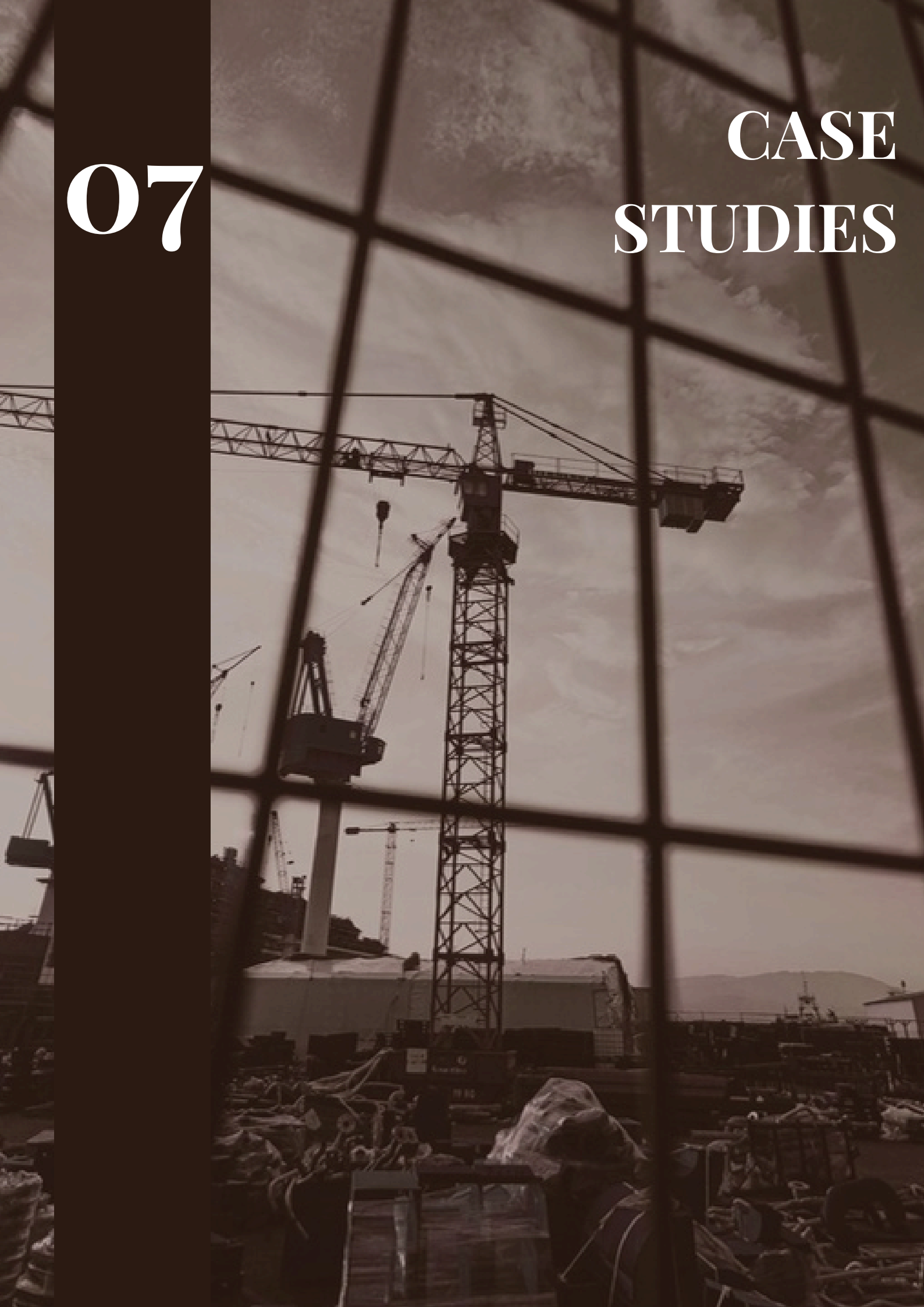
standards required in resettlement, hold parties accountable, and provide avenues for affected communities to hold parties accountable. This gives more credibility to the policy, ensuring that its provisions are not undermined in practice.

Conceptually, this recommendation rethinks the relationship between development and risk. It questions the dominant assumption that vulnerability can be managed as an external condition to infrastructure development. Rather, it acknowledges that vulnerability is often created through the very processes of development. Addressing the creation of risk at its source shifts the policy from a reactive approach to disaster management to a proactive approach to risk governance.

The broader implication is a new understanding of efficiency in infrastructure policy. Efficiency is generally understood in terms of cost, speed, and output. Nevertheless, in instances where development leads to greater vulnerability, it is possible that the long-run costs of disaster and social instability outweigh the initial benefits. The inclusion of spatial justice in such an understanding ensures efficiency is aligned with sustainability.

Thus, it is evident that the Spatial Justice Mandate is an attempt to integrate equity and risk into the very logic of infrastructure governance. In doing so, it ensures not only that development is not just a redistribution but also an attempt to deal with issues of vulnerability.





07

CASE STUDIES

CASE STUDIES

The Chennai Floods

Introduction

The floods in Chennai, which occurred in 2015, were a consequence of torrential rains caused by the annual northeast monsoon during November and December 2015, and they heavily impacted the Coromandel Coast of the South Indian states of Tamil Nadu and Andhra Pradesh. In contrast to SWM (South West Monsoons), these disturbances are driven by events and are far more volatile, particularly due to their susceptibility to the El Niño effect. That was the time when high Sea Surface Temperature (SST) in the Bay of Bengal combined with weak vertical wind shear conditions made the circumstances just perfect for the cyclones, tropical storms and other rainstorms that made landfall on the coast of southeastern India.

The concept of Torrential rains is associated with extremely heavy downpour, exceeding 100 millimetres an hour, implicitly causing floods and other crises. Chennai on December 1, 2015, saw an average city rainfall of 286 mm, with some areas receiving 500 mm. The impact obviously extended beyond Chennai, with the entire stretch of the Coromandel Coast extending into Andhra Pradesh's major coastlines. However, the city played a special role in the impact due to the sheer infrastructural damage and population density.

There are multiple other reasons, apart from the impact analysis, as to why Chennai acts as the key stakeholder.

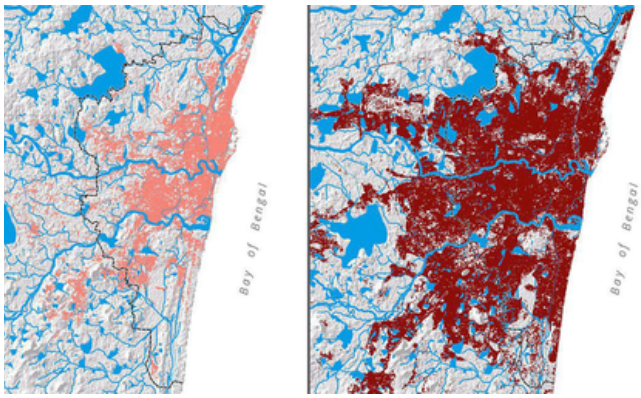
The urbanisation has been both unsustained over the centuries and the rapid growth in the last few decades. The ignorant infrastructural growth, rapidly becoming a key characteristic of the majority of the city, shook the city's flood-combating capabilities. The policy failed on three counts.

- Inability to enforce land use regulations and building laws, especially around encroachment on the sea bodies. The Protection of Tanks and Eviction of Encroachment Act came into effect in October 2007. However, there has been a lack of implementation of this law.

- The erasure of key lakes and inland water bodies that used to create a 'sponge' absorption effect.

- An unplanned and unscientific approach to a flood-prone and vulnerable city, for example, with unattended solid waste management flaws, adds to and exacerbates problems faced by the flooded city. Solid waste was dumped into water bodies on a massive scale.

This wreaked havoc to the extent that the death toll exceeded 500, while more than 1.8 million people were displaced. The loss and damage estimates exceeded Rs 11,000 Crores, with hundreds of acres of infrastructure submerged.



Geography

The impact on geography is well worth talking about. 80% of Chennai was considered a wetland in the 1980s, due to a complex network of inland water bodies. This number dwindled down to a little over 15% by 2015. This network involved 3 major rivers, the Kosathalayar, Cooum and Adayar. Another major channel in Chennai is the Buckingham canal, running north to south, which was an artificial construction connecting all coastal wetlands and was conceived as an inland waterway for transport.

A study done in 2022, by Vidya and Murthy, also talked about climate change playing a role in the increased flooding, and about how the government's failure to address broader issues has shaped the impact as a whole. It predicts that in Chennai, the maximum summer temperature will increase by 1.3–1.5°C and the minimum winter temperature will increase by 1.6–1.8°C over the next 30 years. This has been calculated based on the trends of the last 30 years, since 1991.

Moreover, the change in rainfall is expected to increase by 6% to 11% in comparison with historical rainfall records, and the total number of rainy days is expected to be about 2576 to 2612 days over the next 30-year period. This is in comparison with 2460 rainy days observed over the last 30 years.

In the year 2007, a risk perception study for extreme weather events in Chennai was conducted by the University of Freiburg, Germany, Care Earth Trust and Loyola College. This was supported by the German Agency for Technical Cooperation (GTZ). This consisted of the analysis of flood risk exposure, analysis of risk perception and management and the development of flood risk maps. One of the biggest takeaways from the study was that floods are quite a regular occurrence in the city, and the reasons were identified as the key factor contributing to the city's vulnerabilities. The study documents a total of 26 floods from 1943 to 2006, with a sharp increase in the number of floods from the 1970s.

Infrastructural Ignorance

Before we understand the systematic failure, we must understand the system. The system stands relatively unaccountable and unanswerable to the people, and a key reason is the introduction of an unquestioned British era centralised oversight body. The PWD has followed the set footsteps of relying purely on the guided steps of civil engineers, and this has led to a gap in accountability. Moreover, the improvised version included over 6-7 different authorities with different roles and responsibilities for the city's wetlands and lakes, making the system highly inefficient.

The following system worsened with CMA's (Chennai Municipal Authority) expansion and growth, both in importance and area of control, in a rapid and unplanned manner. From 1991 to 2011, the extent of the CMA was a mere 176 square kilometres, including only the Chennai district. As per the 2011 Census, it expanded by almost four times to 426 square kilometres. This leads to an urgency to expand urban infrastructure, which acts as a constant loop in itself, as the body's existence necessitates urbanisation, and the urbanisation necessitates the body's existence.

- Although the core issue was unchecked urbanisation, the subsequent encroachment on the city's critical natural water bodies can be deemed to be a separate step. There were more and more roads and paved areas getting constructed, especially near the Pallikaranai Marsh, which in turn greatly increased the impermeable surfaces and consequently the surface runoff. The surface runoff was such a huge amount that the stormwater drain network, which was not good in terms of both quality and management, was also plagued with silt and waste that often hung up. On top of that, there came the final disastrous factor, which was the supposed mismanagement of the Chembarambakkam reservoir, where the release of excess water into the already strained Adyar river, which was happening late, caused the flooding of nearby places.

- Prior to the year 2015, the development was under the control of an outdated land classification system, which usually regarded large areas of essential seasonal wetlands (Eri-System) as 'wastelands' or 'disposable land'. Such a view and categorisation, especially under the popular 'Eri Scheme' of the 1970s, made it easier for the authorities to legally change the use of these areas from natural flood-mitigation to residential, institutional, and public infrastructure zones. This was heavily misused, and encroachment was a common practice.

- The natural water bodies of the city, namely, Cooum and Adyar rivers, along with the Buckingham Canal, were not only filled up but also turned into the first choice for the disposal of untreated sewage and solid waste. This situation drastically affected their capacity for carrying water, especially during peak flow events. The total reduction in the storage capacity of 'tanks' (lakes) in Chennai since the year 1900 has been estimated in millions of cubic meters. Therefore, when the rainfalls of 2015, which had no precedent historically, occurred, the water had no opportunity for being absorbed and no easy, non-obstructed way to the ocean, thus causing quick and long-lasting flooding. In this way, the flooding was an indirect consequence of taking away the city's natural sponges and veins and replacing them with concrete.

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Skewed impact

Poor Infrastructure: North Chennai, a relatively backward area, and other similar zones, almost always have inadequate public infrastructure. This included the worst water supply per capita, sewage and storm water drains with extremely low coverage, and all of these factors combined to worsen the flooding situation.

Unequal Health Access: The health institutions that were located in the low-income areas were generally either unprepared or inundated, and hence, the very important services were suspended at the times when they were most needed, and the treatment of chronic diseases was made more difficult.

Eviction and Displacement: The government, at the time of the 2015 floods, implemented a policy to shift thousands of riverbank families through the "post-flood rehabilitation" and relocate them to out-of-the-way resettlement areas like Perumbakkam and Kannagi Nagar. These new areas often lack even the basic facilities, are far from where jobs are available, and lead to the creation of a new sense of economic vulnerability. Sometimes the new areas were flood-prone themselves too, creating an inescapable cycle of state dependence.

Effects

The flood of 2015 was due to the overflowing of the two rivers due to the heavy rainfall in the western outskirts of the city, followed by the opening of the shutters of the major reservoirs.

The Auto Component Manufacturers Association reported that more than half of their employees in the manufacturing industry lost their homes and objects in the floods.

The water reached everywhere from the ground floor of the shops and offices, destroying their inventories and machinery, to the IT parks and the multinational corporate headquarters. The flood's intensity was unprecedented, and a clean drinking water crisis was declared. Drives were carried out across the nation to mitigate the humanitarian crisis from worsening.

The big corporations, middle-class housing and slums which were built on the swamps, marshlands and low-lying areas got inundated as they were at the end in direct contact with the large overflowing regional tanks. This simple idea compounded in its effect to debase hundreds of acres of land and destroy thousands of crores.

To understand the importance of the geographical classifications, we must look at the development of marshlands in Chennai as a means of expansion. Marshlands of the city and the riverbanks were replaced by impermeable surfaces to facilitate rapid development in the city. The unconverted marshland of the city post-independence was reduced to almost 600. This led to a reduction in the absorbing capacity of the discharge that flows from West to East. Several fishing and agricultural villages and hamlets were also engulfed by the development in the city, leading to several environmental challenges.

Eventually, the recharge structures like lakes, tanks, ponds and streams were gradually filled up over a period of time. Thus, increasing the surface water flow manifold. The major tanks were silted due to continuous dumping of solid wastes, resulting in overflowing during heavy rains. Apart from that, the reclamation of the environmentally sensitive areas for development purposes was a dominant practice in Chennai.

Punjab

Punjab, popularly known as the Food Bowl of India, stands on the brink of sinking every year. The state has endured its worst floods in 1955, 1988, 2019, and 2023, but the year 2025 was the most violent year in this category. The floods claimed 30 lives, affected 2,56,000 persons, as many as 1,400 villages were inundated, and over 3,00,000 acres of crop were lost. All 23 districts of the state were inundated, with Gurdaspur, Amritsar and Ferozepur being the worst hit.

The 2025 Punjab floods were caused by a number of factors, natural and anthropogenic, including river spill-over, high monsoon rainfall, drainage, mismanagement, and infrastructure failure.

- **Swelling Up of Rivers:** Three rivers in Punjab are perennial: Ravi, Beas, and Sutlej. Due to the availability of these rivers, agriculture has flourished in this region. But the rivers that make the agriculture of this region possible are also the ones that bring disaster during the monsoon. The rainfall in Punjab and the upstream flow of these rivers in Himachal Pradesh and Jammu & Kashmir have mainly triggered the swelling of these rivers. These rivers breached embankments and inundated adjacent areas as well as croplands, resulting in devastating floods.

- **Unusually Heavy Precipitation:** The Himalayan and sub-Himalayan regions experienced extreme rainfall through monsoons and western disturbances, which resulted in record-breaking waterflow into the Beas, Sutlej, and Ravi river basins during the months of August and September in 2025. The Beas received its greatest water flow during the season, while Bhakra showed high water flow rates throughout that time. The inflows caused the water levels in Punjab's rivers to rise. The 2025 rainfall showed major differences from standard patterns through both its amount and its timing of distribution.

- **Poor Timing and Mismanagement:** Due to very high inflows, upstream reservoirs such as Bhakra, Pong and others managed by the Bhakra Beas Management Board were very much full to the brim. BBMB stated that the seasonal inflows were very high and they managed the releases so as to keep the levels under control. However, critics argued that the release of water from the reservoirs and the coordination between the states might have been better if the timing and volume of releases had been chosen in such a way that the peak flow could have been avoided downstream, especially because multiple tributaries were flooding at the same time. The Public Action Committee (PAC) in a petition accused the BBMB and the Punjab state government of negligence that led to these "man-made floods". The PAC alleged that dam mismanagement, lack of efforts to check illegal mining, and riverbed encroachments had contributed to the problem. The BBMB released water from the dams, even before the reservoirs were full. The BBMB follows a "rule curve" that guides how much water should be stored or released based on weather forecasts and hydrology. However, extreme rainfall events often force sudden releases, and it happened in this case as well. The PAC also condemned the state government for its failure to improve the river bunds following the previous floods and to check illegal mining and riverbed encroachments. This callousness on the part of the government further aggravated the environmental damage and the flood situation.

Members of the PAC said that they had sent a legal notice to BBMB in early August 2025, following a warning from the India Meteorological Department (IMD) about the looming crisis. They said that their warnings were ignored, leading to the disastrous floods.

- **Governance Failures:** The number of inundated villages was 324 in Gurdaspur, 123 in Kapurthala, 107 in Ferozepur, 93 in Amritsar, 92 in Fazilka, and 81 in Pathankot, while as many as 77 villages were affected by floods in each of the Muktsar and Mansa districts. Urban areas like Mohali, Ludhiana, Jalandhar, Amritsar & Chandigarh experienced urban flash floods as it rained without a break from 1 September to 3 September, 2025. Most of the embankments along the Sutlej, Beas and Ravi rivers were either temporary, ill-maintained or not ready for high flows. Many of the Dhussi Bandhs (temporary embankments) were breached or overflowed, leading to a quick flood of the floodplain settlements. In Ropar, irrigation canals and embankments developed large breaches, such that over 50 villages were endangered due to canal breaches. There were delays in emergency engineering responses. Old and poorly maintained flood control systems failed under pressure, inflating the flooding. Rapid urban expansion in Punjab's towns and cities has reduced areas for natural water absorption. Cities like Ludhiana and Amritsar saw severe urban flooding due to this issue.

Blocked canals and drains were a major factor in flooding due to siltation and the failure of authorities to desilt these canals. The poorly planned construction of roads, bridges, and concrete walls across natural streams and rivers stopped the natural flow of excess water into the big rivers. The floods caused immense destruction to the road network in the state, with preliminary estimates pointing to damage worth 850 crore. Based on the survey by the Public Works Department (PWD) and the Punjab Mandi Board, around 1, 200 kilometres of roads were affected, with most of the damage being reported in the rural areas.

Based on the report, the Cross Dependency Initiative released on February 20, 2023, Punjab is one of the top 50 places globally where climate change is expected to cause maximum damage to human-made infrastructure. Considering such international reports, both the state and central governments should be well ahead in introducing measures to lessen the effects of natural disasters. Any form of construction and land encroachment in the floodplains of rivers, streams, and seasonal drains should be strictly prohibited, and regular cleaning and maintenance of these water bodies is more than a necessity.

The government should give importance to the cleaning and desilting of old seasonal drains, ponds, and other similar areas. Recharge wells must also be constructed wherever the rainwater collects in low-lying areas of cities and villages so that the water can be absorbed underground before it overflows.

Before allowing any kind of construction (houses or other buildings), making rainwater harvesting arrangements should be a must. Inter-state cooperation in management should be established between Himachal Pradesh, Jammu & Kashmir, and Punjab, because the release from the upstream dam has a direct impact on the downstream state.

Himachal Pradesh

Introduction

Infrastructure development in the mountainous region has always been a challenge due to the risk of calamities like landslides, slope failures and floods. These factors are even more prominent in the state of Himachal Pradesh. Factors like steep terrain, tectonic instability, and intense monsoon rainfall make it a high-risk zone.

The Kotrupi Landslide Case

A massive landslide occurred in the Kotrupi village of Mandi district of Himachal Pradesh on 12 August 2017. This disaster took the lives of more than 50 people and left many missing as well. This case marks a major event with respect to the relationship between natural disasters and the infrastructure projects associated with them.

Analysis of slope instability over the long term.

Images taken from satellites show the gradual slope deformation and pre-existing scars on the slope between the time period of 2001 and 2017. There are other incidents as well, like a minor slide in 1977, as well as in 1997, further adding to the vulnerability of landslides in the year.

This analysis helps in finding out that the landslide was not a sudden one but was a result of cumulative long-term geographical deformation.

Several key findings from these satellite data were:

- During this time period, a reduction in vegetation of forest cover between 18-22% was seen.
- The NH-154 widened from the previous 9 meters to 12-14 meters.
- Satellite images showed that there was a slope cut at least 4 times.

Contributing Factors:

A) **Geological and structural weakness:**

The area of our study, Kotrupi, lies in the Lesser Himalayan Geological Province and is known as one of the world's most structurally disturbed and active mountainous systems.

The major problems are:

- **Highly deformed and fractured rock mass:** The area comprises weakly weathered and foliated metamorphic rocks like schists, phyllites, and quartzites. The masses of thrust rocks combined with poor drainage cause internal instability. Apart from that, they have low shear strength, high weathering rates, discontinuous planes, and weak bonding between minerals.

- **Major Tectonic Structures:** The slope consists of tectonic features like the Main Boundary Thrust (MBT) and the Kandori Thrust. Through years of repeated tectonic movements, it has fractured the rock and resulted in planes of weakness where sliding can easily occur.

- **Poor Drainage Systems:** Factors such as the geometry and rock structure of the slope have resulted in problems due to which rainwater cannot drain internally and gets accumulated in shear zones. This results in slopes prone to extremely sensitive rainfall triggers.

B) **Human involvement factors:**

- Widening of National Highway 154: Road expansion through the widening of National Highway 154 resulted in the weakening of the base support of the hill. Additionally, the road load and vibration from this activity also increased instability.

- **Slope cutting:** Slope cutting takes place without proper planning and unscientific means, such as vertical cutting instead of terracing, which adds to the cause.

- **Construction combined with Deforestation:** Heavy deforestation resulted in the removal of much vegetation and reduced soil cohesion. Development projects resulted in Increased surface runoff.

- **Mining and blasting in nearby areas:** Vibrations occurring from the continuous mining activities and blasting to clear paths resulted in amplification of the instability or slope.

C) **Climate factors:**

- **Intense Rainfall:** Rainfall during the period of Late July to early August of 2017 led to a significant increase in soil moisture. During the time just before the landslide, rainfall peaked at 96 mm/day.

- **Rise in soil moisture:** It was reported that the moisture recorded just before the landslide was 0.032 g/mm², which is above the normal range of 0.026–0.029 g/mm². This, combined with a time lag of 2–3 days between rainfall & moisture, is commonly associated with catastrophic landslides in the Himalayas.
- **Runoff Concentration due to Road cutting:** Construction of highways in the area resulted in alteration of the natural drainage pattern. It caused concentration of runoff on the slope, led to erosion of the toe area and washed away the anchoring roots.

Factors like these resulted in a weak slope and acted as a trigger for this landslide.

Impact analysis

Human Impact: According to reports, at least 50 people lost their lives because of the occurrence of this disaster. Passengers in Himachal Road Transport Corporation (HRTC) Buses were burned alive. Apart from that, the nearby areas faced disruption as their agricultural land was damaged. Thus, it affects their entire livelihood.

Infrastructure Damage: The National Highway 154, which connects Punjab to Himachal Pradesh and runs from Pathankot to Mand, was severely impacted, and about 300 metres of it was completely destroyed. Asphalt, retaining walls, culverts and slope support structures were swept away

The road connectivity between Mandi, Kullu, and Manali was disrupted for days, and emergency responses were also delayed as a result of blocked routes in the area.

Economic Impact: The Direct costs which resulted as a result from this disaster include road construction, movement of teams like the National Disaster Response Force (NDRF), Border Roads Organisation (BRO), Public Works Department (PWD), etc. Apart from it, the other impact was that it temporarily halted trade and transport in the area and also the cost incurred in the reconstruction of the highway, which was badly damaged.

Environmental Impact: The deforestation and vegetation loss, which were already predominant in the area, led to an increased and accelerated soil erosion. This re-shaped the entire slope profile. The exposed slope was now at a higher risk of reactivation from future rainfall events.

Relation of Infrastructure Development with Risk Amplification

During recent years, there has been an increase in the number of infrastructure development activities in the Mandi district, with development projects like widening of NH-154, building of retaining walls, transportation expansion through slope cutting and so on. These developments, although necessary, are often done without proper geotechnical assessment. This causes destabilisation of the fragile Himalayan slopes. The road widening process involves slope cutting and the dumping of debris in the nearby valleys. Many surveys conducted by the Geological Survey of India (GSI) and the National Institute of Disaster Management (NIDM) tell us that improper road construction practices can increase the possibility of landslides by around 30-40%.

part from these, there are several other constructions as well, like drainage systems and protection structures, which have remained inconsistent. They have caused not only blocked drains but also led to concentrated water infiltration and thereby resulted in weakening of the slope.

Overall, the rapid unscientific infrastructure development in an area where a slope has already been declared as a Very High Landslide Susceptibility Zone has significantly increased the risk of catastrophic failures, as we witnessed in the 2017 Kotrupi landslide. This shows that unless engineering practices are revised and development is done following the strict geotechnical guidelines, the probability of future disasters in the region will be many times greater than it is now.

Bihar

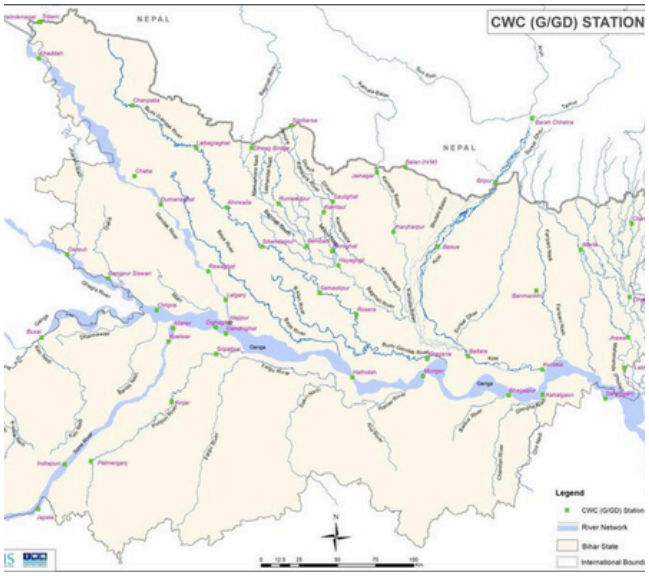
Bihar's infrastructural failures, especially with relation to its bridges, are infamously characterised as the sole burden of governmental failures. However, the issue runs much deeper. To understand this, one must first understand the role of bridges in the state.

Bihar has a highly complex and interconnected riverine nature that acts as the state's veins, adding to its rich agricultural land. The River Ganga divides the state sharply into two, North Bihar and South Bihar, which have vastly different qualities. The North has fertile plains and rich agricultural lands. It borders the foothills of the Himalayas and essentially acts as the ideal art of the state eastwards.

On the other hand, the south borders the Chota Nagapur plateau. This means that the river drainage is primarily from the southern rivers, flowing northwards. Another thing to be noted in this divide is the importance of

1. Connection between these two areas, not just through large-scale projects, but through a systematic and continuous model. The northern areas are primarily agrarian and, consequently, poorer. Urbanisation, outside of Muzaffarpur, is scarce, and agricultural products, therefore, have to be transported elsewhere and sold. The connection to the South becomes extremely important. The trade between these two regions, especially the flow of money and agricultural products, is pivotal to the state's economy. This transportation can only happen with trusted and safe bridges across the Ganga and its northern tributaries. Apart from this, the relative urbanisation of Patna can only reach the poorer north if it is realised in the secured movement of human and financial capital, for which bridges are pivotal.
2. Bridges, moreover, play a special role in North Bihar. Since this region is covered in Ganga's northern tributaries, efficient transport of both goods and humans can be seriously hampered without bridges. This is again, realising the fact that unlike the southern rivers, the Ganga and its tributaries are perennial, and in fact, rapid and larger in volume too. This means that for half the year, the Southern parts of the state have droughts in pockets, while the northern parts suffer from imminent flooding.

This flooding is another characteristically unavoidable burden the North has to take, and is a major reason for the underdevelopment in this region. The irrational governmental measures of barricading the river banks have worsened the water holding capacity due to increased alluvial deposition, and now the situation only gets worse year after year. However, even in these fast-flowing, wide and flood-prone rivers, sturdy and well-planned bridges are a necessity. Thus, both for trade and commuting in general, cross-river transportation forms the core of North Bihar's interests. Not only that, this region stands at a comparative disadvantage too, due to its vulnerable economy and geography. This also means that the failure of bridges as an infrastructural policy has hurt the vulnerable parts of the state much more.



As far as the bridges themselves are concerned, as stated in the two major needs for bridges in Bihar, the types of bridges in operation are also of two types. One is large-scale in nature, with spans of 2-6 kilometres, central government involvement, and either connecting the north and the south via the Ganga or crossing the Sone River.

This translates to accelerating the travel between North and South, and Bihar and UP. These projects have had a deep historical context and heavy budgetary allocations. Thus, their failures have been extremely disturbing in the development narrative, as bridges have formed the base for Bihar's growth story.

The first bridge developed to link the North and the South was the Rajendra Setu in 1959. It was the first rail-cum-roadway bridge in independent India. There have been several other historical examples, showcasing the role bridges have played in infrastructural growth in Bihar. The 19th-century project, Koliwar Bridge, was once the biggest in the Indian subcontinent, while the Mahatma Gandhi Setu has been a megaproject spanning 5.7 kilometres. This legacy has been more or less continued in the current policies, with a heavy focus on the continued policy of the Chief Minister's Bridge Building Programme since 2005. Major river crossings over the Ganga and its tributaries have seen significant development, with 25 large bridges built from 2005 to 2020 compared to only 16 in the preceding 58 years post-independence.

However, a specific case analysis of the Aguwani-Sultaganj Bridge is a must. The Rs 1,710 crore plan of creating a 3,16-kilometre-long bridge over the Ganga failed before it could even finish. It collapsed twice, once in 2022 and once in 2023, raising questions over governmental measures and protocol. The bridge was under the Pradhan Mantri Gram Sadak Yojana and the state's ambitious Bridge building Programme, making it a national highlight when it failed.

The collapse was characterised in multiple ways, Governmental, Civil, Structural, etc, but the collapse seemed to scar the image of Bihar's legacy bridges. When investigations were conducted by different agencies, it was found that the quality of the results is directly derivable from the quality of the work. This applies to substandard material, as issued by an IIT Roorkee study, or fundamentally flawed plans, as noted by investigators in a particular collapse. This also extends to negligence in work, associated with a broader range of governmental, bureaucratic and project failures.



The Sultanganj Bridge that collapsed multiple times before completion.

The second side of this paradigm is the small bridges. This is very closely associated with the riverine and flooding nature of several regions in Bihar, and is fundamentally different from the large-scale projects. As established before, there is a very defined vulnerable population in this purview, that is, people who not only depend on these bridges for their economic upliftment, but also the same population being heavily affected by unsafe bridges as the only escape mechanism in the annual and imminent floods that affect North Bihar and take the lives of the homeless.

These small bridges, in the case of the rural areas, transcend from just bridges to a will and command over the rivers. This has no direct economic utility, and often needs an answerable government at every single federal level for its successful implementation. This is especially important in Bihar, as now the development of these bridges, which is extremely important to the poor and agrarian population that dominates the demographics, is very vulnerable to governmental measures. In recent years, the political turn has started to focus on this avenue of micro-development.

This has been associated with the new Chief Ministership in 2005. Between 2005 and 2015 alone, over 5,400 bridges were added, surpassing the pace of previous decades. Over the 2006-2009 period, the Bihar Rajya Pul Nirman Nigam (Bihar State Bridge Construction Corporation Limited) constructed a larger number of bridges than all those constructed in Bihar from 1975 to 2005. The department is said to construct 700 new small bridges, worth Rs 3,000 crore, in rural areas in the state in the year 2025-26. Rapid scaling has, however, been accompanied by quality issues, as demonstrated by more than a dozen collapses in the middle of 2024 alone. These collapses are frequently attributed to poor materials, design non-compliance, insufficient supervision, and flood susceptibility rather than intrinsic engineering problems. A 2024 policy requiring routine inspections and a special maintenance corpus for bridges built after 2005 was prompted by experts attributing these failures to construction shortcuts and maintenance errors.

In spite of these problems, the overall improvement in infrastructure is said to have significantly shortened travel times and increased economic access in areas vulnerable to flooding.

Thus, these small bridges are the forefront of mismanagement and quality lags that eventually lead to Bridges Collapsing. Although this argument has made sense to a lot of analysts, there are certain faults in this assumption.

1. Most of the collapses have been of old bridges, dating anywhere between 25 and 100 years since their openings, indicating a failure to maintain these structures.
2. The failures of the government in obstructing a stable small-scale bridge and something like the Aguwani-Sultaganj Bridge are fundamentally different, and numeracy cannot justify this completely.
3. The success has been in a blanket sense. There were two state agencies involved- the Rural Works Department (RWD) and the Road Construction Department (RCD); the splendid performance of the RCD hid the abysmal performance of the RWD.

The bridges collapsing in large numbers across Bihar is different from the Aguwani-Sultaganj Bridge collapse. In 2024, in a single day, 4 bridges collapsed with no prior notice to the people about the risks of it doing so, harming civilians and property. These incidents have also sparked political controversy and scrutiny over alleged corruption, poor construction quality, lack of maintenance, and weak oversight within the public works department.

The government seems to answer with the argument of the unpredictability of such failures. The nature of Ganga's tributaries is fairly disallowing a completely secure structure to be laid across it, especially at such numbers. This spectrum of reasons is why an analysis of them is pivotal.

Governmental Reasons

1. **Maintenance:** Bihar has, for a long time, been a state without a proper and dedicated Bridge Maintenance Policy, which was applicable to all its infrastructures, mainly to the small rural bridges that were under the management of the Rural Works Department, among others. The consequence of this was the adoption of the reactive maintenance approach (fixing only after problems occurred) along with insufficient funding, where the new construction initiatives were given more importance than the critical maintenance of the existing structures. The Bihar State Bridge Maintenance Policy (2025), the first of its kind in India, is the new mechanism being implemented to manage all 3,968 state-maintained bridges, including the smaller ones. This policy introduces a systematic, technology-driven approach that includes mandatory third-party monthly audits, Bridge Health Card and Index, and lastly bringing as many bridges under the PMGSY as possible.

2. **Quality of construction:** Whether they are old or still being constructed, the failures are directly linked to widespread corruption, which not only allows the use of poor-quality materials but also non-compliance with the prescribed designs.

The collaboration of the contractors, engineers, and officials often concerns personal profit, so it is common to hear that as much as 40% of the project funds are lost to commissions while the structural integrity is being compromised. Thus, the corruption dictates the contractors to take shorter routes, which eventually results in the use of bad quality concrete, fewer steel rods, etc., and even the occurrence of serious issues such as not enough foundation depth. The structures that have been compromised in this manner, i.e., constructed with weak materials and very shallow foundations, are left very vulnerable to the monsoon floods, which result in hydrostatic pressure or scouring and thus, they give way sooner than expected.

3. **Artificial erosion:** The removal of silt around the bridge pillars is a common practice to smooth the installation process. This practice, however, is unfeasible in its safety and application, something that is rarely recognised. This creates artificial desilting and weakens the structure. The process of the bridge's base pillars being eroded is called 'scouring,' and this greatly weakens the overall durability of such a bridge. The collapse is likely to occur when monsoon-driven floods, which are common in the state, cause the river to flow under pressure, making the bridge unsustainable without those pre-existing silt deposits holding the structure in place.

The Additional Chief Secretary of the Bihar Water Resources Department (WRD) has publicly acknowledged that the root cause of some recent collapses may be linked to unscientific desilting around the pillars of bridges by contractors, especially ahead of the monsoon.

Natural Reasons

1. The natural riverine nature of the Ganges plains, especially in the northern Bihar regions. This, along with heavy rains, creates a natural susceptibility to strong river movement.

2. The proximity to the source of the rivers, that is the Himalayas, creates high pressure and a downstream flowing stream of highly eroding and strong current. This current has the potential to not just erode the soil at the base of the bridge's structure, but in fact erode the stability of the bridge itself.

3. Uncontrollable natural elements also play a role, like the Kosi River. Known as the “Sorrow of Bihar," it changes course seasonally, creating both vulnerable and wasted infrastructural resources.

In contrast, there is also the consideration of the harm these failures are doing to the ecology. After the Sultanganj fall, a large amount of debris was washed into the river Ganga. This created an ecological crisis, as dolphins and other marine creatures were gravely affected. This was reported as both the indicator and effect of the collapses' harms by the NGT in 2024. Even after the Bihar State Pollution Control Board filed an Action Taken Report before the NGT, it took months upon months of courtwork to finally have a mandate for the complete removal of the debris.

Uttarakhand

Introduction

Uttarakhand, once known as "Devbhoomi," has increasingly become a "Nirman Bhoomi," marked by rapid infrastructure expansion in the name of development and tourism. Built on the geologically fragile Himalayas, these projects often ignore environmental limits. As a result, development meant to bring progress is instead intensifying ecological instability and disasters.



Roads and Highways: Connectivity at a Cost

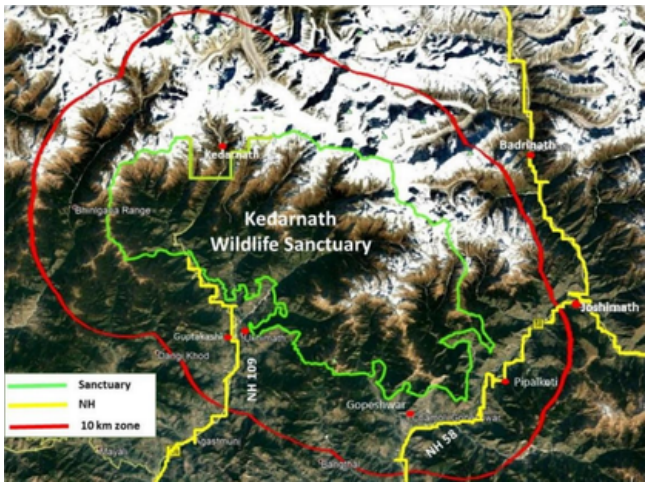
The Char Dham Mahamarg Vikas Pariyojana was introduced with the promise of modernising pilgrimage routes to Kedarnath, Badrinath, Yamunotri, and Gangotri. The project symbolised convenience, faster travel and an economic boost to a tourism-dependent state.

Ecological Distress: Thousands of trees have been uprooted; instead of cutting the slopes vertically, they have been cut horizontally. tremendous quantities of muck have been dumped in the rivers and valleys.

These measures have affected the already precarious slopes. The High Power Committee appointed by the Supreme Court observed that the increase in the width of roads had directly contributed to the landslide hazards. There were frequent slope collapses in the first four months of the project, almost one in a week on the Char Dham routes.

This phenomenon was further elucidated by the BBC's detailed analysis on the 2023 Silkyara tunnel collapse, suggesting that the pace and scale of development being undertaken in the state of Uttarakhand are a major reason for these accidents.

Administrative Shortcuts: A key characteristic of the project was its fragmented nature. It divided the project into 53 segments of smaller size, each of which well under the requirements of an EIA, thereby seeking to avoid these assessments altogether. When the HPC suggested a speedy EIA in late 2019, the ministry drew back on the process and only responded with issuing a consultancy contract months later. The construction process continued. Nine stretches of the project also fall within eco-sensitive zones (ESZs)- areas located within 10km of national parks and wildlife sanctuaries, regions that require strict wildlife and environmental clearances. The HPC found that seven of these had begun work without the necessary approvals, raising concerns about compliance and oversight.



Source: The India Forum

The Larger Issue: The question is not whether Uttarakhand should have roads; it must. The problem is that construction has followed the blueprint of the plains, ignoring the reality that the Himalayas behave differently. They are too young, too dynamic, and too fragile to support rushed, election-cycle-driven infrastructure. Without landscape-sensitive planning, roads meant to enable mobility can paradoxically trigger isolation by cutting off communities each time a landslide wipes out a stretch of highway.

Hydropower: Clean Energy, Dirty Reality

Hydropower has long been celebrated as Uttarakhand's greatest economic opportunity. With its dense network of rivers, Alaknanda, Bhagirathi, Mandakini, Pindar and many more, the place does seem ideal for generating "clean" electricity.

Yet hydropower in Uttarakhand is anything but clean in practice. Scientists have also repeatedly warned that the Himalayas are too fragile to bear large dams, extensive tunnelling, and heavy blasting.

Project Name	Status	Distance from Rockslide
Rishi Ganga Hydropower Project	Operational	14 km
Tapovan Vishnugad Hydropower Project	Under Construction	22 km
Vishnuprayag Hydro Electric Project	Operational	35 km
Vishnugad Pipalkoti Hydro Electric Project	Under Construction	55 km

Hydropower Projects Affected During the Chamoli Flood

A Pattern, Not an Exception

The Chamoli disaster did not occur in isolation. It fits into a longstanding pattern of rushed environmental assessments, limited public consultation, high reliance on blasting techniques, construction in geologically unstable zones, and overlapping infrastructural pressures on the same river systems.

With rising climate risks, glacial retreat, increased avalanche frequency, and rapid river swelling, the margin for error is shrinking. Building heavy infrastructure in this terrain without precaution is not merely risky; it borders on negligence.



Year	Event	Impact
1998	**Malpa landslide**	~255 people died. Early warning of mountain instability.
2013 (16–17 June)	**Kedarnath floods**	Flash floods in the Mandakini river, widespread destruction of roads, bridges, and homes.
2013	**Damage to hydropower tunnels**	The 2013 floods affected hydropower infrastructure downstream.
7 Feb 2021	**Chamoli disaster**	An ice-rock avalanche in Chamoli triggers a flash flood, destroying hydropower infrastructure.
2021	**Joshimath subsidence begins (post-flood)**	Land subsidence accelerated; cracks in buildings, warning of geological instability.
2022–2023	**Rapid subsidence in Joshimath**	ISRO satellite data detected several centimetres of sinking in a short span.
2025 (Feb)	**Avalanche near Mana, Chamoli**	BRO camp hit by avalanche, fatalities reported.

Timeline of disasters in Uttarakhand

Infrastructure Component	Project	Associated Ecological / Disaster Risk
Highways / Road Expansion	**Char Dham Highway (widening to all-weather)**	Unscientific hill cutting → increased landslides. The study recorded 811 landslides over ~800 km along highway routes. Dumping of debris into rivers, slope destabilisation.
Hydropower	**Tapovan Vishnugad (520 MW), Dhauliganga dam**	Vulnerability to glacier-avalanche / flash floods: The Chamoli disaster destroyed parts. Risk of reservoir-induced hazards, changes in natural flow regimes.
Urban / Pilgrimage Towns	**Joshimath**	Land subsidence due to tunnelling, excessive construction, and weak geology. Drainage and water seepage problems destabilise the ground. Also, rapid pilgrim infrastructure build-up.
Disaster Risk Zones	**Glacial lakes, steep slopes**	Around 25 glacial lakes identified to be in "perilous" state, could burst → Glacial Lake Outburst Floods (GLOFs). Cloudburst and increasing extreme rainfall events.

Risk Factors

Delhi

Delhi (NCR): The Capital of Mismanagement

Delhi's rapid urban development has altered its physical landscape so that the city's built-up area expanded from about 486 sq km to over 825 sq km between 2000 and 2022 - an increase of more than 70% in two decades- largely by encroachment on natural land and waterbodies.

During this period, the total wetland area, however, declined from 32.9 sq km to about 30.2 sq km, with South Delhi alone losing almost 97% of its wetland cover. All this destruction results in less natural recharging of groundwater. The risk of floods has also increased.

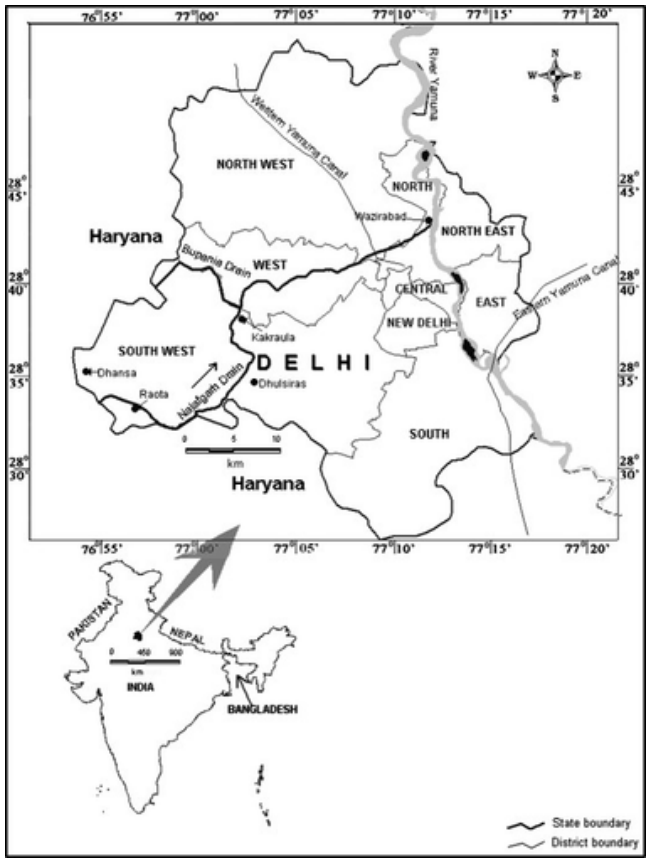
In the first place, the population of Delhi has risen from an approximate 1.47 million people in 1951 to about 33 million people in the year 2023, while the physical size of Delhi has expanded from 201 sq km to 1467 sq km, thereby resulting in ecological systems' overcrowding.

Moreover, as far as the future is concerned, there is a projection, which states that in case this trend continues, by 2033, the proportion of the total area in the larger Delhi, NCR, that will have been urbanised might be around 28%, hence implying that this trend of converting agricultural or open space into built-up space will continue.

1. Sahibi: From River to Drain

Historical Origin

Traditionally, it is known that the Sahibi River originates in the Aravalli hills. After originating in the Aravalli hills, it used to pass through the states of Rajasthan and Haryana, before entering Delhi near Dhansa. There, it expanded into the large wetland of Najafgarh jheel. This large wetland was of great help in addressing flooding issues and groundwater recharge. Prior to the construction of urban drainage infrastructure in the mid-20th century, it served as a natural flood management system for Delhi.



When "Progress" Began to Rewrite Nature

As Delhi expanded and urban pressures mounted, planners decided to "solve" the flood problem. In 1964, a bund and regulator at Dhansa were built to intercept Sahibi's floodwaters before they inundated populated areas. Yet ironically enough, in the very same year, the bund was breached by heavy floods, which meant that engineering had been on shaky ground all along.

Over the years, both wetlands and the natural jheel have faced the fate of drainage, and what has been left behind is merely a channel, which later came to be recognised as the Najafgarh drain. Deliberately, the city decided to turn a living waterbody into a drain, making it straight and deeper so that the flowing water can rush off quickly. A living buffer zone, which can protect the city during floods, was later turned into a conduit, not suitable enough in relation to the shifting requirements of a metropolitan city.

From River to Drain to Sewer

Delhi's expansion did not come alone. With its growing population, colonies, industrial belts and infrastructure, the demand for waste disposal grew massively. The natural drainage systems had long ceased to exist, and hence, the Najafgarh Drain had become a natural outlet. Over the course of time, dozens of smaller drainage systems, unauthorised colonies, industries, and even districts from Haryana started dumping all sorts of waste into it. What had earlier started out as a seasonal river bed turned into a daily dumping station of untreated sewerage and other pollutants.

Recent figures have shown the gravity of the situation. It is estimated that the city produces 720 million gallons a day (MGD) of wastewater. It had been estimated that an estimated 450 MGD flows through the Najafgarh drain, with 105 MGD out of the figure being contributed by Haryana. However, it has to be stated that as of 2025, it was reported that an increased figure of 800 MGD had been discharged, as claimed by a water minister in Delhi.

The measurements of pollution show just how toxic this evolution has been. Water in some of the sections of this drain was even recorded by a recent report, wherein BOD (Biochemical Oxygen Demand), as well as COD (Chemical Oxygen Demand), levels were found to exceed norms significantly, beyond even a polluted but living water body. With as many as 122 drains feeding into it within its 57 km length, Najafgarh is the biggest polluter of the Yamuna River.

As such, a natural water course, which once harboured life, cycles, and ecology, turned into a toxic drain, choking the city.

Infrastructure Failure

Thus, although Delhi added more land area for accommodation development, roads, and increased urban sprawl, in return, Delhi compromised, in the long run, its own original environmental resiliency, ecological balance, water purity, and drainage techniques. The infrastructure that was built to shape and modernise Delhi ended up defeating its environmental sustainability.

Despite decades of "development", the city now spends huge sums on desilting drains, cleaning sludge, installing sewage-treatment plants, and battling pollution, while groundwater declines, flood risk increases, waterlogging becomes common, and rivers die. The drain that once drained water now drains hope.

Attempts at Reversal

Recognising the huge extent of the damage, authorities have initiated a massive rejuvenation drive.

A plan was announced for the rejuvenation of the Najafgarh Drain / Sahibi River, for which an allocation of ₹705 crore has been made.

It also appears that some stretches have been de-silted by a partial gravitational process. Additionally, some of the drainage water from the tributary drains has been checked. Sections of the river had some refurbished sluice controls. Some of the residents are relieved that the flow has returned, the water is no longer stagnant, and the stench has lessened with de-silting.

Meanwhile, there's a suggestion that the water body be renamed from "Najafgarh Drain," or "nallah," to the "Sahibi River," in an attempt to transform the prevailing mindset from "dirty drain" to "river," and thus command some respect and conservation.

Such symbolism is also relevant because when people perceive water as being alive, they will, therefore, care, hold people around them accountable, and advocate to restore it, as opposed to when they perceive it as just a drain to be neglected or abused.

The Cost of Short-term Fixes

The Najafgarh Sahibi episode points out some valuable lessons in how one must plan infrastructure in the country, especially in burgeoning cities. Initially, natural systems, such as wetlands, floodplains, or rivers in specific seasons, should not be seen as "empty lands" to be filled and developed. Constantly draining these zones to build infrastructure like buildings and roads only implies ecological debt.

Second, when these ecosystems are destroyed, engineered systems like drains, embankments, and regulators usually fail to mimic their full range of ecological functions. They may be designed to transport water, but not water cycles; they may be meant to treat sewage, but not biodiversity; they may be built to control floods, but not recharge groundwater or build in resiliency against pollutants.

Third, the development of infrastructures cannot be divorced from issues in governance and environmental planning. Sewage treatment, waste management, land-use control, and inter-state coordination-all require simultaneous strengthening. Otherwise, every new "development" adds to the burden rather than solving the issues.

Finally, public perceptions and identities matter. A "river" is a word that commands respect. A "drain," however, simply invites dumping. Renaming drains as rivers does not necessarily solve the problem in and of itself, but it might alter the social contract and raise public environmental awareness.

2. The Persistent Problem of Waterlogging

Drains help in flowing rainwater from the low-lying areas to the neighbouring lakes or reservoirs. Efficient drainage, among all, happens to be one of the most essential facilities any city must have. Nevertheless, Delhi is a city for which such a statement is untrue, due to a large portion of the city that is unplanned with an improper drainage system.

Delhi experienced its heaviest rainfall, 228.1 millimetres, in June 2024.

The Safdarjung weather station, which is located in Delhi, reported the heaviest rainfall this month in 88 years, reaching 228.1 millimetres in 24 hours, as reported by the India Meteorological Department. As a result of the downpour, a hazardous roof at the airport collapsed, resulting in the death of a person, and five others sustained injuries in the accident. The rain also affected flights, a metro station, and underpasses, leading to huge traffic jams due to the rain. Several bodies and departments received over 300 phone complaints about the waterlogging problem as a result of the rain.

Drainage System That is Largely Inadequate. This is because of the fact that there is an obsolete drain design. This infrastructure is designed to handle only 50 mm of rainwater; something more than this is what creates the waterlogging problem. The drainage system in Delhi was designed for a city that hardly exists anymore.

Plastic Pollution

Poor Solid Waste Management is yet another reason that creates Delhi's permanent waterlogging. The waste, like plastic wrappers, bottles, and other trash, blocks sewers and drains. During the time of the monsoon, the drains have excess water in them, leaving minimal room for water to circulate freely. The garbage that has been piling up throughout the year is difficult for the municipal agencies to get rid of at the last moment, and as a result, only narrow water pathways are left.

This suffocation of drains eventually reduces the carrying capacity of the drains that are already of inadequate size.

Ecological Degradation and Encroachment. The report, "Environmental Improvement Plan of Delhi", stated, "The transformation of wetlands and agricultural fields into concrete structures of habitations, about Delhi, has affected the ecological capacity of the city, which was previously capable of managing water. Urbanisation has resulted in an absence of natural places for absorption, causing rainwater to flow directly onto roads and overwhelm the drainage system."

Mismanagement

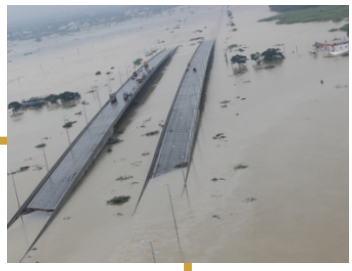
The main reasons for waterlogging, as cited by senior PWD personnel and experts, involve poor coordination, lack of infrastructure, poor architectural designs, and increasing population density. Coordination of drains and roadways is handled by a minimum of eleven different departments or organisations, such as the Public Works Department (PWD), Municipal Corporation of Delhi (MCD), National Highways Authority of India (NHAI), and Delhi Jal Board (DJB).

TIMELINE

INFRASTRUCTURE FAILURES: A DISASTER TIMELINE

Nov-Dec 2015 — CHENNAI FLOODS

1



Torrential NE monsoon rains overwhelmed a city stripped of its wetlands.500+ deaths, 1.8 million displaced; loss of lakes and encroached waterways left no absorption capacity. Chembarambakkam reservoir mismanaged late.

7 Feb 2021 — CHAMOLI GLACIER DISASTER

2



A rock-ice avalanche triggered flash floods that destroyed the Rishi Ganga and Tapovan-Vishnugad hydropower projects. Decades of tunnelling, blasting, and slope destabilisation in the paraglacial zone amplified the disaster.

30 Oct 2022 — MORBI BRIDGE COLLAPSE

3



A 143-year-old suspension bridge over the Machchhu River collapsed days after reopening following a renovation. Over 130 lives were lost. Investigations pointed to substandard repair work, overcrowding, and negligent safety oversight.

Jun-Jul 2024 — BIHAR BRIDGE COLLAPSE

4



Over a dozen bridges collapsed within weeks, including four in a single day, due to poor construction materials, unscientific desilting around pillars (scouring), zero maintenance culture, and monsoon-driven riverbank erosion.

Aug-Sept 2025 — PUNJAB FLOODS

5



Record monsoon surplus (24% above average) overwhelmed Punjab's three rivers. Breached Dhussi Bandhs, delayed dam releases, blocked drains, and 1,200 km of damaged roads left 2,56,000 affected and 3,00,000 acres of crops destroyed.

08

INTERNATIONAL POLICY LANDSCAPE



INTERNATIONAL POLICY LANDSCAPE

International agreements and frameworks, combined with existing environmental protection rules, determine how countries implement and create their development projects.

United Nations Framework Convention on Climate Change (UNFCCC), 1992

The UNFCCC is an international treaty on climate change, which was introduced during the Earth Summit at Rio de Janeiro in 1992. The UNFCCC has 198 member states. The US government declared its intention to leave the organisation in early 2026. The treaty established legal restrictions on greenhouse gas emissions through its emission responsibility framework, which required countries to work together. The principle of Common but Differentiated Responsibilities acknowledged the dilemma of developing nations to pursue growth by putting the onus of climate change on developed countries. The essential elements of UNFCCC include its dedication to sustainable development, its commitment to emission reduction targets, its requirement to share clean technologies, its provision of financial support to developing nations that need protection, and its commitment to maintain open operations. The convention has achieved success because it helps countries deal with climate problems which arise between international borders, while it motivates nations to adopt sustainable development practices.

The UNFCCC organisation currently encounters multiple difficulties, which include scientific uncertainties together with political restrictions, and the absence of legally binding treaties. The process of negotiating international agreements suffers from conflicting national interests, which reduce the effectiveness of joint policy initiatives. The national obligations suffered when short-term economic growth exceeded the total budget for environmental sustainability projects.

Kyoto Protocol, 1997

The Kyoto Protocol is an international agreement, signed by 160 countries in Kyoto, Japan, under the United Nations Framework Convention on Climate Change (UNFCCC). The protocol has 192 current member states. The treaty established binding obligations for major developed nations, including the United States, the European Union and Japan. The protocol served as a major milestone achievement for GHG emissions reduction efforts because it implemented various market-based methods, which provided cost-effective solutions for emissions control. These were achieved through three major methods: Joint Implementation (JI), Clean Development Mechanism (CDM), and Emissions Trading. Annex I comprises a group of industrialised nations that were able to realise a 22% reduction in emissions between 2008 and 2012, which is beyond the 5.2% required for this commitment period.

The Kyoto protocol incorporated flexible and cooperative measures that did not address all its operational deficiencies.

The protocol lost its global impact when Australia withdrew from the treaty and the United States refused to ratify the treaty because both countries were among the largest GHG emitters. The protocol used CBDR to establish its rules, which resulted in the exclusion of India and China because they had become major developing economies after 2006. The developed countries dominated the implementation process while only a few countries participated, thus restricting its effectiveness.

Paris Agreement, 2015

The 195 nations signed the Paris Agreement in 2015, creating its legal status. The US government's withdrawal from the agreement has reduced the participating countries to 194. The treaty establishes a target to restrict global average temperature rise to less than 2°C above pre-industrial levels while making efforts to achieve a 1.5°C temperature limit. The framework which handles climate change provides maximum inclusion and flexibility because it operates through a bottom-up approach. The system enables countries to create their climate action plans, which they refer to as Nationally Determined Contributions NDCs. The parties have been able to maintain the long-term 1.5 °C global warming target till now. But the global emissions of carbon dioxide from burning of fossil fuels hit a new high in 2025, and according to the UN, national plans to cut emissions fall far short of what is needed to limit rising temperatures to 1.5 °C. Based on the current rates, the world could pass the set limit by 2030.

Green Climate Fund

Established by the United Nations Framework Convention on Climate Change, GCF became an operating entity in 2010. It exists to fund projects that support low-carbon, climate-resilient development approaches, which help put into practice the Paris Agreement, the same parent convention.

The GCF is a funding organisation seeking the reduction of global greenhouse gas emissions, especially in developing nations. The organisation has successfully established climate considerations as essential factors, which must be evaluated during all new infrastructure development initiatives. The organisation provides financial support, which enables organisations to conduct climate risk evaluations, monitor greenhouse gas emissions, and create infrastructure systems that can withstand climate change impacts. The funding mechanism suffers from three main problems, which include restricted access, delayed payment processes and complicated funding criteria.

International treaties have created new approaches to climate change and sustainable practices in building infrastructure. The existing solutions still encounter challenges because they cannot find a balance between promoting economic growth and protecting natural resources. Financial restrictions and implementation deficiencies, together with economic trade-offs, create major obstacles for organisations which attempt to handle environmental challenges.

Netherlands

The Netherlands is a country in a delta zone that has always been exposed to the threat of repeated flooding for an extremely long period of time. The country has large parts that are below sea level and would have been flooded were it not for this feature. The geographic drawback has had a vast influence on the societal and infrastructural development of the country. The Dutch territories have suffered from disastrous storm events during the early twentieth century due to extreme exposure to both sea and rivers. The North Sea flood of 1953 is considered the most disastrous event, as it killed over 1900 people and flooded large areas. According to sea level projections, the capital city of Amsterdam is second on the list of cities which are at risk of flooding by 2050. Such instances have prompted early legislative and engineering reforms, including the construction of levees and flood barriers to protect the land surface area.

The Delta Programme

The increased pressures from the rise in sea levels, extreme rainfall, and population living in flood-risk areas weakened the conventional flood-protection systems. For dealing with issues like recurring flooding and changing climatic patterns, a strategy was formulated by the Dutch government: the Delta Programme. This strategy is aimed at strengthening flood safety and water security, with its foundation laid by the Delta Act (2012). It is the Netherlands' approach to flood risk management, with an elaborate system of dams, sluice gates, storm surge barriers, dikes, and other protective measures. The programme brings together experts and government authorities on water management and civil society. All the measures in the Delta Programme are financed from the Delta Fund. An average of €1.25 billion a year has been earmarked for the Delta Fund up to 2032. More than 55 per cent of this amount is for investment in new measures. The remaining 45 per cent is needed for overheads and to cover the costs of management and maintenance. The Delta Programme encompasses three primary aims: protecting the Netherlands from flooding, ensuring sufficient freshwater supply in view of the rising temperatures, and making the country climate-proof.

Sustainable Infrastructure Investments

The current situation requires specialised systems for cities, because existing systems are already stretched beyond their limits. The Dutch floating houses are similar to those constructed on land, but instead of a basement, they are made on a concrete hull that maintains their balance and keeps them stable in the water.

The Netherlands uses spatial adaptation to create flexible decision-making processes which help cities, transportation systems, residential areas and energy facilities to better withstand climate change impacts. The plans include establishing resistance to heat through shading methods and developing systems to control both drought situations and stormwater flooding.

Key Learnings

The Dutch model of climate adaptation is regarded as a global benchmark for resilient nfrastructure and climate adaptation.

Its policy-integrated approach to water and climate-based risks is proactive and scientifically advanced. Initiatives such as the Valuing Water Initiatives are exported worldwide to improve flood management.

The Netherlands shows successful results by creating resilient infrastructure, because it treats climate adaptation as a long-term infrastructure investment instead of a short-term need. The principle of spatial adaptation ensures that cities and transportation systems receive design solutions which enable them to handle heat, flood, and drought conditions. The organisation uses specific budget allocations to support resilience funding, while it links scientific research with public administration throughout its entire operation.

Vietnam

The transformation that Vietnam has undergone over the recent past in terms of infrastructure development following the economic reforms in 1986 under the initiative of Đổi Mới has been significant in catapulting the nation to its current position as a manufacturing and export-driven economy. In the infrastructural field, the role that has been played by the development of ports to find a place in infrastructure has been significant, considering that Vietnam is a nation with a long coastline and thus plays an important role. It should be imperative to focus on the Cái Mép-Thị Vải deep-sea ports. In the past, before the mid-2000s, Vietnamese maritime trade was hindered by its shallow-draft ports, starting with Ho Chi Minh City and Hải Phòng. This means that it was impossible for the nation to receive large ships used for container transport, and its export trade relied on various transhipment centres such as Singapore and Hong Kong. This made the Vietnamese export system more expensive and thus less competitive.

As the Vietnamese export base grew rapidly, the vulnerability of its port infrastructure became a bottleneck. The Vietnamese government realised that the development of deep-sea ports was a priority area. The Cái Mép-Thị Vải (CM-TV) port complex, situated in the province of Bà Rịa-Vũng Tàu, about 70 km from Ho Chi Minh City, was established as the first deep-sea port system in Vietnam that could handle ships with a DWT of over 100,000 tons. The project included a large number of public-private partnerships (PPPs) with investments from worldwide port operators such as APM Terminals, PSA International, and DP World. This was highly relevant due to its particular design with:

- Naturally deep channels reduce dredging requirements
- Direct access to major East–West shipping routes
- Integration with industrial zones and export processing areas

The economic effects of CM-TV have been significant and far-reaching. The port complex allowed Vietnam to establish direct shipping lines to Europe and North America for the first time, bypassing the regional transhipment points. This improved the transit time and further reduced the logistics costs, thus resulting in Vietnamese exports being more competitive in the international market. More significantly, the presence of deep-sea port capacity changed the investment decisions of firms.

Export-oriented manufacturing firms, especially in the electronics, machinery, and premium consumer goods sectors, benefited from the reliability of supply chains, solidifying Vietnam's role in the regional value chains. The port became more than just a transportation infrastructure; it became an enabler of industrial upgrading.

However, the CM-TV experience also revealed some institutional and coordination problems in the framework of infrastructure governance in Vietnam. In the first years of its operation, the port complex was characterised by substantial underutilization, with the volume of traffic being much lower than the planned capacity. This state of affairs was mainly due to the lack of good connectivity, especially in terms of road and waterway access to Ho Chi Minh City and the surrounding industrial zones. The gap between the port capacity and the quality of transport infrastructure highlighted a problem that tends to recur in the development pattern of Vietnam: infrastructure projects were typically developed without being integrated into a comprehensive logistics framework. In a more general development context, the CM-TV case can be seen to provide a number of insights into the Vietnamese development strategy of growth through infrastructure. First of all, it illustrates the importance of focusing infrastructure investment on known economic constraints. Secondly, it underlines the importance of institutional changes and foreign involvement in improving infrastructure performance beyond the creation of infrastructure assets. Finally, it shows how infrastructure can actively influence industrial location, investment, and trade patterns, rather than simply adapting to economic growth.



TIMELINE

GLOBAL CLIMATE FRAMEWORKS

9 May 1992 (adopted) — UNFCC

1

United Nations Framework Convention on Climate Change: Signed at the Rio Earth Summit by 198 nations; established the foundational legal framework for global climate action; introduced Common but Differentiated Responsibilities (CBDR).

11 Dec 1997 — KYOTO PROTOCOL

2



First treaty with binding GHG reduction targets for developed nations, signed by 160 countries. Introduced market mechanisms (Joint Implementation, CDM, Emissions Trading). India and China excluded under CBDR as developing economies.

10 Dec 2010 — GREEN CLIMATE FUND

3



Created under the UNFCCC to direct finance toward low-carbon, climate-resilient development in developing nations. Supports climate risk assessments and resilient infrastructure, but faces criticism for restricted access and complex funding criteria.

12 Dec 2015 — PARIS AGREEMENT

4



195 nations committed to limiting global warming to 1.5–2°C above pre-industrial levels via Nationally Determined Contributions (NDCs). A bottom-up, flexible framework, but current NDC pledges fall critically short of the 1.5°C target.

27 Jan 2026 — US WITHDRAWAL

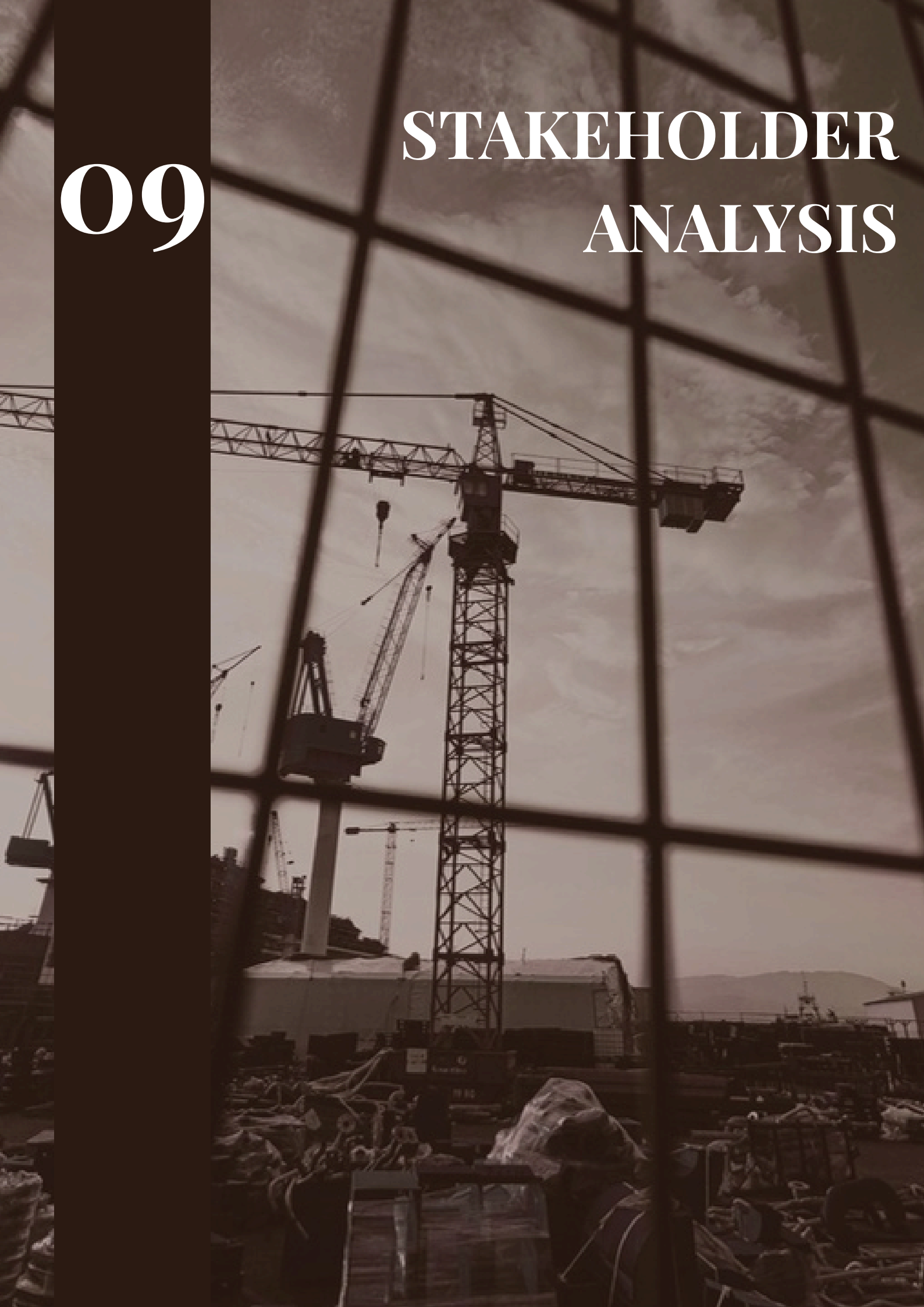
5



The US declared exited the UNFCCC, reducing Paris signatories to 194. As one of the world's largest emitters, its departure weakens multilateral climate enforcement and sets a precedent of national disengagement.

09

STAKEHOLDER ANALYSIS



STAKEHOLDER ANALYSIS

1. Government

Infrastructures, within governance as well as within its public policies, possess a symbolic stature. They are a manifestation of state strength and thus are economically visible, measurable, and politically legible. Infrastructures like national highways, city transportation schemes, or irrigation schemes are usually viewed within the state apparatus as certainly facilitating economic growth, integration, and efficiency.

From this standpoint, progress is associated with scale and speed. Faster execution, more extensive coverage, and higher capital outlay are treated as markers of success. This attitude may be traced in historical construction in terms of colonial railway expansion aimed at consolidation, post-independence mega dams conceptualised as the "temples of modern India," and the recent initiative in terms of national highways/urbanisation as a springboard for enhanced productivity.

Nevertheless, with this kind of institutional focus, what seems to take centre-stage are those outcomes which are easily quantified, such as kilometres of road built, capacity created, and funds spent, with longer-term implications playing a secondary role. Through performance audits, the Comptroller and Auditor General (CAG) of India identifies delays, underutilisation of central schemes such as JNNURM and lack of institutional capacity at the grassroots levels.

2. Public

For people living in and around project sites, infrastructure is seldom abstract. It comes in the form of land demarcations, notices of relocation, dust from construction, changes in water currents, and changes in resource accessibility. Their understanding of development is less about national histories and more about tangible outcomes.

For farmers living around canal development projects, there may be better irrigation and agricultural productivity, but also waterlogging, soil salinisation, or the loss of customary water rights, which have been historically recorded in colonial canal projects and replicated in subsequent irrigation projects.

For people living around highway developments or urban renewal projects, there may be displacement, loss of informal economic activities, or denial of access to the benefits of infrastructure development that infrastructure is meant to provide.

The perception of development that emerges in this context is one of deep ambivalence. Infrastructure can mean connectivity, markets, and benefits, but it can also mean division in social relations and the destruction of ecological supports. The irony is that people are not necessarily anti-development; they are simply opposed to being collateral damage in the name of development.

3. Private Sector

For the private sector, infrastructure is viewed more as a type of asset class than a badge of state capacity, with investment informed by risk/return trade-offs, regulatory certainty, and demand assurance. In the expansionary areas of new urban peripheries, industrial corridors, or greenfield projects, private sector engagement is necessarily selective, focusing on sectors with assured income streams such as toll roads, airports, logistics nodes, and electricity production, with socially necessary but low-return infrastructure projects remaining state-dependent.



The idea of developing public-private partnerships is able to address profit needs and development needs, but in practice, it aims to reduce risks relating to uncertainty of demand, land acquisition, and political risks. This profit-centred approach tends to favour efficiency, as well as costs, instead of equity, particularly in growth centres. While the involvement of the private sector is likely to improve project implementation efficiency and speed, as well as maintenance, there is also a governance challenge, particularly because of renegotiations for filling discovered gaps in demand that result in placing additional risks on the state.

Hence, private sector involvement in infrastructure development is no longer seen as a substitute for an effective role by the public sector, but as a supplemented entity whose developmental gains are predicated upon an effective role by the state.

CONCLUSION

Synthesis of Findings

The evolution of India's infrastructure development since the emergence of the first civilisations through the colonial period until now is covered in the report, with particular emphasis placed on a recurring paradox in which economic goals inevitably come into conflict with the need for sustainability and social justice. While both Bharatmala and Sagarmala, as well as JNNURM and Uttarakhand's geological disaster-prone roads or Punjab's flood-ridden farmlands, point to the negative implications of infrastructure viewed purely as an economic tool rather than as an investment in the future, such a trend can be seen in numerous other projects.

Indeed, the colonial infrastructure development model had much more to do with the extraction of resources than anything else. Similarly, the post-independent Five-Year Plans were based on models that were economically successful while being socially unjust.

The Structural Paradox

Thus, the primary premise of the report is that Indian infrastructure development is characterised by a paradoxical situation where the development programs that bring about certain benefits in terms of economy undermine their own base in environmental and social terms. There are three major systemic factors causing this paradox.

First, metrics of output prevail over metrics of outcome. Indeed, while the success of Bharatmala, Sagarmala, Smart Cities, and AMRUT programs is measured mainly in terms of projects completed, kilometres built, and budgets allocated, there is little consideration of the ecology, durability of maintenance, and equitable distribution of resources in question.

Second, environmental regulation is broken up in a systematic way. As shown in the parts about the EIA framework, NHAI, and the Border Roads Organisation, project fragmentation below assessment thresholds, post-facto approvals, and poor post-construction monitoring are all ways that clearance processes are often bypassed. The effects can be seen in the Char Dham highway's repeated slope failures, the rise in landslides in Himachal Pradesh, and the erosion of the coast caused by the Vizhinjam port breakwater. Cumulative landscape-level risk is structurally imperceptible to a regulatory framework oriented towards individual project evaluation.

Third, the benefits of infrastructure are not evenly spread out; they tend to go to areas that are economically and administratively better off. The geographic spread of NIP investments, Sagarmala's focus on ports and industry, and the difference in performance among Smart Cities beneficiaries all show that existing institutional capacity is a compounding advantage.

Communities in geologically unstable areas, tribal lands, coastal fishing villages, and rural areas prone to flooding, like North Bihar, face a lot of displacement and risk but get a lot less of the benefits. This uneven distribution makes infrastructure investment less socially acceptable in the long run and makes it harder for political conditions to support long-term institutional reform.

Evidence from Case Studies

The case studies provided geographically localised instances of the paradox of structure. The Chennai Floods of 2015 demonstrated the impact of the conversion of the Pallikaranai marshland and the blocking of drainage, as a result of which a heavy monsoon became a government-induced disaster. The Punjab Floods of 2025 demonstrated how the intensity of the rains, the poor management of the damming, the destruction of embankments, and the blockage of drainage intensified the magnitude of the disaster in all twenty-three districts of the state. Finally, the Kotrupi Landslide demonstrated how the slope collapse was caused by improper cutting, deforestation, and the lack of drainage, which increased the danger of a slide in a particularly landslide-prone territory.

In this regard, the Uttarakhand case proves enlightening. The infrastructure development in one of the earth's geologically youngest and tectonically active mountain systems took place without landscape-specific planning and cumulative impact assessments, which should have been carried out considering the complexity of the topography. According to the report prepared by the High-Powered Committee that was appointed by the Supreme Court, road widening contributed to landslides, and some stages of the development were implemented in environmentally sensitive areas without proper authorisation.

In the 2021 Chamoli disaster, where a rock ice avalanche led to massive destruction of hydropower projects and the death of hundreds, nature did not just strike randomly. This is an outcome that was bound to happen because of excessive pressure exerted on the fragile ecosystem. The crumbling of bridges in Bihar, flooding of Delhi, and degradation of Goan coasts all speak of one truth: development without adequate safeguards will only lead to a disaster that destroys any development made.

Policy Recommendations

All corridor-scale and basin-scale programs should do a cumulative impact assessment. Individual project evaluations are incapable of encompassing cumulative ecological and hydrological impacts within shared geophysical contexts. It should be against the law to break up a project to get around assessment thresholds, and an independent statutory body that is not subject to ministerial interference should be in charge of enforcing this. Performance dashboards for NIP, Bharatmala, Sagarmala, and AMRUT should include ecological and distributional indicators as well as physical completion metrics.

People should think of maintenance financing as a first-order investment instead of a leftover expense.

The Parliamentary Standing Committee's finding that maintenance got about one per cent of MoRTH's total budget shows that the whole sector is undervaluing it. Every big infrastructure project should have a required operations and maintenance fund that is paid for over the life of the asset. There should also be independent audits and public disclosure of compliance.

At the state and local levels, land use management in areas that are prone to floods, landslides, and other environmental impacts needs to be improved. The cases of Chennai, Punjab, and Bihar show that the main reason for encroachment on natural water bodies and drainage channels is a lack of enforcement of state-level planning and coordination between departments. Central scheme conditionalities governing AMRUT, Smart Cities, and PMAY should be revised to make continued funding contingent upon the adoption and enforcement of flood zone and wetland protection regulations by recipient urban local bodies.

Community consultation and SIA should be moved from being procedural steps to being inputs into the decision-making process. The forcible eviction of tribes in connection with Five-Year Planning, the displacement of fishermen caused by the construction of ports, and the poor rehabilitation of people living on river banks after flooding are examples of how planning done without community engagement results in higher social disturbance and poorer outcomes. Multilingual documents, longer advance notices, mandatory responses, and facilitators independent of the affected marginal communities should be part of the public hearing procedures under EIA requirements.

Closing Observations

Infrastructure is essential for the pursuit of India's development goals. Road and rail linkages, improvements in port facilities, better urban water and sanitary services, and year-round roads in rural areas all meet real developmental needs. The point made here is not against development infrastructure but rather about development infrastructure that seeks to shift its ecological and social impacts on those most helpless.

India’s aim to develop itself into a developed nation by 2047 in the Viksit Bharat strategy cannot be achieved using a development strategy that causes floods, landslides, coastal erosion, and depletion of the water table faster than the economic benefit derived from the connectivity created. The paradox of development identified in this study can be quantified in terms of the financial cost of periodic failures in the infrastructure system, the socio-economic cost of periodic dislocation, and the ecological cost of undermining the stability of watersheds and slopes in some of the country's most vulnerable environments.

The resolution of such a paradox necessitates an institutional change of equivalent magnitude as the physical infrastructure initiatives that need to be regulated. The data architecture behind the PM Gati Shakti plan is an excellent starting point for the same, provided it is used effectively to bind infrastructure initiatives with their corresponding environmental consequences.

The EIA framework needs to be strengthened legislatively. The NIP initiative needs monitoring tools that can distinguish between infrastructure built and infrastructure that is functioning, managed, and environmentally sustainable. The distributional assumptions behind the major infrastructure initiatives need to be clearly identified and rectified. The infrastructure choices made in the coming decades will define the society India becomes by 2047; those choices must be guided not only by the ambition to build, but by the discipline to build well, sustainably, and for all.

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