

A vision of

WATER

GOVERNANCE

for

VIKSIT BHARAT @2047

Markets, Institutions, *and* Imperatives

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**A VISION OF WATER GOVERNANCE
FOR VIKSIT BHARAT@2047
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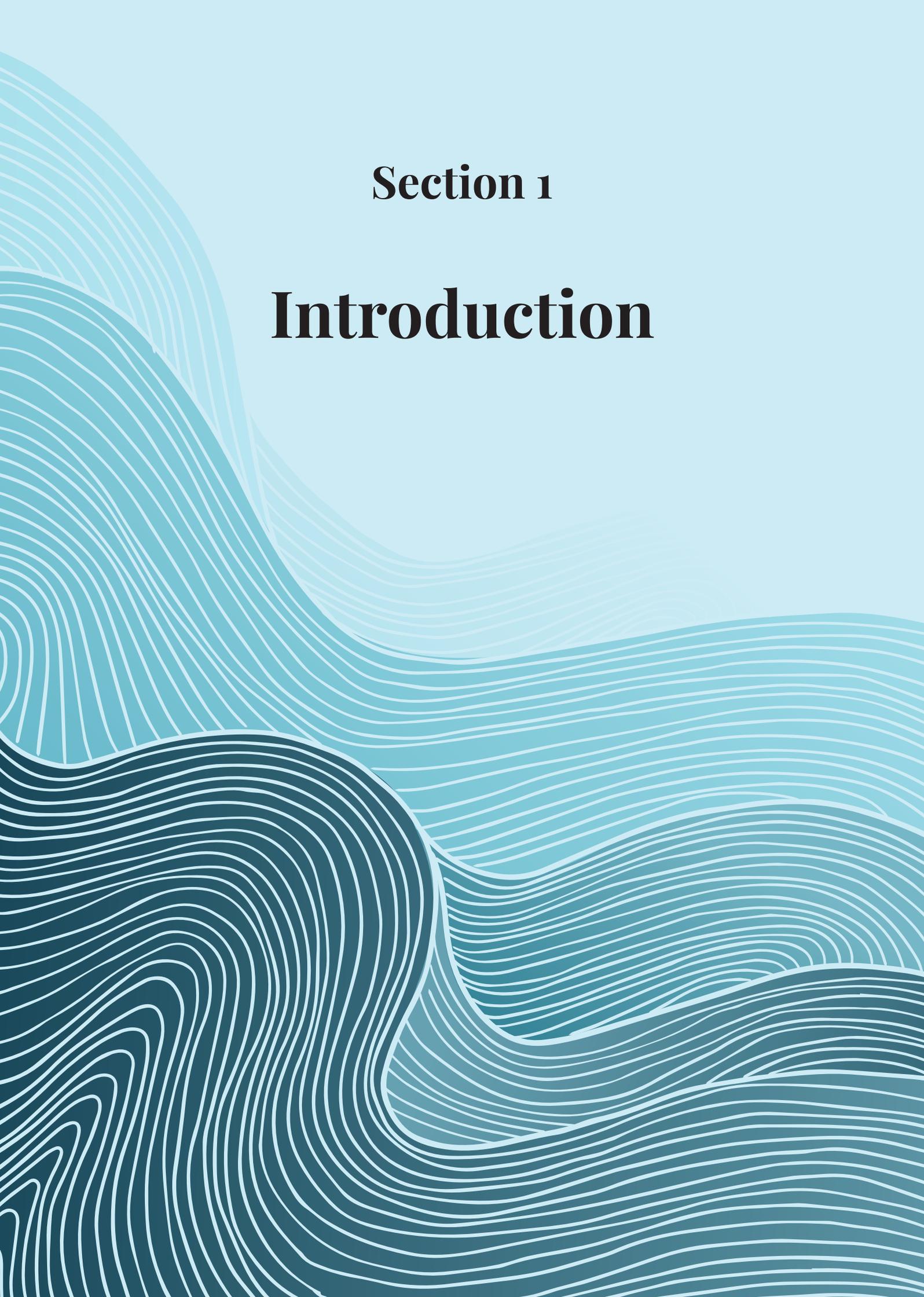
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The background features a series of overlapping, wavy lines in various shades of blue and teal, creating a sense of movement and depth. The lines are more densely packed and darker in the lower-left corner, fading into a lighter blue towards the top and right.

Section 1

Introduction

W

ater inherently transcends multiple boundaries. Water governance, therefore, is a complex,^a “transboundary” challenge.

The first source of complexity emanates from “hydrological transboundariness”: rivers, aquifers, and watersheds cut across villages, cities, states, and countries, linking surface water and groundwater systems. In the process, decisions taken upstream, and their consequences—such as dams, diversions, or pollution—directly affect downstream users, creating spillovers and externalities that governance systems struggle to internalise. A second source of complexity concerns the allocation of water across competing users and sectors—agriculture, urban areas, industry, and ecosystems—each with different priorities, scales, and reliability needs. This implies another form of “transboundariness”, as water effectively “crosses” sectoral boundaries.

A third source lies in the artificial boundaries created for governing water, in the form of fragmented institutions with overlapping mandates, often reinforced by power asymmetries that privilege some users while marginalising others.

a “Complex problems” refer to challenges that cannot be understood, solved, or managed through linear, single-discipline, or purely technocratic approaches. This is because of multiple interacting systems, non-linearity and feedback loops, uncertainty, context dependence, multiple stakeholders, and path dependency and irreversibility.

This fragmentation promotes a disjointed approach to governance rather than the integrated management required for a flow regime. A fourth source originates from the exogenous force of climate change, which introduces deep uncertainty through greater variability, floods, and droughts, undermining governance frameworks built for stable conditions. A fifth source of complexity arises from persistent trade-offs among efficiency, equity, and ecological sustainability, making water governance a political and normative challenge rather than a purely technical one.

While traditional geopolitical approaches restrict the idea of transboundary waters to those crossing international borders, more recent interpretations expand the notion of “transboundariness” to encompass all forms of boundaries—from international and inter-state divisions to smaller social and sectoral demarcations.¹ This broader understanding also includes inter-state water systems within a single nation. Importantly, a new dimension of transboundary water conflict has emerged between the economic and ecological domains.² Human activities motivated by short-term economic interests frequently alter natural flow patterns, leading to severe ecological degradation downstream.

Although river basins are widely acknowledged as the most suitable natural units for planning and managing surface water resources,³ governance structures have historically fragmented them into smaller administrative or political segments, often in an arbitrary manner. This fragmentation stems from two main factors: the managerial convenience it offers, and adherence to existing political or geographical boundaries.⁴ Such an approach reflects a reductionist perspective that treats water merely as a resource to be exploited to meet human needs within defined territories.⁵ This approach has shaped—and adversely impacted—the water governance architecture in India. Recurring water disputes between Indian states, and between state and central authorities, largely arise from this reductionist thinking and the decentralised governance model embedded in India’s federal framework.⁶

India has 25 major river basins and 103 sub-basins spanning multiple states; many of these river basins and sub-basins cross state boundaries. Under the federal division of powers established by the Constitution of India, each riparian state asserts jurisdiction over water resources within its boundaries.⁷ However, disputes over water allocation arise less from physical scarcity and more from fragmented governance that fails to reflect the interconnected nature of river systems.⁸ The unstructured devolution of water management authority to the states has intensified political conflicts, driven largely by divergent interpretations of ownership and rights over shared water bodies.⁹ This fragmented approach is closely tied to India’s long-standing reliance on structural interventions and reductionist governance models, which have shaped the nation’s water management paradigm—from large hydrological infrastructure and irrigation networks linked to food security to the inter-state disputes over shared water resources.

It is also important to note the growing water scarcity in India. Under the Falkenmark Water Barrier Scale definitions (Table 1), physical water availability is classified into five categories based on per capita availability, measured as the number of persons per flow unit of water (defined as one million cubic metres per year).

Table 1: Falkenmark Water Barrier Scale

Description as per Falkenmark Water Barrier Scale	Flow Unit Classification	Per capita Water availability (cubic metres per capita)
Well-Watered Conditions	<100 persons/flow unit	>10,000
Mid-European	100-600 persons/flow unit	<10,000 and $\geq 1,700$
Water stressed	600-1,000 persons/flow unit	<1,700 and $\geq 1,000$
Chronic Scarcity	1,000-2,000 persons/flow unit	<1,000 and ≥ 500
Beyond the Water Barrier	>2,000 persons/ flow unit	<500

Sources: Jobson (1999),¹⁰ Ghosh (2009)¹⁷

Given the classifications in Table 1, Table 2 provides the state of the major river basins of India in 2025, and their projected status in 2050.

Table 2: Water Availability in Select Indian River Basins, 2025 and 2050 (Falkenmark Scale)

River Basin	Population per flow unit in 2025	Classification as per the Falkenmark Index in 2025	Population per flow unit in 2050	Classification as per the Falkenmark Index in 2050
Indus (up to Border)	1,520	Chronic Scarcity	1,788	Chronic Scarcity
Ganga	1,164	Chronic Scarcity	1,369	Chronic Scarcity
Brahmaputra	91	Well-watered	107	Mid-European
Barak & Others	118	Mid-European	139	Mid-European

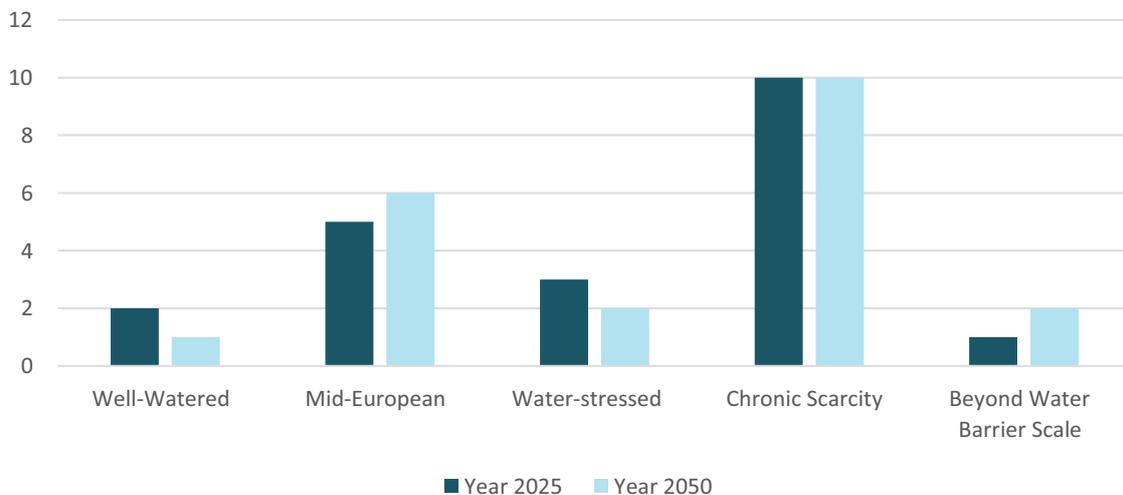
River Basin	Population per flow unit in 2025	Classification as per the Falkenmark Index in 2025	Population per flow unit in 2050	Classification as per the Falkenmark Index in 2050
Godavari	757	Water-stressed	891	Water-stressed
Krishna	1,128	Chronic Scarcity	1,327	Chronic Scarcity
Cauvery	1,749	Chronic Scarcity	2,057	Beyond Water Barrier Scale
Subarnarekha	1,031	Chronic Scarcity	1,213	Chronic Scarcity
Brahmani & Baitarani	458	Mid-European	539	Mid-European
Mahanadi	602	Water-stressed	708	Water-stressed
Pennar	1,454	Chronic Scarcity	1,711	Chronic Scarcity
Mahi	1,159	Chronic Scarcity	1,364	Chronic Scarcity
Sabarmati	1,338	Chronic Scarcity	1,574	Chronic Scarcity
Narmada	417	Mid-European	491	Mid-European
Tapi	931	Water-stressed	1,096	Chronic Scarcity
West Flowing Rivers (Tapi to Tadri)	360	Mid-European	424	Mid-European
West Flowing Rivers (Tadri to Kanyakumari)	452	Mid-European	532	Mid-European
East Flowing Rivers (Mahanadi to Pennar)	1,476	Chronic Scarcity	1,736	Chronic Scarcity

River Basin	Population per flow unit in 2025	Classification as per the Falkenmark Index in 2025	Population per flow unit in 2050	Classification as per the Falkenmark Index in 2050
East Flowing Rivers (Pennar to Kanyakumari)	2,779	Beyond Water Barrier Scale	3,270	Beyond Water Barrier Scale
West Flowing Rivers of Kutch & Saurashtra incl. Luni	1,355	Chronic Scarcity	1,595	Chronic Scarcity
Minor rivers draining into Myanmar (Burma) & Bangladesh	80	Well-watered	93	Well-watered

Source: Estimated by the authors using data from DMEO's "Water Resources" Sector Report.¹²

Table 2 shows that, across the selected river basins, per capita availability of water (reciprocal of the number of persons per flow unit of water) will only decrease over time. Indeed, water stress in India has increased over the years in terms of declining per capita availability (largely due to population growth), from over 1,800 m³ in 2001 to around 1,545 m³ (2011) to about 1,486 m³ (2021 projected based on estimated population data), and finally projected at 1,367 m³ (2031), placing the country in a state of water stress (below 1,700 m³) and nearing chronic scarcity (below 1,000 m³) in many regions, with projections showing demand exceeding supply significantly by 2025.¹³ The projected situation across the river basins presents a sobering picture: with a declining per capita availability, more river basins are moving towards higher levels of scarcity classification by 2050 (Figure 1). Yet, scarcity is only one dimension of the challenge—the complexity is heightened if one considers that water is used by life beyond humans, on which the human society and its existence are reliant.

Figure 1: Classifications of Indian River Basins as Per Falkenmark Index in 2025 and 2050



Source: Estimated by authors, using the Falkenmark indicator definition in Table 1 and the DME0 data in Table 2.

India's Water Policy Landscape

Since the early 1990s, the global water governance landscape has steadily shifted away from its old, reductionist, siloed models anchored in hard infrastructure toward a more nuanced, evolving paradigm of Integrated Water Resource Management (IWRM).¹⁴ This transition is also reshaping the Indian thinking on hydrological projects—redefining irrigation systems central to food security and recalibrating approaches to managing inter-state rivers, urban and drinking water needs, and basin-scale ecological concerns.

For decades, the legacy of British colonial engineering and a fragmented approach to water management dominated India's water governance paradigm. In recent years, however, a perceptible shift away from such reductionism has emerged. There has been greater contemplation about embracing an integrated, river-basin-scale approach to governance grounded in long-term sustainability concerns. India's National Water Policy (NWP) of 2012, which remains in force, and a handful of other governmental reports over the last decade, have emphasised the need for an integrated water management architecture—an approach reinforced through subsequent governmental efforts focused on water security.

These documents not only emphasised the need for a paradigm shift in water governance but also highlighted the requirement for new institutional mechanisms.¹⁵ However, gaps remain in translating these ideas into action—whether in rethinking the water–food linkage beyond traditional assumptions or in embedding ecosystem considerations into river basin governance. Further, though most of these documents tacitly or explicitly subscribe

to the Dublin Principles of IWRM (1992),^b including the notion of water as an economic good, there is limited acceptance or understanding of the economic value of water or of the importance of water markets for efficient and equitable water allocation within civil society and water managers. Globally, water markets and market-based instruments have been envisaged to play important roles in efficient water management, especially under conditions of water scarcity.

Taken together, the multiple dimensions of transboundariness—hydrological, sectoral, and institutional—point to a deeper structural challenge: India’s water stress is not merely a function of physical scarcity but of a governance architecture that fragments a single socio-ecological system into disconnected administrative, economic, and political domains. This fragmentation weakens institutional capacity to anticipate risk, manage trade-offs, and align incentives across scales. The challenge, therefore, is not simply to secure more water but to redesign the rules, institutions, and instruments through which water is valued, allocated, and governed. It is within this broader systems perspective that this report situates its central enquiry.

‘Viksit Bharat@2047’ presents a holistic developmental vision for India, envisaging the country as a developed nation by 2047 through an emphasis on ‘Sustainable Energy Solutions’ and ‘Inclusive Governance Practices’.¹⁶ The *Viksit Bharat* blueprint is not only about achieving per capita Gross Domestic Product (GDP) growth but also about equity and distributive justice while addressing sustainability concerns. Therefore, the focus on water security and climate resilience in the context of *Viksit Bharat* should entail a holistic approach for addressing complex challenges of environmental sustainability and food security, acknowledging and ensuring the changing and diverse uses of water by securing the needs of the human community, and ensuring economic growth under conditions of growing water scarcity and changing hydrological cyclicality caused by climate change.

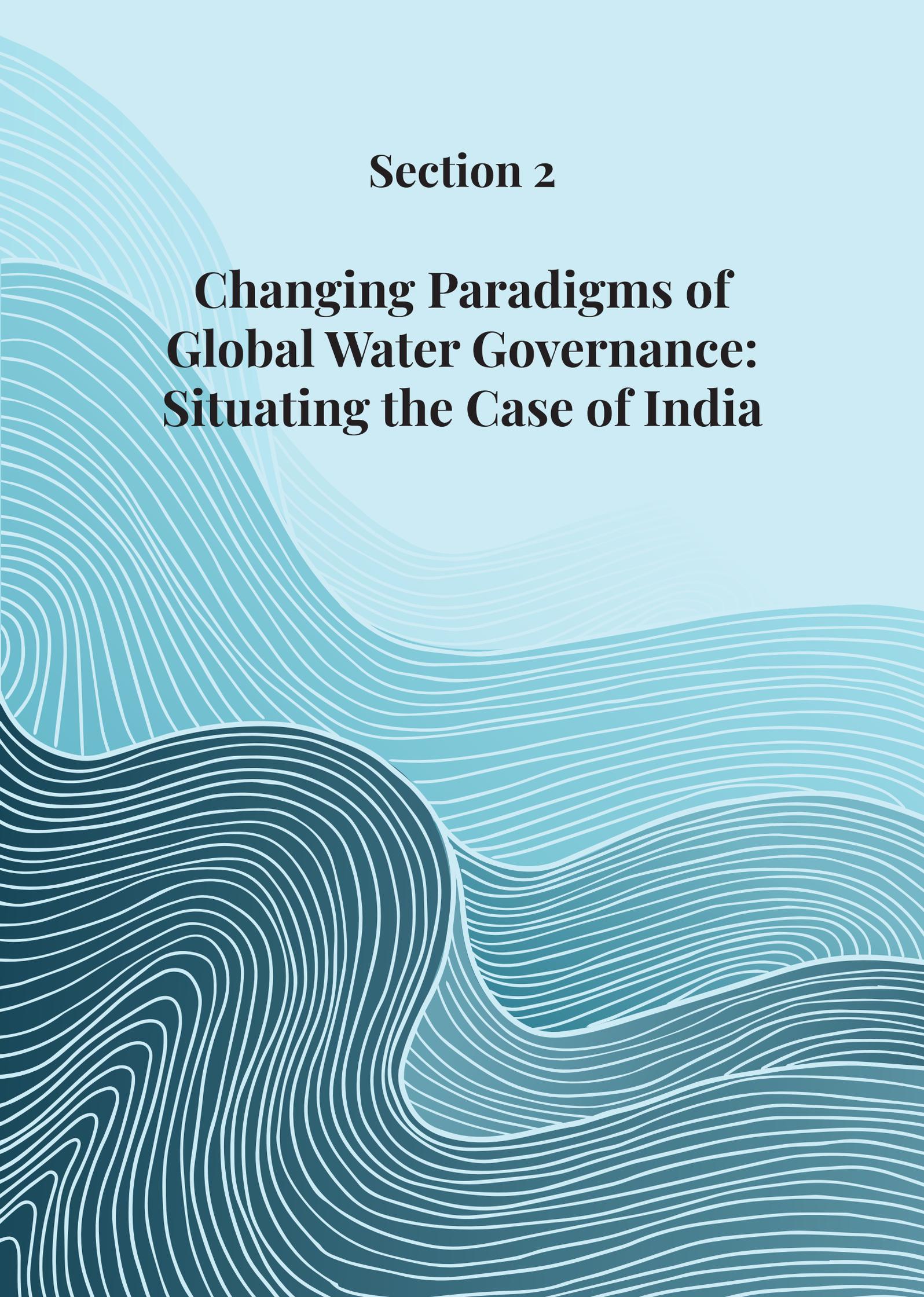
Keeping these considerations in view, this report addresses the following questions:

- 1) What should be the tenets of a National Water Vision for Viksit Bharat?
- 2) What institutional structures and instruments are needed to achieve this vision?
- 3) How can the private sector, including the corporate actors, contribute to this vision?
- 4) What roles can water markets and market-based instruments play?

b The Dublin Principles, established at the 1992 International Conference on Water and the Environment, emphasises four key ideas: water is a finite, vulnerable resource; management requires a participatory approach with users, planners, and policymakers; women play a central role in water management; and water has economic value in all its uses and should be recognised as an economic good, while also being a basic human right. These principles guide holistic water management for sustainable development, striking a balance between human needs and environmental protection.

To answer these questions, the report develops a futuristic vision of an integrated water governance architecture for India, to be realised through structural reforms in institutional mechanisms and the governance paradigm of a multi-layered management framework. Section 2 examines changing paradigms in global water governance and situates the Indian case within this broader transition. Section 3 assesses the institutional, governance, and procedural challenges that shape India's multi-dimensional water governance architecture. Section 4 discusses imperatives for institutional reform, with particular attention to inter-state water governance. Section 5 explores the role of the private and corporate sectors in advancing market mechanisms such as water credits and water derivatives trading, alongside the broader role of water markets and institutions in enabling efficient, integrated, and sustainable water governance. Section 6 highlights the key tenets of India's National Water Vision and proposes a template for strengthening the water governance architecture in tune with the *Viksit Bharat* blueprint. Section 7 concludes with reflections on the need for a more robust water governance architecture.

It is crucial to underline that this report confines itself to the water governance vision of 2047 by setting a systems frame for norms, governance architecture, role of markets, and basin federalism. This report has not tested the implementability of the architectural tenets, an aspect that should be the subject of future research in this domain.



Section 2

Changing Paradigms of Global Water Governance: Situating the Case of India



A

ddressing the questions laid out in Section 1 requires situating India's water governance challenge within a broader global transition in how societies understand and manage water. Historically, the ability to manipulate water through large engineering works has been a hallmark of human progress. Dams, reservoirs, and pumping systems allowed societies to regulate rivers, harness hydropower, control floods, and expand irrigation networks, thereby enhancing productivity and reducing spatial disparities in water availability.¹⁷ While these interventions initially expanded resource availability and supported agricultural and economic growth, they also triggered unintended outcomes of ecological degradation, undermined long-term water security, and proved socially contentious over time.^{18,19} Over the past four decades, water policy across advanced and emerging economies has moved away from a narrow, engineering-led paradigm toward an integrated, basin-scale, and ecosystem-sensitive approach. This shift reflects growing recognition that water systems function as coupled social, economic, and ecological systems, within which infrastructure, markets, and institutions must operate in concert rather than in isolation.²⁰

As an example, the European Union (EU) introduced the Water Framework Directive in 2000, triggering widespread efforts to dismantle outdated dams—about 5,000 have since been removed across countries such as France, Sweden, Finland, Spain, and the United Kingdom.²¹

The directive also obliges member states to restore the ecological integrity of water bodies, promoting renewed attention to maintaining natural flow regimes, consistent with basin-scale IWRM principles. Similarly, the United States, following a dam-building boom between the 1920s and 1960s, has decommissioned over 1,000 dams in recent decades to revive basin-scale ecosystems.²²

This shift also witnessed the development of water markets and financial instruments aimed at promoting more efficient and sustainable water use. Australia, for example, has created water markets in the Murray–Darling Basin, overseen by the Murray–Darling Basin Authority, enabling farmers to trade water and improve productivity while supporting sustainable management.²³ In Chile, the 1981 National Water Code introduced transferable water rights that are legally separate from land ownership, allowing flexible transactions, including short-term arrangements such as “renting” water between neighbouring farmers with varying needs.²⁴ In the United States, a significant step towards demand-side water management came with the launch of water futures based on the Nasdaq Veles California Water Index²⁵ on the Chicago Mercantile Exchange in December 2020, designed to help users hedge risks related to water availability in the western states.²⁶

Meanwhile, in countries like Kenya, the water governance model relies on a mix of government budgets, tariffs regulated by the Water Services Regulatory Board (WASREB), alongside grants from the Water Sector Trust Fund (WSTF) and development partner funding from the private sector to finance services, infrastructure, and underserved areas.²⁷ In Morocco, attempts are being made to achieve IWRM through its National Water Plan (PNE 2020-2050) which enforces rights through policing, metering (e.g., smart meters for groundwater), and data systems (SNIEAU); the financial sustainability framework develops pricing models that reflect full costs, including non-conventional sources like desalination. Launched in 2020, the National Program for Potable Water Supply and Irrigation (PNAEPI) in Morocco is aimed at improving water security by accelerating investments in the water sector and increasing the resilience of drinking water supply and irrigation.²⁸ China, for its part, has a water governance system that integrates a centralised administrative system with market-oriented reforms, defining water rights through state-allocated quotas under the “Three Red Lines” policy and financing via tiered tariffs, resource fees, public-private partnerships (PPPs), and central transfers.²⁹

In contrast, India has been slower to adopt such an integrated approach to its water governance paradigm.³⁰ Structural inertia and resistance to reform by the country’s hydro-technocratic establishment have hindered the transition from a reductionist, construct-centric paradigm to a more holistic governance model. Nonetheless, reform efforts have emerged over the past decade. In 2016, two key legislative drafts—the National Water Framework Bill and the Model Bill for the Conservation, Protection, Regulation, and

Management of Groundwater—were developed, alongside the release of the report, *A 21st Century Institutional Architecture for India's Water Reforms*.³¹ All three were prepared under the leadership of economist and water expert Mihir Shah. In 2019, the Ministry of Jal Shakti constituted a committee led by Shah to formulate a new National Water Policy. Although this draft policy was submitted in 2021, it has yet to be formally presented in Parliament, nor is it available in the public domain. However, the broad contours of the National Water Policy 2020 are discernible from the various media interviews^{32,33} and op-ed pieces³⁴ by Chair Mihir Shah, augmented by personal communication between one of the present authors and the chair.^c The new water governance paradigm articulated in the new National Water Policy is “delineated by a multi-disciplinary and multi-stakeholder approach to water management.”³⁵

Further, while scholars have long debated the potential role of water markets and futures in addressing scarcity and improving allocation, certain questions have been raised about their suitability in India’s socio-economic context.³⁶ In 2022, reports indicated that NITI Aayog was preparing a draft framework to explore instruments such as spot trading, futures contracts, and tradable licences. It has since published a document proposing a transparent trading mechanism for treated wastewater rights.³⁷ The central contribution of water markets lies in efficient price discovery that reflects the scarcity value of water, something that ad-hoc, administratively fixed tariffs rarely achieve, suggesting a strong rationale for India to seriously examine such market-based tools.³⁸

To address this gap, a systems approach to water governance is crucial, covering both general water management and river basin governance. River basins function as interconnected systems in which natural processes and human actions, such as wastewater discharge or deforestation, propagate impacts across space and time.³⁹ In this context, river flow carries not only water and dissolved chemicals but also sediments, energy, and biodiversity; disruption to any one element affects the others.⁴⁰ Any structural intervention can therefore disturb the WEBS (Water-Energy-Biodiversity-Sediment) equilibrium of a basin ecosystem, impairing ecosystem functioning and the delivery of ecosystem services^d to human society, and ultimately proving counterproductive to human systems themselves.

The Farakka Barrage on the lower Ganges, commissioned in 1975, illustrates this dynamic by trapping sediments that would otherwise replenish the Ganges delta, contributing to reduced downstream soil formation. Combined with sea-level rise, land subsidence, and diminished sediments flows, this has resulted in the shrinking of the Ganges delta—home

c Dr. Nilanjan Ghosh, one of the authors of this work, was also invited by the National Water Policy Drafting Committee to present his deliberations, where the basin-level governance frameworks were discussed.

d Ecosystem services are the various goods and services provided by the natural ecosystem through its organic functioning.

to the Sundarbans ecosystem; indeed, over time, the very survival of the delta has come under threat.⁴¹ Further, the accumulation of sediments in the upstream of the barrage has been alleged to aggravate flood risks in Bihar through backwater effects.⁴² This is akin to the drying up of the Colorado Delta in Mexico, which has also been attributed to extensive upstream activities due to the dam-building decades (1920s to the 1960s) of the United States.⁴³ Such an approach to water governance needs a structural overhaul to adhere to the changing paradigm of Integrated Water Governance, also embodied under IWRM.

Integrated Water Governance: Key Principles

Drawing on the existing literature, several core principles of basin-scale integrated water governance can be extrapolated.⁴⁴ They are as follows:

1. Water should be viewed as an integral component of the eco-hydrological cycle rather than a static stock of material to be extracted for human convenience.
2. Water carries economic value across all competing uses, including those of natural ecosystems, which needs to be recognised.
3. The river basin should be treated as the unit of water governance.
4. Continuous water supply augmentation is not a precondition for growth or food security, which, instead, should rely on water-saving technologies and comprehensive project appraisal over the full hydrological cycle.⁴⁵
5. Effective governance also requires a transparent, interdisciplinary knowledge base on the social, ecological, and economic roles of water.
6. An integrated governance demands coherence in policy, decision-making, and cost-sharing across sectors such as agriculture, industry, urban development, navigation, and ecosystems.
7. Robust, multidisciplinary basin-level information systems are essential to understand river basins and the natural and socio-economic forces that shape them.
8. Explicit attention to gender, as affirmed in the Dublin Statement, is critical, recognising the central role of women in water provision, management, and protection.⁴⁶

These points are indicative rather than exhaustive and remain open to refinement as disciplinary understanding evolves. Together, they provide foundational elements for shaping the contours of an emerging governance paradigm.

While international experience illustrates the broad contours of a transition toward integrated and market-aware water governance, the Indian case presents a distinct and more complex political economy. Federal constitutional design, agrarian policy incentives, demographic pressures, and deep social inequalities shape how global principles are translated—or resisted—within national institutions. Understanding why integrated basin governance and market-based instruments have remained limited in practice, therefore, requires a closer examination of India’s internal governance architecture, sectoral priorities, and institutional path dependencies. The following section turns to these domestic challenges, tracing how historical policy choices and institutional fragmentation continue to shape contemporary water conflicts and management outcomes.



Section 3

Challenges for India's Water Governance Architecture

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ater conflicts and crises in India have historically stemmed from a narrow, technocratic vision centred on supply augmentation through conventional engineering and neo-classical economic logic. The complex governance, institutional designs, and jurisdictional overlaps in water governance have also contributed to federal conflicts. More importantly, evolving concerns like climate change, food insecurity, rapid urbanisation, declining availability of usable water, and ecosystem uncertainty have compounded these governance challenges—as will be discussed in the sections that follow.

The Limits of the Reductionist Approach

The reductionist approach to water management—often described as “arithmetic hydrology”—reduces complex governance questions to a handful of numbers, overlooking key ecological and social variables and thereby generating new management problems.⁴⁷ Environmental security concerns around Himalayan transboundary waters have emerged from this same tradition, shaped by colonial-era engineers who applied rigid structural solutions despite a limited understanding of Himalayan water dynamics.⁴⁸



The disasters in Uttarakhand in 2013 and 2021^e have raised serious doubts about the wisdom of constructing large hydropower projects in a seismically active, climate-sensitive mountain region. The single-minded pursuit of electricity generation for short-term economic gain often ignores serious social and environmental risks, increasing disaster vulnerability and leading to massive losses of life and property.⁴⁹ Many Himalayan hydropower projects share these problems. Although promoted as multipurpose schemes for flood control, storage, jobs, and tourism, they impose substantial long-run ecological costs. Dams and related structures modify flow regimes, trap sediments, disrupt ecosystems, and undermine vital services that support downstream livelihoods, particularly for poorer communities.⁵⁰ These losses are rarely incorporated into project cost–benefit calculations; if fully accounted for, many schemes would likely prove economically unjustifiable.⁵¹ Documented evidence from the Teesta basin shows⁵² that successive hydropower installations have sharply reduced dry-season flows, contributing to water tensions between India and Bangladesh.⁵³

Inter-State River Water Disputes

Inter-state rivers in India have become arenas of contestation due to conflicting notions of ownership, lopsided economic instruments linked to food security, the absence of an integrated ecosystems perspective, and continued reliance on reductionist hydrology.⁵⁴ These struggles over the control and use of shared rivers have persisted since Independence and are often prolonged by historical, institutional and political complexities.⁵⁵ Although federalism is a basic feature of the Constitution of India, the division of water-related powers between the Union and the states has produced ambiguities. Schedule VII distinguishes between intra-state uses and inter-state regulation, assigning parliament authority over inter-state rivers under Entry 56 of the Union List, while Entry 17 of the State List gives states the power to legislate on water use for supply, irrigation, storage and power, subject to the Union government's federal mandate.⁵⁶

This arrangement is justified on the grounds that inter-state rivers flow across political borders and no single state can claim exclusive control. Yet the State List in Entry 17 of List II refers only to “water” and not explicitly to “intra-state” water, enabling states to legislate even when rivers or tributaries pass through neighbouring jurisdictions, unless specifically overridden by Central law in the public interest.⁵⁷ The resulting grey area enhances state leverage and weakens the Centre's administrative capacity to regulate inter-state basins. As a result, the Centre has tended to avoid robust basin-wide strategies, relying instead on ad-hoc dispute resolution mechanisms. Chokkakula (2019) highlights the absence of a reliable policy mechanism for inter-state collaboration, attributing it to a policy ecosystem

^e In 2013, floods in Kedarnath in Uttarakhand claimed thousands of lives and left hundreds of thousands of pilgrims stranded. Thousands of locals lost their homes too. Later in 2021, flash floods triggered by glacial melting and landslides in Chamoli claimed the lives of 200 people.

geared towards contingency-driven responses.⁵⁸ Policy frameworks have evolved reactively, with frequent amendments to the Inter-state River Water Disputes Act, 1956, while the River Boards Act, 1956—which could empower the centre to set up basin boards—remains largely unutilised. This combination of constitutional ambiguity and reactive policymaking erodes trust in cooperative federal management and has been described as a form of “conflictual federalism”, which obstructs the adoption of integrated basin governance in India.⁵⁹

An important reform effort came in 2019, when the Lok Sabha passed amendments to the Inter-State River Water Disputes Act to accelerate dispute resolution. The changes introduced fixed timelines for adjudication, authorised the central government to constitute dispute-resolution committee to attempt negotiated settlements prior to tribunal referral, and converted tribunals into a permanent institution with multiple regional benches. The amendment also sought to strengthen implementation by making tribunal awards final and binding and by obligating the Centre to design schemes for carrying out the decisions. Together, these measures aim to rectify long-standing procedural weaknesses and improve India’s capacity to address inter-state water conflicts.⁶⁰

Case Study: Cauvery Water Conflict

The Cauvery dispute between Karnataka and Tamil Nadu reveals how the Constitution’s treatment of water as a state subject encourages fragmented, state-centric use of a shared basin, intensifying tensions and embodying “conflictual federalism”.^{61,62} Economic factors, like the rising minimum support prices of water-intensive paddy, have also played their roles in shifting acreage towards paddy, thereby intensifying competition for limited flows.⁶³ The 2007 Cauvery Water Tribunal (CWT) award typifies “arithmetic hydrology” without consideration of the natural ecosystem. Further, the institutional design of the Cauvery Water Management Authority (CWMA) and Board, in line with the tribunal’s award, is heavily skewed towards engineering expertise. This mono-disciplinary approach runs counter to international practice, which stresses the need for multidisciplinary, ecosystem-sensitive institutions.⁶⁴ Complex disputes such as the Cauvery cannot be resolved solely through traditional engineering and agricultural perspectives; they require inclusive, multi-stakeholder, bottom-up arrangements, akin to the Mekong River Commission, that explicitly incorporate ecological knowledge and community representation.⁶⁵

Food Security: Definitional and Operational Gaps

India's food security strategy has likewise been shaped by resource-intensive, engineering-led thinking. The Green Revolution, rising Minimum Support Prices (MSPs) from the late 1970s, and state procurement policies framed food security primarily in terms of boosting the production and procurement of water-intensive cereals, especially rice and wheat. While yields did increase, MSP for these crops rose much faster than less water-demanding millets, encouraging their cultivation and procurement. Functionally, MSPs operated much like a 'put option' for farmers: when market prices fell below the MSP, they could sell to the state at the guaranteed rate, and over time MSPs became de-facto floor prices that pushed market quotations upward.⁶⁶

This pricing structure systematically privileged rice and wheat over alternatives like millets, shifting the terms of trade in favour of water-consuming staples. Millets, which require only a fraction of the water used by paddy, were crowded out across regions such as the Krishna and Cauvery basins and the Upper Ganges in Uttarakhand and Uttar Pradesh, where irrigated paddy and wheat became common as a third crop in the dry season. The result was a sharp increase in groundwater extraction and surface water diversions. Though many economists characterise Indian irrigation as primarily groundwater-based, over-abstraction of aquifers also diminishes baseflows and puts additional pressure on surface water, a concern often neglected in policy debates.

In much of southern India, the expansion of canal irrigation reduced surface flows and enabled extensive summer paddy cultivation, as seen in the Cauvery basin during the 1990s. Similar patterns, linking high-yield, high-water-use crops, have appeared in Haryana and Punjab and in the Teesta water dispute between India and Bangladesh, where summer paddy acreage expanded dramatically. These cases show how an "agricultural economics" lens, coupled with large, engineering-intensive irrigation projects, has deepened water conflicts by anchoring food security to the production and procurement of highly water-intensive crops. This stands in contrast to global evidence that water and food security are not related in a linear manner and that numerous best-practice water management strategies can decouple food security from ever-rising water use.⁶⁷

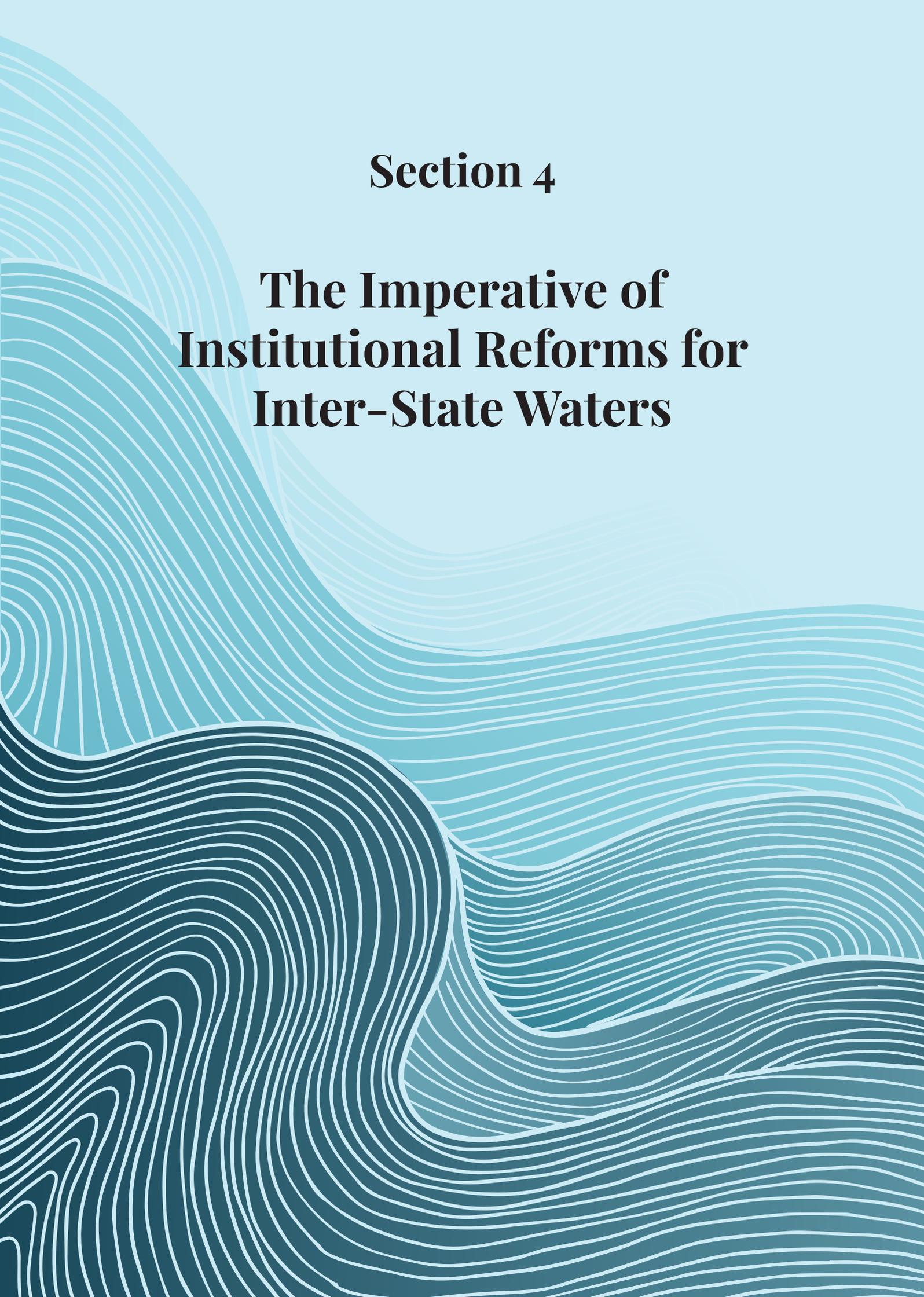
Across large areas of South Asia, agricultural expansion has also transformed landscapes in ways that degrade ecosystems and constrain their ability to provide essential services, including food production. Heavy reliance on chemical fertilisers and pesticides has damaged soil health in many regions of north and south India, undermining the natural fertility on which long-term productivity depends. Large hydraulic structures also interrupt sediment transport, weakening the rivers' capacity to replenish soils and thereby eroding the ecological foundations of the food system.

Aggravating Water Crisis

India confronts a pressing water crisis driven by population expansion, rapid urbanisation, and climate change. Per capita water availability has declined dramatically and is expected to fall further from 1,486 cubic metres in 2021 to 1,367 cubic metres by 2031.⁶⁸ Regional and seasonal fluctuations in water resources exacerbate challenges in management and fair distribution. With 55 percent of arable land relying on monsoons, agriculture remains acutely vulnerable to drought, endangering productivity and food security.⁶⁹ Even though recent droughts have been milder over time, they have caused harm to farming and exposed deep flaws in the nation's water security system.

India's water scarcity is further intensified by inefficient consumption across sectors and the absence of a cohesive national water management framework. Agriculture consumes nearly 80 percent of freshwater withdrawals, yet excessive dependence on groundwater and low irrigation efficiency have caused drastic aquifer depletion. Industrial growth and swift urbanisation have escalated water demand beyond local capacities, heightening competition between sectors. Inadequate wastewater treatment has aggravated scarcity, with nearly 70 percent of surface water polluted and unsuitable for drinking or irrigation. Over-extraction of groundwater, coupled with insufficient rainwater harvesting infrastructure, hampers replenishment and sustainable resource management. Climate change worsens extreme weather, triggering more frequent droughts, unpredictable monsoons, and falling water tables, thus making conservation and smarter allocation imperative. With about 87 percent of extracted groundwater directed to agriculture—where waste remains pervasive—instilling stricter water use discipline is vital for long-term viability.

In light of such multi-dimensional challenges that vitiate India's water management framework, the role of various governance institutions as well as stakeholders like the private and corporate sectors and water markets are extremely crucial for developing a holistic and resilient water governance architecture.



Section 4

The Imperative of Institutional Reforms for Inter-State Waters

If water insecurity in India is rooted not only in scarcity but also in the misalignment of institutions with the basin-scale, socio-ecological nature of water systems, then institutional design becomes the critical lever of reform. Inter-state rivers, in particular, expose the limits of fragmented authority and adversarial federalism, as political boundaries intersect with hydrological realities. The question is not simply how disputes are resolved, but how governance structures can be reconfigured to promote cooperation, shared knowledge, and long-term ecological stewardship.

India's inter-state river water governance demands fresh strategies for ensuring cooperative federalism, with river basins as the ideal unit due to their hydrological, geographic, and ecological alignment—far superior to gerrymandered, mutable boundaries marked by people on maps. However, as Ghosh and Modak (2021) argue, river basins are often framed as depoliticised and “scientific” spaces, where appeals to nature and expertise marginalise alternative viewpoints.⁷⁰ However, this framing is questionable, as natural boundaries and their governance should remain open to political debate and scrutiny. River basins are

open systems and are essentially connected to the sea and the atmosphere. Their boundaries often do not conform to the boundaries of an underlying aquifer; the water within the river courses is connected to the underlying aquifer system, and groundwater may contribute to streamflow (and vice versa) based on the movement of the water table. Moreover, the use of water may transcend the boundaries of river basins due to inter-basin water transfer.

The natural delineation, too, can be ambiguous, depending on the physical characteristics of the land, making any political boundary based on watershed a problematic proposition.⁷¹

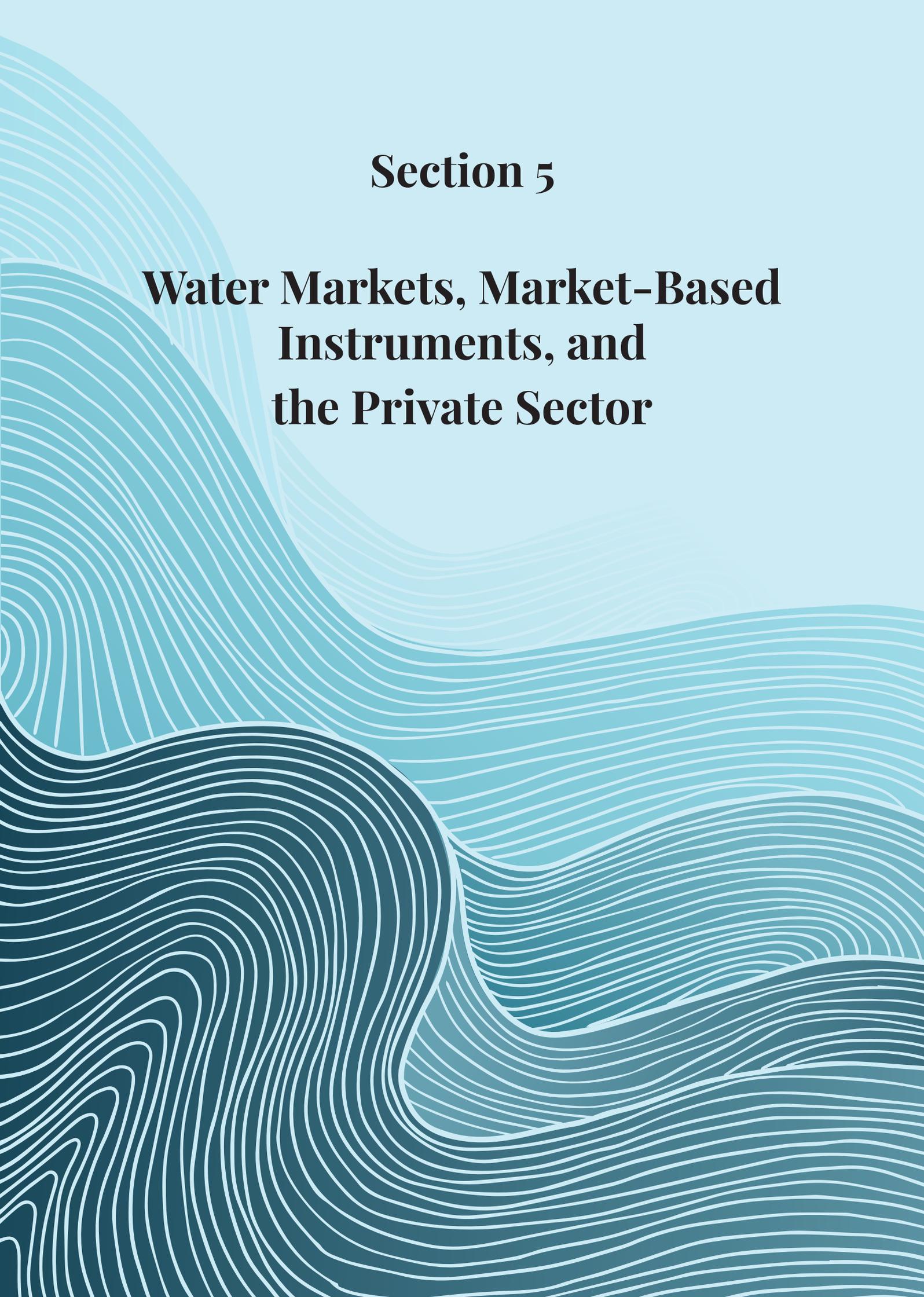
At the time of Independence, the Constituent Assembly Debates sidelined inter-state water disputes amid the turbulence of Partition, fostering a fragmented approach to water governance. Globally, Integrated River Basin Management (IRBM) today prevails, viewing water holistically within geo-hydrological cycles, prioritising demand management over endless supply for food security. The 2018 Draft River Basin Management Bill breaks this inertia, proposing the creation of River Basin Authorities (RBAs) for basin-level water governance via participation, cooperation, and sustainable use, including master plans and demand strategies in tune with the Integrated River Basin Management framework. Its two-tier setup—political Governing Council atop the technical Executive Board, with an optional Advisory Council—aims for balanced oversight.⁷² Across the globe, however, River Basin Organisations (RBOs) often have much broader mandates of basin-level ecosystem governance (e.g., the Mekong River Commission), by considering the integrated basin system, at an international transboundary scale, as the unit of planning and management.⁷³

The Centre has attempted to promote cooperative federalism by proposing a permanent forum for basin states to deliberate on inter-state rivers and coordinate action. Yet key concerns persist. Chapter 3, Section 8 of the draft 2018 bill frames water as a “Common Pool Community Resource” held by states under the doctrine but omits how communities will engage in management absent full user rights, raising doubts over whether social and political institutions can secure democratic deliberations.

Chapter 4 of the draft bill implies comprehensive basin needs assessment and unified master plans via state coordination. But it skips enforcement mechanisms or an anchor—especially without central representatives. Rotating chief ministers as Governing Council chairs, rather than neutral figures prioritising basin longevity, squanders a key facilitative role, as states inherently prioritise self-interest. To strengthen holistic ecosystem governance, direct state interactions can be complemented by a more inclusive, interdisciplinary Executive Board—bringing in social scientists alongside technical experts—and by formalising expert advisory mechanisms beyond ad hoc provisions such as Chapter 5, Section 15.

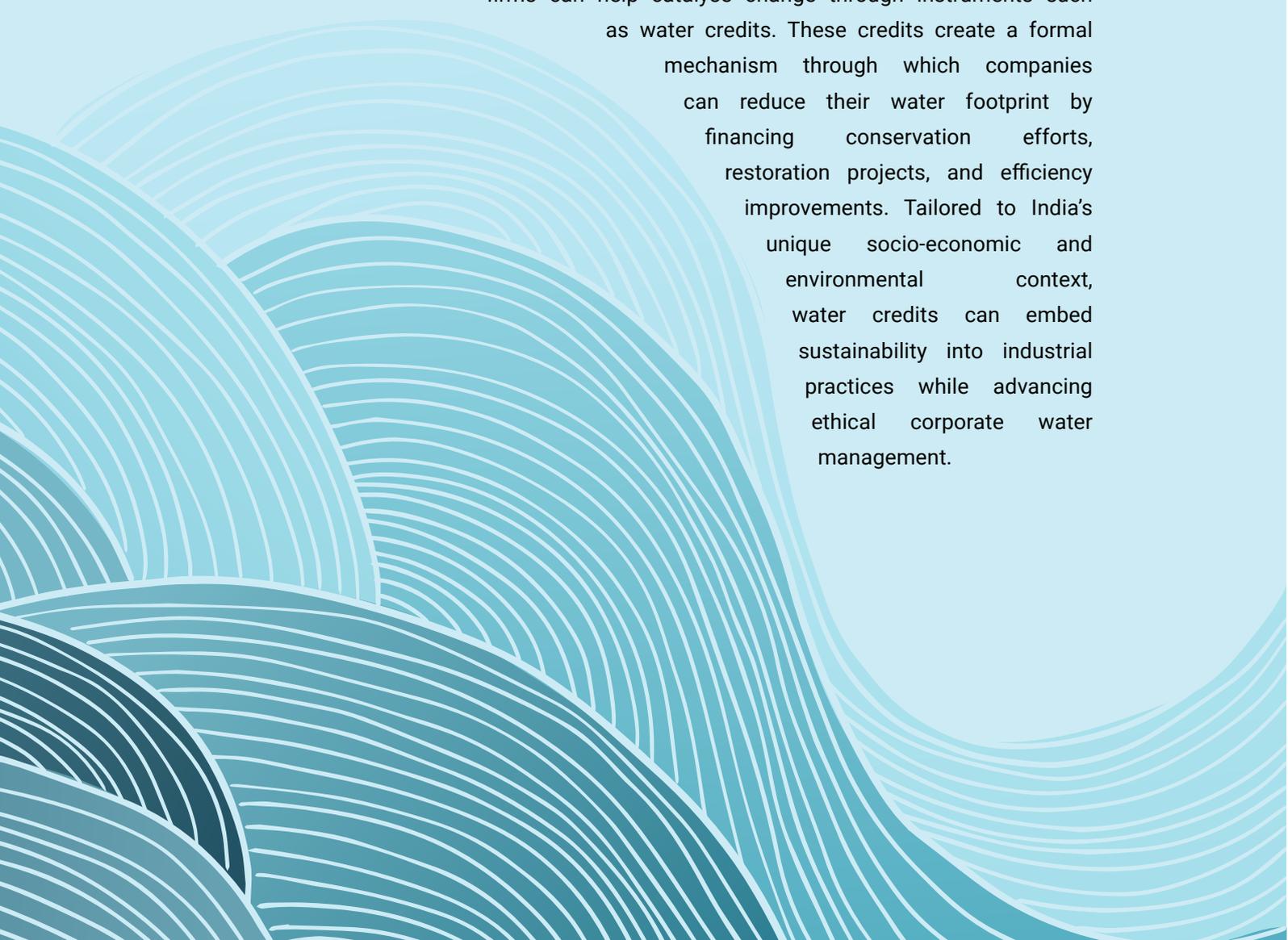
Effective River Basin Authorities must be able to engage with socio-economic complexities and interdisciplinary insights for climate-adaptive plans. Larsen and Kørnøv, analysing the Denmark scenario, advocate shifting basin plans from rigid metrics to complexity-embracing models via stakeholder-involved social scoping.⁷⁴

Transboundary River Board Organisations (RBOs) model autonomous consensus, transparent data-sharing, and stakeholder roles to bolster authorities—yet India’s federal politics and institutional tangles challenge true autonomy, especially if Centre-state actors favour short-term gains, forcing RBOs to penalise non-compliance. It is clear by now that political negotiation—backed by a will for consensus-driven resource sharing—stands as India’s sole enduring alternative to river conflicts.⁷⁵ While this has been recognised in the present statutes, their implementation remains the key for a sustainable water future.



Section 5

Water Markets, Market-Based Instruments, and the Private Sector



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patial and temporal variations in water availability complicate efforts to allocate the resources in an equitable manner. Policymakers have adopted a range of distribution strategies, resulting in uneven outcomes. Growing water scarcity has intensified interest in approaches that can reduce conflict over this essential but limited resource. Groundwater overexploitation, weak rainwater harvesting, widespread pollution, and ineffective governance have collectively deepened the water crisis. Together, these challenges underscore the need for innovative instruments, such as a water credits system, to encourage conservation and promote sustainable management across various sectors.⁷⁶

Contextualising Water Markets

Markets can provide a useful mechanism for addressing water scarcity and its associated challenges. Modern industries, with greater financial strength and business expertise, are well placed to advance market-based solutions. Although industrial water use often competes with agricultural and domestic demands, placing pressure on limited supplies,

firms can help catalyse change through instruments such as water credits. These credits create a formal mechanism through which companies can reduce their water footprint by financing conservation efforts, restoration projects, and efficiency improvements. Tailored to India's unique socio-economic and environmental context, water credits can embed sustainability into industrial practices while advancing ethical corporate water management.

As regulatory pressures mount, global standards evolve, and consumers demand greater environmental accountability, industries are increasingly embracing water security strategies that balance growth with ecological stewardship.

In this context, water markets in various forms have emerged globally as an important policy intervention. A central element in conceptualising such markets is the valuation of water as a natural resource, as emphasised in the Dublin Statement. Weak valuation frameworks and poor management practices continue to impede the efficient use and conservation of water resources.⁷⁷

The Imperative of Water Valuation

Water plays a vital role in delivering ecosystem services, especially in aquatic environments such as rivers, wetlands, estuaries, and coastal zones that provide a wide range of goods and services to human societies. Goods include drinking water and fisheries, while services encompass water purification, flood control, and recreation.⁷⁸ Environmental flows—the flow regimes required to maintain ecosystem health—are essential to maintaining these functions. When such flows are disrupted, aquatic ecosystems deteriorate, undermining the communities and industries that rely on them. Over time, the failure to define and protect environmental flows threatens ecosystem viability, placing the livelihoods and security of dependent populations at risk.⁷⁹

Economists have placed greater emphasis, especially in the last three decades, on recognising the value of ecosystem services, regardless of whether these values are fully captured by conventional markets. Balancing water allocation for direct human uses—like agriculture, power generation, domestic supply, and industry—with indirect benefits through ecosystem goods and services is a critical yet frequently neglected priority when establishing environmental flow requirements. As water diversions from natural aquatic systems intensify, striking a balance between ecosystem needs and human demands for diverted water has become essential in river basins worldwide.⁸⁰ The Millennium Ecosystem Assessment highlights the critical importance of valuing water-related ecosystem services.⁸¹ This framework classifies such services into provisioning (e.g., food, fibre, energy), regulating (e.g., carbon sequestration, microclimate control), supporting (e.g., soil formation, primary production that underpins other services), and cultural (e.g., tourism, spiritual value). Despite these insights, water-linked ecosystem services are frequently sidelined in narrow, reductionist policymaking.

Water allocation challenges stem from variations in water availability across space and time. This mirrors the classic economic dilemma of ‘allocation of scarce resources among competing ends,’ underlying the need for research on efficient water allocation methods.⁸²

Yet institutional theory has struggled to fully tackle this problem, failing to offer any comprehensive solutions and remaining trapped within abstract boundaries. Institutional scholars have analysed existing water management practices, property rights economics, and resulting disputes, but their inability to propose practical management tools has left water resources under judicial oversight, fostering inefficient and biased usage patterns. With the global water crisis intensifying, developing effective valuation methods is essential for better management and allocation. Where institutional economics has proven inadequate in resolving conflicts, creating impartial tools based on advanced valuation approaches becomes imperative.

The use of valuation in the management of water resources and dispute resolution is key to providing a more objective instrument for decision-making and can also provide clearer foundations for the decisions to be taken.⁸³ Valuation enables both efficient and equitable resource allocation, supporting optimal social consumption and production. Policymakers must weigh trade-offs between equity and efficiency—or blends of both—when designing policies, while social planners evaluate net welfare to select distribution strategies. This is extremely relevant in the context of water-intensive industries. Responsible water management by such industries can be ensured if water extraction permission and flexibility are made contingent upon responsible water use and sustainable replenishment efficiency in managing water resources. These industries can develop optimisation models with water uses and costs of extraction (dictated by the nature of the terrain) as the control variables, and then by factoring in constraints like resource limits, infrastructure gaps, and economic conditions.⁸⁴ This can generate shadow prices that reveal welfare gains from easing specific bottlenecks. In the process, with such shadow valuation of water in the context of industries, greater allocations can be given based on responsible water management, rather than by the ongoing practices.

Valuation also informs legal damage assessments for harms like pollution, guiding precise compensation, and underpins management tools such as taxes, externality internalisation, regulations, and tradable permits.

Valuation of natural processes and resources prompts a reassessment of investment choices, especially in infrastructure projects. By incorporating ecological costs, proposals can be adjusted to mitigate environmental damage. Valuation curbs market failures, fosters new markets for previously unpriced assets like air and water, and helps set market-clearing prices for scarce environmental goods. Water valuation within consumer utility frameworks typically employs two main strategies: stated preference methods, notably the Contingent Valuation Method (CVM), which constructs hypothetical markets and surveys people on their willingness to pay; and revealed preference approaches.

The stated preference approach relies solely on the CVM, which constructs hypothetical markets and surveys individuals on their willingness to pay for environmental changes, whether qualitative or quantitative. However, applying CVM or travel cost methods to value irrigation water as a consumer good remains uncommon in research, since irrigation water functions primarily as a production input rather than a direct consumption item. Water's value fluctuates based on rainfall patterns, scarcity levels, and economic conditions. Establishing its economic and ecological worth marks only the initial step toward rational use. For water markets to succeed, pricing must incorporate both scarcity and sustainability factors. Water pricing remains highly contentious, demanding careful balance among cost recovery, social equity, and conservation incentives.

Ghosh and Bhowmick's (2025) work underlines: "Whether driven by government regulations or market forces, water pricing plays a crucial role in improving water allocations and promoting conservation, particularly once basic water needs are met for all individuals."⁸⁵ The optimal price of water should cover all service provision costs—operation and maintenance, capital investments, resource scarcity value, and pollution externalities from usage.⁸⁶ Water pricing hinges on two key considerations: efficiency and equity. Efficiency seeks to allocate resources optimally using available technology and volumes to maximise net benefits, ideally equalising marginal benefits across sectors for overall social welfare.⁸⁷ Equity, by contrast, ensures fairness across diverse economic groups, though it often clashes with efficiency due to its subjective nature and measurement challenges.

Market-based pricing, unlike volume-based differential tariffs, promotes efficiency by letting water's value emerge through market dynamics, reflecting its supply and scarcity. Higher prices signal stronger demand and spur conservation efforts. Optimal water pricing must secure sustainable service delivery, universal access to quality water, and effective conservation of resources. Implementation, however, encounters significant obstacles. Designing water tariffs requires a comprehensive strategy that optimises resource allocation for efficiency while ensuring users view rates as fair. Equitable pricing across customer categories upholds justice, while tariffs must generate sufficient revenue for financial stability and operational continuity. Transparency in rate-setting for building public trust, and pricing structures must incentivise conservation without compromising affordability. In this context, innovative market institutional reforms and initiatives like Green Water Credits, Water Futures Trading, and the development of a Water Availability Index are key to devising sustainable practices for the water market.

Water Credits Frameworks Including Green Water Credits

A water credit framework should initially target industrial sectors where water use can be reliably measured and tracked across both direct operations and the indirect or value-chain footprint. Industries can be further classified according to their water consumption profiles and ecosystem impacts. Water-intensive industries could use credits to meet sustainability goals, comply with regulations, or enhance ESG (Environmental, Social, and Governance) reporting by compensating high consumption—similar to carbon credits—while securing reliable blue water supplies. In any case, the choice of industries to initiate the credit framework has to be based on data collection and monitoring, as without data sufficiency, the idea will fail. Therefore, the concept could begin with those industries where measurement and tracking of water consumption is possible, with well-defined rights from the statutory and regulatory systems. Further, a holistic approach is needed for data monitoring with respect to surface and groundwater.

On the other hand, green water—soil moisture available to plants—is central to ecosystem health, livelihoods, and rain-fed agriculture, yet has received limited policy attention. This neglect has enabled practices that undermine environmental and economic resilience. Valuing green water is therefore essential to promote efficient and equitable resource use.⁸⁸ Green Water Credits (GWCs) seek to address this oversight by incentivising farmers through financial rewards for sustainable practices like drip irrigation and land levelling, which boost retention, curb erosion, and raise yields. Inspired by global Payments for Ecosystem Services (PES) models, GWCs align private gains (higher productivity) with public benefits (improved water availability), creating market-based conservation.⁸⁹ By linking upstream efforts to downstream advantages for industries and cities, GWCs offer a win-win solution to water scarcity.

Implementing GWCs effectively demands a structured, collaborative effort that integrates data analytics, stakeholder partnerships, adaptable market systems, and rigorous monitoring frameworks. This trading system fosters a vibrant market where GWC prices respond to supply and demand, spurring efficiency and innovation in water management. Reliable monitoring and verification systems are vital to uphold the GWC framework's integrity. Technologies like IoT-based water tools and field inspections track adherence to green water practices and verify results. A credible, scalable credit system requires empirical evidence and measurable metrics for validation.

Water Futures Trading

Water futures trading can be an important tool for water-scarce economies. Even in the absence of a physical market, futures can help reduce the scarcity value of water—defined here as the marginal value generated by relaxing water availability by one unit. Water futures

markets offer several benefits. First, they enable price discovery and establish benchmark prices that reflect scarcity, guiding more efficient allocation and distribution. Second, under efficient conditions, futures prices can signal expected future scarcity, aiding investment choices and risk management amid variable water availability. Third, these prices support impact assessments for water infrastructure projects—especially when prioritising among competing options—by providing a quantified basis for decisions, particularly influenced by agriculture’s dominant role in water demand.

Fourth, water pricing heightens public and political awareness of water’s importance, availability, and the vital basin ecosystems supporting it, while addressing market failures in regions lacking valuation systems. In South Asia, where formal physical water markets are absent, futures trading can reveal scarcity values based on future supply, alerting policymakers to impending crises under growing water stress. Fifth, futures markets equip investors, lenders, and agri-finance firms with hedging against water-related risks in loans and projects, while enabling banks to craft tailored financial products for clients. Sixth, water futures markets can drive technological innovation by spurring investments in data collection, processing infrastructure, and decision-support systems, thereby strengthening research capacity and future crisis management.

In water-scarce economies, futures markets can guide critical water-related decisions while promoting equitable distribution and ecosystem conservation—such as compensating communities to leave water instream. Benefits extend beyond agriculture to hydropower firms, municipalities, water boards, and urban utilities, which can hedge risks and fund infrastructure upgrades. Since agriculture dominates water use, futures trading will most profoundly reshape the value chain, from farmers to consumers, by offsetting producer and supplier losses and enabling cost pass-throughs. Acting as a market-based safety net, these markets ease fiscal pressures on governments.⁹⁰

Water Availability Index

India lacks formal physical spot markets for water at the river basin or state levels, largely because water has not been clearly defined as a tradable good or commodity. Ghosh (2022)⁹¹ has argued that water futures markets could work through a Water Availability Index (WAI), priced objectively and independently to resist manipulation. Contracts would target major river basins within states—for instance, separate ones for Cauvery Basin water in Karnataka’s reservoirs versus Tamil Nadu’s. Research shows that water scarcity varies across boundaries in the same basin, and a single basin-wide index fails to capture this reality, necessitating state-specific indices under the broader WAI for effective risk hedging by farmers and stakeholders.⁹²

India's 2025 Dynamic Groundwater Resource Assessment by the Central Ground Water Board (CGWB), covering 6,762 assessment units, estimates annual recharge at 448.5 BCM and extractable resources at 407.8 BCM, with total extraction at 247.2 BCM, placing the national Stage of Groundwater Extraction at 60.6 percent. Of these units, 10.8 percent are over-exploited, 3.0 percent critical, 11.2 percent semi-critical, 73.1 percent safe, and 1.9 percent saline—highlighting localised stress amid overall national-level adequacy.⁹³ While CGWB's Assessment Units (AUs) classify groundwater stress based on the extraction-to-recharge ratio, they provide only a partial, groundwater-centric view of water availability. Given this limitation, they are poorly suited as the primary unit for water futures trading to enable promotion of an integrated water management framework. In order to do that, a holistic, basin-scale perspective integrating surface water, climatic variability, storage, and demand dynamics is required. However, AU-based stress indicators can usefully complement broader market frameworks as a localised signal of groundwater risk.

The Role of the Private Sector

The private sector can act as a steward of best practices in water management, especially in the creation of water markets, and can also play a complementary philanthropic role by financing water infrastructure. Water credits represent an important market-based mechanism for promoting sustainable water management, in which both market and private actors have a pivotal role to play. Water-intensive industries—such as beverages, textiles, and energy—are well placed to lead the adoption of water credits and, through Corporate Social Responsibility (CSR) initiatives, support investments in water infrastructure.

The beverage sector, in particular, can pioneer sustainable water stewardship through various initiatives. Public-private partnerships (PPPs) enable collaboration between governments and non-government organisations to roll out structured water credit programmes. Effective water pricing plays a pivotal role in optimising allocation while upholding social and environmental protections. Supply chain integration mandates sustainable water practices in supplier contracts. ESG investments enable companies to use water credits as offsets to achieve sustainability targets. By engaging in water credit markets, industries can strengthen their environmental profiles while advancing wider conservation objectives. Translating these principles into practical conservation measures, however, demands industry engagement and tailored sectoral strategies. The beverage sector—a major water user—can lead with innovative management practices and better demand management infrastructure, and show how water credits can be woven into corporate sustainability frameworks.

Case Study: Bisleri Studies on Water Credit

Bisleri's water credit model proposal for the beverage industry, aligned with the government's 2023 Green Credit Programme, marks a key step in environmental stewardship by replenishing water use and advancing corporate sustainability. The framework promotes accountability among manufacturers, enabling companies to earn credits via conservation measures like rainwater harvesting, efficient usage, wastewater treatment, and reuse. Developed with the TERI School of Advanced Studies by Kansal et al., the study reviews national and global water trading practices while crafting a solid method for calculating water footprints.⁹⁴ The 2025 study by Ghosh and Bhowmick referenced earlier has assessed the water footprint of two Bisleri plants in different terrains, highlighting the importance of localised conservation strategies that account for watershed-level rainfall patterns and groundwater quality.⁹⁵ However, implementation hurdles persist—like uneven water supplies, varied tariff structures, groundwater over-extraction penalties, compliance burdens for no-objection certificates, and shifting extraction fees—which complicate operations for beverage manufacturers. Establishing baseline footprints proves challenging given the scale of water units and inter-company technological variations, while verifying sustained conservation claims is difficult amid evolving monitoring needs, local conditions, and technologies. Water credits in the beverage sector demonstrate the promise of market-driven conservation while exposing practical barriers, including regulatory hurdles and validation complexities.

The Role of the Private Sector in Institutionalising Water Credits

The private sector, especially the corporate sector, can play a key role in institutionalising water credits in agriculture and beyond. First, the beverage industry can lead with demand-driven incentives. As major water users—alongside agriculture—in carbonated drinks, bottled water, juices, and alcoholic beverages, these companies can integrate GWCs into their corporate water stewardship programmes. By committing to buy credits from farmers' sustainable conservation efforts, they create a reliable market that motivates adoption of these practices. Second, beverage companies can also spearhead Public-Private Partnerships (PPPs) for sustainable water management by collaborating with governments, NGOs, and financial bodies like the National Bank for Agriculture and Rural Development (NABARD), the World Bank, and FAO to build accessible water credit programmes for farmers and supportive policy environments. Third, through supply chain integration, these firms—which rely on water-intensive crops like sugarcane, barley, coffee, and tea—can require sustainable water practices in supplier contracts, tying farm-level conservation to market incentives.

Fourth, leveraging the carbon-water nexus and rising ESG investments, beverage companies can treat water credits like carbon offsets amid growing ESG reporting demands. This aligns with global standards such as the Carbon Disclosure Project (CDP), Water Security and the Alliance for Water Stewardship (AWS), positioning them as active GWC market participants to boost liquidity and depth. Fifth, securing funding and financial backing is essential to promote green water practices. Beverage companies can lead by funding capacity building and technology adoption while streamlining operations—from raw material sourcing and upstream logistics to processing efficiency and overhead costs—to strengthen overall supply chain sustainability. Sixth, leveraging their influence with think tanks, advocacy groups, and policymakers, the beverage industry can help establish uniform standards for measuring water credits within governance frameworks.⁹⁶

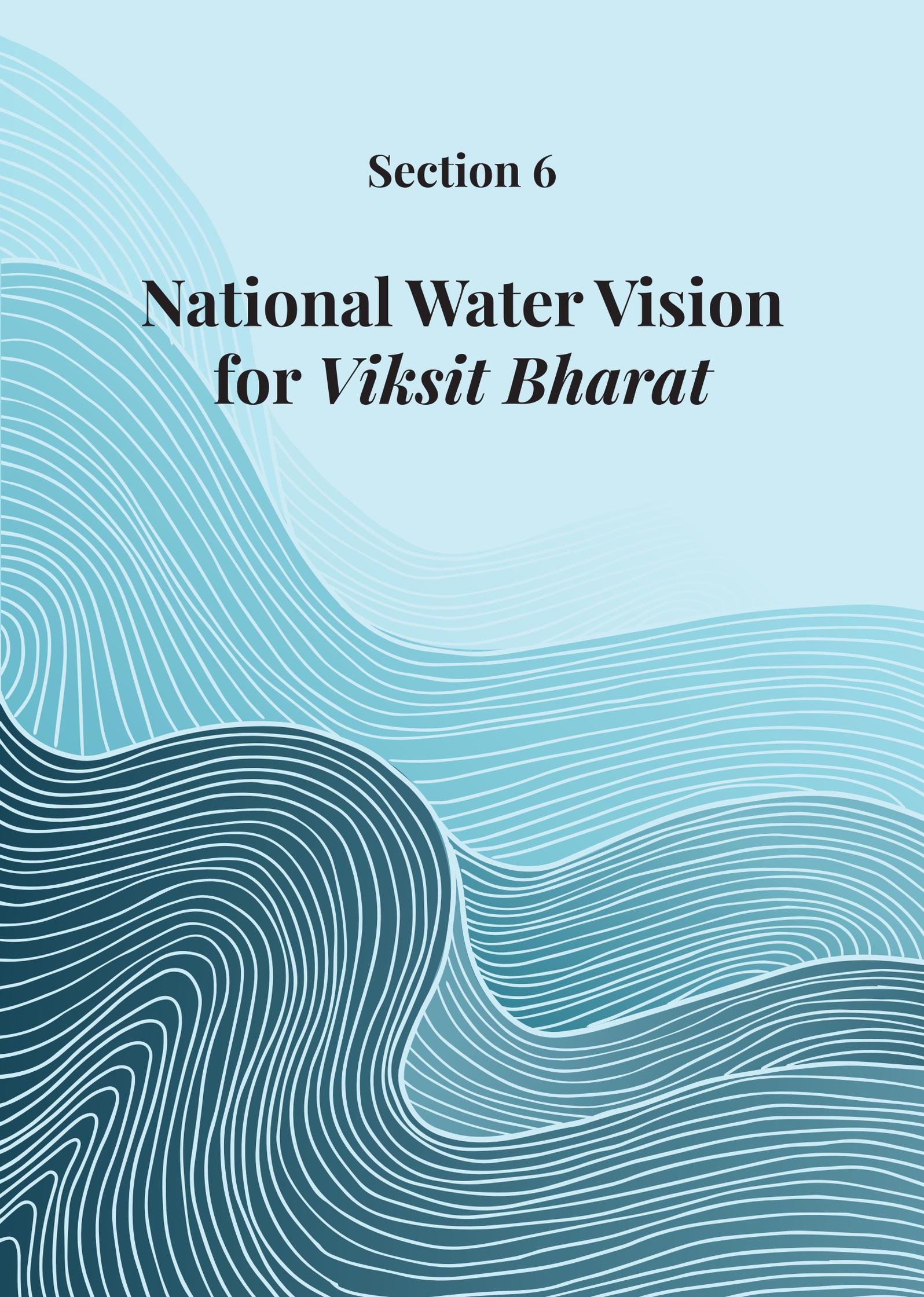
Successful water credit implementation demands a strong policy framework with standardised measurement protocols for uniform assessment of water savings and credit values. Regulatory oversight ensures compliance, curbs market manipulation, and promotes fair credit distribution; at the same time, alignment with the broader National Water Mission,^f and the various other national initiatives supporting it like Jal Shakti Abhiyan,^g Atal Bhujal Yojana,^h and the National Water Policy, creates synergy. Water credit systems face hurdles, including low awareness among stakeholders—especially smallholder farmers unaware of benefits and processes. Data and monitoring gaps complicate accurate tracking of usage, conservation, and transactions. Regulatory uncertainty from unclear legal frameworks stalls market growth. Overcoming these requires focused policy measures, capacity building, and digital tools for real-time verification.⁹⁷

In any case, while the private sector has to play its role, it is important for the government to enable the conditions for such markets to develop. The regulatory mechanisms and the principles of well-being need to be accorded due importance, and therefore, it is important for the government to play an enabling role in this entire framework and encourage private sector participation in various ways.

f India's National Water Mission (NWM) was launched in 2011 as one of the eight National Missions under the National Action Plan on Climate Change (NAPCC). It positions water governance squarely within India's climate adaptation strategy, and has stressed water-use efficiency and basin-scale IWRM.

g The Ministry of Jal Shakti launched the Jal Shakti Abhiyan (JSA) in 2019 in 1,592 out of 2,836 blocks in 256 water-stressed districts of the country. Under the initiative, a campaign was implemented in 2020 to nudge the states and all stakeholders to create Rain Water Harvesting Structures (RWHS).

h A Ministry of Jal Shakti scheme focusing on sustainable groundwater management in water-stressed areas across seven states, viz. Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh, utilising community participation and demand-side interventions.



Section 6

National Water Vision for *Viksit Bharat*

India's recent dispensations have been making attempts to create a framework for water security, as reflected in recent government reports. The 2016 report, *A 21st Century Institutional Architecture for India's Water Reforms* proposed creating a multidisciplinary National Water Commission and expanding the role of social scientists, management professionals, and other experts in water governance.⁹⁸ Recognising the need for new approaches, the Ministry of Jal Shakti constituted an independent expert committee in November 2019 to draft a new National Water Policy, marking a departure from earlier, more tightly controlled official committees.

Drawing on extensive stakeholder inputs, the committee called for a paradigm shift away from construction-heavy, command-and-control approaches toward more grounded, realistic, and holistic forms of governance capable of addressing twenty-first-century challenges. The draft NWP 2020 report, as reported in the media, argued for moving beyond a supply-augmentation mindset towards a genuinely integrated model and advanced several recommendations. The National Water Vision for Viksit Bharat should

further this cause with a longer-term view that creates a water-secure India through the strengthening of India's water governance architecture. The following 12 points articulate the tenets of the National Water Vision for Viksit Bharat@2047.

1. Water is a strategic national asset and common-pool resource, with women playing a central role in its governance.

Water should be governed as a shared natural capital that underpins public health, food systems, energy security, industrial competitiveness, and ecological stability, rather than as a sectoral input or a purely economic commodity. Women, as primary users and water managers, should be central to its governance at all levels.

2. Human well-being and intergenerational equity should be the primary objective.

All water policies should prioritise safe access, nutritional security, disease prevention, and ecosystem integrity, ensuring that present development pathways do not compromise the rights and opportunities of future generations.

3. Ecological integrity and basin-centric governance should be promoted.

River basins and aquifers should be treated as ecological systems and, over time, as administrative units. Governance frameworks should align with hydrological boundaries, ecosystem functions, groundwater assessment units, and climate dynamics.

4. Federal cooperation and subsidiarity should be the key to governing inter-state waters.

Water governance should be anchored in cooperative federalism, with the Union facilitating basin-scale coordination and states and local institutions exercising subsidiarity in planning, allocation, and enforcement.

5. Demand management should be promoted, replacing supply augmentation.

The guiding principle of national water planning shall be “efficiency first”, privileging demand governance, reuse, crop-water alignment, and loss reduction before new extraction, diversion, or storage.

6. Equity, inclusion, and livelihood security should receive top priority.

Policies must ensure fair access and risk-sharing for smallholders, the urban poor, informal workers, and water-dependent communities, recognising water security as a foundation for inclusive growth and social stability.

7. Natural ecosystems should be treated as a fundamental water infrastructure, with Nature-based Solutions (NbS) assuming an important role in climate action.

Ecosystems should be recognised as core water infrastructure, with restoration, blue-green urban design, and catchment stewardship mainstreamed as primary tools for climate action and disaster risk reduction.

8. Scientific data should be treated as public goods.

Hydrological data, water-quality information, and aquifer intelligence should be treated as open and trusted public assets, enabling evidence-based policymaking, accountable institutions, and credible market mechanisms.

9. Market-based instruments should be promoted with public purpose.

Where markets are used, they ought to be designed to signal scarcity, reward conservation, and manage risk, while remaining anchored in regulatory oversight, equity safeguards, and ecological limits.

10. Governance should be participatory, based on a multidisciplinary knowledge system.

Decision-making should integrate scientific expertise, local knowledge, primary water users, and civil society, recognising water as a socio-ecological system requiring transdisciplinary stewardship. The use of Artificial Intelligence (AI) to project scenarios of water shortage and scarcity can strengthen multidisciplinary knowledge system in water governance.

11. Water quality should be secured for prevention-oriented public health promotion.

Water governance should be embedded within India's health and human capital strategy, prioritising pollution control, wastewater management, and safe reuse as preventive investments rather than post-crisis responses.

12. Innovation, digitalisation, and adaptive policy design should be adopted.

Institutions should remain future-ready, leveraging digital systems, remote sensing, AI-driven forecasting, and continuous policy learning to respond to climate variability, demographic changes, and economic transformation.

Given these tenets, this study proposes the following implementation pathways. As emphasised earlier, women should be treated as central actors in these pathways, both as water users and managers.

From Supply Expansion to Demand Governance

In view of growing scarcity, water security must shift from a paradigm of perpetual supply augmentation to one of strategic demand management. Central to this shift is crop diversification, given that agriculture accounts for more than 80 percent of water use. Public procurement policies should move beyond rice and wheat to include nutri-cereals, pulses, and oilseeds. These crops should also be promoted through the Public Distribution System and mid-day meal schemes, aligning water efficiency with nutritional security and public health outcomes. National campaigns such as the “Sahi Fasal” initiative, launched in 2019, should be institutionalised to guide farmers in water-stressed regions toward climate-resilient, low-water cropping systems.

Circular Urban Water Economy: Reduce–Recycle–Reuse

Urban water governance should be organised around a circularity principle, mandating universal sewage treatment, decentralised wastewater systems for neighbourhoods and institutions, and ecological restoration of polluted urban river stretches. Treated wastewater will become the default for all non-potable uses, including sanitation, fire services, landscaping, and vehicle washing, thereby reducing freshwater extraction and strengthening urban climate resilience.

Efficient Irrigation and Smart Water Infrastructure

Achieving the vision requires pressurised, closed-pipe conveyance systems, SCADA-enabled monitoring, and large-scale micro-irrigation to unlock underutilised storage in dams and expand irrigation coverage at lower water and energy costs. This is paired with a national water-quality architecture, including dedicated central and state-level quality departments, effective monitoring of urban, rural, and agricultural water consumption patterns, deployment of low-energy eco-sensitive treatment technologies, and a specialised task force for monitoring emerging contaminants and public health risks.

Nature-Based Solutions as Core Water Infrastructure

This includes catchment rejuvenation through ecosystem-service incentives, rain gardens, bioswales, restored river corridors, wet meadows, constructed wetlands, permeable pavements, and green roofs. These interventions position nature as functional infrastructure that delivers climate adaptation, flood mitigation, groundwater recharge, and urban liveability.

Participatory and Equitable Groundwater Governance

The Vision establishes aquifers as shared natural assets, governed through community-based stewardship. Building on the Central Ground Water Board's Aquifer Mapping and Management Programme, stakeholders should have access to transparent data on aquifer boundaries, storage, and flows, enabling locally tailored groundwater management plans that balance livelihoods, ecosystems, and intergenerational equity.

Rivers as Living Systems: Rights-Based Protection

The Vision rejects an instrumentalist view of rivers and advances a Rights of Rivers framework, recognising rivers' rights to flow, meander, and reach the sea. Policy measures include catchment revegetation, stricter regulation of groundwater abstraction and riverbed pumping, and tighter controls on sand and boulder mining, embedding ecological integrity and cultural values at the core of river governance.

Basin-Scale Federalism and Cooperative Governance

Recognising river basins as both ecological and political systems, the Vision calls for a basin-wide, ecosystem-based governance architecture. It prioritises institutionalised political dialogue among states, supported by the Union government as a neutral facilitator, to reduce litigation-driven gridlock, strengthen compliance with tribunal and court decisions, and ensure timely, cooperative management of shared water systems.

Integrated Institutions for Whole-of-System Water Governance

A National Water Commission should be established as a multidisciplinary apex body, integrating expertise from hydrology, agronomy, soil science, hydrometeorology, public health, river ecology, ecological economics, social mobilisation, and governance. The Commission will serve as a model for state-level reforms, embedding primary water users, indigenous knowledge systems, and community-based conservation practices into formal decision-making structures.

Market-Based Instruments for Scarcity Signalling and Risk Management

The Vision introduces a new generation of water market institutions:

- **Green Water Credits (GWCs)** to reward farmers for soil-moisture retention, drip irrigation, and land-levelling practices that enhance upstream "green water" while strengthening downstream "blue water" availability.

- **Water Futures Trading** to enable price discovery, drought hedging, and risk transfer for agriculture, industry, hydropower, and municipalities.
- A **Water Availability Index (WAI)** to provide an objective, data-driven, and manipulation-resistant benchmark for scarcity, especially in inter-state basins, enabling transparent allocation and informed policy responses.

Strategic Private Sector and PPP Engagement

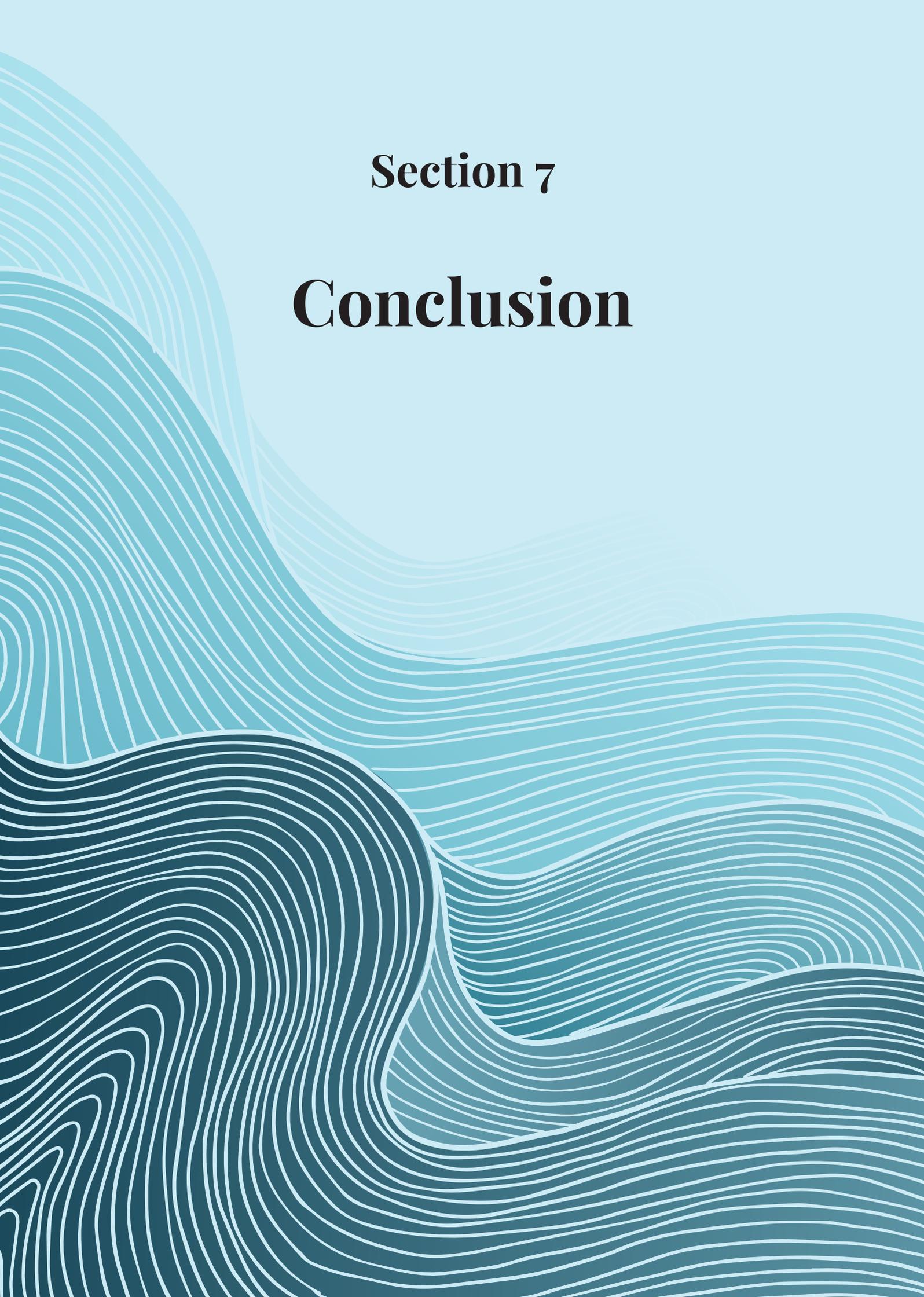
The Vision positions the private sector—particularly water-intensive industries such as beverages and agribusiness—as co-stewards of national water security. Through Public-Private Partnerships, firms can mainstream GWCs within supply chains, support farmer training and micro-irrigation deployment, align ESG and disclosure frameworks (CDP, AWS) with water stewardship goals, and help build interoperable national standards for water credits and monitoring systems.

Water Security as a Public Health and Human Development Priority

The Vision explicitly links water quality, sanitation, nutrition, and disease prevention, embedding water governance within India's broader health and human capital strategy. Investments in safe water, wastewater reuse, and pollution control are treated as preventive health infrastructure, reducing long-term healthcare burdens and productivity losses.

Digital, Data-Driven, and Transparent Water Governance

A national digital backbone will integrate real-time hydrological data, remote sensing, SCADA systems, aquifer maps, and water-quality dashboards into open, interoperable platforms. This enables evidence-based policymaking, transparent federal coordination, and market instruments such as GWCs and the WAI, strengthening trust and accountability across institutions and stakeholders.

The background features a series of overlapping, wavy lines in various shades of blue and teal, creating a sense of movement and depth. The lines are more densely packed and darker in the lower-left corner, gradually becoming more sparse and lighter towards the top-right.

Section 7

Conclusion



T

he Vision presented in this report marks a decisive departure from the traditional model of water resource development, long characterised by engineering-led supply expansion, fragmented institutions, and sectoral optimisation. In contrast, this vision repositions water as a strategic national asset and a socio-ecological system, governed through basin-scale thinking (and also bringing in assessment units for groundwater governance), demand management (shifting cropping patterns from water-guzzlers like paddy to nutritious climate-resilient millets, efficient water pricing, among others), ecological restoration, market mechanisms, and cooperative federalism rather than through isolated projects and administrative silos.

Its strength lies in integrating human development, economic productivity, and environmental integrity within a single governance architecture. By embedding water policy into nutrition, health, industrial competitiveness, climate resilience, and digital governance, the framework moves beyond crisis management toward preventive, anticipatory and risk-informed decision-making.

The introduction of transparent data systems, participatory institutions, and market instruments with public purpose further ensures that scarcity is signalled, conservation is rewarded, and equity is safeguarded across regions and social groups.

For Viksit Bharat@2047, this proposed vision positions water not as a binding constraint on growth, but as a strategic enabler of prosperity, social stability, and geopolitical credibility. It strengthens India's capacity to deliver safe cities, resilient agriculture, competitive industries, and cooperative river-basin diplomacy, while protecting the ecological foundations of long-term development. In doing so, it aligns national ambition with intergenerational responsibility, ensuring that India's journey toward a developed, inclusive, and climate-secure future is built on the sustainable stewardship of its most vital natural capital.

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