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MAPPING OPPORTUNITIES for Corporate Engagement in Biodiversity Conservation in Critical Ecosystems of India

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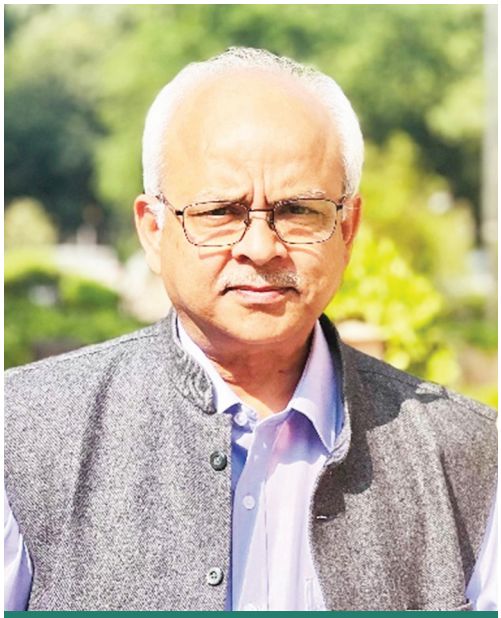

Ratnesh Jha
Executive Director
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India's diverse ecosystems—from urban wetlands and mangroves to the Aravallis, marine habitats, and semi-arid agricultural landscapes—are fundamental to the nation's environmental and economic resilience. This report offers a clear pathway for corporate engagement in biodiversity conservation, a subject of growing importance as industrial and urban development increasingly intersect with our natural heritage.

The document examines the challenges faced by these critical ecosystems and provides concrete examples of how various sectors—such as real estate, energy, mining, tourism, and agriculture—are rethinking their operations. Through detailed case studies, the report illustrates effective strategies in areas like sustainable watershed management, habitat restoration, and the implementation of nature-based solutions. These real-world insights demonstrate that integrating biodiversity into core business practices not only protects the environment but also reinforces long-term business stability.

In addition, the report aligns its findings with contemporary policy frameworks and international commitments, underscoring the strategic link between sound environmental practices and market competitiveness. Recommendations on governance, financing, and monitoring have been developed to guide companies in embedding conservation principles within their overall operations.

This publication stands as both a strategic blueprint and a call to action. It emphasizes the vital role that corporate engagement plays in preserving India's natural capital and ensures that industrial growth can go hand in hand with ecological stewardship, securing a sustainable future for generations to come.

ACKNOWLEDGEMENTS

This report, *"Mapping Opportunities for Corporate Engagement in Biodiversity Conservation in Critical Ecosystems of India,"* is the result of extensive research, collaboration, and a shared commitment to advancing nature-positive action within India's corporate sustainability landscape.

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EXECUTIVE SUMMARY

This study report presents the findings of **"Mapping Opportunities for Corporate Engagement in Biodiversity Conservation in Critical Ecosystems of India,"** conducted by the United Nations Global Compact Network India (UNGCNI). The study aims to identify actionable pathways for corporate entities to contribute better to biodiversity conservation through strategic CSR initiatives, ESG integration, and innovative partnerships for selected, critical landscapes in India.

The study examines opportunities for corporate contribution to five critical Indian ecosystems: Urban Wetlands, Mangroves of Goa and Tamil Nadu, The Aravallis, Marine Ecosystems, and agricultural ecosystems in semi-arid regions. The report evaluates the current status of these ecosystems, documents positive corporate conservation contributions, and outlines potential corporate interventions to safeguard ecosystem integrity.

The findings reveal a mixed landscape of corporate engagement. While some organizations have implemented successful conservation strategies through CSR initiatives, sustainable business practices, and multi-stakeholder partnerships, many continue to adversely impact these fragile ecosystems through pollution, unsustainable levels of resource extraction, habitat destruction, and unsustainable development. This report provides targeted recommendations for more proactive leadership by corporates towards the protection and enhancement of biodiversity in the selected ecosystems.

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1. INTRODUCTION

India's biodiversity is both vast and critical, encompassing approximately 7-8% of the world's recorded species within just 2.4% of the global land area. This includes over 45,000 species of plants and 91,000 species of animals, highlighting the country's status as one of the 17 megadiverse nations globally. However, this ecological wealth is under severe threat from a combination of anthropogenic and environmental pressures. Rapid urbanization, deforestation, habitat fragmentation, and unsustainable agricultural practices are leading to the loss and degradation of ecosystems. Climate change further exacerbates these pressures, altering species distribution and ecosystem functioning. Additionally, invasive alien species, pollution,

and overexploitation of natural resources pose serious threats to native flora and fauna. Despite legal frameworks such as the Wildlife Protection Act (1972) and initiatives like the National Biodiversity Action Plan, enforcement gaps and limited community participation often undermine conservation efforts. These challenges necessitate an integrated approach combining scientific research, traditional knowledge, policy support, and grassroots engagement to ensure the long-term survival of India's unique and irreplaceable biodiversity.

In response to these challenges, India has undertaken several initiatives to protect and restore its biodiversity, reflecting its deep ecological heritage and international climate commitments. One of the most notable successes is Project Tiger, launched in 1973 to curb the alarming decline of tiger populations. Over the decades, this centrally sponsored scheme has significantly contributed to the revival of tiger numbers, with the 2022 census reporting 3,682 wild tigers, making India home to over 70% of the global tiger population. The project's success is attributed to a landscape-level conservation approach, the establishment of over 50 tiger reserves, and strong political and community support.

Building on its biodiversity and climate goals, India has launched several contemporary initiatives. The Mangrove Initiative for Shoreline Habitats & Tangible Incomes (MISHTI), announced in 2023, aims to restore and expand mangrove cover across coastal districts, enhancing carbon sequestration and shoreline protection while supporting local livelihoods. The Amrit Sarovar initiative, launched under the Azadi Ka Amrit Mahotsav, focuses on rejuvenating over 75 water bodies in every district, contributing to water conservation, biodiversity revival, and community engagement. In the climate finance and sustainability domain, the Carbon Credit Trading Scheme (CCTS), introduced in 2023, enables market-based mechanisms to incentivize emission reductions. Complementing this, the Green Credits Program rewards environmentally positive actions like afforestation, water conservation, and sustainable agriculture with tradable credits. Meanwhile, the LIFE (Lifestyle for Environment) Mission, championed by India at COP26, promotes sustainable lifestyle choices as a grassroots movement to combat climate change and biodiversity loss. Together, these programs signal India's multidimensional approach to integrating biodiversity protection with climate action, community participation, and sustainable development.

The *"Ek Ped Maa Ke Naam"* campaign, launched on World Environment Day 2024, has resulted in the planting of over 102 crore trees, with a target of 140 crore by March 2025. Furthermore, the number of Ramsar sites—wetlands of international importance—has increased from 26 in 2014 to 89 in 2025, reflecting a commitment to preserving critical ecosystems. These measures aim to address the pressing need for biodiversity preservation and highlight India's dedication to environmental stewardship.

India's ecological diversity is a cornerstone of its environmental heritage, encompassing a wide range of ecosystems that support biodiversity, regulate climate, and sustain livelihoods. The ecosystems included in the study—Urban Wetlands, Mangroves of Goa and Tamil Nadu, the Aravallis, Marine Ecosystems, and Agricultural Ecosystems in Semi-Arid Regions—are representative of the country's varied landscapes, from coastal zones to arid interiors. These ecosystems are of specific interest to the United Nations Global Compact Network India

(UNGCNI) due to their critical ecological roles and significant potential for enhanced corporate engagement in conservation, sustainable development, and climate resilience initiatives.

Urban wetlands, found in and around India's rapidly growing cities, are vital yet often overlooked. These include lakes, ponds, and marshes such as Bengaluru's Bellandur Lake, Delhi's Yamuna floodplains, and Chennai's Pallikaranai Marsh, which act as natural sponges, absorbing excess rainfall, recharging groundwater, and mitigating urban flooding—a growing concern amid climate change (Ramsar Convention Secretariat. (2018); Jain, M., Singh, C., & Ghosh, S. (2020)). They also serve as biodiversity hotspots, supporting migratory birds, fish, and aquatic plants, while improving air quality and providing recreational spaces (Wetlands International South Asia. (2021)). However, rapid urbanization, pollution, and encroachment threaten their survival, with Pallikaranai, one of Chennai's last remaining marshes, shrinking significantly due to industrial and residential development (Care Earth Trust. (2019); Sood, J. (2022)). This study identifies potential opportunities for corporate involvement through wetland conservation initiatives, waste reduction initiatives, and green infrastructure investments, which can help restore these ecosystems and align with sustainable urban development goals (TERI., 2021).

Along India's coasts, mangroves thrive in saline conditions, forming a critical buffer between land and sea. In Goa, mangroves along the Mandovi and Zuari estuaries, such as those in Chorao Island's Dr. Salim Ali Bird Sanctuary, protect against erosion and support fisheries (Da Silva et al., 2014; Goa State Biodiversity Board, 2020). In Tamil Nadu, the Pichavaram and Muthupet mangroves are renowned for their dense root systems that stabilize coastlines and sequester carbon at rates far exceeding terrestrial forests (Alongi, 2012; Forest Survey of India, 2021). These coastal forests are biodiversity powerhouses, hosting species like crabs, migratory birds, and even the Royal Bengal Tiger in the broader Sundarbans context, while shielding communities from cyclones and tsunamis, as demonstrated during the 2004 Indian


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Ocean tsunami (Kathiresan & Rajendran, 2005). Yet, aquaculture, tourism, and pollution pose significant threats (MoEFCC, 2019; NCSCM, 2021).

Inland, the Aravalli Range, one of the world's oldest mountain systems, stretches across Rajasthan, Haryana, and Delhi, acting as a natural barrier against desertification from the Thar Desert (Bhuvan, ISRO, 2020). This ancient ecosystem regulates the microclimate, supports unique flora and fauna like leopards, hyenas, and drought-resistant plants such as Acacia, and sustains groundwater recharge in a water-scarce region (TERI, 2018; Wildlife Institute of India, 2019). In Haryana's Gurugram and Faridabad, the Aravallis are critical for maintaining ecological balance amid urban sprawl. Yet illegal mining, deforestation, and real estate development have degraded large swathes of this range (CSE, 2020).

India's marine ecosystems, spanning its 7,500-kilometer coastline, encompass coral reefs, seagrass beds, and open ocean waters in the Arabian Sea, Bay of Bengal, and Andaman and Nicobar Islands. The Gulf of Mannar and Andaman reefs are biodiversity hotspots, hosting over 3,000 species, including corals, dugongs, and whale sharks, while regulating global carbon cycles and supporting fisheries that sustain millions of livelihoods (CMFRI, 2020; UNEP, 2022). These ecosystems also protect coastlines from erosion, but overfishing, plastic pollution, and coral bleaching due to rising sea temperatures threaten their health, as evidenced by the 2021 mass bleaching event in the Andamans (ZSI, 2021).

UNGCNI sees marine ecosystems as a frontier for corporate action through sustainable fishing practices, plastic waste management, and investments in blue carbon projects, aligning with global ocean conservation goals (UNGCNI, 2022).

In the country's semi-arid interiors, agricultural ecosystems in states like Rajasthan, Gujarat, and Maharashtra are characterized by low rainfall, high evaporation, and resilient farming

systems. These regions rely on crops like millets, sorghum, and pulses, alongside pastoralism, to sustain rural economies, with traditional practices such as rainwater harvesting (e.g., johads in Rajasthan) and agroforestry, enhancing soil fertility and water retention (Agarwal & Narain, 1997; ICAR, 2020). Critical for food security and climate adaptation, these ecosystems support millions of smallholder farmers, yet erratic monsoons, soil degradation, and over-reliance on groundwater challenge their sustainability (FAO, 2021; NABARD, 2019).

Together, these ecosystems—Urban Wetlands, Mangroves of Goa and Tamil Nadu, the Aravallis, Marine Ecosystems, and Agricultural Ecosystems in Semi-Arid Regions—reflect India's ecological diversity, from urban water bodies to coastal forests, ancient hills, oceanic expanses, and dryland farms. Their preservation is essential for biodiversity, climate regulation, and human well-being.

UNGCNI's focus on these areas underscores their untapped potential for corporate collaboration in precision agriculture, renewable energy-powered irrigation, and supply chain sustainability, offering avenues for innovation, investment, and sustainable practices that can safeguard India's environmental future while advancing business leadership in sustainability and enabling businesses to bolster resilience in these climate-vulnerable landscapes.

1.1. Policy and Regulatory Framework

India's biodiversity conservation efforts are anchored in a robust legal and institutional framework aimed at protecting, sustainably using, and equitably sharing biological resources. The Biological Diversity Act (2002) and Rules (2004) established a decentralized governance structure for biodiversity conservation. This includes the National Biodiversity Authority (NBA) at the central level, State Biodiversity Boards (SBBs) at the state level, and Biodiversity Management Committees (BMCs) at the local level (NBA, 2021). These institutions regulate access to biological resources, implement conservation initiatives, and ensure fair benefit-sharing through the Access and Benefit-Sharing (ABS) mechanism (UNDP India, 2019). A key tool supporting these efforts is the People's Biodiversity Register (PBR), which documents local biodiversity, traditional knowledge, and conservation practices, serving as a valuable resource for policy decisions and sustainable management (MoEFCC, 2020).

The Ministry of Environment, Forest and Climate Change (MoEFCC) is the apex body responsible for biodiversity policy and conservation efforts, overseeing major programs such as the National Biodiversity Action Plan (NBAP). This plan aligns India's conservation strategies with global commitments, including the Kunming-Montreal Global Biodiversity Framework (KMGBF) (MoEFCC, 2023; CBD, 2022).

Other key legislations play a vital role in conservation. The Forest Conservation Act (1980) regulates forest diversion and mandates compensatory afforestation (MoEFCC, 2019). The Wildlife Protection Act (1972) safeguards wildlife through protected areas and species-specific programs such as Project Tiger and Project Elephant (WII, 2020). The Wetlands (Conservation and Management) Rules (2017) focus on wetland preservation by restricting harmful activities and promoting sustainable management (MoEFCC, 2017). The Environmental Protection Act

(1986) serves as an overarching law for environmental conservation, including biodiversity protection (MoEFCC, 2020).

India's Global Commitments to Biodiversity Conservation:

As a signatory to multiple global agreements, India integrates international conservation commitments into its national policies:

1. **United Nations Convention on Biological Diversity (CBD):** Aims to conserve biodiversity, ensure sustainable use of biological resources, and promote equitable benefit-sharing. India has actively implemented CBD objectives through national legislation and played a significant role in developing the Kunming-Montreal Global Biodiversity Framework (KMGBF), which includes the ambitious 30x30 target of protecting 30% of global land and marine areas by 2030 (CBD, 2022; MoEFCC, 2023).

2. **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES):** Regulates international trade in endangered species to prevent their over-exploitation. India enforces CITES provisions through the Wildlife Protection Act (1972) and has strengthened measures against illegal wildlife trade (CITES, 2022; TRAFFIC India, 2021).

3. **Ramsar Convention on Wetlands:** Focuses on the conservation and sustainable use of wetlands. India has designated 75 wetlands as Ramsar sites and promotes their protection through initiatives such as the National Wetland Conservation Programme (NWCP) and the Namami Gange Programme for riverine ecosystem restoration (Ramsar, 2023; MoEFCC, 2022).

4. **Convention on Migratory Species (CMS):** Also known as the Bonn Convention, CMS focuses on protecting migratory species and their habitats. India hosted CMS COP-13 in 2020 and launched the Central Asian Flyway Action Plan, further strengthening conservation programs for species like the Asian elephant, great Indian bustard, and dugong (CMS, 2020; MoEFCC, 2020).

5. **United Nations Framework Convention on Climate Change (UNFCCC):** Addresses climate change and its impact on biodiversity. India's Nationally Determined Contributions (NDCs) under the Paris Agreement emphasize increasing forest cover, promoting ecosystem-based adaptation, and integrating biodiversity into climate action. Programs like the Green India Mission and National Adaptation Fund for Climate Change (NAFCC) support these objectives (UNFCCC, 2023; MoEFCC, 2021).

6. **United Nations Convention to Combat Desertification (UNCCD):** India has been an active participant in the United Nations Convention to Combat Desertification (UNCCD) since its inception in 1994 and has taken significant steps to fulfill its commitments under the convention. As a country with vast stretches of arid and semi-arid land, India faces substantial challenges related to land degradation and desertification, which affect agricultural productivity, water security, and rural livelihoods. Recognizing these challenges, India has integrated land restoration into its national policies, including the National Action Programme to Combat Desertification (NAPCD) and initiatives like the National Afforestation Programme, Watershed Development Programmes, and soil health management schemes.

7 India further reinforced its global leadership by hosting the 14th Conference of the Parties (COP14) to the UNCCD in New Delhi in September 2019. During COP14, India assumed the presidency of the UNCCD for the 2019–2021 term and pledged to restore 26 million hectares of degraded land by 2030, aligning with the global goal of achieving Land Degradation Neutrality (LDN). The conference also highlighted India's commitment to promoting nature-based solutions, enhancing community participation, and leveraging technology for land restoration. These efforts underscore India's proactive stance in combating desertification and its contribution to global sustainability and climate resilience goals.

India's commitment to these global frameworks reflects its proactive approach to biodiversity conservation, integrating international goals with national strategies to protect its rich ecological heritage.

1.2. Corporate Biodiversity Action and Reporting

Corporate engagement in biodiversity conservation has gained significant momentum in recent years, driven by the increasing recognition of the ecological and economic value of nature. Businesses are now expected not only to minimize their ecological footprint but also to contribute proactively to the restoration and preservation of natural ecosystems. Several internationally recognized frameworks guide companies in this transition towards nature-positive practices, offering structured methodologies for setting targets, disclosing impacts, and ensuring regulatory compliance.

One of the leading initiatives in this space is the Science-Based Targets for Nature (SBTN), which provides companies with a robust, science-driven approach to set measurable and time-bound biodiversity goals. It encourages businesses to assess their dependencies and impacts on nature, prioritize action areas, and implement strategies that align with planetary boundaries and global conservation goals.

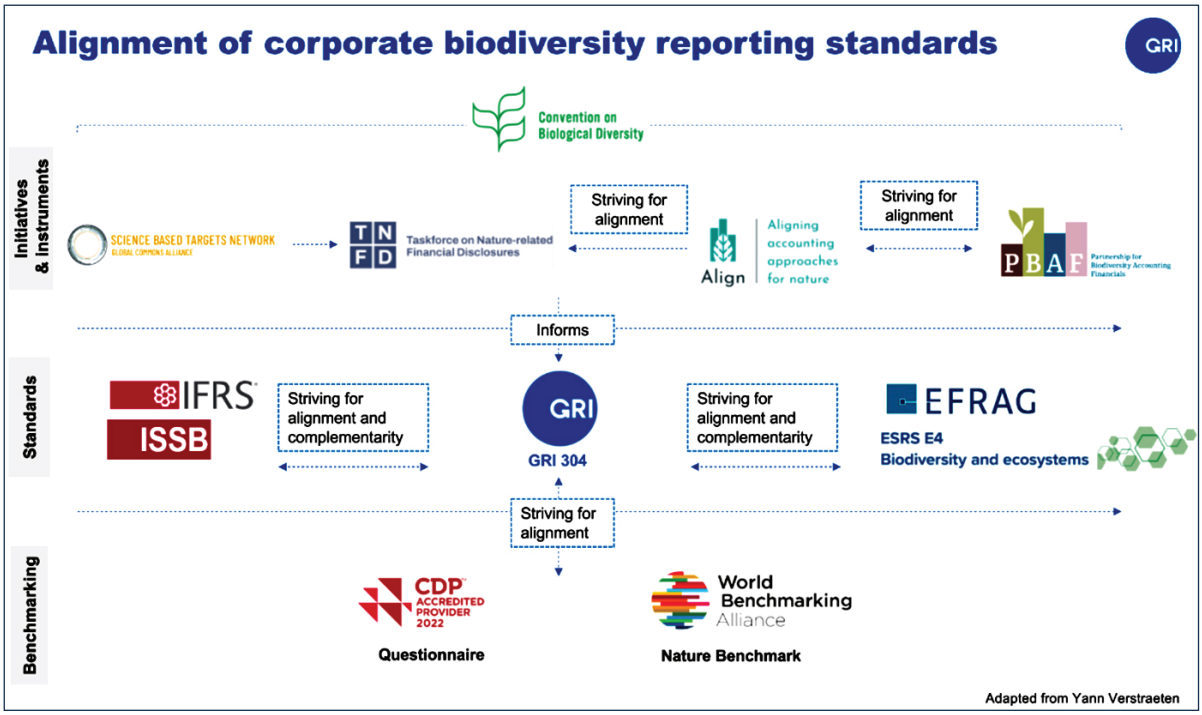
Complementing this, the Taskforce on Nature-related Financial Disclosures (TNFD) offers a comprehensive framework to identify, assess, manage, and disclose nature-related risks and opportunities. This enables companies to integrate nature into strategic decision-making and risk management processes, recognizing biodiversity loss as a material financial risk comparable to climate change.

The Natural Capital Protocol, developed by the Natural Capital Coalition, equips businesses with a standardized approach to understand and value their interactions with natural systems. By evaluating how corporate activities affect natural capital—defined as the world's stocks of natural assets including geology, soil, air, water, and all living things—companies can make informed decisions that support sustainable development and ecosystem resilience.

At the global policy level, the Kunming-Montreal Global Biodiversity Framework (GBF), adopted during the 15th Conference of the Parties to the Convention on Biological Diversity (CBD COP15), sets ambitious targets for halting biodiversity loss by 2030. The GBF specifically calls for stronger engagement from the private sector in achieving conservation outcomes through mainstreaming biodiversity into business operations, supply chains, and financial flows.

In the Indian context, adherence to the Biological Diversity Act, 2002 is critical for corporate biodiversity governance. The Act mandates companies to regulate access to biological resources and ensure fair and equitable sharing of benefits arising from their utilization, thereby supporting local communities and traditional knowledge systems. Furthermore, the Securities and Exchange Board of India (SEBI) has introduced the Business Responsibility and Sustainability Reporting (BRSR) framework, which mandates the top 1,000 listed companies to disclose their environmental, social, and governance (ESG) performance. The BRSR includes key performance indicators related to biodiversity, such as ecosystem impact assessments and conservation efforts, thereby integrating biodiversity into corporate sustainability disclosures.

Additionally, the Global Reporting Initiative (GRI) standards, particularly GRI 304: Biodiversity, offer detailed guidance for biodiversity-related disclosures. These standards help businesses measure, manage, and report their impacts on ecosystems in a transparent and accountable manner. By adopting such disclosure practices, companies can enhance stakeholder trust, comply with emerging regulatory expectations, and demonstrate leadership in environmental stewardship.



Together, these frameworks underscore the growing convergence of biodiversity conservation with corporate strategy, finance, and governance. They empower companies to not only mitigate environmental risks but also unlock new opportunities through sustainable innovation, resilient value chains, and contributions to global biodiversity targets.

1.3. Corporate Biodiversity Engagement

Corporate engagement in biodiversity conservation in India is gradually evolving, supported by expanding regulatory mandates and growing awareness within the private sector. The Securities and Exchange Board of India (SEBI) has introduced a phased implementation of ESG-related disclosures, including biodiversity indicators, through the Business Responsibility and Sustainability Reporting (BRSR) framework. Since FY 2022–23, the top 1,000 listed companies have been required to publish ESG data, and in 2023, SEBI extended this requirement to the top 250 firms for 75% of their supply chains by 2025–26 (Reuters, 2025). Although the compliance deadline was extended by one year in December 2024, these developments indicate a strengthening policy direction toward biodiversity-related corporate accountability.

However, the quality and consistency of biodiversity reporting remain areas of concern. A recent analysis of BRSR disclosures from over 300 companies—representing approximately 70% of India's market capitalization—found that while biodiversity is increasingly mentioned, the information disclosed is often vague and lacks quantifiable indicators (CFA Institute, 2024). Similarly, a longitudinal study analyzing the biodiversity risk and concern disclosures of BSE 500 companies from 2000 to 2023 noted a steady increase in references to biodiversity but observed that such mentions were frequently superficial and lacked integration into core strategy or risk frameworks (Goyal & Gupta, 2024). These findings echo earlier research that identified biodiversity as an under-prioritized theme in corporate social responsibility (CSR) initiatives, often overshadowed by issues perceived to have more immediate reputational or regulatory relevance (Singh et al., 2023).

Additionally, a press release by Capgemini India (2023) indicated that only 24% of organizations have a biodiversity strategy in place. These findings suggest that while there is a growing awareness of biodiversity among Indian companies, the development of dedicated policies and reporting on specific biodiversity-related key performance indicators remain limited (Potdar et al., 2016; Capgemini, 2023). According to a 2023 study, only 24% of organizations have a biodiversity strategy in place. The report also indicates that 16% of organizations have assessed the impact of their supply chains on biodiversity, and 20% have evaluated the impact of their operations. These figures highlight a gap between corporate acknowledgment and concrete, strategic action for biodiversity preservation (Capgemini, 2023).

The nature of corporate involvement in biodiversity conservation varies across industries and is largely driven by regulatory compliance and corporate social responsibility (CSR) initiatives. Many companies undertake biodiversity assessments and mitigation measures as part of Environmental Impact Assessments (EIAs) to meet legal obligations. CSR efforts commonly

focus on activities such as tree plantations, watershed management, sustainable agriculture, and in some cases, support for protected areas. Additionally, sustainable sourcing practices are increasingly adopted, especially in agriculture, forestry, and fisheries. Certain industries, such as mining, infrastructure, and manufacturing, are engaged in habitat restoration to offset environmental damage. Beyond direct interventions, some companies contribute to biodiversity research and public awareness programs, reflecting a growing recognition of the need for long-term, science-based solutions.

While corporate biodiversity engagement in India is evolving, there remains a significant opportunity for businesses to adopt more ambitious, integrated, and measurable biodiversity strategies. To catalyze more meaningful corporate action, there is a pressing need to shift from compliance-driven disclosures to strategic integration of biodiversity into core business operations. This involves setting measurable science-based targets, aligning with national biodiversity frameworks, investing in ecosystem restoration, and building partnerships with scientific and conservation institutions to ensure that interventions are both effective and scalable.

1.4. Business Case for Biodiversity Conservation

Corporate engagement in biodiversity conservation is influenced by multiple value propositions that impact business strategy, risk management, and financial performance.

Risk Management

Businesses are increasingly recognizing the operational, regulatory, and reputational risks associated with biodiversity loss. A significant portion of companies depend on critical ecosystem services, making them vulnerable to resource scarcity. For instance, a study by the European Central Bank found that 75% of corporate loan exposures in the euro area have a strong dependency on at least one ecosystem service (European Central Bank, 2021). While specific data for Indian companies is limited, similar dependencies are likely present.

As biodiversity-related regulations become more stringent, companies face increased compliance risks. Although exact figures for biodiversity compliance risks are scarce, a PwC survey highlighted that 42% of Indian organizations are facing increased security vulnerabilities due to legacy technologies, indicating a broader trend of regulatory challenges (PwC India, 2023).

Reputational concerns are also significant. A survey by Bain & Company revealed that about 83% of Indian consumers consider the environmental impact of packaging important or very important, underscoring the importance of responsible environmental stewardship (Bain & Company, 2024).

Value Creation Opportunities

Beyond risk mitigation, biodiversity conservation presents opportunities for value creation. The demand for sustainable products and services is substantial. India's overall economy is projected to reach approximately INR 830 lakh crore (USD 10 trillion) by 2032, driven by robust growth in manufacturing, infrastructure, and services sectors (EY & CII, 2023).

While this figure encompasses the entire economy, it reflects the significant growth potential for businesses prioritizing environmental responsibility.

Biodiversity challenges also drive innovation, leading to new technologies and business models. Proactive engagement in conservation strengthens stakeholder relationships and enhances a company's social license to operate, fostering long-term trust and market resilience.

Financial Performance

Integrating biodiversity-conscious strategies can yield tangible financial benefits. Optimizing natural resource efficiency can reduce operational costs while improving environmental outcomes. The expansion of sustainable finance instruments has created new avenues for companies to access capital by demonstrating strong environmental commitments. In India, green finance flows increased by 150% from FY2017–2018 to FY2019–2020, indicating growing investor interest in sustainability (Climate Policy Initiative, 2021).

Overall, integrating biodiversity into corporate decision-making enhances long-term financial resilience, positioning businesses for sustainable growth.

2. METHODOLOGY

The study adopted a multi-dimensional assessment framework that integrated comprehensive secondary research, and stakeholder consultations to systematically identify and prioritize corporate biodiversity engagement opportunities in the selected ecosystems. The research process began with an extensive review of existing literature, reports, and datasets from various sources, including government agencies, research institutions, and conservation organizations. This secondary research provided critical insights into biodiversity trends, regulatory landscapes, and corporate sustainability practices.

To validate findings and incorporate diverse perspectives, stakeholder consultations were conducted with key informants from multiple sectors, including corporate sustainability leaders, government policymakers, conservation experts, and academic researchers. These discussions provided qualitative insights into industry best practices, policy constraints, and practical challenges in implementing biodiversity initiatives. The corporate biodiversity engagement opportunities were systematically mapped and categorized into seven key intervention types: Habitat Protection and Restoration, Sustainable Resource Management, Biodiversity Offsets and Compensatory Conservation, Nature-based Solutions for Climate Change, Sustainable Supply Chain Management, Research and Innovation, and Community Engagement and Capacity Building. Each opportunity was assessed using a structured evaluation framework based on four critical dimensions: Conservation Impact, Business Value, Implementation Feasibility, and Scalability Potential. This holistic methodology ensured that the proposed biodiversity interventions were scientifically robust, aligned with corporate sustainability objectives, and practically implementable at scale.

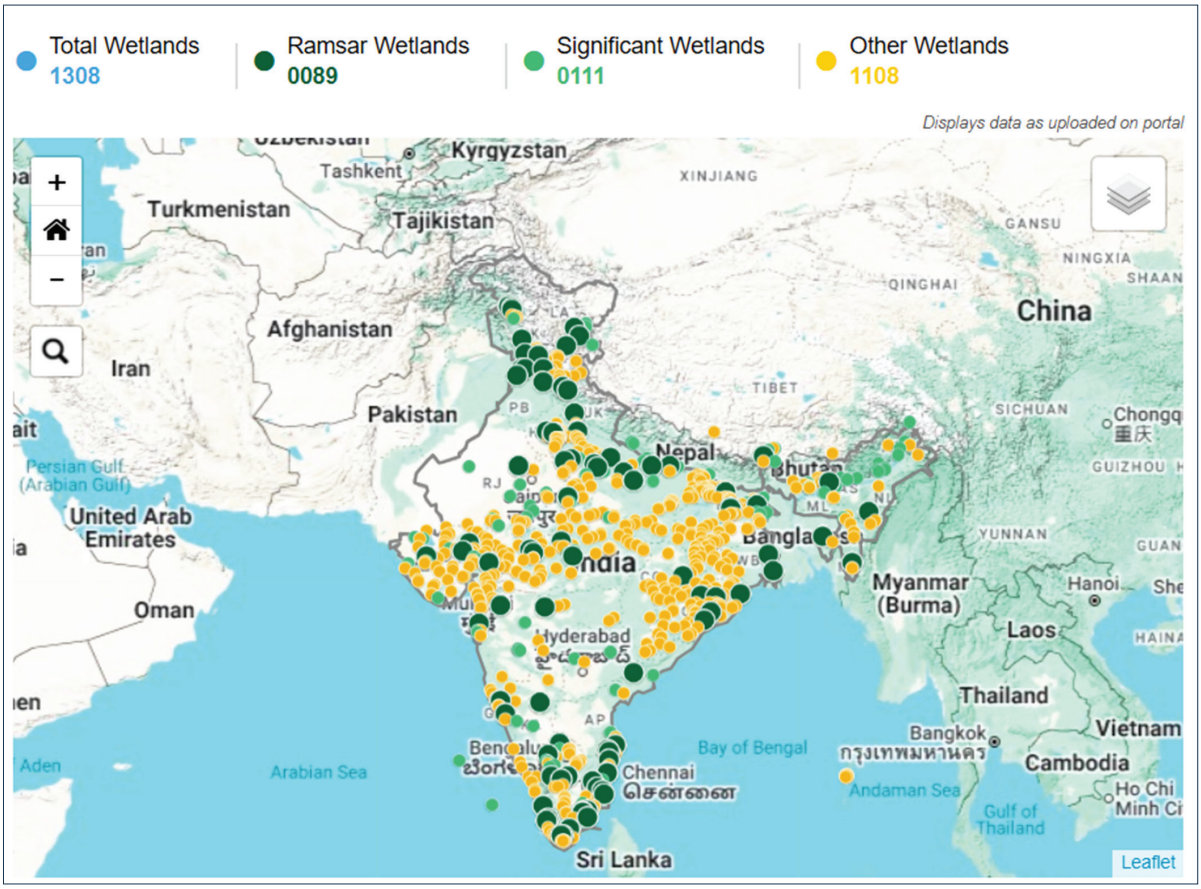
3. ECOSYSTEM ASSESSMENTS

3.1 Urban Wetlands of India

India's urban wetlands, encompassing approximately 757,060 hectares according to the National Wetland Atlas (2011), represent vital ecosystems under increasing pressure from urbanization. Urban wetlands serve as crucial biodiversity hotspots within highly developed areas, providing essential ecosystem services including flood control, groundwater recharge, water purification, and carbon sequestration (MoEFCC, 2019). They support a diverse range of flora and fauna, including migratory birds, and play a vital role in urban climate regulation.

Maps showing distribution of wetlands in India:

Fig 1(a)- Distribution of total wetlands across India.

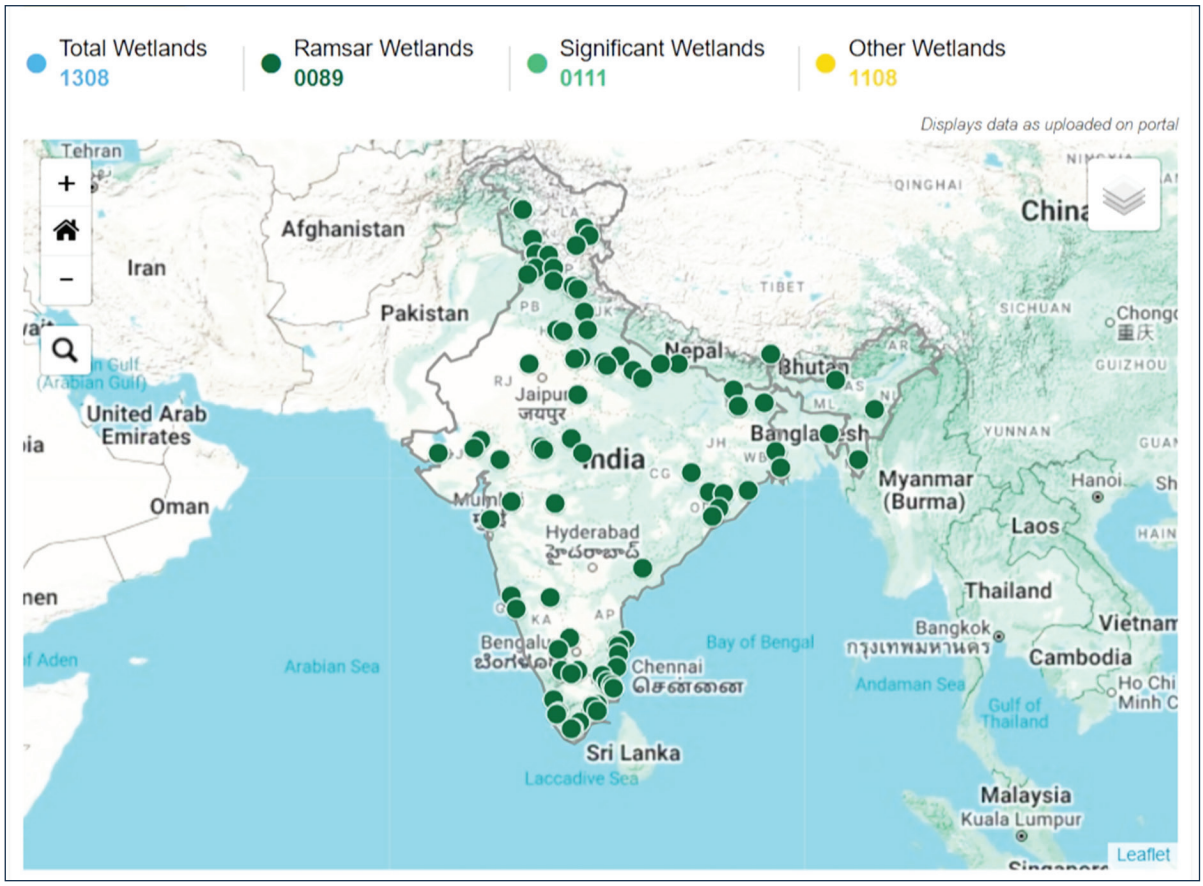


Source: Wetlands of India Portal

Notable examples include the East Kolkata Wetlands—a designated Ramsar site that provides natural sewage treatment while supporting livelihoods through aquaculture (Ghosh, 2005; Ramsar Secretariat, 2023); Deepor Beel in Guwahati, another Ramsar wetland of international importance; and Pallikaranai Marsh in Chennai, which has lost over 90% of its original extent due to urban encroachment and infrastructure development (Jayaram, 2005; Sudhakar et al., 2018). These wetlands deliver significant economic benefits, estimated at ₹ 200,000 per hectare annually through services like flood mitigation, groundwater recharge, and fisheries production, supporting livelihoods for thousands of urban poor (Bassi et al., 2022).

Despite their ecological and economic importance, urban wetlands face severe degradation, with nearly 30% lost to encroachment, pollution, and waste dumping in the past two decades. The Bhoj Wetland in Bhopal and Ousteri Lake in Puducherry further exemplify urban wetlands with rich biodiversity, supporting over 160 bird species and numerous endemic flora (Kumar et al., 2023). Research by the Indian Institute of Science estimates that urban wetlands contribute approximately 4.8% to the GDP of metropolitan areas through direct and indirect economic services, including tourism, recreation, and carbon sequestration, valued at about ₹ 15,000 crores annually (Bassi et al., 2022).

Fig 1(b): Distribution of Ramsar sites across India.



Source: Wetlands of India Portal

The National Wetland Conservation Programme identifies 115 urban wetlands requiring immediate conservation interventions, with only 37 currently under comprehensive management plans (MoEFCC, 2024). Recent initiatives like the National Plan for Conservation of Aquatic Ecosystems (NPCA) and the Wetlands (Conservation and Management) Rules, 2017 aim to protect these threatened urban ecosystems, though implementation remains inconsistent across different cities (MoEFCC, 2019). Community-led conservation efforts in cities like Bengaluru and Mumbai have demonstrated successful wetland restoration models, increasing water retention capacity by 40% and reviving local biodiversity (Kumar et al., 2023).

The Ministry of Environment, Forest and Climate Change (MoEFCC) has allocated ₹180 crores for urban wetland conservation for 2022–2027, prioritizing nature-based solutions and integrated watershed management approaches (MoEFCC, 2024). Urban wetlands face multiple threats that continue to degrade these fragile ecosystems. Encroachment and land-use changes, driven by rapid urbanization and agricultural expansion, are leading to significant habitat loss. Industrial and domestic pollution further exacerbate the issue, contaminating water bodies and soil, which disrupts delicate ecological balances.

Additionally, sedimentation and the spread of invasive species threaten native flora and fauna, reducing biodiversity and altering natural habitats. Urban development has also led to altered hydrology, affecting water availability and quality, which is crucial for sustaining wetlands and riverine ecosystems. Finally, the growing impacts of climate change, including erratic weather

patterns, rising temperatures, and extreme events, are intensifying these challenges, making conservation efforts even more urgent (MoEFCC, 2024)

Fig 2: Urban wetland in Mumbai

Source: Hindustan Times

Fig 3: Pallikaranai Marshlands in Chennai, Tamil Nadu

Source: Samyak Kaninde, Nature in Focus

3.1.1. Business Impacts on Urban Wetlands

Urban wetlands in India play a crucial role in maintaining ecological balance, supporting biodiversity, regulating water cycles, and mitigating floods. However, rapid urbanization, unregulated industrial expansion, and poor waste management—often driven by corporate activities—have placed immense pressure on these fragile ecosystems. Businesses, particularly in sectors such as pharmaceuticals, real estate, manufacturing, and fast-moving consumer goods (FMCGs), have significantly contributed to wetland degradation through pollution, land conversion, and unsustainable resource extraction. The following case studies illustrate how specific industrial and commercial actions have adversely impacted urban wetlands across India, underlining the urgent need for corporate accountability and nature-positive strategies.

CASE STUDY -1 **Wetlands in Hyderabad**

The wetlands surrounding Hyderabad have suffered significant environmental damage, particularly due to pollution from pharmaceutical companies operating in the region. These companies have been reported to discharge untreated effluents containing active pharmaceutical ingredients (APIs) and heavy metals into local water bodies. Studies have detected antibiotic concentrations in the Musi River—which flows through Hyderabad—that are up to 1,000 times higher than typical levels found in rivers in developed countries, contributing to the global threat of antimicrobial resistance (Nordea, 2018). A study by the Changing Markets Foundation (2023) also highlighted the presence of toxic heavy metals like chromium and cadmium in the river's sediments, which pose severe risks to both ecosystems and human health. These pollutants have degraded water quality, impacted aquatic biodiversity, and exposed local communities to chronic health conditions.

Fig 4: Pollution level in Musi River

Source: Deccan Chronicle

CASE STUDY -2 Mumbai Coastal Wetlands

Mumbai, India's financial capital, has witnessed a drastic transformation of its coastal wetlands and mangrove ecosystems over the past three decades, driven largely by real estate development, infrastructure expansion, and unregulated land reclamation. A comprehensive analysis of the Mumbai Metropolitan Region revealed that wetland degradation and conversion for urban infrastructure have accelerated since the early 2000s, particularly in ecologically sensitive areas such as Uran, Navi Mumbai, and Mankhurd (Nikam & Kumar, 2019). According to the Bombay Natural History Society, approximately 1,200 hectares of wetlands across 29 sites in Uran alone were lost to reclamation between 2005 and 2016, often in violation of environmental regulations (BNHS, 2018).

The disappearance of these wetlands has significantly weakened the city's natural flood-buffering systems. Wetlands and mangroves play a vital hydrological role by absorbing excess monsoon rainfall, stabilizing coastal soils, and mitigating storm surges. Their destruction has been directly linked to increased urban flooding in Mumbai, which has become more severe and frequent over the years. A study by Wang et al. (2023) noted that land use changes combined with climate variability have exacerbated Mumbai's vulnerability to flooding, particularly as natural drainage systems are replaced with impermeable surfaces.

Beyond hydrological impacts, the ecological and socio-economic consequences have been profound. The degradation of mangrove habitats has led to the decline of bird and fish species that depend on these ecosystems, disrupting local food webs and ecosystem services. At the same time, traditional fishing communities, whose livelihoods are closely tied to the health of coastal ecosystems, have experienced economic displacement and reduced income opportunities (Sibal, 2018). The case of Mumbai illustrates the interconnectedness of biodiversity loss, climate resilience, and social well-being, underscoring the urgent need for integrated urban planning and wetland conservation strategies that align development with ecological sustainability.

CASE STUDY -3 Gujarat's Urban Wetlands

Industrial manufacturing in Gujarat, especially in cities like Ahmedabad and Vadodara, has resulted in severe pollution of urban wetlands and groundwater sources. A 2019 study on the Vatva Industrial Area found that 78% of groundwater samples contained chemical pollutants—such as phenols, cyanides, and heavy metals—that exceeded BIS (Bureau of Indian Standards) safety thresholds (Modi et al., 2019). Furthermore, a 2023 study by Thakker and Tank documented heavy metal contamination in urban water bodies, including dangerous levels of lead, arsenic, and mercury, posing grave risks to public health and aquatic life. These findings highlight the cumulative environmental impact of untreated industrial discharge and the inadequacy of pollution control measures.

CASE STUDY -4 **Plastic Pollution**

Fast-Moving Consumer Goods (FMCG) companies have emerged as major contributors to plastic pollution, especially in urban wetlands. A study reported widespread microplastic contamination in Indian water bodies, including wetlands in Delhi, Kolkata, and Chennai, with microplastic concentrations ranging from 100 to 500 particles per liter in some sites (Mukherjee & Sarma , 2024). The majority of this waste comes from single-use plastic packaging, a common feature in FMCG supply chains. Microplastics not only threaten aquatic life through ingestion and entanglement but also enter the human food chain via contaminated fish and water. Additionally, plastic waste clogs drainage systems and reduces wetland functionality, worsening urban flooding and ecosystem degradation.

3.1.2 Corporate Contribution to Conservation Strategies

As the importance of environmental sustainability becomes increasingly central to global and national agendas, corporations in India are beginning to play a more active role in ecosystem conservation and restoration. Going beyond regulatory compliance and corporate social responsibility (CSR), forward-thinking companies are now investing in nature-based solutions, public-private partnerships, and community-led ecological projects. These efforts not only contribute to biodiversity conservation but also enhance long-term business resilience by restoring vital ecosystem services such as water purification, groundwater recharge, and climate regulation. The following case studies illustrate how Indian corporations have contributed meaningfully to urban wetland ecosystem restoration and biodiversity enhancement.

CASE STUDY -1 **Wipro's Integrated Watershed Management – Bengaluru Lakes**

Wipro, through its Wipro Foundation, has undertaken an integrated watershed management initiative targeting several lakes in Bengaluru, including Kaikondrahalli and Kasavanahalli. The project focuses on the rejuvenation of degraded water bodies using a combination of bioremediation, floating treatment wetlands, silt removal, and the eradication of invasive plant species (Wipro Foundation, 2024). In partnership with local civic groups and the Bruhat Bengaluru Mahanagara Palike (BBMP), Wipro has also facilitated the creation of biodiversity zones, planting over 5,000 native trees and shrubs and installing bird perches and butterfly gardens. These interventions have led to a 25–30% increase in groundwater levels in adjacent areas and a noticeable return of bird species such as purple herons, kingfishers, and spot-billed ducks. Additionally, the initiative has enhanced community stewardship, with regular citizen clean-up drives and educational programs involving local schools.

CASE STUDY -2 Restoration of Man Sagar Lake and Jal Mahal Palace in Jaipur

The restoration of Man Sagar Lake and the adjacent Jal Mahal Palace in Jaipur stands out as a model public-private partnership (PPP) for urban ecological restoration. In 2004, the Rajasthan Tourism Development Corporation (RTDC) signed a 99-year lease agreement with Jal Mahal Resorts Pvt. Ltd. to rehabilitate the lake and conserve the palace, with both ecological and tourism goals in mind (World Bank PPP, 2020). The restoration plan included removal of approximately 500,000 cubic meters of silt, installation of two sewage treatment plants (STPs) with a combined capacity of 15 MLD, and bioremediation of lake water using aquatic plants and natural filters. As a result, dissolved oxygen levels in the lake improved from <1 mg/L to over 5 mg/L, significantly enhancing water quality and aquatic life. The revitalization of the lake also led to the re-establishment of bird populations, including migratory species such as flamingos and cormorants, and turned the area into an ecotourism hub that benefits both conservation and local employment.

Fig 5: Jal Mahal Palace, wetland in Jaipur Rajasthan

Credit: McKay Savage

3.1.3 Corporate Engagement Opportunities

Urban wetlands are critical ecosystems that provide essential services such as flood mitigation, water purification, groundwater recharge, urban cooling, and biodiversity support. However, they are increasingly under threat due to unregulated urbanization, industrial pollution, and encroachment. As the urgency to restore and protect these ecosystems grows, there is a rising opportunity for corporate actors to play a transformative role in urban wetland conservation. Through financial investment, technical expertise, community outreach, and collaborative governance, businesses can contribute meaningfully to the preservation and resilience of urban wetland systems while aligning with sustainability goals and regulatory frameworks.

1. Wetland Adoption and Restoration

Corporate involvement in urban wetland conservation often begins with the adoption and restoration of degraded wetland ecosystems. This process includes a multi-faceted approach aimed at pollution abatement, habitat enhancement, and fostering community engagement. Pollution abatement efforts may involve the installation of constructed wetlands, bioremediation techniques using aquatic plants, and the deployment of floating treatment wetlands to naturally filter contaminants. Habitat enhancement strategies focus on restoring native vegetation, removing invasive species, and establishing biodiversity corridors to support the movement of wildlife. Additionally, corporations can collaborate with local stakeholders, NGOs, and municipal authorities to engage communities through educational programs, volunteer clean-up drives, and eco-tourism initiatives. By integrating social and environmental aspects, wetland restoration projects create resilient ecosystems that serve both ecological and urban functions.

2. Green Infrastructure Development

The implementation of nature-based solutions for stormwater management plays a crucial role in mitigating urban flooding, reducing pollution, and enhancing groundwater recharge. Corporate-supported green infrastructure development includes the construction of rain gardens—planted depressions that absorb and filter stormwater runoff—bioswales, which are vegetated channels designed to direct and treat rainwater, and permeable pavements that allow water to infiltrate the ground rather than contribute to surface runoff. These interventions not only improve the hydrological balance of wetlands but also contribute to urban cooling, increase green cover, and reduce the burden on conventional stormwater drainage systems. By integrating green infrastructure into city planning, businesses can contribute to climate resilience while ensuring long-term water sustainability.

3. Citizen Science Programs

Corporate-sponsored citizen science initiatives play a key role in enhancing wetland conservation by involving local communities in monitoring and research efforts. These programs equip citizens with tools and training to collect real-time data on wetland health indicators such as water quality, biodiversity, and habitat conditions. Companies can partner with academic institutions, environmental organizations, and technology firms to develop

user-friendly mobile applications that enable data collection and visualization. Periodic wetland health reports, derived from citizen contributions, can help guide policy decisions and inform conservation strategies. Additionally, corporate-backed research grants and fellowships can support scientific investigations into wetland restoration, climate resilience, and pollution control. Encouraging community participation in wetland conservation fosters a sense of ownership and strengthens the sustainability of restoration efforts.

4. Sustainable Water Management

Industries play a significant role in water consumption and pollution, making sustainable water management an essential aspect of corporate environmental responsibility. Water stewardship programs aim to reduce industrial impacts by optimizing water use, implementing wastewater recycling systems, and ensuring compliance with strict effluent treatment standards. Advanced wastewater treatment technologies, such as membrane bioreactors and constructed wetlands, can help industries minimize pollution before discharge. Additionally, corporations can support watershed-based approaches to water conservation, such as recharging aquifers, restoring riparian buffers, and funding local water conservation initiatives. By prioritizing sustainable water management, businesses not only mitigate environmental risks but also contribute to the long-term availability of clean water resources for both urban and ecological needs.

These corporate-led initiatives demonstrate how businesses can actively participate in wetland conservation, integrating environmental responsibility into their operational and community engagement strategies while fostering long-term ecological and social benefits.

3.2 Mangroves of Goa and Tamil Nadu

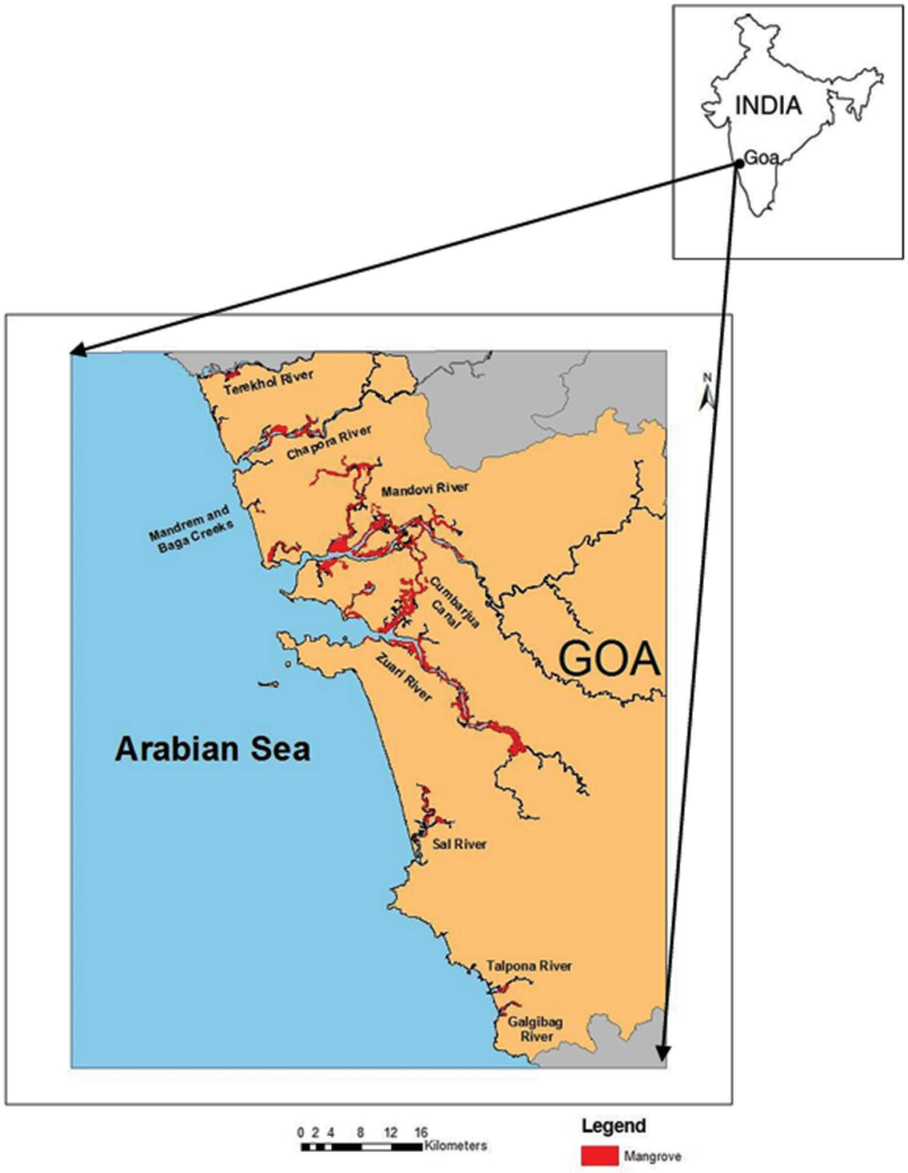
India hosts approximately 497,500 hectares (4,975 sq km) of mangrove forests, representing about 3.3% of the global mangrove coverage, according to the Forest Survey of India's 2023 assessment (Forest Survey of India [FSI], 2023). These ecosystems are primarily distributed along the eastern coast (59.1%), western coast (23.5%), and Andaman & Nicobar Islands (17.4%). The Sundarbans in West Bengal constitutes India's largest mangrove forest 211,400 hectares (2,114 sq km), followed by Gujarat's Gulf of Kachchh and Maharashtra's coastal stretches. With 39 true mangrove species and 81 mangrove associates, India's biodiversity in these ecosystems is remarkably rich, hosting iconic species like the Royal Bengal tiger, saltwater crocodile, and Olive Ridley turtles (MoEFCC, 2022). Being highly productive ecosystems, mangroves serve as natural barriers against coastal erosion, storm surges, and tsunamis. They are critical fish nurseries, carbon sinks, and support unique biodiversity adapted to the dynamic interface between land and sea (Kathiresan & Rajendran, 2023).

Economically, mangroves contribute significantly to coastal livelihoods and national security. They generate approximately ₹10,000 crores annually through fisheries production, with each hectare supporting about 275 kg of fish catch per year (National Centre for Sustainable Coastal Management [NCSCM], 2021). Studies by the NCSCM estimate that Indian mangroves provide ecosystem services worth ₹1.2 lakh crores annually through carbon sequestration (storing 40–

50 tonnes of carbon per hectare), coastal protection, and timber products. Nearly 4.5 million people directly depend on mangrove resources for their livelihoods, particularly in fishing, honey collection, and ecotourism (NCSCM, 2021).

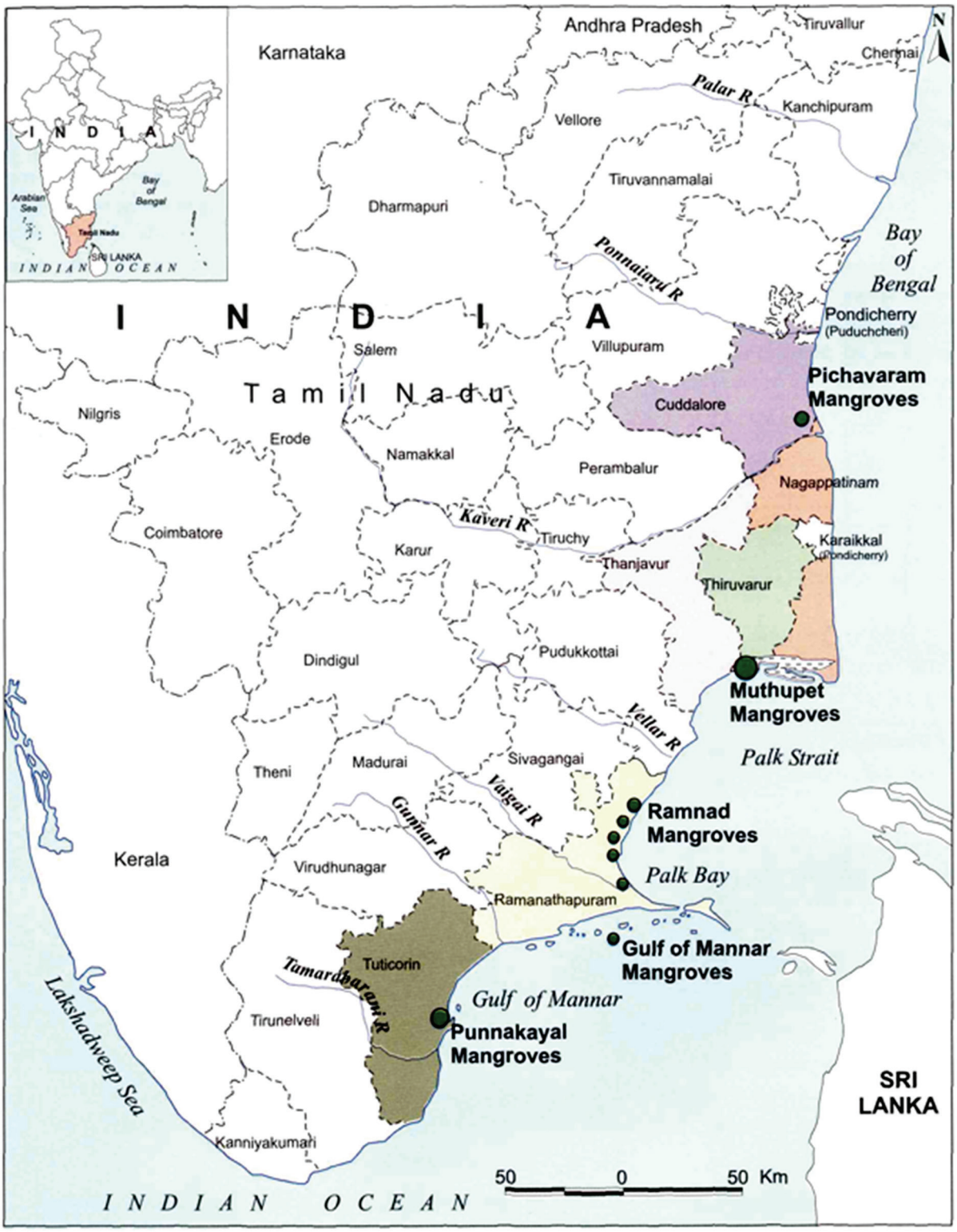
Despite their importance, mangroves in India face significant threats from coastal development, aquaculture expansion, and climate change. However, conservation efforts have yielded positive results, with a net increase of 16,200 hectares (162 sq km) in mangrove cover since 2015 (FSI, 2023). The MoEFCC implements the National Coastal Mission, allocating ₹350 crores (2022–2027) specifically for mangrove restoration and conservation (PIB, 2022). Community-based conservation models in Odisha and Gujarat have proven particularly successful, with local communities restoring over 200 hectares through plantation drives and sustainable harvesting practices (Satyanarayana et al., 2022).

Fig 6(a): Distribution of Mangrove Ecosystem in Goa



Source: Nagi, H. M., Rodrigues, R. S., ManiMurali, R., & Jagtap, T. G. (2014). Using remote sensing and GIS techniques for detecting land cover changes of mangrove habitats in Goa, India.

Fig 6(b): Distribution of Mangrove Ecosystem across Tamil Nadu



Source: Selvam, V. & Lakshmanan, Gnanappazham & Muthu, Navamuniyammal & Ravichandran, K. & M, Karunagaran. (2019). Atlas of Mangrove Wetlands of India Part 1 -Tamil Nadu.

Current research indicates that mangroves provide 10–100 times more protection against storm surges than other coastal vegetation, preventing approximately ₹2,200 crores in property damage annually along India's vulnerable coastlines (Kathiresan & Rajendran, 2023). The Blue Carbon Initiative recognizes Indian mangroves as critical carbon sinks, with potential for carbon credit markets valued at ₹5,000–7,000 per hectare annually, creating new economic incentives for preservation (Blue Carbon Initiative, 2023).

Fig 7: Mangrove ecosystem

Source:NCCR

MISHTI and State-Level Initiatives

MISHTI Scheme (National Level):

The Mangrove Initiative for Shoreline Habitats & Tangible Incomes (MISHTI) was launched by the Government of India in 2023 as part of its broader climate resilience and biodiversity conservation agenda. This five-year initiative aims to restore approximately 54,000 hectares of mangroves across nine coastal states and three Union Territories (Press Information Bureau [PIB], 2023). The program focuses on conserving and rejuvenating mangrove ecosystems to enhance coastal biodiversity, strengthen natural defences against erosion and extreme weather, and support sustainable livelihoods for coastal communities. MISHTI is being implemented through convergent efforts involving Mahatma Gandhi NREGA, Compensatory Afforestation Fund Management and Planning Authority (CAMPA), and other centrally sponsored schemes.

Goa:

The Goa Forest Department initiated mangrove afforestation in 1985–86, and by 1996–97, approximately 876 hectares had been covered through plantation efforts (Forest Department Goa, 2023). In recent years, civil society engagement has been bolstered by awareness campaigns led by organizations such as the OneEarth Foundation, whose project

"Mangrove Odyssey" combines field activities, youth outreach, and media to encourage public participation in mangrove conservation. As of 2023, Goa's total mangrove cover stood at 2,618 hectares (26.18 sq km), showing modest but steady growth (India State of Forest Report [ISFR], 2023).

Tamil Nadu:
Under the Tamil Nadu Coastal Restoration Mission, mangrove restoration has been prioritized as part of climate adaptation and coastal resilience strategies. As of 2023, the state has restored approximately 2,500 hectares (25 sq km) of mangroves, with an additional 1,500 hectares (15 sq km) proposed under a World Bank-supported Integrated Coastal Zone Management (ICZM) project (Tamil Nadu Environment Department, 2023; Optimize IAS, 2023). The state has also established 20 village-level conservation committees to ensure long-term community engagement, afforestation monitoring, and knowledge sharing at the grassroots level.

Mangrove ecosystems in Goa and Tamil Nadu (TN) are under significant threat from various anthropogenic and environmental factors:

Coastal Development and Urbanization
In Goa, the traditional Khazan lands—coastal agro-aquaculture systems regulated through bunds and sluice gates—are deteriorating due to rapid urban expansion and infrastructure development. Urban encroachment, especially in regions surrounding Panaji and Margao, has led to the conversion of Khazan lands for real estate and other developmental purposes, thereby undermining their flood regulation functions and ecological productivity (Fernandes & Naik, 2012; Mascarenhas, 1999; Rao et al., 1985). These systems, once central to coastal resource management, are now increasingly abandoned or poorly maintained.

Similarly, Tamil Nadu's mangrove forests have been extensively cleared for urban infrastructure and tourism development. Such land-use changes have led to habitat fragmentation, loss of biodiversity, and increased vulnerability of coastal regions to erosion and storm surges (Asari et al., 2021; Alongi, 2002). The ecological services provided by mangroves—including shoreline stabilization and carbon sequestration—are diminishing as a result.

Expansion of Aquaculture
The rise of commercial aquaculture, especially shrimp farming, has become a significant driver of mangrove loss in Tamil Nadu. Mangrove areas are often converted into aquaculture ponds, disrupting ecosystem balance and causing habitat loss for numerous species (Asari et al., 2021).

In contrast, Goa's traditional aquaculture systems within the Khazan lands have seen a marked decline due to a mix of socio-economic and institutional changes. Studies show that reduced agricultural interest, urban pressures, and deteriorating water infrastructure have rendered many of these lands marshy and unproductive (Sawaiker, Gauns, & Borkar, 2022). The erosion of traditional ecological knowledge and community-based management has accelerated the

degradation of these ecosystems, compromising their resilience to environmental stressors (Sonak, Giriyan, & Rao, 2014; Sonak, Patil, & Giriyan, 2005).

Industrial Pollution and Oil Spills
Industrial pollution poses a serious threat to mangrove habitats in both states. In Tamil Nadu, the discharge of industrial effluents and incidents of oil spills have degraded water quality, adversely affecting mangrove flora and fauna (FAO, 2023). Goa's mangroves have experienced similar impacts due to inadequate waste management and unchecked industrial runoff, particularly near port areas and estuarine zones (FAO, 2023).

Altered Freshwater Flows
Changes in hydrological regimes due to damming and freshwater diversion for agriculture and urban supply have led to increased salinity in estuarine zones. In Tamil Nadu, this has impaired mangrove regeneration and growth, while in Goa, it has disrupted the saline-freshwater balance critical for the functioning of Khazan ecosystems, thereby reducing soil fertility and agricultural yields (IWA Publishing, 2023).

Climate Change and Sea-Level Rise
Sea-level rise, intensified storms, and saltwater intrusion—hallmarks of climate change—are exerting further pressure on coastal ecosystems in both regions. In Tamil Nadu, rising seas are submerging low-lying mangrove areas and salinizing nearby agricultural lands (IWA Publishing, 2023). Goa's coastal wetlands are similarly vulnerable, with increased risks of storm damage and erosion threatening both mangrove ecosystems and human settlements (IWA Publishing, 2023).

Breakdown of Traditional Management Systems
The Khazan system in Goa has historically supported both agriculture and aquaculture while protecting mangrove ecosystems through careful water management. However, socio-economic transformations, such as rural out-migration and a shift away from traditional occupations, have led to the neglect of this indigenous system. The weakening of collective management institutions has left Khazan lands more susceptible to saline intrusion, encroachments, and ecological decline (Sonak et al., 2014; Sawaiker et al., 2022).

The degradation of mangrove ecosystems in Goa and Tamil Nadu is a multifaceted issue rooted in both human activity and environmental change. Addressing these challenges requires an integrated approach that includes restoring traditional ecological management systems like Goa's Khazans, enforcing pollution control regulations, promoting sustainable land-use practices, and implementing climate adaptation strategies. Preserving these ecosystems is critical not only for biodiversity conservation but also for sustaining coastal livelihoods and enhancing regional climate resilience.

Fig 8: Mangrove ecosystem

Credits: Dr Manikandan B., Senior Scientist CSIR NIO

3.2.1 Business Impacts on Mangrove Ecosystems

India's mangrove ecosystems are among the most productive and valuable natural habitats, providing critical services such as shoreline protection, carbon sequestration, fish nursery support, and storm mitigation. Yet, rapid industrialization, unregulated urban expansion, and unsustainable tourism and aquaculture practices have placed immense pressure on these fragile ecosystems. Business activities, while often drivers of economic growth, can have significant adverse impacts on mangroves—especially when conducted without adequate environmental safeguards. The following case studies illustrate the multifaceted ways in which sectors such as ports, tourism, aquaculture, and petrochemicals have affected mangrove ecosystems across Goa and Tamil Nadu, often with irreversible consequences for biodiversity and local livelihoods.

CASE STUDY -1 **Ennore Port Development in Tamil Nadu**

Major port development projects have led to extensive destruction of mangrove ecosystems, disrupting their critical role in coastal protection and biodiversity conservation. Over 1,800 hectares of mangroves have been cleared to accommodate port facilities and container terminals, stripping away natural buffers that shield coastlines from erosion and storm surges (Reddy & Pattnaik, 2020).

Ennore Port, officially known as Kamarajar Port, is located on the Coromandel Coast of Tamil Nadu, near Chennai. Established in 2001, it has expanded to become a major hub for

handling coal, petroleum, and other cargo. This development has had notable environmental repercussions, particularly concerning mangrove habitats (Srinivasalu et al., 2021)

A study focusing on the Ennore region highlighted that port development activities have led to the destruction of mangrove forests, which are crucial for coastal protection and biodiversity. The expansion of port facilities has resulted in the loss of these vital ecosystems, exacerbating the area's vulnerability to coastal erosion and extreme weather events (Maritime Commons, 2017). The study emphasized the necessity for sustainable port development practices that integrate environmental considerations to mitigate such adverse impacts.

The case of Ennore Port exemplifies the broader conflict between infrastructure development and environmental conservation in India. While port expansions contribute to economic growth, they often lead to significant ecological consequences, particularly for sensitive habitats like mangroves. The loss of mangroves not only diminishes biodiversity but also reduces natural coastal protection, increasing vulnerability to erosion and extreme weather events.

Additionally, dredging activities have significantly disrupted sediment flows, which are essential for mangrove establishment and regeneration. The expansion of port infrastructure has also altered hydrological regimes, negatively impacting the health of surrounding mangrove forests by changing tidal patterns and reducing nutrient availability (Sahu & Kar, 2022). Further compounding the damage, oil and chemical spills from shipping operations have introduced pollutants into these fragile ecosystems, degrading water quality and harming marine life.

CASE STUDY -2 Tourism Industry - Goa's Mangrove Ecosystems

Unregulated tourism development in Goa has severely impacted mangrove ecosystems, threatening their biodiversity and ecological functions. The construction of resorts and accommodations in mangrove buffer zones has led to habitat fragmentation, reducing the connectivity of these vital coastal forests (Kamat, 2019). Additionally, boat tours catering to tourists have caused significant physical damage to mangrove pneumatophores and seedlings, hampering natural regeneration.

The tourism sector has also contributed to water pollution through the discharge of untreated sewage from hotels and resorts, further degrading water quality and affecting aquatic life (Noronha, 2020). Moreover, increased light and noise pollution from tourism activities have altered the behavior of mangrove-associated fauna, disrupting feeding and breeding patterns. As a result, the fragmentation of continuous mangrove stands has led to a 38% decline in avifauna diversity (Kamat, 2019). Furthermore, the progressive degradation of ecosystem services, such as water filtration and storm protection, poses long-term environmental and economic risks for coastal communities.

CASE STUDY -3 Aquaculture Industry - Tamil Nadu Mangroves

The expansion of commercial aquaculture in Tamil Nadu has been a major driver of mangrove deforestation, leading to severe ecological and socio-economic consequences. Over 5,200 hectares of mangroves have been converted into shrimp farms, stripping coastal regions of their natural defence against erosion and storm surges (Sahu & Kar, 2022). This large-scale conversion has also resulted in the salinization of adjacent agricultural lands and freshwater sources, rendering them unsuitable for farming and drinking water use.

Additionally, aquaculture operations have introduced harmful contaminants into the ecosystem, including antibiotics and growth hormones used to enhance shrimp production. These chemicals have seeped into surrounding mangrove forests, disrupting microbial communities and affecting aquatic biodiversity. Another major issue has been the blocking of tidal channels, which are critical for maintaining mangrove health by facilitating nutrient exchange and sediment deposition. The degradation of mangrove ecosystems has increased coastal vulnerability during storm events, contributed to the loss of traditional fishing grounds, and led to the contamination of surrounding ecosystems with aquaculture pollutants, further threatening biodiversity and local livelihoods (Reddy & Pattnaik, 2020).

CASE STUDY -4 Petrochemical Industry - Mangrove Contamination

Petrochemical operations along mangrove coasts have caused long-term environmental damage, with widespread contamination affecting both flora and fauna. Chronic oil pollution from minor spills and operational leaks has led to persistent degradation of mangrove habitats, coating roots and sediments with toxic residues. Additionally, heavy metals from industrial effluents have accumulated in mangrove sediments, with concentrations exceeding safety standards by 300-500%, posing severe risks to marine life and water quality (Sahu & Kar, 2022).

The bioaccumulation of these toxins in mangrove-associated fauna has had cascading effects on local fisheries, impacting the safety of seafood consumed by coastal communities. Furthermore, air pollution from petrochemical facilities has resulted in visible leaf damage across mangrove canopies, reducing their ability to photosynthesize and grow effectively. These combined factors have contributed to reproductive failures in mangrove species, contamination of fishery products, and an overall decline in ecosystem resilience, making mangroves more vulnerable to climate stressors such as rising sea levels and extreme weather events (Sahu & Kar, 2022).

3.2.2 Corporate contribution to conservation strategies

Mangrove ecosystems serve as critical buffers against coastal erosion, storm surges, and biodiversity loss, while also playing a vital role in carbon sequestration. Recognizing their ecological and economic significance, several Indian corporations have taken proactive steps to restore and protect mangrove forests through collaborative, science-based interventions. These initiatives often go beyond afforestation to include community engagement, sustainable livelihoods, and blue carbon monitoring—reflecting an integrated approach to ecosystem restoration. The following case studies illustrate how corporate-led efforts are contributing meaningfully to mangrove conservation and coastal resilience in India.

CASE STUDY -1 **Tata Chemicals - Integrated Mangrove Conservation and Community Development**

Tata Chemicals has implemented a holistic mangrove conservation program in Tamil Nadu, combining ecological restoration with community engagement. A key component of the initiative was the restoration of 1,200 hectares of degraded mangroves through canal excavation techniques, which improved water flow and enhanced seedling establishment. To ensure long-term sustainability, community-managed mangrove nurseries were established, producing 1.5 million saplings annually for afforestation efforts.

The program also introduced mangrove-friendly aquaculture practices, benefiting 350 fishing families by integrating sustainable livelihoods with conservation efforts. Additionally, blue carbon monitoring and verification systems were implemented to explore potential carbon credit opportunities, further incentivizing mangrove restoration. The project achieved an 82% survival rate for planted mangroves, enhanced coastal protection during cyclonic events, increased fish catch by 35% for participating communities, and created a scalable model for integrating conservation with the blue economy (Tata Chemicals, 2023).

CASE STUDY -2 **Reliance Foundation's Mangrove Restoration – Odisha**

Coastal communities across three districts in Odisha are enhancing their mangrove cover with Reliance Foundation's support to better resist cyclones, storm surges and shoreline erosion that have been altering the landscape, affecting ecological balance and impacting livelihoods. Over the past year, about 55,000 mangrove plants were planted with Reliance Foundation's support in vulnerable areas in Balasore, Jagatsinghpur and Ganjam districts.

Ahead of International Day for the Conservation of the Mangrove Ecosystem on July 26, mangrove plantation in these cyclone vulnerable areas of Odisha are being stepped up and awareness enhancement efforts, especially for youth and school-children, are being organised by Reliance Foundation and its partner organisations.

In Kharasahapur village, Balasore, more than 50 residents have been involved since June 2023 in planting mangroves across a 1 km stretch of the coastline. After the 1999 Super Cyclone,

Fig 9: Mangrove Nursery

Source: Reliance Foundation, 2003

Phailin has been one of the most devastating cyclones for the village, as recounted by members of the community. Reliance Foundation has facilitated knowledge transfer from scientific experts, sourcing mangrove plant material and guided the community in management of plantation (Reliance Foundation, 2023).

3.2.3 Corporate Engagement Opportunities

With the growing emphasis on Environmental, Social, and Governance (ESG) commitments, the private sector is uniquely positioned to contribute to mangrove conservation through targeted investments and collaborations. Across states like Goa and Tamil Nadu, there are numerous region-specific opportunities where corporations can align their CSR goals with tangible environmental outcomes. These include restoration and afforestation programs, sustainable aquaculture integration, blue carbon financing, and coastal community development initiatives. The following section outlines key avenues for corporate engagement that offer both ecological impact and socio-economic co-benefits.

1. Mangrove Restoration and Afforestation

Goa:

Goa's mangrove ecosystems, particularly along the Mandovi and Zuari rivers, are vital for coastal protection and biodiversity. Corporate partners can collaborate with local organizations like the One Earth Foundation, which has initiated campaigns such as "Mangrove Odyssey" to raise awareness and engage communities in mangrove conservation. Companies can support these efforts through funding, employee volunteer programs, and by facilitating scientific research to enhance restoration techniques.

Tamil Nadu:

Tamil Nadu's Pichavaram and Muthupet mangrove forests are among the largest in India. The state has seen an expansion of mangrove cover from 4,500 hectares in 2021 to 9,039 hectares in 2024, attributed to natural regeneration and afforestation efforts. Corporations

can partner with initiatives like the M.S. Swaminathan Research Foundation's restoration projects in Muthupet, contributing to the planting of mangrove saplings and supporting community-based conservation programs.

2. Sustainable Aquaculture Integration

Goa:

Integrating sustainable aquaculture with mangrove conservation can benefit both the environment and local communities. Companies can invest in eco-friendly aquaculture practices that preserve mangrove habitats, providing technical and financial assistance to local fishery communities to adopt sustainable methods. This approach supports biodiversity while enhancing the livelihoods of coastal residents.

Tamil Nadu:

The concept of Integrated Mangrove Fishery Farming Systems (IMFFS) has been recognized in Tamil Nadu as a sustainable practice that combines aquaculture with mangrove conservation. Corporations can support the development of such systems, providing funding and expertise to establish pilot projects that demonstrate the viability of silvofisheries, thereby promoting environmental sustainability and economic development.

3. Blue Carbon Financing

Goa:

Mangroves in Goa act as significant carbon sinks, offering opportunities for blue carbon financing. Businesses can invest in projects that focus on the conservation and restoration of these ecosystems to offset carbon emissions. Collaborating with local authorities and environmental organizations to develop certified blue carbon credits can enhance corporate sustainability portfolios.

Tamil Nadu:

Tamil Nadu has been proactive in exploring the potential of blue carbon ecosystems, including mangroves, for climate change mitigation. The state's mangroves store approximately 873,000 tonnes of carbon stock. Corporations can engage in blue carbon financing by investing in these ecosystems, supporting research, and participating in carbon credit programs to offset emissions.

4. Coastal Community Development

Goa:

Mangrove conservation in Goa can be integrated with community development initiatives. Companies can fund vocational training programs for sustainable fishing, eco-tourism, and mangrove-based enterprises such as honey production or handicrafts. Collaborations with local NGOs and community groups can ensure that conservation efforts also enhance the socio-economic well-being of coastal residents.

Tamil Nadu:

In Tamil Nadu, involving local communities in mangrove restoration has proven effective. Projects that provide skills and capacity-building for managing fisheries and mangrove

resources have been implemented successfully. Corporations can support such initiatives by funding training programs, establishing public-private partnerships, and aiding in the development of community-led conservation policies, thereby promoting sustainable livelihoods and environmental stewardship.

By engaging in these region-specific initiatives, corporate entities can play a pivotal role in conserving mangrove ecosystems in Goa and Tamil Nadu, while also fulfilling their corporate social responsibility (CSR) and environmental, social, and governance (ESG) objectives.

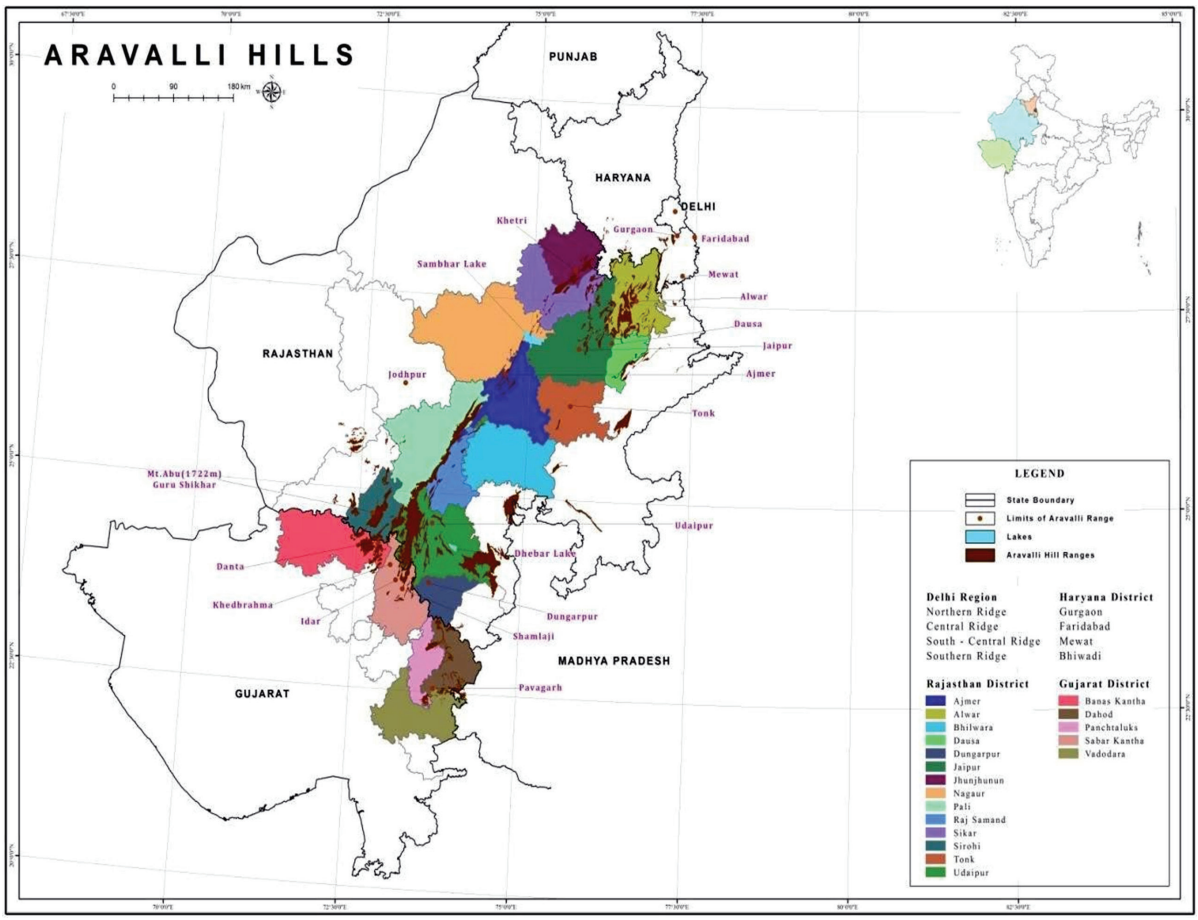
3.3 The Aravallis

The Aravalli Range, one of the world's oldest mountain systems, stretches approximately 800 kilometers across the Indian states of Rajasthan, Haryana, Gujarat, and Delhi. With geological origins dating back nearly 2.5 billion years (Valdiya, 2010), the Aravallis serve as a vital ecological barrier, demarcating the semi-arid and arid regions of northwestern India from the more fertile plains to the east. This ancient range supports a rich and diverse ecosystem, home to numerous endemic plant species and wildlife, including leopards, striped hyenas, and a variety of bird species (MoEFCC, 2023a). In addition to its ecological significance, the Aravallis play a crucial role in groundwater recharge, sustaining the water security of surrounding urban and rural regions (Central Ground Water Board [CGWB], 2021).

Fig 10: Aerial view of Aravalli Mountain range

Source: World Atlas

Fig 11: Map Showing the mountain ranges of India.



Source: Habib, B., Talukdar G., Jain, P. and Bhasin A. (2017): Mapping landuse/landcover patterns in Aravallis Haryana with special reference to key wildlife species. Project Completion Report. Wildlife Institute of India, Dehradun and Haryana Forest Department

Economically, the Aravallis contribute through mining activities, yielding valuable materials such as marble, sandstone, and granite. These resources have supported regional economies but have also led to significant ecological degradation. Local communities have traditionally relied on the forest for resources like medicinal plants and fodder, highlighting the range's socio-economic importance (TERI, 2018). However, the Aravalli ecosystem is under severe threat from environmental challenges such as illegal mining, urban encroachment, and deforestation. These pressures have caused habitat fragmentation, soil erosion, biodiversity loss, and diminished water availability, increasing the region's vulnerability to climate change.

Among these threats, illegal mining remains one of the most pressing. Rich in minerals, the Aravallis have attracted extensive legal and illegal mining operations, especially in Rajasthan and Haryana. Despite Supreme Court bans in 2002 and 2018, illegal mining persists, leading to widespread ecological damage (Supreme Court of India, 2018). Key consequences include the loss of forest cover due to clearing for mining sites, soil erosion and land degradation from the removal of topsoil, and excessive groundwater extraction that exacerbates water scarcity.

Urbanization and infrastructure expansion also pose critical challenges. In regions like Haryana and Delhi, forest lands have been encroached upon for real estate development, highways, and industrial projects (CSE, 2022). This unchecked urban growth has fragmented ecosystems, reduced green cover, and worsened the urban heat island effect. The rapid transformation of the National Capital Region (NCR) has led to the conversion of forest areas into residential and commercial zones, undermining the ecological integrity of the range.

Deforestation has further intensified habitat fragmentation. Once covered in dense dry deciduous forests, the Aravalli Range has witnessed the loss of approximately 31–40% of its forest cover over the last four decades (ISRO, 2021). This has contributed to a decline in biodiversity, with keystone species like leopards, striped hyenas, and caracals facing population pressures. As habitats shrink, human-wildlife conflicts have increased, often resulting in retaliatory killings. Roads, railways, and industrial corridors have isolated wildlife populations, reducing genetic diversity and elevating extinction risks (Wildlife Institute of India [WII], 2020).

Groundwater depletion presents another critical issue. The Aravalli forests significantly contribute to aquifer recharge; however, unsustainable extraction and loss of vegetation have caused alarming declines in groundwater levels (CGWB, 2021). In some parts of Haryana and Rajasthan, groundwater extraction exceeds natural recharge by as much as 185%. As a result, rivers originating in the Aravallis, such as the Sahibi and Indori, have either dried up or become seasonal, disrupting ecosystems and agriculture alike.

The weakening of the Aravallis' natural functions has also accelerated desertification. Acting as a barrier to the spread of the Thar Desert, the range has traditionally protected northern India's fertile plains. However, deforestation and land degradation have compromised this buffer, increasing wind erosion and allowing desert sands to encroach into agricultural areas (MoEFCC, 2023b). Soil quality has deteriorated, reducing crop yields and rural incomes. Deforestation has also led to higher surface runoff and flash flooding, which in turn causes sedimentation in water bodies and worsens land degradation.

Despite legal protections through the Forest Conservation Act (1980) and Biological Diversity Act (2002), enforcement remains weak. Many forested areas within the Aravallis are unclassified and lack proper legal recognition, making them susceptible to illegal encroachment and development (MoEFCC, 2023a; CAG, 2020). Coordination gaps between state governments and political pressures often result in the dilution of conservation measures, further undermining environmental protection efforts.

Recognizing the ecological and socio-economic importance of the Aravallis, the Indian government has initiated several conservation efforts. Among the most ambitious is the Aravalli Green Wall Project, launched in 2023 by the Ministry of Environment, Forest and Climate Change (MoEFCC). This project aims to restore 25,000 hectares of degraded land by 2030 through afforestation with native, drought-resistant tree species (MoEFCC, 2023b). By creating a contiguous green belt, the initiative seeks to enhance biodiversity, stabilize soils, and boost groundwater recharge. Community participation is central to the project, involving local farmers and indigenous populations in afforestation efforts to ensure sustainability.

To coordinate restoration and policy efforts, the government has also established the Aravalli Biodiversity Board, an interstate body overseeing conservation across Rajasthan, Haryana, Gujarat, and Delhi. This board facilitates policy formulation, monitors restoration programs, promotes research, and enforces anti-mining regulations. It also spearheads initiatives to develop wildlife corridors to reconnect fragmented habitats (MoEFCC, 2023a).

Community-based conservation models have also shown promise, particularly in Rajasthan. Village-led afforestation programs have successfully restored over 5,000 hectares of degraded land. These initiatives integrate traditional water harvesting techniques, such as johads and check dams, to improve groundwater recharge and secure local water resources. By blending ecological restoration with sustainable livelihoods, these models have enhanced rural resilience and revitalized endangered plant species (TERI, 2018).

Finally, policy reforms are underway to expand protected areas within the Aravalli Range. Currently, only about 4.8% of the range is under formal protection through wildlife sanctuaries like Sariska, Ranthambore, and Nahargarh. The government is working to designate more forested areas as eco-sensitive zones under the Environment Protection Act, restricting harmful industrial and commercial activity and bolstering biodiversity conservation (MoEFCC, 2023a).

The Aravalli Range is of immense ecological and economic importance. While it faces considerable environmental challenges, ongoing conservation efforts, legal interventions, and community participation are crucial for its preservation and the sustainable development of the region.

3.3.1. Business Impacts on the Aravalli region

The Aravalli Range, despite its critical ecological and hydrological significance, has been subject to extensive exploitation due to a range of business activities. While industries such as mining, real estate, cement manufacturing, and water-intensive manufacturing contribute to economic growth, their operations have triggered severe environmental degradation, resource depletion, and loss of biodiversity. The following case studies illustrate the multifaceted impacts of these sectors on the Aravalli ecosystem.

CASE STUDY -1 **Mining Industry - Habitat Destruction**

Extensive mining operations in the Aravalli region for the extraction of minerals like Marble (high-quality white and green marble, particularly in Rajasthan), Granite (pink, red, and black granite), Sandstone (yellow and red sandstone), Limestone, Quartz and Feldspar, Lead and Zinc, Copper, Iron Ore (Rajasthan and Haryana), Bauxite, Gypsum, Soapstone (Talc) have led to widespread environmental degradation, threatening biodiversity and ecological stability (CSE, 2021; MoEFCC, 2022). Over 25,000 hectares of forest cover have been cleared for mineral extraction, leading to the destruction of critical habitats for endemic wildlife. The lowering of groundwater tables by up to 80 meters in mining zones has severely impacted water availability for both natural ecosystems and local communities (WAPCOS, 2021).

Additionally, air pollution from mining activities has affected vegetation health up to 15 kilometers from extraction sites, coating leaves with dust and reducing photosynthesis (Sharma & Singh, 2019). The combination of deforestation and excavation has also triggered severe soil erosion, leading to increased sedimentation in water bodies, further degrading aquatic habitats. These impacts have resulted in the local extinction of specialized Aravalli fauna, accelerated desertification of surrounding agricultural lands, and the permanent loss of unique geological formations that define the landscape (WWF India, 2022).

CASE STUDY -2 Real Estate Development - Urbanization of Aravalli Foothills

The rapid expansion of real estate development in the Aravalli foothills has led to large-scale environmental degradation and loss of critical ecosystem services (Haryana Forest Department, 2021). Illegal construction on protected Aravalli lands has encroached upon ecologically sensitive areas, while the fragmentation of wildlife corridors has disrupted natural movement patterns of key species, increasing the likelihood of human-wildlife conflict (CSE, 2022).

Groundwater depletion due to excessive extraction for luxury housing projects and golf courses has exacerbated water scarcity in an already water-stressed region (CGWB, 2020). Furthermore, increased light and noise pollution from urban developments has altered the behaviour of nocturnal wildlife, affecting their feeding and breeding cycles. These factors have contributed to a severe groundwater crisis impacting millions of residents in the Delhi NCR region, while the loss of ecosystem services, such as air purification, climate regulation, and biodiversity conservation, is estimated at ₹38 billion annually (IUCN, 2021).

CASE STUDY -3 Cement Industry - Quarrying and Dust Pollution

Cement manufacturing in the Aravallis has resulted in significant ecological and human health challenges. The large-scale quarrying of limestone has led to the destruction of hills and ridges, altering the region's topography and disrupting natural drainage systems (MoEFCC, 2022). Dust generated from quarrying operations has settled on surrounding vegetation, reducing photosynthesis and weakening plant health, leading to a decline in native forest cover (TERI, 2020).

Additionally, heavy metal contamination from industrial activities has polluted soil and water bodies, posing long-term risks to both ecosystems and human populations (CPCB, 2021). The expansion of road networks and industrial facilities has further fragmented habitats, making it difficult for wildlife to migrate and sustain viable populations. The combined effects of quarrying and pollution have resulted in increased respiratory health issues in nearby communities, a sharp decline in native vegetation, and the disruption of traditional pastoral livelihoods that rely on healthy grazing lands (WWF India, 2022).

CASE STUDY -4 **Water-Intensive Industries - Groundwater Depletion**

The excessive extraction of groundwater by manufacturing industries in the Aravallis has created a severe water crisis, endangering both human and ecological systems. Industries have been withdrawing groundwater at rates 300-400% above natural recharge capacity, leading to the depletion of aquifers and declining water tables (CGWB, 2020). Contamination from industrial chemicals has further deteriorated water quality, making it unsafe for drinking and irrigation (CPCB, 2021).

Surface water resources have also been diverted away from natural ecosystems to meet industrial demands, disrupting local hydrological cycles. In some areas, land subsidence has been reported due to over-extraction, affecting geological stability and increasing the risk of structural collapses. The drying of natural springs, which once supported unique biodiversity, has accelerated desertification processes in previously vegetated areas. The competition for water resources has intensified conflicts between industrial users and agricultural or domestic stakeholders, threatening long-term sustainability in the region (TERI, 2020).

3.3.2 Positive Corporate Conservation Strategies

Amid growing concerns about the ecological degradation of the Aravalli range, several corporates have taken proactive steps to reverse environmental damage and promote sustainable development. These initiatives go beyond regulatory compliance, reflecting a deeper commitment to ecological restoration, community welfare, and climate resilience. The following case studies highlight how businesses have contributed meaningfully to the conservation and regeneration of the Aravalli landscape through innovative, collaborative, and scalable strategies.

CASE STUDY -1 **Hero MotoCorp's Water Conservation Initiative**

Hero MotoCorp, a global leader in two-wheeler manufacturing, has implemented comprehensive water conservation initiatives as part of its commitment to environmental sustainability. These efforts encompass both internal operational strategies and community-focused projects, aiming to promote efficient water use and support local ecosystems (Hero MotoCorp, 2024).

Within its manufacturing processes, Hero MotoCorp has adopted a five-pronged approach to water conservation: reduction, recycling, recharge, reuse, and respect. By implementing measures to minimize water consumption across factories, ensuring all wastewater is treated and reused, and harvesting rainwater to replenish groundwater levels, the company has significantly reduced its water footprint. Additionally, it has transitioned to waterless painting processes, leading to an annual savings of approximately 3.8 million kilolitres of water. With an ambitious goal to become 500% water positive by 2025, Hero MotoCorp continues to set benchmarks in sustainable water management (CII, 2023).

Fig 12: MoU Signing between Govt of Haryana and Hero MotoCorp

Source: Hero MotoCorp 2024

Beyond its internal operations, the company actively engages in community-based water conservation projects across Haryana, Rajasthan, and Gujarat. These initiatives include rainwater harvesting, the construction of check dams to enhance groundwater recharge, and the restoration of ponds to improve water storage and quality. Collectively, these efforts have benefited over 800,000 individuals, improving water availability and supporting sustainable livelihoods.

Recognizing its leadership in water conservation, Hero MotoCorp's Gurugram manufacturing facility received the Confederation of Indian Industry (CII) National Award for Excellence in Water Management. This accolade highlights the company's dedication to responsible water stewardship. Through these multifaceted initiatives, Hero MotoCorp exemplifies corporate responsibility in water conservation, balancing operational efficiency with community welfare and environmental sustainability.

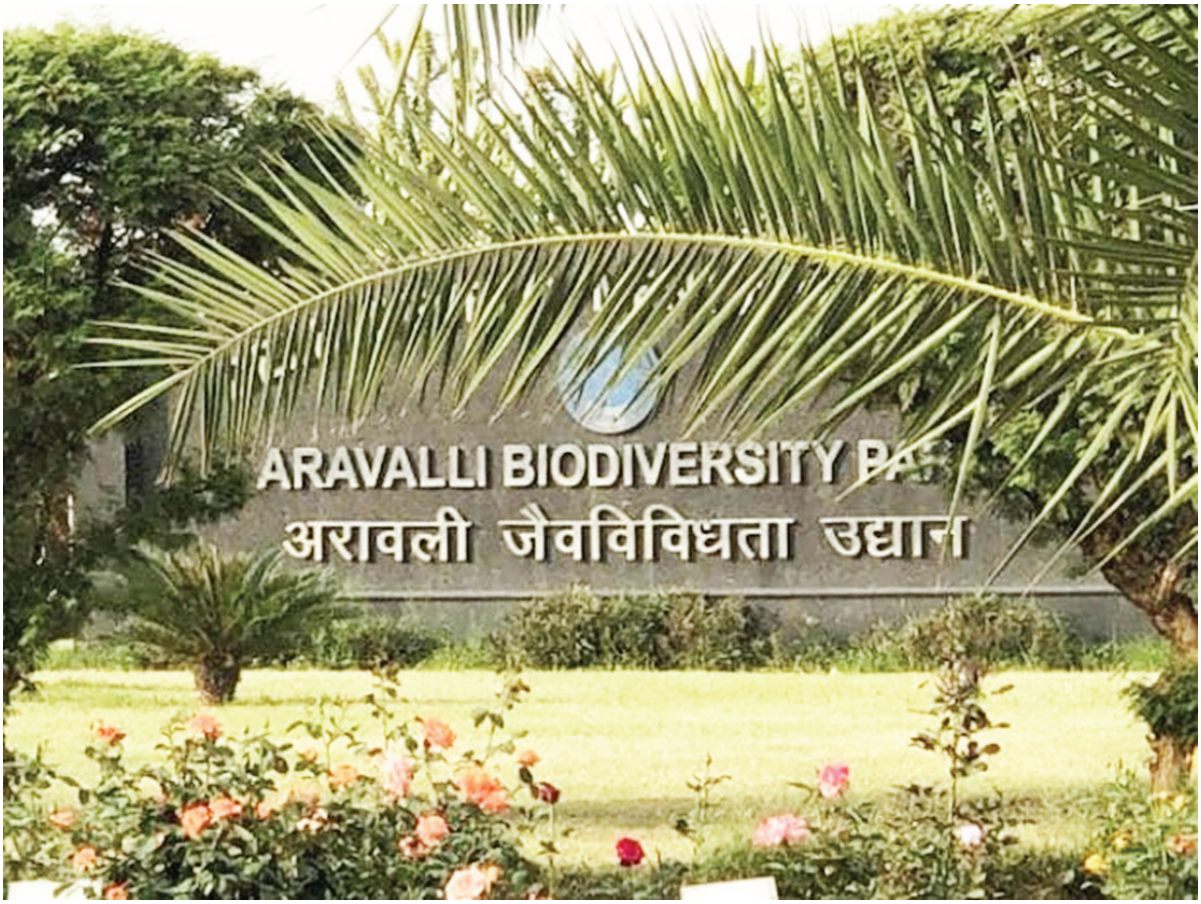
CASE STUDY -2 Aravalli Biodiversity Park

A notable example of corporate involvement in biodiversity conservation in the Aravalli region is the collaboration between IAmGurgaon, the Municipal Corporation of Gurugram, and various corporate entities to establish the Aravalli Biodiversity Park. This initiative successfully transformed 350 acres of degraded land into a thriving biodiversity hotspot, demonstrating the positive impact of public-private partnerships on environmental restoration (IUCN, 2022).

Recognizing the urgent need for restoration, IAmGurgaon, a citizen-driven initiative, spearheaded efforts to rejuvenate a barren expanse owned by the Municipal Corporation of Gurugram. The goal was to create an urban forest that would serve as a green lung for the city and a sanctuary for native flora and fauna.

The project's success hinged on a unique public-private partnership model, where corporate entities provided essential funding and resources to enable large-scale ecological interventions. This collaboration facilitated the removal of invasive species, soil rehabilitation, and the planting of indigenous vegetation, transforming the landscape, promoting ecological balance, and enhancing biodiversity.

Fig 13: Aravalli Biodiversity Park



Credit: Rakesh Kumar

As a result of these efforts, the restoration led to the revival of native plant species and the return of various wildlife species, including birds, insects, and small mammals. The park now serves as a crucial habitat corridor, improving ecological connectivity in the region. Beyond environmental benefits, the park also offers educational and recreational opportunities for the community, fostering a deeper connection with nature.

In recognition of its ecological significance, the Aravalli Biodiversity Park was declared India's first Other Effective Area-based Conservation Measures (OECM) site by the International Union for Conservation of Nature (IUCN) in 2022. This designation acknowledges the park's role in biodiversity conservation outside traditional protected areas. Since April 2021, Hero MotoCorp Ltd. has supported the park's management as part of its corporate social responsibility initiatives, further exemplifying corporate commitment to environmental stewardship (iamgurgaon, 2024).

The development of the Aravalli Biodiversity Park serves as a model of how corporate involvement, in partnership with civic initiatives and governmental bodies, can lead to successful biodiversity conservation and ecological restoration. This case study highlights the potential for businesses to contribute meaningfully to environmental sustainability while balancing urban development with conservation efforts.

CASE STUDY -3 **Bry-Air's Eco-Restoration Project at Aravalli Nagar Van, Gurugram**

Bry-Air, a leader in dehumidification and environmental control solutions, launched an Eco-Restoration Project at Aravalli Nagar Van in collaboration with the NGO 'IAmGurgaon' on September 25, 2024, as part of its 60th-anniversary celebrations. This initiative aims to rehabilitate degraded land and enhance biodiversity by reintroducing native Aravalli species into the ecosystem. A key component involves channeling stormwater from areas like MG Road to Sunset Boulevard into the forest to mitigate urban flooding and reduce erosion. Additionally, the project focuses on restoring water bodies and seasonal ponds to support diverse flora and fauna. Bry-Air collaborates with government bodies and partners such as The Rewilders and Rootscapes to create functional landscapes with minimal intervention (Bry-Air, 2024). This comprehensive approach underscores Bry-Air's commitment to environmental sustainability and biodiversity conservation in the Aravalli region.

3.3.3 Corporate Engagement Opportunities

As businesses increasingly recognize their role in environmental stewardship, corporate engagement in sustainability initiatives has become essential. Industries that depend on natural resources, land, and water must take responsibility for mitigating their ecological footprint. In the context of landscape restoration, biodiversity conservation, and sustainable resource management, companies have several avenues for meaningful intervention. By investing in eco-restoration, water conservation, biodiversity corridors, and sustainable agriculture, corporations can contribute to long-term environmental resilience while ensuring positive socio-economic impacts for surrounding communities.

Eco-Restoration of Mined Areas

Mining operations significantly alter the landscape, leading to soil degradation, deforestation, and habitat destruction. Once mining activities cease, the abandoned sites often remain barren, with depleted topsoil, poor vegetation cover, and disrupted hydrological systems. If left unattended, these degraded areas contribute to further soil erosion, water contamination, and biodiversity loss.

Corporate engagement in mine rehabilitation involves a comprehensive restoration strategy focused on soil stabilization, native species reforestation, and hydrological restoration. Native plant species play a critical role in reviving soil fertility and preventing erosion, while soil amendments and contour bunding techniques improve land stability. Hydrological restoration ensures that water availability in these regions improves over time, fostering the return of aquatic and terrestrial biodiversity.

Many companies in extractive industries, such as cement, coal, and metal mining, have begun implementing mine closure plans that prioritize ecological restoration. By adopting scientific approaches such as seed ball dispersal, assisted natural regeneration, and geotextile-based soil conservation, corporations can transform mined-out land into ecologically viable spaces. Restored mining areas can also serve as biodiversity parks, carbon sequestration sites, or community green spaces, thereby contributing to environmental sustainability and social well-being.

Watershed Management

Water scarcity is a growing global challenge, exacerbated by climate change, deforestation, and unsustainable water extraction. In industrial regions and urban peripheries, groundwater depletion and surface water pollution are common concerns that affect both businesses and local communities. Corporations, particularly those with water-intensive operations, must take an active role in restoring and conserving watershed ecosystems.

Corporate-funded watershed management projects focus on rainwater harvesting, groundwater recharge, and erosion control to improve water security for industrial and agricultural needs. Check dams, percolation ponds, and artificial recharge wells are essential interventions that help retain water, replenish underground aquifers, and sustain local hydrological cycles. Reforestation in catchment areas enhances the ability of soil to absorb and store rainwater, preventing surface runoff and reducing the risk of floods and droughts.

Industries can also support community-led water conservation programs, working with farmers and local stakeholders to introduce sustainable irrigation techniques such as drip irrigation, crop rotation, and water-efficient farming. By integrating watershed conservation into their environmental, social, and governance (ESG) strategies, corporations can mitigate their own water risks while ensuring long-term availability of freshwater resources for local populations.

Biodiversity Corridors

As urbanization and infrastructure development expand, natural habitats are increasingly fragmented, isolating wildlife populations and reducing their genetic diversity. Highways, railways, industrial zones, and urban settlements create physical barriers that disrupt the

free movement of species, leading to increased human-wildlife conflict, habitat degradation, and biodiversity loss. Corporations, particularly those involved in construction, real estate, and infrastructure development, can play a pivotal role in mitigating these impacts by supporting biodiversity corridor projects.

Biodiversity corridors aim to restore ecological connectivity between fragmented forests, grasslands, and wetland ecosystems. This is achieved through afforestation, the removal of invasive plant species, and the creation of underpasses, overpasses, and buffer zones that facilitate safe wildlife movement. Wildlife crossings—such as vegetated bridges and culverts along roads—help reduce the risk of animal-vehicle collisions while ensuring that species can migrate between habitats without disruption.

Corporations can also engage in long-term habitat monitoring and conservation programs, funding research initiatives and collaborating with conservation organizations to protect endangered species. By aligning biodiversity conservation efforts with global frameworks like the Convention on Biological Diversity (CBD) and the Sustainable Development Goals (SDGs), companies demonstrate a commitment to sustainable growth while preserving ecological integrity.

Sustainable Agriculture Promotion

Agricultural expansion is a major driver of deforestation, land degradation, and water depletion, particularly in regions surrounding industrial operations. Unsustainable farming practices, such as excessive pesticide use, monoculture farming, and overgrazing, lead to soil erosion, biodiversity loss, and declining crop productivity. Companies, especially those in the agribusiness, food processing, and forestry sectors, can contribute to sustainable agriculture initiatives that balance productivity with environmental responsibility.

One effective approach is the promotion of agroforestry systems, which integrate trees with crops and livestock to create resilient agricultural landscapes. Agroforestry enhances soil fertility, improves water retention, and provides additional income streams for farmers through timber, fruit, and medicinal plant cultivation. Companies can support these efforts by investing in farmer training, providing access to sustainable inputs, and developing markets for eco-friendly agricultural products.

Another key area is the revival of traditional and regenerative farming practices, such as organic farming, crop diversification, and conservation agriculture. These methods reduce dependency on chemical fertilizers and pesticides, improve soil health, and enhance biodiversity within farmlands. Additionally, corporations can collaborate with local communities to establish climate-smart agricultural practices, ensuring that farming remains viable despite changing environmental conditions.
By integrating sustainable agriculture initiatives into corporate responsibility programs, businesses not only improve environmental resilience but also contribute to food security, rural livelihoods, and carbon sequestration. Supporting sustainable farming in buffer zones around industrial sites further helps mitigate land-use conflicts and promotes a harmonious balance between development and conservation.

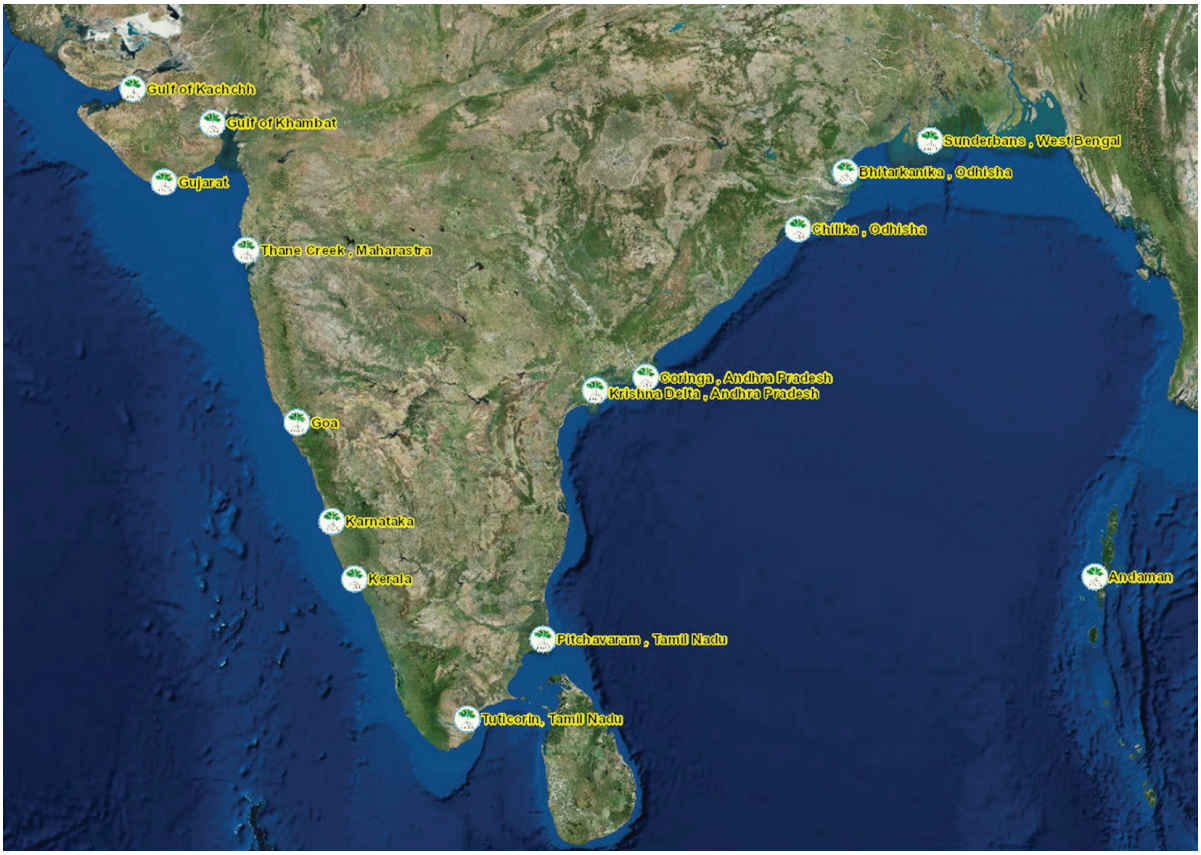
Corporate engagement in environmental conservation presents a win-win opportunity for businesses, communities, and ecosystems. Companies that invest in mine rehabilitation, watershed management, biodiversity conservation, and sustainable agriculture not only fulfill their corporate social responsibility (CSR) obligations but also enhance their long-term sustainability and reputation.

By embedding scientific methodologies, community participation, and long-term ecological monitoring into their initiatives, corporations can drive meaningful change in degraded landscapes and fragile ecosystems. As the global focus on environmental accountability continues to grow, businesses that proactively contribute to sustainability will be at the forefront of responsible and ethical industrial development.

3.4 Marine Ecosystems of India

India's extensive coastline of approximately 7,517 kilometers encompasses a diverse array of marine ecosystems, including coral reefs, mangroves, seagrass meadows, Salt Marshes, estuaries, and open ocean habitats (Press Information Bureau [PIB], 2023a). These ecosystems are home to a rich biodiversity, supporting over 3,000 fish species, 26 marine mammals, five sea turtle species, and numerous invertebrates. They provide vital ecosystem services such as fisheries, coastal protection, carbon sequestration, and tourism opportunities.

Fig 14(a): Distribution of Mangrove Ecosystem in India.

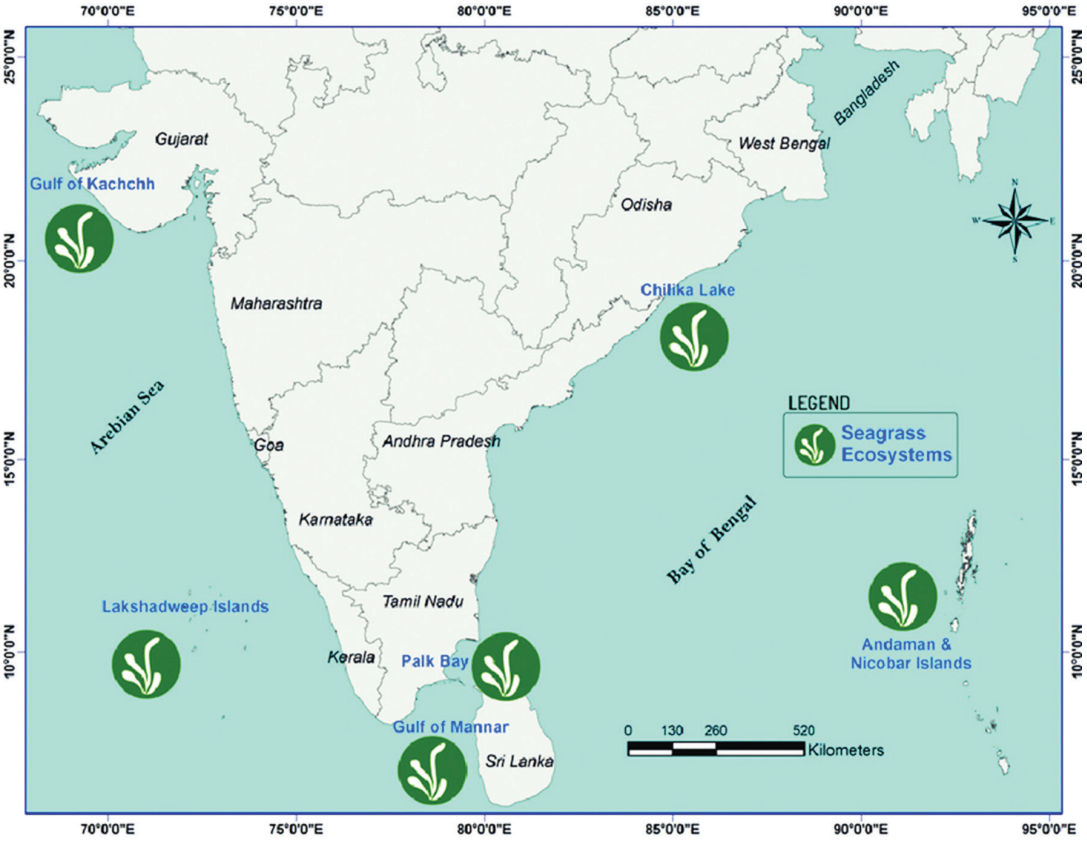


Source: NCSCM

Fig (14b): Distribution of Coral Reef Ecosystem in India

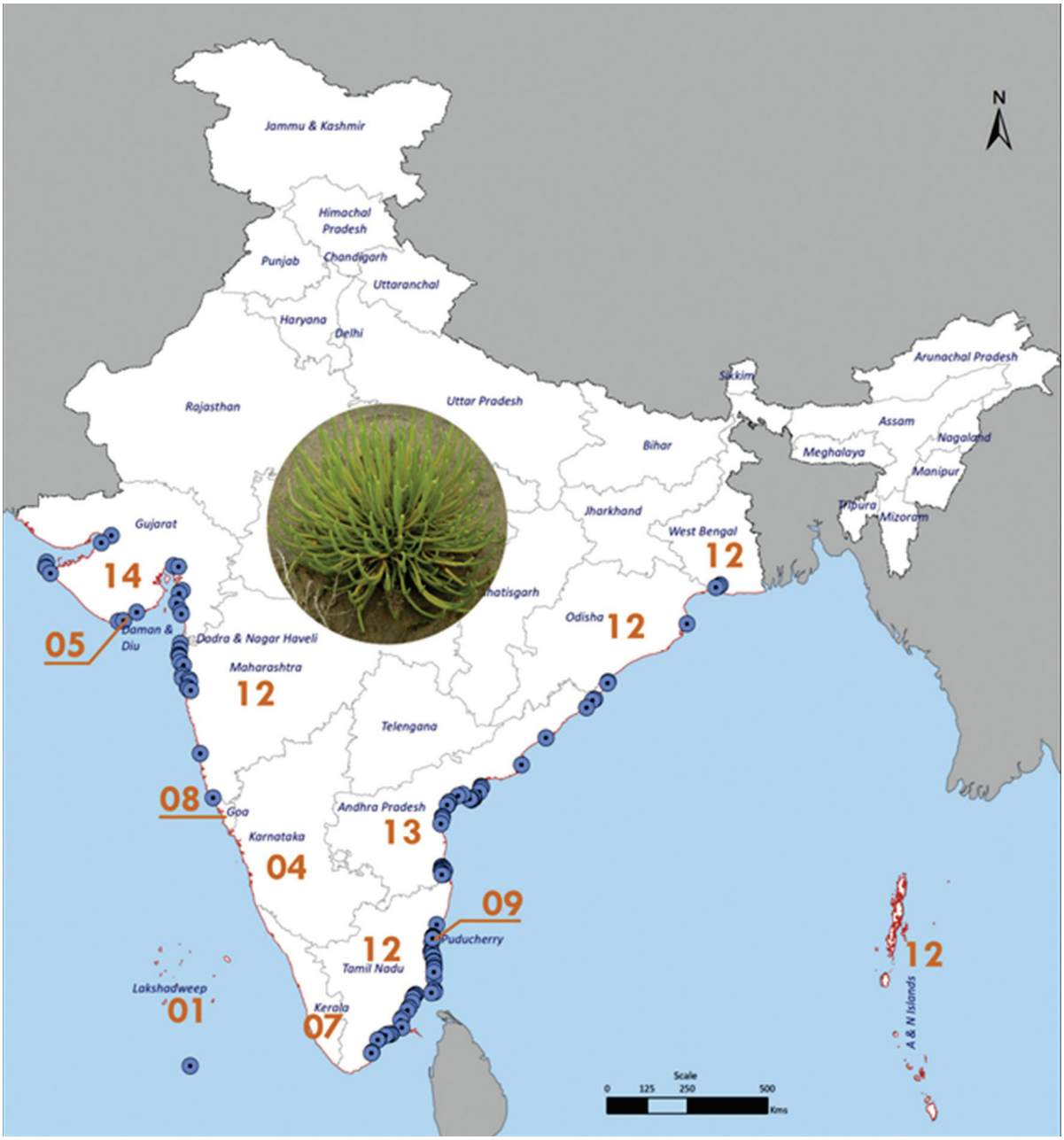
Source: NCSCM

Fig 14(c): Distribution of Seagrass Ecosystem in India



Source: NCSCM

Fig 14(d): Distribution of Salt Marsh ecosystem in India.



India's marine ecosystems play a vital role in sustaining both biodiversity and economic livelihoods. Coral reefs, covering an estimated 2,375 square kilometers, are primarily located in the Gulf of Mannar, Gulf of Kachchh, Andaman and Nicobar Islands, and Lakshadweep Islands. These vibrant underwater structures support remarkable biodiversity, including more than 200 coral species and a wide range of reef-associated fish. Mangrove forests, which span approximately 4,991.68 square kilometers or 0.15% of India's total geographical area, have shown encouraging signs of recovery. Between 2001 and 2023, mangrove cover expanded by 509.68 square kilometers—an 11.4% increase—thanks to targeted conservation efforts (PIB, 2023b). Similarly, seagrass meadows, covering around 516.59 square kilometers along

the coastline, provide essential habitats for marine life, including endangered species such as dugongs and sea turtles (PIB, 2022).

Marine fisheries form the backbone of India's blue economy. Fish production has witnessed a substantial rise from 95.79 lakh tonnes (9.579 million tonnes) in 2013–14 to 184.02 lakh tonnes (18.402 million tonnes) in 2023–24 (PIB, 2024). This growth underscores the sector's critical role in supporting coastal livelihoods and enhancing food security. Beyond fisheries, marine tourism has emerged as a significant contributor to economic development. Government initiatives such as the Swadesh Darshan Scheme are promoting the creation of sustainable and responsible coastal tourism destinations, showcasing the sector's long-term potential (Ministry of Tourism, 2023).

Despite their ecological and economic importance, India's marine ecosystems are increasingly threatened by human activities and climate change. Over the past two decades, coral reefs have declined by 40%, while seagrass meadows have diminished by 35% (Tandon et al., 2020; TERI, 2022). Nearly 50% of coastal waters exhibit signs of eutrophication due to excessive nutrient inputs, leading to degraded water quality and oxygen-depleted zones (Dinesh Kumar et al., 2022). Marine protected areas currently encompass only 3.6% of India's territorial waters—far below the global conservation target of 10% (Down To Earth, 2023).

Overfishing and unsustainable fishing practices have resulted in the depletion of fish stocks and the disruption of marine food webs. Illegal, unreported, and unregulated (IUU) fishing has further compounded this issue, undermining both ecosystem stability and the livelihoods of coastal communities. The Indian Ocean region, in particular, is under severe pressure from overfishing, leading to declining biodiversity and economic uncertainty for dependent populations (Vivekananda International Foundation [VIF], 2023).

Climate change is another major driver of marine ecosystem degradation. Rising sea surface temperatures and increasing ocean acidification have led to more frequent coral bleaching events and altered species distribution. The North Indian Ocean has experienced a sea-level rise of approximately 1 to 2 millimeters per year, which contributes to coastal erosion and the loss of crucial habitats (Unnikrishnan & Shankar, 2007).

Marine pollution from land-based sources, especially plastic waste and industrial effluents, poses a growing threat to ocean health. The accumulation of plastics in particular endangers marine species through ingestion and entanglement, significantly affecting biodiversity (Bhattacharya et al., 2022). In addition, rapid coastal development has led to widespread habitat destruction, further weakening the resilience of marine ecosystems. These impacts are exacerbated by climate change-related stressors such as ocean warming and acidification, intensifying the challenges to sustainability (IUCN, 2023).

Fig 15: Seagrass bed with a hard coral

Source: Ocean's Foundation, PADI

Conservation Measures

In response to these threats, India has implemented several conservation strategies:

1. **Marine Protected Areas (MPAs):** India has established several MPAs that include coral reef ecosystems. These areas are designated for the conservation of marine biodiversity, with regulated activities to minimize human impact. For example, the Gulf of Mannar Marine National Park and the Mahatma Gandhi Marine National Park in the Andaman and Nicobar Islands are MPAs with coral reef protection mandates (KSG India, 2023).

2. **Artificial Reefs:** The state of Odisha has initiated the deployment of 93 artificial reef units along its 480-kilometer coastline. These structures are designed to mimic natural reefs, providing habitats for marine organisms and aiding in the restoration of degraded ecosystems. This initiative aims to enhance fish stocks and promote sustainable fisheries (Mongabay-India, 2023).

3. **Coral Translocation Projects:** India's largest coral translocation project, led by the Zoological Survey of India, involved relocating 16,522 corals from intertidal and subtidal zones to suitable sites around Narara, Gujarat. Additionally, 2,000 coral cement frames (artificial reefs) have been strategically placed to ensure the long-term preservation of marine biodiversity (PIB, 2021).

4. **Legislation and Policy Measures:** The conservation of Indian coral reefs is enforced under the Wild Life (Protection) Act (WLPA) 1972, the Marine Fishing Regulation Act (MFRA) 1983, 2000, and the Coastal Regulation Zone (CRZ) Notification, 2011. These legal frameworks aim to regulate activities that impact marine ecosystems and promote sustainable use of marine resources (DRS NIO, 2023).

Fig 16: Coral Reef ecosystem of Lakshadweep

Photo Credits: Dr Manikandan B., Senior Scientist CSIR NIO

3.4.1. Business Impacts on the Marine Ecosystems

India's vast and diverse marine ecosystems are not only ecological treasures but also critical economic assets. However, growing industrialization and commercial activities along the coasts and in offshore waters have increasingly strained these fragile environments. Various sectors—from large-scale fishing operations to coastal industrial development, shipping, and tourism—have contributed to the degradation of marine biodiversity and ecosystem functions. These human-induced pressures often stem from unsustainable practices, inadequate regulation, and the prioritization of short-term economic gains over long-term ecological balance. The following case studies illustrate how specific business activities have adversely impacted India's marine ecosystems, highlighting the urgent need for sustainable management practices and policy interventions.

CASE STUDY -1 **Industrial Fishing - Overharvesting and Bycatch**

Industrial fishing practices have severely impacted marine ecosystems by depleting fish stocks, damaging habitats, and disrupting food webs. A 2008 study by the Central Marine Fisheries Research Institute indicated that 53% of commercially important fish species along India's southwest coast were declining, highlighting the extent of overfishing (Mongabay, 2024). Bottom trawling, a fishing method that drags heavy nets along the seafloor, has led to extensive damage to marine ecosystems. This practice disturbs seabed habitats, uproots coral reefs, and destroys vital spawning and feeding grounds for numerous marine species, disrupting the delicate balance of marine biodiversity and leading to the decline of fish populations and other bottom-dwelling organisms. Additionally, the resuspension of sediments caused by trawling reduces water quality and affects the survival of marine plants and animals that rely on clear waters for growth and reproduction.

Bycatch remains a significant issue, with global estimates indicating that between 85,000 and 250,000 sea turtles are caught annually in fishing operations, along with many other threatened marine species (Wallace et al., 2010). Selective harvesting of specific fish populations has further destabilized marine food chains, affecting predator-prey relationships. Additionally, the unsafe disposal of fishing nets, commonly known as ghost nets, has emerged as a major environmental threat. These abandoned or lost nets continue to trap and kill marine life, including fish, turtles, dolphins, and seabirds, leading to significant biodiversity loss. Ghost nets also contribute to plastic pollution, as they degrade into microplastics that enter the marine food web. The long-term consequences of these unsustainable practices include the collapse of traditional fisheries, loss of marine biodiversity, and a decline in ecosystem functions that support coastal communities.

CASE STUDY -2 Coastal Industrial Development - Marine Pollution

Coastal industrial activities have contributed significantly to marine pollution, affecting biodiversity and human health. The discharge of untreated or partially treated industrial effluents has led to contamination of marine waters, impacting aquatic life. Thermal pollution from cooling water discharges has altered temperature-sensitive marine ecosystems, leading to changes in species distribution and mortality.

Heavy metals and toxic chemicals have accumulated in coastal sediments, posing long-term risks to marine organisms and seafood consumers. Studies have confirmed significant heavy metal contamination in the coastal sediments, with alarming concentrations in regions like the Cochin Backwaters, Thondi Coast, and Cochin Estuary. Research has detected high levels of iron (15,517–90,885 g/g), zinc (58.7–2,233.2 ppm), cadmium (0.2–40.7 ppm), and lead (6.8–99.6 ppm), with sources linked to industrial effluents, municipal wastewater, and harbour activities (Anu et al., 2014). Cadmium, in particular, poses severe ecological risks, and its presence is notably high along Tamil Nadu's Thondi Coast. The contamination is exacerbated during the monsoon season due to runoff, emphasizing the urgent need for stricter pollution controls and sediment remediation strategies.

Additionally, oil spills and chemical leaks from industrial operations have further degraded water quality. The consequences of these pollutants include reproductive failure in marine organisms, bioaccumulation of toxins in the food chain, and the formation of **"dead zones"**—areas with severely depleted oxygen levels, making them uninhabitable for marine life.

CASE STUDY -3 Shipping and Port Operations - Habitat Destruction

Shipping and port activities have caused extensive damage to marine habitats, particularly in ecologically sensitive coastal regions. Over 3,500 hectares of seagrass beds and coral reefs have been physically destroyed due to dredging, anchoring, and port expansion. The introduction of invasive species through ballast water discharge has further disrupted local ecosystems, outcompeting native marine life.

Toxic compounds from antifouling paints used on ships have polluted surrounding waters, impacting the health of marine species. Additionally, noise pollution from vessel traffic has interfered with the communication and navigation of marine mammals, leading to disorientation and habitat displacement. These impacts have resulted in the permanent loss of critical marine habitats, declining populations of sensitive species, and disruption of ecosystem services valued at ₹65 billion annually.

CASE STUDY -4 **Tourism Industry - Reef Degradation**

Unregulated tourism activities have significantly contributed to the degradation of coral reef ecosystems. Snorkeling, diving, and boat traffic have caused physical damage to corals, leading to reef fragmentation and slow recovery. Coastal development has resulted in the destruction of mangroves, which serve as natural buffers against erosion and storm surges, and has encroached upon sea turtle nesting beaches.

Sewage discharge from coastal resorts has led to algal blooms, which outcompete corals for space and light, further deteriorating reef health. Artificial lighting from beachside developments has disrupted the natural behaviours of marine species, particularly hatchling sea turtles, which rely on natural moonlight for navigation. These factors have led to the degradation of 65% of accessible coral reefs, a decline in marine biodiversity in popular tourism destinations, and a weakened ability of ecosystems to withstand climate-related stressors.

3.4.2 Corporate contribution to conservation strategies

As pressures on marine ecosystems continue to mount from industrialization, pollution, and climate change, the role of the private sector in environmental conservation has become increasingly critical. In India, several corporations have begun integrating sustainability into their core operations, not only to mitigate the environmental impacts of their activities but also to contribute meaningfully to ecosystem restoration and protection. These corporate-led initiatives often involve collaboration with government agencies, civil society organizations, and local communities, demonstrating that business interests and environmental stewardship can go hand in hand. The following case studies illustrate how two major companies—Coca-Cola India and Adani Ports and Special Economic Zone Ltd (APSEZ)—have contributed to marine conservation through targeted programs and long-term sustainability strategies.

CASE STUDY -1 **Coca-Cola India's Collaboration with United Way**

Mumbai's coastline, once known for its scenic beauty, has increasingly suffered from marine pollution and plastic waste accumulation. In response to this growing concern, Coca-Cola India partnered with United Way Mumbai to launch the 'Clean Shores Mumbai' initiative in 2018. The program aimed to restore the cleanliness of Mumbai's beaches and reduce marine pollution through a multi-stakeholder approach, involving corporate volunteers, environmental groups, and local communities (United Way Mumbai, 2018).

The initiative focused on three core objectives: enhancing beach cleanliness through sustained waste removal efforts, engaging the local community to foster long-term environmental stewardship, and raising awareness about marine pollution and sustainable waste management. The implementation of the project began with targeted clean-up drives at key locations, including Dadar Chowpatty, Dadar Beach, and Mahim Chowpatty. These efforts saw active participation from volunteers, including corporate employees, students, and environmental organizations such as 'Beach Please,' 'Jay Foundation,' and 'Mahim Beach Clean-up.' To ensure alignment with municipal waste management policies, the Municipal Corporation of Greater Mumbai's G/North ward also collaborated on the initiative.

Several strategic interventions were introduced under the program. Regular clean-up drives were conducted to systematically remove waste from the beaches and surrounding waters, ensuring a long-term reduction in marine pollution. Additionally, aesthetic improvements were made to encourage community participation in maintaining beach cleanliness. Responsible waste management practices, including segregation and recycling of collected waste, were implemented to minimize landfill dependency. To sustain these efforts, the program also established clean beach task forces within local communities, empowering them to take ownership of the initiative and ensure its longevity.

The impact of the 'Clean Shores Mumbai' initiative has been significant. Over a 14-month period, clean-up efforts across locations from Bandra to Worli resulted in the collection of approximately 700 tons of dry waste. More than 4,900 volunteers actively participated in these efforts, removing around 58.3 tons of waste from Mumbai's shores. Additionally, educational campaigns and awareness programs sensitized over 15,000 individuals on marine conservation and sustainable waste management practices. These achievements demonstrate how corporate-led initiatives, when integrated with community engagement and municipal collaboration, can drive meaningful environmental change.

Through the 'Clean Shores Mumbai' initiative, Coca-Cola India and United Way Mumbai have exemplified the effectiveness of corporate involvement in environmental conservation. By

Fig 17: Cleanliness drive on Mumbai Shores

Source: United Way Mumbai, 2018

combining clean-up activities with awareness campaigns and community engagement, the initiative has not only improved the cleanliness of Mumbai's beaches but has also fostered a culture of environmental responsibility. This case study highlights the potential for collaborative approaches to address urban environmental challenges and promote long-term ecological sustainability.

CASE STUDY -2 Adani Ports' Commitment to Marine Ecosystem Conservation

Adani Ports and Special Economic Zone Ltd (APSEZ) is India's largest commercial port operator, handling significant volumes of cargo and maritime activities. Given the environmental impact associated with large-scale port operations, APSEZ has undertaken multiple initiatives to mitigate ecological damage and promote marine biodiversity conservation. These efforts are part of the company's broader commitment to sustainability and environmental stewardship.

Fig 18: Media coverage for the environmental work

Adani Ports secures top position for its climate actions and environmental performance

AGENCIES
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Adani Ports and Special Economic Zone Ltd (APSEZ) has secured the top position for its climate actions and environmental performance in assessments done by four global rating agencies.

According to a press release by Adani, the CDP assigned leadership band "A-" to APSEZ, recognising the company's efforts in implementing the current best practices to tackle climate change risks and opportunities. Around 23,000 companies, worth over half of the global listed market cap, participated in the assessment performed by the CDP on behalf of the investors representing an AUM of over USD136 trillion.

APSEZ received the highest rating of "A" for its emission reduction initiatives, climate governance and risk management processes. Notably, a handful of companies make it to the leadership band every year.

APSEZ has also secured the top position in the environmental dimension of the S&P Global Corporate Sustainability Assessment (CSA) 2023 among the 324 leading players in the Global Transportation and Transportation Infrastructure sector, which includes marine ports, shipping, air, road and rail transport, logistics, mass transit system and other transportation businesses, the release stated.

The environmental pillar provides 56 per cent weight for climate indicators and strategy, with APSEZ improving its score for the third consecutive year to achieve the top position. On the overall ESG assessment, APSEZ with a 96 percentile score stands among the top 15 leading companies in the sector globally and is apparently the only port operator to feature on the list.

The Sustainalytics Low Carbon Transition Rating has also assigned APSEZ the top rank in the ports sector during their January 2024 update.

The indicator measures the alignment of the projected emissions of the company with the global net zero target.

While Sustainalytics found the company's current projected emissions in line for a 1.7oC rise in global temperature, APSEZ has already announced its commitment to reach net zero by 2040, a decade earlier than the requirement for the global GHG emissions to hit net zero to keep to 1.5oC.

On the overall environmental dimension covering biodiversity and land use, emission and pollution control and waste management, Sustainalytics has assigned a low to negligible risk rating to APSEZ on account of a strong risk management framework that the company has implemented, it stated.

APSEZ has also received an 'Advanced' rating in the last Energy Transition Rating from Moody's, reflecting its leadership position.

Furthermore, Moody's evaluated APSEZ on an environmental, social and governance basis in 2022, wherein the Company secured first rank in the Transport and Logistics sector and ninth across all sectors/ industries in the Global Emerging Markets.

In India, APSEZ was ranked 1st on ESG performance across all the sectors. There were 4,885 companies globally that were evaluated by the rating agencies on a range of ESG indicators, policies, processes, and systems. The next assessment by Moody's is likely this year.

Adani Ports and Special Economic Zone Ltd (APSEZ), a part of the globally diversified Adani Group, has evolved from a port company to an Integrated Transport Utility providing an end-to-end solution from its port gate to customer gate.

Source: www.adaniports.com/Newsroom/Media-Coverages

Conservation Initiatives

1

Protection of Olive Ridley Turtles: One of APSEZ's flagship conservation programs is dedicated to the protection of the Olive Ridley Turtle, a vulnerable species listed on the IUCN Red List. The company has committed ₹30 crore towards conservation efforts, particularly on Kanika Island, where it works in collaboration with the Forest Department. The initiative includes habitat restoration through mangrove and Casuarina plantation and the clearing of channels to improve nesting conditions.

2

Large-Scale Afforestation and Coastal Green Cover: To counteract deforestation and habitat loss, APSEZ has planted over one million trees across various project locations. This effort enhances coastal resilience, reduces soil erosion, and provides habitats for local biodiversity.

3

Environmental Monitoring and Compliance: APSEZ conducts rigorous environmental assessments across its port facilities. At the Vizhinjam Port in Kerala, for instance, the company carries out routine monitoring of ambient air quality, noise pollution, and marine water conditions. The environmental monitoring reports confirm that pollution levels are maintained within permissible national standards, ensuring regulatory compliance and ecological safety.

4

Recognition for Environmental Performance: APSEZ's sustainability efforts have been acknowledged by global rating agencies. In 2023, the company secured a leadership band "A-" in the CDP Climate Assessment, highlighting its proactive approach to climate action. Additionally, APSEZ ranked first in the environmental dimension among 324 companies in the transport and transport infrastructure sector in the S&P Global Corporate Sustainability Assessment (CSA). The company also topped the marine ports sector in a low-carbon transition assessment by Sustainalytics and received an 'Advanced' rating from Moody's Energy Transition Rating.

APSEZ's conservation efforts have contributed significantly to maintaining the ecological integrity of coastal zones, particularly through its turtle conservation program and large-scale afforestation. However, while the company has demonstrated strong environmental leadership, there is no publicly available evidence confirming additional initiatives such as the establishment of marine protected areas, coral reef restoration through transplantation, or advanced oil spill prevention mechanisms.

Moving forward, APSEZ's commitment to sustainability could be further strengthened through increased transparency and independent verification of its marine conservation programs. Expanding its documented initiatives to include more tangible marine biodiversity restoration efforts could position the company as a global leader in responsible port operations (Adani Ports, 2023).

3.4.3 Corporate Engagement Opportunities

As marine ecosystems face escalating threats from overexploitation, pollution, and climate change, the private sector is increasingly being recognized as a critical stakeholder in advancing ocean conservation. Corporate engagement in marine protection offers a range of strategic opportunities to align business practices with environmental sustainability goals. Whether through direct investment in conservation projects, integration of ecological safeguards into operational strategies, or support for community-led initiatives, businesses can leverage their financial, technological, and organizational capacities to drive positive ecological outcomes. These opportunities not only help protect marine biodiversity and ecosystems but also foster innovation, build consumer trust, and strengthen regulatory and community relationships. The following subsections outline key areas where corporate involvement can significantly contribute to marine conservation, from species protection and plastic waste reduction to sustainable fisheries, coral reef restoration, and cutting-edge marine technologies.

Marine Species Conservation

Corporate engagement in marine biodiversity conservation presents significant opportunities, particularly in species protection efforts for threatened marine animals such as dugongs, dolphins, and sea turtles. Companies can contribute by funding and implementing habitat restoration projects, such as seagrass meadow regeneration for dugongs or mangrove conservation for coastal species. For instance, businesses in coastal industries can partner with research institutions and conservation organizations to monitor marine mammal populations, mitigate human-wildlife conflicts, and support rescue and rehabilitation programs. Corporate-led eco-tourism initiatives, such as dolphin-watching programs with strict sustainability guidelines, can also promote conservation while generating revenue for local communities. Additionally, industries that impact marine environments, such as fisheries and shipping, can invest in technological innovations like marine mammal detection systems to reduce accidental entanglements and vessel strikes.

Companies can further engage in conservation by integrating biodiversity considerations into their sustainability strategies and adopting responsible supply chain practices. Seafood companies, for example, can support sustainable fishing certifications and eliminate bycatch of endangered species by promoting selective and less destructive fishing gear. Businesses in the oil, gas, and shipping sectors can minimize underwater noise pollution, which disrupts cetacean communication, by implementing quieter vessel technology and adhering to designated marine protected areas. Corporate social responsibility (CSR) initiatives can fund community-led conservation programs, such as the protection of dugong habitats in the Gulf of Mannar or dolphin conservation in the Chilika Lagoon, fostering collaboration between businesses, governments, and local stakeholders. By actively participating in marine conservation, companies not only enhance biodiversity resilience but also strengthen their environmental stewardship and brand reputation.

Marine Plastic Pollution Reduction

The growing crisis of marine plastic pollution has led to increased corporate responsibility in mitigating its impacts on ocean ecosystems. Companies are implementing comprehensive

programs aimed at reducing plastic waste through improved waste management systems, recycling initiatives, and sustainable product design. These initiatives often involve setting up plastic collection and recycling centers in coastal areas, promoting circular economy models, and adopting biodegradable alternatives to single-use plastics. Additionally, corporate collaborations with non-governmental organizations (NGOs) and local communities help drive beach clean-up campaigns, public awareness programs, and policy advocacy to curb plastic waste at its source. By leveraging financial and technological resources, corporations play a crucial role in preventing plastic from entering marine environments and harming aquatic life.

Sustainable Fisheries Management

Unsustainable fishing practices have led to declining fish stocks, habitat destruction, and disruptions in marine food chains. Corporations, particularly those in the seafood, retail, and hospitality sectors, have a vested interest in ensuring the long-term viability of fisheries. Through corporate-supported initiatives, businesses promote responsible fishing techniques that minimize bycatch, reduce overfishing, and protect spawning grounds. Sustainable fisheries programs often include training for local fishers on selective fishing gear, establishing no-catch zones, and supporting certification schemes such as the Marine Stewardship Council (MSC) certification. Additionally, businesses help improve traceability in seafood supply chains by using blockchain and digital tracking technologies to ensure that only sustainably sourced seafood reaches consumers. By integrating sustainability into procurement policies and consumer education, corporations can drive demand for responsible fishing practices while preserving marine biodiversity.

Coral Reef Restoration

Coral reefs are among the most biologically diverse ecosystems on the planet, yet they are increasingly threatened by climate change, pollution, and human activities. Businesses are investing in coral restoration techniques such as coral gardening, where fragments of resilient corals are cultivated in nurseries before being transplanted onto degraded reefs. Additionally, artificial reef structures made from eco-friendly materials are deployed to create new habitats for marine life, promoting coral regeneration. Corporations involved in coastal tourism, diving, and marine industries are actively funding research on coral resilience and rehabilitation strategies to counteract bleaching events and ocean acidification. Through partnerships with marine conservation organizations and scientific institutions, businesses contribute to the long-term survival of coral reefs, ensuring their ecological and economic benefits for future generations.

Marine Conservation Technology

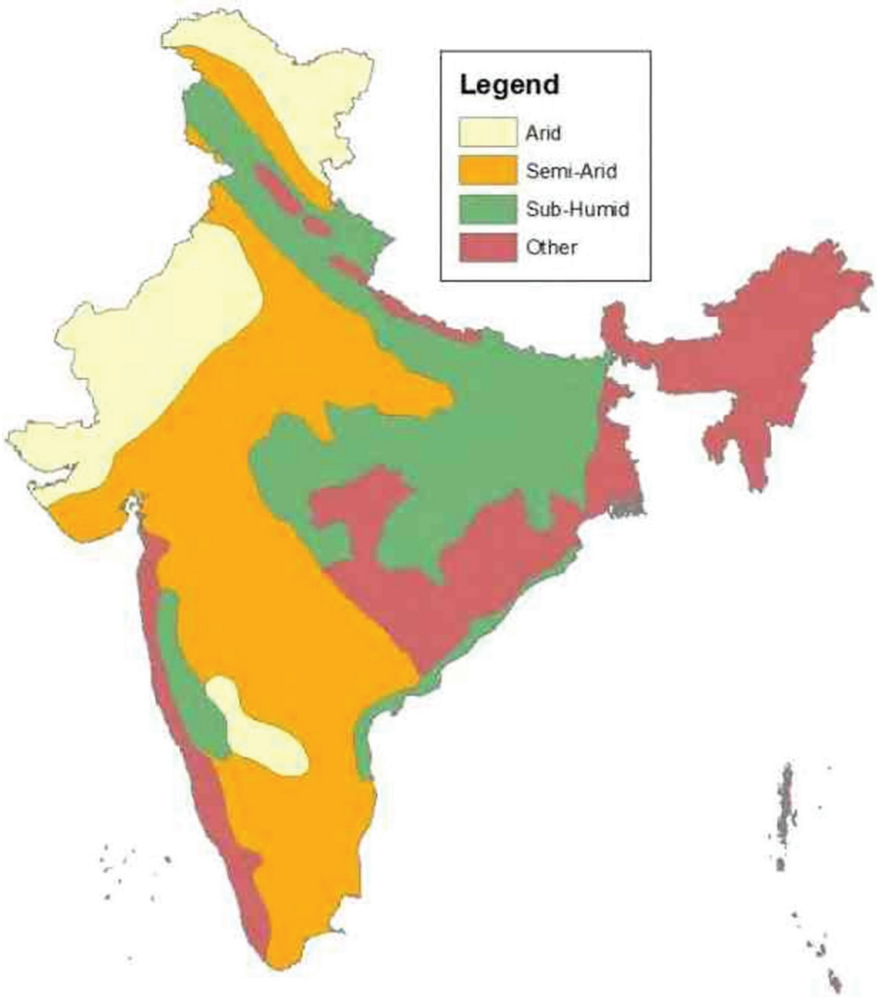
The advancement of technology has opened new possibilities for monitoring and protecting marine ecosystems. Corporations are investing in innovative solutions such as satellite surveillance, drone-based ocean monitoring, and AI-powered data analysis to track illegal fishing, pollution levels, and biodiversity trends. Smart buoys equipped with sensors can provide real-time data on water temperature, acidity, and pollution, helping scientists and policymakers make informed conservation decisions. Companies are also developing biodegradable fishing

nets to prevent ghost fishing and designing sonar-based systems to minimize ship collisions with marine animals. By integrating these technologies into conservation efforts, businesses can significantly enhance the effectiveness of marine protection programs and drive data-driven decision-making for sustainable ocean management.

Through these corporate engagement opportunities, businesses can play a transformative role in addressing marine conservation challenges while aligning their operations with global sustainability goals. By investing in ocean protection, companies not only safeguard marine ecosystems but also create long-term economic value, enhance brand reputation, and contribute to a more sustainable future for all.

3.5 Agricultural Ecosystems in Semi-Arid regions of India

Fig 19: Map showing Semi-Arid area and other regions in India



Source: https://s01.sgp1.digitaloceanspaces.com/inline/896881-kccsuxwcbe-538565716.jpg

India's semi-arid regions span approximately 127.4 million hectares (38.8% of total geographical area), primarily across Haryana, Gujarat, Rajasthan, Maharashtra, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Madhya Pradesh and some parts of Uttar Pradesh. Characterized by annual rainfall between 400-800mm, these regions experience pronounced rainfall variability with 35-45% coefficient of variation and frequent drought cycles occurring every 3-5 years (CRIDA, 2023). Supporting nearly 37% of India's population, these semi-arid zones contribute significantly to national agricultural production, accounting for 60% of cotton, 80% of coarse cereals, 35% of pulses, and 55% of oilseeds production.

The agricultural systems in these regions are predominantly rainfed (nearly 68% of cultivated area), with limited irrigation covering the remaining 32%, primarily through groundwater sources. Traditional farming systems demonstrate remarkable resilience through mixed cropping patterns, with farmers typically cultivating 4-7 crop species simultaneously to mitigate climate risks. Major cropping systems include pearl millet-mustard, sorghum-chickpea, cotton-wheat, and groundnut-fallow rotations, along with traditional agroforestry systems incorporating drought-resistant tree species like Acacia, Prosopis, and Azadirachta indica (Rao et al., 2023).

Economically, semi-arid agriculture directly employs approximately 118 million people while generating agricultural output valued at ₹7.2 lakh crores annually (11.3% of national GDP). However, the average farm income in these regions is about ₹74,000 per annum—42% lower than the national average—reflecting persistent productivity challenges and market vulnerabilities. Livestock systems play a crucial complementary role, contributing nearly 40% of household income through dairy, meat, and wool production. The region supports about 217 million livestock units, primarily indigenous cattle, buffaloes, sheep, and goats adapted to water-scarce conditions (NAARM, 2024).

One of the most pressing concerns is soil degradation and erosion, which affects nearly 40% of India's total agricultural land (ICAR, 2023). Factors such as intensive ploughing, deforestation, and overgrazing have accelerated topsoil loss, reducing soil fertility and increasing vulnerability to desertification. Wind and water erosion remove vital nutrients, making large tracts of land unsuitable for cultivation. In regions like western Rajasthan, desertification is expanding, with estimates suggesting that 68% of the state's land is undergoing some degree of degradation (CSE, 2023).

Groundwater depletion poses another severe threat, particularly in semi-arid states where irrigation is heavily dependent on deep tube wells. Over-extraction has led to a dramatic decline in water tables, with states like Punjab, Haryana, and Gujarat experiencing drops of 1-3 meters annually (Central Ground Water Board, 2023). In Maharashtra's Marathwada region, recurring droughts have further exacerbated water scarcity, leading to farmer distress and migration. The loss of traditional crop varieties and agricultural biodiversity also threatens the resilience of farming systems. High-yield hybrid crops have replaced indigenous varieties of millets, pulses, and drought-resistant grains that were well-adapted to arid conditions. This shift has reduced genetic diversity, making crops more susceptible to pests, diseases, and erratic climatic conditions (National Bureau of Plant Genetic Resources, 2022). For instance, pearl millet (bajra), once a staple in Rajasthan, has seen a decline in cultivation due to a preference for water-intensive wheat and rice, further straining regional water resources.

Fig 20: Semi- Arid agricultural land

Photo Credits: India water portal

The impacts of climate change, including rising temperatures, erratic monsoons, and increased drought frequency, are intensifying these challenges. Semi-arid regions are projected to experience temperature increases of 1.5-2°C by 2050, leading to higher evapotranspiration rates and reduced soil moisture retention (Indian Institute of Tropical Meteorology, 2023). Droughts are becoming more frequent and intense, with extreme weather events like heatwaves and unseasonal rainfall disrupting cropping patterns. The 2022 drought in Bundelkhand, which resulted in a 30% reduction in crop yields, exemplifies the growing instability in these fragile ecosystems. Additionally, unsustainable agricultural practices, such as excessive use of chemical fertilizers, monocropping, and unregulated expansion of groundwater-based irrigation, have further degraded soil and water resources. The overuse of fertilizers, particularly urea, has led to soil acidification and nutrient imbalances, with studies indicating a 20-30% decline in organic carbon levels in intensively farmed lands (ICAR-Indian Institute of Soil Science, 2022).

Addressing these challenges requires a shift towards sustainable agricultural practices, including organic farming, agroforestry, integrated watershed management, and the promotion of traditional, drought-resistant crops. Efforts such as the National Mission for Sustainable Agriculture and state-led water conservation initiatives like Rajasthan's Mukhya Mantri Jal Swavlamban Abhiyan have shown potential in mitigating environmental degradation while ensuring food security. However, large-scale implementation of climate-resilient agricultural strategies will be essential to securing the livelihoods of millions of farmers in India's semi-arid regions.

Climate change poses existential threats to these agricultural systems, with ICAR models projecting 10-40% yield declines for major rainfed crops by 2050 under current practices. Temperature increases of 0.2-0.3°C per decade since 1980 have already shortened growing seasons by 5-12 days across different semi-arid regions. Groundwater depletion presents another critical challenge, with water tables declining at 0.3-1.2 meters annually in intensive cultivation zones, threatening long-term agricultural sustainability (Amarasinghe et al., 2022).

Despite these challenges, remarkable innovations are emerging across India's semi-arid regions. Climate-resilient crop varieties developed by ICAR institutes have demonstrated 18-35% yield advantages under moisture stress conditions. Watershed development programs covering 24.8 million hectares have increased water availability by 30-45% while reducing soil erosion by 60-70% in treated catchments. Digital agriculture initiatives have reached 8.4 million farmers with weather-based advisories, reportedly reducing input costs by 15-20% and increasing yields by 10-25% through precision resource management (Rao & Dixit, 2023).

Community-managed seed systems have revived over 1,200 traditional drought-adapted crop varieties, while farmer producer organizations (currently 3,845 in semi-arid regions) have improved market access and value addition opportunities. The National Mission for Sustainable Agriculture allocates approximately ₹8,400 crores (2022-2027) specifically targeting climate resilience in rainfed agriculture through integrated farming systems, micro-irrigation technologies, and carbon sequestration initiatives. Value chains for minor millets, particularly finger millet, barnyard millet, and foxtail millet (collectively termed "nutri-cereals"), have grown at 14% annually since 2018, creating new economic opportunities while enhancing nutritional security (Raju & Pavithra, 2023).

Research indicates that integrated adoption of climate-smart practices could potentially increase farm incomes by 45-70% while reducing vulnerability to rainfall variability. Agroforestry systems incorporating economically valuable species like Moringa, Tamarindus, and Hardwickia have demonstrated carbon sequestration potential of 2-5 tonnes CO_2 equivalent per hectare annually, creating opportunities for carbon credit markets valued at ₹2,500-4,000 per hectare (Chaturvedi et al., 2023). Policy innovations through guaranteed procurement of millets, crop insurance reforms, and direct benefit transfers are gradually strengthening economic resilience in these vulnerable yet vital agricultural landscapes

Fig 21: Semi- Arid region in Tamil Nadu

Source: India Water Portal

3.5.1. Business Impacts on Agricultural Ecosystems in Semi-Arid regions

Semi-arid regions, characterized by low rainfall, high temperatures, and fragile ecosystems, are particularly vulnerable to ecological degradation driven by industrial expansion and intensive land use. As businesses pursue growth opportunities in renewable energy, agribusiness, textiles, and mining, their activities increasingly intersect with the natural resource base and socio-ecological systems of these landscapes. While economic development in these regions can contribute to local employment and infrastructure, it often comes at a high environmental cost. The conversion of native grasslands, over-extraction of groundwater, pollution of soils and water bodies, and loss of biodiversity are among the pressing challenges emerging from business operations. These impacts not only threaten the ecological integrity of semi-arid zones but also undermine the livelihoods of rural communities who depend on agriculture, pastoralism, and natural resources for their sustenance. The following case studies explore how specific business sectors—renewable energy, industrial agriculture, textiles, and mining—have affected agricultural ecosystems in India's semi-arid regions, revealing a complex interplay between economic activity, environmental sustainability, and social resilience.

CASE STUDY -1 **Renewable Energy Development - Habitat Conversion**

While renewable energy is crucial for reducing carbon emissions, its expansion in semi-arid regions has led to significant ecological disruptions. Over 38,000 hectares of natural semi-arid habitats have been converted into solar farms and wind energy installations, fragmenting once-continuous grassland ecosystems (Ghosh et al., 2022). The placement of wind farms along migratory bird pathways has resulted in increased collision-related mortality, particularly for large species such as the critically endangered Great Indian Bustard (Bhatia et al., 2021). Additionally, the extensive water requirements for cleaning solar panels in water-scarce regions have placed additional strain on already fragile water systems (Kiesecker et al., 2019). The unintended consequences of these developments include declining populations of grassland species, altered water flow patterns affecting seasonal wetlands, and disruptions to traditional pastoral communities that depend on these landscapes for grazing (Joshi & Dhyani, 2020).

CASE STUDY -2 **Agricultural Corporations - Intensive Farming Practices**

Large-scale agribusinesses have transformed traditional agricultural landscapes, leading to environmental degradation in semi-arid regions. The adoption of water-intensive crops in areas ill-suited for such farming has exacerbated groundwater depletion, with deep borewells rapidly exhausting fossil aquifers (Amarasinghe et al., 2022). Additionally, the heavy reliance on chemical pesticides and fertilizers has significantly depleted soil biodiversity, reducing long-term soil fertility and productivity (ICAR-Indian Institute of Soil Science, 2022). Monoculture cropping systems, which prioritize short-term yields over ecological resilience, have replaced diverse traditional farming methods, further undermining the region's ability to withstand

climatic fluctuations (Rao et al., 2023). As a result, 60% of semi-arid districts are now experiencing critical groundwater shortages, agricultural biodiversity has declined, and farming communities face increasing vulnerability to climate shocks such as prolonged droughts (CRIDA, 2023).

CASE STUDY -3 **Textile Industry - Water Pollution and Extraction**

The textile industry, particularly dyeing and processing units, has emerged as a major contributor to water pollution in semi-arid regions. Large volumes of untreated effluents containing toxic dyes, heavy metals, and chemicals are discharged into local rivers and groundwater sources, rendering them unfit for human consumption and agricultural use (CSE, 2022)).

The excessive extraction of groundwater to meet industrial water demands has further aggravated water scarcity, depleting reserves at unsustainable rates (CGWB, 2023). Chemical contamination from textile production has also led to soil degradation, negatively impacting surrounding agricultural land. These combined factors have resulted in the contamination of drinking water sources for 1.8 million people, the collapse of traditional pastoral livelihoods due to the degradation of communal grazing lands, and progressive desertification that threatens the long-term viability of the region (Tirkey et al., 2021).

CASE STUDY -4 **Mining Operations in Semi-Arid Zones**

Mining activities in semi-arid regions have caused irreversible damage to fragile ecosystems. The destruction of rocky outcrop habitats, which support highly specialized and range-restricted species, has led to local extinctions and a significant loss of biodiversity (Sinha & Krishna, 2021). The extraction process has also severely depleted limited water resources, with contamination from heavy metals and mining waste further reducing water quality.

Additionally, dust pollution from mining operations has had widespread effects, reducing plant productivity and altering local agricultural systems. Beyond environmental consequences, mining has displaced traditional land users from their ancestral grazing lands, disrupting long-standing pastoral livelihoods (Tiwari et al., 2020). The cumulative impact of these activities includes accelerated soil erosion, desertification, and permanent alterations to the region's hydrology, making it increasingly difficult for local communities to sustain themselves (TERI, 2023).

3.5.2 Corporate contribution to conservation strategies

In recent years, Indian corporations have increasingly recognized the importance of embedding conservation into their sustainability agendas. With growing environmental pressures and

the urgency of restoring degraded ecosystems, businesses are emerging as pivotal actors in implementing large-scale ecological interventions. Corporate conservation strategies are not only enhancing biodiversity outcomes but are also contributing to water security, climate resilience, and the socio-economic upliftment of rural communities. From supporting sustainable agriculture and preserving genetic diversity to restoring watersheds and investing in green infrastructure, companies are leveraging their financial, technical, and organizational capacities to achieve measurable conservation goals. These efforts reflect a shift toward environmental stewardship as a core business value rather than a peripheral responsibility. The following case studies—ranging from sustainable cotton cultivation by Ambuja Cement Foundation to Dabur's medicinal plant initiatives, ITC's landscape-scale watershed restoration, and Mahindra & Mahindra's integrated water conservation programs—illustrate the diverse ways in which Indian corporates are actively contributing to ecological sustainability and rural development.

CASE STUDY -1 Sustainable Cotton Initiative

The Ambuja Cement Foundation (ACF) has been actively involved in promoting sustainable cotton cultivation through its partnership with the Better Cotton Initiative (BCI). Initiated in 2010, this collaboration focuses on enhancing the capacities of cotton farmers by educating them on best practices that lead to higher yields, improved product quality, reduced pesticide use, and efficient fertilizer application.

The Ambuja Cement Foundation (ACF) has significantly expanded its Sustainable Cotton Initiative since its inception in 2010. As of the 2023-24 period, ACF's Better Cotton programme has engaged with approximately 213,000 farmers across 1,952 villages in 12 districts spanning four states, with women constituting 6.5% of the participants. This marks a substantial growth from the 17,213 farmers involved by 2014.

The implementation of BCI practices has promoted work ethics on farms, ensured soil health coupled with safe environmental practices, and generated better profit margins for farmers.

In Gujarat, ACF's initiatives have been particularly impactful. The foundation has reached out to more than 7,100 farmers from 377 learning groups, focusing on reducing the use of chemical fertilizers and pesticides. Additionally, ACF is promoting producers' organizations among BCI farmers, paving the way for the sustainability of the project.

Furthermore, ACF has implemented plantation drives in its Better Cotton project villages, recognizing the importance of protecting and enhancing biodiversity. As of recent reports, the foundation has planted a total of 937,183 trees across 648 project villages, involving around 65,000 farmers (Ambuja Cement, 2023).

CASE STUDY -2 Mahindra & Mahindra contribution in watershed development

Mahindra & Mahindra has demonstrated a strong commitment to watershed development through various initiatives aimed at conserving water and enhancing agricultural productivity. Notably, the company collaborated with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) to implement watershed projects in Telangana. In Buchinelli village, this partnership led to the creation of 51 water-harvesting structures over three years, resulting in the annual collection of approximately 137,000 cubic meters of rainwater and benefiting around 150 farmers. These efforts contributed to increased crop yields by 15% to 40% and additional incomes ranging between ₹5,000 and ₹15,000 per acre annually (I CRISAT, 2023).

In Madhya Pradesh, Mahindra & Mahindra, in partnership with the National Bank for Agriculture and Rural Development (NABARD), launched the Integrated Watershed Management Project (IWMP) in Hatta-Damoh in 2015. This initiative resulted in the conservation of over 10 million liters of surface water per year. Key interventions included seed replacement, creation of farm ponds, farm bunding, toilet construction, health camps, and the installation of drinking water tanks and LED lights (Orissa Diary, 2022).

Furthermore, Mahindra Finance has undertaken watershed development programs to improve farmers' livelihoods in drought-prone areas by constructing and renovating watershed structures, thereby increasing groundwater levels. In the Zaheerabad region, these efforts significantly raised the water table from 450 feet to 60 feet (Mahindra Group, 2023).

CASE STUDY -3 Agricultural Biodiversity Conservation Initiative

Dabur India Limited has demonstrated a commitment to biodiversity conservation through various initiatives aimed at promoting sustainable agriculture and preserving traditional knowledge (Dabur, 2023a). The company's Biodiversity Policy aligns with the Convention on Biological Diversity (CBD 1992), reflecting its dedication to ecological preservation (Dabur, 2023b).

A notable endeavor is the "Herbal Kingdom" program, which focuses on the cultivation of medicinal plants. This initiative involves the free distribution of quality planting material to farmers, capacity-building programs to enhance farmer awareness, and efforts to restore and conserve forest ecosystems and their biodiversity. The program has been implemented across multiple states, including Gujarat, Tamil Nadu, Maharashtra, Chhattisgarh, Uttarakhand, and Odisha.

In collaboration with the Border Security Force (BSF), Dabur launched a plantation project aimed at ecological restoration and biodiversity conservation. This initiative involves planting approximately 1.2 lakh medicinal plants and herbs across nine BSF campuses in seven states: Gujarat, Rajasthan, Odisha, Chhattisgarh, Haryana, Madhya Pradesh, and West Bengal.

CASE STUDY -4 **ITC's Integrated Watershed Development Programme**

ITC's Integrated Watershed Development Programme has implemented soil and water conservation measures across approximately 1.47 million acres (about 595,000 hectares) in water-stressed areas, benefiting over 400,000 individuals. This initiative has led to the creation of water storage capacity exceeding 46.9 million cubic meters and has improved groundwater tables by 20-30% in the project areas (India CSR, 2023; The Economic Times, 2022).

The programme employs a comprehensive approach that includes supply augmentation—such as area treatment, water harvesting, groundwater recharge, and biodiversity conservation—and demand-side management. Community participation is central to the initiative, with the formation of Water User Groups (WUGs) that involve small and marginal farmers, including active participation from women.

3.5.3 Corporate Engagement Opportunities

Corporations play a critical role in fostering sustainable agricultural and environmental practices that balance productivity with ecological resilience. By investing in initiatives that address climate change, water security, biodiversity, and land management, businesses can contribute to long-term sustainability while supporting rural livelihoods. The following are key corporate engagement opportunities in this domain:

1. **Climate-Smart Agriculture: Aligning with Net-Zero and Science-Based Targets**
   Climate-smart agriculture (CSA) is a holistic approach that enhances agricultural resilience, improves productivity, and mitigates environmental impacts. Corporate initiatives in this area include promoting precision farming, drought-resistant crop varieties, and regenerative agriculture techniques such as minimal tillage and organic soil amendments. By supporting farmers in adopting water-efficient irrigation systems like drip and sprinkler irrigation, businesses can help reduce water usage while maintaining high yields. Additionally, companies can invest in digital solutions such as climate forecasting and remote sensing to enable farmers to make informed decisions based on real-time environmental data. Climate-smart agricultural programs not only improve food security but also reduce greenhouse gas emissions by integrating carbon sequestration practices like cover cropping and agroecological methods.

   To go beyond CSR, corporations can embed climate-smart agriculture (CSA) into their ESG strategy by setting **Science-Based Targets (SBTs)** for greenhouse gas reduction, including emissions from upstream agricultural activities. This may include incentivizing regenerative practices such as cover cropping, conservation tillage, and agroecological farming that enhance carbon sequestration and soil health. Companies can also support **carbon farming initiatives,** where farmers are rewarded for verified carbon sequestration efforts, integrating these credits into insetting strategies within their supply chains. To increase resilience and transparency, corporations should incorporate **sustainable procurement standards,** requiring suppliers to adopt water-efficient irrigation methods, climate-resilient crop varieties, and low-emission farming techniques.

Progress on these initiatives can be measured through ESG metrics such as yield per unit of carbon emitted or area under climate-smart cultivation, and reported annually in sustainability disclosures.

2. **Watershed Development: Advancing Net-Positive Water Strategies**
   Corporate-backed watershed management initiatives are essential for improving water availability and maintaining soil health in water-stressed regions. These programs focus on soil and water conservation techniques such as rainwater harvesting, check dam construction, groundwater recharge pits, and afforestation in degraded catchment areas. By investing in watershed development, businesses can support sustainable water use, prevent soil erosion, and enhance agricultural productivity. Many corporate social responsibility (CSR) initiatives engage local communities in watershed restoration projects, ensuring long-term maintenance and equitable distribution of water resources. These efforts contribute to rural economic stability by providing farmers with reliable water access, reducing dependency on erratic monsoons, and fostering climate resilience.

   Corporate watershed initiatives can be elevated to ESG standards by adopting net-zero or net-positive water use targets, particularly for operations in water-stressed regions. Companies should assess their water risk exposure using tools such as the WRI Aqueduct or WWF's Water Risk Filter, enabling them to prioritize investments in catchment-level interventions such as rainwater harvesting, check dams, and groundwater recharge systems. These actions should be guided by recognized frameworks like the Alliance for Water Stewardship (AWS), ensuring stakeholder engagement and ecosystem-based management. Corporations can also enter catchment stewardship agreements in collaboration with local governments and communities to ensure equitable water distribution and long-term sustainability. Reporting on key ESG indicators—such as cubic meters of water recharged, seasonal availability improvements, and stakeholder engagement outcomes—ensures transparency and accountability.

3. **Agroforestry and Sustainable Grazing: Mainstreaming Nature-Based Solutions**
   Agroforestry is an integrated land management approach that combines tree cultivation with crops and livestock to enhance biodiversity, sequester carbon, and improve soil fertility. Corporations can play a vital role in promoting agroforestry by supporting farmer training programs, distributing high-value tree saplings, and creating incentives for sustainable land-use practices. Sustainable grazing management is another critical area, particularly in arid and semi-arid regions where overgrazing leads to land degradation. Companies engaged in dairy and livestock value chains can support silvopastoral systems, rotational grazing, and fodder cultivation to reduce pressure on natural grasslands. These interventions not only boost farmers' incomes but also contribute to ecosystem restoration by maintaining soil structure, preventing desertification, and supporting wildlife habitats.

   Integrating agroforestry and sustainable grazing systems into corporate land management approaches offers a dual benefit of supporting rural livelihoods and restoring degraded ecosystems. From an ESG perspective, companies can use Natural Capital Accounting and emerging tools like the Taskforce on Nature-related Financial Disclosures (TNFD) to quantify and report the ecosystem services generated—such as carbon storage, soil

stabilization, and biodiversity enhancement. Corporations involved in livestock or dairy value chains can invest in silvopastoral systems and rotational grazing techniques to combat overgrazing and prevent desertification. These nature-based solutions should be monitored using biodiversity key performance indicators (KPIs), including survival rates of tree plantations, increase in vegetation cover, or the return of native species. By embedding such metrics into their ESG disclosures, companies demonstrate their commitment to landscape restoration, climate adaptation, and ecosystem stewardship.

4. **Agrobiodiversity Conservation: Embedding Resilience into Supply Chains**
   Preserving traditional crop varieties is essential for maintaining genetic diversity, ensuring food security, and adapting to climate change. Corporate programs focused on agrobiodiversity conservation involve establishing seed banks, promoting indigenous and climate-resilient crops, and facilitating market linkages for farmers growing traditional varieties. Many businesses in the food and beverage industry are integrating heirloom grains, pulses, and drought-tolerant crops into their supply chains, creating demand for diverse agricultural products. By investing in research and development, companies can also support the breeding of climate-adaptive crops that require fewer chemical inputs while delivering higher nutritional value. Public awareness campaigns and farmer training sessions on the importance of biodiversity conservation further help in sustaining these efforts.

Corporate engagement in sustainable agriculture and ecosystem conservation offers immense potential to address environmental challenges while strengthening rural economies. Climate-smart agriculture, watershed development, agroforestry, and agrobiodiversity conservation are interconnected strategies that can improve land productivity, enhance resilience to climate variability, and promote responsible resource management. Agrobiodiversity conservation plays a critical role in building climate-resilient and sustainable food systems. Companies can integrate biodiversity safeguards into their ESG frameworks by incorporating traditional and underutilized crop varieties into sourcing strategies, ensuring seed diversity and genetic resilience across their supply chains. Establishing community seed banks, supporting climate-resilient landraces, and promoting public-private partnerships for indigenous crop research are all impactful ways to preserve agrobiodiversity. Businesses can align these initiatives with global frameworks such as the Nagoya Protocol to ensure equitable benefit sharing and protection of farmers' rights. Further, biodiversity footprinting tools like the Global Biodiversity Score can help measure and disclose the ecological impact of agricultural sourcing areas. Consumer-facing brands may also develop sustainable product lines featuring heirloom grains or native crops, with clear labelling and impact stories that enhance market differentiation while supporting conservation goals.

4. CROSS-CUTTING OPPORTUNITIES

4.1 Nature-based Solutions for Climate Change

Nature-based solutions (NbS) are defined by the International Union for Conservation of Nature (IUCN) as “actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.” In the context of climate change, NbS offer a powerful approach to mitigating greenhouse gas emissions, enhancing biodiversity, and improving ecosystem services, making them a key strategy for corporate sustainability initiatives.

Corporate engagement in NbS can generate multiple benefits. Firstly, carbon sequestration and storage can be achieved by enhancing natural carbon sinks through ecosystem restoration and conservation. Secondly, climate adaptation can be supported by building resilience to climate impacts through ecosystem-based approaches, such as wetland conservation to reduce flooding risks. Lastly, biodiversity conservation efforts can protect and enhance species and habitats while addressing climate challenges.

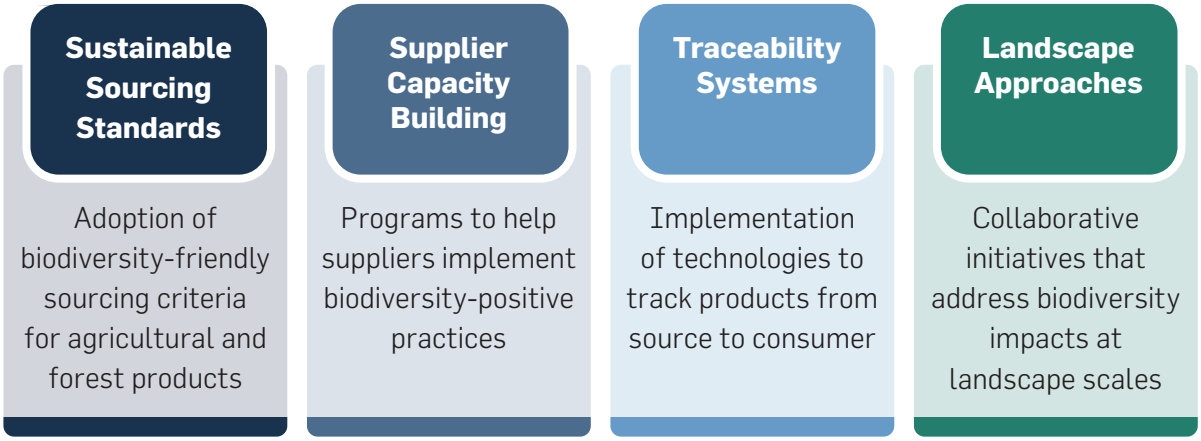
There are several intervention opportunities where businesses can contribute. Forest carbon projects, including reforestation, afforestation, and forest conservation initiatives, generate carbon credits while promoting biodiversity. Blue carbon initiatives focus on conserving and restoring coastal ecosystems such as mangroves and seagrass beds, which play a significant role in carbon sequestration and coastal protection. Agroecology approaches, through climate-smart agricultural practices, enhance soil carbon while supporting biodiversity and improving food security. Additionally, urban green infrastructure, such as green roofs, tree planting, and biodiversity corridors, provides NbS in cities, helping to mitigate urban heat island effects and improve air quality.

By integrating NbS into corporate climate strategies, businesses can align with global climate goals, such as the Paris Agreement and the Kunming-Montreal Global Biodiversity Framework, while also strengthening long-term environmental resilience and sustainability.

4.2 Sustainable Supply Chain Management

Corporate supply chains often have significant biodiversity impacts, making it crucial to integrate biodiversity considerations into supply chain management. Doing so can reduce negative impacts while creating business value. Companies can adopt sustainable sourcing standards by implementing biodiversity-friendly criteria for agricultural and forest products.

Supplier capacity building programs can support suppliers in adopting biodiversity-positive practices, ensuring sustainability throughout the supply chain. Traceability systems, which use technologies to track products from their source to consumers, enhance transparency and accountability. Additionally, landscape approaches can facilitate collaborative initiatives that address biodiversity impacts at a broader, landscape scale.



4.3 Sustainable Packaging: Reducing Plastic Pollution and Promoting Circular Economy

India generates approximately 3.5 million tonnes of plastic waste annually, of which only about 12% is properly recycled, while nearly 40% remains uncollected, eventually polluting land and water bodies (CPCB, 2023). Single-use plastics are particularly detrimental to biodiversity, with marine species like sea turtles, fish, and seabirds suffering from plastic ingestion and entanglement. Terrestrial ecosystems are also affected, as plastic waste degrades soil health and disrupts natural habitats.

Corporations, particularly in the fast-moving consumer goods (FMCG), e-commerce, and retail sectors, can significantly reduce their environmental impact by adopting sustainable packaging solutions. Several Indian and multinational brands have started replacing single-use plastics with biodegradable, compostable, and recyclable materials. For example: Tata Consumer Products has introduced plant-based bioplastic and paper-based packaging for some of its products, reducing its reliance on conventional plastic. ITC Limited's WOW (Well-being Out of Waste) initiative promotes sustainable packaging through recycled paper and board manufacturing. Amazon India and Flipkart have pledged to eliminate single-use plastic packaging by integrating reusable and recycled packaging in their supply chains.

By incorporating design for recyclability, minimalist packaging, and biodegradable alternatives such as bamboo, jute, and seaweed-based materials, businesses can drastically reduce plastic pollution and contribute to a circular economy where materials are reused rather than discarded.

4.4 Waste Management: Addressing Industrial and Consumer Waste Impacting Biodiversity

Unregulated waste disposal, including industrial effluents, hazardous waste, and electronic waste (e-waste), is a growing environmental challenge in India. The country produces more than 62 million tonnes of solid waste annually, with only about 30% being processed scientifically, while the rest either ends up in landfills or is illegally dumped (MoEFCC, 2023). Toxic chemicals leach into the soil and water, degrading ecosystems and threatening biodiversity in forests, wetlands, and coastal regions.

Corporates have a significant opportunity to reduce their waste footprint through:

Extended Producer Responsibility (EPR): The EPR framework, mandated under the Plastic Waste Management Rules, 2016, and E-Waste Management Rules, 2022, requires

manufacturers to take responsibility for collecting and recycling their products after use. Companies like Samsung and Dell have implemented take-back programs for electronics, while Coca-Cola and PepsiCo are working on plastic waste collection and recycling initiatives.

Zero-Waste Manufacturing Practices: Industries can minimize waste by adopting lean manufacturing techniques, using waste-to-energy conversion methods, and integrating closed-loop production processes. The Aditya Birla Group has successfully reduced its industrial waste footprint by promoting sustainable raw material use and recycling in its textile and cement industries.

Plastic Waste Management in Coastal Areas: The influx of plastic waste into India's marine and freshwater ecosystems has severely impacted biodiversity. In response, companies like Reliance Industries and Hindustan Unilever have launched initiatives to collect, recycle, and repurpose plastic waste from beaches, mangroves, and riverbanks, reducing harm to aquatic life.

Effective corporate waste management strategies not only help in biodiversity conservation but also contribute to India's Swachh Bharat Abhiyan and Circular Economy Action Plan, fostering a cleaner and more sustainable business ecosystem.

4.5 Community Engagement and Biodiversity Stewardship: Strengthening Livelihoods and Conservation

Local communities play a crucial role in conserving biodiversity, particularly in rural and ecologically sensitive regions like mangroves, forests, grasslands, and semi-arid agricultural landscapes. However, habitat degradation, overfishing, and deforestation have disrupted these ecosystems, affecting both biodiversity and community livelihoods. Businesses can create a positive impact by integrating corporate social responsibility (CSR) programs, nature-based solutions, and sustainable livelihood initiatives that empower communities while conserving ecosystems.

Examples of Corporate-Led Community Engagement Initiatives: Mangrove Restoration and Fisheries Support: The Tata Power Coastal Biodiversity Initiative in Maharashtra has helped restore over 250 hectares of mangroves, enhancing fish stocks and providing economic benefits to local fishers. Mangrove conservation not only sequesters carbon but also reduces coastal erosion and cyclone impact, benefiting both biodiversity and human settlements. Forest Conservation and Indigenous Community Livelihoods: ITC's Social Forestry Program has planted over 1 million trees, benefiting farmers by promoting agroforestry models that restore degraded land and create sustainable income sources. The program works with tribal communities in Odisha and Chhattisgarh to protect biodiversity-rich forests while improving their economic resilience. Sustainable Agriculture and Water Conservation: Companies like Nestlé India and Mahindra & Mahindra are investing in climate-smart agriculture and water conservation projects, helping small farmers adopt practices like drip irrigation, organic

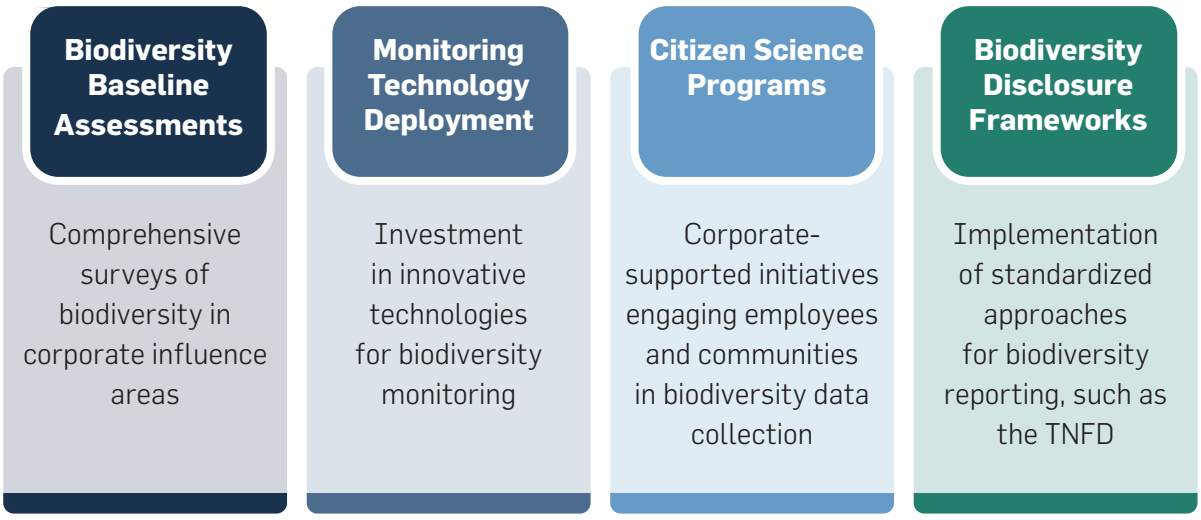
farming, and soil moisture conservation. In Rajasthan, the Hindustan Zinc Company has implemented watershed management projects that have restored thousands of hectares of degraded farmland, securing both water resources and biodiversity.

By fostering corporate-community partnerships, businesses can enhance ecological resilience while supporting sustainable development goals (SDGs). These efforts not only safeguard India's biodiversity but also promote inclusive economic growth, climate adaptation, and long-term environmental stewardship.

4.6 Biodiversity Monitoring and Reporting

Effective biodiversity conservation requires robust monitoring and reporting systems, and corporate engagement can play a vital role in strengthening these efforts while improving biodiversity disclosures. Conducting biodiversity baseline assessments helps businesses understand the biodiversity present in their areas of influence through comprehensive surveys. Investing in innovative monitoring technologies can improve data collection and analysis for better conservation outcomes.

Corporate-supported citizen science programs can engage employees and communities in biodiversity data collection, fostering a culture of environmental stewardship. Finally, implementing biodiversity disclosure frameworks, such as the Taskforce on Nature-related Financial Disclosures (TNFD), can standardize reporting practices and enhance corporate transparency in biodiversity conservation efforts.



5. IMPLEMENTATION FRAMEWORK

5.1 Governance Models

Effective corporate engagement in biodiversity conservation requires well-structured governance models that facilitate collaboration and accountability. Based on successful initiatives, several governance models have proven effective. Corporate-NGO partnerships leverage the complementary expertise of businesses and conservation organizations, fostering impactful biodiversity initiatives. Multi-stakeholder platforms bring together businesses, government agencies, communities, and experts to create collaborative conservation

efforts. Community-based conservation programs, supported by corporations, empower local communities to take the lead in preserving biodiversity. Additionally, science-business alliances facilitate partnerships between corporations and research institutions, ensuring that conservation approaches are evidence-based and scientifically sound.

5.2 Financing Mechanisms

Sustainable financing plays a crucial role in ensuring the longevity of biodiversity conservation efforts. Several mechanisms provide opportunities for corporate engagement. Corporate Social Responsibility (CSR) investments can be strategically directed toward biodiversity conservation priorities, ensuring positive environmental outcomes. Biodiversity offsets allow companies to implement compensatory conservation measures to mitigate the residual impacts of development projects. Blended finance, which combines corporate funding with public and philanthropic capital, can help scale conservation initiatives effectively. Payments for ecosystem services offer market-based incentives for landowners and communities to maintain vital ecosystem functions. Furthermore, environmental impact bonds serve as innovative financing instruments, linking financial returns to measurable conservation outcomes:

1. **CSR Investments:** Strategic allocation of CSR funds toward biodiversity conservation priorities.
2. **Biodiversity Offsets:** Compensatory conservation measures to address residual impacts of development projects.
3. **Blended Finance:** Combinations of corporate funding with public and philanthropic capital to scale conservation initiatives.
4. **Payments for Ecosystem Services:** Market-based mechanisms that reward landowners and communities for maintaining ecosystem services.
5. **Environmental Impact Bonds:** Innovative financing instruments that link returns to conservation outcomes.

5.3 Monitoring and Evaluation Framework

To ensure the effectiveness of corporate biodiversity initiatives, a robust monitoring and evaluation framework is essential. This framework should include biodiversity indicators, which use science-based metrics to track changes in species populations, habitat quality, and ecosystem functions. Social impact measures assess the benefits of conservation initiatives for local communities and stakeholders, ensuring inclusive and equitable outcomes. Business value metrics help quantify corporate benefits, including risk reduction, operational efficiency, and reputational gains. Lastly, adaptive management protocols provide a structured approach for using monitoring data to refine and improve conservation strategies over time, ensuring continuous learning and impact enhancement.

1. **Biodiversity Indicators:** Science-based metrics to track changes in species populations, habitat quality, and ecosystem functions.
2. **Social Impact Measures:** Indicators to assess benefits to local communities and stakeholders.
3. **Business Value Metrics:** Measures of corporate benefits, including risk reduction, operational efficiency, and reputational gains.
4. **Adaptive Management Protocols:** Processes for using monitoring data to refine and improve conservation strategies over time.

5.4 Recommendations for enhanced corporate engagement

This section outlines a series of steps which corporates could adopt towards a more structured and proactive contribution towards biodiversity conservation. The first step involves conducting Biodiversity Impact Assessments. These assessments enable organizations to systematically evaluate how their operations and value chains depend on and affect biodiversity. By identifying key areas of impact and dependency, businesses can make informed decisions that reduce harm and enhance ecological resilience.

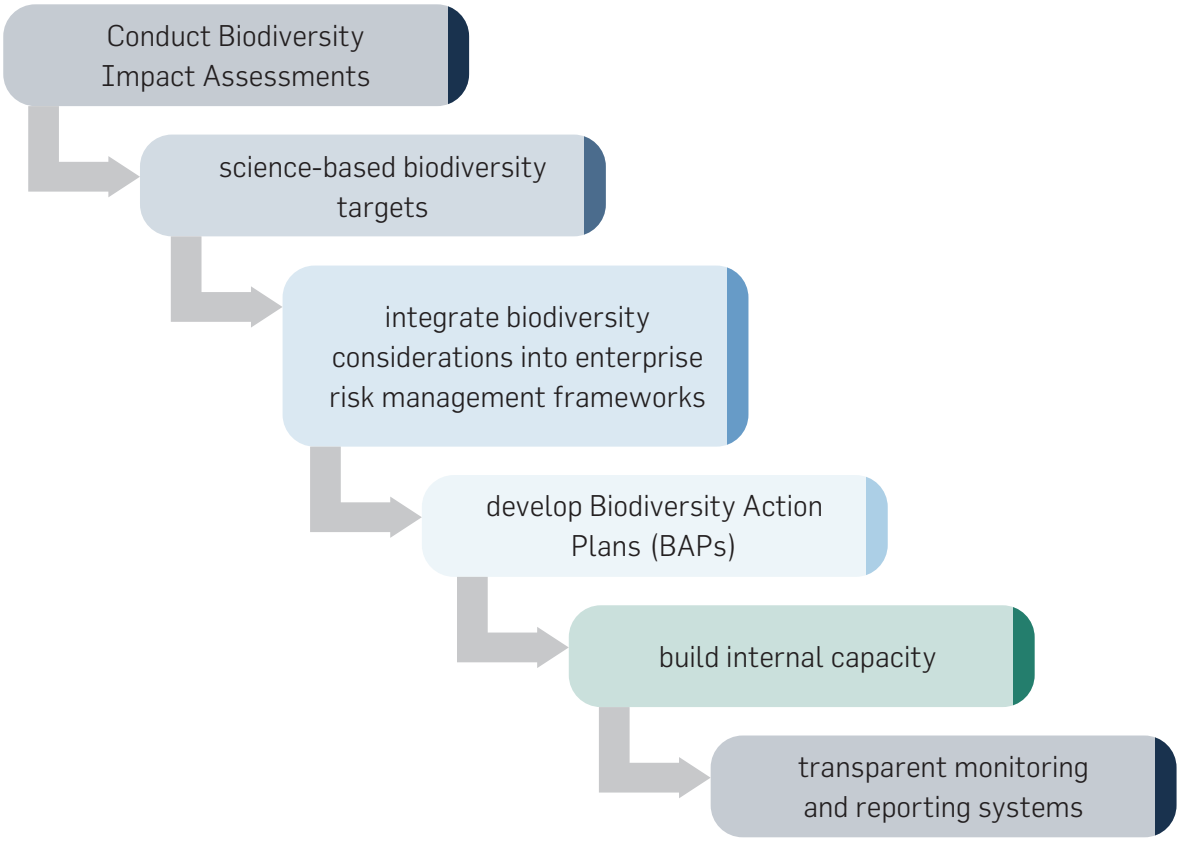
Next, companies can set science-based biodiversity targets that are specific, measurable, and time-bound. These targets provide a clear roadmap for conservation and restoration efforts, aligning corporate actions with global biodiversity goals such as those outlined in the Kunming-Montreal Global Biodiversity Framework.

It is also essential to integrate biodiversity considerations into enterprise risk management frameworks. Recognizing biodiversity loss as a material risk helps companies anticipate regulatory, operational, and reputational challenges while building long-term business resilience. In support of this, organizations can develop Biodiversity Action Plans (BAPs)—comprehensive documents that lay out strategic actions, timelines, and responsibilities. These plans help translate commitments into tangible steps and facilitate accountability.

To ensure effective implementation, companies must build internal capacity by equipping employees and management teams with the necessary knowledge and skills related to biodiversity. Training programs, awareness campaigns, and cross-functional teams can help embed ecological thinking into everyday decision-making.

Importantly, biodiversity should be integrated into core business operations rather than being treated solely as a component of corporate social responsibility (CSR). Embedding biodiversity into procurement policies, product design, supply chain management, and investment decisions enables a more holistic approach to sustainability.

Finally, companies should establish transparent monitoring and reporting systems that track biodiversity performance and disclose impacts in a clear and credible manner. By adopting robust metrics and aligning with international reporting standards, businesses can enhance stakeholder trust and contribute meaningfully to global biodiversity conservation efforts.

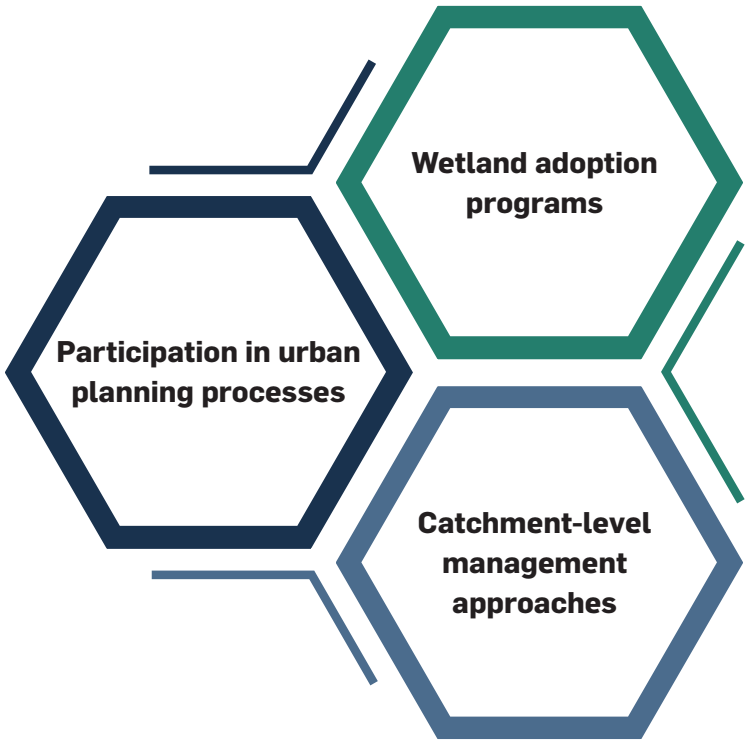


5.5 Ecosystem-specific Recommendations

Urban Wetlands

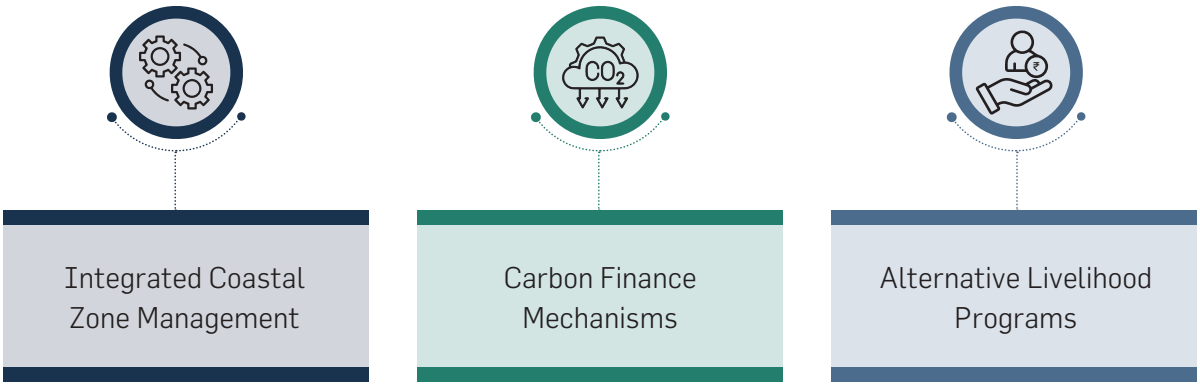
Urban wetlands play a crucial role in flood regulation, water purification, and urban biodiversity. Corporations can lead by initiating wetland adoption programs, where they commit to the comprehensive restoration and long-term management of selected urban wetlands. These

efforts should be supported by active participation in urban planning processes, ensuring that wetland conservation is integrated into broader development strategies rather than treated as an afterthought. Moreover, companies can champion catchment-level management approaches to address pollution at its source and regulate water flows, thereby maintaining the ecological integrity of wetland systems.



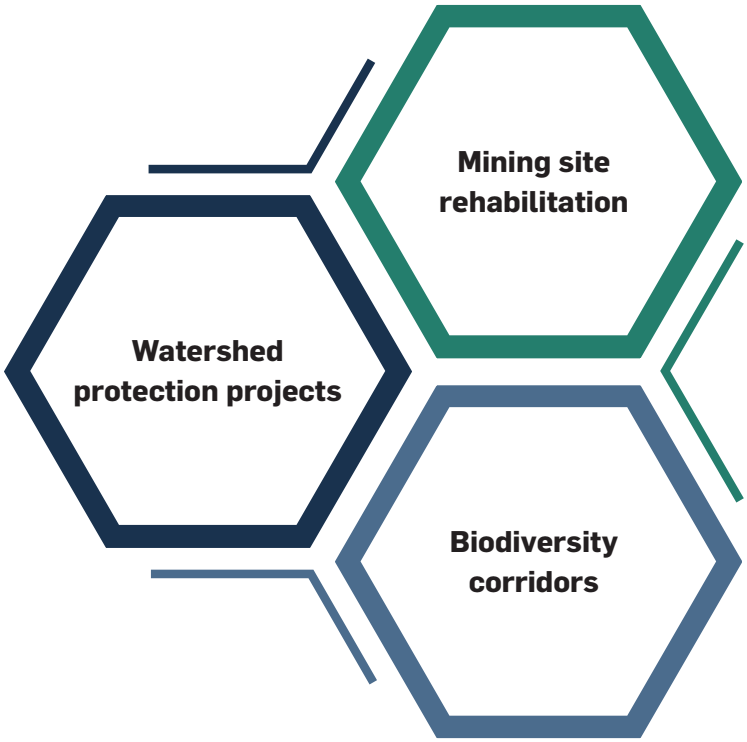
Mangroves

Mangrove ecosystems are vital for coastal protection, carbon sequestration, and supporting livelihoods. Companies can support Integrated Coastal Zone Management (ICZM) initiatives, which balance ecological preservation with responsible coastal development. Additionally, businesses should explore carbon finance mechanisms, such as blue carbon projects that generate verified carbon credits while conserving mangrove forests. To reduce anthropogenic pressure, alternative livelihood programs can be implemented in collaboration with local communities, promoting sustainable income sources that align with mangrove conservation.



The Aravallis

The Aravalli hills, rich in biodiversity and vital for regional water security, are under severe threat from mining and land degradation. Corporations can take a leading role in mining site rehabilitation, investing in the restoration of abandoned quarries using native species and ecological landscaping methods. These efforts should be complemented by support for watershed protection projects, which not only improve water availability but also sustain ecological balance. Furthermore, companies can facilitate the creation and maintenance of biodiversity corridors that reconnect fragmented habitats and enable wildlife movement, thereby enhancing the overall ecological resilience of the region.



Marine Ecosystems

Marine ecosystems face significant stress from plastic pollution, overfishing, and habitat degradation. Corporates can make a substantial impact by implementing comprehensive plastic reduction strategies, targeting both operational practices and supply chains to prevent plastic from entering marine environments. Supporting sustainable fisheries certification helps local fishing communities gain market access while promoting responsible harvesting practices. In addition, businesses can contribute to the effective management of marine protected areas (MPAs) by providing financial resources, technical expertise, and advocacy for stronger protection measures.

Plastic Pollution Reduction	Sustainable Fisheries Certification	Marine Protected Area Support

Semi-Arid Agriculture Ecosystems

In semi-arid regions, agriculture must balance productivity with environmental stewardship. Corporations can champion **climate-smart agriculture,** promoting techniques that increase resilience to climate change while safeguarding biodiversity. Equally important is **water stewardship,** where companies adopt and support integrated water management strategies that consider both agricultural demands and the ecological needs of semi-arid landscapes. Finally, businesses should invest in **agrobiodiversity conservatio**n by preserving and promoting traditional crop varieties and farming practices that are well-adapted to local environmental conditions and cultural heritage.

5.6 Partnership Models and Financing Mechanisms

To foster more effective biodiversity conservation and ecosystem restoration, it is essential for businesses to engage in innovative partnership models that leverage the strengths of various stakeholders. One key approach is the development of multi-stakeholder platforms, which serve as collaborative forums where corporations, governments, communities, and NGOs can jointly participate in ecosystem-specific conservation planning. These platforms encourage knowledge-sharing, align diverse interests, and promote coordinated action.

Another powerful strategy involves public-private partnerships (PPPs), where companies collaborate with public sector agencies to implement large-scale, landscape-level restoration initiatives. These partnerships can pool financial, technical, and logistical resources, making it possible to achieve conservation outcomes at a scale that would be difficult for any single actor to accomplish alone. Additionally, research collaborations between corporations and scientific institutions can drive innovation and evidence-based decision-making. These partnerships help integrate the latest ecological science into corporate sustainability strategies, ensuring that interventions are both effective and adaptive.

Furthermore, industry consortiums provide a platform for companies within a specific sector to collectively address biodiversity-related challenges. By working together, businesses can

develop shared standards, exchange best practices, and advocate for stronger biodiversity policies, thus elevating the entire industry's contribution to conservation.

In parallel, innovative financing mechanisms are crucial to sustain long-term biodiversity efforts. Blended finance approaches—which combine corporate capital with philanthropic or public conservation grants—can maximize impact by de-risking investments and unlocking larger funding pools for conservation projects. Businesses can also engage in biodiversity offset mechanisms, but to ensure credibility and effectiveness, these should be guided by rigorous metrics and third-party verification systems that guarantee real, measurable ecological benefits.

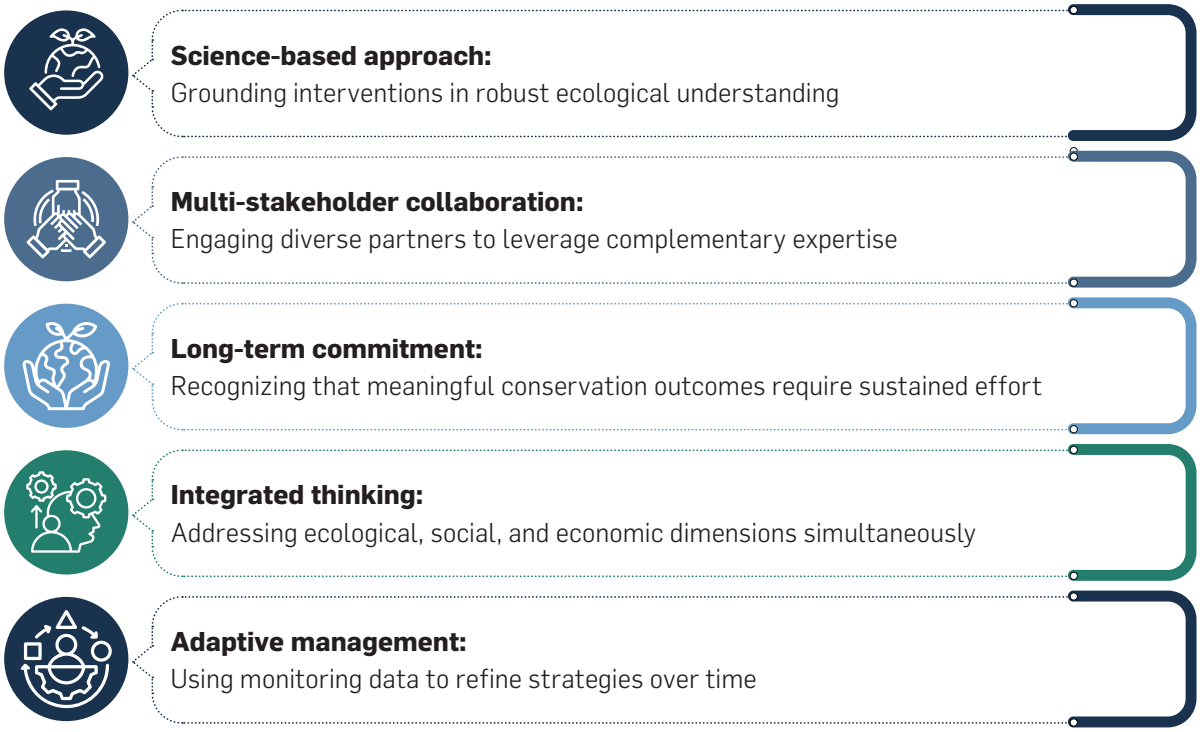
To support ongoing ecosystem stewardship, companies may invest in conservation trust funds—corporate-backed endowments that provide a steady flow of resources for the long-term management and protection of critical habitats. Additionally, payment for ecosystem services (PES) models offer a direct way to engage and incentivize local communities. By compensating communities for activities such as afforestation, watershed protection, or sustainable land use, businesses not only support livelihoods but also embed conservation into local economies.

Together, these partnership and financing strategies enable corporations to move beyond ad hoc environmental actions and toward systemic, scalable solutions that support biodiversity conservation and ecosystem resilience

6. CONCLUSION

Corporate engagement in biodiversity conservation represents a crucial opportunity to address India's biodiversity crisis while creating business value and supporting sustainable development. This study has identified numerous opportunities across five critical, but under-invested ecosystems, highlighting successful approaches and lessons learned.

The case studies presented demonstrate that effective corporate biodiversity initiatives share several key characteristics:



This report suggests few strategies which could help businesses make meaningful contributions to biodiversity conservation while enhancing their sustainability performance and long-term business resilience. Government agencies, civil society organizations, and other stakeholders can support this transition by creating enabling environments and collaborative platforms.

Ultimately, the future of India's biodiversity—and the ecosystem services upon which both businesses and communities depend—will be shaped by our collective ability to integrate conservation into economic decision-making at all levels. Corporate leadership in this area has the potential to catalyze transformative change toward a more sustainable and resilient future.

This report demonstrates the dual role corporations play in India's critical ecosystems. While innovative conservation initiatives show the potential for positive corporate engagement, substantial adverse impacts continue to threaten ecosystem health and resilience.

The path forward requires a fundamental shift in corporate approaches to biodiversity—moving from isolated CSR initiatives to comprehensive integration of conservation principles into core business operations. Through strategic partnerships, science-based targets, and innovative financing mechanisms, corporations can transform from being primary drivers of biodiversity loss to becoming leaders in ecosystem restoration and protection.

The case studies presented here provide both cautionary tales and inspiring models for future action. By learning from both successes and failures, corporate entities can develop approaches that balance business objectives with the imperative to preserve India's invaluable natural heritage for future generations.

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