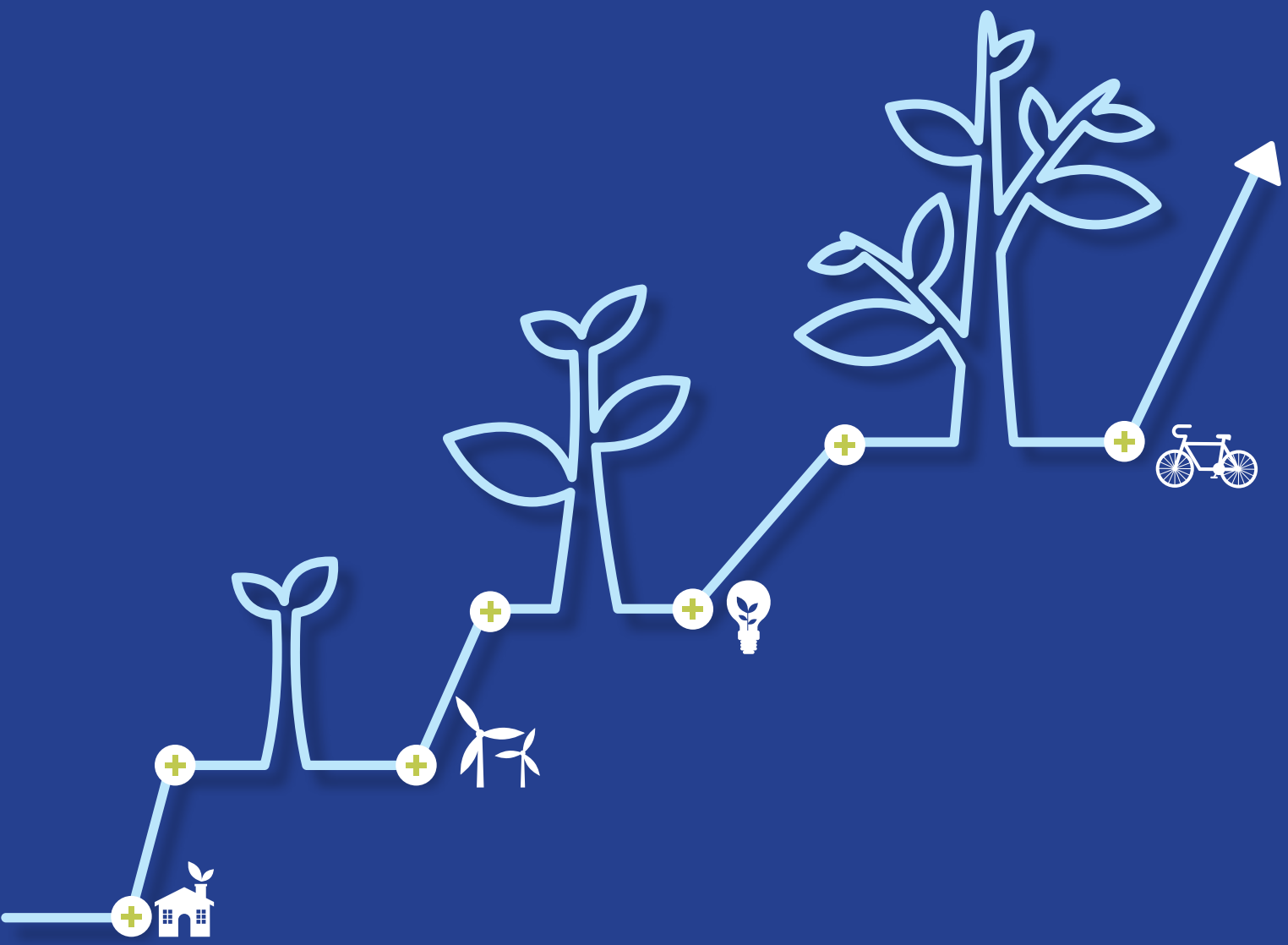
RUN UP TO THE MID-CENTURY

A Draft Guiding Framework For India's Long-Term Strategy: Adaptation

Kavya Michael, Pankhuri Sekhon, Mekhala Sastry, Swati Pillai, Saurabh Bhardwaj, Md Irfan



teri | The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

RUN UP TO THE MID-CENTURY

A DRAFT GUIDING FRAMEWORK FOR INDIA'S LONG-TERM STRATEGY: ADAPTATION

KAVYA MICHAEL, PANKHURI SEKHON, MEKHALA SASTRY,
SWATI PILLAI, SAURABH BHARDWAJ, MD IRFAN

teri | The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

ACKNOWLEDGEMENTS

Developing a guiding framework for India's Long-Term Strategy is a critical exercise. This draft framework is an outcome of detailed consultations with several experts across sectors. This draft framework also incorporates key comments from the web-based event 'Moving Towards a Climate-Resilient Development Pathway' held on 1 July 2020 and co-organized by TERI. The authors are grateful to the keynote speakers and participants for their expert views that helped shape this guiding framework.

The authors would also like to thank the reviewers of this draft – Ms Rohini Kohli, Lead Technical Specialist, National Adaptation Plan–Global Support Programme (NAP-GSP), UNDP and Mr Saba Kalam, Programme Officer, Climate Change and Energy, UNDP, who took the time to share their insights and provide us critical inputs for this framework.

The authors are extremely grateful to the internal advisors – Dr Ajay Mathur, Mr R. R. Rashmi, and Mr Amit Kumar – for their support and guidance throughout the project.

The authors would also like to thank The Children's Investment Fund Foundation (CIFF) for helping build this project.

TABLE OF CONTENTS

KEY MESSAGES

Under Article 4 of the Paris Agreement, in addition to the submission of renewed Nationally Determined Contributions (NDCs), Parties have been called to formulate and communicate a long-term low greenhouse gas emission development strategy and submit these to the UNFCCC by 2020. However, developing a Long-Term Strategy (LTS) is a critical and intensive exercise that should factor in the flexibility to evolve. This draft framework provides recommendations to assist policymakers on the development of India's long-term adaptation policy and ties in the need for a resilient sustainable development. The framework's recommendations are outlined as follows:

1. LTS will bring about coherence

A strong and robust LTS will enable India to align its existing and upcoming policies, institutional and governance mechanisms, and resource allocation. This will ensure a better coherence of climate action and overall economic growth. An effective LTS can be used to attain existing and upcoming short-term policies such as the NDCs.

2. LTS can be used as a tool to develop Climate-Resilient Development Pathways

Based on projections for urbanization and income growth, it can be said that India will still have a developmental gap by 2050. While the world will need to be on a path to net-zero emissions by 2050, India must play a role in this while being cognizant of its ongoing development. Climate-Resilient Development Pathways (CRDPs) offer a transition from incremental responses and business-as-usual approaches to transformational pathways that involve ambitious mitigation action, transformative adaptation practices, and climate-sensitive developmental responses.

3. Linking adaptation to development and understanding vulnerabilities

While it is critical for India to achieve its developmental goals, there is a certain aspect that can be used to the country's advantage. Multiple linkages exist between development and climate change. While development both adds to and is hindered by climate change, a possible solution can be found by 'mainstreaming climate change' in the decision-making and developmental planning process. This also provides the necessary avenue to address the 'uncertainty' and the 'decision-making under uncertainties' conundrums. Understanding vulnerabilities constitutes an integral component of mainstreaming climate change into the existing policy mechanisms. This analysis should therefore go beyond simple analysis and quantification of immediate climate change-related hazards and exposure. This becomes crucial for India as the country is heavily dependent on climate-sensitive sectors for its development.

4. Transformative adaptation and integrated systems-based approach

An LTS for India can only be effective and successful if the strategy is based on the principles of transformative adaptation and integrated systems approach. Incremental responses (immediate response to climatic risks) do not necessarily address the question of 'adaptation for whom?'. A transformative adaptation approach can be used to bring about fundamental change. This approach is useful in addressing socio-cultural and economic vulnerabilities. A major component of this approach is to recognize the intersections between various sectors (agriculture, water, urban and rural areas, natural environment) that are part of the socio-economic and socio-ecological systems. A 'systems thinking' approach will enable the development of a long-term strategy that is mindful of the intersections and continuous feedback loops that exist between different sectors.

5. A sound LTS needs to be based on an exhaustive understanding of current/past climate risks

A robust adaptation strategy should be underpinned by scientific evidence and the latest technology. The best available information on the current and future climate will support in developing an informed decision on adaptation. One of the key considerations to generate a robust climate risk profile is the scale. Since climate change impacts and risks are often context-specific, a localized risk profile is always a preferred choice as it takes into account those unique characteristics of an area.

6. A strong LTS requires effective resource allocation

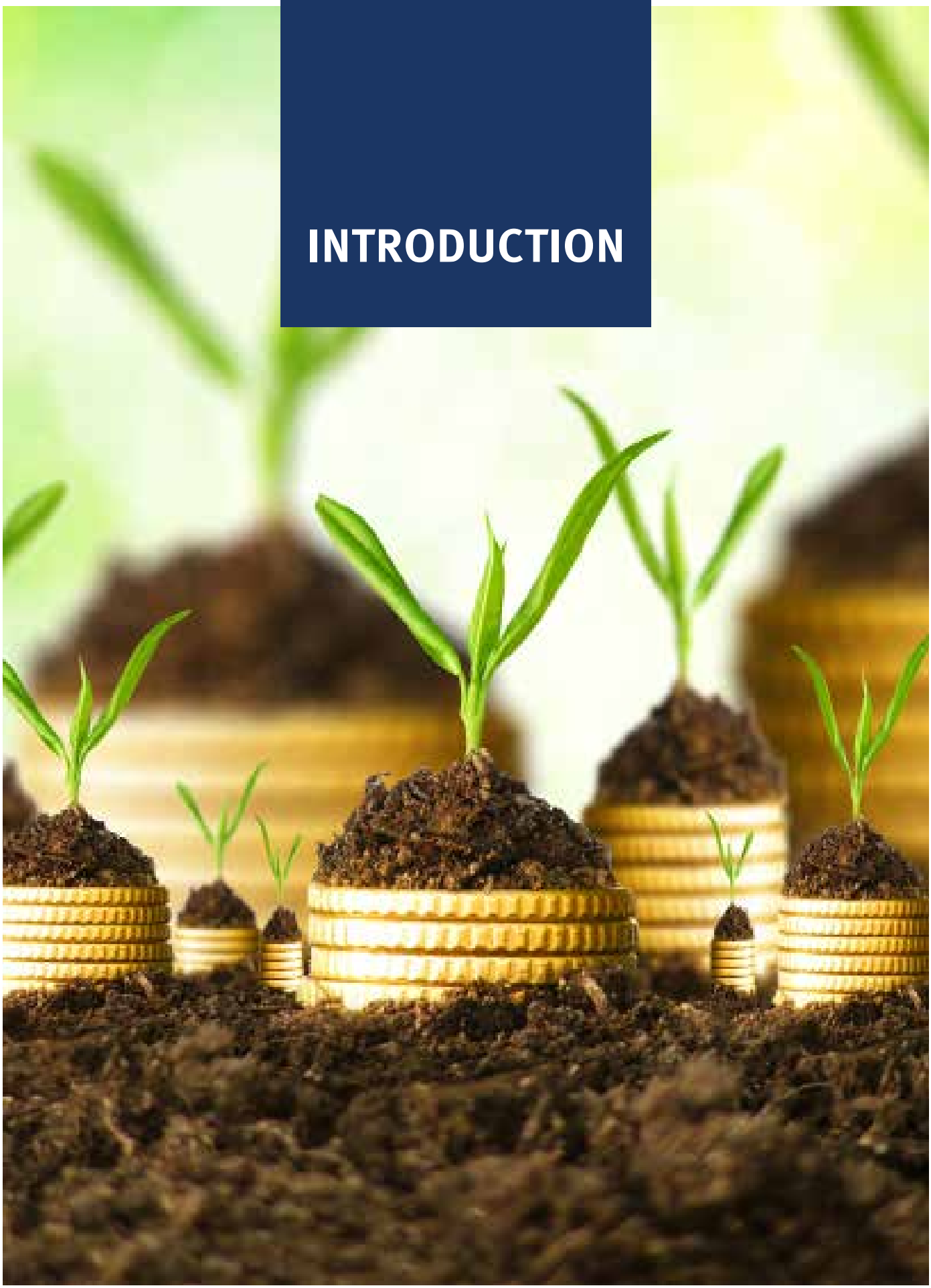
A long-term strategy on adaptation requires critical inputs that go beyond, but are not unresponsive to, financial and technological capital. Resourcing for adaptation requires mobilization and allocation of resources, which is informed by a thorough landscape assessment and future-scenario analysis. Achieving effective mobilization and allocation of resources for adaptation planning requires an integrated and holistic approach at different levels. Assessments must be made with respect to human, social, natural, and infrastructural capital, along with technological and financial assessments.

7. An LTS would only be successful with strong governance

Transformative adaption action underscores the need for a mode of governance that reiterates not just the integration of institutional structures, interventions, and processes across scales at national, state, and local levels, but also emphasizes the corresponding horizontal integration. This allows for institutional structures and governance framework to reflect the key priorities of *'Inclusivity, Ownership, and Equity'*. To encourage a governance process that moves away from the traditional 'one-off planning' to a more iterative and interactive exercise would involve emphasizing two key aspects, namely – 1. Stakeholder Engagements and 2) Monitoring, Evaluation, and Learning.

Keeping in mind the expanse of type and scale of adaptation interventions required in India and the labyrinth of administrative networks, a truly collaborative and integrated governance framework requires 'strong leadership and political support' stewarded by viable legal frameworks. Effective, interactive, and innovative governance practices can help address the institutional barriers (and to some extent capacity barriers) that lead to 'adaptation implementation deficit'.

INTRODUCTION



1. Introduction

Under the aegis of the Paris Agreement, Parties committed to developing mid-century or long-term low emission development strategies by 2020 (Long-Term Strategy or LTS). These strategies must align with the short-term as well as medium-term climate action, and chalk out a Climate-Resilient Development Pathway (CRDP).[1] In a country like India, it is critical that such a pathway also embraces the principles of 'common differentiated responsibilities' and respective national capabilities (See TERI LTS Mitigation document for more details).[2] To ensure coherence with the national development priorities, it is critical that the country's LTS also aligns with the Nationally Determined Contributions (NDCs). While the NDCs can be used as a potential tool of targeting short-term policy, the LTS could be an instrument to attain long-term developmental goals.[3]

The Intergovernmental Panel on Climate Change (IPCC) (2018)[4] defines a Climate-Resilient Development Pathway (CRDP) as development trajectories that reduce climate change risks as well as its impacts or, in other words, '*combine adaptation and mitigation to realize the goal of sustainable development*'. As indicated in Figure 1, the CRDP involves a transition from incremental responses and business-as-usual approaches to transformational pathways that involve ambitious mitigation action, transformative adaptation practices, and climate-sensitive developmental responses.[5] Adaptation and mitigation choices have the potential to offset and contribute to sustainable development. Hence, it is critical that these choices are looked at holistically to minimize the trade-offs and maximize the co-benefits.

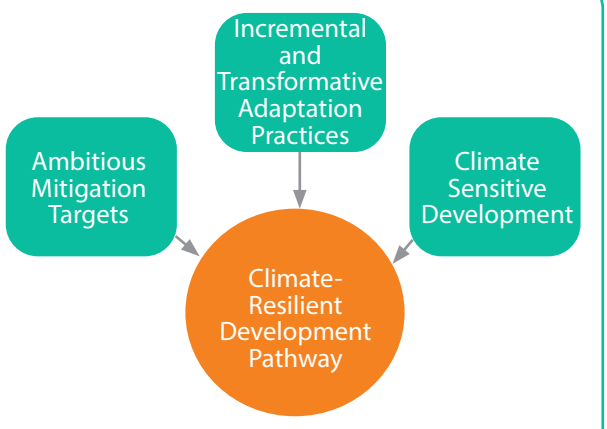


Figure 1: Climate-Resilient Development Pathway

A CRDP can be envisaged as an iterative dynamic process for managing changes in climate and other developmental forces within complex systems. It has been underlined that the effects of climate change get filtered through the socio-economic systems in a country and hence can lead to uneven impacts on different socio-economic groups within countries.[6] The trade-offs associated with adaptation and mitigation action are also linked to the socio-economic and developmental context of a country. This outlines the importance of climate action rooted in the socio-economic and developmental context of a country, including understanding the role of the existing inequalities and the power structure. A robust LTS for India should, thus, be capable of fulfilling developmental priorities and enhancing the resilience of local communities.[2] TERI has already developed a framing document for India's LTS on climate change mitigation. This document addresses the adaptation component of an LTS for India.

The Paris Agreement put forth a global adaptation goal (Article 7.1) on '*enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and adequate response in the context of the aforementioned temperature goal*'.[1] While it is imperative to limit rising temperatures, the benefits of addressing adaptation cannot be ignored any longer. Climate change is already decelerating developmental outcomes and increasing disaster risks across the world. As highlighted by the Global Commission on Adaptation (GCA) Report released in 2019, investing in adaptation leads to avoided losses (in terms of lives and assets), economic benefits, and environmental benefits.[8] The GCA Report approximates that an investment of USD 1.8 trillion globally from 2020 to 2030 in five adaptation priority areas including early warning systems, climate-resilient infrastructure, improved dry-land agriculture, mangrove protection, and resilient water resources can generate USD 7.1

trillion in net benefits.[8] The attainment of sustainable development goals also calls for stronger adaptation action.

We argue that a long-term strategy for adaptation should be embedded in principles of transformative adaptation. Incremental responses to climate change adaptation are often achieved through technological interventions and business-as-usual practices (e.g. building higher dykes to combat sea-level rise) and do not necessarily 'challenge or disrupt existing systems'.[9] Adaptation, when viewed through the lens of transformation, places a critical focus on the questions of power and preferences that often dictate the outcomes of adaptation action.[10] While incremental responses are important to address immediate climatic risks, transformational adaptation envisages adaptation as an opportunity to put forth 'novel policy options and position adaptation firmly as a component of development policy and practice'.[7]

Such an approach also pushes decision-makers to extend their concerns from proximate causes of risk including demographic characteristics and livelihood composition among others to directing fundamental change at the existing socio-ecological system, addressing root causes such as socio-cultural and economic structures, and questions of power as well as agency.[11] A major barrier to transformational practices is the silo-based nature of climate change adaptation, often operationalized in a project mode focusing on specific sectors. Such an approach fails to capture the integrated nature of the socio-ecological system as well as the intersections and continuous feedback loops that exist between different sectors. In light of the earlier discussions, this framing document outlines a comprehensive guideline that can aid in the formulation of a long-term adaptation strategy for India.

2. Pillars of Framework

This section builds on a broad approach that is recommended for developing a long-term adaptation strategy. Figure 2 shows the key determinants of a successful long-term CRDP, which also form the framework of this guiding document.

At the onset, it is imperative to take stock of the *Developmental Context* of the country. Climate change and development have direct linkages, and evidence suggests that climate risks pose a threat to the developmental process. The developmental context of a country influences impacts and vulnerabilities, shapes the responses to climate change, and governs the outcomes of adaptation. In the context of a developing country like India, policymakers must review the growth trajectory, identify key barriers and opportunities to integrate and better facilitate the developmental and resilience agendas.

The second pillar is a sound *Analytical Framework* that builds on the developmental context and provides an in-depth understanding of climate change realities and assumptions to design smart future policies. This pillar has a strong basis in climate science, integrating climate modelling, risk assessment, and vulnerability analysis. An essential aspect of this pillar is that it aims to address the uncertainties that often pose as hindrances in long-term planning. It looks at the need for granular and integrated assessment, and thorough landscaping to recognize the nature of uncertainties and ensure a robust, well-informed, and relevant adaptation decision-making process.

The third pillar of this framework, *Resourcing Adaptation,* forms a crucial aspect of the LTS. This section highlights the role of development indicators and socio-economic capital along with fiscal and technological capital with respect to climate change adaptation. It follows a three-step approach, which begins with conducting a landscape assessment of Human, Social, Infrastructural, and Natural Capital to understand the current scenario. The second step involves financial and technological mapping to understand the status and access to both these capitals and then estimating costs of future action. The third and final step focuses on resource mobilization and allocation, which includes allocation and redistribution of existing resources as well as additional resources to ensure the financial viability of a CRDP.

Governance of Adaptation forms the last pillar of this framework. It looks at ensuring strong institutional arrangements, effective stakeholder engagements as well as enhanced monitoring, evaluation, and learning in the adaptation strategy, thereby ensuring it is cognizant of the dynamism of climate change and adaptation.

These pillars address two critical issues that must be encompassed in the LTS – domestic development and building community resilience. The subsequent sections shed light on each pillar in a comprehensive manner, and highlight the challenges and opportunities associated with them.

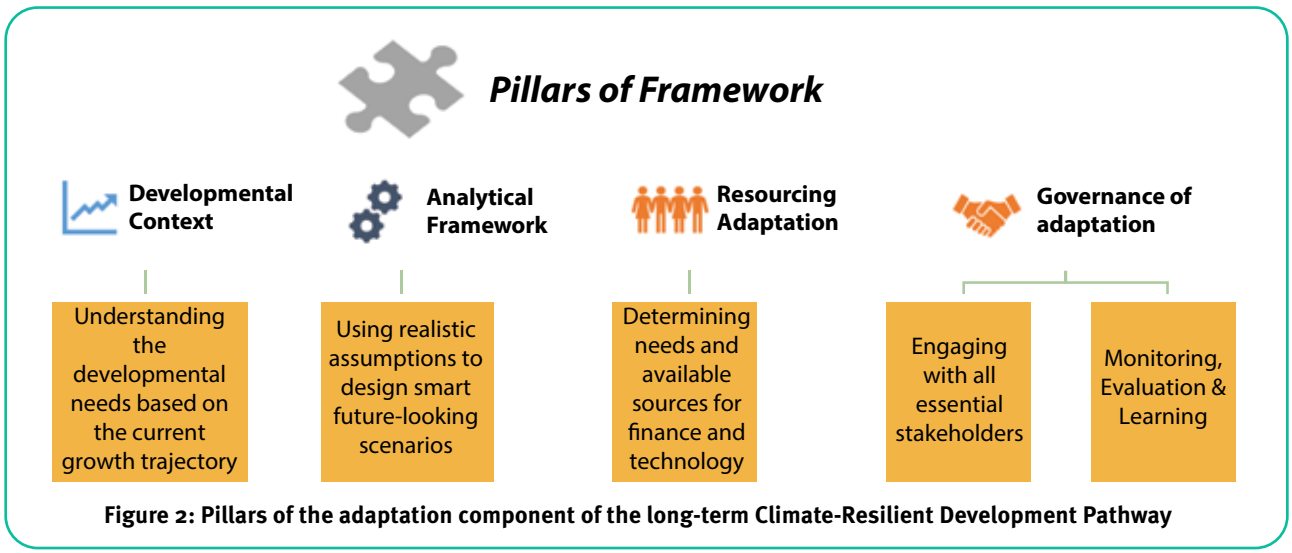


Figure 2: Pillars of the adaptation component of the long-term Climate-Resilient Development Pathway

3. Developmental Context – Linking Adaptation and Development

A plethora of literature exists that provides evidence on the close linkages between climate change and development, also arguing that climate risks and vulnerabilities derail the development process. Climate change is predicted to lead to a rise in India's population of the poor by 50 million, by 2040.[12] India, prone to hazards such as floods, cyclones, and droughts,[13] is also one among the most disaster-recumbent nations in the world with as many as 1.2 billion people exposed to fragile landscapes. Therefore, it is critical that India addresses climate change and developmental issues in an integrated manner.

The developmental context of a country structures the nature of impacts and vulnerability, individual and collective responses to climate impacts and, thereby shape the outcomes of adaptation.[14,15] Climate action, including adaptation and mitigation, plays a key role in realizing developmental goals. Adaptation is strongly embedded in the local developmental context and hence, coordination and integration with existing development action are crucial. It is thus imperative that CRDPs look at developing resilience across levels – national, subnational, as well as local level – making mainstreaming a key aspect. One possible solution to address this conundrum is to mainstream climate change into the decision-making and development planning process.[16] 'Mainstreaming' should not only create opportunities for effective and efficient use of resources, but also aid in achieving development that is resilient to current and future risks.[16,17] This addresses the critical aspect of tackling differential vulnerability and the potential trade-offs that exist between adaptation and development.[18] Such an approach also allows for a means to scale-up adaptation actions at the local level, aligning adaptation action with national development plans.[3] For example, a substantial case can be made for the integration of climate change in India's Five-Year Action Plan.

Additionally, while there are multiple benefits to mainstreaming climate change into development, a major factor that is associated with the climate discourse is that of uncertainty (Box 1). The proposed CRDP aids in the decision-making process by making it more flexible in terms of implementation and limits mal-adaptive practices. This practice would entail a mix of technological, financial, and governance solutions for climate change adaptation.[19] The participatory nature of this process allows for a more transformational approach to climate change adaptation.

Box 1: COVID-19 Pandemic and Decision-making Under Uncertainty

The COVID-19 pandemic has not only highlighted the aspect of uncertainty, but has also brought to the forefront the crucial notion of 'decision-making under uncertainty'. Living in the COVID world – beyond working for a safe and resilient future, a key issue is to defend the development gains today, which poses as such a huge global burden. The pandemic has exposed vulnerabilities across multiple levels, especially at the systems levels, and the world is currently struggling to find a restart button. The understanding of the nuances of such situations is necessary to envision a secure future.

3.1 Understanding Adaptation in Climate-Sensitive Sectors: Systems-Based Approach

Climate change is a complex issue that integrates many scientific fields to explain and estimate the immediate and potential long-term implications. The impact of climate change includes effects of GHGs on the planet's climatic system, energy balance, and ecosystems as well as social and economic systems.[20] A complex issue demands a layered response to tackle it, both at the temporal and spatial scales.

The Assessment of Climate Change over the Indian Region Report, published by the Ministry of Earth Sciences, gives the latest data on climate change observed in the Indian subcontinent. It reports that there has been a noted 0.7°C rise in the average temperature over India for the 1971–2018 period.[21] It also estimates that the average temperature is

projected to rise by 4.4°C over the country by the end of the century. The report also gives evidence to the changing precipitation pattern, increasing sea surface temperature of the Indian Ocean, rising sea level, increasing droughts, and changes in temperatures of the Hindu Kush Himalayan region.[21]

The report launched by the Global Commission on Adaptation in 2019 enumerates the imperative for climate adaptation on three fronts: the *human imperative,* the *environmental imperative*, and the *economic imperative*.[8] The report identifies five key systems that are severely impacted by climate change. These systems are – food, water, natural environment, infrastructure, and cities. Additionally, the report estimates that investing $1.8 trillion globally in five areas from 2020 to 2030 could generate $7.1 trillion in total net benefits.

The development pathway of India is marked by the dependence on climate-sensitive sectors – agriculture, water, health, infrastructure, natural ecosystems and forestry, and energy. This makes the socio-economic system of the country highly vulnerable to climate change and its impacts. For the purpose of the guiding framework, six sectors have been identified for developing a long-term strategy, namely – 1. *agriculture, 2. water, 3. urban 4. health, 5. rural health,* and *6. natural environment*. *Disaster risk management* and *resilient infrastructure* are cross-cutting areas relevant to all the six climate-sensitive sectors.

As discussed in the earlier section, there are several benefits to mainstreaming adaptation action. This narrative can be further strengthened by adopting a 'Systems Thinking' approach to identify adaptation action within the aforementioned climate-sensitive sectors. Systems thinking is defined as a 'cognitive paradigm that involves an implicit tendency to recognize various phenomena as a set of interconnected components that interact with one another to make a dynamic whole'.[22] This systems-based approach is cognizant of the dynamic relationship between the climate-sensitive sectors and is also underscored by the complexity of climate change. This approach encompasses the understanding that the social, economic, and natural systems are interconnected, they are constantly changing, and that human beings are members of this dynamic system.[23] Given the developmental imperative that exists in the Indian context, such a systems-based approach offers an avenue to build stronger synergies between development and adaptation planning in the long term.

3.1.1. Systems-Based Approach

Transformative adaption action necessitates the need for both inter-departmental coordination at local/ regional level, and inter-ministerial coordination at the national level to be cognizant of the dynamic relationship between climate-sensitive sectors. Consider Figure 3 to understand the proposed systems-based approach.

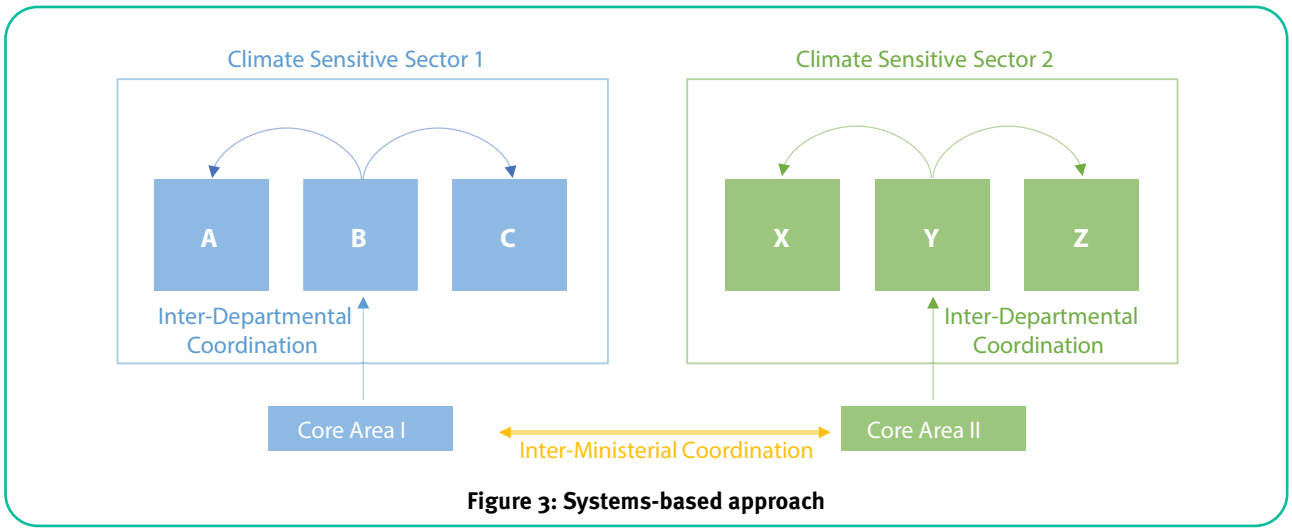


Figure 3: Systems-based approach

Systems 1 and 2 represent one of the climate-sensitive sectors discussed earlier. A, B, C and X, Y, Z are representative of various line departments, local/ regional government institutions associated with that particular climate-sensitive sector. Core areas I and II represent the ministries that oversee a climate-sensitive sector at the national level.

This systems-based approach that addresses risks within and across climate-sensitive sectors is further referred to in Chapter 7: Governance of Adaptation.

The following sub-sections describe the challenges faced by the climate-sensitive sectors. However, this is only an indicative list that can be modified to best address a climate-resilient development pathway.

3.1.1.1. Food

Climate change is a threat to food and nutritional security.[24] The Food and Agriculture Organization (FAO) defines food and nutritional security as, 'Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food, which meets their dietary needs and food preferences for an active and healthy life'. While India is self-sufficient in several food crops (such as rice and wheat), the country still faces the significant challenge of food insecurity. Food assistance schemes were introduced as early as the 1940s in India, and while they have had a significant impact on tackling hunger, food systems face new challenges.[25] These challenges such as increasing populations, improper natural resource management coupled with changing climate systems have made the country's food system susceptible to imbalance. Food systems are highly vulnerable since they are influenced by changing weather patterns, extreme weather events, and reduced quality of natural resources. Climate change has several impacts on food systems, including changing crop productivity as a result of changing weather, unequal access (for different social groups) to food exacerbated by the differential vulnerability. These impacts are expected to have an overall negative impact on the country's economic development.[26]

3.1.1.2. Water

India is the second most populous country in the world, but only has 4% of the world's total water resources. The country is heavily dependent on precipitation to meet its water needs.[27] The rise in the frequency of extreme weather events leads to increased instances of floods and droughts, and changing precipitation patterns lead to a natural reduction of groundwater recharge. Changes in the glacial melt also have severe impacts on some of the major river systems in India. Any alteration in the Ganga-Brahmaputra-Meghna system will have an adverse impact on irrigation and subsequently the food security of the millions of people dependent on this river system.[28] 'The Water Gap – The State of the World's Water' report estimates that more than 163 million people do not have access to clean water.[29] Droughts, reduction in groundwater levels, poor water management exacerbate this problem. The Composite Water Management Index released by NITI Aayog in 2018, states that an investment close to INR 20,00,000 crore is required to bridge the expected water supply gap by 2030.[30]

3.1.1.3. Rural

Rural areas are predominantly defined in terms of vast open areas and smaller settlements. Populations in these areas are dependent on several sources of income, of which agriculture and exploitation of natural resources have a greater share.[31] The dependence on agriculture and natural resources makes rural areas highly vulnerable to the impacts of climate change. These impacts compounded with existing vulnerabilities – poverty, lower levels of education – make these regions highly vulnerable.[32] The impact of climate change is twofold: first, it influences infrastructure and causes loss of life, and second, it adversely impacts agriculture and the natural resources that rural populations depend on.[33]

3.1.1.3.1 Agriculture-dependent Livelihoods

Agriculture plays an important role in the Indian economy. Along with fisheries and forestry, it is one of the largest contributors to the country's GDP. It is estimated that 49% of the country continues to be dependent on agriculture as its principal source of income.[28] For the 2017–2018 period, the Central Statistics Office estimated that the share of agriculture and its associated allied sectors accounted for 14.82% of the Gross Value Added (GVA). It is estimated that 70% of rural India is primarily dependent on agriculture

for their livelihood. This sector can be considered one of the most climate-dependent sectors since 52% of agriculture is rain-fed.[28] Changing climate, inadequate and unequal distribution of rainfall, rising temperature, sea-level rise, increased frequency of extreme weather events have an adverse impact on crop yield. This puts the rural economy at great risk. Agriculture plays a dual role in climate change – while the sector is highly vulnerable to climate change and its impacts, it is also a major contributor to climate change. Therefore, adaptation action within the agricultural system provides an opportunity to realize the goals of reducing vulnerability (thereby building resilience) and emissions reduction.

3.1.1.3.2 Non-agriculture-dependent Livelihoods

While agriculture plays a significant role in the rural economy, it is also shaped by non-agricultural activities and is constantly influenced by the ever-changing urban landscape.[26] The non-agricultural activities include mining and quarrying, manufacturing, and processing among others.[31] It has been noted that in the last four decades, the share of agricultural income in rural areas has reduced from 72.4% to 39.2%.[34] National data suggests that a staggering 88% of farming households are dependent on some non-agriculture-related activities for their source of income.[26,35] Non-agricultural activities are therefore becoming an important part of the rural economy. This calls for adaptation action in rural areas that consider both socio-economic and natural environment aspects to safeguard life and livelihoods.

3.1.1.4 Urban

The 2011 Census estimated that 31.14% of the country's population (about 377 million) lived in urban areas. This population is further projected to grow to about 600 million in 2031 and 850 million by 2051. This increasing rate of urbanization in recent decades is propelling the country to become the second largest urban system in the world. These growing urban systems increasingly face climate stressors in the form of heatwaves, floods, droughts, etc. Some of the largest and most densely populated cities in India are found along the country's long coastline and these are exceedingly vulnerable to sea-level rise and the associated risks. These risks include loss of land due to erosion, damage to infrastructure, and a heightened vulnerability to flooding. The compounded risks of rising sea levels and heightened vulnerability to flooding increase the destructive potential of storm surge.[8,21] Additionally, within urban areas, urban informal settlements face critical risks. Informal settlements are marked by poor and/or no access to basic infrastructure and services. These are often located at the most geographically vulnerable locations and are also faced with issues of legality. These factors make them particularly vulnerable, and these vulnerabilities are further compounded by the impacts of climate change.

There are around 50 cities in India that have a million-plus population and often experience disasters that have a devastating impact on the socio-economic system. The floods that affected the cities of Kochi, Chennai, and Mumbai in 2019, 2015, and 2005 respectively, necessitate the need for adaptation planning at the city level. In the face of such enormous challenges posed by a changing climate and existing socio-economic inequalities, cities must address the components of disaster risk management and building resilient infrastructure.

3.1.1.5. Health

Several studies indicate that climate change poses a major threat to human health. High temperatures and extreme weather events have been associated with increased risk of heat strokes, waterborne and vector-borne diseases, etc. With the country witnessing record temperatures in consecutive years, heatwave occurrences have become common and urban areas are left with the twin challenges of heat stress and urban heat island effect. Higher moisture content and warmer temperatures are conducive for the spread of vector-borne diseases. The threat posed by climate change to agriculture and water resources can impact the affordability of food and potable water, thereby leading to reduced nutritional intake especially in the economically weaker sections.

3.1.1.6 Natural environment

India accounts for only 2.4% of the world's land area but is home to 7–8% of all the recorded species on the planet and has four out of 34 biodiversity hotspots. Several geographical regions in the country are

extremely vulnerable to the impacts of climate change. The Himalayan ecosystem, coastline (7517 km), forests, deltas, mangroves are some of the natural environments that face the threat of climate change. These areas are of paramount importance since they provide natural protection against the changing climate. For example, forests play a vital role in regulating water services, mangroves provide a natural protection against storm surges, etc. These ecosystems underpin the smooth functioning of the economy and society as a whole.[36] Several studies show us that these ecosystems bear the brunt of threats and severe destruction due to anthropogenic activities. This calls for action to harness the potential of nature-based solutions and ecosystem-based adaptation to build community resilience.

3.1.1.6.1. Cross-cutting Areas: Disaster Risk Management and Resilient Infrastructure

A common theme that emerges as a cross-cutting issue across the sectors is the need for disaster risk management and climate-resilient infrastructure to deal with dynamic changes. India ranks 14 on the Climate Risk Index 2020, released by Germanwatch.[37] Each year, weather-related extreme events lead to loss of life in the thousands and economic losses in the billions. 'Assessing India's mounting climate losses to financial institutions' by Action on Climate Today (ACT) notes that the economic losses have doubled in India over the last decade.[38] These risks have, especially in recent times, accumulated and intensified, further straining the limited resources. Scientific evidence further suggests that this trend of compounded risks shall also continue, and as a consequence, this will have a cascading effect across all sectors. This further strengthens the need for adaptation planning and action in the longer run.

3.1.1.6.2. Disaster Risk Management ‹H4›

Given the geographic and climatic diversity, India is prone to all major natural disasters. According to the National Institute of Disaster Management (NIDM), about 58.6% of the country's landmass is prone to earthquakes; over 12% (40 million hectares) of land is prone to flooding; of the 7516 km long coastline, close to 5700 km is prone to cyclones and tsunamis; and 68% of cultivable land is prone to droughts. As per the UNDRR (United Nations Office for Disaster Risk Reduction) mandate, disaster risk management entails understanding risks and their impacts, reducing associated losses and preventing the emergence of new risks.[39] Disaster risk cuts across sectors and when coupled with compounding risks, the role of disaster risk management plays a crucial role in building resilience. Disaster risk management in India is based on proactive prevention, mitigation, and preparedness for conserving developmental gains to minimize loss of life, livelihood, and property. These steps would aid in sustainable development towards a more resilient future.[40]

3.1.1.6.3 Climate-Resilient Infrastructure ‹H4›

The aim of addressing developmental agenda can only be realized with sound investments in infrastructure. Innovative infrastructure can play the dual role of emissions reduction and building resilience.[41] Climate-resilient infrastructure encompasses climate-resilient buildings and essential services such as reliable power, road networks, water and sanitation, and health infrastructure. The lack of sound investments in these kinds of infrastructure will have severe impacts across the social and economic systems. Therefore, the dominant theme that emerges is the need for climate-resilient infrastructure to be integrated into all climate-sensitive sectors. An initiative like the Coalition for Disaster Resilient Infrastructure (CDRI) by the Government of India is a crucial step to realizing the goal of building climate resilience. The government has pledged USD 70 million to fund this coalition that aims to pool not only resources but to share best practices and to build resilience. Addressing the twin challenges of inadequate infrastructure and climate change risks paves the way for building resilience and a transformative approach to adaptation.

Box 2: A Systems-based Perspective of Heat Stress Management

With the rise in global temperatures, increased instances of *heat stress* will become more common. Heat stress refers to *'heat received in excess of that which the body can tolerate without suffering physiological impairment'* which especially increases workers' vulnerability and occupational risks.[42] Adaptation action plays a critical role in addressing heat stress concerns.

A report by the Ministry of Earth Sciences points out that it is likely that India will experience increased frequency of warm days and nights in the coming decades. It is also projected that the frequency, duration, intensity, and areal coverage of heatwaves will likely increase during the course of the century.[21] India's highly vulnerable status necessitates that heat stress management be applied using a *Systems Thinking* approach. It is crucial that adaptation measures are implemented across sectors that will most likely be impacted by heat stress.[42]

1. Agriculture (technological improvements to adapt more effectively to heat stress, research on heat-resistant crops, promoting mechanization and skills development in order to ensure higher productivity and food security, thereby enhancing access and efficiency of supply chains and storages)
2. Rural (with respect to early warning systems, monitoring and information sharing on weather conditions in agricultural areas)
3. Urban (adaptive measures to be provided for the most vulnerable communities within urban areas; energy efficiency of buildings addressed in both domestic and commercial sectors; increasing green cover)
4. Health (infrastructure to cope with increased future inflow related to heat stress)

A systems-based thinking approach as elucidated earlier can be adopted to ensure adaptation and build resilience.

4. Analytical Framework

4.1 Risk Profiling

An exhaustive understanding of current/past climate risks is one of the most important foundations for the formulation of adaptation strategies to manage future climate risks. It is also necessary to consider the relationship between past risks and the adaptation strategies developed to manage those risks.

The changing climate creates cascading risks in various key sectors such as food, rural, water, urban, health, and natural environment, which are often interrelated and even lead to undesirable consequences at various scales. Although climate change impacts on individual systems are extensively studied, their overlaps and interactions are rarely considered. However, as stated in the previous pillar, these impacts lead to indirect impacts in other regions, thus intensifying the challenges to adaptation. Therefore, it is a major scientific challenge to assess climate change risks across domains and that too in a meaningful manner for the decision-makers.

Risk profiling (Figure 4) is a key element in the risk assessment process of a region. It is developed by identifying the types of events that could occur in a particular geographical location, the probability of the occurrence of events with varying severity and the impacts of those events including economic, infrastructure, socio-cultural, and public health losses.[43] A granular scale risk profiling and risk assessment can assist regional scale long-term adaptation planning by identifying areas with varying exposure to various climate change-related hazards and formulating a step-based plan to prepare and mitigate possible repercussions such as sea level rise, extreme heat, storms, flood, droughts, etc. It would also make the communities well informed about the reality of the risks that they could face in the near future.

A robust adaptation strategy should underpin scientific evidence and latest technologies. The best available information on the current and future climate will support informed decision-making on adaptation. For the same, it is suggested that an LTS includes

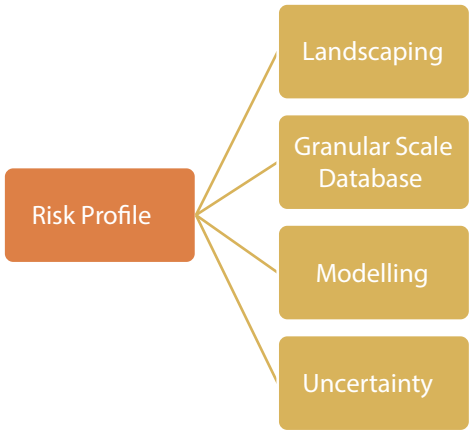


Figure 4: Pillars of Risk Profiling

a *Landscape Assessment,* generation of a *Granular Scale Database, Integrated Modelling Approach,* and acknowledgment of *Uncertainty* in the process.

4.1.1 Landscaping

A *landscaping* exercise is imperative to understand the current state of climate risks and assessments being carried out in the country, which helps in identifying the relevant loopholes and limitations within the available resources. Such a practice would also be beneficial for recognizing the key questions and components that need further clarification. Landscaping is also necessary to identify the current challenges being faced by climate risk decision-makers, namely in terms of identification and interpretation of timely, reliable, and appropriate climate risk information and then using that to make well-informed decisions. Proper landscaping paves the way for the formulation of a comprehensive and holistic climate risk profile of the country that incorporates the solutions to address the shortcomings in the existing practices.

4.1.2 Granular Scale Database

One of the key considerations to generate a robust climate risk profile is the scale. Since most of the climate change impacts are local in nature, these are best addressed through bottom-up methods, which are suited to particular activities and locations. The climate change risks that a particular community faces vary from place to place. Hence, a localized risk profile is always a preferred choice as it takes into account the

unique characteristics of an area. It helps communities engage in an informed and comprehensive decision-making process. A local-scale risk assessment and profile help in identifying the parts of a community that might be at risk.

Currently, climate-related information such as extreme weather and climate-scale events, climate projections, and risks of climate change etc., are available for both global and national levels. However, the most challenging aspect is the translation of the available information into information more relevant at the local and city level due to limitation in granular data at that scale. The lack of data hinders the development of a strong adaptation strategy. Hence, an emphasis should be made on generating a comprehensive granular scale database on climate change risks and impacts by assisting the translation of available global information onto regional and local levels. A coarser resolution data for risk could be relied upon as a first degree of approximation in case of non-existence of local level risk information, e.g., while moving from the district level to the state and zonal level.

Although climate modelling data sets for India are available on the CORDEX India website, which is being coordinated by Indian Institute of Tropical Meteorology, Ministry of Earth Sciences, Government of India, the data sets lack granularity and do not provide sufficient resolution to draw out substantial information over district scale.[44] Currently, these are the only dynamically downscaled global modelling data sets available with the Government of India. These data sets provide information on meteorological parameters and seldom include information about sectoral impacts.

While identifying various climate risks, it is also important to classify the risks according to the systems or sectors based on their impact, such as for agriculture, water, health, urban, and natural environment. This would help in further granularizing the risks system-wise and present different options to either adapt with, mitigate or avoid the impacts**.** In the past, many institutions in India have incorporated the climate modelling data sets for assessing the climate risks for different states as well while drafting the State Action Plan on Climate Change**.**

4.1.3 Modelling

To effectively understand the future climatic conditions and the associated risks, a set of different kind of models can be used. One approach is to use the latest state-of-the-art Integrated Assessment Models (IAMs). These are a unique class of models that integrate global biophysical and economic systems.[45] It has become a common tool for assessing strategies to address climate change, including the costs and benefits of such strategies over time.[46] It highlights how the human development and societal choices in the future could affect and interact with the regional climate, which is necessary to determine and support national-level and regional-level adaptation policy decisions between different choices. Such an integrated assessment modelling tool brings together all the elements including climate economics, population growth, etc., and therefore, provides a picture of what the future would look like. It provides a coherent framework for understanding the climate change problem and for informing judgements on different options to deal with climate change.

An alternate approach is the use of a combination of hybrid coupled climate models and impact models. Even though, Global Climate Models (GCMs) provide reliable climate-related information and support a better understanding of the variability and changes on a large scale, the information from GCMs is, however, spatially too coarse to assess the regional or local scale impact of climate change. GCMs also have large biases and uncertainties attached in representing the current and future climate and these issues cascade to the local scale, which limit the applicability of GCMs in impact assessment studies.[47] Hence, to bridge this gap between the GCMs and impact models, downscaling techniques should be used to synthesize the regional or local-level climate information from the GCMs. Therefore, a suite of regionally relevant and bias-corrected, high-resolution regional climate models should be used for simulating the regional-level climatic parameters as required by impact assessment models. Impact models are a class of models which model the impact of climate change including on a range of economic sectors. These models incorporate climate model outputs and analyse how these can

impact environmental changes on various sectors such as agriculture, water, health, and urban, and natural environment.

4.1.4 Uncertainty

Uncertainty can be defined as a state of incomplete knowledge that can result from a lack of information or from disagreement on what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminologies, or uncertain projections of human behaviour. Uncertainty can, therefore, be represented by quantitative measures (e.g. probability density function) or by qualitative statements (e.g. reflecting the judgement of a team of experts).[48] Climate change assessments are often dominated by uncertainty and affect the choice of methods and the confidence attached to the results. Uncertainty is considered a major hindrance to well-informed adaptation policy. There can be many sources of uncertainties related to climate change impacts and adaptations, which include measurement errors, natural variability resulting from unpredictable natural processes within the climate system, model limitations, future emissions trajectories, future changes in societal preferences, etc.[49] Often, improper consideration for uncertainties leads to increase the likelihood that action taken will be inadequate, inappropriate or increase vulnerability. Hence, recognizing the nature of uncertainties is crucial for a robust, well-informed, and more relevant adaptation decision-making process.

Based on this understanding, what is proposed is that the following principles must guide the risk profiling exercise of an LTS:

1. The need to have strong and comprehensive landscaping before risk profiling and risk assessment.
2. An understanding of an ideal, prescribed scale at which the risk profile must be developed, emphasizing the need for granular scale data to improve the accuracy of evidence that further informs adaptation.
3. Use of various possibilities and methods of modelling, ideally through state-of-the-art Integrated Assessment Models (IAMs) or alternatively, a combination of hybrid coupled climate models and impact models to have relevant, regional scale understanding of climate risks that form the basis of the development of adaptation strategies.
4. Acknowledging the importance of uncertainty to be embedded in the communication of climate information for adaptation planning.

4.2 Vulnerability Assessment

Understanding vulnerabilities constitutes an integral component of mainstreaming climate change into the existing policy mechanisms. Vulnerability to climate change is subject to a range of social, economic, and environmental factors that a system is exposed to. Vulnerability Analysis (VA) refers to the process of identifying, quantifying, and prioritizing the vulnerabilities to climate change in a system. The dominant literature on vulnerability and adaptation is impact-oriented and focuses largely on specific outcomes of climatic risks on socio-economic systems.[50] However, to harness the transformative potential of adaptation measures, VA must have a renewed focus on structural rather than proximate causes.

The IPCC[51] provides a typology of vulnerability under which it is identified as encompassing two key elements – adaptive capacity and sensitivity. Sensitivity refers to the degree to which a system will respond to a change in climate, either positively or negatively. Adaptive capacity describes the ability of a system to adjust to actual or expected climate stresses or to cope with the consequences. The IPCC WGII AR5 also refers to the capacity to adapt as 'a function of wealth, technology, education, information, skills infrastructure, access to resources, and stability and management capabilities'.[52] This highlights the multiple dimensions to risk and vulnerability and, consequently, reiterates the argument that climate change VA should go beyond simple analysis and quantification of immediate climate change-related hazards and exposure. It should be capable of informing adaptation planning and policy by identifying 'hotspots', reasons/causes of vulnerabilities and, understanding how

different elements interact within a system and in the larger narrative of a changing climate. It assesses characteristics of the system itself and its response to hazards – i.e. sensitivity and the system's ability to deal with anticipated impacts – i.e. adaptive capacity.[53] A thorough VA helps establish an understanding of the extent to which climate variabilities and extremes will affect the system in question. It also carries forward the understanding from defining climate risks, while it elucidates on the questions of who and/or what is at risk, to what extent and from what. It integrates information regarding climate risks with risks that are socio-economic, political, infrastructural, financial, institutional, and technological in nature within a system.

'Vulnerability is systemic, and a consequence of the state of development. It is often manifested in some aspect of the human condition, such as under-nourishment, poverty, or lack of shelter. Outcomes are determined by a combination of climate hazards and system vulnerability'.[54] The existing human condition, socio-economic, cultural, and political factors act as key drivers in amplifying the vulnerability of a system to climatic variability and extreme weather events, as well as impact the capacity to deal with such changes. India has historically always been a climate-sensitive region because of its vast landmass, which is surrounded by oceans and mountains. However, over the years, there has been a significant shift in the pattern of climate risk in the country, and its vulnerability as impacted by its state of development. Poverty and inequality continue to be two drivers that increase our society's vulnerability to climate risks. Further, relational vulnerabilities and their outcomes are manifested in the Indian context such as increased vulnerabilities of those engaged in agriculture and allied sectors, as well as those belonging to marginalized groups.[55]

India's vulnerability to climate change, in this regard, is influenced by a mix of non-climatic drivers, including those related to its economy, social development, governance, and environmental sustainability.[56] India's economy is tied to crucial sectors such as agriculture, water resources, natural ecosystems and forestry, health, sanitation, infrastructure and energy. It must also be noted that regions with medium, low climate sensitivity can still be highly vulnerable to climate change due to low adaptive capacity. The extent of biophysical and socio-economic diversity in India calls for focused VAs of different landscapes. These focused VAs, it is thus suggested, could be based on arid and semi-arid areas, coastal zones, and the Himalayan regions.[25] Such an assessment may also need to be mindful of urban, rural, and rurban contexts. Further, inter-linkages and the inherent complexities prevalent in the climatic and socio-economic systems impact the definition of 'vulnerability', and therefore, who/what is vulnerable evolves. This highlights a need for regular VAs which inform adaptation planning accordingly. Thus, it can be inferred that there exists a need to analyse short, medium and long-term projections of climate change over India along with their impacts on key economic sectors and human systems at sub-regional scales.[27,57] Such an assessment would allow informing adaption planning and policy in a manner that is regionally as well as temporally contextual (Figure 5).

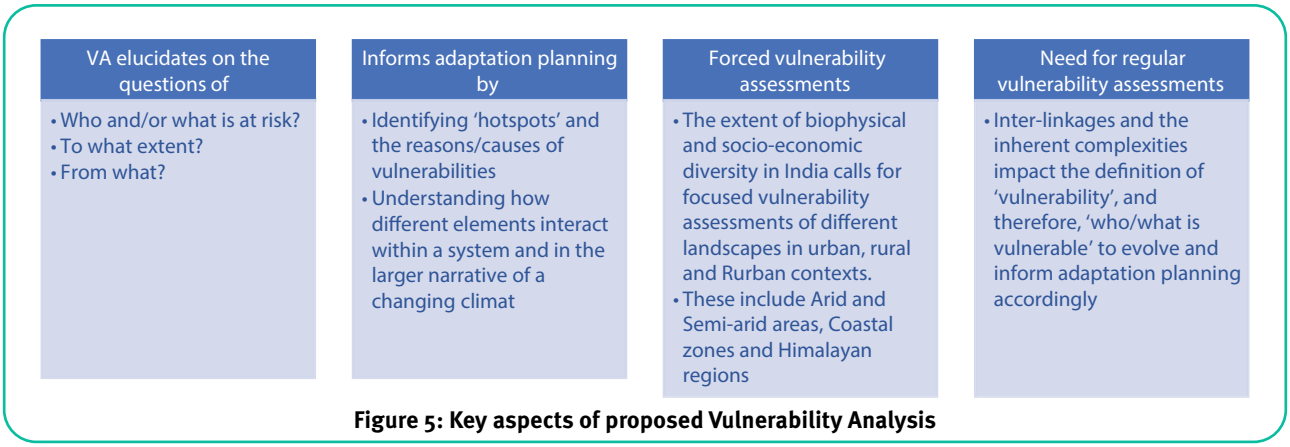


Figure 5: Key aspects of proposed Vulnerability Analysis

What is thus proposed is that adaptation planning is informed by a thorough understanding of contextual vulnerabilities and not limited to climatic risks, but also encompassing socio-economic factors. In the long run, for effective policy, VA must focus on certain principles which include the following:

1. A strong basis on inferences of current and future risks from climate sciences. While there exists a high degree of uncertainty in long-term planning, science-based risk assessments and climate modelling provide evidence in minimizing these uncertainties and better inform future and long-term action.

2. The VAs should be focused on scientific and downscaled studies, i.e., ensuring the VA encompasses all landscapes and contexts. Landscapes may be divided into arid and semi-arid areas, coastal zones, and the Himalayan regions, 25 as has been done in previous assessments in India. With respect to contexts, it is recommended that the analysis should encompass the urban, rural and the rural-urban (rurban) continuum.

3. An understating that the VA must inform adaptation planning should be embedded in the process. The VA should also answer key questions of who and/or what is at risk, to what extent and from what, providing a clear insight into the identification of hotspots and understanding interactions within a system.

4. Given that climate change is a dynamic phenomenon, its effects and their consequent contexts and risks are ever-changing. Additionally, vulnerability as a concept is a constantly evolving phenomenon. Thus, it underscores the requirement of regular VAs to be conducted to ensure pertinent and timely formulation of long-term policies.

5. Such a thorough and regular understanding of vulnerabilities also safeguards against maladaptation while planning, thereby enhancing the relevance and effectiveness of these policies.

5. Resourcing Adaptation

This section discusses the framing of resourcing strategy for adaptation following an account of the methodology and rationale. To begin with, it must be noted that adaptive capacity is linked directly to broader development indicators, such as education levels and existing technical capacities, along with the current and future state of natural environment, which are dynamic in nature.[58,59] Thus, climate change adaptation must be understood within these constantly evolving socio-economic and developmental contexts. Further, actions that lead to adaptation enhance a system's coping capacities, just as their existing state determines the level of response to adaptation action. This implies that adaptation entails within it a certain level of uncertainty that requires deepening of human, social, and technical capital that further equips us to respond at the same pace of change in climate and its impacts.[60] As a result, efforts to get the right financing (fiscal mechanisms) in place are as important for successful adaptation as is ensuring having the right institutional structures, investment in social and human capital, legal framework, and political will.[61] Adaptation planning, thus, requires critical inputs that go beyond, but are not unresponsive to, financial and technological capital. So, for the purpose of this document, we use the broader term 'Resourcing for Adaptation' in place of financing.[62,63]

The pathway proposed by this Long-Term Strategy (LTS) reiterates the need to integrate and align long-term climate adaptation and resilience-building goals to sustainable development goals, as has been noted in India's National Action Plan on Climate Change (NAPCC). Resourcing for adaptation, thus, requires mobilization and allocation of resources, which is informed by a thorough landscape assessment and future-scenario analysis. Building on this need for a more holistic, integrated approach to adaptation planning and investment, the LTS proposes a three-stage analysis and planning framework for climate adaptation-related resourcing. *Stage 1* includes assessing capital for adaptation with reference to human, social, natural, and infrastructural capital. *Stage 2* involves a financial and technological assessment, and *Stage 3* refers to mobilization and allocation of resources.

- **Stage 1: Assessment of Human, Social, Infrastructural, and Natural Capital**

This document proposes a pathway that aims towards the development of aligned and integrated policies for catalysing long-term resilience. As an initial step, an assessment of its Human, Social, Infrastructural, and Natural Capital is proposed. Successful and effective utilization of resources allocated to adaptation is contingent on these components. Such an analysis would, thus, provide a baseline assessment of current capacity and access within each capital component and, a baseline report could help further highlight levels of vulnerability, which may affect the urgency and type of action required. Additionally, a future needs assessment could be helpful to understand better what kind of resource allocation for capital development is required to improve adaptive capacity and reduce vulnerability.

An assessment of the NATCOM-II by Patra[56] revealed that adaptation planning and programmes in India have primarily focused on agriculture, water, and disaster risk management systems. The health and natural environment systems, as well as social components such as dimensions of gender and inequality, continue to receive little attention. Landscaping of the current social, human, infrastructural, and natural capital as suggested in this stage could bring forward such socio-economic realities and help address the gap.

- **Stage 2: Financial and Technological Mapping**

To begin with, it is proposed that a technological mapping exercise be conducted on the status of and access to existing technological capacity, along with a review of the best available technologies (how those can be accessed, their costs, etc.). This would generate a better understanding of the need for technology and their efficient allocation. Moving further, a step may be estimating the financial costs of adaptation action, in addition to those of acquiring and distributing best technologies. This would allow estimating costs of execution and implementation of proposed plans, thereby analysing their financial viability. Such an analysis, at this stage, would include accounting for both existing domestic and international climate and development funding through proposed projects and

policy measures, as well as finance earmarked through national development plans.

Following this, the identification of a need for resourcing with respect to finances, technology, and/or a need for capital-specific research and development within the country would be beneficial and better inform planning for resource allocation and mobilization. For example, in the case of development of disaster-resilient infrastructure on the flood-prone east Indian coast, a project may face any of the three shortfalls: (a) lack of financing for such a project, (b) lack of access to Flood Resilience (FRe) technologies or (c) lack of a locally contextual, suitable, pre-existing measures that address all vulnerabilities of the area. Effective adaptation in such a case would occur only if resources are chosen and allocated with careful consideration of local issues.

- **Stage 3: Resource Mobilization and Allocation**

Article 7 of the Paris Agreement determines that countries should put more emphasis on adaptation planning and based on this planning, Parties should strengthen national and international cooperation, including through the transfer of funds.[1] Presently, according to India's adaptation financing is derived primarily from its national budget. However, most of these allocations have been only through traditional development plans. An analysis of India's budgetary allocation for climate change adaptation programmes also found that a low level of integration existed between allocation towards building human capabilities and their assets, and, towards natural resource management. This further points towards several gaps in policy with reference to internalization of the development-adaptation continuum.[64]

India is amongst the top recipients of international financial assistance for climate change policy and action.[65] Despite this, relatively little is aimed specifically toward adaptation. A review of the findings of Climate Funds Update brings to light that of all financing allocated from dedicated multilateral and bilateral climate funds since 2003, USD 54.23 million,

Box 3: Resourcing Adaptation – A System's Perspective

As per International Labour Organization's 'Working on a Warmer Planet' report (2019), with respect to the global economy, response to increased risks of heat stress should include[42] the following:

1. adaptation policies and actions to protect workers from these conditions;
2. overall strategy to mitigate climate change and limit further temperature rise;
3. structural reforms to help agricultural workers achieve the transition to other sectors;
4. measures to prepare for climatic hazards.

Continuing with the example of heat stress management mentioned in the 'Key Systems' chapter, with respect to resourcing, it is suggested that within the identified systems (agriculture, rural, urban, health, water) a more nuanced *assessment of social and human capital* is conducted to provide an estimate of those at risk and at what level. This would allow clarity as to what, where, and how resources must be mobilized and allocated. Further, *technological and financial mapping* would allow formulating a coherent approach to ensure adaptation along with sustainable economic development.

For example, within the agricultural sub-system itself, adaptation measures to manage heat stress would include 'technological improvements to adapt more effectively to heat stress, research on heat-resistant crops, promoting mechanization, and skills development in order to ensure higher productivity and food security; enhancing access and efficiency of supply chains and cold storage'.[42] Such measures would require financial investment to aid in the technological and infrastructural development. It would also require skilling human capital to best utilize this infrastructure, and re-skilling them to continue being effectively employed in a world where their work profiles or professions could also change.

which amounts to only 4.4% of the total funding, has been allocated to Adaptation in India. Whereas, USD 1119.929 million, or 91.04%, has been allocated towards Mitigation.[66] It can be inferred that India requires directed funding for adaptation planning and programmes. This could be through reallocation of funds or additional funding, including financing beyond developmental funding. Thus, as the next step to Financial and Technological Mapping, in consideration of existing development finance earmarked for both development and climate adaptation action, allocation of existing resources – which may also include redistribution to increase effective use, along with additional financing – to address the various challenges in effective adaptation to climate change is suggested. Herein, a need for skilling human capital to best utilize technical and procedural advances is equally crucial.

Following the allocation of existing resources, there may continue to be a need for additional support and knowledge sharing which can be addressed through multiple channels. These include, first, through bilateral or multilateral engagements for international climate and development finance. Second, through new and innovative financing tools and methods such as via private-public partnership to finance long-term action, which has the potential of increasing the financial viability of certain development alternatives.

6. Governance of Adaptation

A 'coherent and integrated regulatory response' is an essential requirement to deal with systemic risks, the prominence of which is reflected in the high impact and increasingly regular climatic events (such as cyclones, floods, etc.) and the latest in the COVID-19 pandemic. The interdependencies and the strong coupling of systems and risks, the absence of a deterministic trend in its evolution, effects that transgress national boundaries, the presence of tipping point beyond which a complete collapse of systems might be witnessed and the gap in regulatory and policy response, render such events within the tightly held framework of what Schweizer (2019) (Figure 6) defines as 'high complexity, non-linearity, transboundariness, tipping points, and lag in regulation and perception.'[67]

A governance system, defined by the Global Assessment Report 2019[68] as encapsulating 'actions, processes, traditions, and institutions (formal and informal) to reach and implement collective decisions', would therefore need to imbibe the very qualities of interconnectedness, constant evolution, and transboundariness to be able to better gauge and give an appropriate corollary regulatory response.

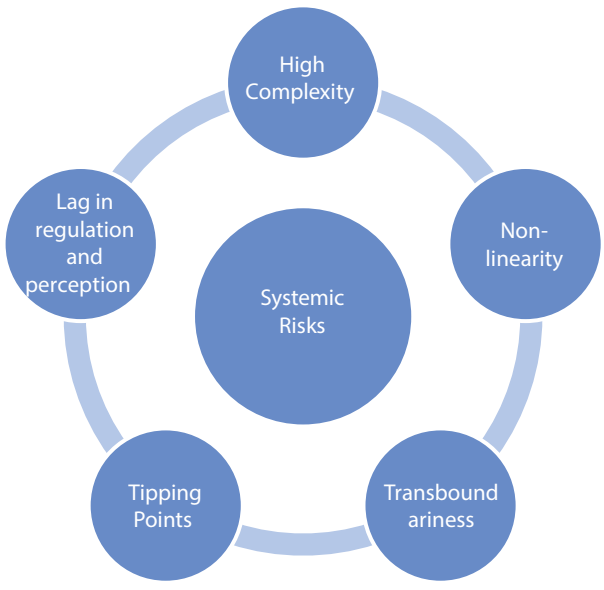


Figure 6: Systemic risks in the governance of adaptation

Source: Adapted from Schweizer (2019)[67]

The evolution of a CRDP, therefore, calls for 'transformative actions' which in turn would require the foundational basis of institutional structures and processes to be strong, interconnected, and evolving and which '*adaptively manage the allocation of resources and processes of change*'.[4] Thus, this underscores the need for a network mode of governance which reiterates the integration of institutional structures, interventions, and processes not just across scales at national, state, and local level but also with corresponding horizontal integration. This allows for institutional structures and governance framework to reflect the key priorities of '*Inclusivity, Ownership, and Equity*'.

Inclusivity: Resulting from stakeholder inputs from varied scales (national, state, and local), sectors/systems (urban, rural), and type (government, private sector, NGO, civil society, academia).

Ownership: Allowing for better uptake of resultant institutions, processes, and interventions across scale, sector, and type of stakeholders.

Equity: Ensuring that there is equity in the representation of needs, challenges, and opportunities for all the relevant stakeholders in the ensuing institutional structure.

In India, the recognition of climate change as a divisive factor and the reflection of it in policy and institutional framework were first seen with the establishment of the Prime Minister's Council on Climate Change (PMCCC) in 2007. It was formed largely to formulate the national action plans on assessment, adaptation, and mitigation of climate change. The sub-group on climate change, which made recommendations to the 12th Five-Year Plan, suggested renewed focus on key areas such as impact assessment, adaptation strategies, mitigation options, and capacity building. The PMCCC along with relevant government departments released the National Action Plan Climate Change (NAPCC) for India in 2008, which elucidated 8 national missions

to aid in the climate change mitigation and adaptation strategies in India. The NAPCCs were then decentralized through the mandate that required each state and UT in the country to prepare their respective State Action Plan for Climate Change (SAPCC).

The establishment of a multi-level and multi-sectoral institutional structure has ensured that the pathway to adaptation planning in the country be embedded in a more integrated development planning. Mangotra, Ahuja, Spencer, *et al.*[2] captures the current institutional coordination and integrated planning of climate governance in India, across levels in Figure 7. This is reflective of programmes in the country that integrate climate action with employment generation, afforestation, and empowering women, and local youth. Apart from an evolving focus on climate at the domestic level, India has also mainstreamed the same as part of its global and regional relations, thus allowing for greater access to resources that are financial and technological in make.[56]

To continue encouraging a governance process that moves away from the traditional 'one-off planning' to a more iterative and interactive exercise, would involve laying emphasis on two key features of the framework (Figure 8), which are as follows:

1. Stakeholder Engagements
2. Monitoring, Evaluation, and Learning

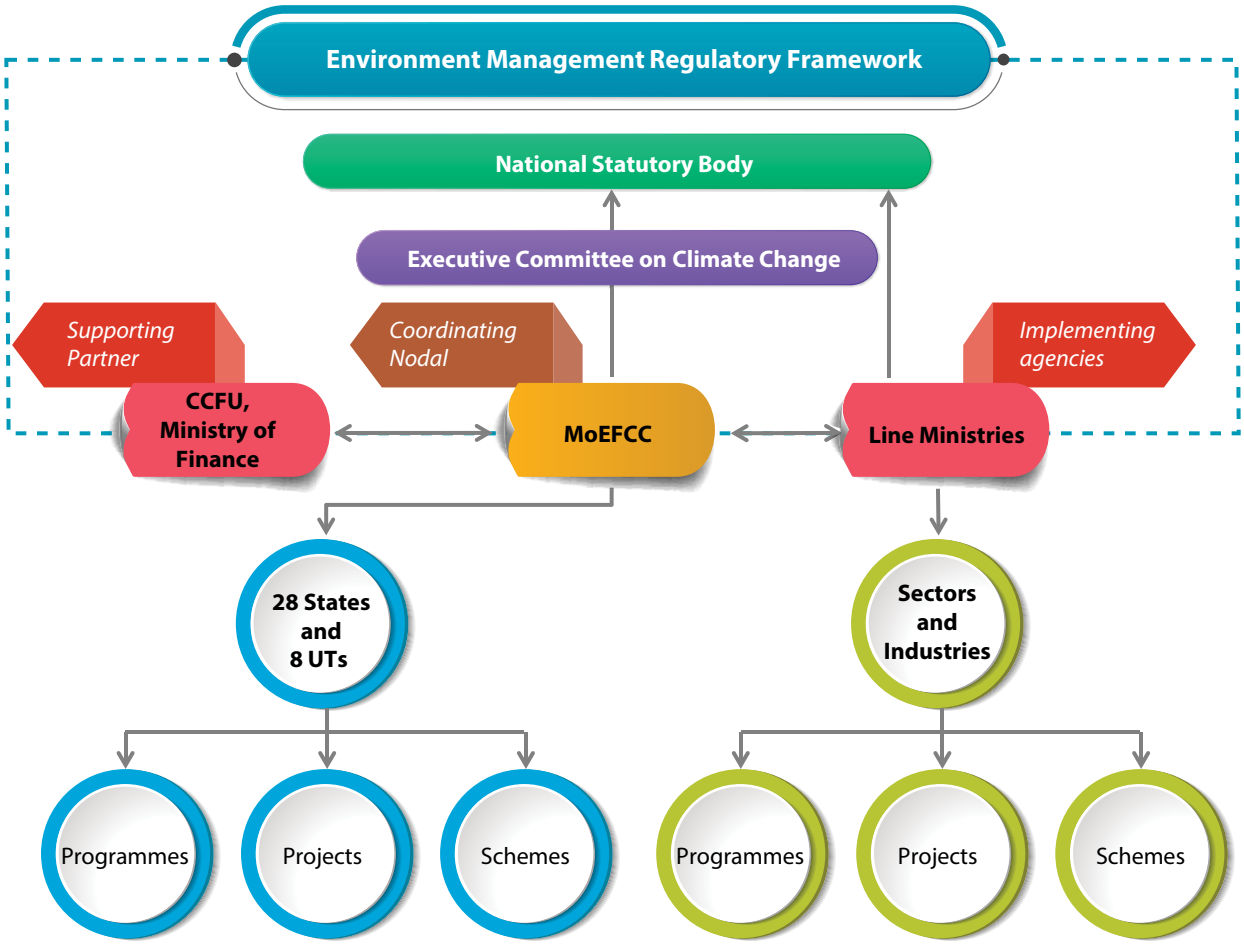


Figure 7: Indian Institutional framework with respect to the Environmental Management Act

Source: Mangotra, Ahuja, Spencer, et al. (2020)[2]

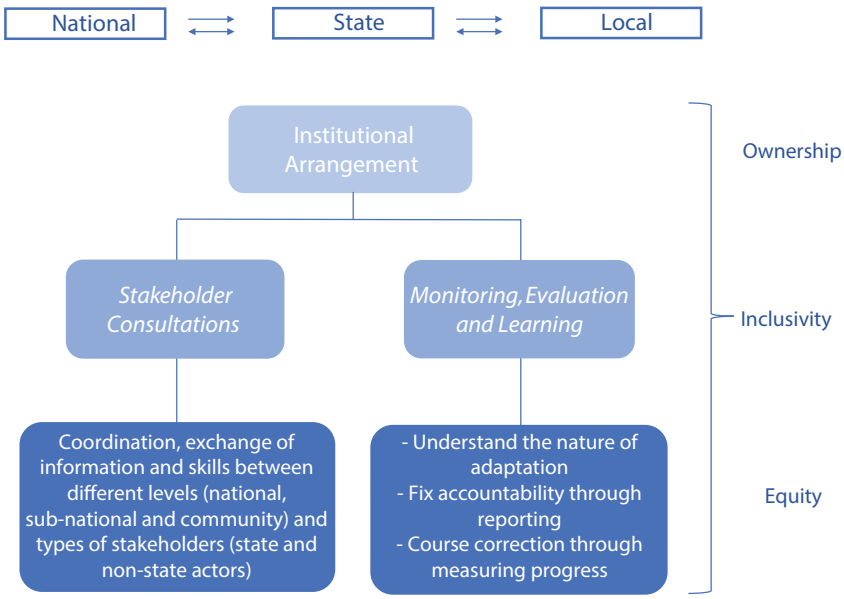


Figure 8: Governance Framework

6.1 Stakeholder Engagement

An active and timely stakeholder engagement (Figure 9) is one of the cornerstones of a well-functioning climate governance structure. Stakeholder engagements, as part of adaptation planning process, would require to underscore participatory and consultative approaches that involve relevant stakeholders at all levels (national, sub-national, and local) in order to allow for more inclusive and holistic designing of policies and better uptake of the said policies at the implementation and scaling up phase. The increasing *Fragmentation* (owing to the presence of multiple sub-systems, public and private sector organizations), *Complexity* (stemming from interconnectedness and interdependencies of problems and their solutions), and *Dynamism* (unpredictable changes due to the continuous interactions of institutions, procedures, and processes across stakeholders and systems) within the societal structure make an interactive form of governance more appreciable.[69]

Regular and exhaustive stakeholder consultations, which form a key part of such innovative governance practices allow and encourage coordination, exchange of information/knowledge and skills between different levels (national, sub-national, and community), type (state and non-state actors) of stakeholders, and also encourage pertinent collaborations between the various sectoral line ministries and the state governments. It underlines an important step towards 'proactive, integrated, and cross sectoral approach' that functions using the different agents/nodes in the interconnected systems and levels.

Figure 9: Stakeholder Engagement

Source: Mangotra, Ahuja, Spencer, et al. (2020)[2]

Some of the key points to be kept in mind for the stakeholder consultations are as follows:

1. **Identifying Stakeholders**: Effective consultation would entail identification of key stakeholders, both state and non-state, at each level – national, state, and local. While the state actors will entail the relevant ministries and administrative networks at all the three levels, the term 'non-state actors' is taken to be inclusive of private sector actors, civil society organizations, NGOs, vulnerable and indigenous groups, and academia. Identification of relevant stakeholders will be guided by, first, an in-depth understanding of the 'climate adaptation issue' in question.
2. **Periodicity**: Ascertain the periodicity of stakeholder engagements.
3. **Conflicting interests**: Gauge the mode of manoeuvring through conflicting interests, owing to the expanse in the stakeholder expectations.
4. **Mode of engagement**: Considering the expanse of key stakeholders, an effective mode of engagement for the consultations must be considered.

6.2 Monitoring, Evaluation, and Learning for Long-Term Adaptation

Institutional implementation and stakeholder engagement are key instruments in climate action. But there exists an 'almost infinite diversity and complexity of climate change impacts', especially in the long term.[70] And, while concerted adaptation action might minimize our vulnerability, its ability to improve resilience and adaptive capacity may vary. Thus, an essential and effective measure to ensure successful adaptation is by establishing robust Monitoring, Evaluation, and Learning (MEL) systems.[71]

MEL systems foster an inherent sense of ownership, inclusivity and equity, and fix accountability through reporting. As also stated in the Mitigation LTS framework, monitoring and evaluation of the processes and action – which imbibe principles of *enhanced transparency, strengthened data availability,* and *access to updated information* – ensure effective implementation of an LTS.[2]

Climate Change Adaptation is a dynamic field, and in the governance of adaptation, existence of an efficient MEL system allows understanding its evolving nature and course correction through measuring progress.

In the long run, certain principles one must be mindful of when preparing an adaptation MEL include the following:

1. An MEL should build on existing systems on national governance and evaluation. This would allow for integration of adaptation planning and information into existing planning and M&E cycles improving their efficacy by promoting data-sharing, coordination, and accountability between the various levels. Such an integration would also allow adaptation action to develop as an iterative learning process.[72,73]
2. Given the nature of governance of climate change in India, it is also crucial that an MEL for long-term adaptation assesses both *horizontally and vertically, across systems and levels*. Such a framework would also ensure a comprehensive feedback loop necessary to review implications of adaptation action.
3. It must be noted that adaptation is often considered to be an end in itself, but it should be evaluated on *how adaptation actions impact safeguarding a resilient development*.

Additionally, for an effective LTS, MEL that informs adaptation action is suggested to be mindful of the following:

1. Measuring the processes and implementation of adaptation action, such as status, availability, and effectiveness of institutional financial framework for climate change response, which reflects institutional readiness.
2. Assessing the impact or results of a specific action within the action plan. Adaptation requires local, contextual action and as a result is often project-based. However, adaptation action carries within it an underlying

uncertainty and has an inherent risk to fail and become maladaptive in the long run. A regular evaluation, as suggested by this document, will help keep a check on adaptation while accounting for the recurrent uncertainties.

3. Tracking how current action feeds into the long-term resilience and development objectives, and accounting for adaptation and development synergies and co-benefits.

4. Apprising future policymaking on fostering an integrated approach and iterative process, which would reduce disruptions and enhance opportunities for sustainable development.

Through adopting an MEL framework within its adaptation planning, India has the potential to continuously evaluate its adaptation action which would allow it to assess its national adaptation progress. This can further help to inform planning and executing international commitments such as those on reporting adaptation progress under Article 13.8 and the Enhanced Transparency Framework.[1]

Box 4: Heat Stress Management and Governance of Adaptation: A Systems-based Perspective

The Action Plan on Preventing and Management of Heat Wave by the National Disaster Management Authority clearly lists out the government ministries/ departments responsible for key strategy implementation. A list of Expert Group Members on National Guideline on Heat Wave along with technical support has also been created. The different government agencies are crucial to not just the preparation of the heat stress management plan but also to respond to the instances of the same at the local level. Clear intra- and inter-departmental coordination, regular appraisal of the current status with the steering committee, regular monitoring and evaluation of the implementable components along with learning emanating from transparent flow of communication and evaluations, will aid in an unbridled on-ground implementation of the plan.

References

1. UNFCCC. *Paris Agreement*. (2015).
2. Mangotra, K., Ahuja, R., Spencer, T. & Hall, W. P. *Guiding Framework for India's Long-Term Strategy (LTS) | TERI*. https://www.teriin.org/sites/default/files/2020-05/Guiding-document-for-India.pdf. (2020).
3. Grodon Jessica; Kohli, Rohini, Kurukulasuriya, P. Principles in Practice: Integrating Adaptation into Long-term Strategies. https://files.wri.org/expert-perspective-gordon-kohli-kurukulasuriya.pdf.
4. Denton, F., Wilbanks, T., Burton, I., Chandani, A. & Gao, Q. Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development. *wg2ar5gate.wordpress.com*.
5. Mukhi, N., Rana, S., Mills-Knapp, S. & Gessesse, E. World Bank Outlook 2050 Strategic Directions Note. (2020).
6. Ribot, J. Vulnerability does not just fall from the sky: Toward multi-scale pro-poor climate policy. in *Handbook on Climate Change and Human Security* (eds. Redclift, M. R. & Grasso, M.) 164–172. (2013). doi:10.4337/9780857939111.00016.
7. Pelling, M., O'Brien, K. & Matyas, D. Adaptation and transformation. *Clim. Change* **133**, 113–127. (2015).
8. Bapna, M., Carter, B., Chan, C., Patwardhan, A. & Dickson, B. *Adapt Now: A Global Call for Leadership on Climate Resilience*. https://cdn.gca.org/assets/2019-09/GlobalCommission_Report_FINAL.pdf. (2019).
9. Kates, R.W., Travis, W. R., & Wilbanks, T.J. , undefined. Transformational adaptation when incremental adaptations to climate change are insufficient. *Natl. Acad Sci.*
10. O'Brien, K. Climate Change Adaptation and Social Transformation. in *International Encyclopedia of Geography: People, the Earth, Environment and Technology* 1–8 (John Wiley & Sons, Ltd, 2017). doi:10.1002/9781118786352.wbieg0987.
11. Wisner, B. *Vulnerability as Concept, Model, Metric, and Tool*. vol. 1 (2016).
12. Jacoby, Hanan; Rabassa, Mariano; Skoufias, E. *Document Detail*. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/726661468050954514/distributional-implications-of-climate-change-in-india. (2011).
13. Kapur, A. *Vulnerable India : a geographical study of disasters*. Indian Institute of Advanced Study. (2010).
14. Boyce, J. K. *The political economy of the environment*. (Edward Elgar Publishing, 2002).
15. Blaikie, P., Cannon, T., Davis, I. & Wisner, B. *At Risk: Natural Hazard, People's Vulnerability and Disaster.* (Routledge, 2004).
16. Ayers, J., Huq, S., Wright, H., Faisal, A. M. & Hussain, S. T. Mainstreaming climate change adaptation into development in Bangladesh. *Clim. Dev.* **6**, 293–305. (2014).
17. Klein, R., Schipper, L. & Dessai, S. Integrating mitigation and adaptation into climate and development policy: three research questions. *Environ. Sci. Policy* **8**, 579–588 (2005).
18. Huq, S. *et al.* Mainstreaming adaptation to climate change in Least Developed Countries (LDCs). *Clim. Policy* **4**, 25–43. (2004).
19. Werners, S. *et al.* Adaptation pathways for climate-resilient development. *4th European Climate Change Adaptation Conference* https://www.ecca2019.eu/adaptation-pathways-for-climate-resilient-development/. (2019).

20. Ingwersen, W. W., Garmestani, A. S., Gonzalez, M. A. & Templeton, J. A Systems Perspective on Responses to Climate Change. *Clean Technol. Environ. Policy* **16.** (2013).

21. Krishnan, R. *et al. Assessment of Climate Change over the Indian Region: A Report of the Ministry of Earth Sciences (MoES), Government of India*. https://link.springer.com/book/10.1007%2F978-981-15-4327-2. (2020).

22. Randle, J. & Stroink, M. No Title. *Syst. Res. Behav. Sci.* **35**, 645–657. (2018).

23. Ballew, M., Goldberg, M., Rosenthal, S., Gustafson, A. & Leiserowitz, A. Systems thinking as a pathway to global warming beliefs and attitudes through an ecological worldview. *Proc. Natl. Acad. Sci. U. S. A.* **116**, 8214–8219. (2019).

24. FAO. *Climate Change and Food Security: A framework Document*. (2008).

25. Piesse, M. *Hunger Amid Abundance: The Indian Food Security Enigma*. http://www.futuredirections.org.au/publication/hunger-amid-abundance-the-indian-food-security-enigma/. (2019).

26. Pingali, P., Aiyar, A., Abraham, M. & Rahman, A. *Transforming Food Systems for a Rising India*. (Palgrave Macmillan, 2019). doi:10.1007/978-3-030-14409-8.

27. INCCA. *Climate change and India: A 4x4 assessment – A sectoral and regional analysis for 2030s*. http://www.indiaenvironmentportal.org.in/files/fin-rpt-incca.pdf (2010).

28. MoEFCC. *Second Biennial Update Report to the United Nations Framework Convention on Climate Change*. moef.gov.in/wp-content/uploads/2019/04/India-Second-Biennial-Update-Report-to-the-United-Nations-Framework-Convention-on-Climate-Change.pdf. (2018).

29. Wheeler, C. *et al. The Water Gap – The State of the World's Water*. https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/The Water Gap State of Water report lr pages.pdf. (2018).

30. NITI Aayog. *Composite Water Mangament Index*. https://niti.gov.in/sites/default/files/2019-08/CWMI-2.0-latest.pdf. (2019).

31. Majumdar, K. Rural Transformation in India: Deagrarianization and the Transition from a Farming to Non-farming Economy. *J. Dev. Soc.* **36**, 182–205 (2020).

32. Dasgupta, P. *et al.* Rural areas. in *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (eds. Field, C. B. et al.) 613–657 (Cambridge University Press, 2014).

33. Singh, C., Rahman, A., Srinivas, A. & Bazaz, A. Risks and responses in rural India: Implications for local climate change adaptation action. *Clim. Risk Manag.* **21**, 52–68 (2018).

34. Chand, R., Srivastava, S. & Singh, J. *Changing Structure of Rural Economy of India Implications for Employment and Growth*. (2017) doi:10.13140/RG.2.2.17270.09280.

35. Chandrasekhar, S. & Mehrotra, N. Doubling farmers' incomes by 2022 what would it take?. *Econ. Polit. Wkly.* **51**, 10–13 (2016).

36. GoI. *India's Intended Nationally Determined Contribution: Working Towards Climate Justice*. https://www4.unfccc.int/sites/submissions/INDC/Published Documents/India/1/INDIA INDC TO UNFCCC.pdf. (2015).

37. Eckstein, D., Künzel, V., Schäfer, L. & Maik, W. *Global Climate Risk Index 2020: Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2018 and 1999 to 2018*. https://germanwatch.org/sites/germanwatch.org/files/20-2-01e Global Climate Risk Index 2020_10.pdf. (2019).

38. Singh, C., Rio, C. R. Del, Soundarajan, V., Nath, V. & Shivaranjani, V. *Assessing India's mounting climate losses to Financial Institutions*. http://www.indiaenvironmentportal.org.in/files/file/climate-losses-revised.pdf. (2019).

39. UNDRR. Building Risk Knowledge. https://www.undrr.org/building-risk-knowledge. (2019).

40. National Disaster Management Authority - Government of India. Disaster Management Cycle. https://ndma.gov.in/en/hazard-risk-mitigation.html. (2016).

41. Naswa, P. & Garg, A. Managing climate-induced risks on Indian infrastructure assets. *Curr. Sci.* **101**, 395–404. (2011).

42. ILO. *Working on a Warmer Planet: The impact of heat stress on labour productivity and decent work – Executive Summary*. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_712011.pdf. (2019).

43. Urban Land Institute. *A Guide for Assessing Climate Change Risk*. (Urban Land Institute, 2015).

44. CCCR MoES. CORDEX South Asia: Centre for Climate Change Research. http://cccr.tropmet.res.in/home/cordexsa_about.jsp.

45. Edmonds, J. A. *et al.* Integrated Assessment Modeling. in *Encyclopedia of Sustainability Science and Technology* (ed. Meyers, R. A.) (Springer, 2012). doi:https://doi.org/10.1007/978-1-4419-0851-3_359.

46. Patt, A. G. *et al.* Adaptation in integrated assessment modeling: where do we stand? *Clim. Change* **99**, 383–492. (2010).

47. Gebrechorkos, S. H., Hülsmann, S. & Bernhofer, C. Regional climate projections for impact assessment studies in East Africa. *Environ. Res. Lett.* **14.** (2019).

48. H., K. *et al.* Integrated Risk and Uncertainty Assessment of Climate Change Response Policies. in *Climate Change 2014:Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (eds. Edenhofer, O. et al.) 151–206 (Cambridge University Press, 2014).

49. EEA. *Climate Change, Impacts and Vulnerability in Europe 2016: An indicator-based report*. (European Environment Agency, 2017).

50. Wise, R. M. *et al.* Reconceptualising adaptation to climate change as part of pathways of change and response. *Glob. Environ. Chang.* **28**, 325–336. (2014).

51. IPCC. Climate change 2014 impacts, adaptation, and vulnerability. (2014).

52. Ahmad, Q. K. *et al.* Summary for Policymakers. in *Climate Change 2001: Impacts, Adaptation, and Vulnerability - Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change* (eds. McCarthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J. & White, K. S.) 1–18 (Cambridge University Press, 2001).

53. Downing, T. E. & Patwardhan, A. Assessing vulnerability for climate adaptation. in *Adaptation Policy Framework: A Guide for Policies to Facilitate Adaptation to Climate Change* (eds. Lim, B., Spanger-Siegfried, E., Burton, I., Malone, E. L. & Huq, S.) 67–89. (2003).

54. Patwardhan, A., Narayanan, K., Parthasarathy, D. & Sharma, U. Framework for Assessing Vulnerability. in *Climate Change and India: Vulnerability Assessment and Adaptation* (ed. Shukla, P. R.) 330 (Universities Press, 2003).

55. Rao, N. D., Riahi, K. & Grubler, A. Climate impacts of poverty eradication. *Nat. Clim. Chang.* **4**, 749–751. (2014).

56. Patra, J. *Review of Current and Planned Adaptation Action in India*. https://www.iisd.org/sites/default/files/publications/idl-55866-india.pdf. (2016).

57. Chambers, R. Vulnerability, coping and policy. *IDS Bull.* **20**, 1–7. (1989).

58. Jones, L., Ludi, E. & Levine, S. Towards a characterisation of adaptive capacity: a framework for analysing adaptive capacity at the local level. *ODI: Background Note*. (2010).

59. Smith, J. B., Huq, S. & Klein, R. J. T. *Climate change, adaptive capacity and development Book*. (Imperial College Press, 2003). doi:10.1142/P298.

60. Brooks, N. & Adger, W. N. *Assessing and Enhancing Adaptive Capacity: Technical Paper 7*. https://www4.unfccc.int/sites/NAPC/Country Documents/General/apf technical paper07.pdf (2004).

61. Aldrich, D. P., Page, C. & Paul, C. J. Social Capital and Climate Change Adaptation. in *The Oxford Encyclopedia of Climate Change Communication* (eds. Nisbet, M. C. et al.) (Oxford University Press, 2018).

62. Huq, S. *Adaptation: resources now to plan and implement*. *IIED Opinion* https://pubs.iied.org/pdfs/17117IIED.pdf. (2011).

63. Hallegatte, S. *et al.* Resourcing Adaptation: Opening Plenary, Adaptation Futures 2018. (2018).

64. Panda, G. R. & Ganguly, K. *Adaptation to climate change in India: A study of Union Budgets*. https://www.cbgaindia.org/wp-content/uploads/2016/03/Adaptation-to-Climate-Change-in-India-A-Study-of-Union-Budgets.pdf. (2010).

65. OECD. *Climate-Related Development Finance: Interactive Workbook*. https://public.tableau.com/views/Climate-relateddevelopmentfinance-RP/CRDF-Recipient?:embed=y&:%0Adisplay_count=no&%3AshowVizHome=no#3. (2015).

66. Climate Funds Update. Climate Funds Update: Data Dashboard. https://climatefundsupdate.org/data-dashboard/#1541245664232-8e27b692-05c8. (2019).

67. Schweizer, P. J. Systemic risks–concepts and challenges for risk governance. *J. Risk Res.* 1–16 (2019) doi:10.1080/13669877.2019.1687574.

68. UNISDR. *Global Assessment Report on Disaster Risk Reduction (GAR)*. https://gar.undrr.org/ (2019) doi:https://doi.org/10.18356/f4ae4888-en.

69. *Theories of democratic network governance*. (Palgrave Macmillan, 2007). doi:10.1057/9780230625006.

70. IIED. *How integrated monitoring and evaluation systems can help countries address climate impacts*. https://pubs.iied.org/pdfs/17470IIED.pdf. (2018).

71. STAP. *Strengthening Monitoring and Evaluation of Climate Change Adaptation: A STAP Advisory Document*. https://www.thegef.org/sites/default/files/publications/STAP_CCA_ME_complete_synthesis.pdf. (2017).

72. GIZ. Cambodia: The national climate change monitoring & evaluation framework. Monitoring and Evaluating. in *Adaptation at Aggregated Levels: A comparative analysis of ten systems*. (2017).

73. Rai, N., Brooks, N., Ponlok, T., Baroda, N. & Nash, E. *Developing a National M&E framework for Climate Change: Tracking Adaptation and Measuring Development (TAMD)*. http://pubs.iied.org/10118IIED. (2015).

THE ENERGY AND RESOURCES INSTITUTE
Creating Innovative Solutions for a Sustainable Future

The Energy and Resources Institute,
6C, Darbari Seth Block, India Habitat Center Complex,
Lodhi Road, New Delhi, Delhi 110003
Phone: 91 11 24682100