Guiding Framework for India's Long-Term Strategy: Adaptation

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1. Executive Summary

(To be drafted later)

2. 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, for short). These strategies must align with the short-term as well as medium time climate action and, also 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" as well as respective national capabilities (See TERI LTS Mitigation document for more details)[2]. To ensure coherence with the national development priorities it is critical that country's LTS also aligns with the Nationally Determined Contributions (NDC's) where the NDC's can be used as a potential tool of targeting short-term policy and the LTS as an instrument to attain long-term developmental goals [3].

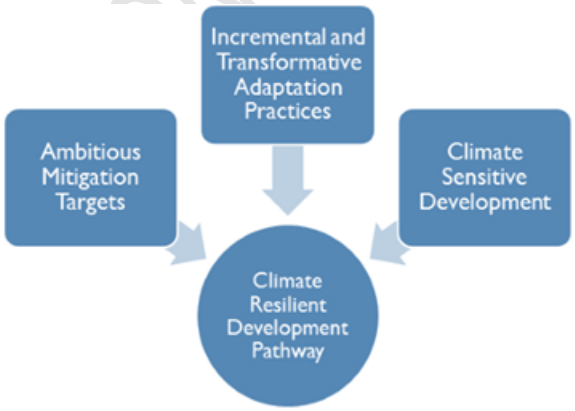

Fig 1: Climate Resilient Development Pathway

IPCC (2018) [4] defines a climate-resilient pathway as development trajectories that reduce climate change as well as its impacts or, in other words, "*combine adaptation and mitigation to realize the goal of sustainable development*". As indicated in Fig 1, Climate Resilient Development Pathway (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 as well as 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.

A climate-resilient developmental pathway can be envisaged as an iterative dynamic process for managing changes in climate and other development 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 tradeoffs associated with adaptation and mitigation action are also linked to the socio-economic and developmental context in a country [7]. This outlines the importance of climate action rooted in the socio-economic and developmental context of a country including understanding the role of existing inequalities and 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 concerning 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 globe. As highlighted by the Global Commission on Adaptation 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 US$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 US$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, and,
- an integrated systems approach

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 like 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 above discussions, this framing document outlines a comprehensive guideline that can aid in the formulation of a long-term adaptation strategy for India.

3. Pillars of Framework

The following 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 climate-resilient development pathway, which also form the framework of this guiding document.

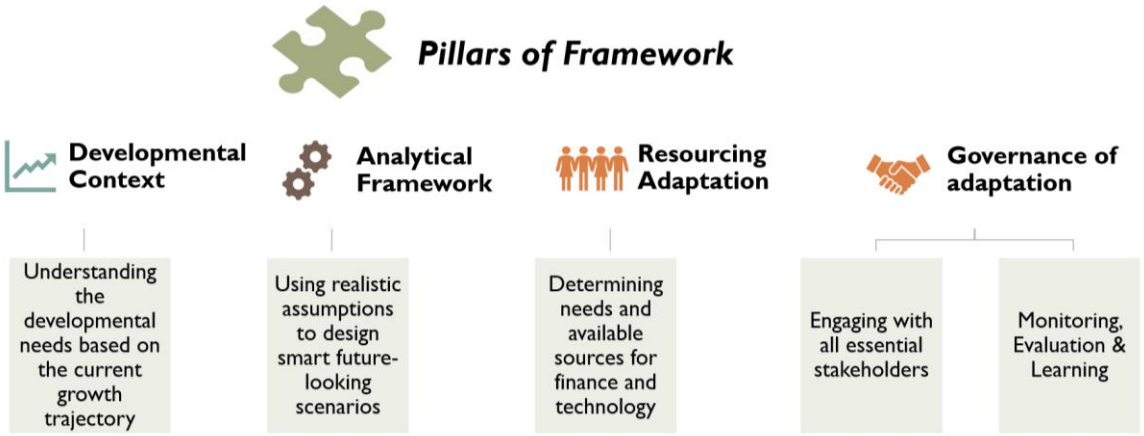

Fig 2: Pillars of the Adaptation Component of the Long-Term Climate Resilient Development Pathway

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 impacts and influence the outcomes of adaptation. In the context of a developing country like India, policy makers 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 the 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 recognise 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 status and access to both these capitals and then estimating costs of future action. The third and final step focuses on resource mobilisation and allocation which includes allocation and redistribution of existing resources, as well as additional resources to ensure the financial viability of a climate-resilient development pathway.

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, ensuring it is cognisant 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.

4. 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 increase India's poor population by 50 million than there otherwise, by 2040 [12]. India is also one among the most disaster recumbent nations in the world with as many as 1.2 billion people exposed to fragile landscapes prone to hazards such as floods, cyclones and droughts [13]. 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 realising developmental goals. Adaptation is strongly embedded in the local development context and hence coordination and integration with existing development action is very critical. It is thus imperative that CRDPs look at how to develop resilience at all 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 & 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 addressing 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 developments plans [3]. For example, a substantial case can be made for the integration of climate change in India's Five-Year Action Plan.

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

The COVID-19 pandemic has not only highlighted this aspect of uncertainty but has brought to the forefront the crucial notion of 'decision-making under uncertainty'. Living in the COVID world - beyond working for a safe and resilient futures, a key issue is to defend the development gains today, which poses as such a huge global burden. The pandemic has exposed vulnerabilities in multiple levels, especially at the systems levels and the world struggles to find a restart button there. Understanding of the nuances of such situations is what is necessary to take into the future.

In addition, 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. The proposed climate-resilient development pathways aid the decision making process by making it more flexible in terms of implementation and limits undesirable 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.

4.1. Key Systems

Climate change is a complex issue that integrates many scientific fields to explain and estimate the immediate and potential long-term impacts. The impacts include effects of GHGs on the planet's climatic system, energy balance, and ecosystems as well as social and economic systems [20]. A complex issue garners a complex 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℃ rise in average temperature over India for the 1971-2018 period [21]. It also estimates that the average temperature is projected to rise by 4.4℃ 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 Himalaya 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 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, the following 6 systems are identified for developing a Long-term Strategy- *agriculture, water, urban, rural, health,* and *natural environment*. *Disaster risk management* and *resilient infrastructure* are cross-cutting issues across the 6 systems mentioned above.

4.1.1. Food

Climate change is a threat to food and nutritional security [22]. The 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 (like 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 [23]. These challenges like 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- 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 economic development [24].

4.1.2. Water

India is the second-most populous country in the world, but only has 4% of the world's total water resource. The country is heavily dependent on precipitation to meet its water needs [25]. The rise in 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 [26]. '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[27]. Droughts, reduction in groundwater levels and poor water management exacerbates this problem. The Composite Water Management Index released by Niti Aayog in 2018, states that an investment close to INR 20,00,000 crores is required to bridge the expected water supply gap by 2030 [28].

4.1.3. 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 [29]. 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, etc. make these regions highly vulnerable [30]. The impacts of climate change can be two-fold: impacting infrastructure and causing loss of life and, the impact on agriculture and the natural resources that rural populations depend on [31].

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 their principal source of income [26]. For the 2017-18 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. It is estimated that 70% of rural India is primarily dependent on agriculture for their livelihood. Therefore, agriculture plays a vital role in the economy of the country. This sector can be considered as one of the most climate-dependent sectors since 52% of agriculture is rain-fed [26]. 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 a major contributor to climate change. Therefore, adaptation action within the agricultural system provides an opportunity to goals of addressing vulnerabilities (thereby building resilience) and emissions reduction[32].

Non-agriculture dependent livelihoods

While agriculture plays a significant role in the rural economy, it also shaped by non-agricultural activities and is constantly influenced by the ever-changing urban landscape [24]. The non-agriculture activities include- mining and quarrying, manufacturing and processing, to name a few [29]. It has been noted that in the last four decades, the share of agricultural income in rural has reduced from 72.4%- 39.2% [33]. National data suggests that a staggering 88% of farming households are dependent on some non-agriculture related activity for their income [24,34]. Non-agriculture 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.

4.1.4. Urban

The 2011 Census estimates 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 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, are often located at the geographically most vulnerable locations and are also faced with issues of tenure security. 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 devastating impacts on the socio-economic system. The devastating 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 the 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.

4.1.5. Health

Several studies indicate that climate change poses a major threat to human health. High temperatures and extreme weather have been associated with increased risk of heat strokes, water-borne 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 leading to reduced nutritional intake especially in the economically weaker sections.

4.1.6. 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 globe 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 [35]. Several studies show us that these ecosystems face a severe threat of 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.

Systems thinking is defined as "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" [36]. This approach encompasses the understanding that the social, economic and natural systems are interconnected, constantly changing and that human beings are members of this dynamic system [37].

A common theme that emerges as a cross-cutting issue across the systems is the need for disaster risk management and climate-resilient infrastructure necessary to deal with dynamic change. Given the geographic and climatic diversity in India is prone to all major natural disasters. As given by the National Institute of Disaster Management 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 7,516 km long coastline, close to 5,700 km is prone to cyclones and tsunamis; and 68% of cultivable land is prone to droughts (NIDM). The subsequent section on Risk Profiling describes the importance of assessing climatic risks and ensuring that the basis of a long-term adaptation strategy rests on robust scientific evidence.

India ranks no. 14 on the Climate Risk Index 2020 released by Germanwatch [38]. 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 ACT notes that the economic losses have doubled in India over the last decade [39]. An increasing frequency[21] of climate-related disasters necessitates the need for climate-resilient infrastructure to reduce the loss of life and

348 economic losses as well. The aim of addressing developmental agenda can only be realised with
349 sound investments in infrastructure. Innovative infrastructure can play the dual role of emissions
350 reduction and building resilience[40]. An initiative like the Coalition for Disaster Resilient Infrastructure
351 (CDRI) by the Government of India is a crucial step to realising the goal of building climate resilience.
352 The government has pledged USD 70 million to fund this coalition that aims to pool not only
353 resources but to share best practices as well to build resilience.

Box 2: A System's Perspective of Heat Stress Management

With the rise in global temperatures there will be 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 [41]. 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 [41].

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, 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 (health infrastructure to cope with increased future inflow related to heat stress)

A systems thinking approach as elucidated above can be adopted to ensure adaptation and building resilience.

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5. Analytical Framework

5.1. Risk Profiling

India is one of the most vulnerable countries to changing climate and has experienced a vast number of climate-related extreme events in the recent past including floods, droughts, heatwaves, cyclones and other associated consequences on health and livelihood. India will continue being impacted by climate change mainly because of its growing population and huge dependence on agriculture-related activities. Hence, it is of utmost importance to have a robust, comprehensive and holistic approach to develop a long-term adaptation strategy considering the wide-ranging climate-related risks and hazards the country is facing and is expected to face towards the mid-century period. 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.

Changing climate creates cascading risks in various key systems such as food, rural, water, cities, urban, health and natural environment which are often inter-related and even leads to an undesirable consequence at various scales. Although climate-change impacts over individual systems are extensively studied, their overlaps and interactions are rarely considered. However, these impacts are likely to be of great effect, as they can amplify effects and lead to indirect impacts in other regions, thus strongly increasing the challenges to adaptation. Therefore, it is a major scientific challenge to assess climate risks across domains, and in a meaningful manner to decision-makers.

Risk profiling 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 [42]. 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 the possible the consequent impacts like 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 be underpinned by scientific evidence and the latest technology. The best available information on the current and future climate will support developing an informed decision making on adaptation. For the same it is suggested that an LTS includes a *Landscape Assessment,* generation of a *Granular Scale Database, Integrated Modelling Approach,* and acknowledgment of *Uncertainty* in the process.

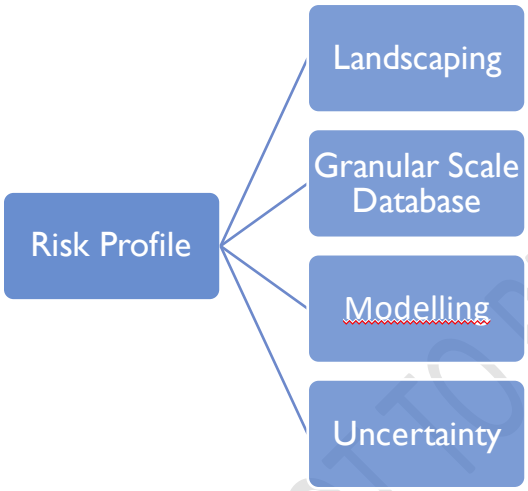

Fig 3: Pillars of Risk Profiling

5.1.1. 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 faced by climate risk decision-makers viz. 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 way for the formulation of a comprehensive and holistic climate risk profile over the country which incorporates the solutions to address the shortcomings in the existing practices.

5.1.2. 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, it is best addressed through bottom-up methods suited to particular activity and location. The climate change risks that a particular community faces vary from place to place. A localised risk profile hence is always a preferred choice as it takes into

account those unique characteristics of an area. It will help communities engage in an informed and comprehensive decision-making process. A local-scale risk assessment and profile would help in recognising the parts of a community which might be at risk. Currently, climate information like extreme weather and climate scale events, climate projections and risks of climate change etc. are available for both global and national level. 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 assisting the translation of available global information onto regional and local level. A coarser resolution data for risk may be relied upon as a first degree of approximation in case of non-existence of local level risk information e.g. while moving from district level to state level to zonal level.

Although climate modelling datasets 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 datasets lack granularity and does not provide sufficient resolution to draw out substantial information over district scale[43]. Currently, these are the only dynamically downscaled global modelling datasets available with the government of India. This dataset provides information about the meteorological parameters and does not 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 impacts 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 datasets for assessing the climate risks for different states as well as while drafting the State Action Plan on Climate Change for different states**.**

5.1.3. Modelling:

To effectively understand the future climatic conditions and the associated risk, a set of different kind of models can be used. One approach is towards using the latest state of the art Integrated Assessment Models (IAM). These are a unique class of models that integrate global biophysical and economic systems [44]. It has become a common tool for assessing strategies to address climate change, including the costs and benefits of such strategies over time [45]. It highlights how the human

development and societal choices in the future 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. This integrated assessment modelling brings together all 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 judgments on different options for dealing 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 (GCM) provide reliable climate information and support a better understanding of the variability and changes on 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 limits the applicability of GCMs in impact assessment studies at the local scale [46]. Hence, in order 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 environmental changes will have an impact on various such as agriculture, water, health, urban and natural environment.

5.1.4. Uncertainty:

Uncertainty can be defined as a state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can, therefore, be represented by quantitative measures (e.g. a probability density function) or by qualitative statements (e.g. reflecting the judgment of a team of experts) [47]. Climate change assessments are often dominated by uncertainty and affect the choice of methods and the confidence attached to the results. Uncertainty is considered as one major hindrance for 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 [48]. Often, improper consideration for uncertainties leads to increase the likelihood that the action taken will be inadequate, inappropriate or increase vulnerability. Hence, recognising 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:

- The need to have strong and comprehensive landscaping before the risk profiling and risk assessment
- An understanding of an ideal, prescribed scale at which the risk profile needs to be developed, emphasizing the need for granular scale data to improve the accuracy of evidence that further informs adaptation.
- Use of various possibilities and methods of modelling, ideally using 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
- Acknowledging the importance of uncertainty to be embedded in the communication of climate information for adaptation planning.

5.2. Vulnerability Assessment

Understanding vulnerabilities constitute 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 [49]. However, to harness the transformative potential of adaptation measures, vulnerability analysis has to have a renewed focus on structural rather than proximate causes.

The IPCC [50] 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' [51], highlighting the multiple dimensions to risk and vulnerability and, consequently, reiterating 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' and the 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 - sensitivity, as well the system's ability to deal with anticipated impacts – adaptive capacity [52]. A thorough VA not only 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.

Patwardhan, et. al argued that "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" [53]. 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 its 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 its society's vulnerability to climate risks. Furthermore, relational vulnerabilities and their outcomes are well 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 [54].

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 [55]. India's economy is tied to crucial sectors such as agriculture, water resources, natural ecosystems and forestry, health, sanitation, infrastructure and energy. It has to be also 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 vulnerability assessments of different landscapes. These focused vulnerability assessments, it is thus suggested, could be based on Arid and Semi-arid areas, Coastal zones, Himalayan regions. Such an assessment may also need to be mindful of Urban, Rural and Rurban contexts. Furthermore, 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 vulnerability assessments 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 changes over India along with their impacts on key economic sectors as well as human systems at sub-regional scales [25,56]. Such an assessment would allow informing adaption planning and policy in a manner that is regionally as well as temporally contextual.

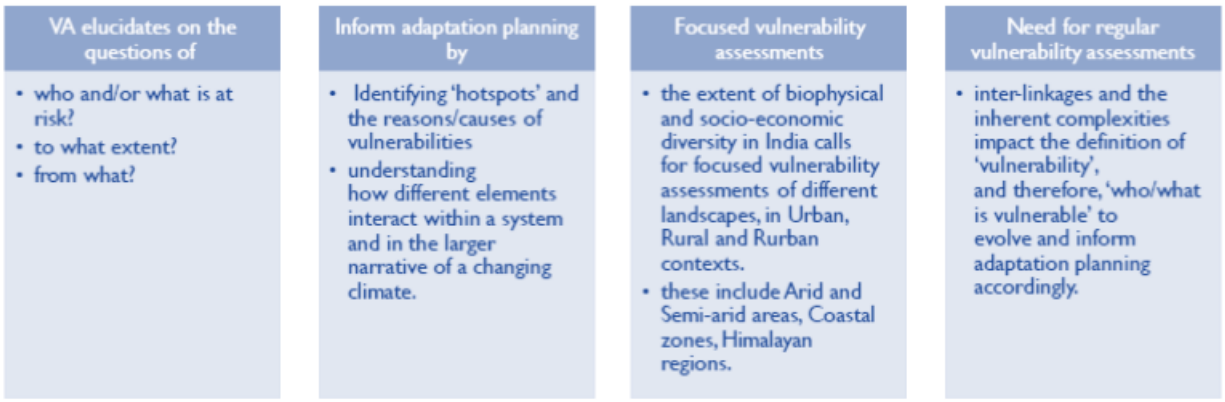

Fig 4: Key aspects of proposed vulnerability analysis

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, the VA must focus on certain principles which include:

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 vulnerability assessments should be focused on studies, i.e. ensuring the VA encompasses all landscapes and contexts. Landscapes may be divided into Arid and Semi-Arid, Coastal Zones and Himalayan Regions, as has been done in previous assessments in

India. With respect to contexts, it is recommended that the analysis should encompass the Urban, Rural as well as 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 impacts and their consequent contexts and risks are ever-changing. Additionally, even vulnerability as a concept is a constantly evolving phenomenon. This thus requires that VA's, especially those informing long-term policies are conducted regularly. This would ensure that planning and policies are relevant and enhance their effectiveness.

6. 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 its current and future state of the environment [57,58]. Actions that lead to adaptation enhance a system's coping capacity, just as their existing capacities determine the current response and level of adaptation. Furthermore, climate change adaptation must be understood within constantly evolving socio-economic and developmental contexts. This implies that adaptation entails within it a certain level of uncertainty that requires deepening of human, social and technical capital that allows us to respond at the same pace of change in climate and its impacts [59]. As a result, efforts to get 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 [60]. Adaptation planning, thus, requires critical inputs that go beyond, but are not unresponsive to, financial and technological capital; and so, for the purpose of this document, we use the broader term 'Resourcing for Adaptation' instead of financing [61,62].

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 mobilisation 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 w.r.t human, social, natural, and infrastructural capital. *Stage 2* involves a financial and technological assessment, and *Stage 3* includes mobilisation 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[55] revealed that adaptation planning and programs in India have focussed 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 would bring forward all realities and help address this gap.

Stage 2: Financial and Technological Mapping

To begin with, it is proposed that a technological mapping 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 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, 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, identification of a need for resourcing w.r.t. 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 mobilisation. 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]. At present, according to India's adaptation financing is derived primarily from its national budget. However, most of these allocations have been through traditional development plans only. An analysis of India's budgetary allocation for climate change adaptation programs also found that a low level of integration exited between allocation towards building human capabilities and their assets, and, towards natural resource management. This further points towards gaps in policy w.r.t internalization of the development-adaptation continuum [63].

Furthermore, India is a top recipient of international financial assistance for climate change policy and action. However, relatively little is aimed specifically toward adaptation. A review of the findings of Climate Funds Update brings to lights that of all financing allocated from dedicated multilateral and bilateral climate funds since 2003, 54.23 million USD which amounts to only 4.4% of the total funding has been allocated to Adaptation in India. Whereas, 1119.929 million USD, or 91.04%, has been allocated towards Mitigation [64]. It can be inferred that India requires directed funding for Adaptation planning and programs. This could be via reallocation of funds or through 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 for effective adaptation to climate change is suggested. Herein, a need for skilling human capital to best utilise technical and procedural advances is also a crucial element.

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, it could be sought via private-public partnership to finance long-term action, which has the potential of increasing the financial viability of certain development alternatives.

Box 3: Resourcing Adaptation – A System's Perspective

As per International Labour Organisation's "*Working on a Warmer Planet*" report (2019), with respect to the global economy, response to increased risks of heat stress should include [41]:

1. adaptation policies and actions to protect workers from these conditions
2. overall strategy to mitigate climate change and limit further temperature increases
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 here, it is suggested that within the identified systems (i.e. 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 need to be mobilized and allocated. Furthermore, *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 heat stress management 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" [41]. Such measures would not only require financial investment to aid the technological and infrastructural development, but also require skilling human capital to best utilise this infrastructure as well as re-skilling them to continue being effectively employed in a world where their work profiles or professions may also change.

661

7. 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 - renders such events within the tightly held framework of what Schweizer (2019) defines as 'high complexity, non-linearity, transboundariness, tipping points and lag in regulation and perception'[65].

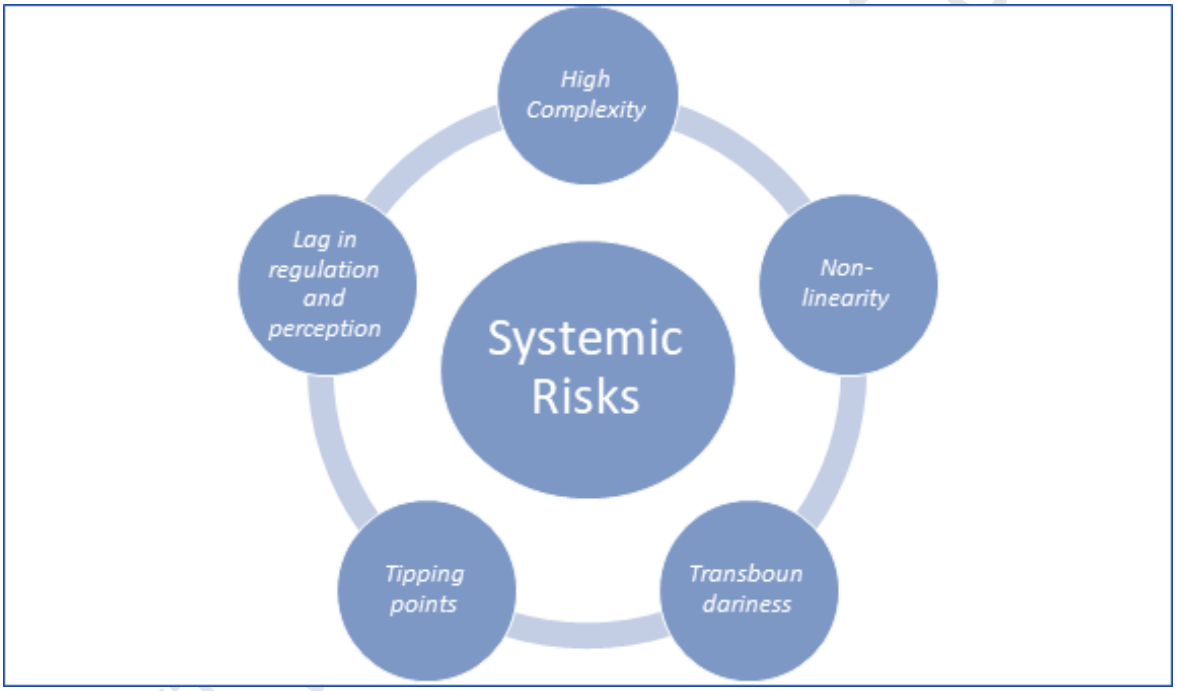

Fig 5. Systemic risks in the governance of adaptation

(Source: Adapted from Schweizer. 2019 [65])

Governance system, defined by the Global Assessment Report 2019[66] 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 better gauge and give an appropriate corollary regulatory response.

679 The evolution of a climate resilient development pathway, therefore, calls for 'transformative
680 actions' which in turn would require the foundational basis of institutional structures and processes
681 to be strong, interconnected and evolving and which '*adaptively manage the allocation of resources*
682 *and processes of change*'[4]. Thus, underscoring the need for a network mode of governance which
683 reiterates the integration of institutional structures, interventions and processes not just across
684 scales at national, state and local level but also with corresponding horizontal integration. This
685 allows for institutional structures and governance framework to reflect the key priorities of
686 '*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.

687

688 In India, the recognition of climate change as a divisive factor and the reflection of it in policy and
689 institutional framework were first seen with the establishment of the Prime Ministers Council on
690 Climate change (PMCCC) in 2007. It was formed largely to formulate the national action plans on
691 assessment, adaptation and mitigation of climate change. The sub-group on climate change, which
692 made recommendations to the 12th five-year plan, suggested renewed focus on key areas like
693 impact assessment, adaptation strategies, mitigation options and capacity building. The PMCCC
694 along with relevant government departments released the National Action Plan Climate Change
695 (NAPCC) for India in 2008 which elucidated 8 national missions to aid the climate change mitigation
696 and adaptation strategies in India. The NAPCCs were then decentralized through the mandate that
697 required each state and UT in the country to prepare their respective State Action Plan for Climate
698 Change (SAPCC).

699 The establishment of a multi-level and multi-sectoral institutional structure has ensured that the
700 pathway to adaptation planning in the country be embedded in a more integrated development
701 planning. Mangotra et al. [2]captures the current institutional coordination and integrated planning of

climate governance in India, across levels in Fig 4. This is reflective of programs in the country that integrate climate action with employment generation, afforestation, empowering women, and local youth. Apart from an evolving focus on climate at 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[55].

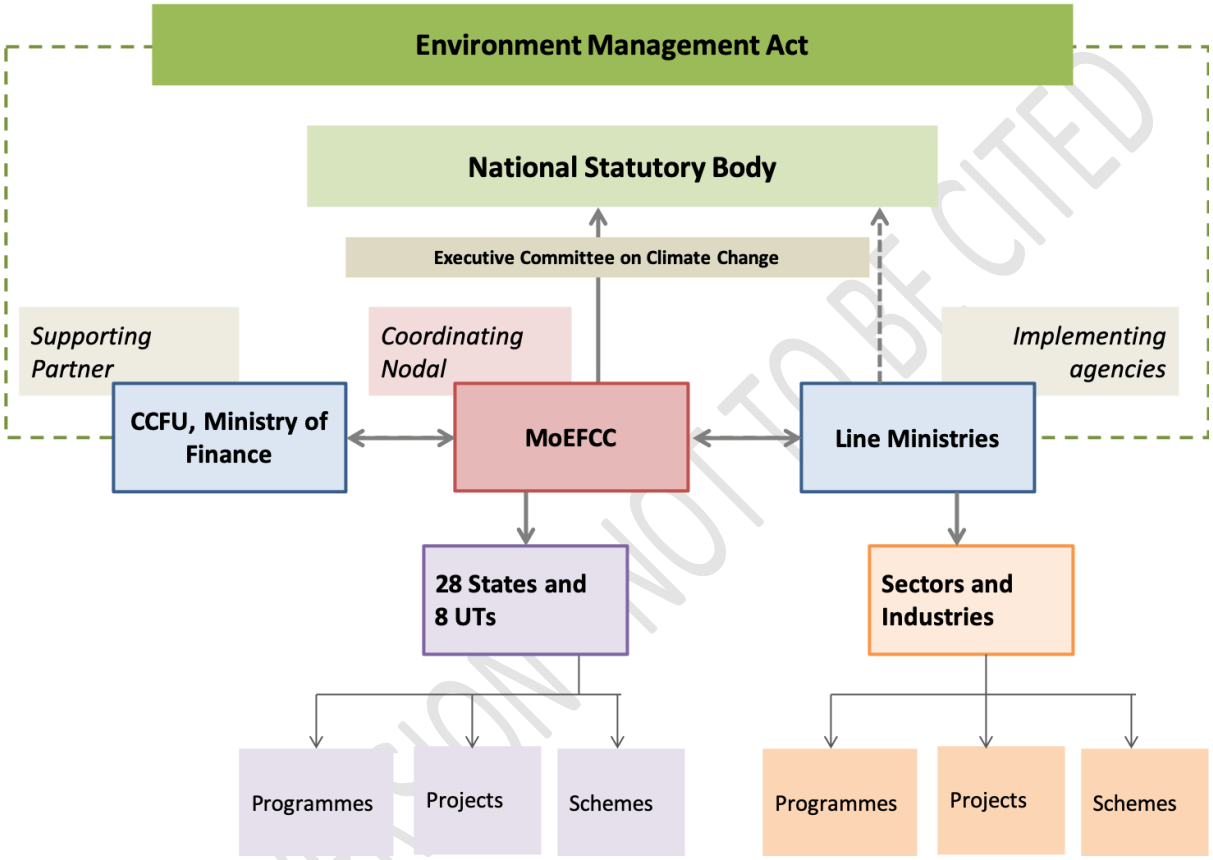

Fig 6: Indian Institutional framework w.r.t. the Environmental Management Act

(Source: Mangotra, Ahuja, Spencer and Hall, 2020[2])

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:

1. Stakeholder engagements
2. Monitoring, Evaluation and Learning

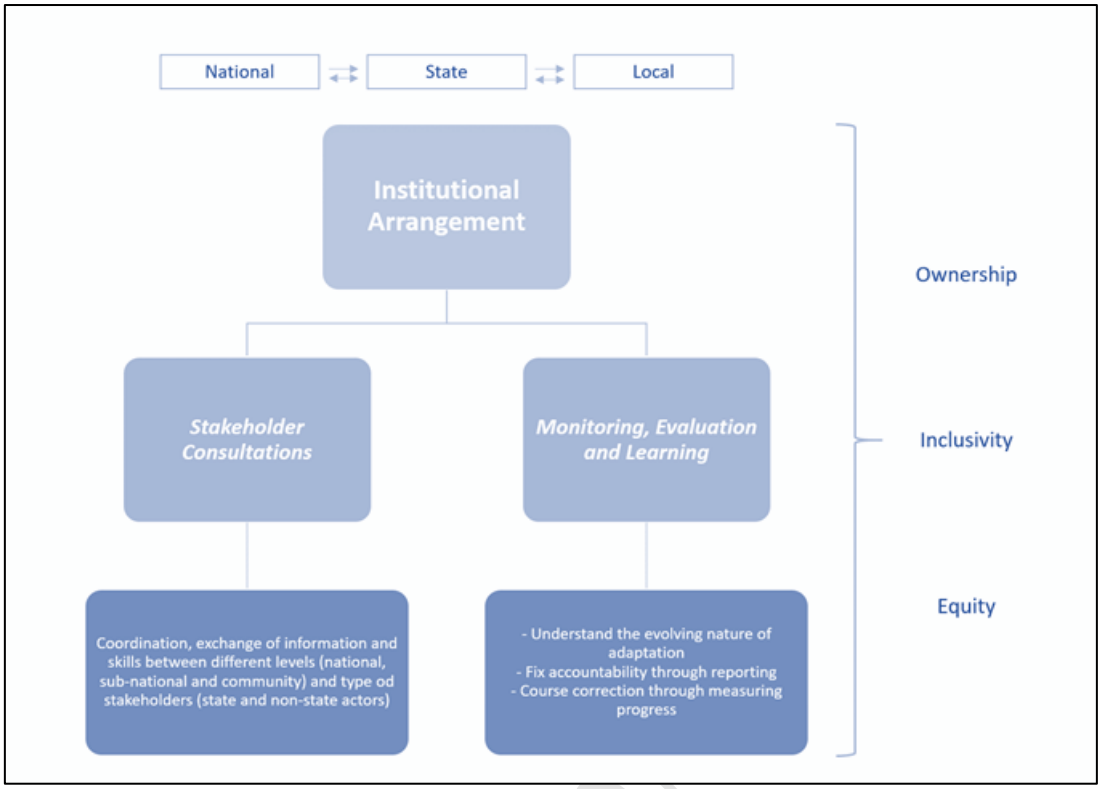

Fig 7: Governance Framework

7.1. Stakeholder Engagement

Active and timely stakeholder engagements is one of the essential cornerstones of a well-functioning climate governance structure. These 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 organisations), *Complexity* (stemming from inter-connectedness 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 [67].

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 encourages 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.

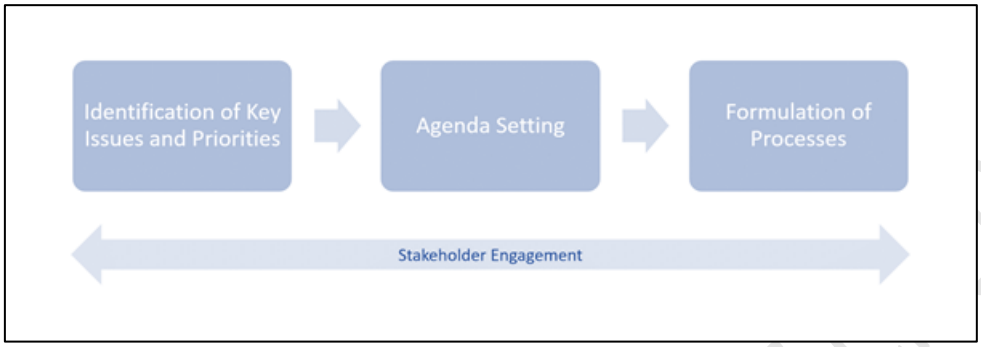

Fig 8: Stakeholder Engagement

(Source: Mangotra, Ahuja, Spencer and Hall, 2020[2])

Key points to be kept in mind for the stakeholder consultations:

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 will need to be considered

7.2. Monitoring, Evaluation and Learning for Long-Term Adaptation

Institutional implementation and stakeholder engagement are key in climate action. But there exist an 'almost infinite diversity and complexity of climate impacts', especially in the long-term [68]. And, while concerted adaptation action may minimise 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 for adaptation[69].

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 to be mindful of when preparing an adaptation MEL include:

1. A 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[70,71].
2. Given the nature of governance of climate change in India, it is also crucial that a MEL for long-term adaptation assesses both *horizontally and vertically, across systems and levels*.
3. It must be noted that often 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 must focus on:

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.
3. Tracking how current action feeds into the long-term resilience and development objectives.
4. Accounting for adaptation and development synergies and co-benefits.
5. Apprising future policy making on fostering an integrated approach and iterative process, which reduce disruptions and enhance opportunities for sustainable development.

Through adopting a MEL system within its adaptation planning, India has the potential to continuously evaluate its adaptation action which would allow it to assess its national adaptation progress can help countries to inform planning and as well as international commitments such as

those on reporting adaptation progress under Article 13.8 and the Enhanced Transparency Framework [1].

Box 4: Heat Stress Management & Governance of Adaptation: A Systems 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 responding to the instances of the same at local level. Clear intra and inter-departmental coordination, regular appraisal 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 an unbridled on ground implementation of the plan.

8. Key Messages

A few broad conclusions can be drawn from the discussion above

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 like the NDCs.

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

   Based projections for urbanisation, 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. CRDPs offers 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 climate change 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 uncertainties' conundrums associated with the discourse on climate change. Understanding vulnerabilities constitute 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 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 recognise the intersections between various sectors (agriculture, water, urban & rural areas, natural environment) that are a 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 exists 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 developing an informed decision making 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 localised 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 mobilisation and allocation of resources which is informed by a thorough landscape assessment and future-scenario analysis. Achieving effective mobilisation 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 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*'. 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- Stakeholder engagements and Monitoring, Evaluation and Learning.

Keeping in mind the expanse of type and scale of Adaptation interventions required in India and the labyrinth of admirative 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'.

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