Climate Change Adaptation and Mitigation

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□ ABSTRACT □

In recent decades, change in climate have caused impacts on natural and human systems on all continents and across the oceans. In many regions, changing precipitation or melting snow and ice are altering hydrological systems, affecting water resources in terms of quantity and quality.

Many terrestrial and freshwater species have shifted their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions in response to ongoing climate change.

According on many studies provided from researchers and NGO`s in many reports and national agreements, covering a wide range of regions and crops, negative impacts of climate change on crop yields have been observed, such as non-climatic factors like inequalities and poverty which are increasing the vulnerability and exposure of poor, and also the effects from recent climate-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability.

Thus adaptation and mitigation are the required tools to prevent the universe from climate change effects.

Keywords: vulnerability, adaptation, mitigation, greenhouse gases, global warming.

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التكيف مع تغير المناخ والتخفيف من حدته

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□ ملخّص □

في العقود الأخيرة ، تسبب تغير المناخ في تأثيرات على النظم الطبيعية والبشرية في جميع القارات وعبر المحيطات. في العديد من المناطق، يؤدي تغير هطول الأمطار أو ذوبان الثلوج والجليد إلى تغيير النظم الهيدرولوجية، مما يؤثر على موارد المياه من حيث الكمية والنوعية.

لقد غيرت العديد من الأنواع البرية وأنواع المياه العذبة نطاقاتها الجغرافية وأنشطتها الموسمية وأنماط الهجرة والوفرة وتفاعلات الأنواع استجابة لتغير المناخ المستمر.

وفقًا للعديد من الدراسات التي قدمها الباحثون والمنظمات غير الحكومية في العديد من التقارير والاتفاقيات الوطنية، والتي تغطي مجموعة واسعة من المناطق والمحاصيل، فقد لوحظت الآثار السلبية لتغير المناخ على غلات المحاصيل، مثل العوامل غير المناخية مثل عدم المساواة والفقر التي تزيد من قابلية تأثر الفقراء وتعرضهم، وكذلك التأثيرات الناجمة عن الظواهر المناخية المتطرفة الحديثة، مثل موجات الحرارة والجفاف والفيضانات والأعاصير وحرائق الغابات، وتكشف عن ضعف وتعرض بعض النظم البيئية والعديد من النظم البشرية لتقلب المناخ الحالي.

وبالتالي فإن التكيف والتخفيف هما الأدوات اللازمة لمنع الكون من آثار تغير المناخ.

الكلمات المفتاحية: القابلية للتأثر، التكيف، التخفيف، غازات الدفيئة، الاحتباس الحراري.

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Introduction:

1-to climate vulnerability assessment [1]:

The objectives of our study are to solve many issues such as, explaining the basic concepts of climate change science, identifying the anthropogenic drivers of climate change, explaining the observed and projected trends in the climate, and describing different climate change scenarios and their implications. Also to answer such questions as, why Current Climate (Inherent) Vulnerability Assessment? what is Climate Change Adaptation and Mitigation?

2-to Climate Change Science [2]:

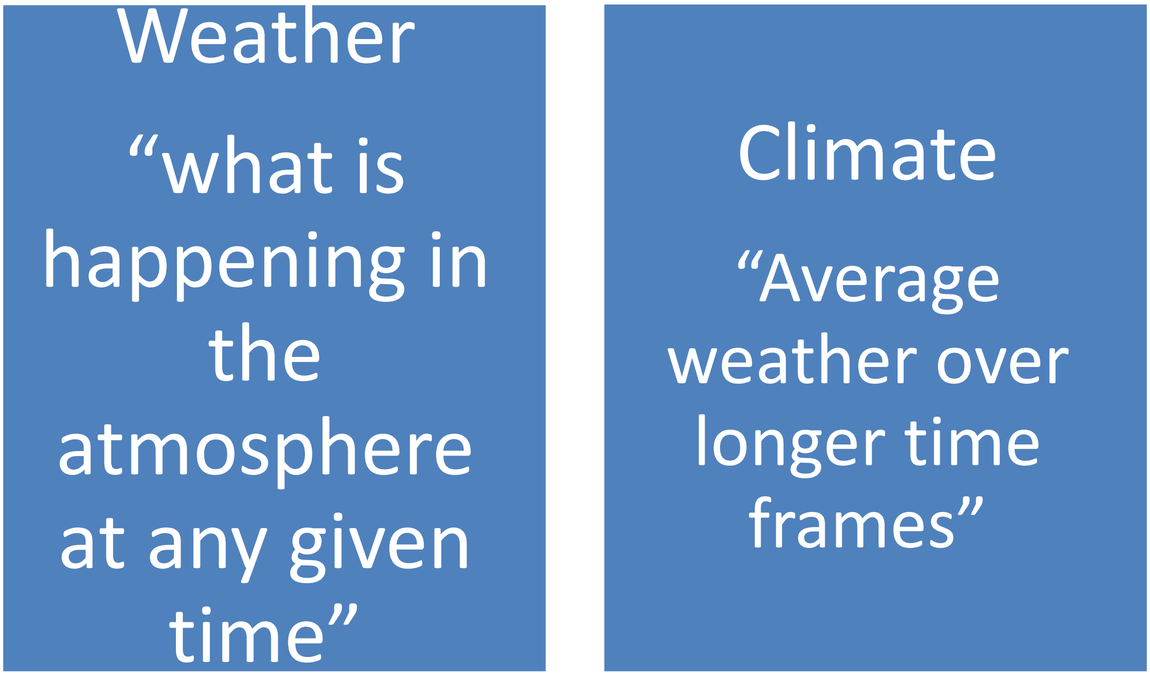
Climate change science provides important information for decision-making and Climate models can help to forecast long term climate scenarios and the Important input for vulnerability assessments and adaptation planning can also help us plan appropriately for emergency responses, in case of climate-related hazards, such as cyclones.

Climate change science provides important information for decision-making at various levels. For example, sound weather data and forecasts can help us determine when the best time would be to harvest our lands. It can also help us plan appropriately for emergency responses, in case of climate-related hazards, such as cyclones. Climate models help to forecast long term *climate scenarios* and are important for proactive planning.

3-What Is Weather & Climate?

It is important to understand the difference between "*weather"* and "*climate*" see (1). What is happening in the *atmosphere* at any given time is considered "weather" (including e.g. wind speed and direction, precipitation, barometric pressure, temperature, and relative humidity). Weather changes in the short term (e.g. daily, weekly, monthly). Climate is average weather and occurs over long time frames (e.g. 30 years) **[3] see figure (1).**

A common confusion between weather and climate arises when scientists are asked how they can predict climate 50 years from now when they cannot predict the weather a few weeks from now. The chaotic nature of weather makes it unpredictable beyond a few days. Projecting changes in climate (i.e., long-term average weather) due to changes in atmospheric composition or other factors is a very different and much more manageable issue. As an analogy, while it is impossible to predict the age at which any particular man will die, we can say with high confidence that the average age of death for men in industrialized countries is about 75 **[4].**



Figure(1) Weather & Climate[3]

1-3-What Is the Greenhouse Effect?

The temperature of the Earth results from a balance between energy coming into the Earth from the Sun (solar radiation) and the energy leaving the Earth into outer space. About half the solar radiation striking the Earth and its atmosphere is absorbed at the surface. The other half is absorbed by the atmosphere or reflected back into space by clouds, small particles in the atmosphere, snow, ice and deserts at the Earth's surface **[5] .see figure (2).**

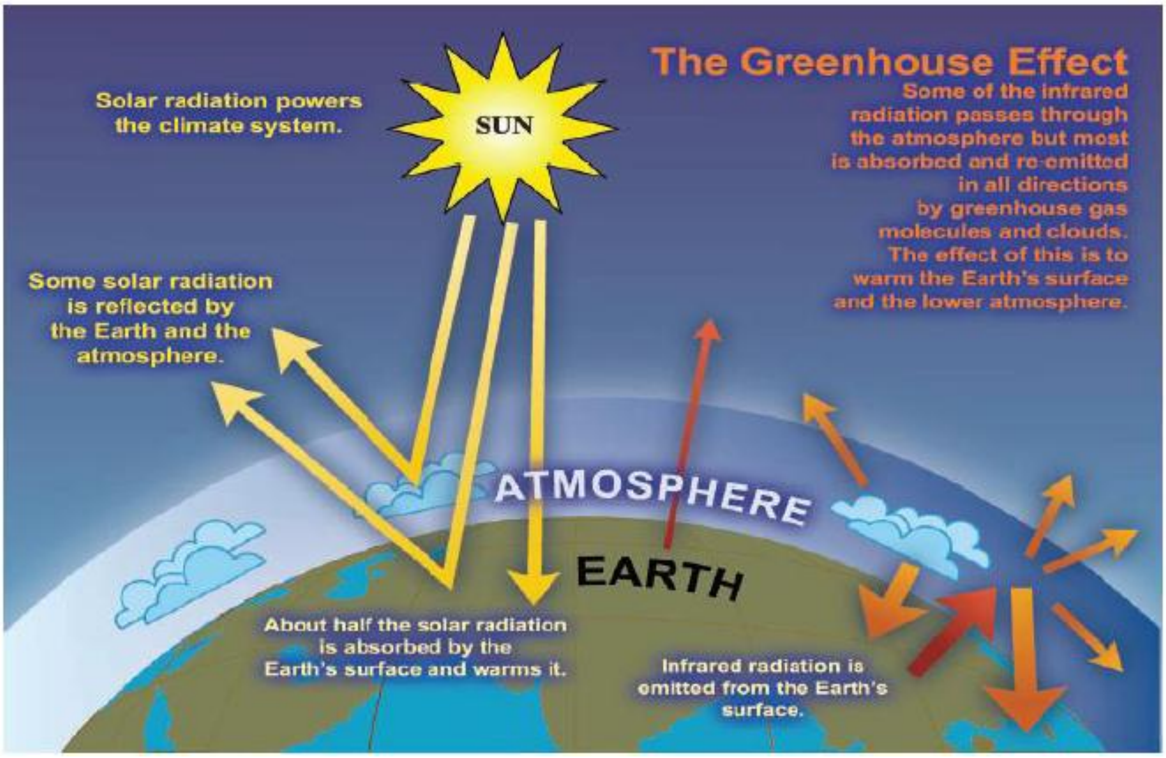


Figure (2) **The Greenhouse gases** [5]

Part of the energy absorbed at the Earth's surface is radiated back (or re-admitted) to the atmosphere and space in the form of heat (or thermal) energy. The temperature we feel is a measure of this heat energy. In the atmosphere, not all thermal radiation emitted by the Earth reaches outer space. Part of it is absorbed and reflected back to the Earth's surface by greenhouse gas (GHG) molecules and clouds (the greenhouse effect) leading to a global average of around 14°C, well above the -19°C which would be felt without the natural greenhouse effect. The concentrations of some GHGs, such as carbon dioxide (CO2), are significantly influenced by humans, others, such as water vapor, are not[6].

1-3-1-Further information:

The two most abundant gases in the atmosphere, nitrogen (comprising 78% of the dry atmosphere) and oxygen (comprising 21%), exert almost no greenhouse effect. Instead, the greenhouse effect comes from molecules that are more complex and much less common[7]. Water vapor is the most important greenhouse gas, and carbon dioxide (CO2) is the second-most important one. Methane, nitrous oxide, ozone and several other gases present in the atmosphere in small amounts also contribute to the greenhouse effect[2].

1-3-2- What is the Greenhouse Effect?

Overview of Greenhouse Gases Regulated under the Kyoto Protocol:

Greenhouse gases (GHGs) are trace gases in the atmosphere that absorb and emit long wave radiation. They naturally blanket the earth and keep it at about 33° C warmer than it would be without these gases in the atmosphere. The table features the seven most important greenhouse gases as regulated under the Kyoto Protocol. The seven gases each have a different capacity to trap heat in the atmosphere, or a so-called "*global warming potential*" (GWP). They all belong to the group of long-lived greenhouse gases (LLGHGs), because they are chemically stable and persist in the atmosphere over time scales of a decade to centuries or longer, so that their emission has a long-term influence on climate see table (1)**[6].**

Some of the GHGs occur naturally (e.g. CO_2, CH_4 and N_2O) but increases in their atmospheric concentrations over the last 250 years are due largely to human activities. Other greenhouse gases are entirely the result of human activities (e.g. HFCs, PFCs, SF_6 and NF_3) **[6].see table (1).**

Table (1) Greenhouse gases Emission [6].

Greenhouse Gas	Global Warming Potential (GWP) (over 100 years)	% of Total Anthropogenic GHG Emissions
Carbon dioxide (CO_2)	1	76%
Methane (CH_4)	25	16%
Nitrous oxide (N_2O)	298	6%
Hydrofluorocarbons (HFCs)	124-14,800	< 2%
Perfluorocarbons (PFCs)	7,390-12,200	< 2%
Sulphur hexafluoride (SF_6)	22,800	< 2%
Nitrogen trifluoride (NF_3)	17,200	< 2%

2-Climate Change and Global Warming:

2-1-Global Warming

Refers to the overall warming of the planet, based on average temperature over the entire surface of the Earth

2-2-Climate Change

Refers to changes in climate characteristics, including temperature, humidity, rainfall, wind, and severe weather events over long term periods.

The main cause of global warming is the increased concentration of greenhouse gases in the atmosphere since the industrial revolution in the late 18th century. The increased amount of gases which absorb and re-emit thermal radiation, have directly led to more heat being retained in the atmosphere and thus an increase in global average surface temperatures. The increase in temperature is also leading to other effects on the climate system. Together these affects are known as anthropogenic (human caused) climate change.

Observed Change in Surface Temperature (1901–2012):

This diagram gives an indication of the observed change in average surface temperature between 1901 and 2012. It shows that almost the entire globe has experienced surface warming **[7] see figure (3).**

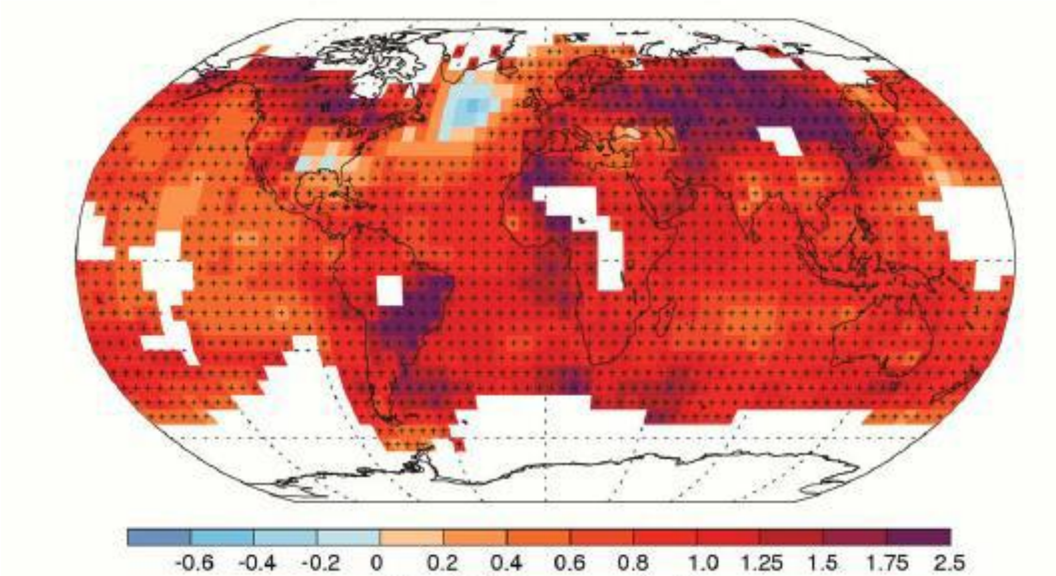


figure (3)Trend (degree C over period) [7]

3-Tools to Predict and Project Changes in the Climate:

• 3-1-Climate Prediction

A climate prediction or climate "forecast" is an attempt to produce an estimate of the actual evolution of the climate in the future.

• 3-2-Emissions Scenario

Emissions scenarios describe future releases to the atmosphere of greenhouse gases, aerosols, and other pollutants and, along with information on land use and land cover, provide inputs to climate models.

• 3-3-Climate Model

A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for some of its known properties.

• 3-4-Climate Projection

A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models **[8]**.

4-system to understand and predict its behavior:

One of the inputs to a climate model are *emission scenarios*, which estimate future releases of greenhouse gases and aerosols to the atmosphere based on assumptions concerning, for example, future socioeconomic and technological developments. The outputs of a climate model feed into a *climate projection*, i.e. a simulated response of the climate system to a certain emission scenario. This dependence on emission scenarios differentiates climate projections from *climate predictions* which are based on conditions that are known at present and assumptions about the physical processes that will determine future changes **[9]**.

4-1- In Focus: Representative Concentration Pathways (RCPs):

- Set of four new scenarios defined by the scientific community for the Fifth IPCC Assessment Report.
- Four RCPs include:
  - one mitigation scenario leading to a very low forcing level (RCP2.6),
  - two stabilization scenarios (RCP4.5 and RCP6), and

- ○ one scenario with very high greenhouse gas emissions (RCP8.5).
- RCPs represent a range of 21st century climate policies.

4-2-Why Current Climate (Inherent) Vulnerability Assessment?

Identifying current and potential hotspots:
Which are most likely to be adversely impacted by Current climate
To identify the drivers of Vulnerability:
Factors contributing to the Vulnerability; especially non-climate factors
Identifying entry points for intervention:
Information on the factors underlying a system's vulnerability can serve as a starting point for identifying suitable adaptation interventions.

4-3-Prioritizing for adaptation interventions:

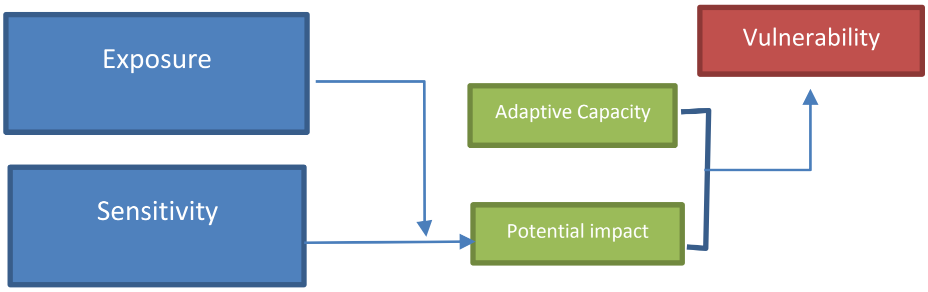
It allows to prioritize households, villages, *panchayats*, blocks, cropping systems, etc., for current adaptation planning and implementation to enable targeted programmes to reduce vulnerability.
Tracking changes in vulnerability and monitoring and evaluation (M&E) of adaptation:

4-4-A relatively new approach is to use vulnerability assessments to track changes in vulnerability over time:

This complements existing methods for M&E of adaptation measures and generates additional knowledge on the effectiveness of adaptation.

5-The Components of Vulnerability:

Various components contribute to climate vulnerability, see figure (3). For example, if climate change leads to heavy rainfalls in a certain region (exposure) and the crops traditionally planted in this region ,not resistant to high amounts of precipitation (sensitivity), then this will lead to decreased crop productivity (potential impact) see figure (4).. If, however, the adaptive capacity of the region is very high (farmers are able to switch to more resistant crop varieties) then vulnerability is reduced, despite high exposure and sensitivity see figure (5) **[10].**



Figuer(3)
Reproduced from Midgley, Davies &Chesterman 2011p3[10].

“Adaptation to climate change refers to adjustments in human and natural systems in response to actual or expected climatic variation, with a view to moderating harm or exploiting beneficial opportunities.” (source: Based on IPCC2001)	
Type	Action
Anticipatory adaptation	Taking action in preparation of climate change
Reactive adaptation	Taking action when climate change effects are experienced

Figuer (4) Climate change adaptation [10].

vulnerability to climate change

"The degree to which a system is susceptible to, and uncable to cope with, aadverse effects os climate change, including climate variability and extremes . Vulnerability is a function of the character,

magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity."

(IPCC 2007)

Adaptive Capacity

"The whole of capabilities, resources and institutions of a country or region to implement effective adaptation measures.

(IPCC 2007)

Resilience

"The ability of a social or ecological system to absorrb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change."

(IPCC 2007)

Climate Risk

"The combination of the li;elihood (probability of occurence) and the consequences of an adverse event (e-g-tropical cyclone, drought, flood)."

(UNDP 2011)

Figuer (5) Definition of Related Concepts [10].

5-1-Steps for Mainstreaming Climate Change Adaptation in Development Plans:

• Step-1

Historical / Current Climate trends and Variability assessment -Response of Farmers / Food production

• Step-2

Make Climate change projections at District / Block level

• Step-3

Model based Assessment of impacts of climate change On Agriculture / Water resources / Forests

• Step-4

Assessment of Risk / Vulnerability Profiles - Current climate vulnerability & Future climate vulnerability

• Step-5

Assessment current coping strategies to current climate risks – If possible Assess Adaptation Deficit
• Step-6
Development of Resilient / Adaptation Packages / Practices to ADDRESS Climate Variability & change
• Step-7
Mainstreaming Adaptation in Developmental Plans / Programs.

5-2-Vulnerability Assessment steps:

Step-1: Scoping of Vulnerability Assessment:

- Identification of the need for vulnerability assessment (for example, to rank the most vulnerable districts in a state for adaptation investment allocation)
- Defining the specific objective/s of the assessment (for example, to develop vulnerability profiles of the districts, to rank the districts using vulnerability index and identifying the drivers of vulnerability), and Identification of the stakeholders and target groups for the vulnerability assessment. See figure (6).

Steps	Steps in Vulnerability Assessment
Step1	• Scoping and objectives of vulnerability assessment
Step2	• Selection of type of vulnerability assessment
Step3	• Selection of Tier methods
Step4	• Selection of sector, Spatial scale, Community/ system and period for vulnerability assessment
Step5	• Identification, definition and selection of indicators for vulnerability assessment
Step6	• Quantification and measurement of indicators
Step7	• Normalization of indicators
Step8	• Assigning weights to indicators
Step9	• Aggregation of indicators and development of vulnerability index
Step10	• Representation of vulnerability; spatial maps, charts and tables of vulnerability profiles and index
Step11	• Vulnerability ranking of sectors, regions, communities, cropping systems, river basins, watersheds, forest types, etc.
Step12	• Identification of drivers of vulnerability for adaptation planning.

Figuer (6) Vulnerability Assessment Steps [10].

Step 2: Which category of Vulnerability assessment?

1. Biophysical V assessment
2. Socio-economic V assessment
3. Integrated; Bio-physical and Socio-economic
4. Sectoral Vulnerability
1. Agriculture vulnerability
2. Forest vulnerability

5. Hazard Specific Vulnerability

Step-3: Selection of tier for assessment:

WHY: It helps to match the “Objectives – Resources (and time) - Methods for Vulnerability Assessment”.

Tier-1: It is a top-down approach and largely based on secondary data

Tier-2: It involves a combination of top-down and bottom-up data, approaches or studies

Tier-3: It involves top down and bottom-up approaches, along with spatial remote sensing and GIS information/data.

STEP-4: Selection of sector, spatial scale, community/ system and period for vulnerability assessment:

Sector:

Agriculture / Forest / Water resources

Spatial Scale:

State / district / Block level

Community:

Tribal / Non-Tribal / Land less / Small Farmers / Large Farmers - Rainfed and irrigated farmers

Period:

Current Climate Vulnerability

Step 5: Identification, definition and selection of indicators for vulnerability assessment:

Vulnerability cannot be measured directly / it is non-observable

Indicators are used as Proxy for Vulnerability

Vulnerability is a function of sensitivity and adaptive capacity components of a system.

Vulnerability (V) = f [Sensitivity (S), Adaptive Capacity (AC)]

As, $V \infty S$ and $V \infty 1/AC$, therefore $V = f[S, 1/AC]$

Step 7: Normalization of Indicators:

Indicators are in different units

Ha, tones, population, literacy levels, etc

Normalization is a process of rendering the different indicators dimensionless so they can be aggregated

Before normalizing indicators, it is important to identify the functional relationship between the indicators and vulnerability

Step 8: Assigning weights to indicators:

Different indicators have different levels of impact on vulnerability.

For example, percentage area irrigated may have a higher impact on agriculture vulnerability than say, land area per household.

Thus, there is a need to provide weights to the indicators to reflect the comparative importance or contribution of each indicator to the total vulnerability of the system or communities.

Step 10: Ranking of Districts, Blocks, Villages on Vulnerability scale:

Vulnerability index is normally developed to assist the policy makers, development administrators, NGOs and banks in prioritizing the districts, blocks, sectors or cropping systems for Adaptation interventions.

Such agencies would be interested in three types of outputs

A comparative index value of different districts or cropping systems or communities

Spatial distribution of the high or low vulnerability units

Drivers of vulnerability, so that adaptation investments can be focused on dominant drivers.

Step 11: Identifying drivers?:

Vulnerability assessments are designed to assist in adaptation planning, with the overall objective of reducing vulnerability in the region or sector under consideration.

A vulnerability assessment can also help to substantiate decision-making when it comes to selecting adaptation measures, based on the assessment of drivers of vulnerability with their index value.

Thus, vulnerability assessments can be designed to assess the drivers of vulnerability for developing targeted adaptation planning to reduce vulnerability.

It is important to identify the drivers of vulnerability to prioritize adaptation strategies.

Essentially, this means to identify the contribution of each indicator to vulnerability.

6-Climate Change and extreme events [3] :

6-1-Weather, Climate and Climate change:

• Weather: Conditions of Atmosphere over a short period of time (e.g. Daily, Monthly) **Example**: Today it is raining heavily.

• Climate: how the atmosphere "behaves" over relatively long periods of time (decade, 30 years [for climatological studies] or more). Example: Chennai has a very hot and humid climate).

• Climate Change: Any systematic change in the long-term statistics of climate elements (such as temperature, pressure, or winds) sustained over several decades or longer. Example: Compared to mid 20thcentury, Bangalore is becoming hotter.

6-2-Physical variables:

• Temperature
• Mean Sea Level Pressure (MSLP)
• Specific Humidity/ Relative Humidity
• U-Wind/ V-Wind.
• All above mentioned variables at different pressure levels
• Precipitable Water
• Geopotential Height : geopotential height observation represents the height of the pressure surface on which the observation was taken.

6-3- the importance of modeling :

6-3-1-Modeling Climate Change:

• Development of climate change needs understanding of climate system in terms of:
• Radiation: the way in which the input and absorption of solar radiation and the emission of infrared radiation are handled.
• Dynamics: the movement of energy around the globe by winds and ocean currents.
• Surface Processes: inclusion of the effects of sea and land-ice, snow, vegetation and the resultant change in emissivity and surface-atmosphere energy exchange.
• Chemistry: The chemical composition of the atmosphere and the interaction with other components.

Resolution in both time and space: The time step and the spatial grid size for solving climate models.

6-3-2-General Circulation Models (GCMs):

3-D modeling considers all geophysical laws and dynamics.

• Considered as ‘complete model’.
• Sets of equations considered in GCM
• Conservation of mass
• Conservation of momentum

- Conservation of energy
- Conservation of water vapor
- Equation of state
- Ideal Gas Law
- Types of GCM
- Atmospheric GCM: considers atmospheric processes.
- Oceanic GCM: considers oceanic processes.
- Coupled GCM: couples both the GCMs.

6-4-What a Global Climate Mitigation (GCM) simulate?:

- Simulates time series of climate variables globally, accounting for effects of greenhouse gases in the atmosphere.
- Can simulate large scale circulation patterns and climate variables globally.
- Cannot produce hydrologic variables such as precipitation very well.
- Works in a large spatial grid, and therefore fails to model local scale processes

6-5-What is an extreme event?:

- Extreme: – Reaching a high or the highest degree, very great – Not usual; exceptional – Very severe or serious
- Event: a thing that happens or takes place, especially one of importance

6-5-1-Many practical problems require knowledge of the behavior of extreme values:
In particular, the infrastructures we depend upon for food, water, energy, shelter and transportation are sensitive to high or low values of meteorological variables. For example, high precipitation amounts and resulting stream flows affect sewerage systems, dams, reservoirs and bridges. The motivation for analyzing extremes is often to find an optimum balance between adopting high safety standards that are very costly on the one hand, and preventing major damage to equipment and structures from extreme events that are likely to occur during the useful life of such infrastructure on the other hand **[8].**

6-5-2-Most existing systems for water management and other infrastructure have been designed under the assumption that climate is stationary:
This assumption of stationary is still common practice for design criteria for (the safety of) new infrastructure, even though the notion that climate change may alter the mean, variability and extremes of relevant weather variables is now widely accepted.

-New infrastructure is typically designed on the basis of historical information on weather and climate extremes. Often, the maximum value of a particular variable in the historical record is considered to be the normative value for design.

-In other cases, extreme value theory is applied to the historical observations of extremes to estimate the normative value, again disregarding climate change.

-It is possible to account for non-stationary conditions (climate change) in extreme value analysis, but scientists are still debating the best way to do this. Nevertheless, adaptation strategies to climate change should now begin to account for the decadal scale changes (or low-frequency variability) in extremes observed in the past decades, as well as projections of future changes in extremes such as are obtained from climate models. Some types of infrastructure currently have little margin to buffer the impacts of climate change.

7-Descriptive indices of extremes [11] :

To gain a uniform perspective on observed changes in weather and climate extremes, ETCCDI has defined a core set of descriptive indices of extremes. The indices describe particular characteristics of extremes, including frequency, amplitude and persistence.

7-1-Climate indices for air temperature:

• The air temperature is an atmospheric parameter that is recorded since the start of weather recording. The air temperature is measured daily in 2 m height above ground and long time series exist for many stations.

• Number of frost and ice days
• Number of summer days and tropical nights
• Extreme values during a specific period Exceeding specific limits (Percentile)
• Daily temperature range
• Heating degree day
• Warm and cold spell duration
• Growing season length.

7-2-Climate indices of precipitation:

• Maximum 1- and 5-day precipitation per Year
• Simple precipitation intensity index
• Annual count of days when the precipitation is greater than a defined limit
• Maximum length of dry spell
• Maximum length of wet spell
• Annual total precipitation when rain rate is above a defined limit (Percentile)
• Annual total precipitation in wet days

8-Intended National Determined Contributions – INDCs (the practical section):

• To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.

• To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.

• To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.

• To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance (GCF).

• To create an additional carbon sink of 2.5 to 3 billion tones of CO_2 equivalent through additional forest and tree cover by 2030.

• To better adapt to climate change by enhancing investments in development programmes in sectors

• Vulnerable to climate change, particularly agriculture, water resources,

• Himalayan region, coastal regions, health and disaster management.

• To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.

• To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies. See figure (7)& (8)&(9).

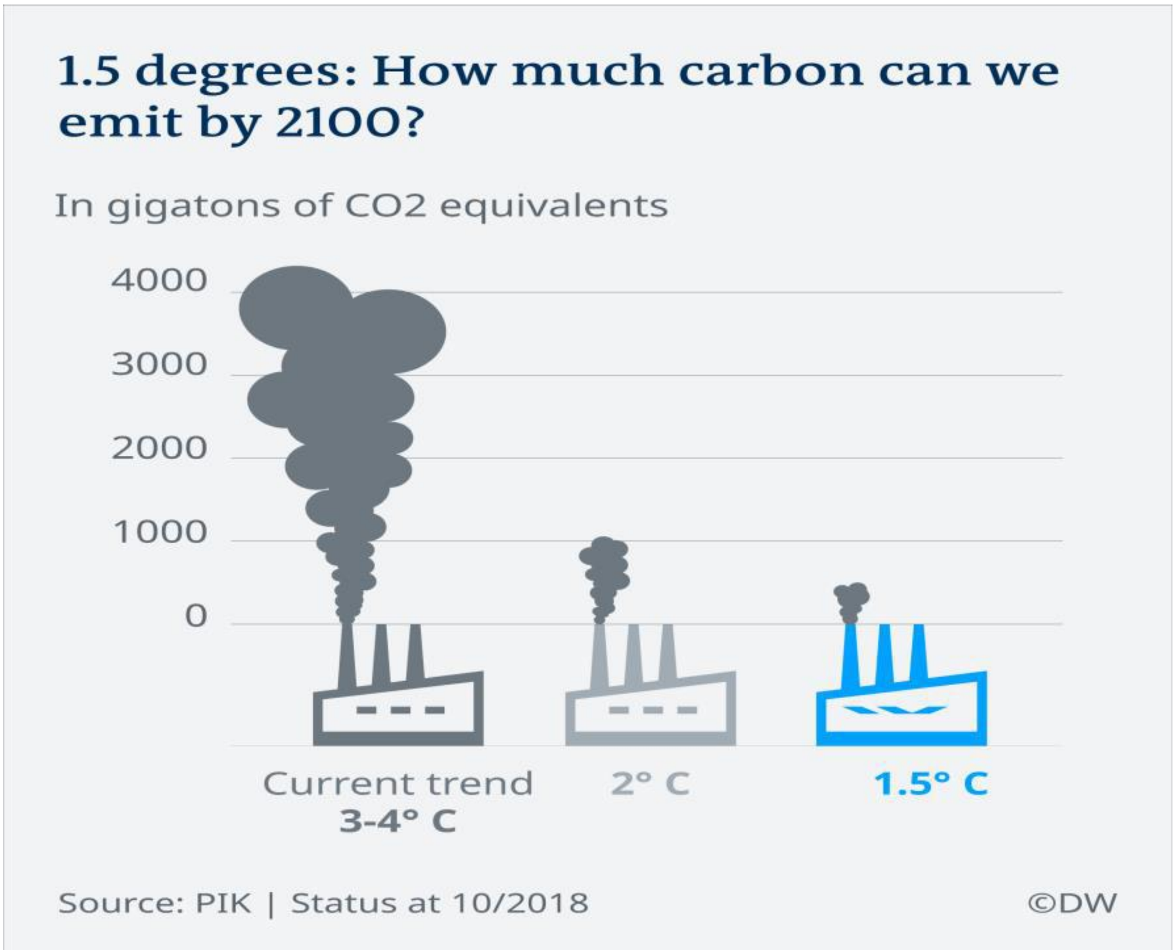


Figure (7). PIK/ Status at 10/2018 [11]

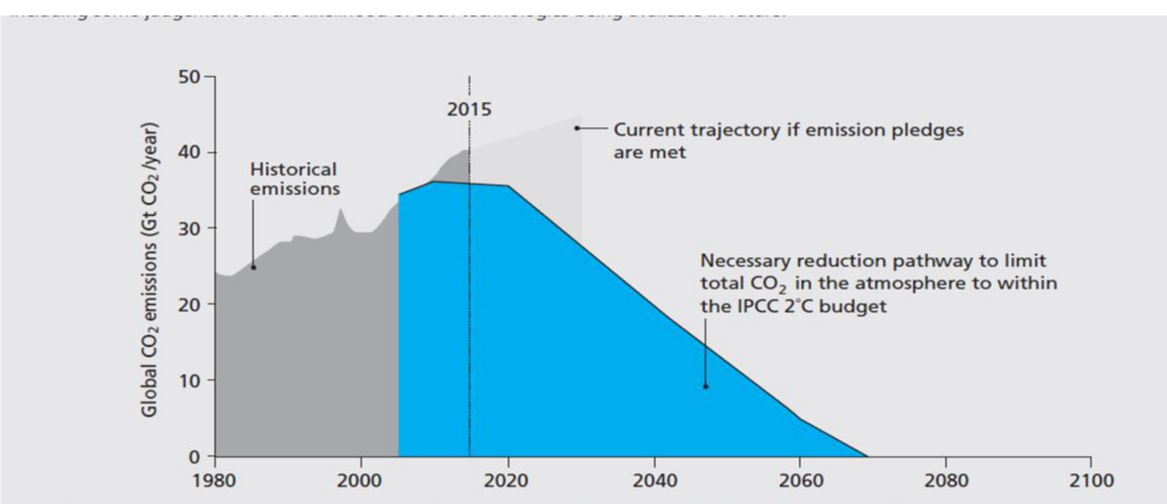


Figure (8) Emission pathways required to limit emissions to within the IPCC budget for 2degree C. Anderson and Peters (2016) [12]

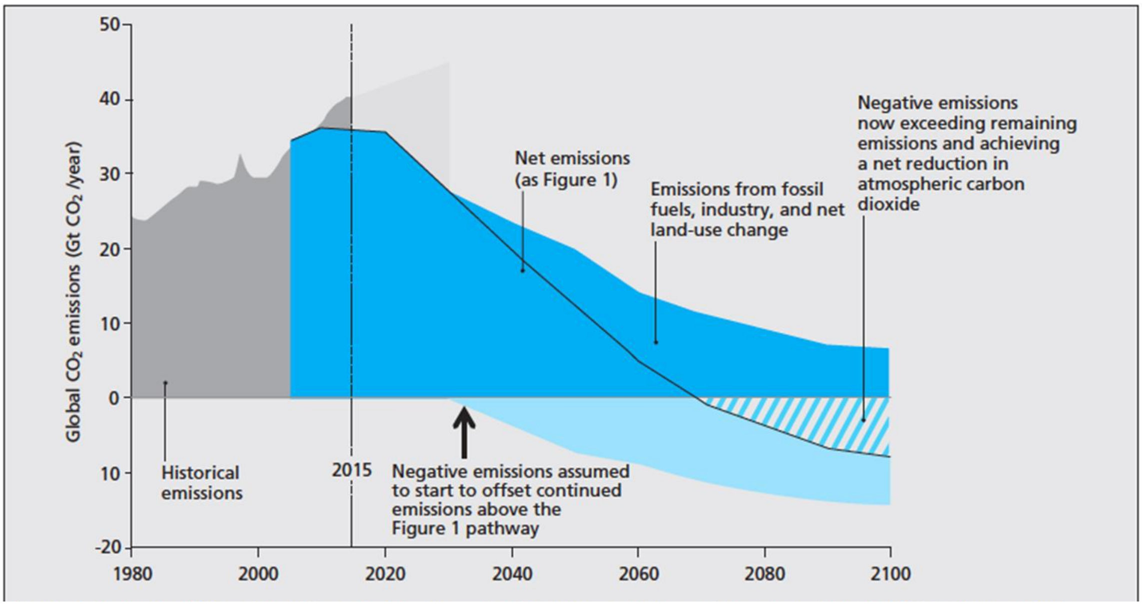


Figure (9) Inclusion CO2 removal in scenarios, thus allowing larger emissions without breaching the IPPC carbon budget. Anderson and Peters (2016) [12]

8-1-Negative Emission Technologies [13]

• Afforestation and reforestation to sequester carbon in forest and plantations
• Land management to sequester carbon in soils
• Bioenergy with Carbon Capture and Storage (BECCS)
• Enhanced weathering
• Direct capture of CO2 from ambient air with CO2 storage (DACCS)
• Ocean fertilisation to increase CO2
• Carbon Capture and Storage (CCS) .

8-2-Implications of Paris Agreement 8-2-1-Global Response to the Threat of Climate Change

• (a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

• (b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;

• (c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development

8-2-2-Paris Agreement – Targets [14]:

• 1- “Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels”,

• 2-recognizing that this would significantly reduce the risks and impacts of climate change;

• 3-Parties aim to reach global peaking of GHG emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science,

• 4- so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century,
• 5-Net Zero GHG Emissions by 2050s .see table (1) and figure (10).

Table (2) Targets of Paris Agreement[14] .

<table>
<tr><th>Article/</th><th></th><th>Implications</th></tr>
<tr><td>Article 4 (19)</td><td>“All Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, … taking into account CBD, and national circumstances.”</td><td rowspan="5">1. Methods and models for selection/evaluation of mitigation technologies, policies and measures
2. Methods and models for assessing the mitigation impact of various technologies and measures
3. Methods and models for assessment of the co-benefits or tradeoffs
4. When and how to achieve peaking of emissions for India
5. Periodic assessment of the potential for enhancing the GHG emission reduction commitments for India
6. Continuous monitoring, reporting and verification of GHG mitigation measures, implementation, GHG reduction etc.
7. Strategy for enhanced public and private sector participation in implementing mitigation measures
8. Estimation of requirement of finance and investment for implementing NDCs
9. Strategy for technology development and transfer for mitigation and adaptation
10. Technology options for radically reducing GHG emissions and for achieving no net emissions</td></tr>
<tr><td>Article 5 (1)</td><td>“Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse”</td></tr>
<tr><td>Article 4 (7)</td><td>“Mitigation co-benefits resulting from Parties’ adaptation actions and/or economic diversification plans can contribute to mitigation outcomes under this Article.”</td></tr>
<tr><td>Article 4 (3)</td><td>…Assess and report Nationally Determined Contributions that represent a progression over the previous NDCs…</td></tr>
<tr><td>Article 4 (1)</td><td>… Reaching global peaking and rapid reduction – strategy and plan for the country … achieving balance between GHG emissions / sinks</td></tr>
</table>

Figure (10) sustainable Development Goals .

8-2-3-What does US Departure from Paris Agreement Mean?

- If Paris pledges are followed by the world but not improved on, by 2100,
- the world will be 3.3 °C warmer than in pre-industrial times (range 1.9-4.4 °C).
- If world were to drop the Paris agreement altogether and follow current trends,
- the world would be 4.2 degrees C warmer by 2100 (range 2.5 to 5.5 °C).
- To keep temperatures from rising 2 °C by 2100, need to
- reach peak emissions by 2030 and
- then steadily cut emissions from there, investing in clean energy.

8-3-Initiatives towards carbon neutral economy[15]:

1. Norway: Parliament approves the plan to make Norway Carbon Neutral by 2030
2. Sweden: Passed a law towards zero CO2 emission economy by 2045
3. EU: Aims to decarbonise and reduce GHG emissions by 80 to 95% by 2050. Has set a binding target of reducing emissions by at least 40% compared to 1990 levels by 2030.
4. Germany: Committed to cut carbon dioxide emissions by 40% in 2020 compared to 1990 levels
5. UK: Close all coal-based power plants by 2025
6. China

- China’s CO2 emissions appear to have peaked more than a decade ahead of its Paris Agreement commitment to peak its CO2 emissions before 2030.
- Commitment to peak CO2 emissions by 2030 at the latest, lower the carbon intensity of GDP by 60%–65% below 2005 levels by 2030,

7. California: Emissions cut of 40% below 1990 levels by 2030 .see figure (11).

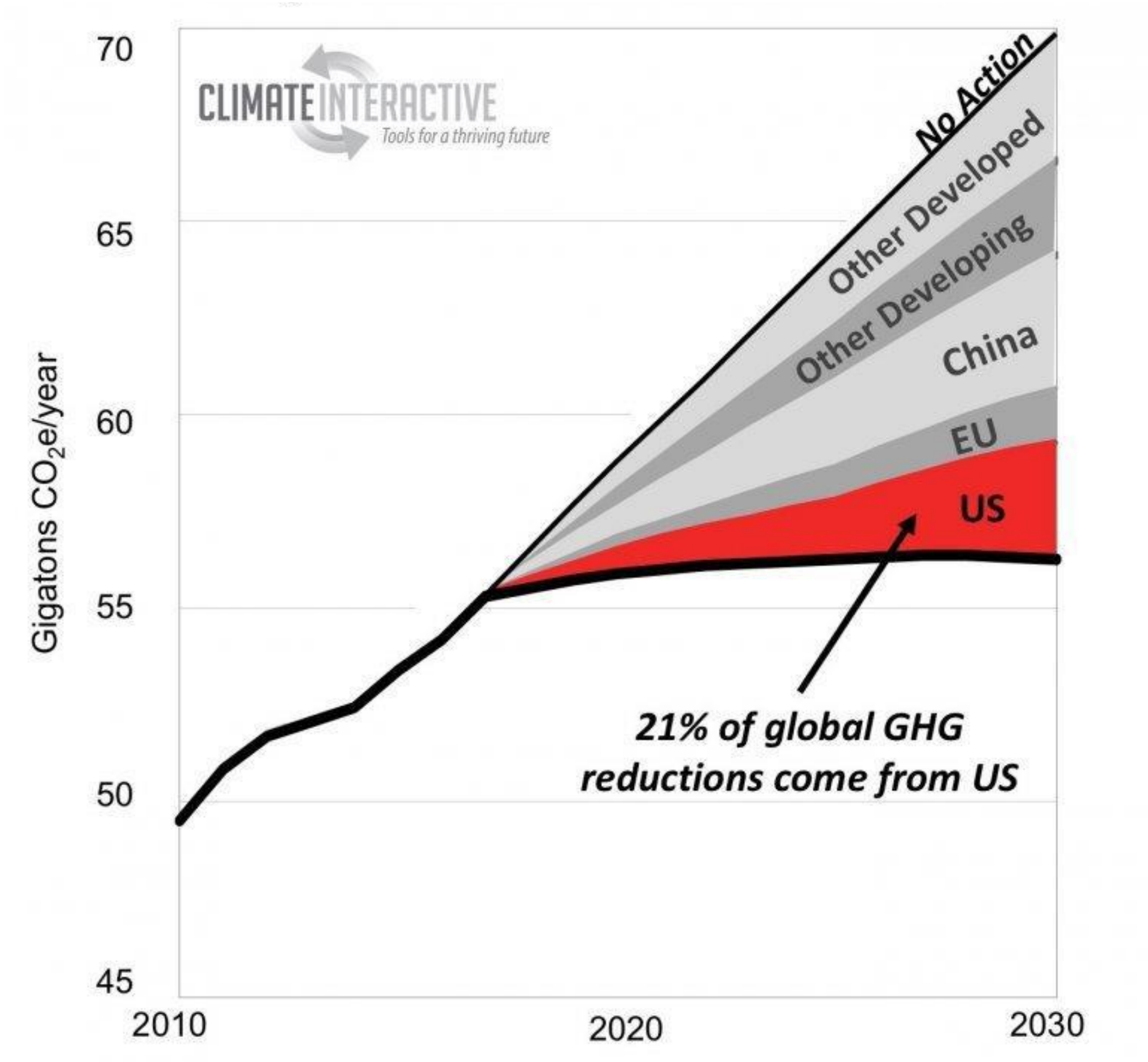


Figure (11) pledged greenhouse gas emission reductions [15].

Conclusions and Recommendations:

1- Climate change is already happening and will soon cross 20 °C

2- Agriculture and Farmers are already subjected to Increasing Climate Variability and Extremes

3- The Climate Variability and Extremes are highly Sensitive with Low Adaptive Capacity

4- We still do not have Robust Assessment of Climate change projections or Impacts assessments at Regional / Local level

• Different crops / communities at Watershed, Block, Panchayat, etc. levels

• Very limited Research / Sustainable Adaptive Capacity Building

5- Many challenges; Land Degradation, Ground Water Decline, Pests, High current Climate Variability

6- Climate change is an ADDITIONAL STRESS.

We recommended to :

1-Invest in research in development of climate resilient crops and varieties, agronomic and forestry practices, efficient water management systems, controlling of vector borne diseases, modelling, etc

2-Strengthen the flagship programmes by incorporating climate resilience and vulnerability considerations .

1- Halting Land Degradation, Ground water decline, inefficient use of Irrigation water, Wastage of grains (post-harvest losses).

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