

EFFECT OF CLIMATE CHANGE ON PUBLIC HEALTH

July 2023



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ABBREVIATIONS



ANM	: Auxiliary Nurse Midwife	LGU	: Local Government Unit
ASHA	: Accredited Social Health Activist	NAPCC	: National Action Plan for Climate Change
AWW	: Anganwadi Workers	PHC	: Primary Health Centres
BMI	: Body Mass Index	SDG	: Sustainable Development Goals
COP	: Conference of Parties	TNA	: Training Needs Assessment
CHC	: Community Health Centres	UNFCCC	: United Nations Framework Convention on Climate Change
FRU	: First Referral Unit	UNPF	: United Nations Population Fund
GHG	: Greenhouse Gas	WHO	: World Health Organization
IDSP	: Integrated Disease Surveillance Programme	WMO	: World Meteorological Organization
IPCC	: International Panel on Climate Change		



EXECUTIVE SUMMARY



Climate change is a pressing global issue with wide-ranging implications for environmental and human well-being, demanding urgent action for mitigation and adaptation. It poses significant threats to human health due to direct and indirect impacts like degraded air quality that exacerbate respiratory ailments, and rising temperatures and intensified extreme weather events that heighten the risks of heat-related illnesses, injuries, and population displacement.

Globally, various conventions such as the **UN Framework Convention on Climate Change, Kyoto Protocol, and The Paris Agreement** work together to address and prevent climate impacts due to human interventions by fostering international collaboration, knowledge sharing, and policy negotiations while promoting transparency and monitoring of climate goals. They also mobilise financial resources and technology transfer to support developing countries in their climate change efforts.

Climate change significantly impacts India, and has profound implications for the population. Heatwaves, air pollution, waterborne diseases, and vector-borne diseases are on the rise, disproportionately **affecting** vulnerable populations such as **children, pregnant women and the workforce exposed to extreme weather conditions.**

The Government recognises the impact of climate change on human health and has implemented various **national and state level action plans** to help mitigate it by developing climate-resilient health programmes, enhancing health system capacities, and improving monitoring, surveillance and research on climate change's health effects to inform evidence-based health policies.

Various factors contribute to the amplification of climate-sensitive health risks. **Demographic characteristics**, such as age and sex of individuals and population dynamics, have different impacts due to climate change. Additionally, **geographical factors** exacerbate the situation, including nutrient deficiencies in regions prone to droughts and waterborne diseases following floods. **Biologically**, women, undernourished populations, and people with chronic illnesses or disorders are more vulnerable to climate change. **Political factors** arise from fragmented climate policies and discriminated populations. **Social and economic factors** are also implicated, with climate change intensifying vulnerabilities for poor populations by reduced access to healthcare, gendered disparities, unsafe water and sanitation, and inadequate shelters.

Going forward, there is a **need for building climate-resilient health systems in India** due to the lack of health data systems to track the effects and challenges of climate change, inequity in access to healthcare resources and lack of preparedness of health systems for disaster management. **Climate-resilient health systems should work on six levers** - leadership and governance, health workforce, health information systems, essential medical systems, service delivery and financing.

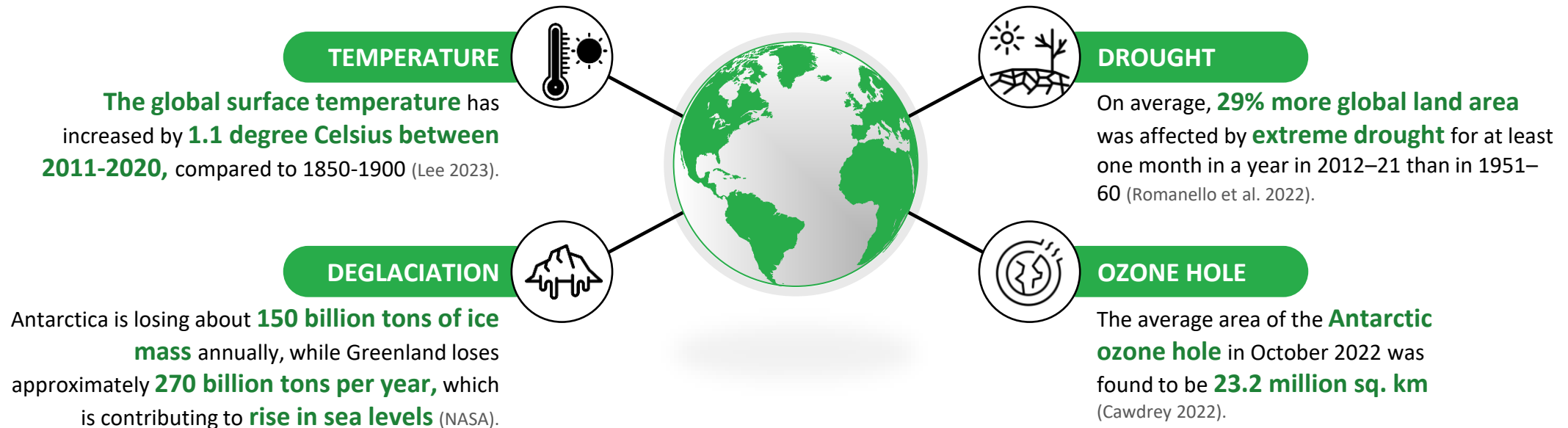


BACKGROUND AND CONTEXT



Globally, climate change is worsening rapidly.

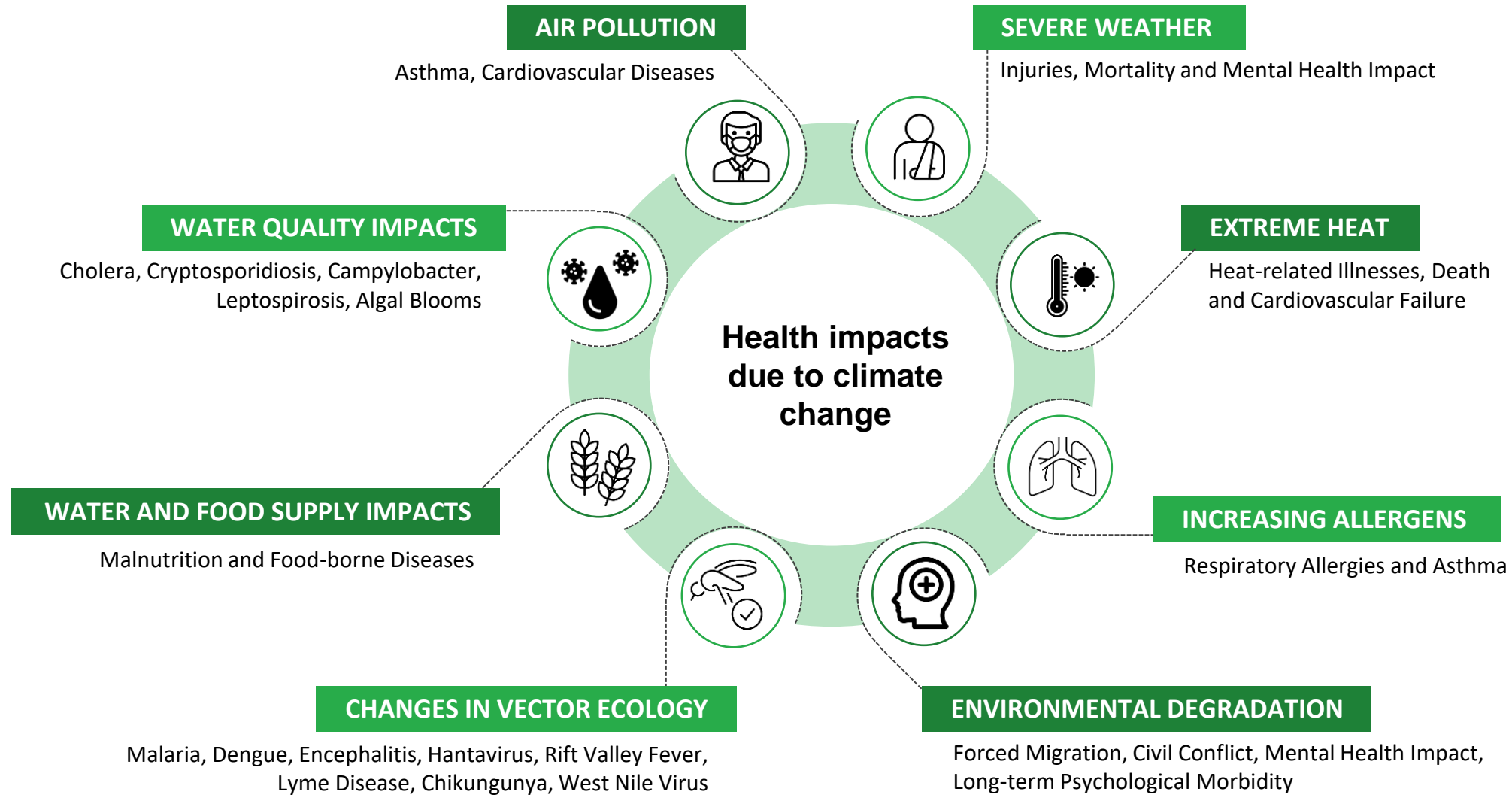
Human activities directly or indirectly alter the composition of the global atmosphere and add to natural climate variability, causing climate change. Burning fossil fuels for energy production, deforestation, industrial processes, and agricultural activities release significant amounts of greenhouse gases, contributing to global warming and climate change (WHO 2016).



16 out of 17 SDGs will be affected by indicators of climate change, such as increased CO₂ concentration, ocean acidification, increased global mean surface temperature, ocean heat content, sea-ice extent, glacier mass balance, and sea level rise (WMO 2021).



The climate crisis is a **health crisis**.

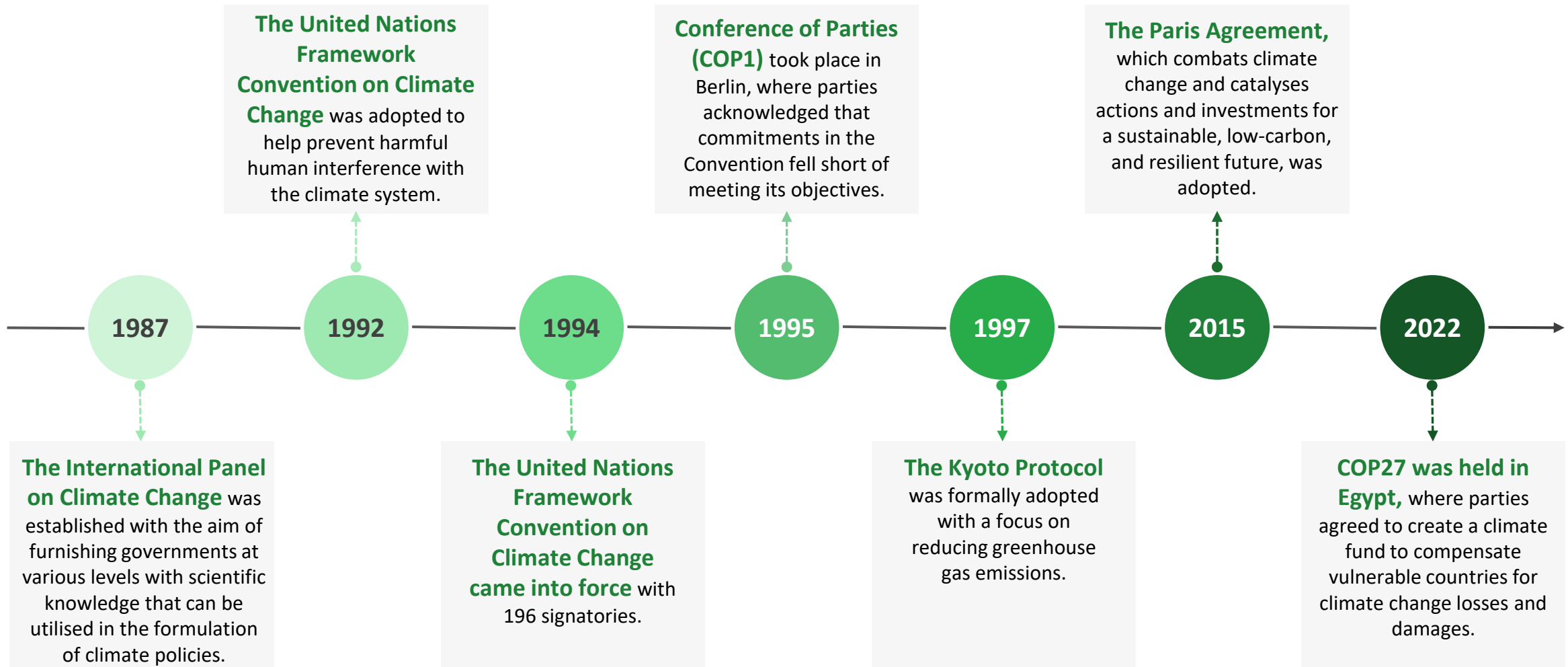


(Adapted from CDC)

GLOBAL CONVENTIONS IN CLIMATE CHANGE AND HEALTH



The focus of global climate conventions has been evolving over four decades.



The UN Framework Convention on Climate Change was adopted in 1992 to address harmful human interference with the climate system.

Aim

Stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system for a period of time will allow for adaptation by people and the environment as well as sustainable economic growth.

The UN Framework Convention on Climate Change

Principles for the Parties

Protect the climate system for the benefit of current and future generations, considering **equity and differentiated responsibilities**

Address the **specific needs and vulnerabilities of developing countries**, particularly those affected by climate change

Prioritise **cost-effective policies**, accounting for socio-economic contexts

Promote **sustainable development** and integrate climate policies with national development programmes

Foster a **sustainable global economy** and ensure climate measures do not unfairly **discriminate or restrict international trade**

Kyoto Protocol and Paris Agreement

The Kyoto Protocol translates the United Nations Framework Convention on Climate Change into action.

It requires industrialised nations and transitioning economies to set specific targets for limiting and reducing greenhouse gas emissions.

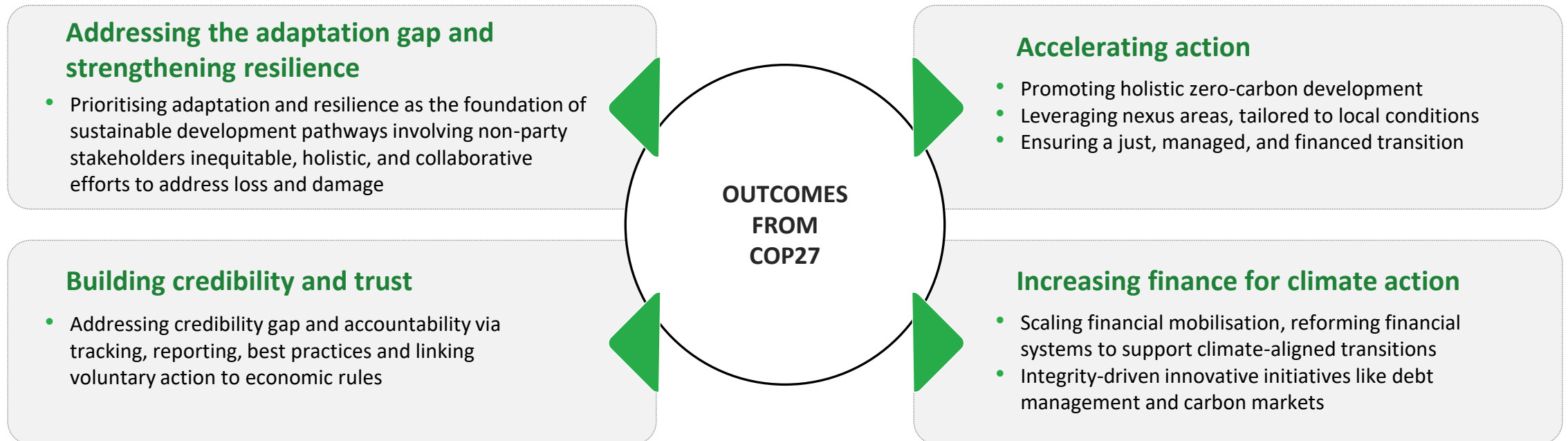
The Paris Agreement pursues efforts to limit the temperature increase to 1.5°C above pre-industrial levels and keep the increase in global average temperature to well below 2°C above pre-industrial levels.

(United Nations 1992)



A Conference of the Parties was established to review the implementation and make the decisions to promote the effective implementation of the Convention.

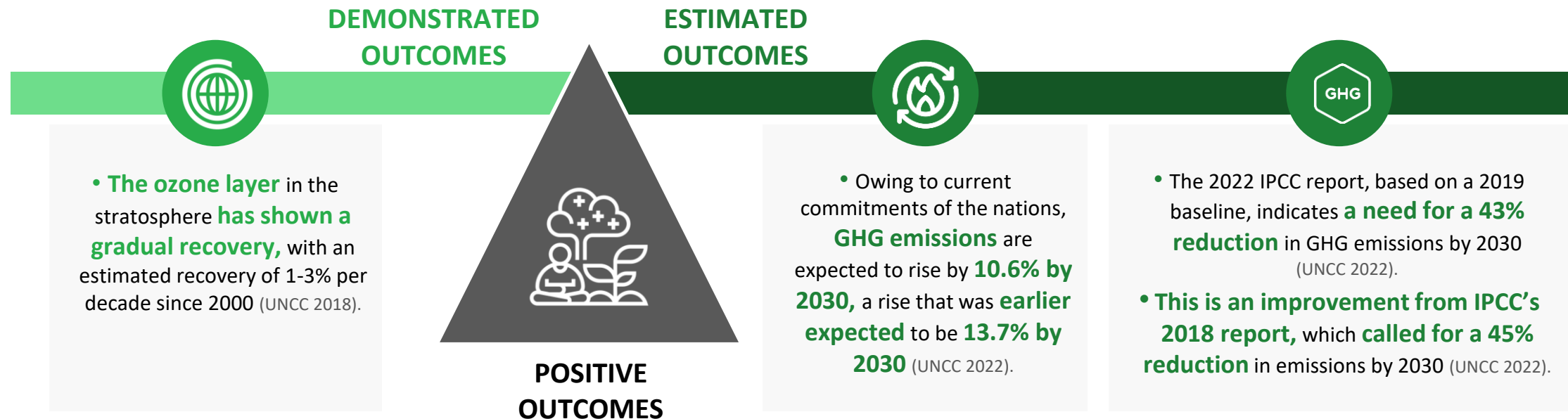
In order to advance the goals and ambitions of the Paris Agreement and make progress in its implementation, parties to the Convention gather annually at Conferences of the Parties (COPs) and in technical meetings throughout the year. The recent **COP27 conference** was held in **November 2022** in Sharm el-Sheikh, Egypt.



(United Nations Climate Change)



The action enabled by global climate conventions has led to certain **positive outcomes**.



CLIMATE CHANGE AND HEALTH IN INDIA



India is highly vulnerable to climate change, which is translating into severe public health impacts.



Carbon dioxide emissions in India have increased by **6% in 2022** (Friedlingstein 2022).



The **average temperature** in the country is projected to increase by **4.4 degrees Celsius** by the end of the year 2100 (Sanjay et al. 2020).



Central India received an **excess of 20% rainfall**, while southern India saw a **surplus of 25%**. This resulted in several instances of flooding in Kerala, Karnataka, and Madhya Pradesh during the year 2022 (Journals of India 2022).



In terms of population-weighted average, India had an average **fine particulate matter (PM2.5) concentration of 53.3 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in 2022**, surpassing WHO's recommended annual guideline level of $5 \mu\text{g}/\text{m}^3$ (IQ Air 2022).



Uttar Pradesh, Bihar, and Odisha have experienced significant **rainfall deficits**, with the east and northeast of India reporting a **17% shortfall** and the northwest a **2% shortfall** (Journals of India 2022).



Heat-related deaths increased by **55%** between 2000-2004 and 2017-2021 (Romanello et al. 2022).

959 mortalities due to floods in 2020 (Salas 2023).

39% of stroke and ischaemic heart disease mortalities are caused by air pollution (WHO 2022).





Target groups, such as children and pregnant women are at greater risk due to climate change.

Target Group	Vulnerabilities	Impact
 <p>CHILDREN</p>	<ul style="list-style-type: none"> Excessive heat leads to dehydration, hyperthermia, and mortality in infants and school absenteeism in children (UNICEF 2021). Floods disrupt safe water, causing diarrhoea outbreaks and malnutrition, particularly affecting children with acute malnutrition conditions like wasting (UNICEF 2021). Air pollution contributes to respiratory problems, absenteeism, and long-term well-being issues in children (UNICEF 2021). 	<ul style="list-style-type: none"> Annually, 352 million Indian children face climatic events (Wise 2022). Infants experienced 0.9 more heatwave days in 2021 (Romanello et al. 2022). Approximately 400,000 children were affected by floods in 2022 (Oberoi & Garmirian 2022).
 <p>PREGNANT WOMEN</p>	<ul style="list-style-type: none"> Pregnant women are at higher risk during heat waves because they experience increased peripheral vasodilation, leading to greater electrolyte and fluid loss (Mishra 2023). Maternal heat exposure is linked to an increased risk of preterm and early-term birth, low and decreased birth weight, stillbirth, and adverse infant stress (Depass & Sakala 2023). Vector-borne illnesses such as malaria and dengue fever have been connected to miscarriage, premature birth, and anaemia (UNPF). 	<ul style="list-style-type: none"> During the warm season (May-September), a 1-degree Celsius rise in the week before delivery was linked to a 6% increase in risk. This equates to around 4 more stillbirths per 10,000 live births (Ha et al. 2017).



Climate change also impacts the **workforce and elderly population** significantly.

Target Group	Vulnerabilities	Impact
 <p>WORKFORCE <i>Exposed to direct heat, such as farmers</i></p>	<ul style="list-style-type: none"> Excessive heat in the workplace can create a variety of health problems ranging from a mild skin rash to a catastrophic heat stroke (Parsons et al. 2022). Sweating, dehydration, salt loss, loss of perceptual and motor performance, heat exhaustion, loss of capacity to work intensively owing to heat exhaustion, increased accident risk, and higher body temperature >37°C are some of the health consequences (Parsons et al. 2022). 	<ul style="list-style-type: none"> Approximately 380 million workers in India, constituting about 75% of the workforce, are exposed to heat-related labour, risking their lives due to potentially dangerous temperatures (The World Bank 2022). Climate change-induced increases in heat and humidity have resulted in India losing 167.2 million work hours in 2021. This loss accounts for around 5.4% of the country's annual GDP (Romanello et al. 2022).
 <p>ELDERLY</p>	<ul style="list-style-type: none"> Age-related vulnerabilities enhance the risk posed by climate change, as well as a reduced ability to respond rapidly to avoid harm, notably during earthquakes, floods, and cyclones (Prasad 2022). 	<ul style="list-style-type: none"> The elderly experienced 3.7 more heatwave days per person in 2021 (Romanello et al. 2022). Mortality caused due to heat stress in people over 65 years have more than doubled since the early 2000s, to more than 31,000 in 2018 (Mascarenhas 2020).

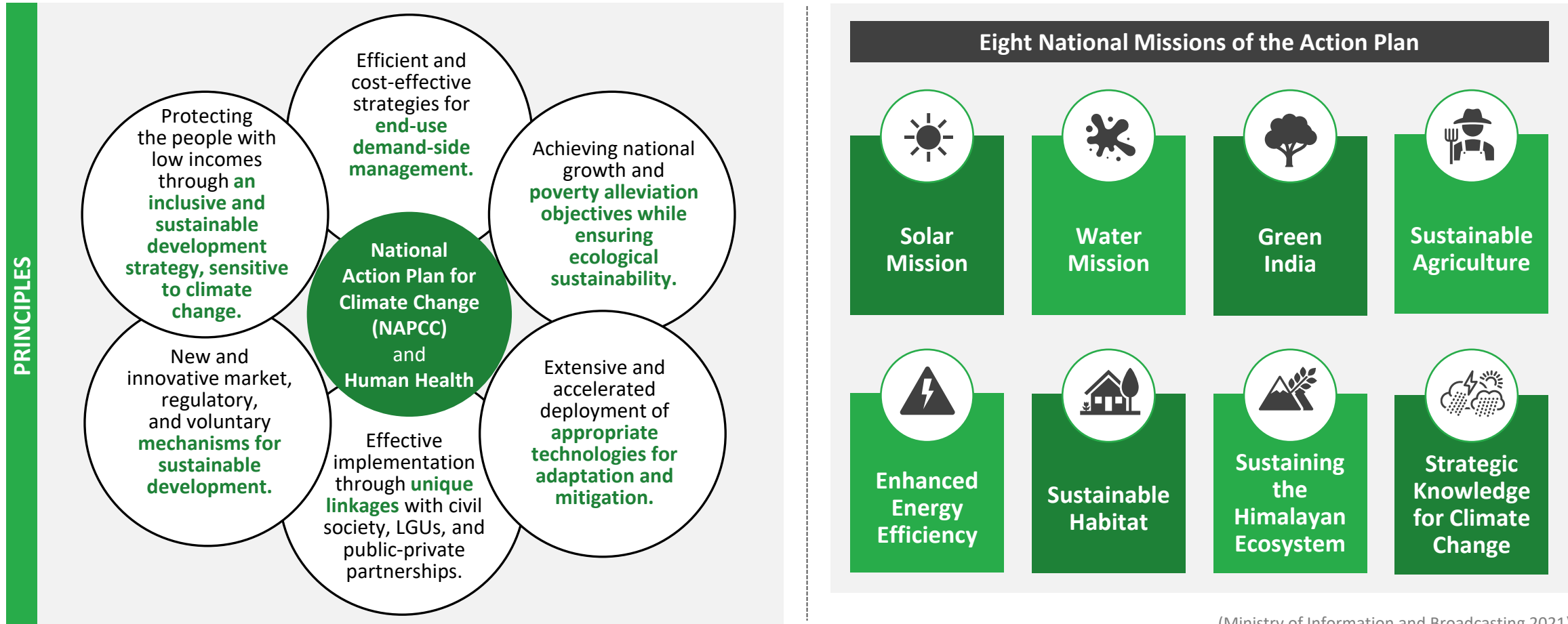


CLIMATE CHANGE POLICY FRAMEWORK IN INDIA



The National Action Plan for Climate Change aims to enable the country to adapt to climate change and enhance its ecological sustainability.

Released in 2008, the plan emphasises the necessity of sustaining a high growth rate to raise the living conditions of the great majority of Indians and lessen their susceptibility to the effects of climate change.



(Ministry of Information and Broadcasting 2021)

The National Action Plan for Climate Change and Human Health aims to strengthen public health against climate-sensitive illness, especially for the vulnerable populations.

PRINCIPLES

- **Raise awareness** of climate change impacts on health for vulnerable communities.
- **Enhance health system capacity** to address climate-sensitive illnesses through infrastructure, training, and resource materials.
- **Strengthen preparedness and response to health impacts** of climate change-related disasters through situational analysis.
- **Support** states in **assessing health vulnerabilities** to climate change and building adaptive capacities.
- **Foster partnerships with the private sector, civil society, and government departments** to align health goals with climate change initiatives.
- **Improve monitoring, surveillance, and research** on climate change's health effects to inform evidence-based health policies.

Climate-resilient Health Programmes

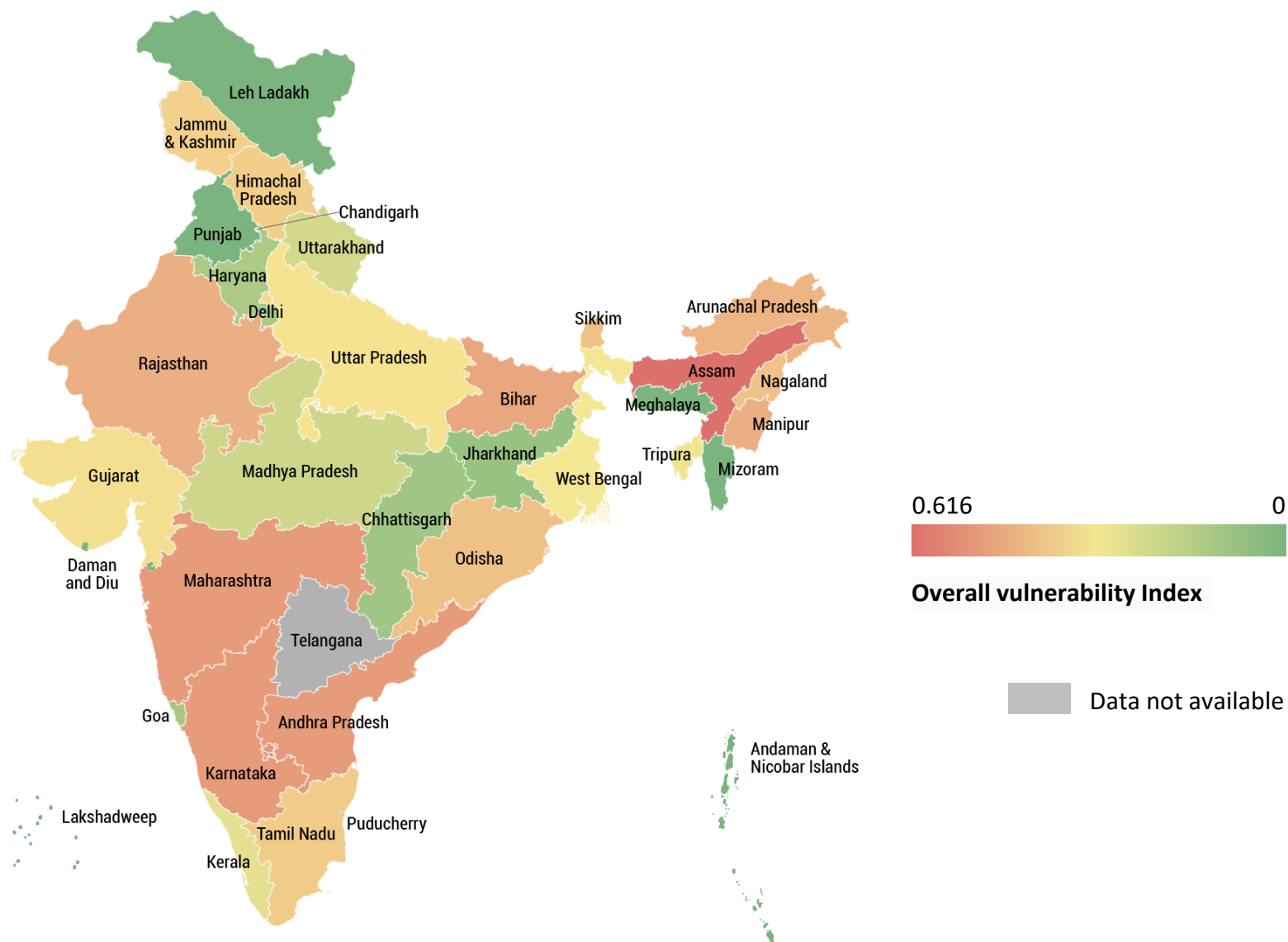
- Improve health facility design, public education, and heat-health plans for **extreme heat**.
- Enhance disease surveillance, food and water quality control, and emergency plans for **waterborne diseases**.
- Expand disease monitoring, **zoonotic disease** detection, and vaccination coverage.
- Develop exposure forecasts, enforce air quality standards, and prepare for increased treatment demand for **allergic and cardiovascular diseases**.
- Implement **nutritional screening** and scale up food security and health programmes in vulnerable areas.
- Assess public health infrastructure and strengthen diagnostic and treatment options for **storms and other emergencies**.
- Enhance risk communication, counselling, and case management skills at the primary healthcare level, including addressing the **mental health needs** of patients.

(Ministry of Health and Family Welfare 2016)

BEST PRACTICES FROM INDIAN STATES



A joint study identifies a number of Indian states as most vulnerable due to climate change.



VULNERABILITY COMPONENTS

EXPOSURE:

People, livelihood, assets, etc., that could be adversely affected

SENSITIVITY:

The degree to which a system is affected

ADAPTIVE CAPACITY:

The ability of a system to adjust to climate change or to cope with the consequences

(Mohanty & Wadhawan 2021)

State Action Plans recognise areas of intervention to combat climate change while focusing on health.



Assam

- Develop a disease forecasting system for disease outbreaks on a daily basis in consonance with a daily weather forecast.
- Develop mobile-based apps on disease outbreak forecast and prevention measures.
- Conduct studies to assess links between climate change and possible malnutrition in the state, especially among children.
(Department of Environment and Forest, Government of Assam 2015)



Andhra Pradesh

- Undertake long-term studies on climate change, disease patterns, pollution and disease links.
- Develop low-cost vaccines for vector-borne diseases.
- Establish rapid response capabilities for climate-related disasters like sun exposure, floods, cyclones, and droughts.
(Environment Protection Training and Research Institute 2012)



Maharashtra

- Develop early warning tools in collaboration with meteorological agencies for different end-users, e.g. early warning systems for heat waves for urban centres, for fishermen, for farming communities, and provide community climate services and health advisories.
- Develop and maintain a decentralised digital health database at fine spatial and temporal scales specifically for climate-sensitive diseases.
- Conduct a Training Needs Assessment (TNA) specific to different tiers of health sector staff.
(The Energy and Resources Institute 2014)



State Action Plans recognise areas of intervention to combat climate change while focusing on health.



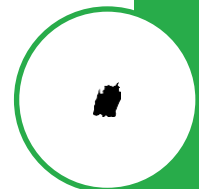
Karnataka

- Surveillance and monitoring measures in response to early evidence of impact.
 - Effective medical treatment to lessen the impact on health.
- (Environmental Management and Policy Research Institute 2021)



Bihar

- Integration of an Early Warning System with health departments to allow early action in terms of procurement and prepositioning of stocks and giving health prevention messages to communities.
 - Capacity building of all medical personnel in districts, including frontline functionaries and personnel associated with various programmes such as the Integrated Disease Surveillance Programme, ANMs, AWW, ASHA and all the medical NGOs in the district to identify the early signs of extreme climatic effects on the population.
- (Government of Bihar 2015)



Manipur

- Detecting and responding to outbreaks of epidemic-prone diseases in a timely manner by identifying early warning signs and initiating effective responses.
 - Implementing the Integrated Diseases Surveillance Programme (IDSP) to monitor and assess the nutritional status of the population, as well as mitigate the impact of nutritional deficiencies.
 - Creating a state-level entomological lab for climate change health research, including epidemiological data analysis and high-resolution impact modelling.
- (Government of Manipur 2013)



FACTORS ABETTING CLIMATE SENSITIVE HEALTH RISKS



TIME
TO
ACT



SAVE
THE
PLANET

Climate change increases **vulnerabilities** towards health risks.



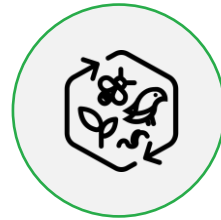
Demographic Characteristics

- Age
- Sex
- Population Dynamics



Geographical Factors

- Unplanned urban housing
- Flood risk zones
- Drought risk zones
- Coastal storm and cyclone risk zones
- Water-stressed zones
- Food-insecure zones
- Remote and rural areas



Biological Factors and Health Status

- Immunocompromised populations
- Undernourished populations
- Populations with high infections and chronic disease burden
- People with mental or physical disabilities
- Pregnant and breastfeeding women



Social and Political Factors

- Political instability
- Discriminated populations
- Existence of complex emergencies or conflict
- Lack of freedom of speech and information
- Reduced civil rights and civil society movements



Social and Economic Factors

- Poverty
- Gender norms, roles and relations
- Unsafe, informal occupation
- Reduced access to healthcare
- Reduced access to education
- Unsafe water and sanitation
- Inadequate shelter

(WHO 2021)





Demographic Characteristics

Age

- Children, **due to their faster breathing rate and increased time spent outdoors**, are at higher risk of exposure to dangerous air pollutants, as well as high exposure to heat and cold, outdoor allergens, and insect bites (US EPA 2022).
- As temperatures increase, the elderly population becomes more susceptible to heat-related illnesses and mortality due to **changes in their bodies' heat response**. The effects of certain medications and compromised immune systems increase the risk of severe illness from insect- and water-related diseases (US EPA 2022).

Sex

- Women suffer disproportionate mortality and decreased life expectancy after disasters and extreme heat events (Sorensen et al. 2018).
- Women experience **more significant deposition of inhaled particles in their lungs**, and anaemic women are more sensitive to toxicological exposure (Sorensen et al. 2018).

Population Dynamics

- More than **3 million people** were forced to migrate due to climate change in 2020-2021 in India (CSE 2022).
- Climate-induced migrations burden women with household and agricultural responsibilities exposing them to **trafficking risks** in flood-prone regions (Rahman 2022).





Geographical Factors

Flood Risk Zones

- **434 cases** of Japanese Encephalitis and **93 fatalities** were recorded in Assam after the floods in 2022 (Kalita 2022).
- Odisha has reported around **900 cases** of diarrhoea and other waterborne diseases after the floods in 2022 (PTI 2022).

Drought Risk Zones

- Chronic drought-affected states like Tamil Nadu and Madhya Pradesh had an **11% and 39% prevalence of stunting** among preschoolers, respectively (Venkaiah et al. 2015).
- In the states of Andhra Pradesh and Tamil Nadu, chronic energy deficiency (BMI<18.5) among adult men during droughts varied from **26% to 50% overall**. Women's rates varied from a low of 30% in Gujarat to a high of 56% in Andhra Pradesh (Venkaiah et al. 2015).

Food-insecure Zones

- India's food production could **drop by 16%**, and the number of those at risk for hunger could **increase by 23%** by 2030 due to climate change (International Food Policy Research Institute 2022).

Remote and Rural Areas

- The climate crisis has **affected tribal and forest-dwelling communities**, impacting their livelihoods and non-timber forest product income through unpredictable rainfalls, floods, cyclones, and other climate events (Goel 2023).

Apart from these factors, unplanned urban housing and coastal storms and cyclone risk zones also face the impact of climate change.





Biological Factors and Health Status

Population with high infections and chronic disease burden

- **Medications and compromised immune systems** can increase their susceptibility to extreme heat-related reactions, diseases transmitted by insects and ticks, and waterborne illnesses (US EPA 2022).

Population with mental or physical disabilities

- Individuals with **mental health conditions**, those **reliant on others for daily assistance**, and those with **limited mobility or transportation face** heightened vulnerability to heat-related illness and mortality.
- Emergency warnings and crucial messages often **lack consideration for accessibility of individuals with disabilities** such as visual impairments, hearing loss, and mobility challenges (US EPA 2022).

Pregnant and Breastfeeding Women

- Extreme heat can cause **adverse reproductive outcomes, including preterm delivery** (Sorensen et al. 2018).
- Women, contributing 60-80% to food production and livelihoods, face threats to their nutritional status from climate-related agricultural decline. Due to shifting rainfall and temperatures, they are **inherently sensitive to the effects of food insecurity**, particularly during menstruation, pregnancy, and nursing (Sorensen et al. 2018).
- Heat stress potentially **disrupts the hormonal equilibrium in the body**, resulting in irregular menstrual cycles and heightened menstrual pain (Uniyal 2023).

Additionally, immunocompromised and undernourished populations are also vulnerable to the effects of climate change.





Social and Political Factors

Fragmented policy landscape

- India **lacks legislation to translate international agreements** like the Paris Agreement and UNFCCC into domestic law, rendering them unenforceable within the country.
- India's **existing environmental policy framework is fragmented**, covering various topics such as pollution, water, energy, transport, waste management, agriculture, mining, forests, environmental clearance, and finances. The National Environmental Policy 2006 provides a brief outline of India's response to climate change but lacks clear prioritisation or implementation strategies.
- The absence of a unified policy framework under the NAPCC leads to **ambiguity and limited research on addressing climate change challenges**. Additionally, there is uncertainty regarding the implementation of existing policies at different levels. (Kumar & Naik 2019)

Discriminated Populations

- India's climate policies **lack a gender-sensitive approach**, despite global evidence demonstrating that women are disproportionately affected by extreme weather events (Rahman 2022).
- Climate change affects India's agriculture sector, where many farmers from Scheduled Castes work as labourers. These communities, already facing discrimination, are disproportionately impacted by extreme weather events like floods, heat waves, and rising sea levels. Additionally, they often **encounter bias during rescue and recovery operations** after climate-related disasters (Khan 2023).
- Marginalised women are denied access to water sources in **48.4% of drought-affected villages** due to segregation and untouchability practices (Jha 2022).





Social and Economic Factors

Poverty

- Climate change disproportionately affects low-income and marginalised groups. **Individuals reliant on manual outdoor labour and those residing in crowded, inadequately ventilated homes** bear a disproportionate burden from prolonged high temperatures.
- Floods, storm surges, and cyclones pose the greatest **threat to densely populated, low-income communities** lacking risk-reducing infrastructure. (Picciariello et al. 2021)

Gender Norms, Roles and Relations

- Due to long-standing gender disadvantages that have led to **differences in information, mobility, decision-making, access to resources, and training**, women are less likely to escape disasters and more likely to suffer injuries (UN Women 2022).
- Females are **less likely to be able to get aid after a disaster**, endangering their ability to survive and rehabilitate as well as setting them up for future disaster susceptibility (UN Women 2022).
- Women and girls were **forced into child slavery or forced marriages** to make ends meet after the Assam floods (Bharadwaj et al. 2021).

Reduced Access to Healthcare

- Disaster-prone areas have **inadequate healthcare infrastructure**, including low availability of doctors and hospital beds per capita, a shortage of qualified health practitioners, weak disease surveillance monitoring, and escalating healthcare costs (Roy et al. 2016).

Additionally, unsafe, informal occupation, reduced access to education, unsafe water and sanitation, and inadequate shelter also lead to risks due to climate change.



WAY FORWARD



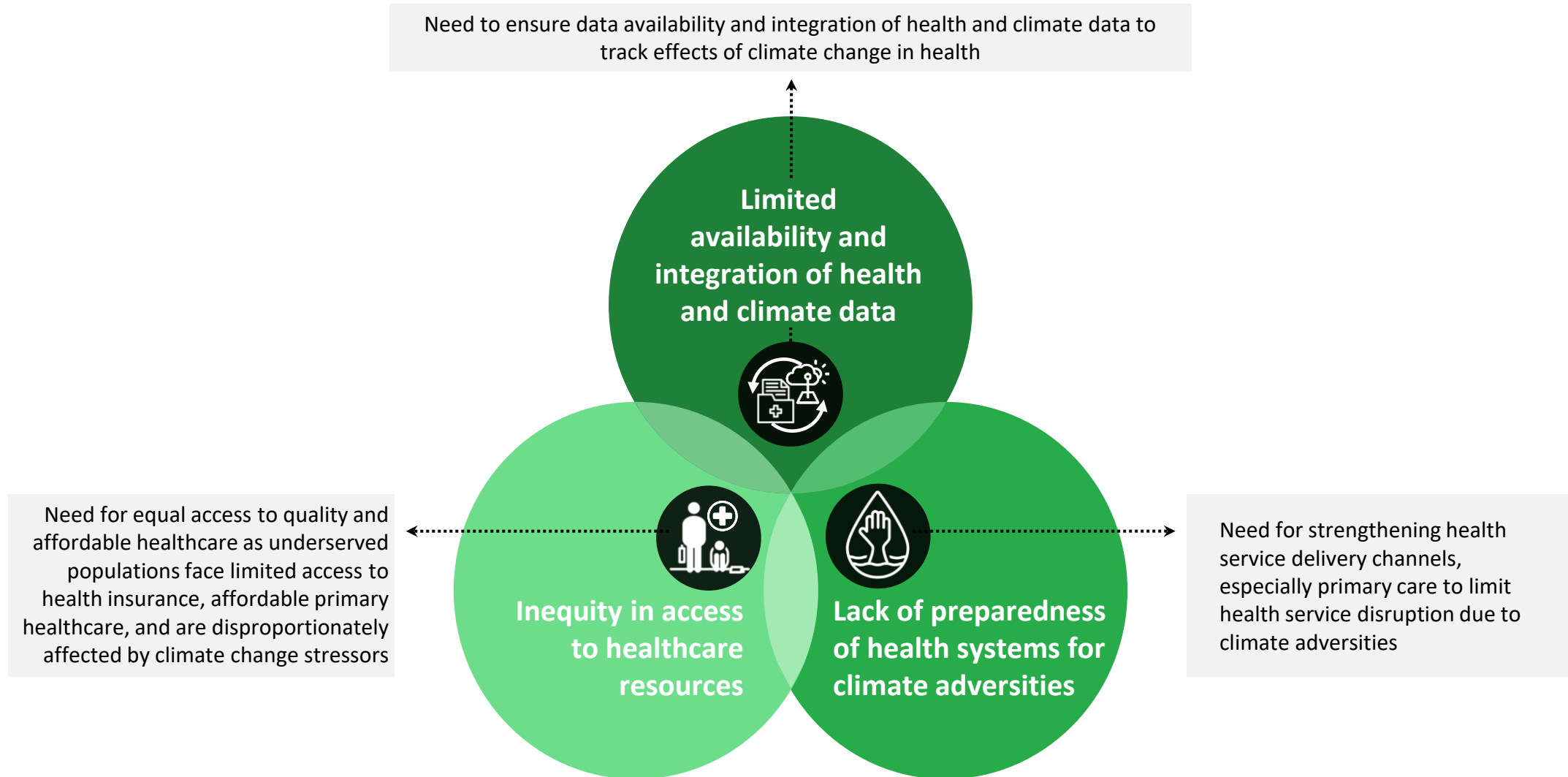
Mitigation interventions in various sectors can minimise the effect of climate change on health.

	Direct Impacts	Impacts on Health
ENERGY	Reduction of air pollution via energy efficiency and fuel switching	<ul style="list-style-type: none"> • Reduced respiratory diseases, cardiovascular damage, cancer, fatigue, headaches, and anxiety • Decreased eye, nose, and throat irritation • Protection for reproductive organs and nervous system • Improved mental health and well-being
WASTE	Reduced air, soil and water pollution by reduction of waste landfilled via improved collection, sorting, treatment, recycling and reuse	<ul style="list-style-type: none"> • Reduced cancer, lymphoma, malformations, and mortality • Decreased impacts on reproductive organs and well-being • Improved mental health and well-being
AGRICULTURE	Reduced soil erosion and water pollution, reduced risk of floods and landslides, and reduced vulnerability to droughts achieved through decreased fertiliser use and increased land productivity	<ul style="list-style-type: none"> • Decreased respiratory, dermatological, and neoplastic hazards • Reduced risk of antibiotic resistance • Reduced impacts on nutrition
LAND	Increased water availability and quality, improved soil quality for enhanced land productivity, increased forest cover and agroforestry production for improved CO2 stocks	<ul style="list-style-type: none"> • Protection of key ecosystem services for human well-being (e.g. water) • Avoided impacts on human health (e.g. floods, fires) • Improved mental health and well-being

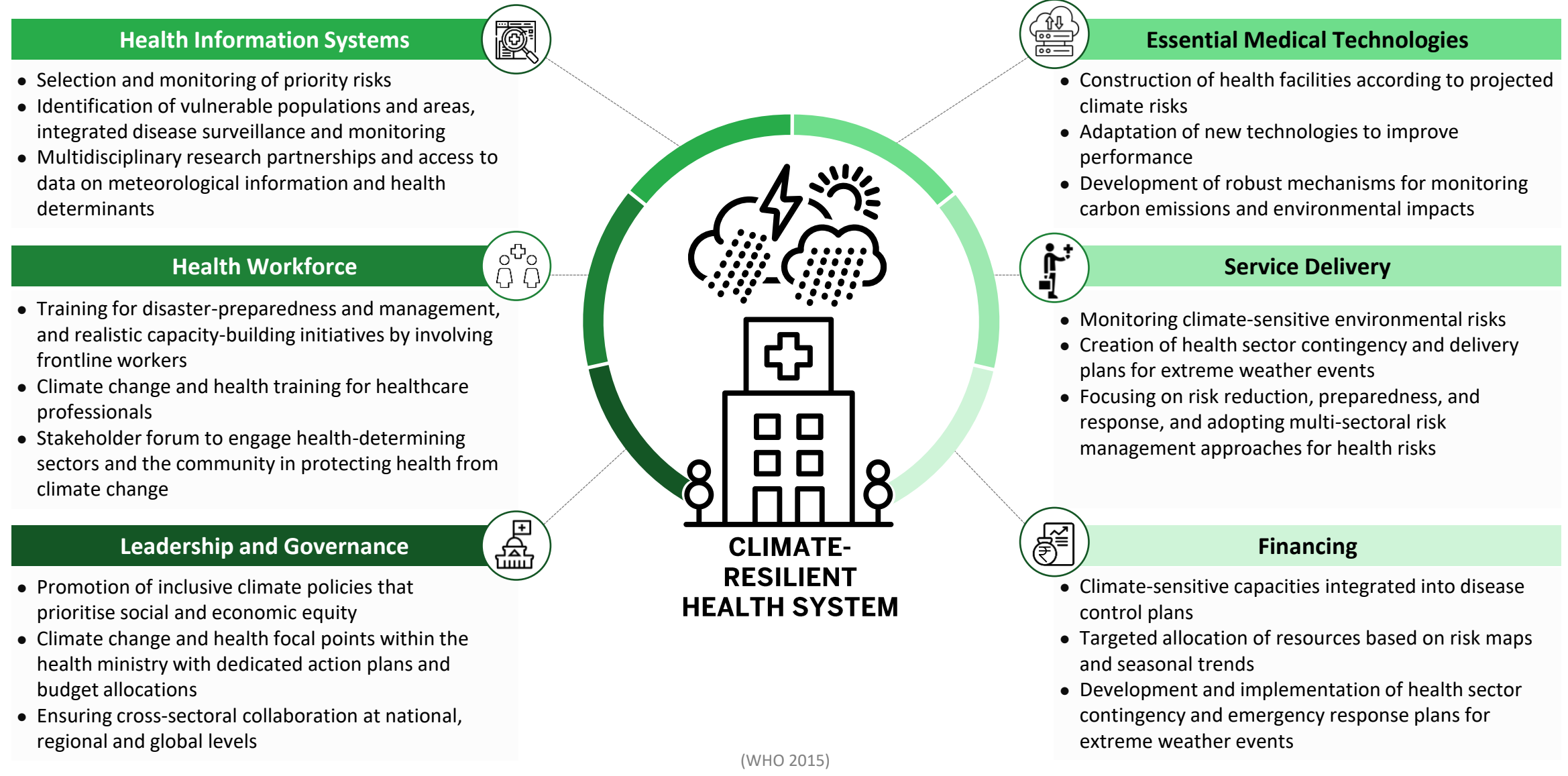
(WHO 2023)



There is a need for building **climate resilient health systems**.



What should a climate-resilient health system look like in India?



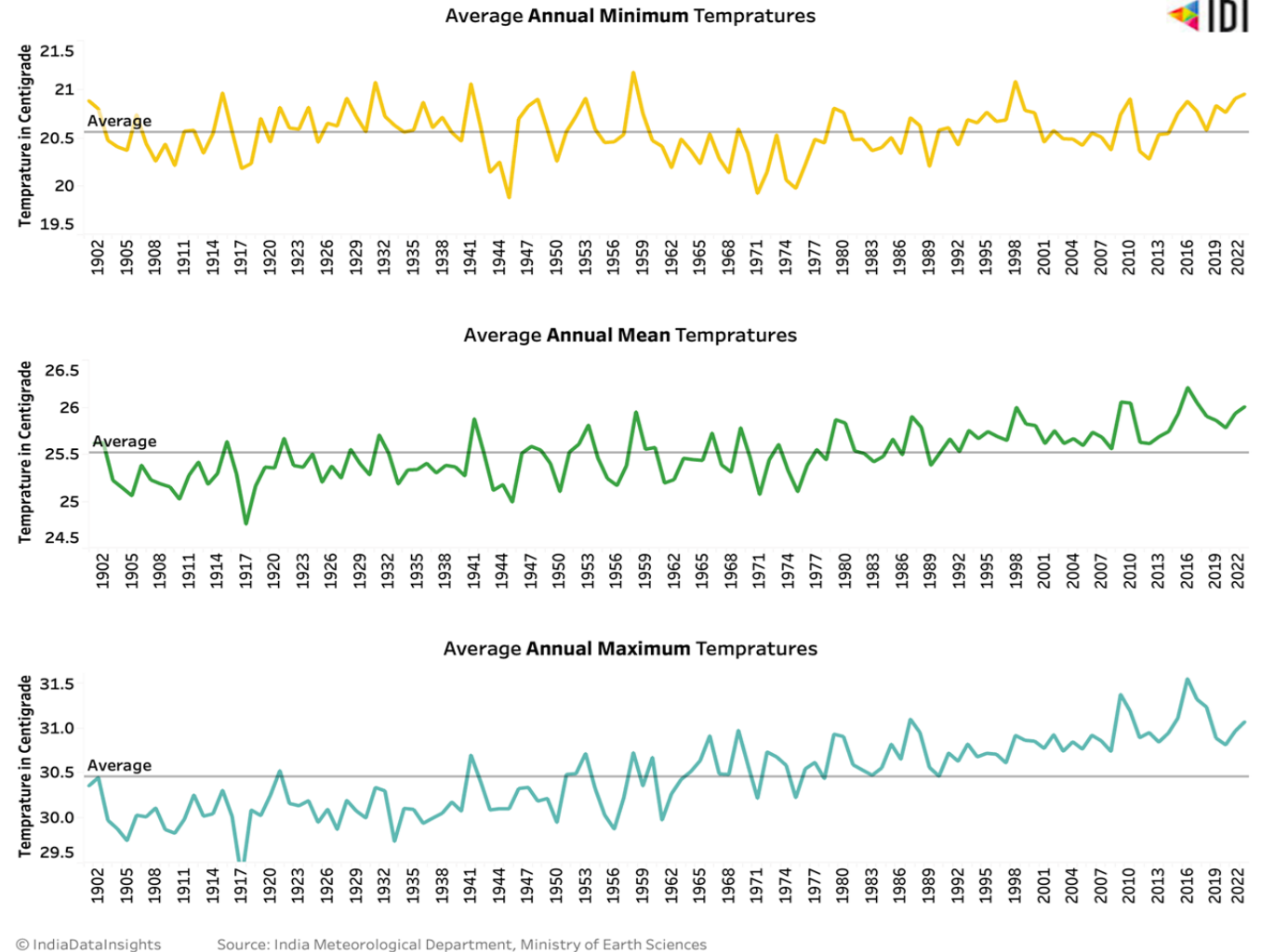
ANNEXURE



High Temperatures

In the last century (1922-2022), while the **annual mean temperature has increased by 0.62 degree Celsius**, maximum and minimum temperatures have increased by **0.91 and 0.35** respectively.

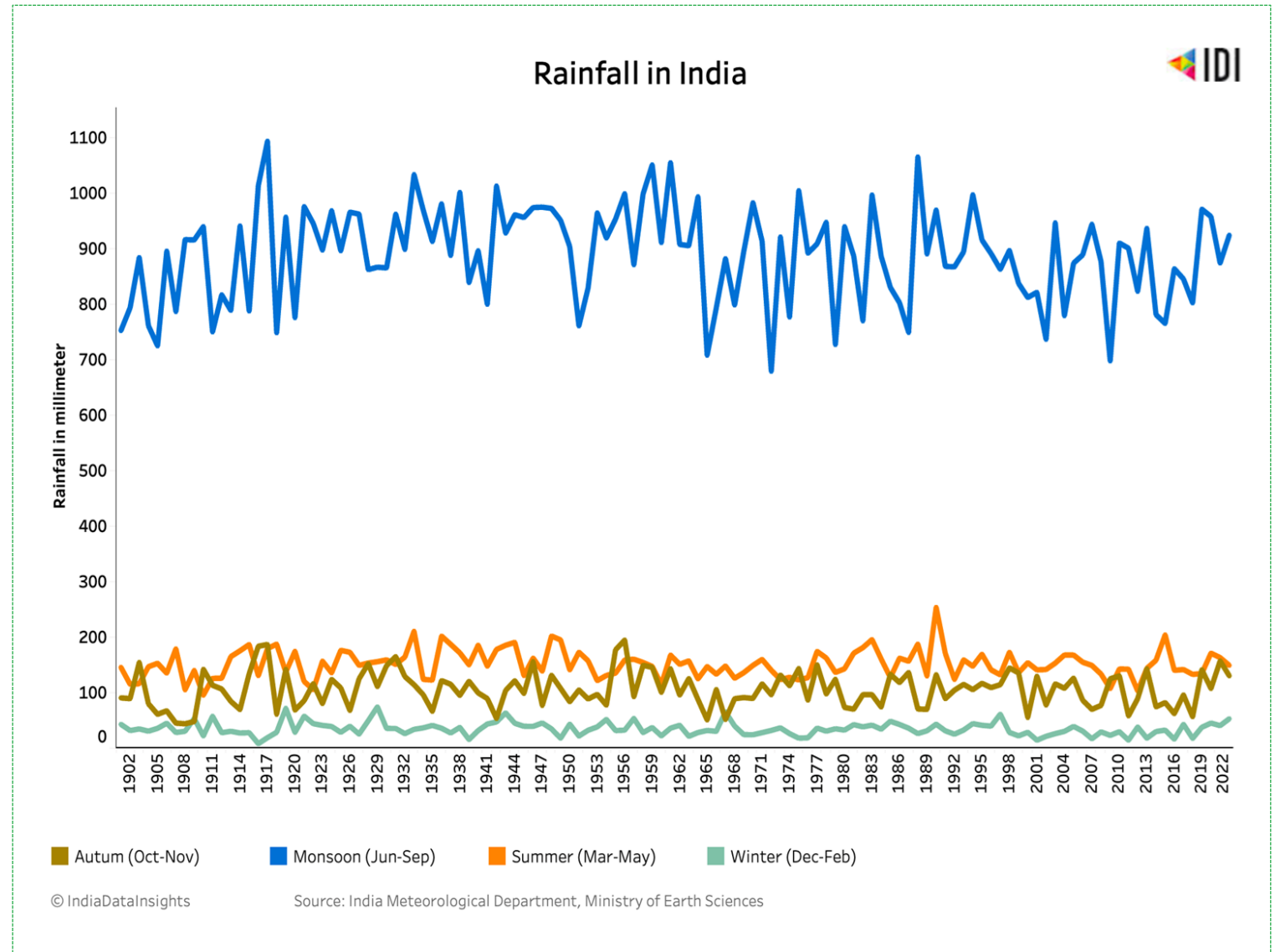
Since 1980, average annual maximum temperature has been consistently more than **30.5** degrees Celsius.



Varying Rainfall

In the last century (1922-2022), India's **rainfall during monsoons (Jun-Sep)** has been varying between **700 and 1000+** millimeters.

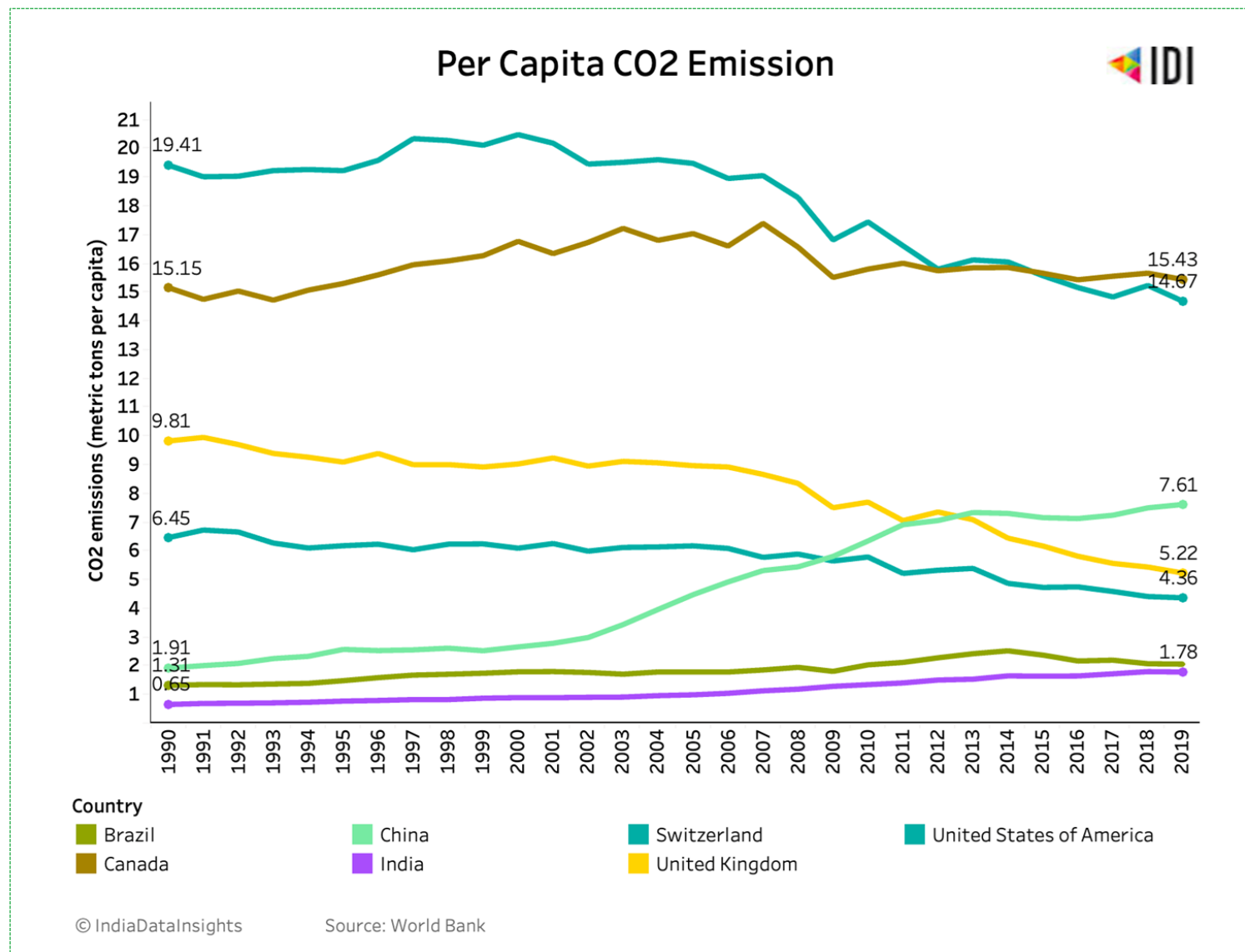
In recent years, 1988 had the highest amount of rain - 1066 millimetres, while the least rainfall was in 2009 with only 698 millimetres.



Carbon Dioxide Emissions

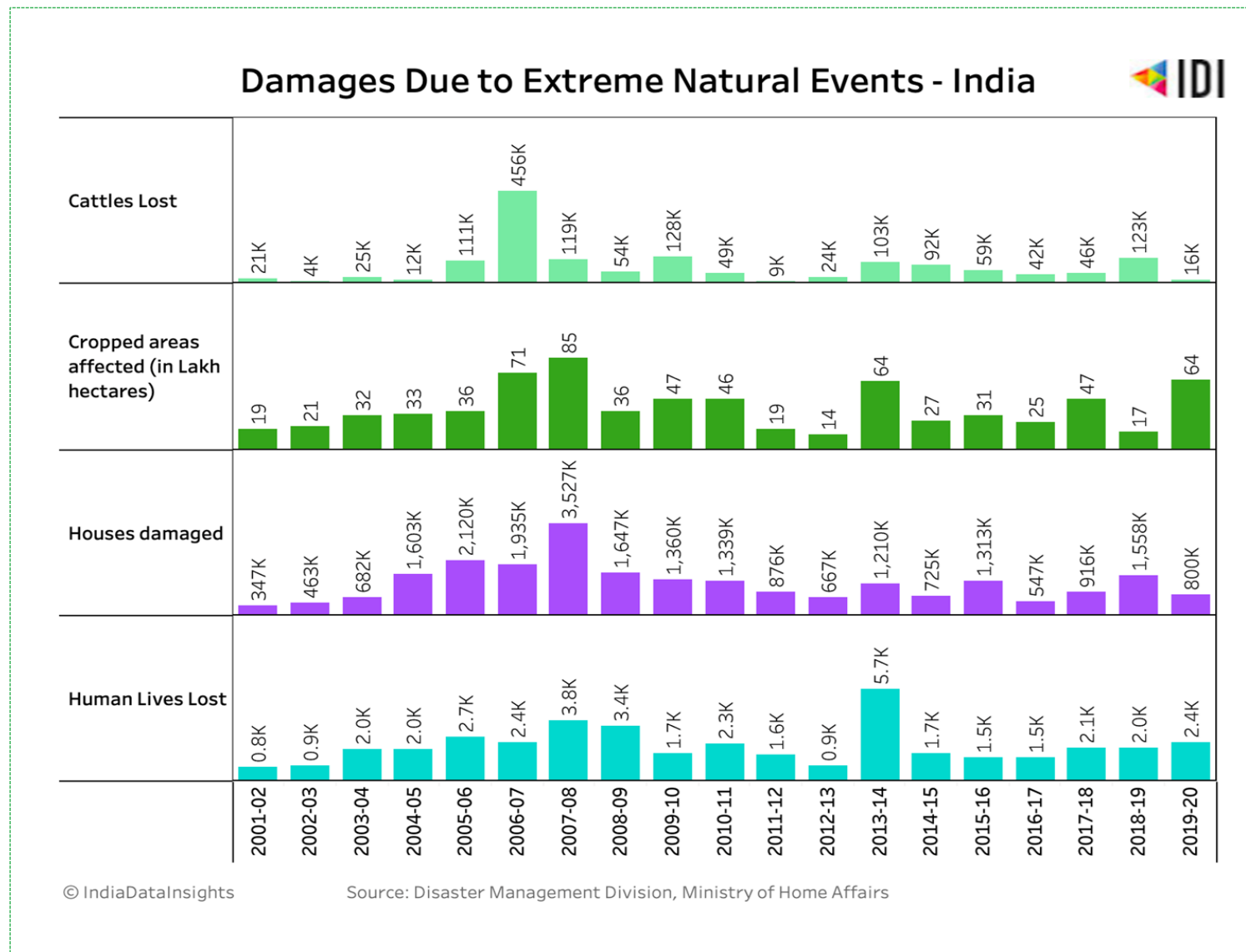
In the last three decades, the **per capita CO2 emission** in India has more than **doubled**.

It was **0.66** metric tons in 1990 and has increased to **1.78** metric tons in 2019 - an increase by **1.12** metric tons.



Over the last two decades, **reported loss of human lives** due to extreme natural events has **tripled**, from **800** people in 2001-02 to **2400** people in 2019-20.

~4 lakh more houses were reported as **damaged** in 2019-20 than in 2001-02. This is caused primarily by extreme natural events like floods, droughts, wildfires, earthquakes, and avalanches.

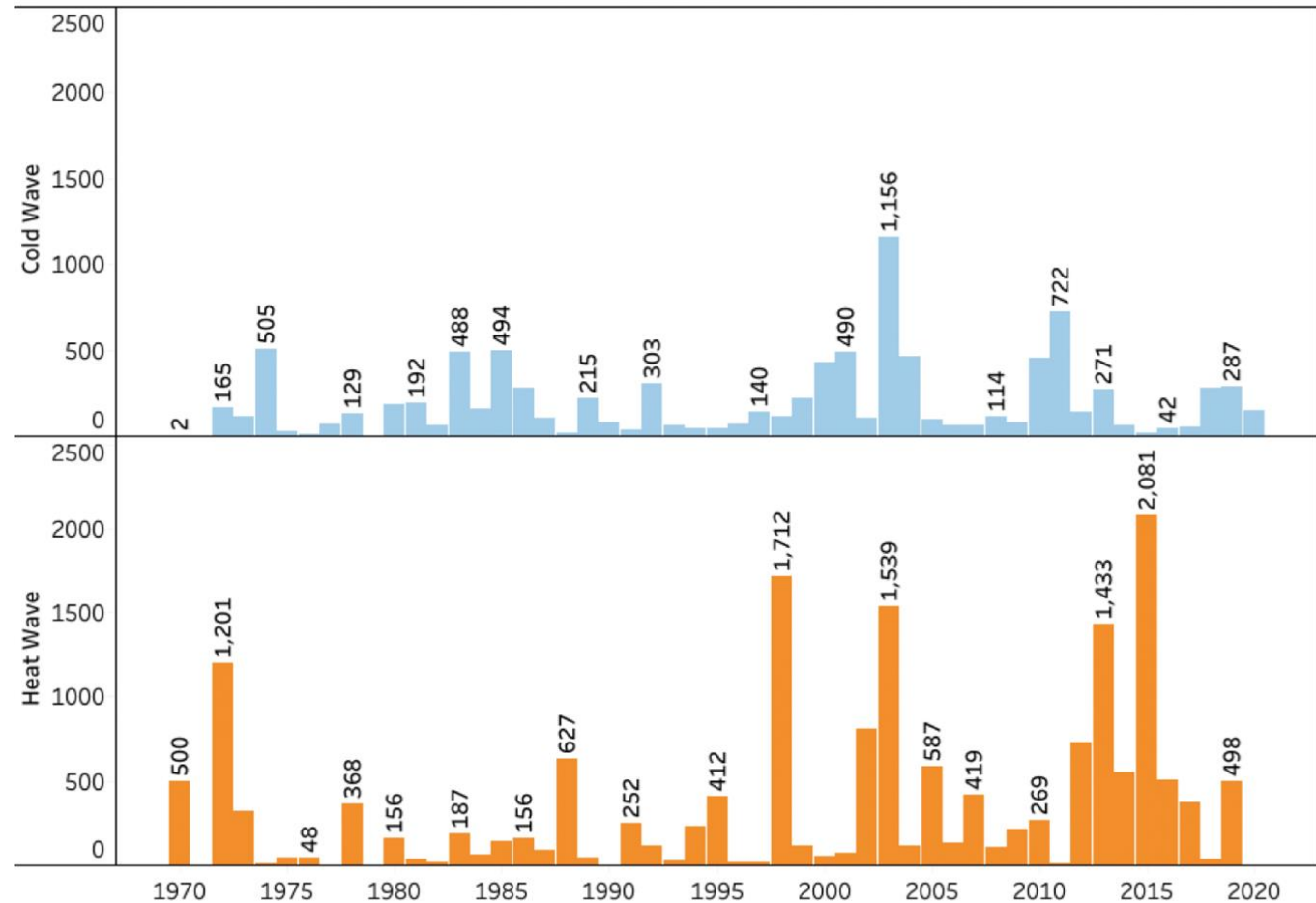


The **highest number of deaths (1,156)** due to cold wave was reported in the year 2003.

In the same year, **heat waves caused 1,539 deaths** in the country.

The **highest number of deaths due to heat waves (2,081)** was reported in the year 2015.

Number of Deaths due to Hot and/or Cold Wave



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Source: India Meteorological Department, Ministry of Earth Sciences

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