

# CLIMATE SMART GOVERNANCE

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Department of Science and Technology



SECTOR - 4

**CLIMATE CHANGE AND HUMAN HEALTH**

**TRAINING MODULE  
(2017-2020)**

# CLIMATE CHANGE AND HUMAN HEALTH

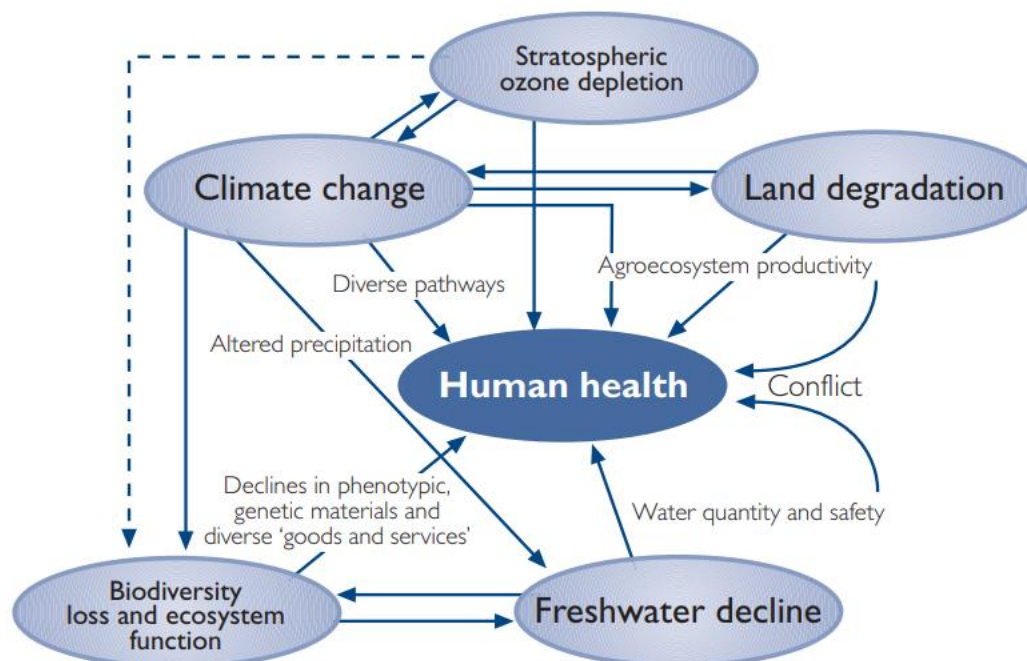
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## 1. CLIMATE CHANGE AND PUBLIC HEALTH

Climate change is projected to have extensive adverse effects on the Earth, imposing diverse threats to ecosystems and people. The threats extend to the health of the public, with warming of the planet projected to have positive and negative consequences that will vary temporally and spatially (Samet, 2010).

The phenomenon of global climate change is linked to human health and influence the increases the prevalence of non-communicable and infectious diseases. The climatic factors (e.g. air temperature, humidity, precipitation, extreme weather events etc.) can directly or indirectly affect the social and environmental determinants of health with the result of health vulnerability (Uzzoli, 2016).



**Figure 4.1: Interrelationships between major types of global environmental change, including climate change impinging on human health (McMichael et al., 2003)**

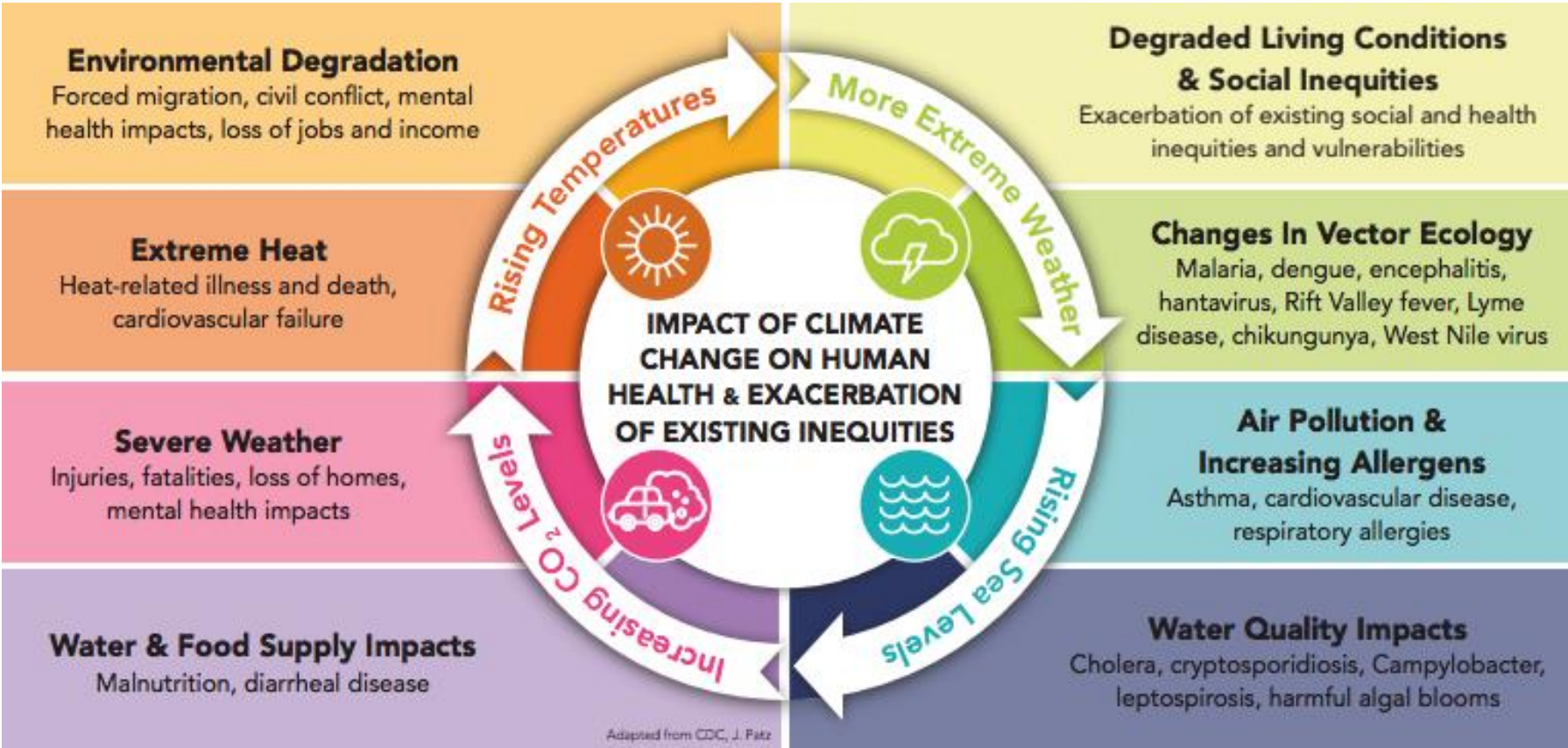
## 1.1 Climate change impacts on health

Climate change poses a threat to human health; it already causing excess mortality and morbidity through heat-related deaths and changing patterns of infectious diseases. Climate change does not create new health problems but may worsen known clinical problems and alter geographic patterns of disease occurrence (Samet, 2010).

Climate change can have a range of impacts on physical, mental, and community health. The impacts of climate change include warming temperatures, changes in precipitation, increases in the frequency or intensity of some extreme weather events, and rising sea levels. These impacts threaten our health by affecting the food we eat, the water we drink, the air we breathe, and the weather we experience.

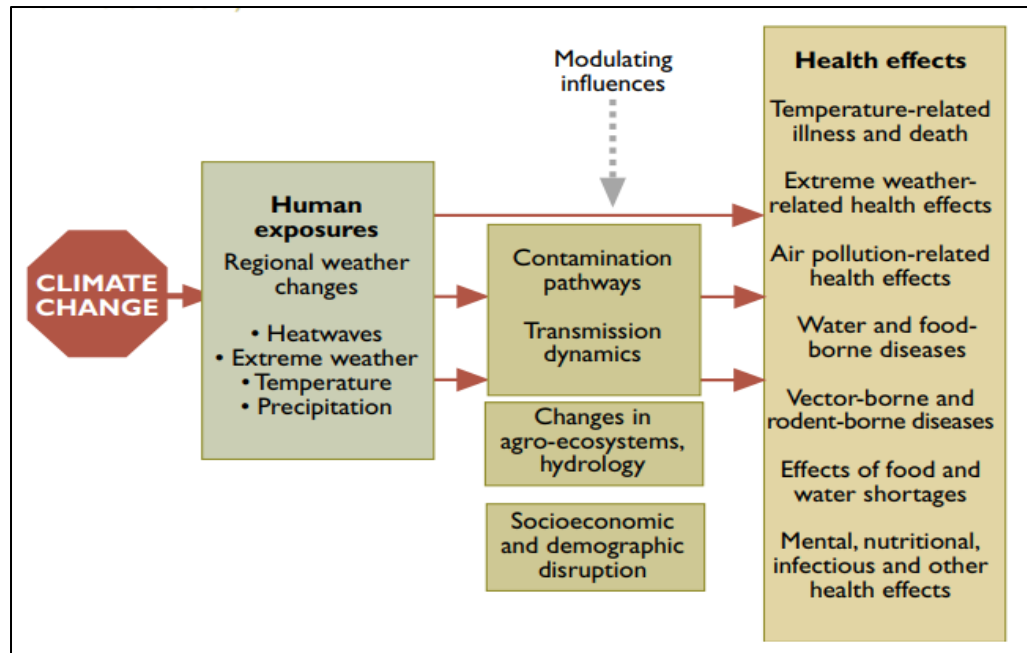
The severity of these health risks will depend on the ability of public health and safety systems to address or prepare for these changing threats, as well as factors such as an individual's behavior, age, gender, and economic status. Impacts will vary based on a where a person lives, how sensitive they are to health threats, how much they are exposed to climate change impacts, and how well they and their community are able to adapt to change (U.S. Environmental Protection Agency [EPA], 2017). Potential, widespread adverse health effects could include:

- heat stress-induced illness and death;
- air pollution-related health effects;
- infectious disease, including water-, food-, vector- and rodent-borne diseases;
- malnutrition;
- extreme weather-related health effects;
- storm surge-related drownings and injuries; and
- health problems associated with displaced, refugee populations (Ballus, 2009).



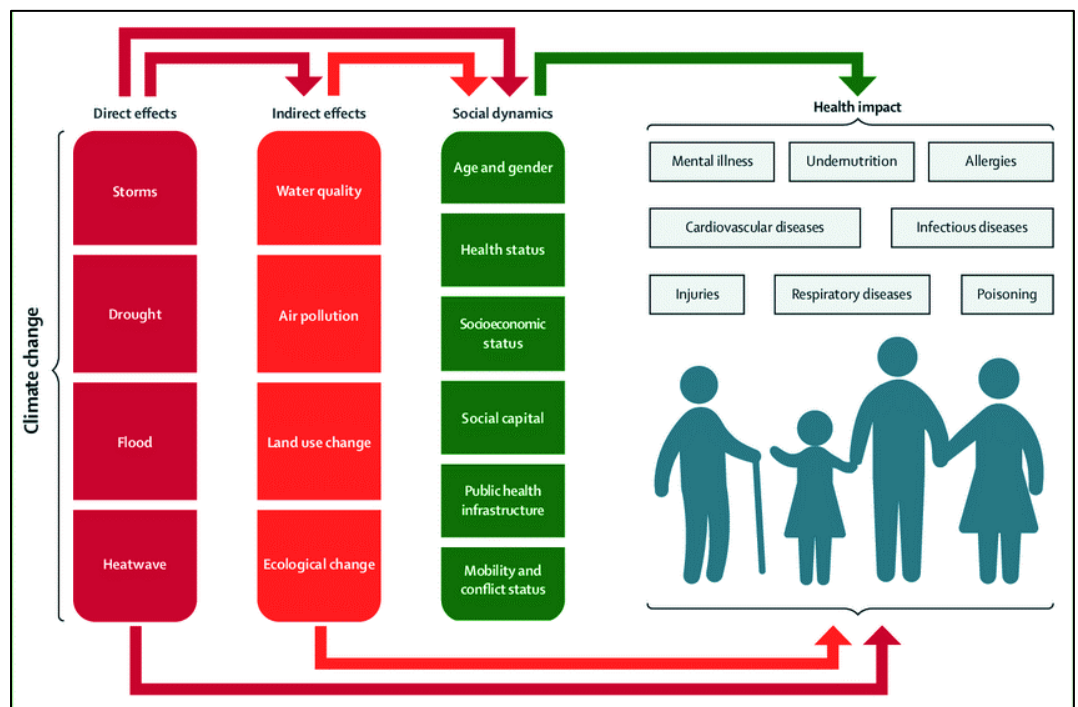
**Figure 4.2: Impacts of Climate Change on Human Health**

**Source:** <https://www.cdph.ca.gov/Programs/OHE/pages/CCHEP.aspx>









**Figure 4.3: Pathways by Which Climate Change affects human health**

Source: <http://www.who.int/globalchange/environment/en/ccSCREEN.pdf>

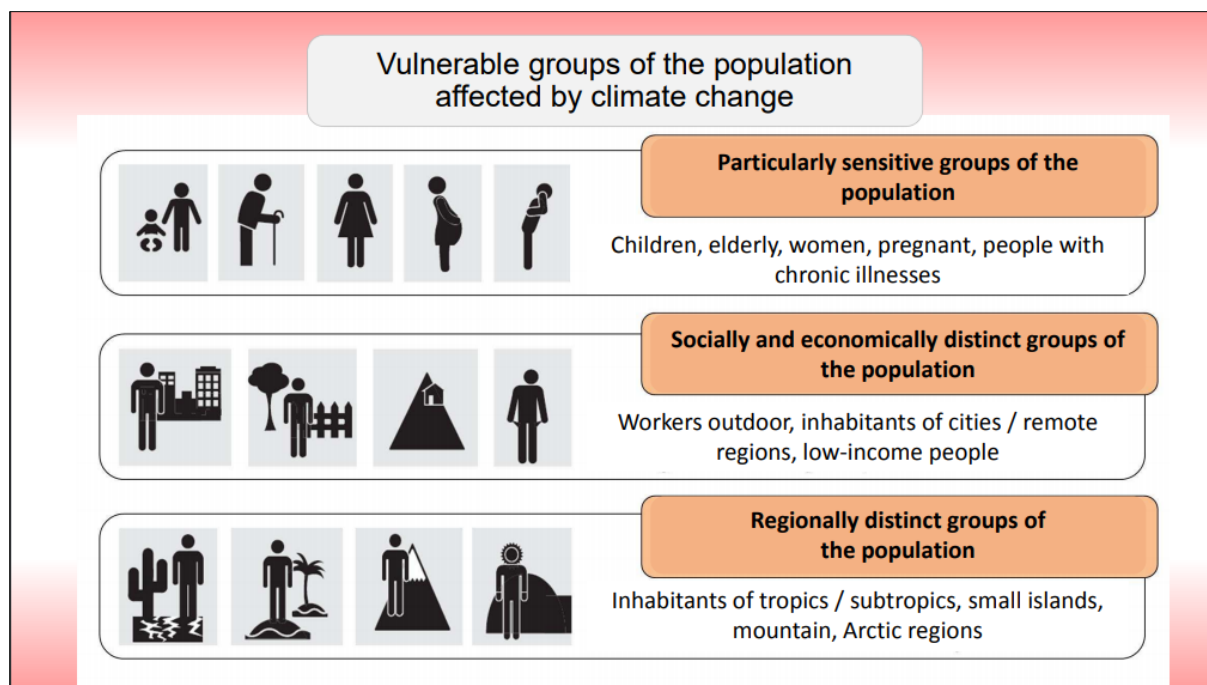


**Figure 4.4: The Direct & indirect effects of climate change impacts on health (Watts et al., 2015)**

	Climate Driver	Exposure	Health Outcome	Impact
 <b>Extreme Heat</b>	More frequent, severe, prolonged heat events	Elevated temperatures	Heat-related death and illness	Rising temperatures will lead to an increase in heat-related deaths and illnesses.
 <b>Outdoor Air Quality</b>	Increasing temperatures and changing precipitation patterns	Worsened air quality (ozone, particulate matter, and higher pollen counts)	Premature death, acute and chronic cardiovascular and respiratory illnesses	Rising temperatures and wildfires and decreasing precipitation will lead to increases in ozone and particulate matter, elevating the risks of cardiovascular and respiratory illnesses and death.
 <b>Flooding</b>	Rising sea level and more frequent or intense extreme precipitation, hurricanes, and storm surge events	Contaminated water, debris, and disruptions to essential infrastructure	Drowning, injuries, mental health consequences, gastrointestinal and other illness	Increased coastal and inland flooding exposes populations to a range of negative health impacts before, during, and after events.
<b>Vector-borne Infection</b> (Lyme disease)	Changes in temperature extremes and seasonal weather patterns	Earlier and geographically expanded tick activity	Lyme disease	Ticks will show earlier seasonal activity and a generally northward range expansion, increasing risk of human exposure to Lyme disease-causing bacteria.
 <b>Water-related Infection</b> (Vibrio vulnificus)	Rising sea surface temperature, changes in precipitation, and runoff affecting coastal salinity	Recreational water or shellfish contaminated with Vibrio vulnificus	Vibrio vulnificus induced diarrhea and intestinal illness, wound and bloodstream infections, death	Increases in water temperatures will alter timing and location of Vibrio vulnificus growth, increasing exposure and risk of waterborne illness.
 <b>Food-related Infection</b> (Salmonella)	Increases in temperature, humidity, and season length	Increased growth of pathogens, seasonal shifts in incidence of Salmonella exposure	Salmonella infection, gastrointestinal outbreaks	Rising temperatures increase Salmonella prevalence in food; longer seasons and warming winters increase risk of exposure and infection.
 <b>Mental Health and Well-being</b>	Climate change impacts especially extreme weather	Level of exposure to traumatic events, like disasters	Distress, grief, behavioral health disorders, social impacts, resilience	Changes in exposure to climate- or weather-related disasters cause or exacerbate stress and mental health consequences, and with greater risk for certain populations.

**Figure 4.5: Impacts of Climate Change on Human Health (National Institute of Health [NIH], 2016)**





**Figure 4.6: Vulnerable groups of Population affected by Climate Change**

**Source:** [https://www.geo.lu.lv/fileadmin/user\\_upload/lu\\_portal/projekti/gzzf/videunilgtspejigaattistiba/7.\\_Climate\\_change\\_and\\_human\\_health.pdf](https://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/videunilgtspejigaattistiba/7._Climate_change_and_human_health.pdf)

## 1.2 Climate change and vulnerability

A useful approach to understand how climate change affects health is to consider specific exposure pathways and how they can lead to human disease. Whether or not a person is exposed to a health threat or suffers illness or other adverse health outcomes from that exposure depends on a complex set of vulnerability factors.

Vulnerability is the tendency or predisposition to be adversely affected by climate-related health effects, and encompasses three elements: exposure, sensitivity or susceptibility to harm, and the capacity to adapt or to cope. All three of these elements can change over time and are place- and system specific.

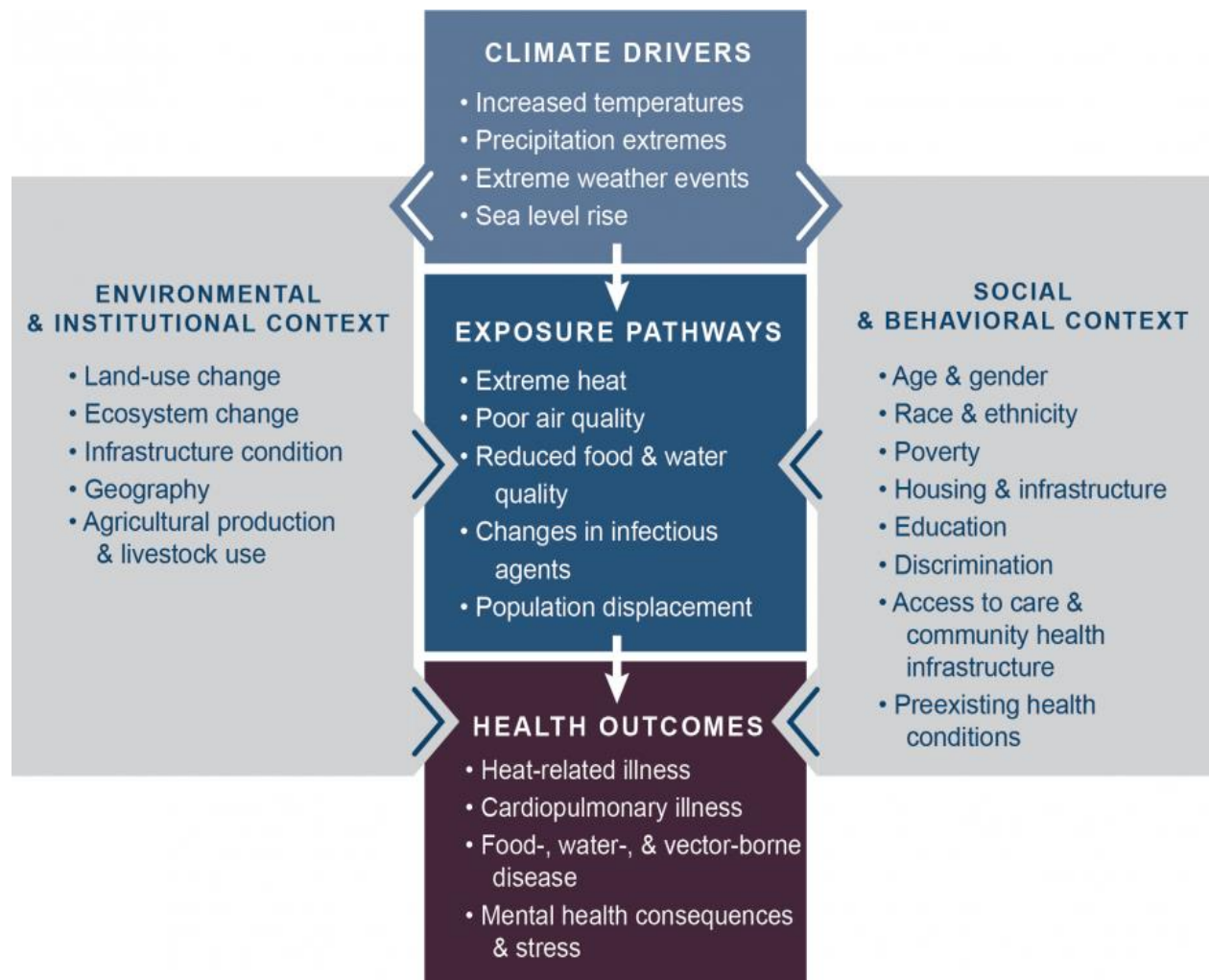
The three elements of vulnerability can be defined as follows:

- **Exposure** is contact between a person and one or more biological, psychosocial, chemical, or physical stressors, including stressors affected by climate change. Contact may occur in a single instance or repeatedly over time, and may occur in one location or over a wider geographic area.
- **Sensitivity** is the degree to which people or communities are affected, either adversely or beneficially, by climate variability or change.
- **Adaptive capacity** is the ability of communities, institutions, or people to adjust to potential hazards, to take advantage of opportunities, or to respond to consequences. A related term, resilience, is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.

Vulnerability, and the three components of vulnerability, are factors that operate at multiple levels, from the individual and community to the country level, and affect all people to some degree. For an individual, these factors include human behavioral choices and the degree to which that person is vulnerable based on his or her level of exposure, sensitivity, and adaptive capacity. Vulnerability is also influenced by social determinants of health including those that affect a person's adaptive capacity, such as social capital and social cohesion (for example, the strength of interpersonal networks and social patterns in a community).

The three components of vulnerability (exposure, sensitivity, and adaptive capacity) are associated with social and demographic factors, including level of wealth and education, as well as other characteristics of people and places, such as the condition of infrastructure and extent of ecosystem degradation. For example, poverty can leave people more exposed to climate and weather threats, increase sensitivity because of

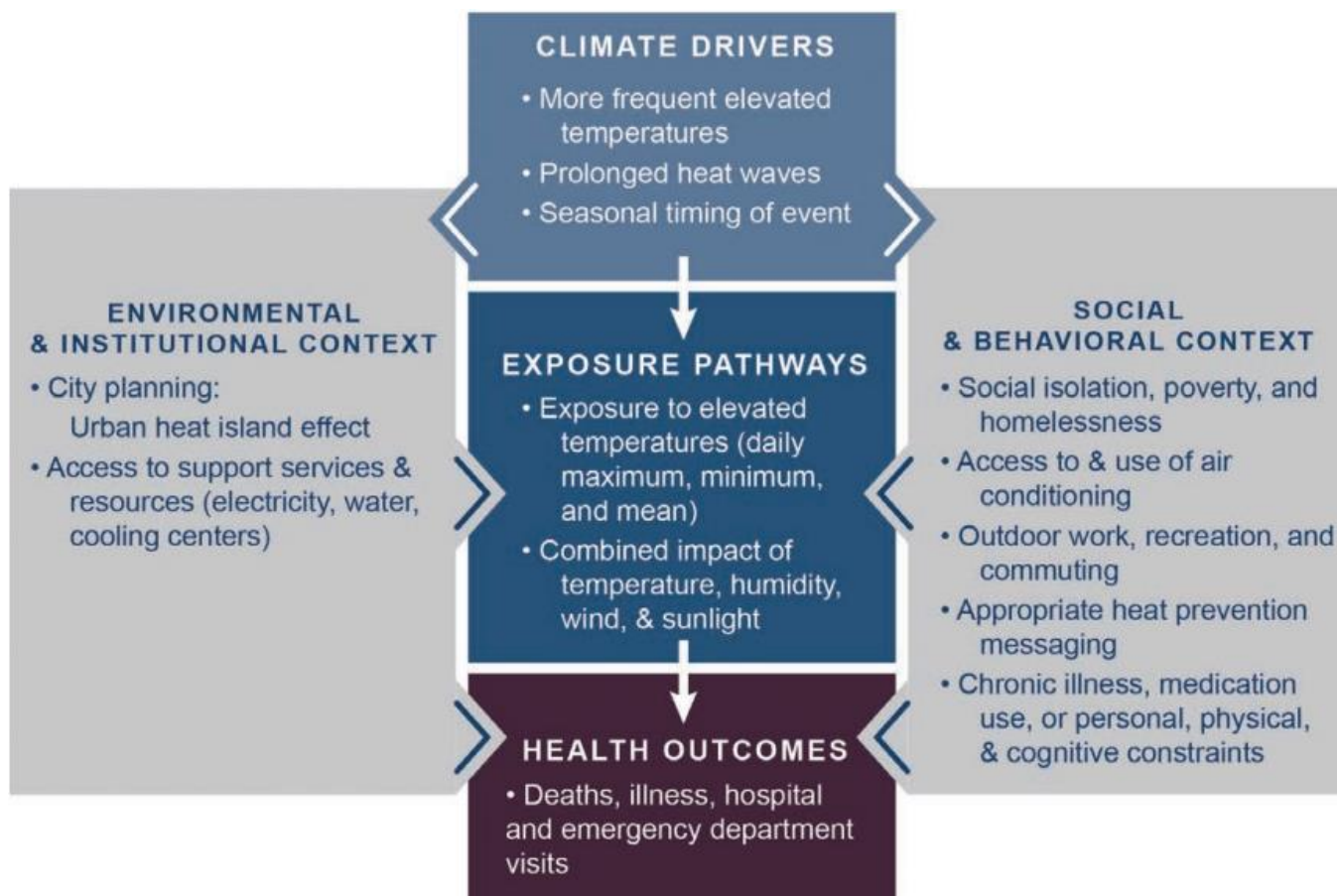
associations with higher rates of illness and nutritional deficits, and limit people's adaptive capacity. As another example, people living in a city with degraded coastal ecosystems and inadequate water and wastewater infrastructure may be at greater risk of health consequences from severe storms. Below figure demonstrates the interactions among climate drivers, health impacts, and other factors that influence people's vulnerability to health impacts.



**Figure 4.7: Conceptual diagram illustrating the exposure pathways by which climate change affects (Crimmins et al., 2016).**

### i. Extreme Heat

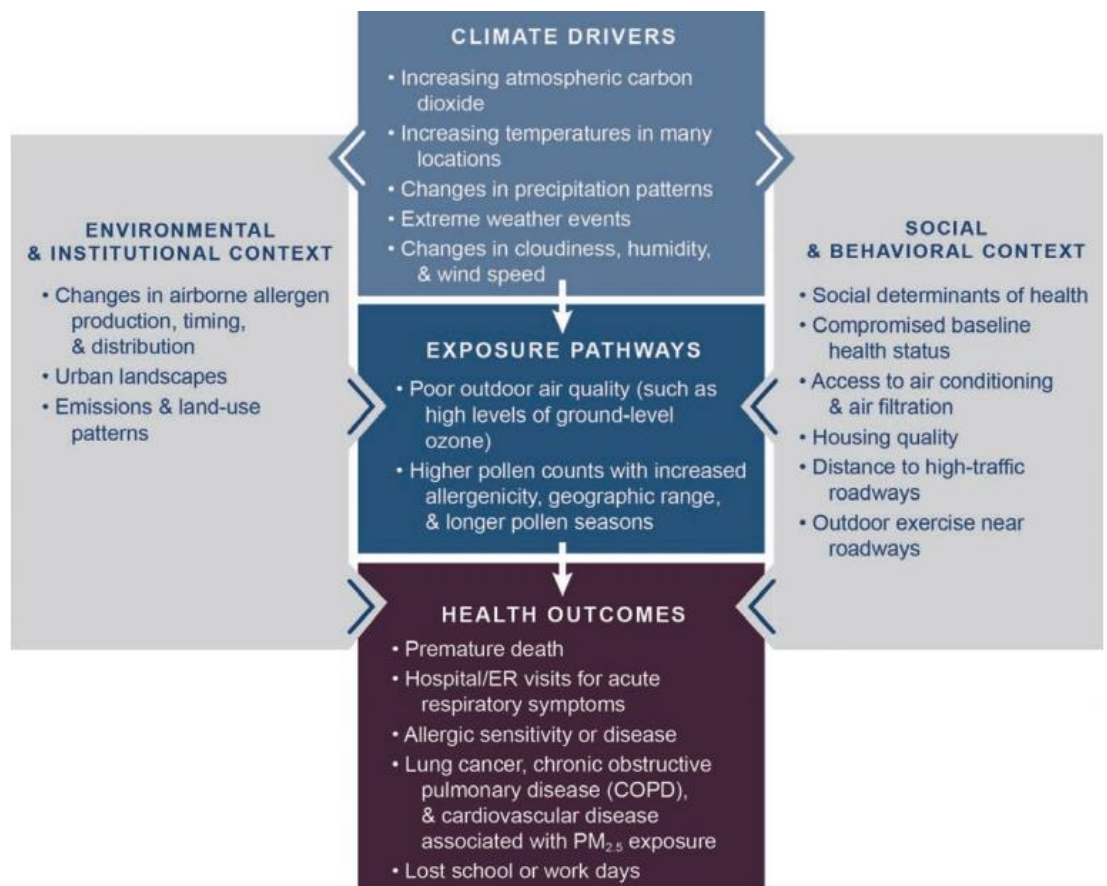
Extreme heat is a direct threat to public health — high temperatures can cause serious heat-related illnesses and even death, especially among vulnerable populations such as individuals who perform strenuous work outdoors and the elderly. Future climate warming could cause up to tens of thousands of additional deaths each year from heat in the summer, from loss of ability to control internal temperature, and worsened chronic cardiovascular and respiratory diseases.



**Figure 4.8: Conceptual diagram illustrates the key pathways by which climate change influences human health during an extreme heat event, and potential resulting health outcomes**

## ii. Air Pollution/Quality

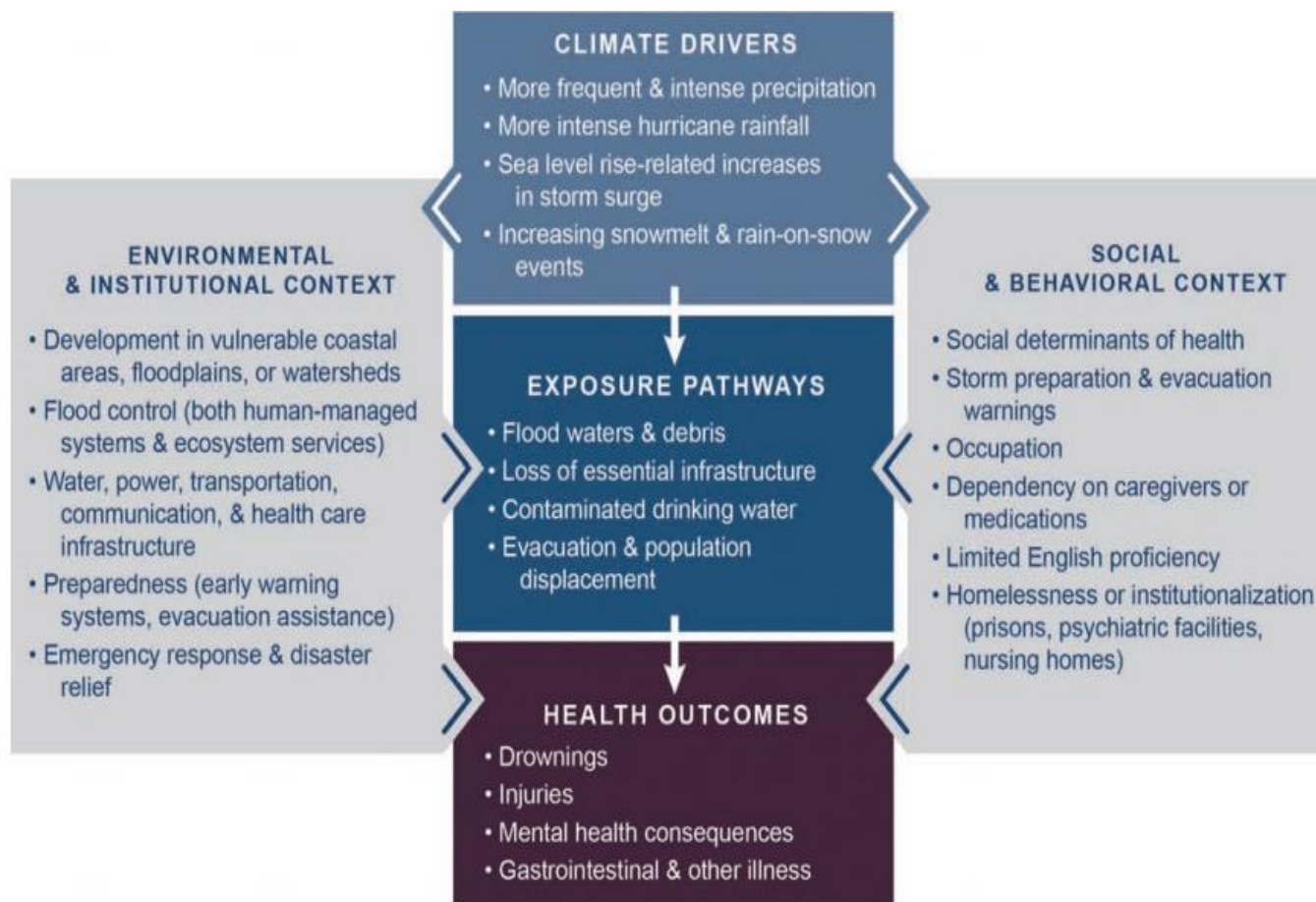
Weather conditions can influence the transportation of air-borne pollutants, pollen production and levels of fossil fuel pollutants resulting from household heating and energy demands. Climate change may increase the concentration of ground level ozone but the magnitude of the effect is uncertain. The future could include limited productivity at work and school due to exacerbated ground-level ozone (smog) health impacts from modified weather patterns conducive to ozone formation, and worsened allergy and asthma conditions from more airborne pollen and longer pollen seasons.



**Figure 4.9: conceptual diagram for an outdoor air quality example illustrates the key pathways by which humans are exposed to health threats from climate drivers, and potential resulting health outcomes**

### iii. Flooding

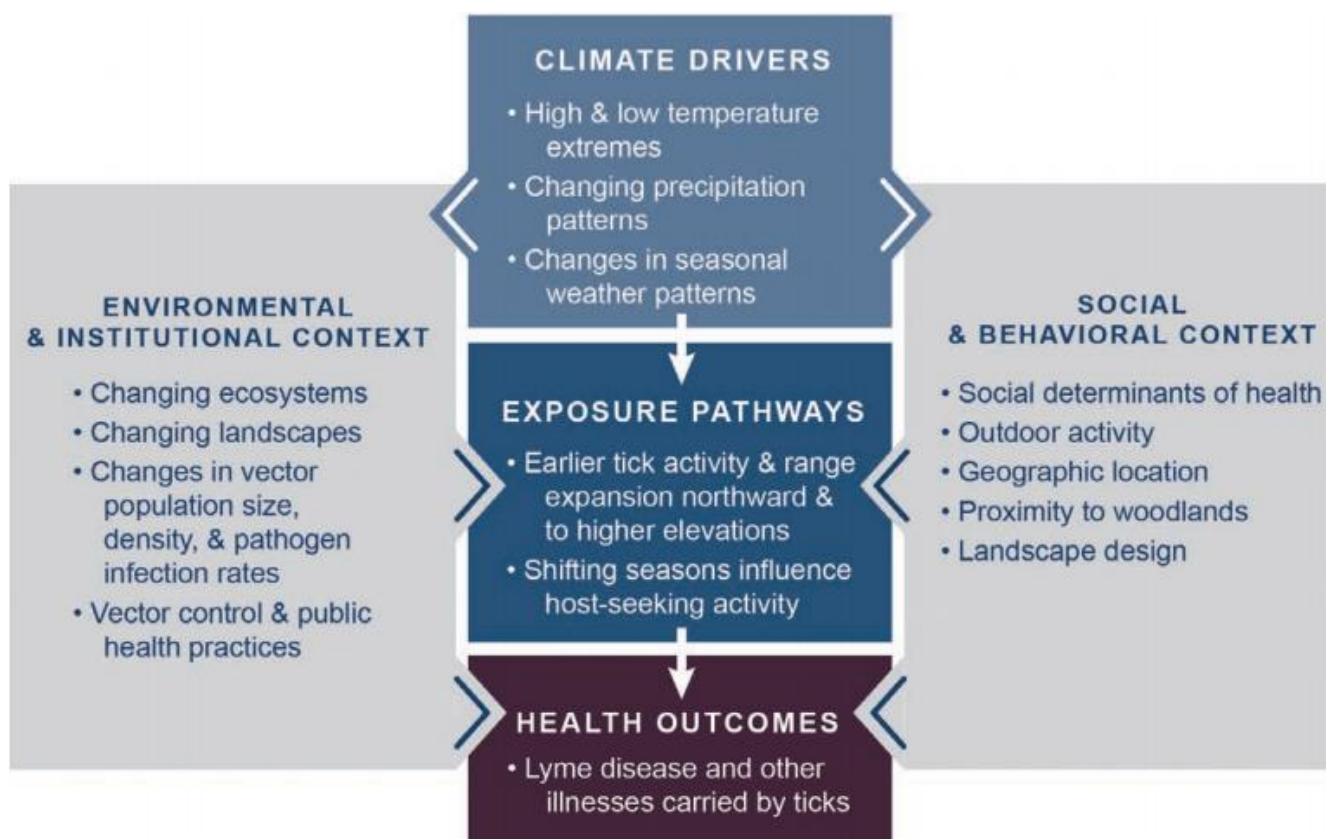
Floods are the primary health hazard associated with extreme precipitation events, hurricanes, and coastal storms. People in flood-prone regions are expected to be at greater risk of exposure to flood hazards due to climate change. Women, children, older adults, low-income populations, and those in poor health, with prior mental health issues, or with weak social networks may be especially vulnerable to the mental health impacts of floods



**Figure 4.10: Conceptual diagram for a flooding event illustrates the key pathways by which humans are exposed to health threats from climate drivers, and potential resulting health outcomes**

#### iv. Vector-Borne Infections

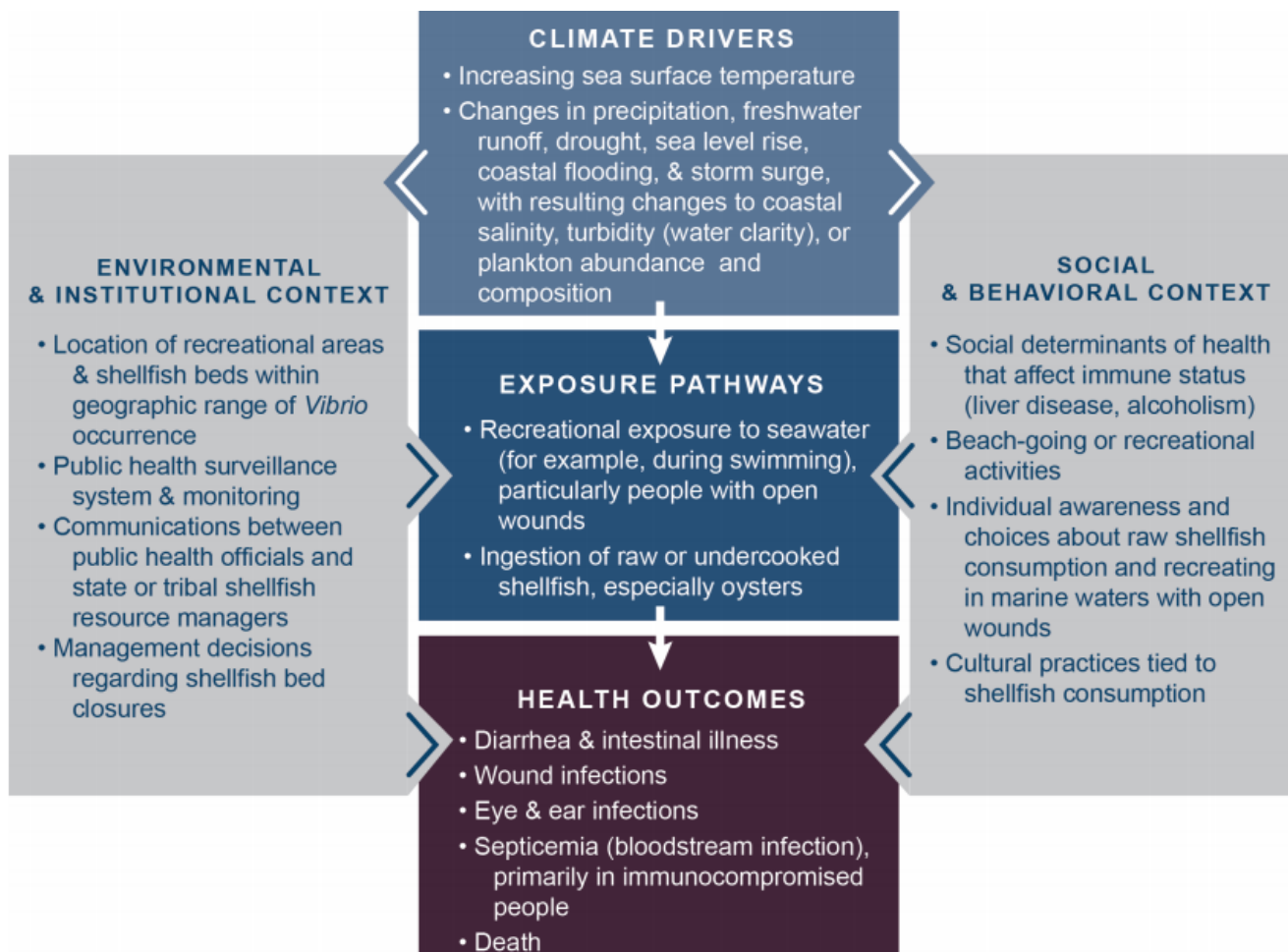
Changes in climate mean conditions and variability would affect many other vector-borne infections (such as dengue, leishmaniasis, Lyme disease, and tick-borne encephalitis) at the margins of their current distributions. The seasonality, distribution, and prevalence of vectorborne diseases, including Lyme disease and West Nile virus, may change with changing temperature and rainfall patterns due to altered geographic and seasonal distributions of mosquitoes, ticks, and fleas.



**Figure 4.11: conceptual diagram illustrates the key pathways by which climate change influences human exposure to Lyme disease and the potential resulting health outcomes**

## v. Water-Borne Diseases

Risk of exposure to illnesses increases as the growth, survival, spread, and toxicity of water-related pathogens and toxins is impacted by temperature and extreme rainfall events, and aging water infrastructure is vulnerable to failure with extreme events and storm surges.

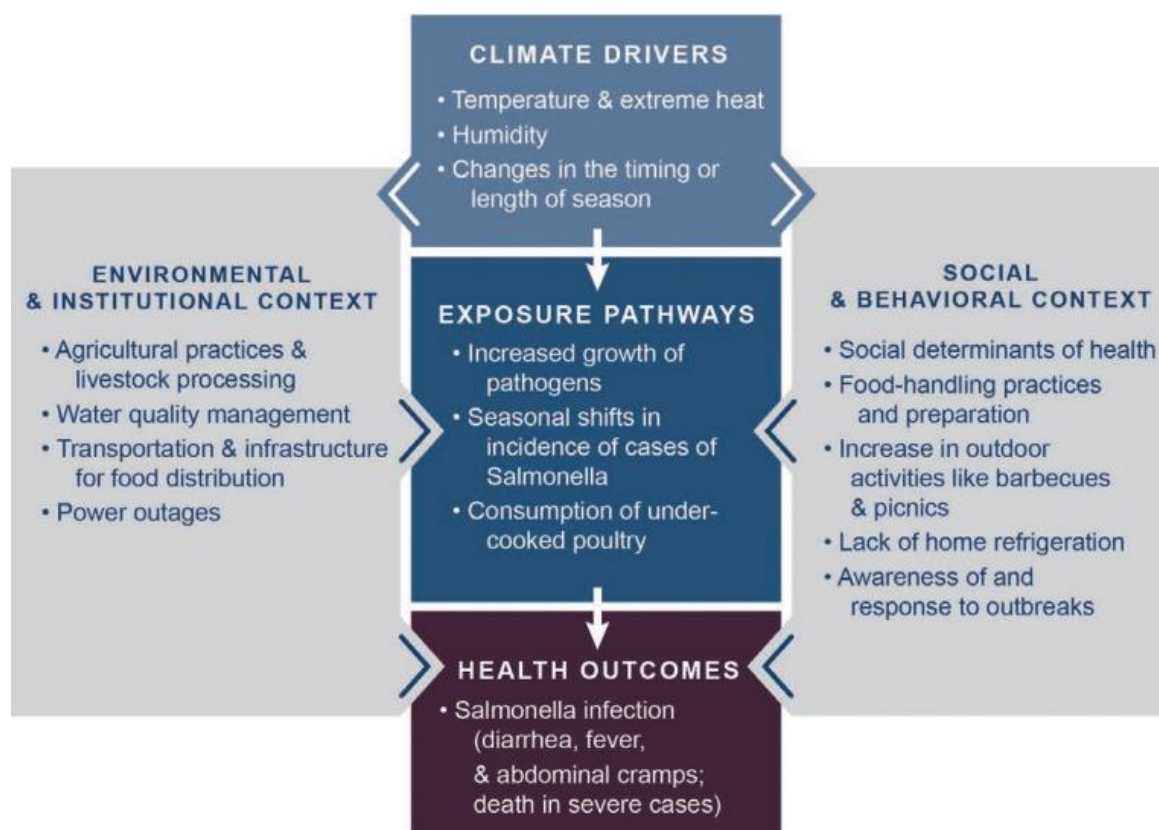


**Figure 4.12: This conceptual diagram for an example of infection by *Vibrio* species (*V. vulnificus*, *V. parahaemolyticus*, or *V. alginolyticus*) illustrates the key pathways by which humans are exposed to health threats from climate drivers.**



## vi. Food Safety and Nutrition

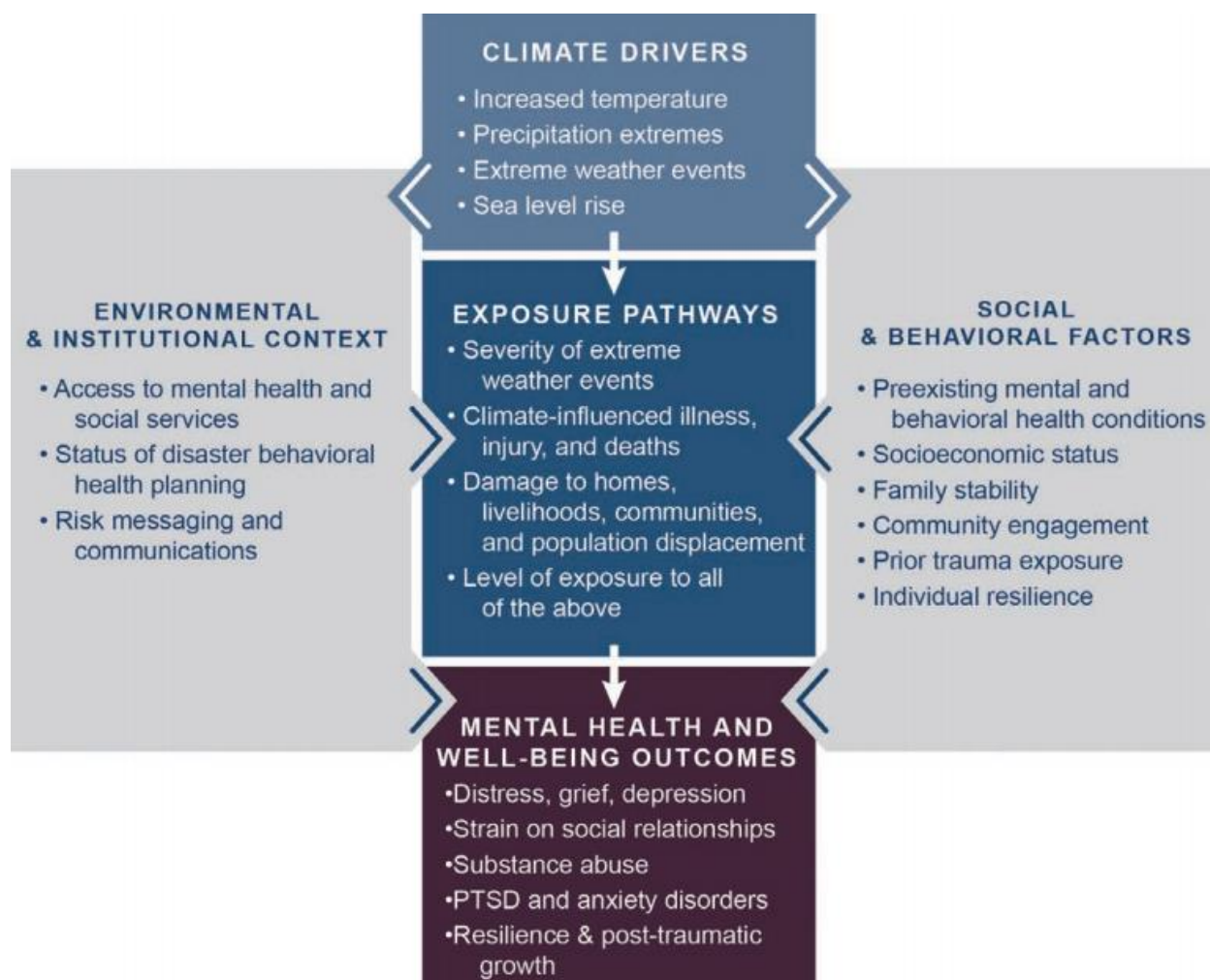
Rising temperatures, changing weather patterns, and extreme events have consequences for contamination, spoilage, and the disruption of food distribution, whereas higher carbon dioxide levels lower nutritional value of crops despite boosting plant growth.



**Figure 4.13: conceptual diagram for a Salmonella example illustrates the key pathways by which humans are exposed to health threats from climate drivers, and potential resulting health outcomes**

### vii. Mental Health and Well being

The cumulative and interactive effects of climate change, as well as the threat and perception of climate change, adversely impact individual and societal health, mental health, and well-being.



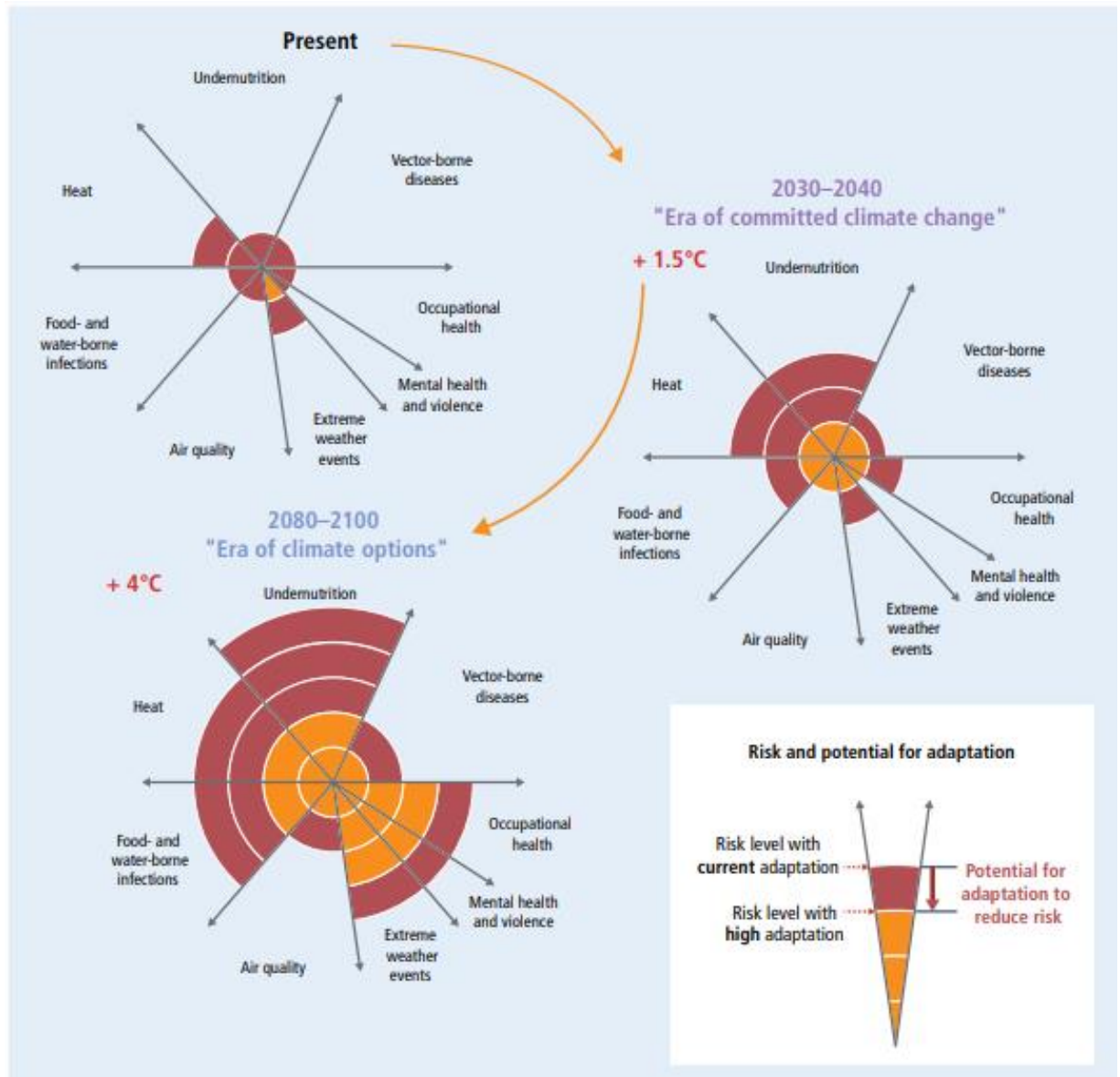
**Figure 4.14: Conceptual diagram illustrates the key pathways by which humans are exposed to health threats from climate drivers, and potential resulting mental health and well-being outcomes (Crimmins et al., 2016; Resource Innovation Group & Biositu, 2012; Ocko, 2016)**

## 2. NATIONAL AND INTERNATIONAL SCENARIO

Although global warming may bring some localized benefits, such as fewer winter deaths in temperate climates and increased food production in certain areas, the overall health effects of a changing climate are likely to be overwhelmingly negative. Climate change affects social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter.

Between 2030 and 2050, climate change is expected to cause approximately 2,50,000 additional deaths per year, from malnutrition, malaria, diarrhoea and heat stress. The direct damage costs to health (i.e. excluding costs in health-determining sectors such as agriculture and water and sanitation), is estimated to be between USD 2-4 billion/year by 2030. Areas with weak health infrastructure – mostly in developing countries – will be the least able to cope without assistance to prepare and respond (World Health Organization [WHO], 2018).

Climate change is expected to have major health impacts in India-increasing malnutrition and related health disorders such as child stunting - with the poor likely to be affected most severely. Child stunting is projected to increase by 35% by 2050 compared to a scenario without climate change. Malaria and other vector-borne diseases, along with diarrheal infections which are a major cause of child mortality, are likely to spread into areas where colder temperatures had previously limited transmission. Heat waves are likely to result in a very substantial rise in mortality and death, and injuries from extreme weather events are likely to increase. Health systems will need to be strengthened in identified hotspots (Kanti, 2017). Reducing emissions of greenhouse gases through better transport, food and energy-use choices can result in improved health, particularly through reduced air pollution.



**Figure 4.15: Conceptual presentation of the health impacts from climate change and the potential for impact reduction through adaptation (Semenza, 2014)**

### 3. CLIMATE CHANGE MITIGATION AND ADAPTATION IN HEALTH SECTOR

Certain adverse health effects can be minimized or avoided with sound mitigation and adaptation strategies. Strategies for mitigating and adapting to climate change can prevent illness and death in people now, while also protecting the environment and health of future generations.

- *Mitigation* refers to actions being taken to reduce greenhouse gas emissions and to enhance the sinks that trap or remove carbon from the atmosphere.
- *Adaptation* refers to actions being taken to lessen the impact on health and the environment due to changes that cannot be prevented through mitigation.

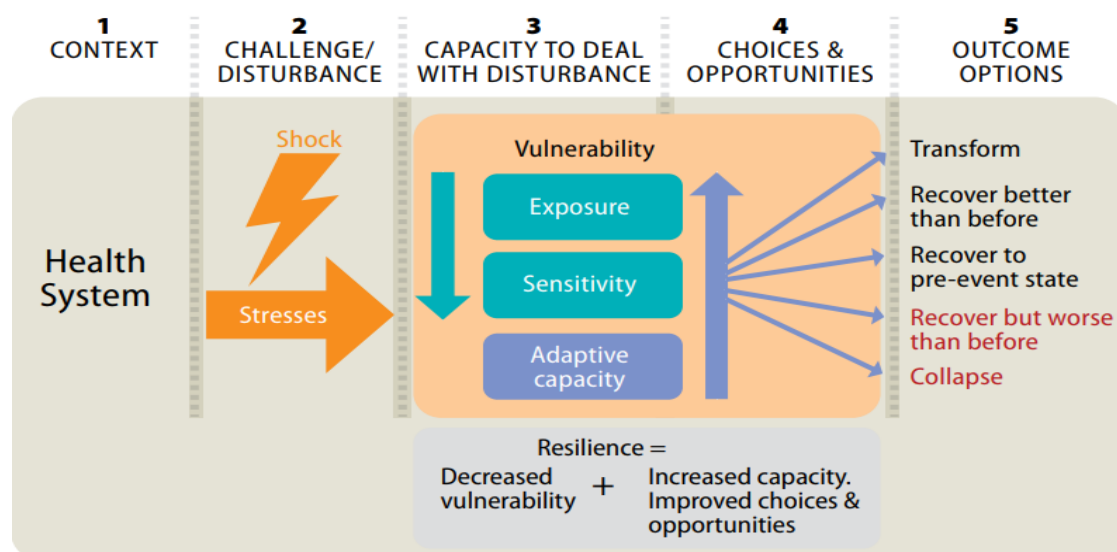
Appropriate mitigation and adaptation strategies will positively affect both climate change and the environment, and thereby positively affect human health. Some adaptation activities will directly improve human health through changes in our public health and health care infrastructure (National Institute of Environment Health Sciences [NIEH], 2018).

Weather Event	Health Effects	Preparedness Measure
Heat waves	Heat stress	Architecture; air conditioning; warning systems; distributed, resilient, "smart power grid"; community response
Extreme weather events	Injuries; drowning	Architecture; engineering; planning; early warning systems
Winter weather anomalies (e.g. rain, ice)	Slips and falls; motor vehicle crashes	Public education; mass transit
Sea-level rise	Injuries; drowning; water and soil salinization; ecosystem and economic disruption	Sea walls and levees; abandonment
Increased ozone and pollen	Respiratory disease exacerbation (e.g. chronic obstructive pulmonary disease, asthma, allergic rhinitis, bronchitis)	Pollution controls; air conditioning; education; medical therapy
Drought, ecosystem migration	Food and water shortages; malnutrition	Technological advances; enhanced delivery systems; trade negotiations
Droughts, floods, increased mean temperature	Food- and water-borne diseases	Public education; water treatment; medical treatment; watershed management
Droughts, floods, increased mean temperature	Vector-borne disease	Public education; vector control; medical prophylaxis and treatment; vaccination
Extreme weather events; drought	Mass population movement; international conflict	Negotiation and conflict mediation; post-disaster response
Climate change generally; extreme events	Mental health	Health communication; post-disaster mental health outreach; various therapeutic and medical management options

**Figure 4.16: Anticipated Health Effects of Climate Change & Preparedness measures for the same (Resource Innovation Group & Biositu, 2012)**

#### 4. BUILDING RESILIENCE HEALTH SYSTEMS

A climate resilient health system is one that is capable to anticipate, respond to, cope with, recover from and adapt to climate-related shocks and stress, so as to bring sustained improvements in population health, despite an unstable climate. Building health system resilience to climate change is a cumulative process.



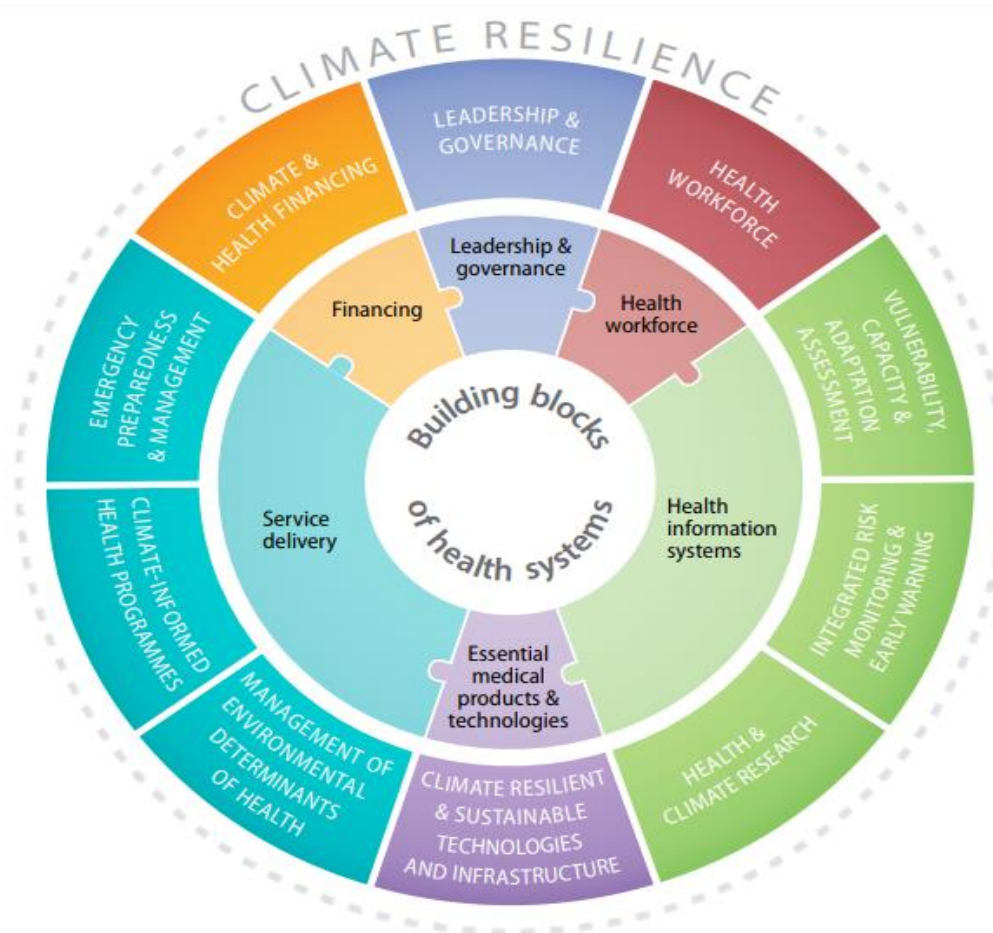
**Figure 4.17.: Conceptual framework for resilience**

Building climate resilience is a process of teaching the health system to more effectively adapt to change, particularly changing health risks due to climate change. The process of building resilience occurs in two principle ways:

- reducing overall vulnerability, and
- developing specific system capacities.

Incorporating these considerations when applying the operational framework is important to integrating climate perspectives to health policy and operations.

WHO has identified 6 building blocks: Leadership and Governance; Health Workforce; Health Information Systems; Essential medical products and technologies; Service delivery; and Financing. Starting from health sector building blocks, and taking into account existing global and regional mandates, the operational framework elaborates on 10 components that together provide a comprehensive approach to integrating climate resilience into existing health systems. These can provide the structure for a health adaptation plan, including the allocation of roles and responsibilities, as well as human and financial resources.



**Figure 4.18: Ten components comprising the WHO operational framework for building climate resilient health systems, and the main connections to the building blocks of health systems (WHO, 2015).**



## 5. CASE STUDIES

### **Study 1: Global Framework for Climate Services (GFCS) Adaptation Programme in Africa:**

The GFCS demonstration project aims to increase the resilience of people most vulnerable to the impacts of weather and climate-related events through the development, implementation and evaluation of a joint multisectoral programme on Climate Services. The project implemented in Malawi and Tanzania, is helping to build integrated frameworks for climate services and has brought together multisectoral research and implementing partners to enhance initiatives in climate services, food security, nutrition and health as well as disaster risk reduction.

WHO, supporting the Ministries of Health to implement the climate services for health component, is working to improve evidence and information for adaptation and risk management of climate sensitive diseases of concern, notably malaria and cholera.

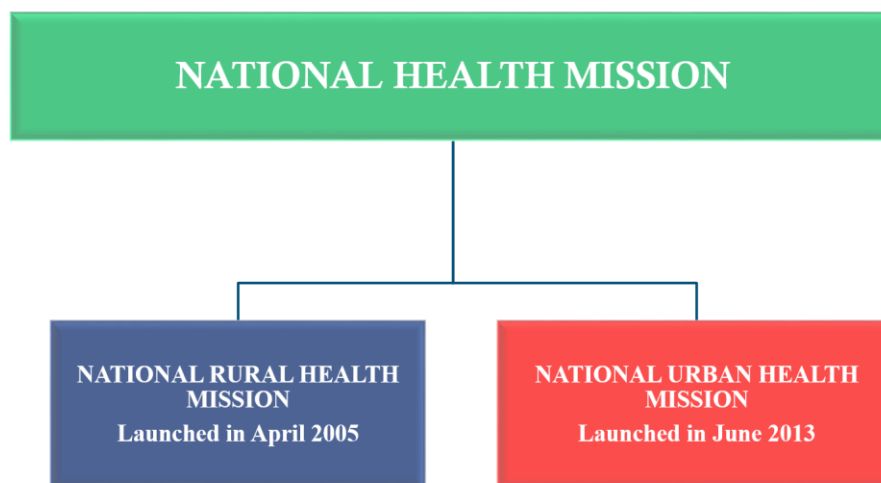
### **Study 2: Extreme Heat and Health Partnership and Climate Services in South Asia**

In response to growing concern and increasing impacts of extreme heat events in South Asia, the WMO and WMO/WHO Joint office have kick-started activities to increase capacity, evidence, and sharing of information and experiences specific to implementing extreme heat health warning systems and action plans. Activities consider impacts and extreme heat exposure risk management for indoor and outdoor workers (World Meteorological Organization, 2016).

## 6. GOVERNMENT POLICIES IN INDIA

### a) National Health Mission

The National Health Mission (NHM) encompasses its two Sub-Missions, the National Rural Health Mission (NRHM) and the newly launched National Urban Health Mission (NUHM). The main programmatic components include Health System Strengthening in rural and urban areas- Reproductive-Maternal- Neonatal-Child and Adolescent Health (RMNCH+A), and Communicable and Non-Communicable Diseases. The NHM envisages achievement of universal access to equitable, affordable & quality health care services that are accountable and responsive to people's needs.



**Source:** <https://nhmpunjab.in/>

#### i. National Urban Health Mission (NUHM)

The National Urban Health Mission (NUHM) as a sub-mission of National Health Mission (NHM) has been approved by the Cabinet on 1st May 2013.

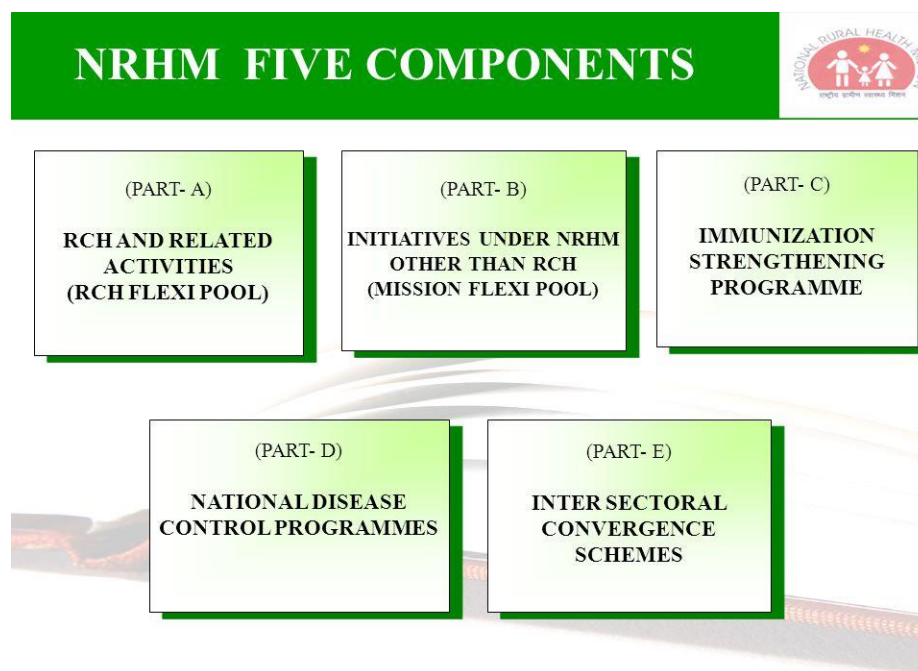
NUHM envisages to meet health care needs of the urban population with the focus on urban poor, by making available to them essential primary health care services and reducing their out of pocket expenses for treatment. This will be achieved by strengthening the existing health care service delivery system, targeting the people living in slums and converging with various schemes relating to wider determinants of health like drinking water, sanitation, school education, etc. implemented by the Ministries of Urban Development, Housing & Urban Poverty Alleviation, Human Resource Development and Women & Child Development.

**ii. National Rural Health Mission (NRHM)**

The National Rural Health Mission (NRHM) was launched by the Hon'ble Prime Minister on 12th April 2005, to provide accessible, affordable and quality health care to the rural population, especially the vulnerable groups. The Union Cabinet vide its decision dated 1st May 2013, has approved the launch of National Urban Health Mission (NUHM) as a Sub-mission of an over-arching National Health Mission (NHM), with National Rural Health Mission (NRHM) being the other Sub-mission of National Health Mission.

NRHM seeks to provide equitable, affordable and quality health care to the rural population, especially the vulnerable groups. Under the NRHM, the Empowered Action Group (EAG) States as well as North Eastern States, Jammu and Kashmir and Himachal Pradesh have been given special focus. The thrust of the mission is on establishing a fully functional, community owned, decentralized health delivery system with inter-sectoral convergence at all levels, to ensure simultaneous action on a wide range of determinants of health such as water, sanitation, education, nutrition, social and gender equality. Institutional integration

within the fragmented health sector was expected to provide a focus on outcomes, measured against Indian Public Health Standards for all health facilities (Ministry of Health & Family Welfare, 2015).



**Source:** <https://slideplayer.com/slide/4603968/>

### b) Ayushman Bharat, 2018

Ayushman Bharat is National Health Protection Scheme, which will cover over 10 crore poor and vulnerable families (approximately 50 crore beneficiaries) providing coverage upto 5 lakh rupees per family per year for secondary and tertiary care hospitalization. Ayushman Bharat - National Health Protection Mission will subsume the on-going centrally sponsored schemes - Rashtriya Swasthya Bima Yojana (RSBY) and the Senior Citizen Health Insurance Scheme (SCHIS) (National Portal of India, 2018).

**Source:** <https://hindi.oneindia.com/news/business/ayushman-bharat-yojna-aby-what-are-the-key-benefits-the-mission/articlecontent-pf153640-473352.html>

### c) Action Plan- Prevention & Management of Heat wave

NDMA has given the guidelines for *Preparation of Action plan – Prevention and Management of Heat wave* (Draft) in 2017. The Heat-Wave Action plan aims to provide a framework for implementation, coordination and evaluation of extreme heat response activities in cities/town in India that reduces the negative impact of extreme heat. The Plan's primary objective is to alert those populations at risk of heat-related illness in places where extreme heat conditions either exist or are imminent, and to take appropriate precautions, which are at high risk. All cities can learn from their experience and develop a plan to deal with Heat wave in their specific cities/town and thus reduce the negative health impacts of

extreme Heat. In addition the State Governments should also prepare a comprehensive plan to combat Heat wave.

Severe and extended heat-waves can also cause disruption to general, social and economic services. For this reason, Government agencies will have a critical role to play in preparing and responding to heat-waves at a local level, working closely with health and other related departments on long term strategic plan.

- **Establish Early Warning System and Inter-Agency Coordination** to alert residents on predicted high and extreme temperatures. Who will do what, when, and how is made clear to individuals and units of key departments, especially for health.

- **Capacity building / training programme** for health care professionals at local level to recognize and respond to heat-related illnesses, particularly during extreme heat events. These training programmes should focus on medical officers, paramedical staff and community health staff so that they can effectively prevent and manage heat-related medical issues to reduce mortality and morbidity.

- **Public Awareness and community outreach** Disseminating public awareness messages on how to protect against the extreme heat-wave through print, electronic and social media and Information, Education and Communication (IEC) materials such as pamphlets, posters and advertisements and Television Commercials (TVCs) on Do"s and Don"ts and treatment measures for heat related illnesses.

- **Collaboration with non government and civil society:** Collaboration with non-governmental organizations and civil society organizations to improve bus stands, building temporary shelters, wherever necessary, improved water delivery systems in public areas and other innovative

measures to tackle Heat wave conditions (National Disaster Management Authority, 2016).

## 7. WAY FORWARD

Climate change will be the most serious public health threat in the 21st century. According to the scientific evidences, climate change and its local consequences will adversely affect the health status in the following decades. Identification of local communities vulnerable to climate change can help health policymakers prevent associated adverse health impacts. The discourse on climate change-related health draws attention the role of integrated approaches in the possible responses (Uzzoli, 2016).

## 8. FUTHER READINGS

- <https://www.cdc.gov/climateandhealth/effects/default.htm>
- [http://apps.who.int/iris/bitstream/handle/10665/189951/9789241565073\\_eng.pdf;jsessionid=529E8F5938A9F0E4598C6726F2BCD7D2?sequence=1](http://apps.who.int/iris/bitstream/handle/10665/189951/9789241565073_eng.pdf;jsessionid=529E8F5938A9F0E4598C6726F2BCD7D2?sequence=1)
- <https://thewire.in/government/new-global-report-further-bad-outlook-india-climate-change-health>
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