Chapter 1
Introduction: Climate Risks in the Health Sector

Abstract This chapter details the structure of the book, and introduces relevant terminology and concepts used in it. The first section describes the scope of the book while the second section presents the conceptual framing in terms of risks to the health sector and adaptation for managing the risks from climate change. It presents the current evidence on climate change and projected risks for the health sector, the association between different climate drivers and prevalence of selected diseases, and concerns of exposure and vulnerability across regions of the world.

Keywords Climate change · Regional risks · Public health · Adaptation

The impacts of climate change are part of multiple interacting contexts in a developing economy, posing risks that can have far reaching economic and social consequences across sectors. The Indian economy represents a developing country context, where multiple stressors co-exist, competing for resources and prioritization in a developmental agenda. Among the projected risks of climate change for Asia, including India, increased flood damage to livelihoods, infrastructure and settlements, heat related human mortality and increased drought related food and water shortages have been predicted, depending upon the time scale and extent of warming. Each of these has far reaching consequences for human health, with associated implications for public health planning. In India, given the large numbers still in poverty and with inadequate access to basic water, health and sanitation services, climate related occurrences are already impacting health outcomes. Directly and indirectly, there are many associations between climate related events and health—both in terms of public health provisioning and individual well being. Under the circumstances, it becomes imperative to understand current vulnerability as well as plan for the future health of human populations with specific focus on its sensitivity to changes in climatic variability and climate change.

The association between different climate drivers and prevalence of selected diseases, and concerns of exposure and vulnerability are extremely relevant for public health planning in particular as this book will seek to demonstrate through an evidence based narrative. An examination of the key risks posed and the challenges

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and opportunities these create for developing countries in terms of economic decision-making in support of risk management strategies requires an understanding of the gravity of the risks and of what adaptation can achieve in terms of managing these risks so that the public health system is prepared to respond effectively to risks from climate change. The current evidence on climate change and climate vulnerability, and the current and projected health risks from climate change are being increasingly recognized. However, thus far these have generated very little adaptation research on how to manage these risks. Integrating climate risks within mainstream health planning and policy is virtually absent in most developing countries.

This chapter details the scope and structure of the book, and introduces relevant terminology and concepts used in the following chapters. It presents the current evidence on climate change and climate variability and, on the current and projected climate risks for the health sector. The association between different climate drivers and prevalence of selected diseases, and concerns of exposure and vulnerability across regions of the world are discussed. The first section describes the scope of the book while the second section presents the conceptual framing in terms of risks to the health sector and adaptation for managing the risks from climate change.[1]

1.1 Scope: Risks, Adaptation and Public Health in Developing Economies

Various aspects of relevance to understanding the issue include an assessment of the risks posed by climate parameters and their associations with health outcomes and health care provisioning; the challenges and opportunities that are faced across developing countries in terms of economic decision-making in support of adaptation strategies and the options that are available; an understanding of the current preparedness of the health sector in India in meeting the challenges posed by climate sensitive diseases; an analysis of what provisions exist and are feasible in the plans and policies for public health in tackling climate related impacts; and learnings from international experience in building resilience to climate sensitive diseases in a manner that is relevant to a developing economy context. The chapters that follow will take up these aspects, presenting illustrations and statistical analysis of evidence from data. The book concludes with a discussion on what are the key challenges and key opportunities to ensure a desirable level of preparedness and capacity of the health system to respond to the threats posed by a changing climate.

Chapter 2 presents the current understanding on adaptation in public health planning as an essential for economies that wish to tackle current vulnerabilities to climate sensitive diseases, as well as build resilience to the adverse impacts on health projected from future climate change. These risks and vulnerabilities

[1]Appendix 1 provides definitions of key terms used in the chapters.

manifest themselves either directly such as through heat events, or indirectly through say, food availability with its attendant implications for undernutrition. The empirical and theoretical literature on the subject is viewed through the lens of public health planning, a persistently important subject for a developing economy context.

There are two interconnected dimensions to building an understanding that addresses the requirements peculiar to the Indian economy. On one hand, there is the concern for meeting current health challenges, many of which get compounded and meshed with sensitivity to climate parameters, due to the nature of the diseases itself as in the case of waterborne or vector borne illnesses. This raises questions on current infrastructure, planning and provision of services including water and sanitation. On the other hand, anticipated climate change, raises challenges in terms of the additionality it brings to the table for appropriate planning to overcome new challenges for the health sector.

There is evidence today that there are observed impacts that can be attributed to climate sensitivity, both in terms of short term climate variability and long term climate change. Where there are already considerable health impacts from climate variability and climate sensitive diseases, the expected impacts from projected climate risks such as heat stress or flooding, irrespective of it occurring in new areas or getting exacerbated in existing vulnerable areas, is a matter of grave concern. It calls for a deeper understanding of what experiences across the world have to offer, towards building resilience in the health sector.

Several complications are introduced by the fact that incidence and geographical distribution of illnesses are impacted by not only climate but non-climate factors as well. Empirical evidence on how socioeconomic and technological factors impact diseases is as important as understanding the role played by awareness, political will and institutional capacity in determining the effectiveness of any desired response to vulnerabilities and hazards.

Historical experiences in adapting to hazards, and putting in place effective adaptation options, have both been in place to a lesser or greater extent in countries across the world. While on one hand certain standard protocols and consensus based international guidelines have emerged, on the other hand there is a lot of learning which has emerged from country specific experiences. In this chapter both these are brought together to frame the domains of an effective adaptation strategy for the health sector.

Chapter 3 discusses the wider context of developing economies with particular emphasis on the challenges of sustainable development faced by them and the economic issues relevant to decision-making for adaptation. It presents a comparative picture of expected regional climate change impacts for these economies, country profiles in health status, vulnerability to climate sensitive diseases and economic development. The Indian context will be used to highlight some of the issues. This is of interest since India represents a country of paradoxes to some extent. Although its economic profile is much better than several others, it continues to face many challenges with regard to poverty alleviation and meeting basic needs including public health.

The chapter also discusses the important issues in economic decision-making for adaptation, with special reference to concerns and challenges that arise with regard to climate change and its economic valuation. Challenges in measuring and assessing adaptation in developing economies, available tools and methods, ancillary and externality effects, and distributional issues in the economic context will be considered as these are relevant to decision-making in developing economies.

Several research efforts are underway in different parts of the world to establish the extent and strength of associations between various climate drivers and illnesses. For instance, there is evidence today that dengue fever is associated with climate variables globally, with high confidence levels. Similarly there is high confidence that existing diseases may extend their ranges into areas that are presently unaffected. For malaria, there is higher confidence for local effect of climate parameters. Detection and attribution of health effects from climate change, linking directly to illnesses, is one particular direction in which research is making some headway worldwide. In India so far, there has been scant attention to these concerns, particularly in terms of linking these to socio-economic factors. The key to building the right associations, lies in drawing the linkages between the dynamically complex set of factors that determine health outcomes and climate factors, moving away from a narrow focus solely on disease transmission pathways. To draw upon the IPCC AR5, the largest health risks will apply in populations that are currently most affected by climate related diseases (Smith et al. 2014).

To understand the factors that become relevant for reducing current and projected risks from climate change in the context of India, it must be remembered that until mid Century, climate change is expected to act mainly by exacerbating health problems that already exist. Adaptation under these circumstances, especially for populations that do not have access to health care and public health services, is as much a question of responding to an amplification of existing threats to public health as of new strategies for managing new threats. What it does entail as new and more forceful, is moving from a situation of reactive responses, to one of foresight and planning.

To illustrate the point, an analysis of secondary data for one state in India is undertaken in Chap. 4. The risk posed by climate events to mortality and economic losses, are statistically analysed. District level indices of health care provision and socio-economic status are constructed and analysed for 18 districts of the state over a period of 12 years from 2002–03 to 2013–14. The statistical associations between risk of mortality from climate events, health sector preparedness and socioeconomic wellbeing are subsequently highlighted.

Chapter 5 analyses the extent and adequacy of the health programmes and the state action plans on climate change in tackling issues of adaptation, in a manner that achieves the ultimate outcome of both reducing the burden of disease and well as building resilience to future climate change induced adverse impacts on health. The chapter presents and critically reviews the current evidence on the prevalence of what are scientifically established to be climate sensitive illnesses in India. These include malaria, dengue, and heat mortality among others. Subsequently a critical

analysis of the current plans and programmes in terms of the capacity to address climate related risks is conducted, and lessons drawn from the historical experience with these programmes.

In India the thrust of the health sector planning lies in the realm of the health ministry, which is logical. Health is a state subject and as a consequence, there is much diversity in the way the plans and programmes are designed at the state level, in the way these are implemented and impact outcomes even for centrally driven programmes. Added to this is the diversity that arises due to geographical and socio-economic factors, leading to variations in the observed health outcomes. It is no surprise that the costs of provisioning and budgetary layouts can also vary substantially across states. Since most of the climate sensitive diseases fall under the classification of communicable (or infectious alternatively in the literature) diseases, there is considerable focus on these illnesses per se. However what remains to be seen is the extent and adequacy of the measures from an integrated point of view that takes climate sensitivity on board in regions vulnerable to these illnesses.

Recently the State Action Plans on Climate Change have been developed and these are currently at various stages of the approval process with the concerned Ministry. These action plans have been evolved under the broad framework of the national action plan on climate change which was initiated several years ago. It is heartening that all these state plans have included health as one of the focus areas for building resilience to climate change. The way forward poses challenges and offers opportunities as the chapter reveals.

Chapter 6 details the adverse health outcomes and risks to health posed by climatic changes for India specifically, with the help of three case studies. Managing the risks climate change poses is a huge challenge for India due to two principal concerns. One key concern is that the science of climate change and its risk management is itself an evolving one. Progress has been made in reaching high levels of scientific consensus on the occurrence of climate change and global warming from climate models. However, as far as managing the risks are concerned, adaptation to climate change in the health sector is still at a nascent stage for most developing economies. To a large extent, countries across the world are learning from each other's experiences, and combining these with learnings from past experiences with managing long term diseases, many of which were non-climatic in nature although these did pose long term decadal managerial problems as well.

The other key concern is the low existing base of the health system. Reaching threshold levels of basic public health care services for all is in itself a huge task for India. Hence, there is a danger that climate sensitivity will tend to be neglected, or at best relegated to an extremely low priority in the hierarchy of health care provisioning. The lack of systematic data which can be used in the attribution of morbidity and mortality to climate sensitive diseases in a conventional sense, often becomes a lament that serves to further take away the focus from adaptation to climate risks in this sector.

However, as highlighted in earlier chapters, the evidence on occurrence of climate sensitive diseases is mounting. The detection and attribution of diseases to climate change has also improved, with epidemiological studies to support such

claims. This chapter will specifically consider three important types of climatic events that have had serious consequences for India in the past, and are likely to persist and even increase in the years to come given the threat of climate change. These are heat stress, flood and cyclone related threats posed to the health sector.

The three case studies have been done in three different districts of a state in India, which have been experiencing these climate events. The case studies bring out the vulnerabilities that become specific to the Indian situation, taking on the complexity posed by socioeconomic factors that are co-associated with adverse health outcomes. The detailed analysis brings out the major domains of relevance to analyzing the Indian context within which adaptation is to be addressed. The criticality of good research through field work in furthering the understanding of how climate sensitivity can add to lowering both the existing burden of diseases and managing future risks is brought out with illustrations from the case studies.

Sustainable development and adapting to climate change impacts on health are inter-related objectives that reinforce each other. Integrating adaptation options in planning for a sustainable future is the way forward for public health planning. In conclusion, Chap. 7 summarises the key understandings developed in the book and key lessons learnt. It also makes recommendations on the way forward in addressing the key challenges and opportunities in adapting to climate change in the specific context that developing economies find themselves in today. The current approach in terms of resource availability, information, and guidelines is discussed along with learnings from the historical experiences of the world in addressing health sector challenges in the past. Building institutional capacities, training and knowledge transfer, being inclusive in targeting vulnerable populations, awareness creation and budgeting for resources for these are as crucial as getting in place the right infrastructure.

Effective adaptation in the near term includes meeting the basic public health measures such as clean water, sanitation, vaccination and child health services, just as much as increasing capacity for disaster preparedness. Innovatively designing long term adaptation measures is also critical particularly for targeted measures such as enhanced surveillance, safety nets and early warning systems. A two pronged strategy is advocated in terms of what can be done within existing programs and policies to reduce climate related impacts and what new areas deserve focus in an interface between health and climate change to reduce the adverse impacts. The book concludes by highlighting the key challenges in reducing climate risks and provides recommendations on the way forward in managing risks.

1.2 Framing the Context for Climate Risks

The IPCC AR5 (Field et al. 2014) report states with very high confidence that the health of human populations is sensitive to shifts in weather patterns and other aspects of climate change. Climate change impacts health in various ways: direct impacts of floods, droughts. extreme heat, cyclones; indirect impacts through

ecological processes such as changes in regulating and supporting services impacting the spread of disease vectors, changes in provisioning services such as food production leading to nutritional concerns, or displacement of populations and mental health. Direct impacts on health care services can also occur such as damages to health infrastructure or disruption in services due to extreme events. However, as per current understanding, the largest health risks will apply in populations that are currently most affected by climate-related diseases. Thus, for example, it is expected that health losses due to climate change-induced under-nutrition will occur mainly in areas that are already food-insecure (Smith et al. 2014). Some of the adverse effects on health are already being felt while projections for the future show much higher levels of risk, with some of these likely to be catastrophic as well (Watts et al. 2015). The consequences in terms of mortality, morbidity, and other economic losses are substantial. As per WHO (Hales et al. 2014) estimates, an additional 250,000 deaths annually between 2030 and 2050, could occur due to some well understood impacts of climate change, even though this estimate excludes many indirect causal pathways for mortality.

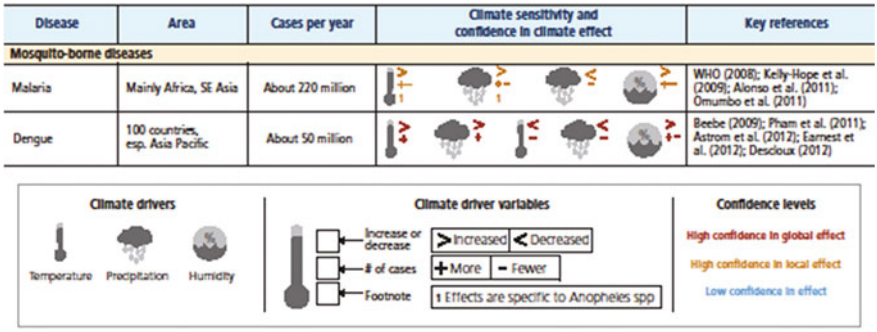
Changes in temperature, precipitation and other climatic variables impact the spread of diseases as these can alter the distribution of disease vectors (for example mosquitoes carrying dengue or malaria) altering their range, reproductive cycles, or the life cycle of parasites; providing conditions for growth of bacteria or through contamination of drinking water (for example diarrhoea, cholera) Causal pathways can be complex, as there maybe indirect impacts such as on vector borne diseases by sea level rise, or biodiversity loss leading to an increase in transmission of some diseases such as schistosomiasis (Watts et al. 2015).

All the risks cannot be accounted for since some risks may increase in a non-linear manner as global warming increases. Large scale impact models do not take into account large scale disruptions, low probability but high consequence events and risks that may interact with each other over time increasing thereby the magnitude of the impact in a non-linear fashion (World Bank 2015; Rockstrom et al. 2009; Lenton et al. 2008).

An issue of increasing importance is the vulnerability of health care services and facilities. The issue of the resilience of health care facilities and delivery of public health care services for climate sensitive diseases is an important one in the context of adaptation to climate change. This study will also seek to increase the understanding on the issue.

It is noted at the outset that essentially all the important Climate Altering Pollutants (CAPs) other than CO_2 have near-term health implications. In 2010, more than 7 % of the global burden of disease was due to inhalation of these air pollutants. There has been a mushrooming of literature tracking the health co-benefits of mitigation activity aimed at reducing the concentration of green house gases. Health co-benefits occur in this case due to reduced concentrations of local air pollutants from the use of cleaner technologies and energy sources. However, this book does not focus on these aspects of CAPs, other local air pollutants or on mitigation aspects, but limits itself to the study of risks from specific climate events and on building resilience to these through adaptation.

Table 1.1 Association between climatic drivers and distribution of vector-borne diseases (2008–2012)



Source Adapted from Table 11.1, Chap. 11, IPCC AR5. Reproduced with permission from the source

Presented in Table 1.1 are some recent findings on the association between observed cases of dengue and malaria, two diseases which are climate sensitive and also currently widespread in their occurrence, over the period 2008–2012. These are high confidence findings. For instance, increases in temperature or precipitation are climatic drivers leading to more cases of dengue. The areas affected include up to one hundred countries, especially in the Asia–Pacific region, with 50 million cases being reported per year.

It is apprehended that new conditions may also emerge under climate change and existing diseases (e.g. food borne infections) may extend their range into areas that are presently unaffected. In fact, the latter is a high confidence finding from the latest IPCC assessment. Local changes in temperature and rainfall have altered distribution of some water-borne illnesses and disease vectors, and reduced food production for some vulnerable populations (Smith et al. 2014). Changes in mean temperature, precipitation and ecological disruptions from extreme weather events can also affect transmission pathways of diseases leading to the opening up of new areas which are vulnerable to such diseases. Where there are projections on spatial or intensity changes in disease occurrence, it implies that existing public health systems may need gearing up to become climate sensitive.

It may also be the case that if specific public health infrastructure is likely to come under threat, new initiatives have to be considered such as advance planning for locating facilities or in changing construction design. This would be called for in several places in developing countries which are projected as potentially likely to be prone to flooding. In the Indian context, both heat stress and flooding are expected to impact public health and health systems. In a situation where there is already considerable health impacts from climate sensitive diseases linked to heat events and floods, this is a matter of concern.

Therefore the key solutions to the risks posed will lie in the planning and policy for tackling health sector risks. A critical assessment of the current plans on climate

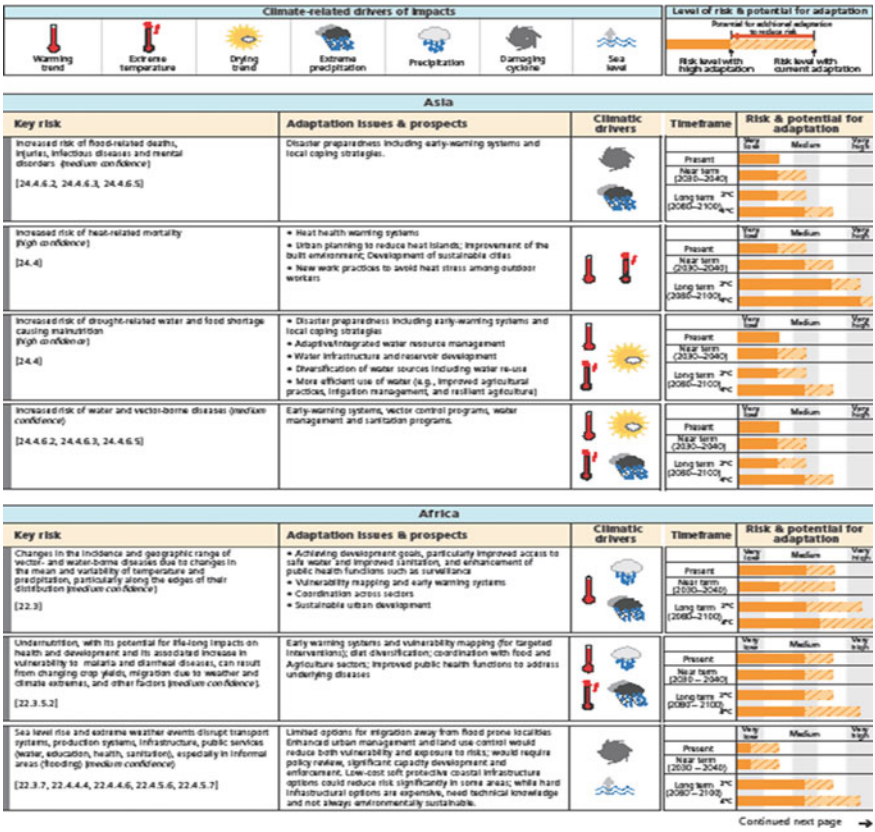
change and state health plans, and evidence from the field study areas, shows that there are many challenges and health policies for the most part have not in the past addressed these concerns. A basic requirement is good surveillance and reporting that contributes in understanding the disease patterns, helps in attribution of outcomes to underlying causes and in designing preventive and curative strategies. How well does the economy perform on these counts is an essential part of the framing that underlies the analysis in the book. What challenges remain and what can be achieved will determine the long run outcomes.

1.3 Key Regional Risks: The Current State of Knowledge

This section presents an analysis of the key health risks posed to different regions of the world, based on a risk assessment done by the IPCC (Field et al. 2014). The findings for Asia and Africa from the assessment are summarized in Table 1.2. Risk levels were based on an extensive assessment of the literature on health of human populations relevant to each of the regions. The climate drivers considered for assessing health risks include the impacts of a warming trend, drying trend, extreme temperature, extreme precipitation, precipitation, cyclones, and sea level rise. Risks are assessed on a scale from very low to very high. Each risk is characterized under four alternative scenarios: the present, the near term (in the years from 2030–2040), and for two future projections of a world which is warmer by 2 °C and a world which is warmer by 4 °C during the period 2080–2100. The nature of the risks for the health sector differ across regions, and the level of any particular type of health risk differs by the scenario considered, whether present, near term or long term. For Asia, mortality from heat and floods, injuries and infectious diseases due to floods, increases in water and vector-borne diseases, and malnutrition due to drought-related food and water shortage are the key risks. Flood related mortality and morbidity risks arise from extreme precipitation and cyclonic activity, while a warming trend and increasing temperatures contribute to the other risks for heat mortality, malnutrition from droughts and increased incidence of water and vector borne illnesses. The latter is also influenced by extreme precipitation events. Mortality risks from heat are higher than other health risks for Asia, under all scenarios, whether near term or long term. In fact, risks for heat mortality reach very high levels even under 2 °C warming in the long term. While there is high confidence in the assessments for heat and drought related risks, there is medium level confidence on the risks presented for malnutrition and flood related events. This is not to underplay the importance of the latter, but rather a demonstration of how risks can be categorized and prioritized by incorporating uncertainty aspects into the analysis.

For Africa, changes in pattern of vector and waterborne disease occurrence, undernutrition and disruption in public health services are identified as key risks. Changes in disease incidence and undernutrition are impacted by increasing temperatures, warming trend and precipitation events. Damaging cyclones and sea level rise impacts the provision of public services. All the key risks are medium

Table 1.2 Key health risks and adaptation potentials by region



Source Adapted from assessment box SPM2 Table 1, summary for policy makers, working group II, IPCC AR5. Reproduced with permission from the source

confidence findings. Risk levels range from medium to high under most scenarios for undernutrition and changes in disease occurrence. In fact, changes in disease incidence reaches very high levels in the long term, even under a 2 °C warming scenario. Risks of undernutrition and adverse impacts on public services reach very high levels in a 4 °C warming world.

In Central and South America, the key health risks are the spread of vector borne diseases associated primarily with increase in temperature, warming trends and precipitation events. It is alarming that risk levels are very high, both at present and in the near term. Mortality, morbidity and infrastructure damage from heat waves constitute a key risk for the health sector in Australasia, due to the influence of increasing temperatures. Risks are contained within medium levels for the most part, except in the long term when risks reach very high levels in a 4 °C warmer scenario.

In Europe, increasing temperature is the main climatic driver associated with health risks to the region. Risks from extreme heat events include economic losses

and adverse impacts in various ways including reduced labour productivity, and air quality, and direct impacts on health and well being. Risk levels are relatively higher than for other regions, being comparable to the risk levels for Asia from heat related mortality in the present and near term. While there is not much difference in risks between the near term and a 2 °C warmer scenario, risks reach very high levels in a 4 °C warmer scenario.

In North America, the heat related mortality is a key risk, which in terms of levels of risk is comparable to the heat related impacts in Europe under alternative scenarios. Increasing temperatures here are associated with higher mortality. Another key risk is the risk from urban flooding associated with extreme precipitation events, damaging cyclones and sea level rise. Risk levels increase progressively over time, and under a 4 °C warming scenario, reach very high levels. Adverse implications arise across sectors due to urban floods, such as damages to property and infrastructure, supply chain disruptions, and losses to public health care and ecosystems.

The above assessments draw upon several studies that have attempted to estimate the likely health impacts from climatic change. Findings from the studies clearly indicate climate change can impact the numbers at risk from diarrhoea and malaria due to increasing temperature, changes in precipitation and water availability (or its scarcity) (World Bank 2015). The causal relationships are complex, and compounded by the many confounding factors linked to social and economic influences on disease incidence. It is a challenge to factor these in adequately. Evidence from some studies that have helped to establish associations with climatic factors is presented below.

Hales et al. (2014) estimate that by 2030, climate change would be responsible for nearly 48,000 additional deaths due to diarrhoeal illness among children under the age of 15: 60,000 deaths due to Malaria, another 38,000 deaths due to heat exposure among the elderly and 95,000 due to childhood under nutrition. As per alternative estimates, climate impacts could lead to an increase of up to 10 % in diarrhoeal disease in some regions of the world (Kolstad and Johansson 2010; WHO 2003, 2002). Low rainfall locations tend to be associated with higher diarrhea disease prevalence among children (Lloyd et al. 2007).

The rise in malarial illness occurs primarily due to the impact of increasing temperatures and precipitation on transmission windows in most modeling exercises. Projections on the impacts of climate change on malaria can be distinguished in terms of the way development or economic growth is factored into the estimations. Overall, malaria is expected to come down globally by 2050, attributable to illness control interventions and economic growth. However, when climate change is factored in, this slow down is adversely hit, especially in some specific regions of the world such as Sub Saharan Africa and India. As per one set of estimates, by 2030, an estimated 3.6 billion people are at risk of malaria, of which a 100 million is attributable to climate change. Without economic growth, the numbers at risk would be much higher and some regions are particularly negatively impacted such as the highlands of East Africa (Beguin et al. 2011; Caminade et al. 2014). Early estimates by the WHO (2003) suggested that a rise in temperatures of 2–3 °C, could lead to an increase in the numbers at risk from malaria by 5 %, while another estimate suggests

that in Africa specifically, it increases by 5–7 % among at risk populations at higher altitudes, increasing the number of cases by up to 28 % (Small et al. 2003). For Central America and the Amazon region, rising temperatures and reduction in precipitation can also lead to a decline in malarial incidence (Smith et al. 2014; WHO 2003). In Senegal it is believed that drought like conditions and less precipitation have led to a decline in malaria prevalence (Githeko et al. 2000).

The fact of the matter is that there is sufficient evidence to associate changes in the populations at risk from changes in spatial and temporal patterns of certain illnesses, mortality and morbidity with changes in climatic variables.

1.4 Managing Risks and Adaptation

There is no doubt that uncertainties continue to exist in predicting exactly how the environment will change in future (Field et al. 2014), about the fact that future impacts of climate change on disease vectors may not be linear (Conafalonieri et al. 2007), and about the future climate sensitivity of potentially affected persons, since these are all affected by socioeconomic and demographic development and technological progress (Ebi and Mills 2013). Yet is undeniable that India, like many other developing countries, is already experiencing the impacts of extreme weather and climate events such as heat waves, floods and storms. Climate change is very likely to increase the risks from current climate and weather related vulnerabilities to the health sector. In the absence of appropriate adaptation, challenges in managing health of the population will exacerbate, with increasing burdens from existing diseases, as well as from new threats as discussed.

Under the circumstances, health is a priority area in the climate context for India, as in several other developing countries. In recognition of the importance of health, several initiatives have been articulated at various levels. At the international scale, the WHO guidance on health adaptation planning (WHO 2014) seeks to ensure development of a national plan to achieve strategic goals for building health resilience to climate change. At the national level, India is formulating a National Health Mission under the umbrella of the National Action Plan on Climate Change (NAPCC 2008), while the states in India are developing State Action Plans on Climate Change in which health finds mention as an important aspect. There are many non-state actors as well that are engaged in provision of health care such as NGOs providing mobile clinics in boats in cyclone prone areas. Health sector plans and programmes have been in place in India since well over 50 years.

Health outcomes are typically observed as the results of complex dynamic multi-causal drivers. While attribution in a multi-causal phenomenon is bound to be problematic, reducing current and projected health risks attributable to climate change by preventing exposures to weather and climate hazards, reducing the consequences of exposure and or reducing vulnerabilities (Ebi and Mills 2013) constitute important components of adaptation to climate sensitive diseases. Until mid-century climate change is expected to act mainly by exacerbating health

problems that already exist (Smith et al. 2014). For the longer term, it is also prudent to keep in mind that studies indicate the presence of non linearities in the health outcome and temperature relationship, such as the extreme temperature-mortality relationship (Anderson and Bell 2011).

For certain contexts, current strategies maybe sensitive to specific requirements for reducing the burdens of such diseases, while in others specific adaptation options may require to be identified to address such illnesses (currently in evidence) or (future projected) threats to human health. To quote: "In the immediate future, accelerating public health and medical interventions to reduce the present burden of disease, particularly diseases in poor countries related to climatic conditions, is the single most important step that can be taken to reduce the health impacts of climate change" (Smith et al. 2014). Accordingly, some scholars see a distinction between whether adaptation to climate change is primarily a question of responding to an amplification of existing threats to public health, or whether it calls for new management strategies in response to distinctly new threats (Hess et al. 2012).

Public health in particular has considerable experience of planning and managing diseases on a multi-decadal timescale ranging from tobacco use management to polio eradication (Vynne and Doppelt 2009). However, the fact is that these have been reactive responses, while tackling future climate threats would require prioritizing anticipated risks in order to bring them into an analytical framework that foresees and plans accordingly. At the same time, it is equally true that populations that do not have access to health care and public health services are more likely to be adversely affected by current climate variability and climate change. (Frumkin and McMichael 2008). Thus, both approaches have to be pursued in parallel. Integrating health adaptation into existing health plans, maximizing synergies across sectors which have implications for health and providing a flexible and context specific approach to health adaptation are key principles of relevance to developing economies, in framing their adaptation plans and policies.

This is also demonstrated by the assessment on the potential for adaptation to key health risks in different regions of the world (Table 1.2). Adaptation prospects for Asia are in building further on disaster preparedness, including early warning systems and local coping strategies, in as much as improving integrated water management and efficiency in use of water resources. The need for vector control programs, water and sanitation programs are also well known for the region. The adaptation prospects lie in both up scaling as well as bringing in new dimensions. Urban planning to avoid heat islands, new work practices to avoid exposure for outdoor labour in heat stress conditions and installing heat health warning systems are new measures for most economies in Asia. Local coping strategies, traditional knowledge and conventional practices are as important as incorporating new ones into health plans for adaptation. It is also equally important to note that risks can be reduced through adaptation, but the extent to which this can be done will depend fundamentally on the extent to which warming takes place by the end of the century. This will determine the most likely overall level of risk for each risk identified for a region, since risks are much higher for the health sector in all regions in a 4 °C warmer world as compared to a 2 °C warmer world. It is also suggestive that the

longer the delay in adaptation, the higher is the cumulative risk level (as indicated by the length of the horizontal bar in the right-most column) for most health sector risks. The striped part of the bar represents the extent to which adaptation can reduce risks. For instance, in Asia adaptation can reduce the risk of increase in vector and water borne diseases from medium to a low level in the near term. In Africa, adaptation interventions can reduce substantially the risk of changes in incidence of water and vector borne diseases from a high level to a low level. Mortality risks from heat can be reduced in Asia from high to medium levels in the near term, but not much is possible through adaptation in the long term under a 4 °C warmer world. This is in contrast to North America, where heat related risks can be brought down through adaptation from very high to a medium level in the long term. Thus, adaptation prospects for human health differ across regions, as much as risks differ across regions. Of course, as discussed, risks will tend to change with socio-economic development and as more clarity develops with regard to uncertainties in climate projections.

Some of the key aspects that the book concerns itself with include the following questions. What is the level of preparedness and capacity of the health care facilities to respond to potential threats from climatic change? What are the key risks to public health in specific contexts? What should be the specific priorities for ensuring sufficient capacity in the health system to respond to these risks? What are the options to reduce current and projected risks based on a prioritization of targets? What policies and programmes can deliver best in managing the risks, reducing risks and building resilience? What capabilities would need to be developed within the public health care system to ensure safer, better prepared and more climate resilient communities?

Appendix 1: Definition of Some Key Terms

- **Adaptation**: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.
- **Incremental Adaptation**: Adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale.
- **Transformational Adaptation**: Adaptation that changes the fundamental attributes of a system in response to climate and its effects.
- **Adaptation Assessment**: The practice of identifying options to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency, and feasibility.
- **Adaptation Deficit**: The gap between the current state of a system and a state that minimizes adverse impacts from existing climate conditions and variability.
- **Vulnerability**: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

- **Outcome vulnerability (End-point vulnerability)**: Vulnerability as the end point of a sequence of analyses beginning with projections of future emission trends, moving on to the development of climate scenarios, and concluding with biophysical impact studies and the identification of adaptive options. Any residual consequences that remain after adaptation has taken place define the levels of vulnerability.
- **Contextual vulnerability (Starting-point vulnerability)**: A present inability to cope with external pressures or changes, such as changing climate conditions. Contextual vulnerability is a characteristic of social and ecological systems generated by multiple factors and processes.
- **Risk**: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard. In this report, the term risk is used primarily to refer to the risks of climate-change impacts.
- **Mitigation (of climate change)**: A human intervention to reduce the sources or enhance the sinks of greenhouse gases.
- **Mitigation (of disaster risk and disaster)**: The lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability.
- **Climate Change**: Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.
- **Climate altering pollutant**: Gases and particles released from human activities that affect the climate either directly, through mechanisms such as radiative forcing from changes in greenhouse gas concentrations, or indirectly, by, for example, affecting cloud formation or the lifetime of greenhouse gases in the atmosphere. CAPs include both those pollutants that have a warming effect on the atmosphere, such as CO_2, and those with cooling effects, such as sulfates.

Source IPCC AR5 WG II Glossary:
https://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-AnnexII_FINAL.pdf.

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