Chapter 2
Climate Change Adaptation: The International Experience in Health

Abstract This chapter presents the current understanding on adaptation needs and its rationale for public health planning. Evolving criteria for guiding adaptation responses and developing an understanding of the economic basis for adaptation decisions are essential for effective adaptation. Historical experiences in adapting to hazards, standard protocols and consensus based international guidelines and learnings from country specific experiences are brought together to frame the domains of an effective adaptation strategy that can address ongoing and new challenges. The role of socioeconomic and technological factors, awareness, political will and institutional capacity in determining the effectiveness of any desired response to vulnerabilities is discussed.

Keywords Adaptation needs · Adaptation capacity · Economic basis for adaptation

This chapter 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. The scientific evidence on the likelihood of climatic change, the associations between climate and health and the concept of adaptation to climate change have been discussed in the opening chapter. Since climate risks and vulnerabilities manifest themselves in many ways that are relevant to the health sector either directly such as through heat events, or indirectly through say, food availability with its attendant implications for undernutrition, it is not surprising that these impacts are already being felt in different parts of the world. Standard epidemiological models of environmental health which are toxicology based are of limited use in assessing and planning health adaptation (Fussel 2008). As a consequence new and relevant research and policy making on how best public health can adapt to climate induced changes has been increasing (Hess et al. 2012). The literature on adaptation for the health sector is reviewed in this chapter, through the lens of public health planning, a persistently important subject for a developing economy context.

© Springer India 2016

P. Dasgupta, *Climate Sensitive Adaptation in Health*,
DOI 10.1007/978-81-322-2824-0_2

2.1 The Need for Adaptation

Drawing from the Intergovernmental Panel on Climate Change (Field et al. 2014) the basic idea of adaptation is to moderate harm or alternatively to exploit beneficial opportunities and is a process therefore of adjustment to actual or expected climate change and its impacts. It implies that there is need to take action since the anticipated risks or already experienced impacts can cause harm to human health. There are two interconnected dimensions to building an understanding on adaptation that addresses the requirements peculiar to a developing 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 future 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 no universally agreed definition of adaptation although there are common elements across the various definitions that have been used either in academia, national policy or international negotiations. Broadly speaking it includes all strategies and responses that can serve to minimize the adverse outcomes arising from climate change. Thus it includes both efforts to increase resilience and efforts to decrease vulnerability to climate change. Vulnerability assessments are a crucial step towards designing adaptation measures. This rationale is also embedded in the reporting that is required from non-annex I countries while submitting their National Contributions to the UNFCCC. India for instance is in the process of its Third National Communication and all of its submissions so far, have had a major focus on sectoral vulnerability assessments. Undertaking vulnerability assessments also requires capacity and resources, financial and institutional, to ensure that these are comprehensive and can lead to effective adaptation strategies.

Adaptation can be autonomous or planned, depending on whether it takes place due to a policy intervention or as a result of individual or community level initiatives, the latter being mostly in the nature of coping responses. Historical evidence on autonomous adaptation has been documented mostly with regard to other sectors such as in agriculture, while there is relatively less on the health sector. From a public health perspective planned adaptation is the primary focus in the present context. It is to be recognised that a specific adaptation strategy, could be planned or not, depending on how it is developed and can provide inputs to the planning process. For instance, a range of strategies that are used at the household level such as use of repellents for safeguarding against vector-borne diseases, or water-purifiers as a preventive measure against water borne diseases, when

incorporated within an awareness raising strategy to adapt against the health impacts of climate change, becomes an example of a planned adaptation option.

Similarly, in some parts of the world it is a common practise to avoid being outdoors during peak temperature hours in tropical climates or during heat wave like conditions. A planned public health response would be to have early warning systems to ensure timely supply of information on heat waves and have in place specific dos and donts such as banning outdoor labour during such time or shutting down of schools during heat stress events. Effective adaptation implies a long term perspective, wherein strategies, plans and resources are put into place well in advance of the expected adverse impacts. Appropriate institutions and responses are also then developed such that in the long run, desirable changes in practise and behaviour are achieved. Vulnerability reduces over time and the ability to adapt or adjust to projected risks of both institutions and individuals increases over time.

2.2 Criteria for Adaptation

Increasingly the understanding of adaptation has moved away from a focus on biophysical aspects, to one of wider social and economic dimensions of vulnerability and improving the capacity of people to respond to challenges. In the health sector, it is felt that the opportunities to adapt are limited by factors such as awareness levels, low capacities to cope, and relatively lesser tools available to respond (Smith et al. 2014). On the flip side, human health features high on the priority of most nations with information and awareness being the primary constraints in planning adaptation. 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, in building the resilience of the health sector in a developing economy such as India.

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 socioeconomic and technological factors and how these 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. As per existing literature, effective adaptation measures for the near-term in situations where basic needs are yet to be met, or resources are scarce, are programs that implement basic public health measures such as provision of clean water and sanitation, secure essential health care including vaccination and child health services, increase capacity for disaster

preparedness and response, and alleviation of poverty. This is also a very high confidence finding from the IPCC (Smith et al. 2014; Hess et al. 2012; Campbell-Lendrum and Corvalán 2007). Progress on innovatively designing adaptive measures has been relatively slow, particularly in the developing countries including India for targeted and climate-specific measures such as heat emergency plans, or regular enhanced surveillance and early warning systems (Field et al. 2014).

To cite from the latest report of the Intergovernmental Panel on Climate Change, based on evidence on adaptation, "findings show that adaptation is highly regional and context specific" (Noble et al. 2014). The more the learnings from different country studies, the more it adds to the knowledge pool to draw upon. For developing countries the adaptation needs are intricately linked with their socio-economic contexts and the existing adaptation deficits. Here, improving public health functions that reduce current adaptation deficits are important for tackling future climate change impacts (Woodward et al. 2011; Pandey 2010).

It also calls for research to create appropriate health policies—that consider not only the domains of modeling and the laboratory: which has dictated most of the climate research on health thus far. In the Indian context, it is time to move towards research that looks at innovative strategies, institutional capacities, public health infrastructure, risk factor analysis and awareness and communication issues that bring value addition to understanding of climate and weather sensitive diseases. This is essential in addressing how to increase adaptive capacity/resilience in the health—climate change interface.

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. Both these aspects need to be brought together to frame the domains of an effective adaptation strategy for the health sector in the context of a developing economy.

2.3 The Economic Basis for Adaptation Decisions

Almost all developing countries devote substantial proportions of financial and human resources in their public health programs to what is termed as climate sensitive diseases. Over the years, a large number of studies from across the world have used tools of environmental economics to evaluate the impacts of changes in the environment on the health sector. This has taken different routes in research studies including calculations of what are popularly termed as costs of illness or health damages, to evaluation of public health programs using methods such as cost-benefit and cost effectiveness analysis. Various techniques of estimating health damages have been used, starting from Grossman's (1972) health production function, with further sophistication and extensions including averting expenditures

to reduce the probability of falling ill as well as incorporating medical expenses incurred (Harrington and Portney 1987; Grossman 2000a, b). There have been several such studies devoted to the analysis of water borne and vector borne diseases in India (e.g. Dasgupta 2004) and other developing countries because of the persistent high rates of prevalence of these diseases world-wide, and the large investment that goes into programs to control these both globally and nationally. There have also been several studies on evaluating the health impacts from air pollution in developing countries using such techniques (Alberini and Krupnick 2000; Choudhary and Imran 2010).

For modeling climate change induced impacts and the adaptation costs of reducing risks, a range of conventional methods in economics have been used across sectors, from simulation modeling to sectoral, standard econometric approaches (Chambwera et al. 2014). However, there are relatively few studies which have applied sophisticated economic modeling for an evaluation of the additional health costs or damages that are attributable to changes in climatic factors. This is primarily due to the complications introduced in developing country contexts, where typically multiple chains of causation complicate the attribution process. As evident from the discussion earlier (see Chap. 1), the bulk of the effort so far has gone into establishing the associations and causations between changes in climatic factors or meteorological variables and its impacts on disease transmission or incidence (Curriero and Rose 2001; Gubler et al. 2001; Kovats et al. 2001; Lu et al. 2009; Chen et al. 2010; Hurtado Diaz et al. 2007; Dhiman et al. 2011). For instance, the relationship between temperature and mortality has attracted attention in several studies (Basu 2009; Barreca 2012; McMichael et al. 2008; Patz et al. 2005).

Among these, very few studies have quantitatively analysed the relationship between changes in climatic factors or weather patterns and disease incidence while explicitly bringing in socio-economic factors. For instance urbanization is often considered as a basis for constructing contexts of vulnerability, although it is not generally an explicit factor incorporated into the analytical process of the model (McMichael et al. 2006, 2008; Hajat et al. 2005) which has a focus on say exploring the relationship between temperature and heat stress and mortality. Similarly others have looked at age and gender specific mortality from temperature change (Abrutzky et al. 2012) or labour productivity impacts (Bosello et al. 2006) or some indicator of socio economic changes (Watkiss and Hunt 2012) thereby acknowledging the role of socio economic factors. Deschenes and Greenstone (2011) is an exception to this literature on climate sensitivity of health, as it uses a one period model of the Becker-Grossman (Grossman 2000a, b, 1972) health production function in estimating the welfare impact of temperature changes for the US. Residential energy consumption is modelled as an adaptation strategy in the relationship between temperature changes and mortality rates.

Estimates of adaptation costs (and benefits) for the health sector are in general not as abundant for different countries and regions, as they are for some other sectors such as sea level rise (Neumann et al. 2010), urban flooding (Ranger et al. 2011) or agriculture (Butt et al. 2006; Sutton et al. 2013). A few studies have concentrated on estimating treatment costs attributable to climate change induced

health impacts for specific diseases. Estimates vary widely depending on the illness and the context.

One notable study (Ebi 2008) focused on global adaptation costs for treatment of diarrhoeal illness, malnutrition and malaria for alternate climate scenarios, explicitly considering the role of socio economic development in the costing exercise. The study estimated that without adaptation, the treatment costs alone for additional cases of these illnesses attributable to climate change, would range between US $4–$12 billion, varying according to assumption made.

Most of these costs were found to be borne by developing countries. Depending on what the assumption on the basic reduction in disease loads is due to development over time, estimates vary on the extent of treatment costs (Pandey 2010) but on the whole these are quite substantial, leave alone the fact that these studies for the most part are only looking at partial costs on the health sector by only considering treatment costs. By and large the larger health sector benefits from adaptation which take note of all the externality benefits of adaptation, or its obverse in terms of the costs of negative externalities from the climate induced impacts, have not been accounted for in studies.

Rigorous quantitative socio economic modeling that explicitly evaluates the health damages from climate change by incorporating socio-economic variables remains a challenge. There is a pressing need for more studies on economic evaluation of the health costs of climate change and the benefits of adaptation both at the community and programmatic scale. These are required to estimate the expected adaptation costs and for making important decisions on prioritizing investments in adaptation for the health sector.

Globally there seems to be agreement on the fact that the currently available funding for adaptation (across all sectors) is much less than what is required, suggestive of a funding gap and a growing adaptation deficit (Field et al. 2014). However, there is much less agreement on the few quantitative estimates available, with the most recent global adaptation costs falling in a range from $70 billion to $100 billion per year globally by 2050.[1] As far as the health sector is concerned, estimates on global adaptation costs for developing countries as a whole vary from about 2 billion to 6 billion US dollars at constant 2005 values (World Bank 2010; UNFCCC 2007). Even where special mechanisms have been provided for, such as in the case of the Least Developed Countries Fund, it is acknowledged that adaptation funding has been far less than needed (LDC Expert Group 2012). An idea of the gaps in availability of financial resources for the health sector can be gauged from recent World Health Organization estimates which show that the current commitments made globally for adaptation in health meet less than 1 % of the annual health costs that will arise from climate change by 2030 (WHO 2013).

[1]Methodological concerns and issues of partial coverage of sectors and regions in these estimates have been discussed in Chap. 3.

2.4 Lessons from International Experience

As commonly acknowledged by researchers, most of the current adaptation programmes in health focus on improvements in existing public health functions which may include enhancing disease surveillance, and improving disaster risk management, among other factors (Woodward et al. 2011). Dynamic complexities are introduced by the fact that both incidence and distribution of climate sensitive diseases are impacted by non climatic factors such as socioeconomic, demographic, land use, urbanization, access to technology and the political context (Suk and Semenza 2011; Ebi et al. 2013). Some of the experiences from the international literature on these aspects of adaptation to climate related health sector impacts are discussed below A number of factors influence the effectiveness of the response to climate change. Some of these are awareness, availability of options, information, skills and technology, political will, availability of human and financial resources, and institutional capacity (see figure below). While alternative frameworks have been developed linking vulnerability with climate change, this framework provides a comprehensive picture of the determinants of climate change adaptation.

In particular the determinants of vulnerability are most relevant to a developing economy context. An integrated view of vulnerabilities along with the capacity to adapt, allows for a delineation of the major domains for an analysis of what international experiences have to offer for creating conditions that lead to building capacity to adapt in the health sector. The analysis below focuses on particular studies that help build key messages of relevance for the health sector (Fig. 2.1).

2.4.1 Governance and Management

Scholars (Hess et al. 2012), have focused and elaborated on the lack of adaptive capacities in place in the public health domain and emphasized on the various strategies and practices that can be implemented to enhance the public sector's adaptive capacity through learning and alterations in management frameworks. Primarily it can be argued that there are two alternative approaches to the issue. One view explains the lack of effort on building adaptive capacity in the public health system in terms of the belief that climate change will exacerbate already known health stresses among the vulnerable populations and can be dealt with to a large extent within the prevailing approach towards health care provisioning and health infrastructure. Another view recognizes the fact that climate change will jeopardize the existing infrastructure of public health and attributes the absence of adaptive capacity to the dearth of innovative strategies to cope with both temporal and spatial differences arising from climate challenges.

The study recognizes the various management challenges in introducing efficient adaptation programs in the form of technological, financial and institutional hindrances. It points towards building capacity among the health systems and focuses

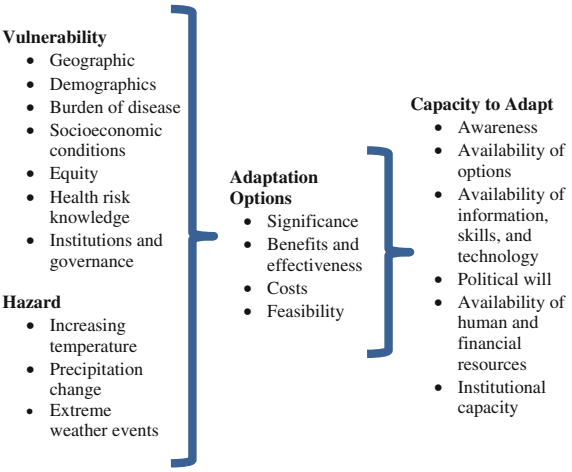


Fig. 2.1 Determinants of climate change adaptation. *Source* Adaptation to the infectious disease impacts of climate change, Ebi et al. (2013). Climatic change, vol. 118 (2), pp 355–365 (permission to reproduce as per: https://s100.copyright.com/AppDispatchServlet?publisherName=Springer&orderBeanReset=true&orderSource=SpringerLink&author=Kristie+L.+Ebi&AuthorEmail=krisebi%40essllc.org&issueNum=2&contentID=10.1007%2Fs10584-012-0648-5&openAccess=true&endPage=365&publicationDate=2012&startPage=355&volumeNum=118&title=Adaptation+to+the+infectious+disease+impacts+of+climate+change&imprint=Springer+Science%2BBusiness+Media+Dordrecht&publication=0165-0009&authorAddress=Stanford%2C+CA%2C+94305%2C+USA)

on the need to develop learning models that can predict and handle uncertainties associated with the various health impacts projected from climate change. It emphasizes the need to develop adaptation management strategies comprising of assessment tools for vulnerable populations, models to project health threats of climate change and decision making tools as it carries sufficient potential to address the public health adaptation issues specifically at the local and regional levels.

2.4.2 Awareness

In an attempt to identify the extent of knowledge and attitudes of public health workers towards growing health challenges caused by climate change, a study was conducted (Polivka et al. 2012), to assess the awareness and perceptions of public health nursing administrators and public health nurses in the health department of United States. Nurses comprise the largest professional workforce in the health institutions and thus can play a vital role in addressing such health threats. The outcome of the study brings forth the available knowledge amongst this workforce on the various dimensions of the link between humans and the environment and their perceptions towards global climate change. Results indicate the prevalence of sufficient knowledge of climate change and its health impacts on vector borne and

air quality related illnesses, along with knowledge about displacement effects and associated mental health conditions caused by frequent and intense floods. In comparison, there is lack of awareness about heat and cold related mortalities and malnutrition associated with climate change. The study concluded that lack of ability and preparedness among health workers to address these health related challenges is one of the major issues. Thus there is an urgent need to educate health care providers not only about the impacts of climate change, but to create and disseminate information on policies and programs that can create confidence and competence for preparedness in tackling the health consequences.

2.4.3 Motivation, Information Availability and Skills

Abaya et al. (2011) assessed the health officials' perceptions and preparedness with regard to climate variability in the Somali region of Ethiopia. The region now experiences high number of cases of malaria and diarrheal diseases which have been attributed to vulnerability from disasters such as floods and droughts. In view of the fact that preparedness against health risks is influenced by the availability of health care institutions, personnel and their understanding of the health impacts of climate variability, the authors analyzed various primary and secondary data sources to elicit information on health impacts attributable to climate variability. Governmental responses to health impacts, available health care resources and knowledge levels among the health officials' regarding the link between climate variability and human health in the study area were considered as important determinants. The study concluded that the region lacked sufficient resources for health care, while governmental health programs and policies were silent on the issue of climate variability. The latter was found to be due to inadequacy of availability of climate data along with poor coordination with the meteorological department. In this case, though general awareness regarding current climate variability and its health threats was found to exist among health officials there was a lack of proactive adaptation strategies. This was attributable partly to a lack of knowledge of the potential and projected long term impacts of climate change.

2.4.4 Options on Resources, Health Policy

Vynne and Doppelt (2009) assessed the awareness, preparation and resource needs of public health employees in Oregon through a primary survey conducted across 35 counties, and including 84 individuals. The results from the survey point to the lack of knowledge and preparedness strategies in most counties and, the respondents' lack of confidence in the health entities capacity to mitigate or adapt to climate related health risks. The resource constraints of budget, staffing, technical expertise, tools and training were recognized as major factors contributing to the

absence of climate change programs in public health. The upgrading of tools and plans that can better disseminate information on local health risks of climate change among the communities and also train extensively the public health employees to deal with health emergencies likely to be triggered by climate change is recommended. To incorporate preparedness for the impacts of climate change on health, as a strategic goal, both local and federal policies play a role.

2.4.5 Training and Knowledge Transfer

A recurring issue in the literature on public health challenges and adaptation with regard to climate risks is the lack of efforts at both national and international levels for education and awareness on climate related risk prevention and reduction. A multiplicity of actors and stakeholders no doubt add to the complexity. Knowledge for action or knowledge translation is a challenge, requiring the development of advanced training for specific groups of actors within the public health system in advanced economies as well (Lapaige and Essiembre 2010). Imparting sufficient training to the health officials in addressing the health impacts of climate change in parallel with improving sanitation and infrastructural facilities such as improving communication and transport linkages to bridge current adaptation deficits, can contribute towards lessening the incidence of both current chronic health risks and also towards better provision of medical facilities in the time of emergencies. It is evident that training and knowledge transfers on the links between long term climate change and reducing current vulnerabilities is also an important component of building resilience and putting in place the motivation for proactively pursuing adaptation in public health responses.

2.4.6 Institutional Capacities, Tools and Finances

Bedsworth (2008) assessed the readiness of various public health institutions in California to deal with the growing health challenges of climate change in the form of heat related mortality and morbidity, adverse health outcomes from increased frequency of air pollution events, and the increasing incidence of vector borne diseases, with available tools at the disposal of the health sector to cope with these health threats. This is an interesting case where measures such as heat emergency plans, air quality information programs, mosquito disease tracking program, and information dissemination programs regarding wildfires and measures are in place. It establishes the keen readiness of the public health sector in California to cope with the threats of climate change. Yet, constraints and limitations are faced in the form of resource constraints as far as personnel, technology and budgets are concerned in building effective adaptation. Lack of information on how to address the

climate health emergencies and interagency coordination failures are concerns that adaptation faces in both developed and developing countries.

Parsons and Hall (2009) examined the response strategies to the health impacts of climate change among 31 Commonwealth countries using the results of a questionnaire based survey. The study highlighted that the health threats of vector borne diseases, heat related mortality and morbidity, and diarrheal diseases are present in all the respondent countries and there is disparity in response measures among these nations. The findings reveal that the health response strategies and programs are in their preliminary stages in almost all the nations. This is true of efforts made in conducting vulnerability assessments, carrying out research, collaborations and dialogues, and developing projects to integrate climate change into the health sector.

2.4.7 Resource Constraints and Infrastructure

The limitations in tackling climate change imposed by resource constraints are admittedly an important determinant of the prioritization that adaptation receives. It is also equally likely that these constraints tend to be magnified in developing economies where current deficits in the public health system are substantial in most countries. Health infrastructure in terms of both adequacy and appropriateness of health care facilities and transport and communications to ensure uninterrupted delivery of health care services, whether in the case of extreme climatic events or in meeting routine health needs is a priority. What is of interest is to recognize that even in a developed country context, there is a felt need for policies that can prioritize climate change impacts when planning for preparedness of the health sector and that there are still substantial gaps in addressing this need.

2.5 The Way Forward: Building Adaptation Capacity

The challenges faced due to lack of financial and human resources, absence of policies, dearth of political support to streamline climate change into health practices, lack of intersectoral coordination and collaboration, along with lack of knowledge and awareness on climate change impacts and adaptation options, continue to hamper the development of adaptation response programs in almost all nations irrespective of their economic status.

Essentially, two strands emerge in the possible directions for adaptation for the health sector: one in terms of having extensions of existing systems to accommodate climate concerns, and the other to invest in innovative adaptation strategies. The implication of the former is that existing public health practices are sufficient, and adaptation for the sector lies in reinforcing investment and making additional funds available for existing essential services (Fussel 2008; Frumkin et al. 2008;

Frumkin and McMichael 2008). As far as adaptation that requires innovation to tackle new threats is concerned, most of it has been reactive, the most familiar examples of which are the ones in response to the occurrence of extreme events. While the two strategies may not be mutually exclusive, these have implications for competing for funding among a list of priorities within public health (Ebi et al. 2009), particularly where basic public health needs have not been met as yet. However, in certain cases, such as where the frequency and severity of hazards is high or likely to increase overall risk, having specific and multiple criteria to identify and address vulnerable populations is called for (Ebi et al. 2006; Keim 2008). In instances of vulnerable areas which are subject to recurrent climatic events such as flooding, there could be erosion of household coping capacity over time (Webster and Jian 2011), and damage to health infrastructure, undermining long term adaptive capacity and increase in cumulative risk (Tapsell et al. 2002). The potential for extreme events to create situations beyond the coping range of a given public health system was amply demonstrated in the case of the European heat wave of 2003. Although the specific context will determine the right mix of the two approaches and the resource allocation priorities thereby, there is need to develop climate sensitivity within the health sector, and intersectoral co-ordination to achieve outcomes on both fronts, i.e. meeting current adaptation deficits and putting in place long term adaptive strategies.

References

Abaya SW, Mandere NM, Winqvist N (2011) Health officials' perceptions of and preparedness for the impacts of climate variability on human health in Somali region of Ethiopia. Mitig Adapt Strat Glob Change 16(5):585–596

Abrutzky R, Dawidowski L, Matus P, Lankao PR (2012) Health effects of climate and air pollution in Buenos Aires: a first time series analysis. J Environ Prot 3:262–271

Alberini A, Krupnick A (2000) Cost of illness and willingness to pay estimates of the benefits of improved air quality: evidence from Taiwan. Land Econ 76(1):37–53

Barreca AI (2012) Climate change, humidity, and mortality in the United States. J Environ Econ Manage 63:19–34

Basu R (2009) High ambient temperature and mortality: a review of epidemiologic studies from 2001 to 2008. Environ Health 8:40

Bedsworth L (2008) Climate change and California's public health institutions report. Public Policy Institute of California. (November). www.ppic.org/contents/pubs/report/R_1108LB3R.pdf. Accessed 11 Nov 2015

Bosello F, Roson R, Tol RSJ (2006) Economy- wide estimates of the implications of climate change: human health. Ecol Econ 58(3):579–591

Butt TA, McCarl BA, Kergna AO (2006) Policies for reducing agricultural sector vulnerability to climate change in Mali. Clim Policy 5(6):583–598

Campbell-Lendrum D, Corvalán C (2007) Climate change and developing-country cities: implications for environmental health and equity. J Urban Health 84(3):109–117

Chambwera M, Heal G, Dubeux C, Hallegatte S, Leclerc L, Markandya A, McCarl BA, Mechler R, Neumann JE (2014) Economics of adaptation. In: Field CB, Barros VR,

Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp 945–977. https://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap17_FINAL.pdf. Accessed 10 Sept 2015

Chen SC, Liao CM, Chio CP et al (2010) Lagged temperature effect with mosquito transmission potential explains dengue variability in southern Taiwan: Insights from a statistical analysis. Sci Total Environ 408:4069–4075

Choudhary T, Imran M (2010) Morbidity costs of vehicular air pollution: examining Dhaka city in Bangladesh. Working paper no. 47–10, South Asian Network for Development and Environmental Economics (SANDEE)

Curriero FC, Rose JB (2001) The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948–1994. Am J Public Health 91(8):1194–1199

Dasgupta P (2004) Valuing health damages from water pollution in urban Delhi, India: a health production function approach. Environ Dev Econ 9:83–106

Deschenes O, Greenstone M (2011) Climate change, mortality, and adaptation: evidence from annual fluctuations in weather in the US. Am Econ J Appl Econ 3:152–185

Dhiman RC, Chavan L, Pant M, Pahwa S (2011) National and regional impacts of climate change on malaria by 2030. Curr Sci 101(3):372–383

Ebi KL (2008) Adaptation costs for climate change related cases of diarrhoeal disease, malnutrition, and malaria in 2030. Glob Health 4:9. doi:10.1186/1744-8603-4-9

Ebi K, Smith J, Burton I, Scheraga J (2006) Some lessons learned from public health on the process of adaptation. Mitig Adapt Strat Glob Change 11:607–620

Ebi K, Balbus J, Kinney PL, Lipp E, Mills D, O'Neill MS et al (2009) U.S. funding is insufficient to address the human health impacts of and public health responses to climate variability and change. Environ Health Perspect 117:857–862

Ebi KE, Lindgren E, Suk JE, Semenza JC (2013) Adaptation to the infectious disease impacts of climate change. Clim Change 118:355–365. doi:10.1007/s10584-012-0648-5

Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) (2014) Summary for policymakers. In: Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change, Cambridge University Press, Cambridge, United Kingdom and New York, USA, pp 1–32

Frumkin H, McMichael AJ (2008) Climate change and public health: thinking, communicating, acting. Am J Prev Med 35(5):403–410

Frumkin H, Hess J, Luber G, Malilay J, McGeehin M (2008) Climate change: the public health response. Am J Public Health 98(3):435–445

Fussel HM (2008) Assessing adaptation to the health risks of climate change: what guidance can existing frameworks provide? Int J Environ Health Res 18(1):37–63

Grossman M (1972) On the concept of health capital and the demand for health. J Polit Econ 80 (2):223–255

Grossman M (2000a) The human capital model. In: Culver AJ, Newhouse JP (eds) Handbook of health economics, vol 1A. Elsevier Science, North-Holland, Amsterdam, pp 347–408

Grossman M (2000b) The human capital model. In: Handbook of health economics, vol 1A. Elsevier Science, North-Holland, Amsterdam, pp 347–408

Gubler DJ, Reiter P, Ebi KL, Yap W, Nasci R, Patz JA (2001) Climate variability and change in the United States: potential impacts on vector- and rodent-borne diseases. Environ Health Perspect 109(2):223–233

Hajat S, Armstrong BG, Gouveia N, Wilkinson P (2005) Mortality displacement of heat-related deaths: a comparison of Delhi, Sao Paulo, and London. Epidemiology 16:613–620

Harrington W, Portney PR (1987) Valuing the benefits of health and safety regulation. J Urban Econ Elsevier 22(1):101–112

Hess JJ, McDowell JZ, Luber G (2012) Integrating climate change adaptation into public health practice: using adaptive management to increase adaptive capacity and build resilience. Environ Health Prespect 120(2):171–179

Hurtado Diaz M, Riojas-Rodrı´guez H, Rothenberg SJ (2007) Short communication: impact of climate variability on the incidence of dengue in Mexico. Trop Med Int Health 12(11):1327–1337

Keim ME (2008) Building human resilience: the role of public health preparedness and response as an adaptation to climate change. Am J Prev Med 35(5):508–516

Kovats RS, Campbell-Lendrum DH, McMichael AJ, Woodward A, Cox JS (2001) Early effects of climate change: do they include changes in vector-borne disease? Philos T Roy Soc B 356:1057–1068

Lapaige V, Essiembre H (2010) Innoversity in knowledge-for-action and adaptation to climate change: the first steps of an 'evidence based climatic health' transfrontier training program. Advances in medical education and practices. Dovepress

LDC Expert Group (2012) National adaptation plans: LDC expert group. UNFCCC Secretariat, Bonn

Lu L, Lin H, Tian L, Yang W, Sun J, Liu Q (2009) Time series analysis of dengue fever and weather in Guangzhou, China. BMC Public Health 9:395

McMichael AJ, Woodruff RE, Hales S (2006) Climate change and human health present and future risks. Lancet 367(9513):859–869

McMichael AJ, Wilkinson P, Kovats RS et al (2008) International study of temperature, heat and urban mortality: the ISOTHURM project. Int J Epidemiol 37(5):1121–1131

Neumann JE, Hudgens DE, Herter J et al (2010) The Economics of adaptation along developed coastlines. Interdisc Rev Clim Change 2(1):89–98

Noble IR, Huq. S, Anokhin YA, Carmin J, Goudou D, Lansigan FP, Osman-Elasha B, Villamizar A (2014) Adaptation needs and options. In: Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 833–868. https://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap14_FINAL.pdf. Accessed 14 Sept 2015

Pandey K (2010) Costs of Adapting to climate change for human health in developing countries. Discussion Paper No. 11, economics of adaptation to climate change (eacc) study, the international bank for reconstruction and development. The World Bank, Washington, DC, USA, p 19

Parsons J, Hall V (2009) Responding to the health impacts of climate change in the commonwealth, in commonwealth health ministers' update 2009

Patz JA, Campbell-Lendrum D, Holloway T (2005) Impact of regional climate change on human health. Nature 438:310–317

Polivka BJ, Chaudry RV, Crawford JM (2012) Public health nurses' knowledge and attitudes regarding climate change. Environ Health Perspect 120(3):321–325

Ranger N, Hallegatte S, Bhattacharya S et al. (2011) An assessment of the potential impact of climate change on flood risk in Mumbai. Climatic Change 104(1):139–167. http://www.lse.ac.uk/CATS/Publications/Publications%20PDFs/85_Ranger_AssessmentMumbai_2011.pdf. Accessed 11 Dec 2015

Smith KR, Woodward A, Campbell-Lendrum D, Chadee DD, Honda Y, Liu Q, Olwoch JM, Revich B, and Sauerborn R (2014) Human health: impacts, adaptation, and co-benefits. In: Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) Climate change 2014: impacts, adaptation, and vulnerability. Part A: global

and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp 709–754. https://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap11_FINAL.pdf. Accessed 12 Dec 2015

Suk JE, Semenza J C (2011) Future infectious disease threats to Europe. Am J Public Health

Sutton WR, Srivastava JP, Neumann JE (2013) Looking beyond the horizon: how climate change impacts and adaptation responses will reshape agriculture in Eastern Europe and Central Asia. World Bank

Tapsell SM, Penning-Rowsell EC, Tunstall SM et al (2002) Vulnerability to flooding: health and social dimensions. Philos Trans Math Soc A. Math Phys Eng Sci 360(1796):511–1525

UNFCCC (2007) Investment and financial flows to address climate change. The United Nations Framework Convention on Climate change, UNFCCC Secretariat, Bonn, Germany

Vynne S, Doppelt B (2009) Climate change health preparedness in Oregon. An assessment of awareness, preparation and resource needs for potential public health risks associated with climate change. Climate leadership initiative. Institute for a Sustainable Environment. University of Oregon with The Oregon coalition of local Health officials, Environmental Health Committee

Watkiss P, Hunt A (2012) Projection of economic impacts of climate change in sectors of Europe based on bottom up analysis: human health. Clim Change 112(1):101–126

Webster PJ, Jian J (2011) Environmental prediction, risk assessment and extreme events: adaptation strategies for the developing world. Philos Trans Math Soc A 369:4768–4797. doi:10.1098/rsta.2011.0160

WHO (2013) Climate change and health: a tool to estimate health and adaptation costs. Regional Office for Europe, World Health Organisation

Woodward A, Lindsay G, Singh S (2011) Adapting to climate change to sustain health. WIREs Clim Change 2(2):271–282

World Bank (2010) World development report 2010: development in a changing climate—concept note. The world Bank, Washington DC

http://www.springer.com/978-81-322-2822-6

Climate Sensitive Adaptation in Health
Imperatives for India in a Developing Economy Context
Dasgupta, P.
2016, XXII, 194 p. 74 illus., Hardcover
ISBN: 978-81-322-2822-6