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CONSIDERATION OF THE RECOMMENDATIONS ARISING OUT OF THE TECHNICAL DISCUSSIONS ON "PROTECTING HUMAN HEALTH FROM CLIMATE CHANGE"

This paper is a summary of the Technical Discussions on" Protecting Human Health from Climate Change", held in New Delhi, 18–21 August 2009. It covers the key issues involved, the consensus obtained during the Technical Discussions and the recommendations emanating thereof.

The paper is now being submitted as information document to the Sixty-second Session of the Regional Committee for consideration of the recommendations arising out of the Technical Discussions on" Protecting Human Health from Climate Change".

Introduction

1. The Twenty-fifth Meeting of Health Ministers of the South-East Asia Region, held in Thimphu, Bhutan in 2007, addressed the issue of climate change impacts on health in the Region. The resulting Thimphu Declaration requested SEARO to support countries in developing national plans and the formulation of a regional strategy to combat the adverse health impacts of climate change. The ministers also proposed to WHO to select "climate change and health" as the topic for World Health Day 2008. They also committed to contribute to national plans and provide the needed funding for that purpose.

2. In November and December 2007, WHO's Regional Office for South-East Asia (SEARO) supported national workshops on human health and climate change in Bangladesh, India, Indonesia and Nepal. The recommendations were to improve intersectoral communication and cooperation to assess vulnerabilities and identify interventions for mitigation and for adaptation; to increase awareness on impacts to health and gather more evidence-based data; to strengthen existing climate-sensitive health programmes, with a focus on early warning systems; and to empower local communities to become climate resilient.

3. In October 2007, the Director-General of WHO selected "Protecting Health from Climate Change" to be the theme of World Health Day 2008.

4. In December 2007, SEARO sponsored a biregional workshop, in Bali, Indonesia, at which government representatives from 22 Asian countries endorsed the "Regional framework for action to protect health from the effects of climate change in Asia and the Pacific". The framework aims to build capacity and strengthen national health systems in countries to protect human health from current and projected risks due to climate change, ensure that health concerns are addressed in the decisions to reduce risks from climate change made by other key sectors, and to reduce the carbon footprint of the health sector itself.

5. In May 2008 World Health Assembly (WHA61.19) Resolution called for stronger action to address the health risks associated with climate change. The WHA requested WHO "to continue close cooperation with appropriate United Nations organizations, other agencies and funding bodies, and Member States, to develop capacity to assess the risks from climate change for human health and to implement effective response measures, by promoting further research and pilot projects in this area, including work on:

(a) health vulnerability to climate change and the scale and nature thereof;

(b) health protection strategies and measures relating to climate change and their effectiveness, including cost-effectiveness;

(c) the health impacts of potential adaptation and mitigation measures in other sectors such as water resources, land use, and transport, in particular where these could have positive benefits for health protection;

(d) decision-support and other tools, such as surveillance and monitoring, for assessing vulnerability and health impacts and targeting measures appropriately;

(e) assessment of the likely financial costs and other resources necessary for health protection from climate change;"

6. The Twenty-sixth Health Ministers' Meeting in 2008 in New Delhi, India passed the "New Delhi Declaration on the impacts of climate change on human health", and requested WHO to support its implementation and report progress thereon

7. The Sixtieth Session of the Regional Committee held in New Delhi, India in 2008 proposed the subject "Protecting Human Health from Climate Change" for the Technical Discussions to be held prior to the Sixty-first Regional Committee Session.

8. Technical Discussions on the subject were held in SEARO, New Delhi, India, 18–21 August 2009. Representatives from 11 Member States of the Region were invited, representing ministries of health as well as ministries of environment, along with experts and centres of excellence from the Region and beyond. The 2008 New Delhi Declaration on the impacts of climate change on human health constituted the main working paper.

9. Participants included 24 representatives from nine Member countries, five experts from SEA Region countries and centres of excellence, four international experts, eleven participants from partner agencies, one participant from WHO Geneva, one each from the India, Indonesia, Maldives, Nepal, Sri Lanka, and Thailand country offices, and ten participants from the WHO Regional Office.

10. Dr R.S. Shukla, Joint Secretary, Ministry of Health and Family Welfare, India, and Dr Babu Ram Marasini, Senior Health Administrator, Ministry of Health and Population, Nepal, and Dr Twisuk Punpeng, Public Health Technical Officer, Department of Health, Ministry of Public Health, Thailand, and Mr Simad Saeed, Member Presidential Advisory Council on Climate Change, Maldives, were elected as Chairpersons, and Mr Gyembo Dorji, Programme Officer, Ministry of Health, Bhutan, and Dr Budi Haryanto, Faculty of Public Health, University of Indonesia, Indonesia, and Ms Nahida Ahmed, Public Health Programme Coordinator, Ministry of Health, Maldives were elected Rapporteurs.

11. Participants discussed the contents of nine technical papers in detail in groups and in plenary. The Technical Discussions concluded with a corpus of recommendations towards accelerating the implementation of the New Delhi Declaration, comprising 17 action points for the Member States and 11 for WHO. The participants to the Technical Discussions also proposed that the Regional Committee may adopt a resolution.

Key issues

12. Climate change will affect, in profoundly adverse ways, some of the most fundamental pillars of health: food, air and water. The warming of the planet will be gradual, but the frequency and severity of extreme weather events, such as intense storms, heat waves, droughts and floods could be abrupt and the consequences will be dramatically felt. The most severe threats are to developing countries, with direct negative implications for the achievement of the health-related Millennium Development Goals, and for health equity.

13. During the last 100 years, human activities, particularly related to the burning of fossil fuels, deforestation and agriculture, have led to a 30% increase in the carbon dioxide (CO_2) levels in the atmosphere, causing trapping of more heat.The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC)[1], states:

14. "Most of the observed increase in globally-averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations;

15. Eleven of the last 12 years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature; and the global average sea level rose at an average rate of 1.8 mm per year from 1961 to 2003. The total rise in the sea level during the 20th century is estimated to be 0.17cm.

16. The AR4 IPCC 2007 report also draws on projections of future changes in climate:

(a) "The projected globally-averaged surface warming for the end of the 21st century (2090–2099) will vary between 1.1 and 6.4 degrees Celsius. The projected rate of warming is greater than anything humans have experienced in the last 10 000 years;

(b) The global mean sea level is projected to rise by 9.88 cm by the year 2100;

(c) It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent; and

(d) It is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and heavier precipitation".

17. At the 5663rd meeting of the United Nations Security Council held at New York, on 17 April 2007, Mr Ban Ki-Moon, United Nations Secretary-General[2], said that, according to the most recent assessments of the IPCC, the planet's warming was unequivocal, its impact was clearly noticeable and it was beyond doubt that human activities had been contributing considerably to it.

18. WHO estimated that the warming and precipitation trends due to anthropogenic climate change of the past 30 years claimed over 160 000 lives every year. In 2000, at least 77 000 deaths attributable to climate change occurred in countries of the South-East Asia (SEA) Region.

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[1] More at : http://www.ipcc.ch/

[2] See: http://www.un.org/News/Press/docs/2007/sc9000.doc.htm

19. A great deal of knowledge already exists related to each of these topics. The 2007 report of the Intergovernmental Panel on Climate Change summarized the state of existing science on the health implications of climate change. The current expert consultation aims to build on these, in order to provide a common understanding of priority research gaps relating to climate change and health.

20. Populations within the SEA Region remain highly vulnerable to a wide variety of health effects from climate change, but are also the fast-growing contributors to greenhouse gas (GHG) emissions. Health impacts will be disproportionately greater in vulnerable populations. In the SEA Region, people at greatest risk include the very young, the elderly, and the medically frail.

21. Local communities with low incomes and living in areas where malnutrition is widespread, education is poor, and infrastructures are weak, will have most difficulty adapting to climate change and related health hazards. Vulnerability is also determined by geography, and is higher in areas with a high endemicity of climate-sensitive diseases, water stress, low food production and isolated populations. The populations considered to be at greatest risk in the Region are those living on islands, mountainous regions, water-stressed areas, mega cities and coastal areas.

22. While community members have a most significant role to play in protecting their health from climate-related threats, the health sector, at international, national and subnational levels, has a responsibility, political leverage and staff with many of the necessary skills to help protect the health of local communities.

Technical discussions

23. All Member States recognized the findings of the 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) on the anthropogenic nature of global warming due to the historical accumulation of greenhouse gases in the atmosphere and the climate implications thereof, and in particular the projected direct and indirect harm that climate change has on the health of communities in the countries of South-East Asia.

24. Member States shared evidence and experiences at regional and national level on the health impact from climate change and mitigation and adaptation thereto.

25. Consensus was reached that there is an urgent need for action by the national governments, and in particular the health sector, to reduce the climate change impact of climate sensitive health determinants such as heat and cold, floods and droughts, food security and water availability, and the effects of these on health conditions such as heat stress and strokes, respiratory illnesses, vector-, water- and food-borne diseases, malnutrition, and mental well-being, which will primarily affect the health and livelihoods of the most vulnerable populations.

26. Member States reviewed the scientific evidence on the impact of climate change on health and recognized the current challenges in terms of poor research capacity, limited data quality, lack of robust research protocols to assess the full dimensions of the burden of disease linked to climate change, the uncertainty linked to vague projections on greenhouse gas emissions, and the need for estimates of the increased health costs linked to climate change;

27. Member States identified research gaps in protecting human health from climate change and developed a draft agenda for operational research in the Region.

28. Given that climate change impact will vary from location to location, therefore the most effective preventive and adaptive action will need to be developed and implemented with the active participation of local communities.

29. Consensus was reached that these challenges can only be overcome by fostering partnerships and collaborating with governmental, nongovernmental and especially community-based actors, and on the fact that a robust capacity to respond to the climate change threats by the health sector can only be achieved by the allocation of additional funding.

30. Member States recognized the significant and varied efforts undertaken and results achieved by national authorities in the countries and by the health sector, as well as by the WHO-SEARO–based Working Group "Protecting Health from Climate Change" to prepare and implement national and regional climate action plans.

31. The Technical Discussions concluded with the following recommendations:

For Member States

It is recommended that Member States should:

(1) Accelerate the implementation of climate change–related actions as committed to in the 2008 New Delhi Declaration;

(2) Appoint and allocate resources for the functioning of a specific climate change and health team in the ministries of health;

(3) Develop a communication strategy to increase the awareness of policy-level officials within and outside the health sector, health professionals and health workers, non profit NGOs, community organizations, corporate and business sectors and media;

(4) Increase awareness of the health consequences of climate change and the need for urgent action within and outside the health sector;

(5) Build up the capacity of health professionals and health workers—but also of professionals in other related sectors—to proactively address the impacts and challenges posed by climate change to health;

(6) Collaborate with national authorities to introduce climate change and health dimensions into education curricula at all levels, in particular medical schools, to strengthen the capacity of professionals in other sectors;

(7) Develop and implement a prioritized national agenda for applied research on selected essential topics (see Annex 2), to assess the scale and nature of health vulnerability to climate change, making use of the best performing available assessment tools, with the aim to prepare action plans to reduce the burden of disease and the economic impact of climate change;

(8) Map the available resources (including human resources), identifying ongoing programmes and national research institutions (see Annex 3), to conduct priority studies, using a standardized research methodology and ensuring that research findings/results are disseminated in a timely, efficient and user-friendly manner;

(9) Strengthen the surveillance of climate-sensitive health determinants and health outcomes to improve the efficacy of early warning systems and increase the availability of reliable databases on climate change–related health problems for risk assessment purposes;

(10) Actively support the empowerment of local communities to become more climate change–resilient, fostering cross-disciplinary partnerships and collaboration with other key sectors, such as environment, agriculture and education, as well as with nongovernmental organizations, in particular with youth groups and consumer organizations;

(11) Recognize gender, fairness and equity when developing and implementing preventive and adaptive measures, which should also enhance health equity and the welfare of women;

(12) Promote and support community leadership and participation in mitigation measures that also improve health, and integrated adaptation actions that reduce the adverse health impacts of climate change at the local, national and global levels;

(13) Ensure synergy between health scientists and meteorologists and strengthen regional cooperation;

(14) Collaborate with non-health sectors to assess health co-benefits and potential negative consequences deriving from mitigation and adaptation measures undertaken outside the health sector;

(15) Ensure the active participation of health representatives in processes to develop and implement national climate action plans, as well as in international forums such as the relevant bodies of the United Nations Framework Convention on Climate Change (UNFCCC), in order to advocate that priority be given to addressing health issues;

(16) Prepare and implement a national plan to reduce the carbon footprint of the health sector;

(17) Develop a strategy to fund health-related climate action plans.

For WHO

It is recommended that WHO should:

(1) Identify and include all relevant climate change and health implications in the WHO 2010-2011 action plans;

(2) Ensure that health and climate change dimensions are included in the efforts to revitalize the primary health care (PHC) agenda and programmes aimed at strengthening health systems;

(3) Recommend SEA Region countries to mainstream climate change–related health issues into the health sector reform agenda;

(4) Direct the SEARO-based Working Group on "Protecting Health from Climate Change" to set up a comprehensive regional mechanism involving all countries and WHO offices to:

(a) Create and update an inventory of the ongoing research programmes relevant expertise in the Region;

(b) strengthen regional networking and cooperation to exchange and share evidence-based data and information on climate-sensitive diseases and health problems;

(c) create a mechanism to discuss the findings and future plans to avoid duplication;

(d) address health issues related to climate change by supporting the development and use of tools and methodologies to assess health vulnerability;

(e) strengthen local skills to find solutions to health threats posed by climate change through capacity development involving local communities and using robust monitoring and evaluation mechanisms;

(f) attract potential partners and interest them in networking with WHO's efforts in the domain of common interest;

(g) identify existing WHO Collaborating Centres in the Region who could undertake research in priority areas and short-list institutions to become new WHO collaborating centres in the SEA Region in the area of human health and climate change.

Annex 1

Research institutions in SEAR countries undertaking research on climate change impact on health

Area of research/Institute	Research activities
Diarrhoeal Diseases (water and food-borne)	
International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR) Dhaka, Bangladesh www.icddrb.org	Collaborative research in areas of (1) diarrhoeal diseases of diverse etiologies and (2) impact of a community-based integrated management of childhood illnesses (IMCI) **and** nutrition.
National Institute of Cholera & Enteric (NICED), Kolkata India- http://www.niced.org/	In-depth epidemiological and operational research in diarrhoeal diseases of diverse etiologies. Retrospective and prospective studies to assess the impact of climate change on cholera
Asian Institute of Technology, Bangkok,Thailand http://www.ait.ac.th/	Basic and applied research on health and quality impacts of community water supply, waste disposal, and air quality related interventions and actions
Nutrition and Food Safety	
National Institute of Nutrition (NIN) Hyderabad, India http://www.ninindia.org	**Determining the social, cultural and environmental factors leading towards healthy dietary practices**
National Nutrition Monitoring Bureau of NIN http://www.nnmbindia.org	Promotion of nutrition and intervention research to combat different forms of malnutrition
Department of Foods and Nutrition, Faculty of Home Science in Maharaja Sayajirao University, India http://www.msubaroda.ac.in/	Generating dynamic state wise database on diet and nutritional status of the communities
Indian Agriculture Research Institute, New Delhi, India www.iari.res.in	Estimation of crop production in view of climate change in India
Centre for Research and Development in Food and Nutrition, Jakarta, Indonesia www.seameo-rccn.org	Assessing micronutrient malnutrition in the Indonesian population and is generating evidence for developing innovative strategies for combating micronutrient malnutrition

Area of research/Institute	Research activities
Institute of Nutrition, Mahidol University, Bangkok, Thailand http://www.inmu.mahidol.ac.th/eng/	Community nutrition and food safety – generating database on nutrition values of Thai foods; evaluation of nutrition status, micronutrient assessment, metabolism and interventions; development of nutrient-rich rice strains and research studies on practical ways of solving food safety problems in products developed by small and medium producers.
Vector-borne Diseases	
National Institute of Malaria Research, New Delhi, India ttp://www.mrcindia.org	Impact of climate change on malaria and dengue; develop framework for adaptation measures for malaria control under climate change scenario; development of tool for early warning of malaria through international collaboration; burden of vector borne diseases following tsunami
Vector Control Research Centre, Pondicherry, India http://www.vcrc.res.in	
Centre for Research In Medical Entomology, Madurai, India www.icmr.nic.in	
National Institute of Virology, Pune, India www.niv.co.in	Basic and applied research in the field of arbovirus (arthropod borne or arthropod transmitted viral diseases) including dengue fever; development of models for prediction of viral epidemics
Department of Medical Research, Myanmar http://www.moh.gov.mm/	Basic and applied malaria research activities which support diagnosis, treatment, prevention and control of malaria; studies on effective and sustainable vector control measures
Malaria Research Division, Institute of Health Research Chulalongkorn University, Bangkok, Thailand http://www.ihr.chula.ac.th/e4.html	Biological characterization of malaria
The Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand http://www.tm.mahidol.ac.th/eng/	Molecular and field studies related to malaria and dengue fever.

Area of research/Institute	Research activities
Health System Development/Adaptation strategies	
National Institute of Preventive and Social Medicine (NIPSOM), Dhaka, Bangladesh http:/www.nipsom.org	Creation and collection of evidence base for services, education & policy in the area of Public Health
Institute of Public Health Administration, Ministry of Health, Democratic Republic of Korea http://www.dprk.searo.who.int/EN/Section17_21.htm	Development of model of PHC-based district health system
Indian Institute of Health Management and Research, Jaipur, India http://www.iihmr.org/	Organization and management of health systems based on primary health care with particular emphasis on district health system in urban and rural districts and quality assurance in health care
Tata Institute of Social Sciences, Mumbai http://www.tiss.edu	Understand dynamics of utilization of research in health policy formulation & implementation and utilization
Indian Institute of Management, Ahmedabad, India www.Iimahd.ernet	Sociological research and adaptation measures in view of threat of climate change
The Energy Research Institute, New Delhi, India www.teri.res.in	
MS Swaminathan Research Foundation, Chennai, India www.mssrf.org	Vulnerability Assessment and adaptation strategies
Health Economics Research Unit Chulalongkorn University, Bangkok, Thailand http://www.md.chula.ac.	Quantitative and qualitative research towards a global standard in health excellence
Epidemiological Studies	

Area of research/Institute	Research activities
National Institute of Communicable Diseases, New Delhi, India http://nicd.org/	Operational research on the application of new epidemiological tools and the development of cost effective disease surveillance and control strategies.
National Institute of Epidemiology, Chennai, India http://icmr.nic.in/pinstitute/nie.htm	Intervention studies, disease modeling, health system research, evaluation of health schemes and issues of statistical methodology, epidemiological investigations and clinical trials on traditional medicine.
Bureau of Epidemiology, Ministry of Public Health Bangkok, Thailand http://203.157.15.4/	Outbreak investigations and respond to emerging and re-emerging diseases; studies on surveillance systems with emphasis on tropics relevant to public health needs and emerging and reemerging diseases.
Occupational/environmental Health	
National Institute of Occupational Health, Ahmedabad, India http://icmr.nic.in/pinstitute/nioh.htm	Health impacts of indoor and ambient air pollution on human health; basic and applied research in the field of heat stress
Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh http://www.bcas.net/	Sustainable development at local, regional, national and global level.
Bureau of Occupational and Environmental Diseases, Ministry of Public Health Bangkok, Thailand http://occ.ddc.moph.go.th	Assessing health impact occupational and environmental pollutants. Molecular mechanisms of toxic pollutants including air pollution.
Chulabhorn Research Institute , Bangkok, Thailand http://www.cri.or.th/en/	
National Physical Laboratory, New Delhi, India www.nplindia.org	Developing models to compute health impact indoor and ambient air pollution on human health
LRS Institute of TB and Respiratory diseases, New Delhi, India www.lrsitbrd.nic.in	
Ramachandra Medical College and Research Institute, Chennai, India http://www.srmc-ehe.org.in/	
National Environmental Engineering Research institute, **Nagpur, India** www.neeri.res.in	

Annex 2

List of essential topics for priority studies on relationships between climate change and human health

General health risk assessments and vulnerability mapping

- Base line data for current dynamics of health outcomes vis a vis climate events such as heat waves, droughts, floods, sea level rise and evaluation of future projections taking into account the IPCC scenario based predictive models;
- Economic estimation of increased health costs due to climate change impact;
- Specific health vulnerability of children and pregnant women and of the poor living in urban settings;
- Effects of the Atmospheric Brown Cloud (ABC) on food production, water availability and rainwater quality;
- Climate change impact on the health of mountain communities in the Hindu-Kush Himalayan Region and depending on the ecosystem delivery for their livelihood;
- Special vulnerabilities and limited adaptation options of remote mountainous populations entirely dependent on delivery of ecosystem services;
- Biodiversity availability and sensitivity of medicinal plants;
- Evaluation of potential and limitations of community-based research and of indigenous knowledge- based coping mechanisms to protect health from climate change;

Food security and malnutrition

- Linkages between nutritional status, climate and climate change;
- Biodiversity availability and sensitivity of coral reefs;
- Sustainability and availability of marine food products, particularly tuna;
- Impact on food safety due to microbial growth from increased temperature;

Occupational health

- Morbidity and mortality records during heat waves and evaluation of future projections taking into account the IPCC scenario based predictive models;
- Health impact from increased exposure and use of pesticides
- Identification of high risk groups to occupational hazard of rising temperatures (indoor and ambient);
- Understanding risk and toxicity of chemicals to workers;

Air quality

- Impact from forest fires, pollens and chemical air pollutants on respiratory health conditions;

Physical injuries

- Vulnerability to increase in physical injuries linked to climate related extreme events;
- Tracking and monitoring of flood related drowning;

Mental well being

- Mental health consequences from climate change;

Vector borne diseases

- Bionomics of disease vectors in relation to climate change and effects on disease patterns;
- Eco-epidemiological stratifications of temporal and spatial, particularly altitudinal distribution of primary and secondary vectors, and related behavioural changes;
- Probability, potential impact of cross-over resistance to insecticides in relation to an increased use of insecticides chemicals in agriculture and in public health and proposal of adaptation measures;
- Operational research on promising vector control approaches and methods;
- Evaluation of community-based integrated vector and pest management systems as coping strategies to reduce potential increase of disease vector and pest pressures;
- Impact of changes in temperature/precipitation on infectious agents in vectors and on their predators;

Water and sanitation

- Water quality monitoring assessment with special reference to microbial and microbiological contamination in relation to ambient temperatures and in reference to impact of floods and evaluation of future projections taking into account the IPCC scenario based predictive models;
- Better understanding risks to water quality linked to accelerated urbanization;
- Study on risks to water quality linked to increased aquaculture;
- Study of integrated water resources management methods as adaptation mechanisms to climate change effects;
- Dynamics of thermal stratification of stagnant water bodies, and impact of water safety with increasing temperatures;

Annex 3

Overview of key research findings relating to climate change and health impact, carried out in SEAR countries

Research topic / findings	Reference
Diarrhoeal Diseases	
A study conducted in Pune (**India**), based on hospital cases of diarrhoea and meteorological data using Auto Regressive Integrated Average model. Rotavirus diarrhoea cases coincided with annual change of climate. It was inversely proportional to temperature and also linked with days of trade winds	[i]
A strong evidence for an increase in rotavirus diarrhoea at high temperatures, by 40·2% for each 1°C increase above a threshold (29° C) was reported from Matlab **Bangladesh**.	[ii]
In **Bangladesh**, several studies describe a regular seasonal cycle for cholera outbreaks, including specific studies on the different strains of *V. Cholera*	[iii] [iv] [v] [vi] [vii]
This seasonal pattern of cholera in **Bangladesh** is correlated with sea-surface temperatures in the Bay of Bengal and with seasonal plankton abundance (blue green algae/copepods- the possible environmental reservoirs of the cholera pathogen, *V. cholerae*).	[viii] [ix] [x] [xi] [xii] [xiii] [xiv]
Flood and cyclone related increases in diarrhoeal disease have also been reported in **India and Bangladesh**.	[xv] [xvi] [xvii] [xviii]
The Energy and Resources Institute, New Delhi (http://www.teriin.org/) and NICED, **India**, have undertaken research project to examine the potential relationship between climate change and diarrhoeal diseases, assess the vulnerability and adaptability and evaluate the economic impact.	[xix]
Malnutrition and food safety	
A study in **Bangladesh** found that drought and lack of food were associated with an increased risk of mortality from a diarrhoeal illness	[xx]
In Gujarat, **India**, during a drought in the year 2000, diets were found to be deficient in energy and several vitamins. In this population, serious effects of drought on anthropometric indices may have been prevented by public-health measures. Malnutrition increases health vulnerability.	[xxi]
Studies following severe drought in 2003 in Western Rajasthan, **India**, showed high prevalence of protein-energy malnutrition and micronutrient deficiencies amongst children under 5.	[xxii] [xxiii] [xxiv]

Research topic / findings	Reference
A study in rural children **in Bangladesh**, aged less than 2 years, during pre- and post-1987 monsoon flooding revealed an adverse effect of flood on nutrition and the effect was dependent on sex of child and intake of vitamin A.	xxv
The following projections have been made for **India** in crop production in view of climate change: ▪ Two to 5% decrease in yield potential of wheat and maize for a temperature rise of 0.5 to 1.5°C. ▪ For every 75 ppm increase in CO2 concentration, rice yields will increase by 0.5 t ha-1, but yield will decrease by 0.6 t ha-1 for every 1 °C increase in temperature. ▪ In Rajasthan, a 2°C rise in temperature was estimated to reduce production of Pearl Millet by 10-15 %. ▪ If maximum and minimum temperature rises by 3°C and 3.5°C respectively, then soya bean yields in M. P. will decline by 5% compared to 1998. Agriculture will be worst affected in the coastal regions, as fertile areas are vulnerable to inundation and salinisation.	xxvi
In view of projected reduction in wheat and rice productions, malnutrition is likely to be experienced in some states in **India**. A model of vulnerability of different states of India to Climate change taking into consideration of various factors was developed. The Vulnerability-Resilience Indicator Prototype or VRIP model has been applied to the 26 Indian states on the basis of following indicators such as: economic capacity, human and civic resources, environment capacity, settlement/infrastructure sensitivity, food security, ecosystem sensitivity, human health sensitivity and water resource sensitivity and found that only 3 states more vulnerable than India as a whole, 23 states less vulnerable, and 9 states showing resilience.	xxvii, xxviii
Vector-borne Diseases	
Study undertaken under the aegis of NATCOM I, **India**, on the Impact of climate change on malaria in India revealed that most of the states particularly in north, show fluctuations in malaria cases over the months and are vulnerable to climate change. The states of Uttar Pradesh, Uttaranchal, Rajasthan, Madhya Pradesh, parts of Karnataka, Gujarat, Maharashtra and Andhra Pradesh and Brahmaputra valley are vulnerable to malaria epidemics which usually occur due to change in meteorological conditions. Transmission windows of malaria in view of projected rise in temperature at coarse level were determined.	xxix
India: Projection of malaria using IS92a emission scenario driven by HadRM2 projections (at 50 x 50Km resolution) of daily temperature and RH for year.	xxx

Research topic / findings	Reference
2050.	
Models based on distribution and vectorial capacity of malaria vectors have projected 2-5 times changes in epidemic potential for *P. falciparum* malaria with 2-4^0 C increase in temperature; highest changes are projected for high altitudes.	xxxi
Potential dengue transmission areas under climate change scenario, overall, with 4^0 C rise in temperature, dengue transmission may be 2-5 times more with new transmission areas in northern sub **Himalayan region** and in southern most areas of **India** have been projected. With 2^{0}C rise in temperature there is possibility of one-week increase in transmission in New Delhi, India, while with 4^{0}C increase, the transmission may be reduced to 34 weeks. In Calcutta (now Kolkata) currently dengue transmission takes place for 44 weeks. With 2 and 4^{0}C increase in temperature, transmission may continue for 53 weeks.	xxxii
The case study in **India** indicates that sustainable development variables may sometimes reduce the adverse impacts on the system due to climate change alone, while it may sometimes also aggravate these impacts if the development variables are not managed well and therefore, they produce a negative impact on the system. Well crafted and well managed developmental policies could result in enhanced resilience of communities and systems, and lower health impacts due to climate change.	xxxiii
Respiratory diseases	
A report on retrospective analysis of urban air pollution data with a focus on particulate air pollution from 1993 to 2002 in Delhi, Kolkata, Mumbai, Hyderabad and Chennai, **India,** highlights the Progress and Challenges in urban air quality management in India	xxxiv
Occupational Health	
Studies done in small glass bangle, ceramics and brassware industries in India showed radiant heat exposure exceeding 50oC. Further there was significant rise (about 2.5oF) in oral temperature and the measurement of the psychological responses showed impairment of immediate memory, significant effect on the visuo-motor coordination and vigilance and downward trend in visual perception indicating their increased accident proneness. Analysis of accident data in textile industry showed that the hottest part of the year (May - September) had the greatest number of accidents per employee. A study on beedi (hand rolled cigarettes) showed 9% loss of production per degree of ET increase.	xxxv, xxxvi, xxxvii, xxxviii, xxxix, xl
Experimental studies in healthy volunteers in climate control chamber with varying workload comparable to the industrial conditions described above were carried out at National Institute of Occupational Health, Ahmadabad, **India.** These studies showed (1) rise in core body temperature up to 2oC and	xli, xlii, xliii

Research topic / findings	Reference
simultaneous rise in skin temperature and sweat rate 3 -7 times above threshold limit indicating imminent danger. (2) The dangers from the heat load could be reduced by reducing work load and increasing intervening rest periods.	
Studies in **Bangladesh and Asia** have reported heat stroke amongst metal workers and cycle rickshaw drivers suggesting that the long term continuous exposure to heat does not necessarily produce acclimatization.	[xliv] [xlv]
The mortality due to heat waves in **India** has been compiled by De and Mukhopadhyay (1998) for the period from 1979 to 2004. Recently Akhtar (2007) has reviewed the mortality due to heat wave in India and found that heat waves occur in the month of March to June. Maximum deaths (1658) occurred in the year 1998. Andhra Pradesh, Orissa, Punjab, Uttar Pradesh, Rajasthan, Bihar and Madhya Pradesh suffer the most. National Physical laboratory, Delhi is working on assessment of heat stress in view of climate change.	[xlvi] [xlvii]

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