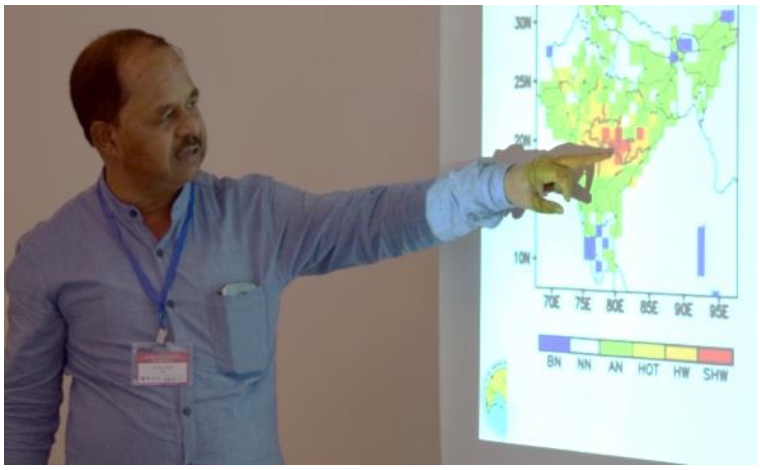
1st South Asia Climate Services Forum for Health (CSF-Health)

# IMPROVING

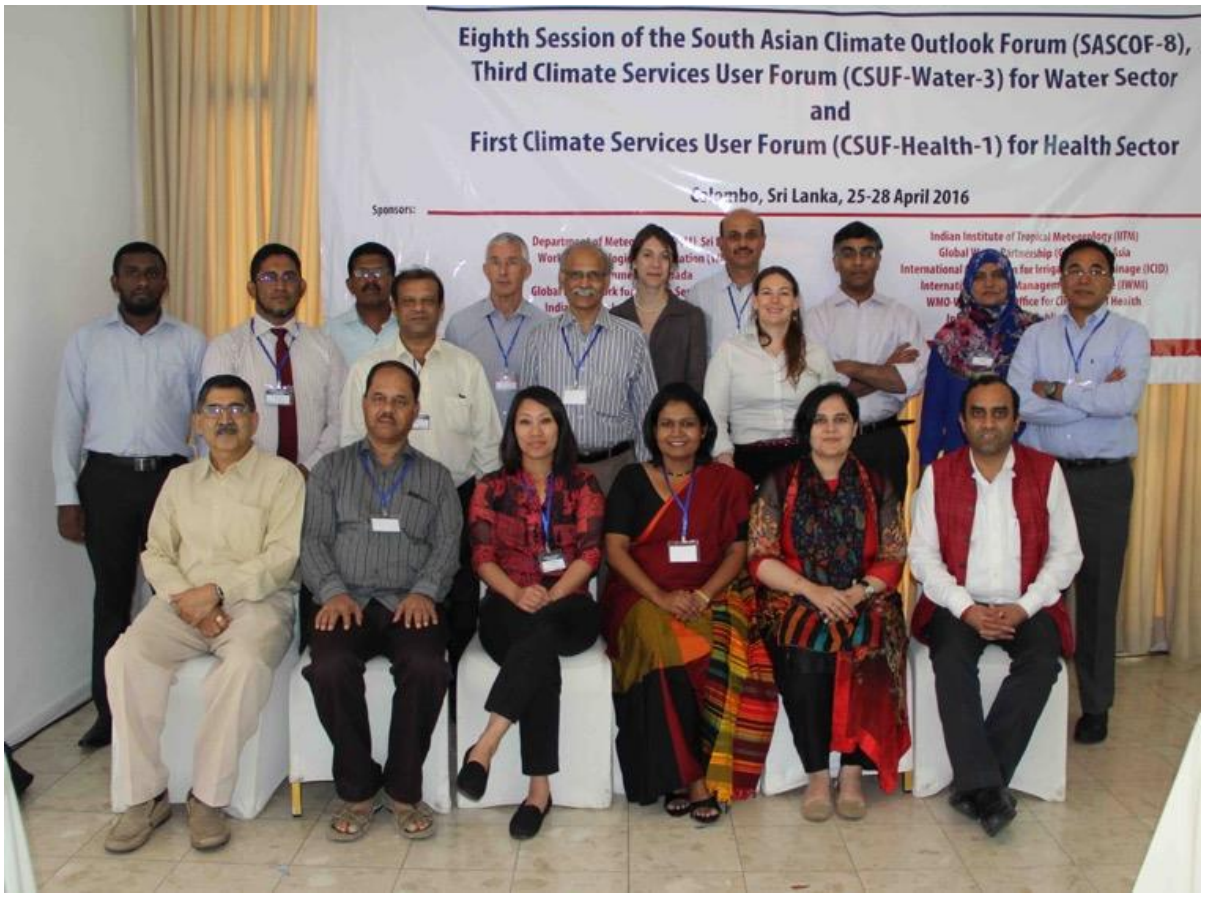
# HEALTH PREPAREDNESS FOR EXTREME HEAT EVENTS

# IN SOUTH ASIA




## MEETING REPORT

Colombo, Sri Lanka | 26-28 April, 2016




Climate Service Forum – Health Participants

## ACKNOWLEDGEMENTS

The organizers and participants acknowledge the great support which came together to make this event possible. Notably, the WHO-South East Asia Regional Officeand WHO-Eastern MediterraneanRegional Office for facilitating participation from the region; the US Interagency climate and health working group (NIH – NOAA – CDC) for coordination and planning support; the IRI technical support to IITM for the development of the first experimental 3-week heat outlook for South Asia, to the IIPH-G for guiding technical discussions based on their pioneering experience; and to the UCHAI network for continued support to communicate meeting findings and promote future activities. The organizers and participants wish to particularly thank the WMO and Government of Canada funding for the meeting; and the Sri Lanka Meteorological Department for ensuring successful meeting logistics.

Report prepared by: WHO-WMO Joint Office for Climate and Health, with review from all participants.

27/06/2016

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ACRONYMS

| | |
|---|---|
| BMD | Bangladesh Meteorological Department |
| CDC | US Centers for Disease Control |
| CSF-H | Climate Service Forum for Health |
| DRR | Disaster Risk Reduction |
| DHIS-2 | District health information system Version 2 |
| EHE | extreme heat events |
| EWS | early warning system |
| HHAP | heat health action plan |
| HAP | heat action plan |
| HHWS | heat health warning system |
| IFRC | International Federation of the Red Cross Red Crescent Societies |
| IIPH | Indian Institute of Public Health - Gandhinagar |
| IITM | Indian Institute of Tropical Meteorology |
| IMD | Indian Meteorology Department |
| IRI | International Research Institute for Climate and Society at Columbia University, USA |
| MOH | Ministry of Health |
| NOAA | US National Oceanographic and Atmospheric Agency |
| NDMA | National Disaster Management Authority - India |
| NHMS | National Hydrological and Meteorological Service |
| NIHHIS | National integrated heat health information system |
| ORS | oral rehydration solution |
| SST | sea surface temperature |
| Tmin | minimum temperature |
| Tmax | maximum temperature |
| UCHAI | Understanding Climate and Health Associations in India |
| VBD | vector borne diseases |
| WBGT | Wet bulb globe temperature |
| WHO | World Health Organization |
| WMO | World Meteorological Organization |


CSF-Health Photos: [L-R top row] Dr. Mavalankar and Dr.R.K. Kolli; Dr. Partha Ganguly; [L-R middle row] Dr. Simon Mason and Dr. Joy Shumake; Dr. M. Nosheen, Dr. Asma Ibrahim, Dr. Mavalankar, Dr Azhar Ghouse; Dr. Hannah Nissan; [L-R bottom row] Dr. Partha Ganguly, Dr. Chowdhury, Dr. N. Dogra; Dr. Shubhayu Saha, Dr. Washeed, Ms. Rada Dukpa.

## BACKGROUND

The issue of climate change has come a long way from being discussed in exclusive platforms of meteorologists and environmental scientists. The impacts of climate variability and change on human health and development has been recognized and discussed widely over last few years across the globe. The Intergovernmental Panel on Climate Change (IPCC), in its fifth assessment report, has clearly documented the growing body of worldwide evidence linking climate change with human health including its proximal determinants, and noting climate change has immense potential to worsen the already existing inequities. Many communities particularly across Asia and Africa, with existing health and development challenges, are particularly vulnerable to negative impacts of climate and weather extremes, expected in a changing climate.

Evidence shows climatic conditions influence important health outcomes, including nutrition, vector borne and water borne diseases, respiratory and airborne diseases, consequences of heat and cold wave exposure, disaster related injury and deaths, and mental health. Furthermore, climate change is expected to influence essential social and environmental health determinants like adequate and safe water, food, and air; migration, societal structures, etc. with wide-ranging social and economic implications. The Government of India in 2010, in a 4x4 assessment report of the Ministry of Environment and Forest, recognized health as one of four priority areas for adaptation, resulting in various State Action Plans for Climate Change. The Governments of Sri Lanka, Bangladesh, Bhutan, and Maldives, also have similar national policies identifying the importance of health in National Climate policies.

A fundamental part of adapting to climate change is managing climate risks through efforts to build capacity, partnerships, and experience to use climate and weather information that allows professionals and the public to better understand and monitor risks, and to inform preparedness and practical action. Climate informed decisions can save money and lives by assisting health systems to better anticipate problems and prevent health impacts of extreme weather events.

The South Asia Regional Climate Outlook Forum (SASCOF) brings together the meteorological authorities of Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, Myanmar, Sri Lanka and Maldives to create a consensus-based seasonal forecast for the region. This forum is convened every six months throughout the region, creating an excellent opportunity for climate-sensitive sectors, such as health, to meet with experts and discuss local climate conditions, and learn how to use available forecasts and outlooks of climate and weather conditions, and discuss how more useful applied decision tools can be developed and used.

In 2015, multiple countries across South Asia experienced the traumatic and devastating effects of a heat wave which took thousands of lives and stressed critical social systems. In response, this first Climate Services Forum for Health (CSF-Health) will bring health and meteorological partners from across the South Asia region to focus on how to improve the management of extreme heat events in South Asia. The two-day meeting aims to review current experiences and capacities, and particularly draw upon successful city-scale heat action plans in India, in order to inform how more health-friendly heat forecasts can be developed and encourage the scale up of city scale heat-health action plans in the region. These new partnerships of health and climate actors, aim to be maintained and evolve to address other important issues in the future such as air pollution and water borne diseases.

## EXECUTIVE SUMMARY

The health risks of extreme heat events (EHE) are an emerging priority in the South Asia Region. Consecutive extreme heat seasons in 2015 and 2016 resulted in thousands of deaths, a range of heat stress and dehydration related illnesses, losses in productivity, and overburdening of health systems, particularly in India and Pakistan. These EHE are part of the observed trend that the numbers of warm days and nights have increased across most of Asia since about 1950, and heat wave frequency has likely increased since the middle of the 20th century in large parts of Asia (IPCC AR5, WGII-24)[1]. These high impact events, along with the observed trends and projections have catalyzed the public health community to improve the evidence base of heat-health impacts, and advocate for accelerated national, state, and local action.

In response to the recognized high risks and potential impacts of extreme heat in South Asia, the 2016 CSF focused on heat health and brought together over 25 experts in public health, climate and meteorology to discuss the needs and opportunities for multi-sectoral collaboration to better understand and address these health risks in the region.

This meeting contributes a regional perspective to a global discussion on the state of the science and practice in heat health action. Under the leadership of the US-NOAA and German Deutscher Wetterdienst (DWD), a global coalition of meteorological experts and health practitioners came together in Chicago in July 2015 to consider three issues. First, to identify knowledge gaps in our understanding of heat exposure and health outcomes across different timescales and geographies; along with the observations, monitoring, data, and forecast product needs. Secondly, to synthesize existing heat health forecasting systems being used around the world and to consider if their prediction parameters correspond to health sector requirements for preparedness. Thirdly, to identify specific partnerships, dialogues or processes needed to improve existing heat health early warning systems and develop heat related climate services for the public health sector to improve community resilience. The need for support and action in South Asia was highlighted at this meeting, and the CSF-Health dialogue and recommendations will feed back into the global effort to increase capacity and action in this region.

**Climate related health risks are varied and significant in South Asia.** The health sector in the South Asia region faces a range of diverse climate-related challenges related to each country's geographic location and health profile. Challenges range from Glacial Lake Outburst Floods from the high Himalayas of Bhutan, to sea-level rise in the Maldives, a Small Island Developing State, and in low-lying Bangladesh. Common health priorities across the region included the widespread resurgence of dengue, risks related to water scarcity, and extreme weather events.

**Extreme heat events are an emerging health priority**. Heat stress is an identified health risk in India, Bangladesh, and Pakistan and further studies to define the health burden of extreme temperatures are needed. In India, extreme heat events have recently been recognized by the government as a natural disaster. In the Maldives and Sri Lanka, extreme heat has recently emerged as a risk that requires exploration of the level of vulnerability and burden of disease that may be due to extreme heat events. In Bhutan extreme heat is not an identified health risk yet authorities intend to remain vigilant that extreme heat may become a future health risk, placing certain populations at risk.

[1] http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap24_FINAL.pdf

**The health sector faces common challenges in climate risk management.** Despite diverse contexts and health risks, many common needs for improving climate-risk management were reported. These include: the need for enhanced coordination across relevant actors to manage the multi-sectoral nature of climate-related health risks, such as water and disasters; the need for improved health information and interoperable data management systems to facilitate vulnerability and impacts research that integrates climate information, and which is also needed to establish climate services that can help to monitor risks and provide early warnings; the need to broadly invest to translate evidence to practical action; and the need for capacity building of both health and meteorological professionals in the access and use of climate information for health.

**Heat Health Action Plans allow for coordinated and effective local action.** Timely forecasts and warnings will have limited impact if they do not inform a pre-established preparedness and response plan. HHAPs have proven a successful approach across Europe, North America, Australia, and China to save lives and reduce the stress placed on communities and health systems during extreme heat events. New experiences in Ahmedabad, India, have tailored these approaches to develop locally feasible and acceptable approaches that have been demonstrated to save lives. This model approach provides an excellent regional example and basis for other cities and countries in the region to adapt and build on.

**Effective advocacy and appropriate action is based upon an empirical evidence-base of heat-exposure and vulnerability.** Evidence-based decision making is fundamental to public health action. In the case of extreme heat conditions, it is essential to conduct vulnerability analyses to identify at risk populations, such as workers, children, the elderly and geographic regions such as mega-cities or drought prone areas. Understanding the current and future heat exposure of local populations requires interoperable data to model and predict health risks, and where interventions will be most needed and effective at saving lives. Health professionals noted that actual heat exposure levels may be much higher than ambient temperature alone as a result of additive heat exposure generated from equipment and machinery in certain occupational settings, radiative heat from the ground in urban heat islands and metabolic heat generated by the body. Evidence-based research on local vulnerability, exposure variability, and institutional responses can help advocate the need for action with local leaders, and inform local policy and practice to protect vulnerable populations from heat stress and extreme heat exposures. As a newly recognized health risk, most Health Information Systems (HIS) in the region do not capture heat-related morbidities and mortality that could allow for systematic tracking of population impacts of increasing temperatures and extreme temperature events. In the absence of local evidence, reference can be made to international research on heat health due to common human physiological responses to heat, which can serve as a good basis for local decision-making until a local evidence base is further developed. The establishment of specific indicators, will allow for systematic collection of information that will facilitate building a local evidence base and enable standardized comparisons across locations.

**Heat health warning systems can extend preparedness lead time and orient interventions to high impact prone areas.** Most cities across South Asia do not have advanced notice of extreme heat events that can allow local hospitals and communities to take protective action. Since 2015, IMD have started providing a 5-day forecast of extreme heat events in India that is now being used by cities such as Ahmedabad to inform their local heat health action plans. However, the farther in advance health professionals know about hazardous conditions, the wider the range of interventions that can be put in place weeks in advance to prevent avoidable

illness and death. The South Asia Heat Outlook produced by IITM and IRI for the 2016 heat season is a step in the right direction for improved HHWS in the South Asia region.

**Feasible national opportunities exist to improve evidence, awareness, coordination, and preparedness.** In countries such as Pakistan, Bangladesh, Sri Lanka, Maldives, and India, which recognize heat as an important emerging health risk, there are many feasible local actions which can help discern the impacts of EHEs on communities. Actions can also be taken to better prepare health systems for an upcoming heat season, and for imminent extreme heat events. During the workshop, each country began to map out opportunities that can help enhance national heat health action.

**Regional knowledge exchange and capacity building can accelerate local heat health action.** Increasing global experience in managing health risks of extreme heat have generated a broad range of valuable technical resources, research, and decision and information tools that can help accelerate the scale up of heat-health plans in South Asia. A regional network of heat health actors can make sure regional and national experts and at-need communities are connected to each other, have access to available resources to adequately support local activities, and are able to share experiences and learning with others.

## CSF-Health Recommendations

The Climate Services Forum for Health made four principle recommendations:

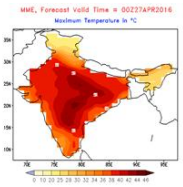
1. **To communicate, advocate, and share resources on heat health in South Asia** by disseminating meeting outcomes and taking steps to reach a broader regional public health community which can help identify further research and public health practice partners.

2. **To advance product research and development on the IITM experimental 3-week Regional Heat Outlook** by proposing steps that can be taken in the short term to improve product communication and suitability, as well as a longer term plan for forecast validation and the development of appropriate extreme heat monitoring and forecasting products.

3. **To develop national action profiles** to scope national activities and propose pilot projects and technical activities that respond to identified needs of the health sector in South Asia.

4. **To develop a South Asia action plan to establish a Regional Heat Health Network** based on the inputs from the CSF-H and the NIHHIS Framework that can unite partners around common directions in research, capacity building, partnerships, and data and information to accelerate heat health action.

FIGURE 1 SOUTH ASIA EXTREME HEAT OUTLOOK APRIL 22-MAY 11, 2016



# SouthAsia Extreme Heat Outlook

## 22 APRIL – 11 MAY, 2016

**Day-time temperatures**

- On 21st April, high day-time temperatures were forecast for 22-26th April along the east coast of the peninsula, Sri Lanka, the Maldives and Bangladesh
- These temperatures may weaken, except over the southern tip of the peninsula, Sri Lanka and Bangladesh, by the end of the month
- Hot and humid conditions were forecast for 22-26th April in Myanmar, especially on the coast
- High day-time temperatures may emerge in southern Myanmar and intensify through to the end of the first week of May
- *Hot days are forecast for the interior of the peninsula, persisting through to the second week of May, which may be exacerbated by humidity.*
- *High day-time temperatures in southeast Nepal may persist to the second week of May*
- High temperatures may develop in Afghanistan in the second week of May, *accompanied by high humidity.*

**Night-time temperatures**

- On 21st April, high night-time temperatures were forecast for 22-26th April along the east coast of the peninsula, Sri Lanka, the Maldives, Bangladesh and Myanmar. These conditions are expected to largely disappear by the end of the month.
- High night temperatures may develop in Pakistan, Afghanistan and the west coast of India in the second week of May.

*Italics indicate areas where the IITM forecast could not be corroborated with evidence from other forecasting centres.*

CSF-HEALTH SCOPE AND PURPOSE

The overall goal of the climate services forum for health was to establish a multidisciplinary international platform that can promote the use of climate and weather information for synergistic, evidence based policy and actions to improve population resilience to health impacts of climate in the South Asia region and at the country level.

The (CSF-Health) served to:

1. Facilitate greater interaction between climate and health sectors at the national and regional level
2. Provide an overview of Climate Risks to Health in South Asia
3. Identify climate and weather knowledge and decision needs to manage extreme heat events
4. Inform the development of health tailored climate applications, and
5. Establish a network of partners and projects to reduce the impact of extreme heat in South Asia.

Specific objectives of the meeting included to:

- Help health professionals appreciate the magnitude and impact of heat extremes on health, and understand the value and use of the South Asia consensus based forecast (sub-seasonal heat forecasts for the remaining part of the heat season and the outlook for the summer monsoon rainfall)
- Raise awareness within the Meteorological community of the health concerns and needs for better and specific information
- Engage key public health scientists and decision makers in South Asia to identify observational, data and forecast product needs for developing and delivering climate information systems for heat health early warning
- Raise awareness and exchange information on good practices (i.e. locally feasible and sustainable actions), tool and resources, and lessons learned across health, and climate and weather agencies that are developing and delivering heat wave early warning and early action systems.
- Develop plans to establish a regional heat health network to provide a structure for developing pilot projects, information exchange, and learning opportunities.

## OPENING STATEMENTS

Dr. Dileep Mavalankar welcomed participants and highlighted the importance of this meeting to bring together health and meteorological partners from across South Asia to explore ways to collaboratively address climate and extreme weather risks to health. Extreme heat events have taken a tremendous toll on India in recent years and catalyzed great interest in taking municipal action to protect local populations. In Ahmedabad, an international collaboration in applied research and practice has successfully demonstrated that advanced notice of heat risks, paired with plans to mobilize local authorities, health workers, and empower communities with information can be a powerful approach to saving lives. This CSUF will hopefully lead to more such projects and encourage collaboration across the region.

Dr. Rupa Kumar Kolli of WMO, provided a background that the seeds for this discussion originated in 2014at a Technical meeting held in Chicago, and organized by NOAA and DWD, on global experiences forecasting and addressing extreme heat and health risks. He noted the Regional Climate Outlook Forums provide a unique opportunity to bring key meteorological and user community actors together, such as health. New advances in seasonal to sub-seasonal climate prediction products are am emerging scientific tool that can help the health community extend the lead time to prepare for health risks such as extreme heat, from 3-5 days advance notice to 20days.Having this type of advance notice can be beneficial to the health sector, who are facing the management of complex risks, such as the combined heat stress and water stress now being faced in many parts of South Asia as a result of the sequential monsoon failures in 2014 and 2015.

Today, in climate prediction we have tremendous opportunity at global and regional scale to provide more precise information at relevant scales which can bring valuable benefits to society. We have the responsibility to give guidance to health sector when and where possible and motivate them to address climate risks, by demonstrating the power of tools such as a sub seasonal heat forecast which can positively influence health services operations.

Ms Sujata Saunik, Principal Secretary, Public Health Department, Govt. of Maharashtra delivered a video message highlighting the serious nature of heat related morbidity and mortality in India, noting although these deaths and illnesses are preventable, annually many people succumb to extreme heat. A national assessment conducted by the Government of India on climate change, projects increasing temperatures for India through the 21$^{st}$ century, including increasing extreme heat events which can lead to dangerous morbidity & mortality including heat stress and heat stroke. The excess heat prone districts in Maharashtra are Nagpur, Akola, Wardha, Chandrapur, Nanded Yavatmal, Jalgaon and Amravati. Historic heat waves witnessed in India have been increasing in frequency in recent years. Gujarat is the first state to devise a Heat Action Plan for the city of Ahmedabad. Maharashtra has followed and adapted the Ahmedabad model to be implemented at regional level in the above mentioned districts.

The model Heat Action Plan has a four pronged approach:

1. Communications outreach to inform people about the risk of heat illness and preventive measures to take. Mobile platforms such as mobile messaging service and WhatsApp are used as dissemination channel along with posters and inter-personal communication.
2. A warning system in the case of a heat wave with actions mapped out for various governmental agencies.
3. Training health care professionals to better respond to heat illness
4. Adapting the physical plan of the city to better cope with heat: mapping high-risk areas, making potable water easily accessible and building temporary cooling spaces during periods of extreme heat.

# SESSION 1: HEALTH RISKS AND RESPONSES TO CLIMATE IN SOUTH ASIA

*Session 1 provided participants an overview of climate and extreme weather risks to health in the South Asia region and responses by the health sector, including cooperation with the Meteorological authorities, as well as recognized gaps and next steps. Presentations were made by representative of the health sector from India, Sri Lanka, Bhutan, Maldives, Bangladesh, and Pakistan.*

## PAKISTAN | MS MOHSAN NOSHEEN |WHO PAKISTAN

Pakistan is a high risk country for being negatively affected by climate change, and regularly affected by chronic drought, serious floods, and other extreme weather that take a high toll on the Pakistan population and health system. As a result of the 2011 floods 40,000 health care facilities were damaged; widespread population displacement, 84% of water supplies were contaminated, breakdown of food systems. Impact analysis of floods to health facilities and water infrastructure, showed severe impacts such as 50% loss of access to water and sanitation – leading to cholera, polio and other outbreaks.

Extreme heat events are a recognized health problem that requires immediate action in Pakistan.

Key points and needs to take future action include:

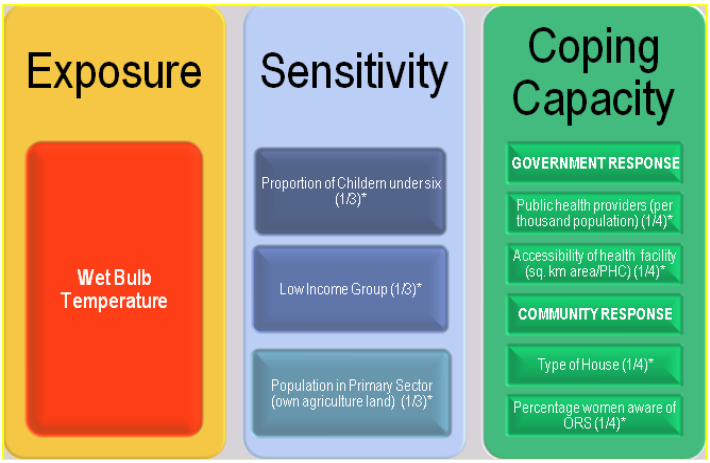
- Need to draft a clear plan to improve coordination between the PMD and MOH
- Need to explore options to better integrate climate information into the HIS, and have interoperable climate and environmental information to be used by district health authorities.
- Needs to strengthen Health sector capacity for extreme weather event preparedness
- Climate information is needed to conduct analysis of dengue and build evidence for other impacts
- Need for better evidence and understanding of Vulnerability assessment at city level (6 cities) and framework for implementation of National Climate Change policy
- Preparedness plans for heat waves do not exist and should be developed, including public awareness campaigns and oral rehydration systems

## INDIA |DR. NITISH DOGRA | TARU

Dr. Dogra highlighted research of the climate and health research community in India, noting that findings often still remain disconnected from health practice and operations. Summary of key research partnerships include:

- Vector Borne Diseases– Malaria EWS based on study of National Institute of Malaria Research (NIMR), India with Univ.Michigan(M.Pascal) – showing decrease in SST in South Atlantic affects Rajasthan/Gujarat and increased lead time for malaria control programs.
- Water Borne Diseases-Cholera EWS based on National Institute of Cholera and Enteric Diseases (NICED), India/International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B)/University of Maryland(R.Colwell) which includes influence of SST and phytoplankton.
- Nutrition: Collaboration of IMD with Agriculture ministry
- Air Quality: SAFAR Program releases real-time data for Delhi, Mumbai and Kolkata but has limited stations. Low-costsensors for air quality monitoring and social media interface is being used to complement the official AQ Measurements
- Heat: IMD now producing forecast for 100 cities showing potential for wide-scale scale-up.

In 2011, a subnational assessment of vulnerability to multiple climate risks was conducted including heat stress, malaria and diarrhea. The framework and maps for the exercise are given below. A detailed validation exercise was also done in two districts.[2] It needs to be emphasized that the indicators and weights mentioned are suggestive. These need further refinement after a more extensive national stakeholder exercise aiming at an expert group consensus.




*Fractions in parenthesis represent respective weight of the indicator in the categories

FIGURE 2HEAT VULNERABILITY INDEX FRAMEWORK AT SUBNATIONAL LEVEL IN INDIA

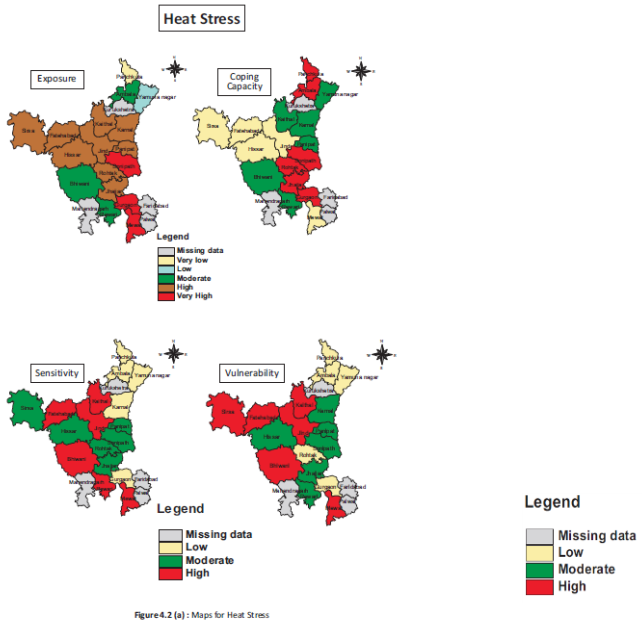



FIGURE 3HEAT VULNERABILITY MAPPING AT SUBNATIONAL LEVEL IN INDIA

Source: 2013. Pilot Tool for Assessment of Health Vulnerability to Climate Change at the Sub-National Level

(https://www.academia.edu/25298462/Pilot_Tool_for_Assessment_of_Health_Vulnerability_to_Climate_Change_at_the_Sub-National_Level_in_India_INSTITUTE_OF_HEALTH_MANAGEMENT_RESEARCH_WHO_Collaborating_Centre_for_District_Health_System_Based_on_Primary_Health_Careonal Level in India)

[2] https://www.academia.edu/25298463/Assessment_of_Baseline_Vulnerability_for_Climate-Sensitive_Diseases_at_the_Local_Level_in_India_INSTITUTE_OF_HEALTH_MANAGEMENT_RESEARCH_WHO_Collaborating_Centre_for_District_Health_System_Based_on_Primary_Health_Care

Dr. Dogra presented the model of NIH supported UCHAI (Understanding Climate and Health Associations in India) initiative. A workshop last year helped map out major actors in India working on climate and health. IMS (Indian Meteorological Society) served as a knowledge partner for meteorology. A scientific committee of Indian and US experts was involved in guiding the workshop. A wide range of agencies working on vector borne diseases, water borne diseases, cyclones and other climate disasters as well as diseases and have a lot to contribute to the discussion. The forum has helped to identify and organize major players to support evidence and capacity building, using e-groups and social media to keep the partners connected.

Key points included

- Many national partners and experts can be drawn upon and brought together to address climate and health.
- Upstream policy and science and downstream operational work – more needs to be done to connect the two.
- Population based cohorts can be used for environmental research purposes
- Model of UCHAI is helping to unify actors and give momentum to mainstreaming science to policy and action.

## INDIA |DR. VIDHYA VENUGOPAL | SRI RAMACHANDRA UNIVERSITY

Dr. Venugopal who is a Climate Change Scientist and occupational health expert at the WHO Collaborating Center for Occupational and Environmental Health at SRU, and discussed ongoing research in India to quantify exposures to occupational heat stress on working adults. Key points included:

- Heat related research often focus on elderly, children and other vulnerable populations, often paying less attention to the working population (age 16-69) who form a special group exposed to high heat conditions, particularly in the occupational set-ups. Workers in the agriculture, construction, brick and high heat industries are the most exposed to high heat conditions, particularly in hot weather conditions.
- Occupational heat stress includes environmental heat exposures (radiation, air temperature, air humidity and wind) and the metabolic heat generated due to physical labor. Research on heat stress exposures in formal and informal occupational sectors in South India demonstrate a range of health problems and productivity losses due to heat exposures above safe threshold values.
- Actual heat exposure levels are much higher than ambient temperature as a result of additive heat exposure generated from equipment and machinery, radiative heat from the ground, and metabolic heat generated by the body.
- Furthermore, many cities experiences warmer temperatures than surrounding rural areas, as building materials and pavements absorb and later re-radiated the sun's energy creating an 'urban heat-island'. Buildings, roads and impermeable surfaces – all absorb and re-radiate heat.
- Occupational heat stress research could benefit from historical information on seasonal conditions, and improved correlations of WBGT measurements and ambient temperatures. Climatchip.org provides climate information

Evidence in India: The health based occupational hazard threshold for heat exposure is est. at 27.5C, above which workers engaged in heavy labor should stop working, or are likely to begin to experience adverse physiological effects of heat exposure. Research in India shows that ~ 89% of workers continue to work in conditions far above this safety threshold – and as a result a wide range of heat stress symptoms of physiological stress, including dehydration, urogenital issues, fatigue, heat rashes are reported. Methods to assess heat stress are based on internationally accepted heat stress index such as Wet Bulb Globe Temperature (WBGT) and physiological indicators of heat stress such as Core

Body Temperature, Sweat Rate, Urinary Specific Gravity and Heart Rate etc. that gives a fair indication of the heat strain and the dehydration status of the exposed individual

Implications: Indian working age population experience significant heat stress and heat related illnesses due to high heat exposures in their occupational settings. Preliminary evidence to support kidney related illnesses in chronically high-heat exposed working population in industries in southern India stands must be viewed as an alert for a looming future problem similar to the ones in Central America. Studies which document economic losses to workers, absenteeism, and illness are nascent but indicate larger-scale significance in a population of 817 million persons of working age. Projections of the future economic productivity losses due to climate change, as a result of physiological limits for the human body to cope with heat are projected to be significant. Reference to T.Kellstrom maps of future climate projections.[3] Occupational Adaptations to mitigate heat exposure may include night-work, reduced working hours, regular breaks and hydration, and stronger enforcement of worker safety regulations. Evidence based research is needed to inform strong labor policy to protect workers and encourage good practices.

## BHUTAN | MS. RADA DUKPA | MINISTRY OF HEALTH BHUTAN

Bhutan suffers from high rates of a series of climate-sensitive health burdens. Projected temperature rise (higher in mountainous areas than elsewhere in the world) is likely to increase the probability of Glacial Lake Outburst Floods (GLOF); increases in the geographic range and incidence of vector-borne diseases, particularly malaria and dengue; and increase in the incidence of water borne diseases. GLOF's represent a major climate change concern in the country. Flash floods and landslides are also common during the monsoon period of June to August. Increasing temperatures are complicating control of vector-borne diseases in Bhutan. Despite sustained containment efforts, Malaria continues to pose threat to the population of the country. In addition, cases of emerging diseases such as Dengue and Chikungunya are on rise. Dengue was first documented in Bhutan in 2004 and is now endemic during the monsoon period. Diarrhoeal diseases represent a significant cause of morbidity in Bhutan for the last decade, and contribute to about 10-15 % of morbidity cases. Climate change has also influenced water resources due to drying up of water sources or contamination due to flooding, increasing the risk of diarrhoeal disease.

**Health priorities related to climate identified in Bhutan**

-Integrated Risk Monitoring & Early Warnings: to build/strengthen climate-health relationship and continuous monitoring

-**Capacity building**: strengthening the organizational, technical and professional capacity of health professionals on climate health actions and increasing the awareness and knowledge for other sectors

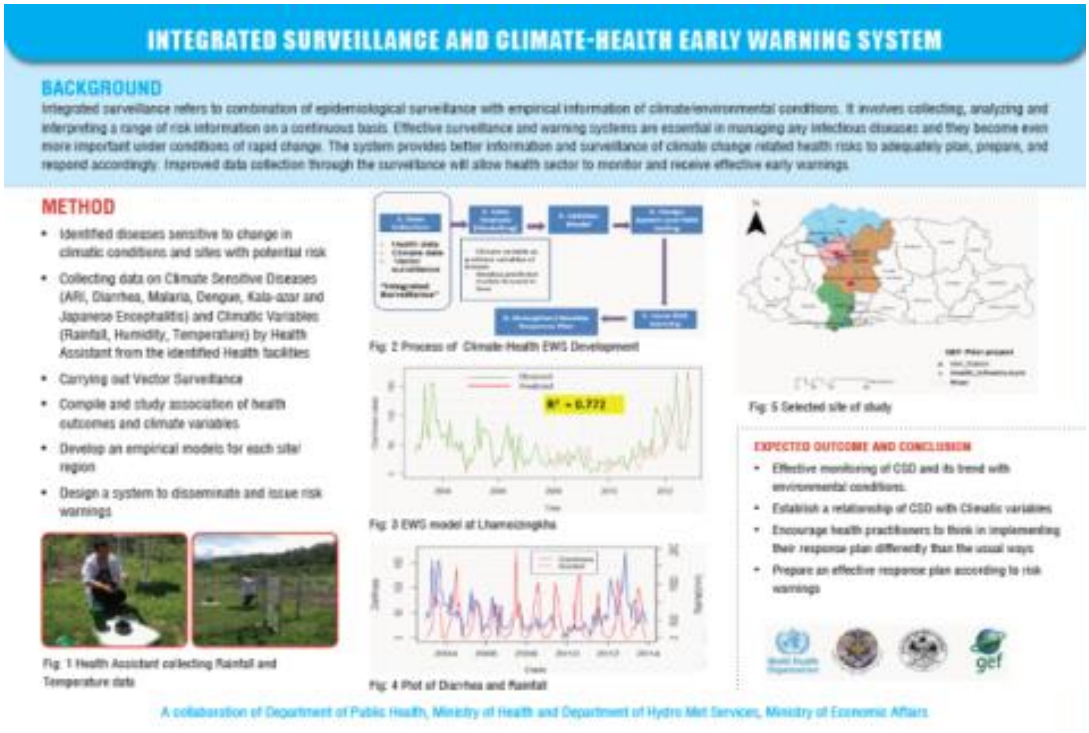
-**Appropriate climate resilient technologies**: exploring and implementing new technologies especially in the eras of water, sanitation and waste management

-**Strengthening Emergency Preparedness and Management:** systematic preparedness plans and emergency management to provide emergency care and services in all times of disasters are essential

[3]The Direct Impact of Climate Change on Regional Labor Productivity

http://ensembles-eu.metoffice.com/docs/kjellstrom_2009_prod_paper.pdfhttp://ensembles-eu.metoffice.com/docs/kjellstrom_2009_prod_paper.pdf

FIGURE 4: OVERVIEW BHUTAN INTEGRATED SURVEILLANCE




## Current practices in the use of climate information in the health sector

- Integrated surveillance and climate health early warning system to track 6 climate sensitive diseases and rainfall, humidity, and temperature at same sentinel sites in order to improve evidence and risk monitoring. System started in 2013, and model for diarrhea and rainfall established

- In terms of climate induced disasters, GLOF Early Warning, and Flood Forecasting and warnings (water level monitoring) implemented by Department of Geology and Mines, Department of Disaster Management in coordination with Department of Hydro met Services (DHMS) – noting another level of coordination required.

## Key Points

- Three varied climatic regions in the country require evidence and diverse strategies
- Health Sector has a major and diverse role in disaster management, pre and during disaster events for preparedness and management. Post disaster it plays a role to assess affected areas and populations, conduct awareness and education, and develop SOPs for WASH and nutrition in emergencies, and conduct trainings for health professionals in emergencies

## Gaps and next steps

1. Strengthen collaboration with DHMS and improve/use seasonal forecast. Need to improve the credibility and reliability of the information, establish a communication strategy with clearly defined roles of agencies
2. Need to Inform climate sensitive climate sensitive public health programs on the magnitude and severity of risks
3. A two-tiered approach was taken to first address first line risks (vector borne, diarrheal disease, GLOFS) but it is time to initiate research on other climate health outcomes (e.g. Nutrition, Air pollution, Heat stress)
4. Plan for responses to other indirect health impacts following extreme weather events

## MALDIVES | DR. ASMA IBRAHIM SUALAIMAN| MINISTRY OF HEALTH, MALDIVES

Maldives is very vulnerable to the associated impacts of climate change, including sea level rise, coral bleaching, extreme weather events like storm surges, sea wall swelling and also increase in temperature. That have direct and indirect effects to health issues such as respiratory diseases, vector and water borne diseases. Water scarcity is affected by all disasters, which frequently affect water quantity and quality and require shipping freshwater to small affected islands. Dengue outbreaks continue to occur and as particular risk. Extreme heat events and heat stress due to prolonged elevated nighttime temperatures are a recognized health risk.

### Health priorities related to climate in the Maldives

- Continuity of services in disasters- vital system, structure and supplies should be protected from damage and run the services as well as preventive and curative services.
- Keeping Hospital Safe – building hospitals in such a way that does not affect infrastructure damage, equipment.
- Catering for Surge Capacity – post situations (flood, tsunami, storms) can increase demands on hospital services due to various injury or due to infectious diseases.
- Planning for Hospital preparedness – all the hospitals should have an Emergency Response Plan with proper orientation of the plan.
- Health Surveillance – Is considered to be good in the Maldives and daily information is transmitted throughout the country. Routine surveillance should be continued and active surveillance as a direct consequences of the disaster, such as Acute Gastroenteritis (AGE)
- Health Promotion and Disease Prevention – health facilities should be disseminating health messages to the public, identify health risks and apply specific preventive measures. Including health alerts during disaster situation
- Coordination – the atoll hospital should take lead in coordinating with other islands.

### Current practices in the use of climate information in the health sector

- Currently the NHMS provides SMS alerts on extreme weather [no example available].SMS are received by two Focal Points at MOH in departments of Environmental Health and Surveillance, who can then transmit onward to others.
- The NHMS have provided historical rainfall data in order to identify any association with waterborne disease risks, and cooperated in efforts to record infrastructure damage [type unknown ]following storm and flood events.

### Proposed Steps to improve climate information for the health sector.

- Sensitization of stakeholders
    - Create climate informed health sector and beneficiary communities that routinely request climate information and use this information to improve effectiveness of health intervention.
- Knowledge Exchange and National and International networking
    - Training to build capacity of climate and health community.
    - Develop effective and functional means for health sectors to routinely use appropriated climate information for prevention and control of climate sensitive diseases.
- Engagement in Applied Research - make climate science useful for health development
- Web-based climate information development
    - Linkage of climate data library and develop a web-based map room from which public health expert can retrieve information easily and use for health development.

## BANGLADESH | DR TANVEER CHOWDHURY | MINISTRY OF HEALTH

The large population, high population density and geographic and low lying location of Bangladesh, make it one of the most climate vulnerable locations in the world. Although the Ministry of Health is proactive to address climate risks, pre-existing population vulnerabilities and climate sensitive disease burdens are significant and pose enormous challenges in Bangladesh. Notably, health infrastructure and health service delivery are vulnerable to extreme weather events which disrupt accessibility, block road access, hamper MCH and reproductive services, and often compromise access to safe drinking water and sanitation.

Extreme heat events are a recognized problem in Bangladesh. Historical observations reveal extreme heat events have increased from 62events in the 1981-1990, to 139times 2001-2010.

Key points:

- Government structures have been put in place to address climate change, and at the MOH to address climate change. Two-tiered model (CCHPU) Climate Change Health Promotion Unit
- ICDDRB research capacity on climate and health
- MOH and Bangladesh Meteorological Dept. (BMD) have long history of collaboration, and CCHPU have planned research on heat island in Dhaka with expected collaboration; MOH have representation on BMD committees; and data sharing does occur.
- Regional collaboration will enhance development of heat alerts and address heat waves.

Needs and proposed action

1. Strengthen the Surveillance of communicable and NCD climate sensitive disease
2. Lack of coordination of activities between government and other stakeholders
3. Lack of awareness among common people (Community participation )
4. Capacity building to improve understanding of complex environmental and health linkages.
5. Need for Technical support for the design and implementation of adaptation and mitigation actions
6. Community protection from floods and storms, including more cyclone and flood shelter in the coastal region, heightened embankment and river dredging is needed

Extreme Heat Events | Little work has been conducted on extreme heat risks, and climate information about Heat Waves is not commonly available or used. There is no HIS indicators for tracking heat related health outcomes, lack of data on heat stroke, heat stress, and temperature related cardiovascular mortality.

## SRI LANKA |DR M B AZHAR GHOUSE|MINISTRY OF HEALTH

Extreme heat events are a recognized emerging problem in Sri Lanka, and some preliminary studies have been conducted but more remains to be documented to fully understand the exposure risk and diseases burden related to heat stress. A study on heat vulnerability was conducted by Mr. K. H. M. S. Premalal at Sri Lanka Met office.

The Sri Lanka MOH provided an overview of the evidence on the sensitivity of dengue to climatic conditions.

- Temperature and rainfall often preceded dengue incidence and epidemics across different spatial units of the study area. There was a pronounced relationship with medium and high rainfall levels occurring 6-12 weeks before incidence, and a similar pattern following high temperatures. Extreme rainfall had a negative impact on dengue risk in the first 2-3 weeks, while the net effect at 12 weeks was largely positive.
- The use of such information can potentially benefit planning and implementation of dengue control efforts in the district by development of prediction models for early warnings using the latency in the system to predict dengue incidence up to 12 weeks ahead. Early warning systems can raise awareness, engage communities and inform specific dengue control measures.

- A similar statistical approach could be implemented to explore multivariate associations between weather and dengue in other districts and beyond, particularly to respond to outbreaks that do not following expected seasonal patterns, such as during El Nino events. Further research is needed to understand the interaction between environment, migration, control efforts and dengue.
- Such information may shed light on the epidemiology of dengue and the drivers of dengue transmission in its full context, provide an improved knowledge base, and lead to more accurate predictions of dengue

## SESSION 1| ISSUES AND DISCUSSION

Each country faces a range of diverse challenges related to their geographic location and existing health profile ranging from high Himalayas in Bhutan, to Small Island Developing States, such as the Maldives. Common health priorities across the region related to the widespread resurgence of dengue, risks related to water scarcity, and extreme weather events.

Heat stress is an identified health issue in India, Bangladesh, and Pakistan and studies have been conducted or are planned to identify the health burden of extreme temperatures. In the Maldives and Sri Lanka, extreme heat has recently been perceived as an emerging risk that requires exploration of the level of vulnerability and burden of disease that may be due to extreme heat events. Bhutan has not identified heat as a health risk, but will remain vigilant that extreme heat may become a future health risk, placing certain populations at risk.

Common issues that emerge in addressing climate risks include:

1. The importance of awareness raising of the linkages of climate and health and subsequent potential value of climate information to anticipate risks and impacts; professional training on how to use such information and systems for decision-making, and institutional capacity building (long term management strategies).
2. Need to invest in work that can connect upstream policy and evidence building with downstream operational work, i.e. translate science to practical action.
3. Complex linkages with other risk factors that exacerbate health risks of extreme weather events, particularly water scarcity, and air quality. Drinking water shortages during flooding events and coincidence of water shortages during heat waves was commonly mentioned without clear solutions. The air quality combined impacts are understudied.
4. Vulnerability and need to protect health infrastructure and continuation of basic health services during hydrological disasters flagged by several countries.
5. More research at local levels is needed to build evidence and strengthen information system
6. Need to improve and adapt health surveillance for both evidence building and EWS. Several countries monitor environmental health hazards relating to water borne diseases, dengue, and malaria – however identifying adequate health data remains a challenge. Approaches to fill information gaps include establishing sentinel sites in Bhutan, and India has identified two population cohorts in other studies that can be used for climate-related health analyses.
7. Establish systems for improved and real-time health surveillance to tracking heat health, noting a general lack of data on heat stroke, heat stress, and temperature related cardiovascular mortality – and almost no systems which report heat related impacts. All-cause mortality is thus still used. What are the barriers to commencing monitoring of heat mortality/morbidity?
8. Need for web-based and online/offline platforms to integrate climate information to the HIS, and integrating climate and environmental data with district health. Advances being made in DHIS-II-linkages may be useful

General issues in health and NHMS collaboration:

1. Although relationships between the health sector and NHMS exists in all countries, need for improved data sharing, coordination and cooperation was reiterated. Limited experience working together translated to limited awareness of terminologies (e.g. prediction vs projection) and methods used by the diverse fields for health and meteorological observations, data management, trend analysis, and forecasting.
2. Enhance arrangements for data sharing, access to relevant climate information for health research and evidence building, (guidance on the use of global datasets and products); and

climate impacts and projections information at a district scale resolution. Availability of climate information, is often related to coordination and capacity building. For example CORDEX provides regional downscaled climate projections that could be helpful to national users, but NHMS may not be aware of global and regional resources and how to use these products.

3. Identifying appropriate climate data for appropriate decision needs and planning horizons. For example, how are long term scenarios useful to health decision-making, given that uncertainties are large and the projections are for far in the future? Long-term scenarios can help convince areas of the importance to prepare for diseases they do to currently experience, (i.e. highlands of Sri Lanka) for policy planning – however, not useful for local planning.

## SESSION 2: HEAT HEALTH WARNING SYSTEMS

*Session 2 provided an overview and framing of heat health action plans, with the in-depth example of the Ahmedabad HHAP which served as the model case study for the meeting.*

### HEAT HEALTH ACTION PLANS | DR.SHUMAKE

Dr. Joy Shumake gave an overview of heatwaves and health sector responses. Key points included perspectives that many countries in northern hemisphere (Europe, North America, China)have developed heat action plans following negative impacts of extreme heat events, and in recognition of the increasing frequency, duration, and magnitude of extreme heat in relation to climate change. Notably, WHO-EURO have produced a wide range of resources and guidelines on developing HHAPs, and 18 European countries have example plans. Heat Health Action Plans commonly include 9 components:

1. Agreement of a Lead Agency
2. Accurate and timely heat health warning and alert systems (HHWS)
3. Heat-related information / communications plan
4. Reduction in indoor heat exposure
5. Special care for vulnerable populations
6. Preparedness of the health and social care system
7. Long-term urban planning
8. Real-time surveillance
9. Evaluation

**Heat Health Warning Systems** are core to HHAPs serving to monitor and forecast extreme heat hazard levels and alert authorities and public in pre-designated ways. WHO/WMO have developed guidance–HHWS components include:

- Local weather forecasts
- Heat exposure response assessment and modeling
- Thresholds of heat-health action triggers
- Alert/action and communication plan
- Issuance of warnings
- Intervention and response strategies
- Evaluation

Dr. Mavalankar provided an in-depth view of the Ahmedabad city HHAP, and the story of why and how a coalition of international partners have united to support this work. This pioneering project serves as a model, and additional documents and resources on the project are provided in annex 2.

Heat stress is an under studied component of climate change in South Asia. Until 2013 India did not even recognize heat waves as a natural disaster. Observed temperatures have been increasing steadily over the past 30years in Ahmedabad (.3 per decade). The 2010 heat wave provided political interest from local authorities. In 2011 an international alliance was formed to address this issue, and a number of preliminary studies were commissioned. Results showed a clear excess daily mortality as a result of exposure to the heat wave, with a total of 800 excess deaths in 1 week during peak of heatwave.

Heat health action plan was developed based on European models, with locally feasible and appropriate activities. A 7-day heat forecast was developed in the US, because IMD was not able to develop city scale forecasts at the beginning of the project. Since 2016, new IMD forecast for 5-day period is being used.

| No Alert <41.0/ | Hot Day (Yellow) 41 -42.9 | Heat Alert Day(Orange) 43 – 44.9 | Extreme Heat Alert Day (Red) >45 |
|---|---|---|---|

FIGURE 5: COLOR CODED ALERT SYSTEM FOR AHMEDABAD HEAT FORECAST

A color coded alert system, as shown above, is developed as per the local threshold determined scientifically. A Nodal officer is designated to receive alerts and trigger activities as per carefully drafted plan. Information network/pathways are decided on how information should be passed across agencies. Various communication channels including social and electronic media are used to increase community awareness on effects of heat on health and ways to prevent those like drinking more water, taking rest in shade, avoiding long stretch of strenuous work during the peak heat hours etc. Training of health staff and doctors for better management of heat illnesses, ensuring supplies (e.g.: ice packs, etc.) to hospitals, opening parks and gardens during the day, provision of more drinking water, minimizing electricity supply interruptions, etc. are the primary action focus.

Though these activities are carried out during the peak heat season from 1st April to 30th June, the Planning Cycle is active throughout the year as depicted below.

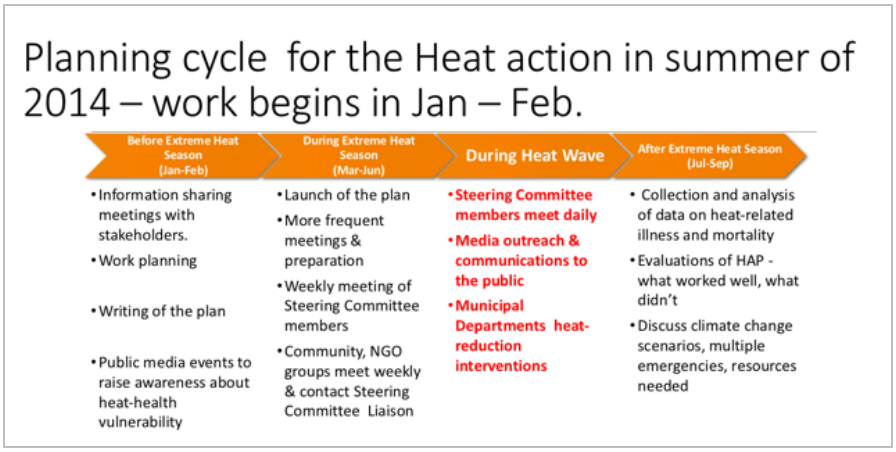



FIGURE 6 PLANNING CYCLE FOR HEAT ACTION PLAN

**Evaluation** – Much less mortality and heat stroke cases during 2014 heatwave compared to 2010 heatwave indicates efficacy of having a HAP. 2015 impacts were even lower. A Performance evaluation of reduced mortality due to HHAP will be published in the peer-reviewed literature in 2016.

**Lessons:** strong partnership across the city government is the foundation of a good HAP. 5-7-day advance temperature forecast, focus on doable action such as readying the hospitals, arranging

drinking water, modifying working hours, avoiding peak hot hours are the key. With the high penetration of mobile phones and internet among the city residents, use of social media and mobile phones played a crucial role in wide dissemination of the plan among various stakeholders and raising awareness in citizens. Evidence building through monitoring and evaluation and scientific research played an important role in policy advocacy at various levels of governance including the national level dialog on climate change.

Further evidence creation: It was observed that different points in the city were 1-3degrees warmer than the IMD observed temperature which is measured in the airport. including urban heat island effects due to radiant temperatures and impact of vegetation on local temperatures. Calculating human exposure for different vulnerable and occupational groups is the next step required to drive the policy directions further and IIPHG has already taken it up in collaboration with other partners. Scale up: Ahmedabad HHAP model has already been adopted and implemented in Nagpur and 7 other cities of Maharashtra in 2016. State of Odisha, through Odisha Disaster Management Authority, has also adopted it to integrate in their state disaster management plan. Discussion are on with health department, NDMA and IMD for national replication in high heat areas of the country.

## SESSION 2| ISSUES AND DISCUSSION

- Issues of acclimatization: Characterization of heat waves: antecedent heat conditions: acclimatization rates – call for monitoring of temperatures to be figured in. Humidity does not play into the HAP because it is a dry climate, until mid-June we do not consider humidity. In some other cities/regions, humidity has a role. Key question: How to characterize heat load is an issue? Early heat waves vs. later heat waves in the season. Duration of events. Magnitude of heat.
- Epidemiological data: Hospital data collection has improved as a result of the project, and clinicians are increasingly reporting heat related morbidity more effectively. Age disaggregated data is not available, neonatal deaths were noted, due to temperature of hospital ward due to the physical location of neonatal ward on top floor.
- Other constraints were low reporting of specific-cause mortality, so "all-cause mortality" is mostly used. Heat stroke has now been included in reporting.
- Physiological adaptation perspectives of health community –
- difficult for health agencies to access information on local climatology.

Ahmedabad experience of Climate Data sharing and Access

- IMD data was difficult to access mostly for bureaucratic reasons, and information from alternative sources such as the METAR network with stations at the airport was used in the absence of IMD data. Forecasts were developed in the first 3 years by Georgia Tech in the USA. Accuracy: the 7-day forecast provided by Georgia Tech was timely but not that accurate, the forecast became more accurate 2-3days out.
- How to integrate the seasonal forecast? The seasonal forecast is mostly used as an advocacy tool to encourage localities to develop HAPs, rather than for decision-making. The new extended range 20-day forecast may in the future be able to shed light on critical periods of risk for different locations.

# SESSION 3: UNDERSTANDING HEAT HEALTH EMERGENCIES AND PREVENTIVE ACTIONS

*Session 3 helped the health professionals better understand extreme heat events, consider important aspects to measuring impacts and vulnerability and identify feasible options to raise public and professional awareness and action.*

## OVERVIEW OF CLIMATOLOGY OF HEAT WAVES IN SOUTH ASIA |DR. SAHAI |IITM

Although India experienced serious heat waves in the past, IMD was previously not prepared to provide operational extreme heat forecasts for applied use by affected sectors and the public. This gap and emerging need triggered discussion and work with IITM in 2016 to develop new relevant products. Today IMD provides gridded temperature data 1x1 degree (since 1951) and forecasts are made by IITM at the same resolution. IMD criteria for hot days, heat waves and severe heat waves are based on minimum departures of maximum daily temperatures from normal, when the temperature is at least 40C in plains and at least 30C in hilly regions (Figure xx). IITM have slightly relaxed these criteria to be appropriate for gridded data and model output. During the hot summer season (April to May), the greatest number of hot days occur in central-north and north-west India, with Rajasthan experiencing the highest number of severe heat wave days in the country. A historical record of heat wave spells during 1981-2015 has been calculated and used to investigate the regional meteorological conditions favorable to heat wave development. Detection of heat waves from the models is difficult, and bias correction is required, along with consideration of circulation anomalies and other conditions. The evolution of the 2015 heat wave was described using Heat Index, TMax Actual, and Tmax Anomaly.

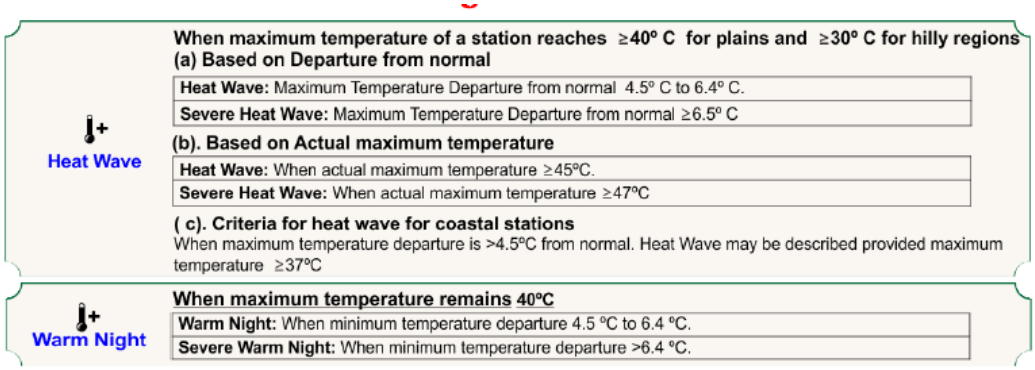



FIGURE 7: IDM HEAT WAVE DEFINITIONS

Extended range prediction of heat waves in response to demand from the Indian government, WMO and the health community, IITM was asked to produce an extended range heat wave forecast, in addition to the 20-day monsoon forecast that was already operational. Maximum (day-time) and minimum (night-time) temperature forecasts show some skill, but this deteriorates beyond 15 days. For this reason, IMD publicly releases the forecast for the first 15 days only. Central and north-west India may retain some skill up to 20 days in advance. Heat wave events classified as hot days, heat waves and severe heat waves are also forecast. Real-time 20 day heat forecasts are updated every 5 days and are available from the IITM website www.tropmet.res.in/erpas/index.php

## HEAT EPIDEMIOLOGY AND MANAGING HEAT RISK|DR. SHUBHAYU SAHA | US-CDC

Dr. Saha provided a health practitioners perspective of conducting heat epidemiology and vulnerability assessments. He noted the importance of exposure pathways between environmental conditions and human health, recalling that we are focusing on direct impacts of extreme heat exposure, but the indirect impacts on waterborne and vector borne, mental health issues are a broader and more complex set of linkages between climate and health. The impacts of heat in south Asia are important but probably underestimated as much of heat-related outcomes are not accurately identified and/or reported in death records. In the USA, an assessment on temperature related deaths and illness identified that increases in

deaths associated with heat will far outweigh winter deaths due to cold in the future. Although undocumented, it is feasible this trend would also hold true in South Asia.

Time and Space-specific health impacts of heat

- Urban heat island effects are key to figure into urban planning, given that the urban population is going to increase globally. Evidence is strong that cities are much warmer than surrounding areas (often up to 7-12C), and nighttime temperatures actually do not drop as much due to heat retention. While there is strong recognition of heat exposure being an important Rural health concern, heat health exposure work is currently urban biased due to population density and station-based weather data availability.

- Geographic differences are important and place matters, particularly in large countries and countries with large topographic variation. Heat definitions likely need to be tailored to accommodate place based factors. Social, cultural, built environment and economics affect health vulnerability from extreme heat. {An example of research was provided that showed how temperature profiles associated heat-related emergency room visits vary by latitude indicating that people living in different regions will have different levels of tolerance.}

- Linking health data to point specific weather station data is crucial. Different models and approaches are needed to conduct the epidemiological data on a geographic basis –such as the example of how to assign health data (number ER visits/count data) to a gridded temperature data.

Modeling health effects from extreme heat

- Some salient features in the analysis of heat epidemiology were highlighted. For example, the impact of extreme heat happens not just for an individual hot day, but there may be a cumulative effect over time; the health risk may change for different levels of temperature indicating *on-linear effects* (changing risk across temperature range). If a heat wave is determined by a specific threshold – it may be set too high or low thus missing the folks in the margins still at risk. (Gasparrini et al 2015)[4] Binary alerts set on fixed thresholds may not be appropriate for all populations, and alternative approaches to issuing warnings needs to be discussed.
- Different temperature metrics to identify exposure can produce very different results (for example Tmax, or heat Index, or Spatial synoptic classification (wind/cloud/mixed variables used in a range of cities in USA) Definition of heat wave also really important to how sensitive your assessment will be to identifying those at risk.
- An example of heat vulnerability analysis was provided that can help health practitioners allocate preventive resources during periods of extreme heat. The study showed how the Minnesota Department of Health created a heat vulnerability map which combined the risk factors using 2 variables a) residential buildings with Air Conditioning and b) elderly living alone.

Prevention of heat related illnesses - available tools of CDC (BRACE)

## ASSESSING HEAT VULNERABILITY IN AHMEDABAD |DR. P. GANGULY|IIPH-G

Dr. Ganguly provided examples of studying the vulnerability of high risk population groups, such as indoor and outdoor workers, slum dwellers, and neonatal infants. He emphasized the value of conducting vulnerability assessments, which can provide clear evidence for protection needs and result in behavior, policy, or physical modifications that can save lives. In the experience of Ahmedabad, studies like these can provide sufficient direction to policy makers to invest in certain activities. He described 4 recent studies, and 2 new studies.

[4] http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(14)62114-0/abstracthttp://www.thelancet.com/journals/lancet/article/PIIS0140-6736(14)62114-0/abstract

- Neonatal Vulnerability Example of "Heat related admissions and mortality among newborns in Ahmedabad hospital in 2010, due to poor building management and placement of department/wards, simply relocating the department to a lower level and changing the roof to be more reflective (Cool Roof) – reduced risk to neonates.
- Slum dweller vulnerability: Most houses are tin roofed, ill ventilated, and cook indoors resulting in increased room temperature, exposing women and children to very high temperatures. Clearly demonstrated more frequent illness soughing healthcare, which again may be an underestimate as the study was conducted in 2011, a non-heat wave year and it was based on self-reporting only. Actual impact of heat on slum dwellers may be much more in magnitude and frequency.
- Construction worker vulnerability survey: all conditions exposed to extreme heat, and 10% hospitalized at least once during previous heat season, awareness of heat effects and preventive behaviors is low in this vulnerable population.
- Indoor workers, such as kite makers, incense stick makers and unorganized outdoor workers rag pickers street vendors – showed high prevalence of heat related illness, increased core body temperatures, minimal awareness of heat stress, WBGT greater than occupational standards.

"New studies 2016"

Ambulance calls for Heat related illness: Trying to measure actual temperature on the scene when a call is received by the ambulance and trying to relate temperature exposure with the nature of illness and physiological effects of the heat stroke victim. Study is being conducted from April 15 – June 15, 2016. Traffic Police study: looking at vulnerability of exposure of heat, AQ, mental health – using WBGT, Infrared cameras, and air quality monitors. Showing a range of occupational hazards based on individual data loggers measuring actual heat exposure of traffic policemen.

## SESSION 3| ISSUES AND DISCUSSION

- Traditional knowledge around personal behaviors to reduce heat exposure has not been adequately documented since lifestyles are changing very quickly. Adaptive behaviors typically include Drink more water, use head coverings, etc. Urban areas are more vulnerable because there are limited trees and green space being lost to urbanization, and urban heat island effects increase residual heat. Further urban temporary workers may know how to protect from heat, for example, construction workers, who cannot determine their own working shifts and lose autonomy to do what traditionally they may know to be protective. The question was raised about how traditional knowledge about vulnerability reduction to heat is being documented or maintained?
- In exposure studies, it was recognized that it is difficult to distinguish heat-stress symptoms from chemical exposures in an occupational setting, and these confounding should be acknowledged.
- In identifying relevant indicators, consideration for (Tmin) is important – as high minimum temperatures are linked to higher mortality in temperate latitudes due to inability of the body to cool; since the day length is long nighttime temperatures don't drop as much as could be assumed.
- A discussion questioned the IMD definition of heat waves and whether these definitions were sensitive enough to capture heat exposure risk. General consensus is that these definitions do not help the health community set exposure thresholds, and percentile definitions may be more useful. For the purposes of health different description should be used, see Ahmedabad hot day, very hot day criteria. Since Ahmedabad is relatively dry humidity does not figure into risk thresholds until late in the season when acclimatization is already higher.

## SESSION 4: IMPROVING HEAT INFORMATION FOR HEAT HEALTH WARNING SYSTEMS

*Session 4 shared the new IITM extended range forecast of extreme heat. It helped consider the strengths/weaknesses of current heat forecast products and feedback was provided on how they can be improved to fit with time scale decision needs and specific health information needs.*

### EXTENDED RANGE 20-DAY HEAT OUTLOOK |DR. A.K. SAHAI | IITM

Dr. Sahai presented the experimental IITM 20 day extreme heat forecast from 22nd April to 11th May 2016. Weather prediction this far in advance is considered experimental, as forecast skill decreases with longer lead times. Regions where confidence in the forecast is higher were highlighted and it was shown that these areas become smaller for forecasts longer into the future. To make the forecast more relevant for heat health practitioners, night-time temperatures and relative humidity were added to the day-time temperatures normally included in the IITM product. Forecasts for these three variables were presented for the South Asia region. For India, the probabilities of extreme heat events, classified as hot days, heat waves, and severe heat waves, were also presented, but a lack of available data from neighboring countries meant this information was not available outside India. The IITM definitions for these heat events do not correspond to the IMD definition, and the need for a consistent message from both organizations was highlighted.

### CONSENSUS HEAT OUTLOOK FOR SOUTH ASIA |DR. HANNAH NISSAN | IRI

Dr. Nissan provided context to the IITM heat forecast by comparing with products from other centres around the world. Forecasts from the Japanese Meteorological Agency, the European Centre for Medium Range Weather Forecasting, the UK Met Office and the NOAA Climate Prediction Center in the U.S. confirmed the main features of the IITM forecast. Areas of disagreement were the prediction of hot days in the interior of the peninsula during late April and high day-time temperatures in south-eastern Nepal persisting to early May, which were forecast by IITM but not seen in other forecasts. As IITM was the only centre providing humidity forecasts, statements about the possible influence of humidity on the apparent temperature could not be confirmed.

Alternative formats for heat forecasts were discussed, including: forecasts of maximum (day-time) and minimum (night-time) temperatures vs. predefined heat waves; presentation of temperature anomalies from daily climatology vs. absolute temperature values; inclusion of information about the “normal” temperatures for the time of year to be used as a reference; map presentations of forecasts vs other options such as a stoplight system. The French heat early warning system was presented as an alternative example: this involves a nationwide forecast for three day average minimum and maximum temperatures issued by Meteo France, in conjunction with local thresholds for minimum and maximum temperature for each department (region) of the country, which have been chosen to reflect critical thresholds for increased mortality in each location. The decreased forecast skill at longer lead times was highlighted, and there was consensus that the final forecast product should include this information, rather than require the user to interpret skill maps.

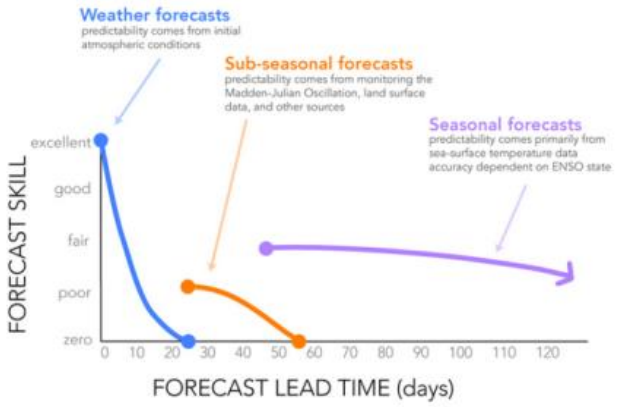



FIGURE 8: FORECAST SKILL AT INCREASING LEAD TIMES. SKILL IN WEATHER PREDICTION IS HIGH AT LEAD TIMES OF A FEW DAYS, BUT DECREASES SHARPLY BEYOND THIS

## SESSION 4| ISSUES AND DISCUSSION

During the group discussion feedback was sought from participants on the usefulness and presentation of the forecast, the appropriate definitions of extreme heat events and the comprehensibility of the scientific information communicated.

- There was a clear demand for the skill to be incorporated into the forecast so that users do not need to interpret a skill map to judge how much weight to place on the prediction.
- Forecast flexibility: participants liked the example of the French heat early warning system and had a preference for a forecast product which allowed them to choose their own locally relevant thresholds, rather than an event-specific forecast or warning.
- The inclusion of night-time temperatures and relative humidity in the IITM forecast was seen as very useful
- Participants were happy with the map format of the IITM forecast, preferring this to a stoplight system because of the flexibility this affords to choose locally relevant thresholds for heat warnings.
- The presentation of temperature and relative humidity anomalies was deemed to be confusing, as it was not immediately understood that these represented anomalies relative to climatological normal values.
- Participants wanted the language of the forecast statement to be more accountable to the scientific information. It was not clear how words like “should”, “may” or “likely to” ought to be interpreted.

## SESSION 5: DECISION-MAKING ACROSS TIMESCALES


### READY-SET-GO AND GENERAL STOREEXERCISES

Participants considered what actions could be taken if they had advance notice of a heat wave by 3-days, 1 week, and 1 month – to emphasize the opportunity for diverse actions that can be made available with longer-lead times. Group work identified based on experience of dealing with heat waves, the following types of activities per time-frame. Actions that can be taken with advanced notice:

| Notice of 3-days | Notice of 1 week | Notice of 1 month | Longer term |
|---|---|---|---|
| Work with the mass media on disseminating key public safety messages<br><br>Alert hospitals of increased expected case load<br><br>Inform utilities of increased power demand<br><br>Release of and prepositioning of, supplies in high impact areas, including<br><br>emergency drinking water | Response teams activated<br><br>Establish special facilities such as ORS<br><br>Inform Schools<br><br>Cooling centers and designated facilities<br><br>Modify schedules and event timing to cooler times of day or cancel<br><br>Improved coordination with disaster management authorities and municipalities<br><br>Notify mass media awareness and religious leaders, and share key messages they can help disseminate<br><br>Water supply for huts | Develop heat health action plans<br><br>Procurement and planning for ORS centers and other intervention.<br><br>Refresher training programs of health professionals in heat stress mgmt., of media to use approved messages, etc.<br><br>Simple construction changes such as reflective roofing, shade construction<br><br>Rescheduling events to different days, or less hot times of day<br><br>Conserve water and plan/procure alternative power backup generators for essential services<br><br>Monitor diseases<br><br>Coordinate with utilities in scheduling of power cuts | Permanent event rescheduling (i.e. Ramadan alignment with heat season is known years in advance)<br><br>Training programs of health professionals to diagnose heat stress<br><br>Construction project scheduling to earlier months of the year.<br><br>**POST-DISASTER**<br><br>Damage assessment, mobilize health workers on preparedness planning, |

Specific Issues raised throughout the exercise included anecdotes of negative outcomes for students participating in school sports during high heat periods in Sri Lanka. In Pakistan, impacts of heat waves significant and compounded by energy cut off in slums, hospitals full and overloaded, resulting in government decision to set up community ORS centers. Participants reflected that advanced warning would have allowed a broad range of additional protective activities such as prepositioning of medicines and ORS in hospitals, and planning of pharmacies to not have stock outs. Hospitals and media could have been asked to send messages to public, and contact could have been made with disaster management to activate preparedness plans, municipalities could have been prepared to provide water. During Ramadan, the religious leaders could have made advanced notice to elderly and sick to make sure they do not fast to protect their health.

## SESSION 6: RESOURCES TO SUPPORT HEAT-HEALTH ACTION

*Session 6 shared available resources that can help build capacity and accelerate the scale up of heat-health plans.*

### CITY RESILIENCE TOOLKIT | (IIPH)

This toolkit was developed based on the Ahmedabad experience, and includes a How-to-manual on steps to develop a HHAP; Journal articles; Lessons Learned; and International resources.https://www.nrdc.org/sites/default/files/ahmedabad-resilience-toolkit.pdf This can be easy to refer guide for anyone planning to develop and implement a HHAP in their city/region

### UCHAI NETWORK |WWW.INDIACLIMATEHEALTH.ORG

This network is an example of how to identify and bring together national actors in a neutral non-governmental setting to develop technical work and improve capacity. Proposed 2016 meeting of key actors in India will be convened to formulate and present to the government suggestions and consensus statement on national level concerns and directions as part of a Road Map for a national heat health action plan, to assess available evidence. Resources: Conference Proceedings, Capacity Building Module, Training Opportunities, Web Portal for information sharing of nationally relevant information, mentor program plans, webinar on outcome of CSUF-H Forum to share information and other activities aimed at synergy of a community of practice.

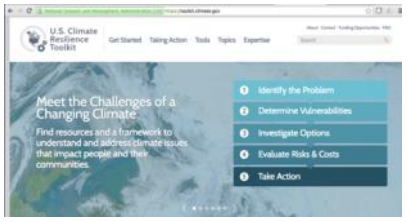
### NATIONAL HEAT HEALTH INFORMATION SYSTEM (NIHHIS)

http://cpo.noaa.gov/AboutCPO/IntegratedInformationSystems/NIHHIS.aspx

New US government initiative. Not a national framework, but can help support the international platform and is ready for international collaboration to advance and support heat/health action in South Asia.

The NIHHIS is an integrated system that builds understanding of the problem of extreme heat, defines demand for climate services that enhance societal resilience, develops science-based products and services from a sustained climate science research program, and improves capacity, communication, and societal understanding of the problem in order to reduce morbidity and mortality due to extreme heat. The NIHHIS is a jointly developed system by the Centers and NOAA.

### US-CLIMATE RESILIENCE TOOLKIT | HTTPS://TOOLKIT.CLIMATE.GOV/




https://toolkit.climate.gov/topics/human-health

https://toolkit.climate.gov/topics/human-health/extreme-heat

Featured tools and resources for health:

**Excessive Heat Events Guidebook:** This guidebook gives public health officials background information on risks and impacts of Excessive Heat Events (EHEs) so that they can make a rough estimate of potential local health risks from EHEs. The guidebook also provides a menu of notification and response actions to consider when developing or enhancing a local EHE program.

**Heat Safety Tool**: This mobile application from the Occupational Safety and Health Administration (OSHA) lets outdoor workers and supervisors calculate the heat index for their worksite. Based on the heat index, the app (for Android and iOS) indicates the risk level to outdoor workers. Users can get suggestions about actions to take at different risk levels to protect workers from heat-related illness.

**Recognizing, Preventing, and Treating Heat-Related Illness:** This course is designed to help coaches, athletic trainers, students, school nurses, parents, teachers, and others understand heat-related illness in student athletes and know how to prevent, as well as treat, it when it occurs. The course includes heat index charts, a wet bulb globe temperature chart, and sweat rate calculator that helps leaders assess if it's safe to play.

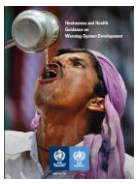
**BRACE Framework**http://www.cdc.gov/climateandhealth/brace.htm

## US CDC TRACKING System|HTTP://EPHTRACKING.CDC.GOV/


The US Tracking System, under Climate Change includes national variables, at the county level (approx. 3000). This can be used as a model for developing national surveillance systems to see the parameters used to track heat vulnerability, exposure, and impacts. Helps health departments have a one stop shop to identify relevant heat exposure data that can allow them to conduct local analyses on observed and experience impacts. The site has downscaled national future climate projections down to the county level so that the information is relevant for health departments. Built on US Census data. Analytics could be made available to help construct similar datasets for vulnerability tracking. Example variables include:

1. Impact: heat stress hospitalizations, heat stress emergency room visits, heat-related mortality.
2. Heat vulnerability: adaptive capacity, exposure, sensitivity (socio-demographics: % poverty, without insurance, over 65 and alone, pre-existing diabetes etc.)
3. Heat exposure variables: Historical extreme heat days and events, temperature distribution, future projections of extreme heat.

## WHO-WMO GUIDANCE AND RESOURCES ON HEAT HEALTH



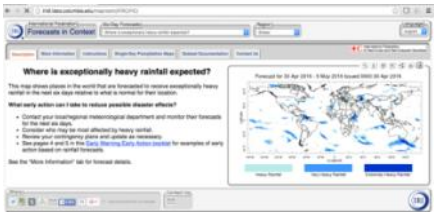
A listing of additional online resources for monitoring and forecasting extreme heat, as well as managing extreme heat events is provided in Annex 3 and 4.

## PAKISTANI RED CROSS-RED CRESCENT SOCIETY

Brochure on Heat Stroke and Illness Awareness Tipshttp://www.prcsindh.org.pk/?p=4267

Heatstroke Treatment and awareness campaign in Karachihttps://www.liverostrum.com/red-crescent-launched-heatstroke-treatment-and-awareness-campaign-in-karachi/1018974.html

## IRI MAPROOMS FORIFRC PREPAREDNESS




https://iridl.ldeo.columbia.edu/maproom/Online data portal of historical and real-time climate information developed by the IRI and the IFRC for humanitarian decision-making. the database is open source and freely available (some features restricted to IFRC) Resolution is coarse at the national level – but provides information on the types of early action that can be taken based on these maps.

## SESSION 7: NEXT STEPS TO RESPOND TO NATIONAL LEVEL NEEDS

*The session identified key issues and opportunities for national action. Proposals were made for new activities and ways to scale up heat health protection at national level across the South Asia Region.*

### BANGLADESH

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|---|---|
| I: Summary | *Extreme heat is an identified risk and specific actions are proposed to strengthen extreme heat risk management. Specific Climate and health policy and project capacity exist within the Ministry of Health, and existing operational collaborations exist with NHMS. A range of proposed activities and requests for technical support were expressed to address the issue.* |
| II: Ongoing Initiatives | - Research by ICDDRB<br>- Operational Health programs and CCHPU in place with capacity to develop new projects and activities |
| III. Needs and Opportunities to improve Extreme Heat Risk Management | - Research: Identified needs to better understand urban heat island effects, population vulnerability, drought related interactions in north.<br>- Sensitization: letter should be sent to districts on heat-stress risks and provide actionable information that can be included and discussed in the sub-district monthly meetings.<br>- Improved heat health surveillance by adding indicators to track heat-related morbidity and mortality<br>- Health Worker Training: Mainstream and sensitive extreme heat risks to health workers including diagnosis and management of heat stress (possibly build on training materials developed in Ahmedabad)<br>- IEC Materials: produced and be localized and gender sensitive<br>- Coordination: need to identify/convene relevant local actors in HHAPs<br>- Heat Forecasting: discuss with BMD potential forecast products for extreme heat alerts – possible R&D project for heat alerts and bulletin.<br>- Proposed to make request to WHO for technical support to build MOH capacity to identify and address heat related health risks<br>- Plans: Next Operational Plan wil include Heat Events as a special work paclage for country-wide awareness and sensitization program - covering all 70 sub-district of Rajshahi, 59 sub-district of Khulna and some more from Sylhet and Chittagong division.<br>- Climate Change and Environmental Health Section of DGHS (Directorate General of Health Services) plans to organize Heat Extreme sensitization program for Doctors and Nurses in all 8 district of Rajshahi Division and 10 districts of Khulna Division; to incorporate Climate Change issues with the service delivery of the 13,500 functioning Community Clinic facilities at Village level; to include BMD in various Climate Change programs at National / Districts /Sub - districts level with a special focus in Extreme Heat Events; to organize training for Health Assistant / Family Welfare Assistant / supervisors - Health Inspector/ Assistant Health Inspector/ FPI - ( Family Planning Inspector ) -- to improve capacity in surveillance of Heat Sensitive Disease. |
| V. NIHHIS Linkages | **Potential HHAP Pilot:** Dhaka City [urban heat islands] including research, forecast and system R&D and piloting, capacity development |
| VI: National Partners | Environment Ministry, WHO, BMD, Red Cross/Red Crescent Society, etc. |

## BHUTAN

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|---|---|
| I: Summary | *Strong climate and health policy and project capacity in ministry of health, with existing collaboration with NHMS. Extreme heat is not yet an identified priority in Bhutan but can be considered along with other efforts proposed for strengthening all-hazards risk management.* |
| II: Ongoing Initiatives | MOH Integrated Disease Surveillance System, Climate and Health Training, DRM activities |
| III. Needs and Opportunities to improve Extreme Heat Risk Management | - Improve SW Forecasting/Alerts: NHMS issued Severe Weather and flood risk alerts are not specific enough for health preparedness. Breakdown in regional specificity could be a good start, and looking at existing system for other sectors.<br>- HIS: Identify key health outcomes/indicators to set a baseline now – that Bhutan can start monitoring to track exposure change over time.<br>- Research: No current information on heat vulnerability. Vulnerability assessment of populations exposed to extreme heat or heat stress could be conducted, such as migrant and agricultural workers in the South – to help consider appropriate thresholds. Could extend to extreme temperatures and include cold exposure.<br>- Consider future research on combined Air quality and heat stress<br>- Water source inventory needs to be updated to include small scale sources relevant for communities.<br>- Impact forecast for diarrheal disease model needs to be validated |
| IV. 2016 Key Relevant events | -Climate and Health Training (October 2016) Thimphu<br>-NCOF May 2016 |
| V. Partners | MOH, Hydro Met, WHO, |
| V. NIHHIS Linkages | No proposed pilots; data system and integrated surveillance; |

## MALDIVES

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|---|---|
| I: Summary | *Heat events are one of many risks, and considered an emerging risk. Multi-hazard risk management is the basis for health sector preparedness and strengthening. Extreme heat events are not yet considered natural disasters, but activities could be developed to strengthen all-hazard alerts to health sector focused on communities and commodity management.* |
| II: Ongoing Initiatives | - Strong DRR platform, and NHMS provide SMS alerts on Severe weather to the MoH |
| III. Needs and Opportunities to improve Extreme Heat Risk Management | - Current severe weather alerts not adequately reaching communities, nor transport managers responsible for sea-routes and shipping. Product development, alert systems, and communication plan could be developed.<br>- Suggestion to extend SMS service to provide email bulletins with more specific risk/impact distribution maps and information on weekly or monthly scale to improve commodity management and transport planning to outer atolls.<br>- Community sensitization<br>- International support and research on evidence of health vulnerability and impacts |
| IV. 2016 Key Relevant events | N/A |
| V. NIHHIS Linkages | TBD |
| VI: National Partners | WHO, National Research Center, National Defense Forces, Red Cross/Red Crescent Society, (etc. please expand) |

## INDIA

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|---|---|
| **I: Summary** | *Extreme heat is an important health risk and specific actions are proposed to strengthen extreme heat risk management in India. Strong political support from key health sector leaders creates favourable conditions for scale up of existing HHAPs and development of new activities. The range of active climate and health, and specific heat and health activities and partners can be further catalysed to support and inform HHAPs.* |
| **II: Ongoing Initiatives** | Policy Process: Gujarat State's Heat Action Plan, Proposed Roadmap for Heat Health National Action (UCHAI Led advocacy and coordination)<br><br>Confirmed HHAP Pilots: Ahmedabad – next phase is testing the new IMD 5-day forecast, sharing experience with other states, conducting vulnerability research and considering how to integrate issues such as water stress and air quality<br><br>New HHAP Projects Nagpu and Vidarbha region of Maharashtra, Surat, Bhubaneswar and state of Odisha<br><br>Other Relevant Projects & Partners:<br>- (UCHAI Led) End to end Climate based Early Warning Systems focused on dengue at city scale.<br>- (RIMES/WMO/IMD/State Planning Commission (SPC) & Public Health |

| | |
|---|---|
| | Department, State Government of Tamil Nadu) Developing prototype Decision Support Systems based on weather and climate information for Malaria and Dengue in two districts of Tamil Nadu. March 2016 consultation meeting hosted by SPC Tamil Nadu.<br>- SAFAR (FMI/IMD/WHO/WMO) air quality, climate change, and health |
| III. Needs and Opportunities to improve Extreme Heat Risk Management | - Support IMD in Marketing of authoritative/accountable status of information for health providers<br>- Advocacy opportunities with new Science and Technology Minister (former Minister of Health)<br>- Health surveillance data validation and improved specific cause mortality reporting<br>- Research on Air Quality and Heat Stress, and Water scarcity/drinking water availability and heat<br>- Operational models for HHAPS: 3 model comparison: Orissa (Disaster Management Authority) Nagpur (State Directive/Support to Municipal Corporation), Ahmedabad (Municipal Corporation) |
| IV. 2016 Key Relevant events | Roadmap for National Heat Health Action Plan<br>Delhi October 2016 \| Air Quality, Climate, Change and Health in India \|Key focal point \| IMD, WHO, FMI<br>Indian Public Health Association Meeting in Jodhpur, Rajasthan in Feb, 2017 |
| V. NIHHIS Linkages | Pilots, Research, Communications, Coordination, Capacity Building |
| VI: National Partners | IIPH-G; UCHAI; IITM, IMD, WHO,(please expand)<br>UCHAI Partners consist of experts from the following institutions: Indian Meteorology Society (IMS), The Energy and Resources Institute (TERI), Indian Institute of Technology, Delhi (IIT), National Institute of Malaria Research (NIMR), National Institute of Urban Affairs (NIUA), Indian Institute of Public Administration (IIPA), All India Institute of Medical Sciences, New Delhi (AIIMS), National Health System Resource Centre, New Delhi (NHSRC) and TARU Leading Edge. |

## PAKISTAN

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|---|---|
| I: Summary | *Extreme heat is an identified important risk and specific actions are proposed to strengthen extreme heat risk management in Pakistan, particularly in the South. A range of climate and health activities have been proposed and requested by the MoH, and specific heat and health activities and partners should be identified and supported for development of HHAPs.* |
| II: Ongoing Initiatives | Proposed V&A Assessments of 6 cities in Pakistan (Share Kathmandu) |
| III. Needs and Opportunities to improve Extreme Heat Risk Management | - Coordination: need for risk sensitization and identification and convening of relevant local actors to inform next steps for HHAPs (proposed workshop to identify existing capacity, needed roles, etc.)<br>- Need technical support and experience sharing for the development of HHAPs (facility and commodity management, media engagement, coordination with urban authorities, etc.)<br>- Need to build upon existing partnership with PMD for flood-risk management to expand coordination, information sharing, and warning communications to all hazard health risk management (including broader spectrum of climate related risks)<br>- Heat Forecasting: discuss with PMD available and potential forecast products for extreme heat alerts – possible R&D project for heat alerts and bulletin.<br>- Policy: Need to have extreme temperatures classified as a natural disaster to trigger DM capacitates during events.<br>- Research: Need to conduct hotspot mapping at the provincial level risks to consider national and provincial scale needs<br>- Research: Need for operational research in Karachi, including looking into the death registry to identify past correlation with extreme heat events (suggest engaging local hospitals and universities to conduct analysis) |
| IV. 2016 Key Relevant events | N/A |
| V. NIHHIS Linkages | Potential HHAP Pilot: Karachi City HHAP, including research, forecast and system R&D and piloting, capacity development. |
| VI: National Partners | CKDN (LEAD); WHO, PMD, Red Cross/Red Crescent Society, (etc. please expand) WASH Network, UNCT/humanitarian cluster |

SRI LANKA

| | |
|---|---|
| I: Summary | *Extreme heat is an identified emerging risk and specific actions are proposed to explore needs and opportunities to consider extreme heat risk management in Sri Lanka. A stocktaking process is needed to identify relevant issues, existing research, and partners.* |
| II: Ongoing Initiatives | In Sri Lanka, extreme heat events are more prominently covered as a climate change issue. The Directorate of Environmental and Occupational Health of the Ministry of Health is the focal point for climate change related health work, and well placed to develop health heat action plans in coordination with other stakeholders. The National Adaptation Plan for 2015 to 2024 includes a health action plan, identifying extreme heat as an issue requiring adaptation action.<br><br>The National focal point for climate change in Sri Lanka is the climate change secretariat of the Ministry of Environment. The Directorate of Environmental and Occupational Health always liaise with the climate change secretariat on climate change activities.<br><br>The DRR framework in Sri Lanka is another vehicle, and includes a National Council for Disaster Management headed by His Excellency the President and the National Disaster Management Coordination Committee (NDMCC) headed by the Ministry of Disaster Management. The NDMCC is a platform for all stakeholders including Health and Meteorology, together with other relevant stakeholders to discuss extreme heat events. However, the EH Directorate is not regularly invited for NDMCC meetings. The MOH focal point for climate change could be used more effectively to coordinate across partners regarding heat related events.<br><br>VBD research and control |
| III. Needs and Opportunities to improve Extreme Heat Risk Management | - Policy: Need to have extreme temperatures classified as a natural disaster to trigger DM and health capacitates during events. Development of a heat health action plan with all stakeholders<br>- Multi-stakeholder forum to to develop guidelines for different target groups especially workers, children and the old; Development of IEC material<br>- Research: HIS reporting is strong across all 26 districts – and analysis of all-cause mortality and ambulatory burden during observed extreme heat events can be conducted to identify excess mortality or morbidity that may be associated with extreme heat. Support research in the areas of air quality and heat events<br>- Capacity building needs: Need to build capacities of health staff and awareness raising for general public<br>- Monitoring and evaluation: Needs to strengthen M&E in the health sector |
| IV. 2016 Key Relevant events | Conducted a National training on climate change for trainers supported by the WHO by the MOH Directorate of Environmental and Occupational health<br>Launching of the National Adaptation Plan for climate change 2015-2024<br>Sri Lanka public health association meeting (Annual Scientific Sessions of the College of Community Physicians of Sri Lanka) |
| V. NIHHIS Linkages | Research, Capacity Building, Data and Information |
| VI: National Partners | Ministry of Health, Ministry of Environment, Ministry of Education, Sri Lanka NHMS, Ministry of Disaster Management, WHO, Red Cross/Red Crescent Society, Professional colleges |

## SESSION 8: DEFINING A REGIONAL HEAT HEALTH NETWORK

Session 7 brainstormed about how a regional support network of partners could unite experts and local partners around common directions in research; data, information and tools; communications and partnerships; and capacity building, to accelerate heat health action. Specific recommendations for the activities a Regional Heat Health network could advance include:

I. RESEARCH

a. **To conduct regional scale South Asia Heat-Health vulnerability assessment** (covering cross-cutting risks of water scarcity, energy cuts, urban planning, informal labor) including regional exposure hotspots and cross-cutting and national action[5].
b. **To conduct systematic review (and knowledge gap analysis) of evidence** on heat-exposure and impacts in the South Asia region[6].

II. DATA, INFORMATION, AND PRODUCT DEVELOPMENT

a. **to provide NHMS guidance/examples** of heat alerts relevant for health – based on good practice and principles suggested in the CSUF
b. **To improve extreme heat prediction products and systems for information dissemination**
c. **To improve data-management systems interoperability for health exposure and impact tracking.** (GFCS pilot to link DHIS-2 and TMA data in Tanzania could provide model for region).
d. **To include heat related illness reporting in the national MIS system (like Integrated Disease Surveillance Project-** IDSP in India)

III. PARTNERSHIPS &COMMUNICATIONS

a. Recommendation for NHMS to **designate health focal points** for a chain of command/information flow to tailor information flow and ensure timely use. Need for MOH to officially do the same.
b. Recommendation specific to India – for IMD to help clarify national to local office chain of command and collaboration – since health officials need to interact with local IMD offices that do not produce the products.
c. Promote opportunities for cross-fertilization of conferences and technical meetings
d. Explore opportunities for technology transfer and knowledge exchange
e. Compile **a communications kit** of existing resources specific to heat-health messaging: including Guidance on Communications, with example materials of general and localized products.
f. Propose ways to address issues of information accountability and authenticity – as private sector and online weather information becomes available. (e.g. Issues of single authorities for issuing warnings, specific populations/gender/target audiences; making sure messages are evidence-based; credibility of forecast products and public health warnings.)

IV. CAPACITY DEVELOPMENT

a. Request WHO support to develop Technical Guidance on HHAP Guidance for South Asia
b. Explore student and faculty exchange opportunities, volunteer expert mentor program to link HHAP teams with expert resources who can share ideas and backstop with technical resources remotely (facilitate exchange visits as funding allows).
c. **For meteorological training/capacity building** –

- Explore existing training/capacity platforms such as WMO PWS Program; SASCOF and NCOF Training days where health sessions can be incorporated.
- To develop training curricula for NHMS professionals (consider IRI-CIPHA course) and focus on NHMS capacity for: scientific communication; understanding of comparable observational data collection systems; understanding of the complex causal pathways of climate and health impacts;

[5] Building blocks include expanding on WHO-funded work at subnational level in India, planned Pakistan urban V&As, WHO desktop V&As)
[6] Building blocks include: TARU assessment in India

d. For health training/capacity building-

- to add heat specific case studies to WHO-SEARO- Climate and Health Training Module on Heat. Disseminate this resource.
- to identify existing relevant training materials, courses, online and elsewhere in heat-epidemiology, how to use climate information, eco-epidemiology. For example, IIPH have platform to run 3m online course – but need funding to run; Medical Schools/IFMSA may be interested to organize specific heat focused training; UCHAI Webinars for information sharing.

V. EVALUATION Consider monitoring

## CONCLUSIONS: CLIMATE SERVICES FORUM FOR HEALTH RECOMMENDATIONS

The meeting concluded with recommendations for four key steps to be taken forward in 2016.

1. To communicate, Advocate, and Share Resources on heat health in South Asia

- Produce CSF-Health Meeting Report, including draft national and regional action plan.
- Organize discussion with WMO and NOAA |to map out and provide guidance on regional network and how South Asia HH network can benefit from NIHHIS
- Create a web presence for the CSUF | UCHAI Webinar proposed June 2016 to share meeting outcomes with wider audience; NIHHIS Website launch (May) could feature South Asia section; WHO-WMO Office Website to feature CSF-H Meeting information (Immediate)
- Disseminate meeting information, resources, and network plans with wider community | since limited number of potential partners were present at the CSF-H - efforts to reach out to a broader regional public health community is needed to identify further research and public health practice partners. Suggestions made to generate a contact list for information sharing and explore professional meetings as a key opportunity for engagement. Upcoming meetings include: Public health association meetings (joint presentation on heat/health or organize specific panels/sessions); IMD meetings October Delhi (sector specific indices meeting) (air quality, climate change, health)

2. To advance product R&D on the IITM experimental 3-week Regional Heat Outlook

- IITM to continue to update the heat outlook over the remainder of the heat season – should be shared with meeting participants and relevant partners.
- Develop short and longer term plans for developing extreme heat products and bulletins.
- WHO-WMO Office to notify WHO Regional Offices of outcomes and specific areas for needed support. Notifiy WMO PRS of meeting outcomes: by sharing report, and (cover letter) to a) solicit future collaboration with national health authorities by designating a health focal point of contact, b) share the IITM heat outlook, c) request support to validate the outlook – for 2017 improvements.
- Develop useful infographic of heat outlook (IRI - Hannah Nissan exploring)
- Identify mechanism to assess and provide feedback on the "value" of the predictions in terms of health sector access, responses and actions and identification of additional information/packaging required for better utility of the outlooks. Suggested inclusion as activity in the national pilot work, particularly in India.

3. To Develop National Action Profiles

- National representatives to further refine proposed activities based on meeting discussions with local stakeholder to further develop pilot projects and technical activities that respond to identified needs of the health sector in South Asia.
- Identification and concept notes for of NIHHIS pilot projects and activities

4. To establish a Regional Heat Health Network and action plan

- Develop propsal based on 1st CSF-H and the NIHHIS Framework to unite partners around common directions in research, capacity building, partnerships, and data and information. IIPH-G have expressed interest to take a leading role in this activity.

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## ANNEX 2: AHMEDABAD HHAP RESOURCES

Dear Colleagues / participants of CSF-Health in Colombo:

Greetings from IIPHG..!!

IIPHG, the Public Health Foundation of India (PHFI), the Natural Resources Defense Council (NRDC), University of Washington, and the Climate Development Network (CDKN) collaborated with the Ahmedabad Municipal Corporation (AMC) launched the Heat Action Plan (HAP) in 2013, the first comprehensive early warning system and preparedness plan for extreme heat events in South Asia. Since then the Plan released every subsequent heat season has improved the components including stakeholder training and capacity building, community outreach activities, and inter-agency communication. With rising temperatures and the threats of climate change, several cities, state and central government officials, researchers and civil society groups have shown an interest in expanding heat wave preparedness and disaster planning in India. Now with the help of IIPHG, NRDC and other key partners, the efforts of Ahmedabad Heat Action Plan has been scaled to several regions of India and released Heat Action Plans in March 2016, including Nagpur Region, Odisha Region, and Surat.

Sharing with you Ahmedabad Heat Action Plan, published papers and other related materials which are freely available on the websites from the following links:

**Ahmedabad Heat Action Plan 2016: Guide to Extreme Heat Planning in Ahmedabad, India**: https://www.nrdc.org/sites/default/files/ahmedabad-heat-action-plan-2016.pdf

For background reading, here are key documents on the heat action plan. I'd recommend starting with the **YouTube video and the**

**YouTube Video**: https://www.youtube.com/watch?v=mEZS_6rgi-Y

**CDKN Inside Story**: Inside Story link: http://cdkn.org/resource/addressing-heat-related-risks-india/

**IIPHG - NRDC Issue Brief Series**

- Rising Temperatures, Deadly Threat (March 2013): *Slum Community* : https://www.nrdc.org/sites/default/files/india-heat-slum-communities-IB.pdf

- Rising Temperatures, Deadly Threat (March 2013): *Outdoor and Construction Workers* https://www.nrdc.org/sites/default/files/india-heat-outdoor-workers-IB.pdf

- Rising Temperatures, Deadly Threat (March 2013): *Medical Professionals* https://www.nrdc.org/sites/default/files/india-heat-health-professionals-IB.pdf

- Rising Temperatures, Deadly Threat (March 2013): *Local Government*: https://www.nrdc.org/sites/default/files/india-heat-government-officials-IB.pdf

- Expanding Heat resilient Cities Across India (March 2016): https://www.nrdc.org/sites/default/files/india-heat-reslient-cities-ib.pdf

**RE Munich Risk Award 2015** (Page 32 & 33): http://www.risk-award.org/dms/MRS/Documents/RISK-Award/2015_RISK_Award_Firsthand_news_low.pdf

**Published Scientific Articles**

*PlosOne Journal Article: Heat-Related Mortality in India: Excess All-Cause Mortality Associated with the 2010 Ahmedabad Heat Wave* (March 2014): http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0091831

*International Journal of Environmental Research and Public Health Journal Article: Development and Implementation of South Asia's First Heat-Health Action Plan in Ahmedabad* (Gujarat, India) (January

2014): http://www.mdpi.com/1660-4601/11/4/3473

*Journal of Environmental and Public Health: Neonates in Ahmedabad, India, during the 2010 Heat Wave Journal Article: A Climate Change Adaptation Study* (January 2014): http://www.hindawi.com/journals/jeph/2014/946875/

*A Cross-Sectional, Randomized Cluster Sample Survey of Household Vulnerability to Extreme Heat among Slum Dwellers in Ahmedabad, India Journal Article* (June 2013): http://www.mdpi.com/1660-4601/10/6/2515

*Indian Journal of Occupational and Environmental Medicine: Perceived heat stress and health effects on construction workers (January 2016): http://www.ijoem.com/text.asp?2015/19/3/151/174002*

## ANNEX 3: ONLINE TOOLS AND RESOURCES. EXTREME HEAT MONITORING AND FORECASTING TOOLS USEFUL FOR HEALTH RISK ASSESSMENT

| Risk Monitoring Tools | | Global | Regional | National | Health |
|---|---|---|---|---|---|
| Heat-Health Watch – UK | Service operates annually between June and mid-September to forecast maximum day and nighttime temperatures and monitor temperatures. Once a heat threshold is passed, warnings are sent to health professionals and updated on their website | | | ● | ● |
| France's Heat Health Watch Warning System | Advisories and monitoring of high temperatures occurs in France between June and August. The Met service coordinates and collaborates with the Ministry of Health to issue warnings about potential heat waves. | | | ● | ● |
| Heatwave Service for Australia – Bureau of Meteorology | National heat wave monitoring and forecasting service for Australia. Provides monitoring from the past two three day periods and forecasts heat waves for the next three to five days. | | | ● | ● |
| National Weather Service – National Oceanic and Atmospheric Administration | Heat-health warning system for the U.S. Each NWS Forecast Office issues a specific one for their region. They also provide a contiguous U.S. forecast map of maximum and minimum temperatures in real-time and maximum heat index forecasts. | | | ● | |
| **Risk Forecasting Tools** | | **Global** | **Regional** | **National** | **Health** |
| Extreme Heat Risk Map (EEA) | Online interactive GIS map of the heat wave risk of European cities based on historical data and climate change projections. | | ● | | |
| EuroHEAT | Medium range heat wave forecasts for Europe for 1-9 day lead times. Forecasts are updated each day and issued for the next 9 days. The forecasts from the past nine days are also available so users can monitor the development of the event. | | ● | | |
| Meteoalarm | Provides extreme heat warnings and alerts for Europe. Information is displayed on an interactive map with available reports and warnings that can be downloaded for each country that have high alerts. | | ● | | |
| Climate Prediction Center - NOAA | Provides forecasts for excessive heat and above normal temperatures | | | ● | |

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|---|---|
| for the United States at 3-7 day lead times. | |

## ANNEX 4:RESOURCES FOR HEALTH RISK MANAGEMENT DURING EXTREME HEAT

| Risk Management and Communication Tools | | Global | Regional | National | Health |
|---|---|---|---|---|---|
| Guidance Documents | | | | | |
| Communicating the Health Risks of Extreme Heat Events | Document for health professionals and emergency managers about how to best communicate the risks of extreme heat. | | | ● | ● |
| Heatwave Plan for England | Provides information about extreme heat and health in England so that people can prepare for, know where to find alerts, and prevent health issues associated with heat waves. | | | ● | ● |
| Heatwave Plan Ahmedabad India | Document discusses how to build awareness, initiate warnings and coordination, build capacity in the health sector, and reduce heat exposure in India. | | | ● | ● |
| Health Vulnerability Index at Sub-national Level in India | The climate vulnerability index for the health sector at the sub-national level in India is a decision making tool for policy planners and program managers | ● | ● | ● | ● |
| **Baseline Vulnerability** Assessment of Baseline Vulnerability for Climate-Sensitive Diseases at the Local Level in India | This is a detailed assessment in two districts carried out as a validation exercise for the index mentioned above. | ● | ● | ● | ● |
| WHO/WMO Heat waves and Health: Guidance on Warning-System Development | Guidance document for practitioners, National Meteorological and Hydrological Services (NMHSs), and National Health Services (NHSs) surrounding extreme heat and how to prepare for and develop heat health warning systems. | ● | | | ● |
| WMO Guidelines on Biometeorology and Air Quality Forecasts | Guidance document for NMHSs on methods of incorporating biometeorology and air quality forecasts into their products and services. | ● | | | |

| | | | | | |
|---|---|---|---|---|---|
| WHO/WMO Atlas of Health and Climate | Provides scientific information on the connection between weather and climate and health challenges. | | | | |
| WHO Heat Health Action Plans | Guidance document for improving public health response to heat waves through the development of heat-health action plans. | ● | ● | ● | ● |
| CDC's Climate Change and Extreme Events | Provides information of how to prepare and respond to extreme events, including extreme heat. | | | ● | ● |
| Web Resources | | | | | |
| Extreme Heat Toolkit for Health Sector (HealthCanada) | Provides information about extreme heat and health including brochures, reports, and guidebooks. | ● | | ● | ● |
| CDC's Extreme Heat and Your Health | Supplies information on how individuals can protect themselves from extreme heat as well as provides resources for public health professionals. | ● | | ● | ● |
| Disaster Information Management Research Center | Provides resources and information pertaining to extreme heat and health. | ● | | ● | ● |
| Environmental Protection Agency | Tips and resources for preparing for and dealing with extreme heat. | | | ● | ● |
| National Oceanic and Atmospheric Administration | U.S. Climate Resilience Toolkit – Extreme Heat. Presents information on the background of extreme heat in the U.S. and its impacts on health. Provides links to featured tools and case studies in the U.S. | | | ● | ● |
| Natural Resources Defense Council (NRDC) – Extreme Heat | Provides information on extreme heat and health, along with maps of the U.S. depicting heat exposure, and resources on the topic. Future risks to health. | | | ● | ● |
| **India Climate Change and Disease Dynamics (Executive Summary)** | Synopsis of the Edited Volume Climate Change and Disease Dynamics in India with 20 chapters covering different dimensions of the linkages including a chapter on thermal stress | | | ● | ● |

| Key Relevant Programs and Partners | | | | |
|---|---|---|---|---|
| World Meteorological Organization | Supports the health sector with weather and climate science tools, services, and resources. | ● | | |
| World Health Organization | Provides support to improve health outcomes for countries around the world. | ● | | ● |
| Centers for Disease Control and Prevention | Provides health information in relation to extreme heat and guidance on how to prepare, respond, and stay safe during heat waves | | ● | ● |
| Health Canada | Provides sound scientific knowledge and communicates public health threats to promote and support healthier lives. | | ● | ● |
| National Oceanic and Atmospheric Administration | Climate Program Office seeks to understand, communicate, and educate the risks associated with extreme heat. | | ● | ● |
| UK MET Office | Provides health forecasts for health conditions that are affected by weather in order to help people take preventative action. | | ● | ● |

## BIBLIOGRAPHY


(IPCC), I. P. (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* (R. P. Core Writing Team, Ed.) Geneva: IPCC.

Ahmedabad Municipal Corporation (AMC). (2015). *Ahmedabad Heat Action Plan 2015: Guide to Extreme Heat Planning in Ahmedabad, India.*

Azhar et al, G. S. (2014). Heat-Related Mortality in India: Excess All-Cause Mortality Associated with the 2010 Ahmedabad Heat Wave. *PLOS One, 9*(3).

Centre for Research on the Epidemiology of Disasters (CRED). (2015). *The Cost of Natural Disasters: A global perspective*. Retrieved February 01, 2016, from http://emdat.be/human_cost_natdis

Dianne Lowe, K. L. (2011). Heatwave Early Warning Systems and Adaptation Advice to Reduce Human Health Consequences of Heatwaves . *International Journal of Environmental Research and Public Health, 8*, 4623-4648.

European Climate Adaptation Platform. (n.d.). *Heat Waves*. Retrieved February 01, 2016, from Climate-ADAPT European Climate Adaptation Platform: http://climate-adapt.eea.europa.eu/tools/urban-adaptation/climatic-threats/heat-waves

Hansen, K. (2012, August 06). *Research Links Extreme Summer Heat Events to Global Warming*. Retrieved January 29, 2016, from National Aeronautics and Space Administration (NASA): http://www.nasa.gov/topics/earth/features/warming-links.html

Jeffrey Berko, D. D. (2014). *Deaths Attribued to Heat, Cold, and Other Weather Events in the United States, 2006-2010sr076.pdf.* National Health Statistics Report, Centers for Disease Control and Prevention and National Center for Health Statistics, U.S. Department of Health and Human Services.

Jeremy J. Hess, J. Z. (2012). Integrating Climate Change Adaptation into Public Health Practice: Adaptive Management to Increase Adaptive Capacity and Build Resilience. *Environmental Health Persectives, 120*, 171-179.

Natural Resources Defense Council (NRDC). (2008, July 01). *Temperature Rising: Global Warning Turns up the Heat on Human Health.* Retrieved January 28, 2016, from Natural Resources Defense Council: http://www.nrdc.org/health/rising-facts.asp

Nikolaos Christidis, G. S. (2014). Dramatically increasing the change of extremely hot summers since the 2003 European heatwave. *Nature Climate Change*.

Scott Greene, L. S. (2011). An Examination of Climate Change on Extreme Heat Events and Climate-Mortality Relationships in Large U.S. Cities. *Weather Climate and Society, 3*(4), 281-292.

Shaposhnikov, D. (2014). Mortality related to air pollution with the Moscow heat wave and wildfire of 2010. *Epidemiology, 25*(3), 359-364.

Smith et al, K. (2014). Human Health: impacts adaptation, and co-benefits. In V. B. C.B. (Ed.), *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* (pp. 709-754). Cambridge and New York, U.K. and New York: Cambridge University Press.

United Nations Office for Outer Space Affairs. (2015). *Extreme Temperature*. Retrieved February 01, 2016, from UN-SPIDER Knowledge Portal: http://www.un-spider.org/risks-and-disasters/natural-hazards/extreme-temperature

Watts et al, N. (2015). Health and climate change: policy responses to protect public health. *The Lancet Commissions, 386*, 1861-1914.

WHO and WMO. (2012). *Atlas of Health and Climate.* Geneva: WHO Press.

World Bank. (2013). *Turn down the Heat: Climate extremes, Regional Impacts, and the Case for Resilience.* Washington, D.C.: World Bank.

World Meteorological Organization (WMO) and World Health Organization (WHO). (2015). *Heatwaves and health: guidance on warning-system development.* Geneva.