**Chapter:** Hazard

Identified case studies

|  |  |  |  |
| --- | --- | --- | --- |
| 1.Humid heat waves at different warming levels | Global | 2017 | <https://www.nature.com/articles/s41598-017-07536-7.pdf> |
| 2.Lancet Countdown | Global | 2017 | <http://www.lancetcountdown.org/the-report/> |
| 3.Surface heat assessment for developed environments: Probabilistic urban temperature modelling | USA | 2017 | <http://linkinghub.elsevier.com/retrieve/pii/S0198971517300613> |
| 4.Evaluation of albedo enhancement to mitigate impacts of urban heat island in Rome (Italy) using WRF meteorological model | Italy | 2017 | <http://linkinghub.elsevier.com/retrieve/pii/S2212095517300652> |
| 5.Global Hazard Map (Met Office) | Global | 2017 | No live link |

**Chapter:** Hazard

**Name:** Humid heat waves at different warming levels

**Publication:** Nature Scientific Reports

**When published:** August 2017

**Overview:** A quantification of humid heat wave hazard in the recent past and at different levels of future global warming. Heat waves can be strongly amplified by humidity.

**Who involved:** - European Commission, Joint Research Centre, Ispra, Italy

- Institute for Environmental Protection and Research, Rome, Italy

- CICERO, Oslo, Norway

- Royal Netherlands Meteorological Institute (KNMI), De Bilt, Netherlands

**What is done:** Defines Apparent Heat Wave Index (AHWI), inclusive of relative humidity.

Takes previous perilous heatwaves (Chicago 1995, China 2003, Europe   2003, Russia 2010), and classifies them differently based on how much of a contribution humidity had on the impact.

Projects using various climate change scenarios how the AHWI.

**Why interesting:** Proposes a new heat wave index, Apparent Heat Wave Index (AHWI) to more effectively give warnings and better classify heat waves as a hazard.

**How potentially useful:** Highlights regions (particularly tropical and subtropical regions) as requiring an adequate understanding of how humidity may be a factor in future dangerous heat wave occurrence.

**Suggestions for future: ‘**This calls for respective adaptation measures in some key regions of the world along with international climate change mitigation efforts.’

**Key facts and figures:** ‘Humid-heat waves with these conditions were never exceeded in the present climate, but are expected to occur every other year at 4° global warming.’

‘At 4 °C warming the yearly probability of occurrence of a heat wave with magnitude greater than the RU2010 will be greater than 10% in Central Europe, India, and across many African regions. **The Eastern US, Northern Latin America and China are expected to experience such type of heat waves with an annual probability greater than 50%, corresponding to an average return period of two years**. This probability is greater than the one projected in the hottest world regions, such as the Arabian Peninsula, Australia and other dry-deserts’.

‘Our results show that some of **the most densely populated regions are among those that are most exposed to humid heat waves**.’

**Links:** <https://www.nature.com/articles/s41598-017-07536-7>

**Chapter:** Hazard

**Name:** Lancet Countdown

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Hazard

**Name:** Surface heat assessment for developed environments: Probabilistic urban temperature modelling

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Hazard

**Name:** Evaluation of albedo enhancement to mitigate impacts of urban heat island in Rome (Italy) using WRF meteorological model

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Hazard

**Name:** Global Hazard Map (Met Office)

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Country** | **Year** | **Source(s)** |
| 1.Global risk of deadly heat | Global | 2017 | <http://www.nature.com/nclimate/journal/v7/n7/full/nclimate3322.html> |
| 2.Estimating population heat exposure and impacts on working people in conjunction with climate change | Global | 2017 | <https://www.ncbi.nlm.nih.gov/pubmed/28766042> |
| 3.Deadly heat waves projected in the densely populated agricultural regions of South Asia | India | 2017 | <http://advances.sciencemag.org/content/3/8/e1603322> |
| 4.Opportunities and Challenges for Personal Heat Exposure Research | Global | 2017 | <https://ehp.niehs.nih.gov/wp-content/uploads/2017/07/EHP556.alt_.pdf> |
| 5.Future population exposure to US heat extremes | USA | 2015 | <http://www.nature.com/nclimate/journal/v5/n7/full/nclimate2631.html> |

**Chapter:** Exposure

Identified case studies

**Chapter:** Exposure

**Name:** Global risk of deadly heat

**Publication:** Nature Climate Change

**When published:** June 2017

**Overview:** A meta-analysis of documented lethal heat events to identify climatic conditions deadly to human health, which uses projections of population and climate to identify exposure of future global population.

**Who involved:** - University of Hawai’i, Honolulu, USA

- Thermal and Mountain Medicine Division, U.S Army Research Institute of Environmental Medicine, Massachusetts, USA

- National Centre of Atmospheric Science, Department of Meteorology, University of Reading, Reading, UK

**What is done:** Uses 783 cases of excess human mortality of excess mortality from heat from 164 cities in 36 countries.

Uses machine learning (SVMs) to identify global threshold beyond which surface air temperature and global humidity become deadly.

Projects increase of population exposure of deadly heat days using population and climate projections.

**Why interesting:** Large-scale meta-analysis of deadly heat events, with a novel analysis of deadly heat days using machine learning.

**How potentially useful:** Highlights that although tropical humid areas will experience less warming than higher latitudes, they will be exposed to the greatest increase in the number of deadly days over time.

**Suggestions for future: ‘**This calls for respective adaptation measures in some key regions of the world along with international climate change mitigation efforts.’

**Key facts and figures:** ‘Around 30% of the world’s population is currently exposed to climatic conditions exceeding this deadly threshold for at least 20 days a year.’

‘By 2100, this percentage is projected to increase to 48% under a scenario with drastic reductions of greenhouse gas emissions and 74% under a scenario of growing emissions.’

‘While it is understood that higher latitudes will undergo more warming than tropical regions, our results suggest that tropical humid areas will be disproportionately exposed to more days with deadly climatic conditions.’

**Links:** <https://www.nature.com/articles/s41598-017-07536-7>

**Chapter:** Exposure

**Name:** Estimating population heat exposure and impacts on working people in conjunction with climate change

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Exposure

**Name:** Deadly heat waves projected in the densely populated agricultural regions of South Asia

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Exposure

**Name:** Opportunities and Challenges for Personal Heat Exposure Research

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Exposure

**Name:** Future population exposure to US heat extremes

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Vulnerability

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Country** | **Year** | **Source** |
| 1.Programs to reduce social isolation in the elderly |  |  |  |
| 2. Undocumented Latino Communities |  |  |  |
| 3. Incarceration and Extreme Ambient Heat |  |  |  |
| 4.Homless |  |  |  |
| 5.Workers |  |  |  |

**Chapter:** Vulnerability

**Name:** Programs to reduce social isolation in the elderly

**Overview:**

Social isolation [amongst the elderly] is associated with increased mortality, poor self-rated physical health and increased susceptibility to dementia. It is well known that without taking appropriate measures, extreme heat events can have a negative effect on human health, leading to a higher mortality, particularly in large urban areas and most of all in vulnerable populations (such as the elderly and young). The older population is at significant risk for hyperthermia and hypothermia; concomitant diseases, multiple medications, and altered perceptions increase the risk of developing complications during heat waves, with isolated elderly being particularly susceptible.

**Who involved:**

Elderly populations, particularly those who are considered lonely or isolated. Community members. Social service workers.

**What is done:**

Programs either provide activities or support to elderly. Large variety in programs, but those considered the best included in-person contact, participatory, and in a group setting. More data and evaluations are needed.

**Why interesting:**

Seeks to reduce syndemic vulnerabilities to EHE: living alone, and be over the age of 65. Has many co-benefits, but programs need to be further studied and evaluation criteria created.

**How potentially useful:**

Very useful and low cost. Has many co-benefits beyond heat health.

**Suggestions for future:**

Increase in programs and increase in monitoring and evaluating these programs.

**Key facts and figures:**

Majority of the victims of the 2003 heatwave in France were elderly individuals living alone.

**Links:**

Dickens AP, Richards SH, Greaves CJ, Campbell JL. Interventions targeting social isolation in older people: a systematic review. *BMC Public Health*. 2011;11:647. doi:10.1186/1471-2458-11-647.

CATTAN, M., WHITE, M., BOND, J., & LEARMOUTH, A. (2005). Preventing social isolation and loneliness among older people: A systematic review of health promotion interventions. Ageing and Society, 25(1), 41-67. doi:10.1017/S0144686X04002594

Findlay R. Interventions to reduce social isolation amongst older people: where is the evidence? Ageing Soc. 2003;23:647–658. doi: 10.1017/S0144686X03001296. [[Cross Ref](https://dx.doi.org/10.1017%2FS0144686X03001296)]

Cattan M, White M. Developing evidence based health promotion for older people: a systematic review and survey of health promotion interventions targeting social isolation and loneliness among older people. Internet Journal of Health Promotion. 1998.

**Chapter:** Vulnerability

**Name:** Undocumented Latino Communities

**Publication:**

1. Sanjeeb S. et al. Unauthorized Border Crossings and Migrant Deaths: Arizona, New Mexico, and El Paso, Texas, 2002–2003.
2. Bethel J, Harger R. Heat-Related Illness among Oregon Farmworkers
3. Moyce S. et al. Heat strain, volume depletion and kidney function in California agricultural workers

**Overview:** Extreme heat is the number one cause of death for undocumented border crossers crossing the US-Mexico border. Many of those that successfully cross the border (legally or illegally) engage in migrant farm work - which is “climate sensitive” and often exposes workers to extreme temperatures. In the short term, migrant farm work in extreme heat can lead to heat stress, and in the long term, without adequate access to water is linked to heat stress induced chronic kidney disease.

**Who involved:**

**What is/could be done:**

Occupational Health Regulations

HHWS at border

Harm reduction approach to UBC

**Why interesting:**

Not a vulnerable community listed in HHAP. Has major implications for other migrant groups in other locations around the world. [See Example.](http://www.un.org/apps/news/story.asp?NewsID=56886#.WabJtoSGOUk) Deaths of UBC between US-Mexico is up 17% this year, even though number of migrants is down, suggesting an increase in risks.

**How potentially useful:**

Could bring awareness to this growing problem. Could help create guidelines towards reducing HH vulnerabilities for migrants.

**Suggestions for future:**

Would be interesting to look at undocumented migrant conditions in detention centers where many work. Intersections between incarceration, migration, and occupational HH issues.

**Key facts and figures:**

Extreme heat is the number one cause of death for UBC along the US-Mexico border

[Migrant deaths between US and Mexico is up 17% this year even though there has been a steep decline in the number of crossers.](https://www.theguardian.com/us-news/2017/aug/05/migrants-us-mexico-border-deaths-figures)

Heat stroke is the leading cause of work-related death among farm workers

A report released by Oxfam and the Farm Labor Organizing Committee (FLOC) in 2011 cites the Centers of Disease Control and Prevention (CDC), stating “During 1992-2006, a total of 68 crop workers died from heatstroke, representing a rate nearly 20 times greater than for all U.S. civilian workers.” [[source]](http://nfwm.org/education-center/farm-worker-issues/health-safety/)

**Chapter:** Vulnerability

**Name:** Incarceration and Extreme Ambient Heat

**Main Publication (see footnotes for additional information sources):**

Holt D. HEAT IN US PRISONS AND JAILS Corrections and the Challenge of Climate Change

<https://web.law.columbia.edu/sites/default/files/microsites/climate-change/holt_-_heat_in_us_prisons_and_jails.pdf>

**When published:**

2015

**Overview:**

Some 2.2 million inmates are currently incarcerated in around 1,800 prisons and jails across the United States. Nearly half a million correctional employees work in these facilities. Indoor environmental conditions in prisons and jails therefore have a direct impact on the health of well over 2.5 million people. Climate scientists forecast with a high degree of confidence that average temperatures in the US will rise throughout this century and that heat waves will become more frequent, more severe, and more prolonged. Extreme heat is already the most common cause of weather related death in the US and it will only become a graver threat to public health in the coming decades. Rising temperatures and increasingly harsh extreme-heat events will jeopardize the health of inmates and correctional officers alike, and will stress the physical plant of the correctional sector. Adapting their systems and facilities to greater heat and the other impacts of climate change will become an urgent challenge for correctional departments. The success or failure of correctional adaptation efforts will be measured in human lives as well as public dollars. [[source](https://web.law.columbia.edu/sites/default/files/microsites/climate-change/holt_-_heat_in_us_prisons_and_jails.pdf)]

**Who involved:**

Governments, private sector (private prisons), incarcerated populations, prison staff and prison guards.

Overlap between occupational health, governmental regulations, human rights, and heat health vulnerabilities because prison population is aging, many pre-existing health conditions amongst prison population, and force dependence on the state.

**What is done:**

1. This is being talked about primarily in the legal realm.
2. Some prisons have developed their own HHAP
3. In mid-July [2017], a United States [federal judge sided](https://texasattorneygeneral.gov/news/releases/ag-paxton-texas-will-appeal-prison-heat-ruling) with a group of Texas inmates who sued the Texas Department of Criminal Justice (TDCJ) over summer heat conditions at the Wallace Pack Unit near Houston. The groundbreaking decision deemed that exposure to extreme heat was cruel and unusual punishment. The decision also referenced the impact of climate change.[[source]](http://www.acclimatise.uk.com/network/article/a-deadly-combination-extreme-heat-and-us-prisons)

**Why interesting:**

1. US prison population is incredibly large, however this issue is applicable across the globe.
2. There are many prisons found in Southern US which are projected to experience a worsening of EHE in the coming decades.
3. Affects correctional guards, staff, and prisoners - all people at the prison.
4. High likelihood of underreporting of deaths.
5. Recently came to media attention after [this event.](https://www.forbes.com/sites/marshallshepherd/2017/07/23/three-reasons-prisons-and-extreme-heat-are-a-volatile-mix/#7bdeac306308)

**How potentially useful:**

Addressing extreme ambient heat in Prison could:

Improve prisoner well being

Improve guards and staff well being

Improve rehabilitation of prisoners

Reduce stressors

Improve prison functioning

**Suggestions for future:**

There are examples of prisons with HHAP

Regulations

Risk Management/Adaptive Responses such as air conditioning

Moving prisons to cooler locations (especially in regions where EHE are frequent)

Reduction in prison population size (alternative rehabilitation, reduce overcrowding)

**Key facts and figures:**

Only 30 of Texas’ 109 prison units are fully air-conditioned. In the summer, the temperature in Texas averages over 908F. Prisoners enclosed in a small place with little freedom to move experience temperatures in excess of that. The Texas Department of Criminal Justice (TDCJ) reports the daytime temperatures at facilities reaching over 1008F by 8:30 a.m (University of Texas School of Law Human Rights Clinic, 2014). The National Weather Service (2014) classifies that as an “extreme danger” category. One half of the 109 TDCJ facilities were built partially or fully with metal; the buildings retain heat and the indoor temperature remains high. Personal fans are sold to inmates for $22.50, a price out of reach for most. Regardless, the CDC has shown that fans do not prevent heatstroke and heat-related illness when temperatures are above 908 (Suarez et al., 2014).

Risk factors for succumbing to heat-related illness, including advanced age, poor mental and physical health, and the use of medications, are prevalent among the 2.2 million US inmates. The inmate population is graying, with one in ten prisoners now 55 or older. Inmates over 50 are generally much less healthy than their peers in the outside world. Mental illness is widespread among inmates of all ages. Obesity, hypertension, and asthma are commonplace. Large numbers of inmates take medications that compromise the body’s ability to handle heat.

**Chapter:** Vulnerability

**Name:** Homeless

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Vulnerability

**Name:** Workers

**Publication:**

**When published**

**Chapter:**

**Name:**

**Overview:**

**Who involved:**

**What is done:**

**Why interesting:**

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Human Impact

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Country** | **Year** | **Source** |
| 1. Extreme ambient heat increasing occupational injuries |  |  |  |
| 2. Cascading Failures: Syndemic health effects of EHE and infrastructure failures |  |  |  |
| 3. |  |  |  |
| 4. |  |  |  |
| 5. |  |  |  |

**Chapter:**  Human Impact

# Extreme ambient heat increasing occupational injuries

**Publication:** Multiple

Source:

Tawatsupa B, et al. Association between Heat Stress and Occupational Injury among Thai Workers: Finding of the Thai Cohort Study. *Industrial Health*. 2013; 51, 34-48.

Source: Gubernot DM, Anderson GB, Hunting KL. Characterizing Occupational Heat-Related Mortality in the United States, 2000–2010: An Analysis Using the Census of Fatal Occupational Injuries Database. *American journal of industrial medicine*. 2015;58(2):203-211. doi:10.1002/ajim.22381.

More

**When published:** 2013

**Overview:**

“We report on the association between heat stress and workplace injury among workers enrolled in the large national Thailand Cohort Study in 2005...Nearly 20% of workers experienced occupational heat stress which strongly and significantly associated with occupational injury (adjusted OR 2.12, 95%CI 1.87-2.42 for males and 1.89, 95%CI 1.64-2.18 for females). This study provides evidence connecting heat stress and occupational injury in tropical Thailand and also identified several factors that increase heat exposure.”

**Who involved:** Workers, but especially workers involved in potentially dangerous work or vulnerable workers.

**What is done:**

1. Heat Safety Tool [(Phone app](https://www.osha.gov/SLTC/heatillness/heat_index/heat_app.html)) - Created by: DOL, OSHA, CDC, NIOSH
2. [Government Occupational Safety Standards (Thailand)](http://www.ilo.org/dyn/natlex/docs/MONOGRAPH/97666/116005/F-1878314023/THA97666%20Eng.pdf), [Chinese Government Occupational Heat Safety Regulations](http://www.chinasafety.gov.cn/newpage/Contents/Channel_6288/2012/0704/172990/content_172990.htm).
3. [Union/employer negotiated occupational heat health safety protocols](https://teamster.org/divisions/warehouse/contract-language) (need better example)

**Why interesting:**

Not enough attention is paid to the many reasons why heat management is necessary to protect workers. Not only can workers suffer from heat illness, they are also more likely to face occupational injuries as performance suffers under heat.

**“Possible consequences of excessive heat stress include an increase in the likelihood of occupation injury due to fainting, confusion, poor concentration, and psychological distress, resulting in reduced protection and unsafe working conditions.”**

Additionally, minor traumatic brain injuries, which under normal temperatures would result in a quick recovery, can lead to permanent injury or death when the worker is hyperthermic.

Chronic dehydration has been linked to [Heat Stress Induced Chronic Kidney Disease](https://www.ncbi.nlm.nih.gov/pubmed/24412050).

**How potentially useful:**

Very. Both in regards to creation of regulations and best practices, but also the enforcement of these practices/regulations. Being proactive in protecting workers health can foster collaborative relationships between stakeholders, but failing to do so risks health, productivity, and exacerbates employer-employee tensions which can result in litigations, [strikes](http://www.cbc.ca/news/canada/british-columbia/farm-worker-temporary-death-washington-smoke-wildfires-bc-1.4241348), etc.

**Suggestions for future:**

Extreme ambient heat on occupational health is a major source of concern, requiring greater attention and stronger regulations and protections.

Need more data, but particularly from the LMIC.

**Key facts and figures:**

“Between 2000 and 2010, 359 occupational heat-related deaths were identified in the U.S., for a yearly average fatality rate of 0.22 per 1 million workers. Highest rates were found among Hispanics, men, the agriculture and construction industries, the state of Mississippi, and very small establishments...Agriculture and construction had the highest rates for HRI deaths” in the US.

**Chapter:**  Human Impact

**Name:** Cascading Failures: Syndemic health effects of EHE and infrastructure failures

**Publication:** Multiple

Utility Management Papers

Electricity

<http://columbiaclimatelaw.com/files/2016/06/Aivalioti-2015-01-Electricity-Sector-Adaptation-to-Heat-Waves.pdf>

Air and Water Quality

<http://www.tandfonline.com/doi/full/10.1080/10962247.2013.851044>

**Overview:**

“Demand for electricity usually increases during heat waves, leading to potential brownouts and blackouts.”

Certain vital infrastructure (such as transportation, electricity, water, etc) is particularly vulnerable during extreme ambient heat events. Failure of this infrastructure can worsen the health consequences of extreme heat events, and should be taken into account when planning risk management and adaptive responses to future events. Not enough attention is focused on these cascading failures, and they should be incorporated into HHAP to prevent/lessen the effects of infrastructure failure.

**Who involved:**

Everyone can be affected, especially in locations with aging infrastructure. The governmental sector is best positioned to manage risks and take preventative actions.

**What is done:**

Many potential solutions, most likely a variety of solutions will be needed.

Urban planning/alternative material use

Upgrading aging infrastructure

Governmental regulations (to promote infrastructure upgrades & behavior changes)

Decentralized renewable energy

**Why interesting:**

Cascading failures can act as tension multipliers, sparking looting and rioting in stressed communities (due to wealth inequities, etc.). “The 1977 New York City blackout was distinguished from those of 1965 and 2003 by violence, arson, and looting that occurred in several areas. These acts resulted in 204 civilian injuries, 436 police injuries, 80 firefighter injuries, and 1037 fires. The violence, arson, and looting caused extensive long-term physical and functional damage to certain areas of two boroughs of the city, Brooklyn and the Bronx.“

Certain cascading failures have recently come to public attention, such as the grounding of airline flights from Phoenix, AZ when a heat wave reached a high of 118F (~43C).

Transportation:

An 100-year-old Bridge in Seattle, WA was closed multiple times, to spraying water on the structure to keep the metal from expanding and damaging the span.

During EHE, trains are either required to slow down or cease operation as the metal of the tracks expands.

Water infrastructure is also vulnerable - with old pipes bursting during EHE. and water supplies can diminish with increasing pipe breaks and water demand.

Another interesting aspect is how cascading failures can influence human behavior in a way that jeopardizes health. For example, blackouts/brownouts/water shortages during an EHE often forces people out of their homes, exposing them to greater radiant heat, air pollution - such as ozone, exposure to exertional heat stress,  increase exposure to toxic algae blooms and drowning.

**How potentially useful:**

Awareness to cascading failures is incredibly important.

Difficult to parse out the health effects related to cascading failures versus the extreme ambient heat itself. Most likely there is a syndemic relationship. More research could go into understanding these relationships.

**Key facts and figures:**

**Chapter:** HHWSs

Identified case studies

|  |  |  |
| --- | --- | --- |
| **Name** | **Country** | **Source(s)** |
| 1.Defining and predicting heat waves in Bangladesh (under review) | Bangladesh | <http://journals.ametsoc.org/doi/pdf/10.1175/JAMC-D-17-0035.1> |
| 2.Developing of framework on heat-health warning system in Thailand | Thailand |  |
| 3.Heat-Health Action Plan to prevent the consequences on the health of the population in the former Yugoslav Republic of Macedonia | Macedonia | <http://www.euro.who.int/en/countries/the-former-yugoslav-republic-of-macedonia/publications3/heat-health-action-plan-to-prevent-the-heat-wave-consequences-on-the-health-of-the-population-in-the-former-yugoslav-republic-of-macedonia> |
| 4.Ahmedabad Heat Action Plan | India | <https://www.nrdc.org/sites/default/files/ahmedabad-heat-action-plan-2017.pdf> |
| 5.Validation of a Temperature Prediction Model for Heat Deaths in Undocumented Border Crossers | USA | <https://link.springer.com/content/pdf/10.1007%2Fs10903-012-9619-1.pdf> |

**Chapter:** HHWSs

**Name:** Defining and predicting heat waves in Bangladesh

**Publication:** Journal of Applied Meteorology and Climatology

**When published:** 2017

**Overview:** The paper proposes a heat wave definition for Bangladesh that could be used to trigger preparedness measures in a heat early warning system (HEWS). The paper also explores sources of predictability for heat waves from a weather to seasonal timescale.

**Who involved:** - The Earth Institute of Columbia University, New York, USA

- Mailman School of Public Health, Columbia University, New York, USA

- Red Cross Red Crescent Climate Centre, The Hague, The Netherlands

- Institute for Environmental Studies, VU University Amsterdam, The Netherlands

**What is done:** Uses generalized additive regression model to propose a definition of a heatwave requiring elevated minimum and maximum daily temperatures over 95th percentile for three consecutive days.

Explores sources of predictability for heat waves in Bangladesh, on both weather forecasts up to 30 days.

**Why interesting:** A stand-out example of a technical exploration of both how to classify heat waves and how best to predict them.

**How potentially useful:** Could be an example to show the ‘art of the possible’ of how expert institutions can work with decision makers to create an effective HEWS tailored to local requirements, working within limitations of health and weather data from developing LMICs.

**Suggestions for future:** Provide weather forecasts for heat wave risk in Bangladesh.

Explore sources of predictability for forecasts on sub-seasonal to seasonal timescales, such as soil moisture.

**Key facts and figures:** ‘Low soil moisture increases the odds of heat wave occurrence for 10 to 30 days, indicating that sub-seasonal forecasts of heat wave risk may be possible by monitoring soil moisture conditions.’

‘Mortality increased by 22% (95% CI: 8-38%) on day-and-night heat wave days, and by 24% ‘(95%CI: 10-40%) on humid-day-and-night heat wave days’.

‘We conclude that day-and-night and humid-day-and-night indicators are 17 the best predictors of mortality from the six indices tested, and we focus on these for the remaining analyses.’

**Links:** http://journals.ametsoc.org/doi/abs/10.1175/JAMC-D-17-0035.1

**Chapter:** HHWSs

**Name:** Developing of framework on heat-health warning system in Thailand

**Publication:** World Health Organization

**When published:** Not yet published (most likely 2017)

**Overview:** The report details work that has led to the development of a HHWS framework in Thailand, a country with a sub-tropical climate.

**Who involved:** - World Health Organization, Country Office for Thailand

- School of Public Health, University of Washington

- Faculty of Medicine, Chiang Mai University

- Meteorological Department, Thailand

- Bureau of Policy and Strategy, Ministry of Public Health, Thailand

**What is done:** The report identifies heat-health temperature threshold in Thailand, then develops heat-health warning criteria.

**Why interesting:** A stand-out example of how to work with multiple partners to create a from-scratch HHWS using appropriate involvement of government-level stakeholders. A relatively untapped area of the world (Asia and sub-tropical climate) introducing a clearly necessary HHWS and HHAP.

**How potentially useful:** Could be an example to show the ‘art of the possible’ for other countries in similar position.

**Suggestions for future:** Proposed as adoption and implementation as an early warning to raise awareness in a wide range of societal concern and improve decision making in preparing effective guidance on heat-voidance and mitigating heat-related illness among Thai population especially in vulnerable groups.

**Key facts and figures:** ‘The number of heat stressed morbidity is substantially increasing from 2010-2013, which is 1,020, 1,241, 1,810, 2,742 cases, respectively.’



**Links:** not currently online

**Chapter:** HHWSs

### Name: Heat-Health Action Plan to prevent the consequences on the health of the population in the former Yugoslav Republic of Macedonia

**Publication:** World Health Organization4

**When published:** 2011

**Overview:** The report details work that has led to the development of a HHWS framework in FYRM with the help of the German government.

**Who involved:**    - World Health Organization, Regional Office for Europe

- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany

- FYRM government (more specific?)

**What is done:** Develops a HHWS for FYRM (called ALERT) as part of a wider HHAP, using 5 meteorological regions countrywide, classifying into 4 warning levels.

Website created ([www.toplotnibranovi.mk)](about:blank) to ‘monitor heat-wave announcements in the FYRM’.

Created threshold temperatures for alerts from health data using Gaius allocation for determining threshold air-temperature values.

**Why interesting:** Demonstrates an example of how another country with expertise (in this case Germany) could work with another with relatively limited resources to provide an operational HHWS and HHAP system.

Clear evaluation structure of how HHWS and HHAP after each summer.

**How potentially useful:** Shows two European partners working together to create a HHWS from scratch

**Suggestions for future:** Implementation of HHAP in FYRM

**Key facts and figures:** ‘In the FYRM over 60% of the population lives in the cities.’

‘According to projections for mortality trends in the country and Skopje for the period after 2035, an increase of only 1C in average monthly temperatures compared to the period 1996-200 will significantly influence the distribution of total mortality expressed as a monthly average. This increase in the monthly mortality rate would be 4-11% higher in the months of April, May and June and an average of 10% higher compared to the period April, May, and June 1995-2004’

‘During the heat-waves in 2007, there were 1000 more deaths during the summer period in comparison to the average for the same period 2004-2007’.

**Links:**

<http://www.euro.who.int/en/countries/the-former-yugoslav-republic-of-macedonia/publications3/heat-health-action-plan-to-prevent-the-heat-wave-consequences-on-the-health-of-the-population-in-the-former-yugoslav-republic-of-macedonia>

http://www.euro.who.int/\_\_data/assets/pdf\_file/0019/215524/PROTECTING-HEALTH-FROM-CLIMATE-CHANGE-A-seven-country-initiative.pdf

**Chapter:** HHWSs

### Name: Ahmedabad Heat Action Plan 2017 and Development and Implementation of South Asia’s First Heat-Health Action Plan in Ahmedabad (Gujarat, India)

**Publication:** NRDC5, International Journal of Environmental Research and Public Health6

**When published:** 2014, 2017

**Overview:** The report gives an update on the operational Ahmedabad Heat Action Plan, providing ‘a framework for the implementation, coordination, and evaluation of extreme heat response activities in Ahmedabad that reduce the negative health impacts of extreme heat.’

**Who involved:**    - Ahmedabad Municipal Corporation (AMC)

                         - India Meteorological Department (IMD)

                                - Indian Institute of Public Health, Gandhinagar

                                - Public Health Foundation of India

                                - Natural Resources Defense Council (NRDC)

                                - Natural Resources Defense Council

                                - Mount Sinai School of Medicine

                                - Climate & Development Knowledge Network

                                - School of Public Health, University of Washington

- School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta

**What is done:** Uses forecasts from a system based on ‘ECMWF Variable Ensemble Prediction System (VarEPS) that is statistically post-processed and calibrated to adjust for model bias in a manner similar to previous work conducted at Georgia Tech’ to create a 7-day probabilistic weather forecast, now brought in-house at IMD.

Developed range of alert levels based on health data (confirm?)

**Why interesting:** Took mix of public and academic to improve forecasting system based on lack of former adequate advance warning from IMD (previously 1 day forecast)

**How potentially useful:** Demonstrates technical partnership of between meteorological agency and academic institutions to create functional warning system.

**Suggestions for future:** Capacity building (more specific?)

**Key facts and figures:** ‘One of India’s fastest growing cities, Ahmedabad is the economic center of the state of Gujarat. Ahmedabad district, including the surrounding suburban and rural areas, is home to 7.2 million people.’

**Links:** https://www.nrdc.org/sites/default/files/ahmedabad-heat-action-plan-2017.pdf

**Chapter:** HHWSs

### Name: Validation of a Temperature Prediction Model for Heat Deaths in Undocumented Border Crossers

**Publication:** Journal of Immigrant Minority Health

**When published:** 2013

**Overview:** ‘A validation study of a weather prediction model that predicts the probability of heat related deaths among undocumented border crossers.’

**Who involved:**   - Department of Emergency Medicine, University of Arizona

                            - Office of the Medical Examiner, Pima County, AZ, USA

**What is done:** Uses health data, daily high temperature (DHT) as the predictor.

Takes medical examiner registry cohort of undocumented border crosser heat-related deaths from January 1, 2002 to August 31, 2009.

Uses logistic regression to model probability of number of deaths given DHT.

Found that a quadratic model of DHT works best to predict deaths,

**Why interesting:** Focusses on a largely untapped area of study, which is how to help warn and prevent undocumented migrants from crossing a border when there is a danger of heat wave.

**How potentially useful:** Use of structure as HHWS for dissemination of warnings along dangerous borders when EHEs are likely.

**Suggestions for future:** ‘These results can be used in prevention and response efforts to assess the daily risk of deaths among undocumented border crossers in the region’.

**Key facts and figures:** ‘The Arizona portion of the United State-Mexico border is the most frequently used section of the border by undocumented border crosses (UBC), with approximately 500,000 UBCs apprehended by the United States Broder Patrol (USBP) per year.’

Environmental heat exposure is the ‘leading cause of death among UBCs, with 61% of deaths attributable to heat-related causes.’

‘35% increase in the risk of a dearth occurrence for each 1C increase in the DHT’

**Links:** https://link.springer.com/article/10.1007/s10903-012-9619-1

**Chapter:** Adaptive Response

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Country** | **Year** | **Source** |
| 1. Philadelphia Block Captains |  |  |  |
| 2. Conflicting Public Health Risk Management and Adaptation - emphasizing the local context |  |  |  |
| 3. Prohibiting the shut offof electricity and water utilities during a heat wave due for non-payment. (the case of Missouri) |  |  |  |
| 4. |  |  |  |
| 5. |  |  |  |

**Chapter:** Adaptive Response

**Name:** Philadelphia Block Captains

**Publication:** [Excessive Heat Events Guidebook (EPA)](https://www.epa.gov/sites/production/files/2016-03/documents/eheguide_final.pdf) & [Strategies to Reduce the Harmful Effects of Extreme Heat Events: A Four-City Study](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3945579/)

**When published:** June 2006

**Overview:**  Philadelphia’s block captains are a critical point of interaction between the public and  
the Health Department during EHEs. Block captains are volunteers elected by residents  
of their block to help coordinate neighborhood improvement projects with the city.  
Philadelphia currently has about 5,000 block captains. They can both identify and evaluate  
the health status of high-risk and hard-to-reach individuals in their residential area during  
an EHE. Although block captains are not required to contact specific individuals during a  
declared EHE, anecdotal evidence suggests that many do. Their actions most likely benefit  
others and, during declared heat events, news crews frequently record and broadcast  
block captains checking on the status of high-risk individuals in their area, spreading the  
message to check on those at risk.

**Who involved:** City government (public health department) and individuals within local communities.

**What is done:** Individuals are elected as “block captains” to spread the heat health messages of the health department, check in on vulnerable individuals, and assist when issues may arise.

**Why interesting:** Social capital program that shares responsibility of responding to extreme heat with the community.  Has been viewed as successful, and has been around for awhile.

**How potentially useful:** Very - in communicating risk, responding to EHE, and in building social capital.

**Suggestions for future:** Expand to other communities. Needs further evaluation.

**Key facts and figures:**

<http://www.philadelphiastreets.com/pmbc/>

**Links:**

[**https://www.epa.gov/sites/production/files/2016-03/documents/eheguide\_final.pdf**](https://www.epa.gov/sites/production/files/2016-03/documents/eheguide_final.pdf)

[**http://www.philadelphiastreets.com/pmbc/become-a-block-captain/**](http://www.philadelphiastreets.com/pmbc/become-a-block-captain/)

**Chapter:** Adaptive Response

**Name:** Conflicting Public Health Risk Management and Adaptation - emphasizing the local context

**Publication:**

**When published:**

**Overview:**

There are many examples when heat risk management and adaptive responses contradict public health recommendations addressing different or similar concerns. These can involve recommending that people open their windows at night - which can be quite dangerous in certain areas of the world due to crime. Similarly, messages which encourage people to participate in outdoor activities can elevate exposure to ozone and extreme ambient heat.

“Example:

For West Nile Prevention - Stay indoors at dusk and dawn, when mosquitoes are most active. Avoid areas with heavy vegetation or shaded areas (i.e. woods)”

For Heat Health - Go outdoors only in the coolest part of the day. When outdoors, stay in the shade whenever possible.”

**Who involved:**

**What is done:**

**Why interesting:**

Having risk management and adaptive responses that don’t contradict other public health efforts are vital for reducing risks and providing clear communications to the general public.

Effective HHAP require collaboration between many sectors and stakeholders. Starting this process early can help reduce the chance of promoting conflicting messaging

**How potentially useful:**

**Suggestions for future:**

**Key facts and figures:**

**Links:**

**Chapter:** Adaptive Response

**Name:** Prohibiting the shut offof electricity and water utilities during a heat wave due for non-payment. (the case of Missouri)

**Publication:**

<http://www.lsmo.org/node/616/hot-weather-rule-utility-disconnections>

**When published:**

**Overview:**

List of US state “Disconnection Laws” [[source](https://liheapch.acf.hhs.gov/Disconnect/disconnect.htm)]

“Utility companies have initiated and financially supported HHWS in the US. Most important where population relies on heavily air conditioning (as in the US)”

**Who involved:**

Utility companies

Governmental Regulations

Civic Engagement

**What is done:**

Several locations have laws which prohibit electricity and water utilities from turning off power/water as a result of non-payments. Missouri has a “Hot Weather Rule” which prohibits electricity shut off every year between June 1 and September 30. On any day [during this period] when the National Weather Service local forecast predicts that the temperature will be greater than 95 degrees or the heat index will be greater than 105 degrees, utility providers are prohibited from disconnecting electricity service.

Certain states have laws targeting specifically the most vulnerable demographics (such as people over the age of 55 years).

**Why interesting:**

**How potentially useful:**

Very useful, especially for protecting the most vulnerable.

**Suggestions for future:**

Switching from a date specific time frame, to a temperature threshold could better prepare Missouri for increasing temperatures related to climate change.

**Key facts and figures:**

**Links:**