Dealing with Extreme Heat Risks: A Narrative on Promising Practices for Local Governments and Their Citizens

Background

Extreme heat events, including heat waves, are on the rise in the Southwest. Heat waves kill more Americans than any other type of weather phenomenon. They are persistent, and many communities are not well prepared. All citizens are affected by heat. Those most at risk from extreme heat events include the elderly, homeless, socially isolated, and many low-income residents. In addition, athletes and outdoor workers are at elevated risk for heat-related illness and death. Our urban areas amplify heat, through the heat absorbing characteristics of the built environment. Moreover, regional temperatures have been increasing, especially in the last several decades.

In the Intermountain Southwest, extreme heat episodes can affect individual cities in almost any year. In the last decade, ***region-wide heat waves*** affected the region in 2005, 2006, 2012 and 2013. In each heat episode, cities tied or broke record high temperatures, or consecutive days with temperatures above a recognizable threshold, such as 90°F or 100°F. A June 27-July 4, 2013 heat episode, which stretched from Salt Lake City to El Paso, set many records. The 2013 heat episode included impacts from increased emergency room visits and deaths, to highway buckling, power outages, and airport flight cancellations.

The Intermountain Southwest is not alone in addressing the challenges of extreme heat episodes. Throughout the world, extreme heat has become a major concern of urban planners and others. This has led to a wide variety of initiatives, in the U.S. and other countries, to improve preparedness for extreme heat episodes, create and implement early warning systems, and develop comprehensive heat-health action plans and communities of practice.

What Can Be Done?

Best Practices, Planning Approaches, and Adaptive Strategies

The national and international public health and climate communities agree upon a general set of principles and best practices to prepare for and respond to extreme heat (e.g., WHO, 2008; MDH, 2012; WMO-WHO, 2015). This is commonly referred to as a heat-health action plan. The core elements include:

1. **agreement on a lead body** (to coordinate a multi-purpose collaborative mechanism between bodies and institutions and to direct the response if an emergency occurs);
2. **accurate and timely alert systems** (heat-health warning systems trigger warnings, determine the threshold for action, and communicate the risks);
3. **a heat-related health information plan** (about what is communicated, to whom, and when);
4. **a reduction in indoor heat exposure (medium- and short-term strategies)** (advice on how to keep indoor temperatures low during heat episodes);
5. **particular care for vulnerable population groups**;
6. **preparedness of the health and social care system** (staff training and planning, appropriate health care, and the physical environment);

7. **long-term urban planning** (to address building design and energy and transport policies that will ultimately reduce heat exposure);
8. **real-time surveillance and evaluation** (to address public health outcomes, such as illnesses and deaths)**;**
9. **monitoring and evaluation of process and outcomes** (this category is an addition proposed by the World Health Organization Europe Office, and it makes explicit the need to evaluate the heat-health plan)**.**

For items 2 through 9 above, best practices, planning approaches, and adaptive strategies are recommended by a number of organizations. These recommendations are based on years of experience, research, and outreach in cities across the United States and the world.

Accurate and timely alert systems

"The overall aim of an HHWS [Heat-Health Warning System] is to alert decision-makers and the general public to impending dangerous hot weather and to serve as a trigger point for the implementation of advice on how to avoid negative health outcomes associated with hot weather extremes" (WMO-WHO, 2015). HHWSs include weather forecasting, the links between weather and health outcomes, and the determination of thresholds for communication and actions. There is no one-size-fits-all system that can accommodate all locations; thus, warning systems must consider local weather, demographics, and urban structure. These systems require communication in language that is easily understood by the public and decision-makers, and messaging to the media and the public (discussed below) with clearly stated recommended actions.

- *Considerations and adaptive strategies*:
    - In the U.S., many cities use the National Weather Service (NWS) heat index, which combines temperature, humidity, and wind speed. The NWS will initiate alert procedures when the heat index is expected to exceed 105°F-110°F (depending on local climate) for at least 2 consecutive days.
    - In cities where heat index values higher than 105°F are common, such as Phoenix and Las Vegas, a high percentage of the population may be acclimatized to the heat, and they may already have adequate adaptive strategies for the majority of extreme heat episodes. In such cases, it is especially important to select thresholds that accurately connect temperature and public health outcomes (usually, mortality).
    - Most HHWSs do not account for indoor conditions, and indoors is where most of the population spends their time. Warning criteria are based on outdoor weather observations and forecasts.

A heat-related health information plan

Development of a well-structured communication strategy that details what is communicated, to whom, and when, is recommended at the beginning of and during summer to reduce the health impacts of heat. This strategy should be prepared beforehand and should include information on how to: stay cool and hydrated; keep out of the heat (including locations of cooling centers and methods of transportation to get there); help others; get help if you have a health problem or others feel unwell (WHO, 2008). The means of communication is as important as the type of

information to be communicated. The most common methods of dissemination include leaflets, websites, and radio and television advertisements.

To maximize the effectiveness of heat-health information plans, especially in preparation for heatwaves, public health officials should work with government and policy- and decision-making officials; this is important, because it affects the allocation of resources for preparedness and response. One strategy advocated by the World Health Organization, based on the experiences of cities, is developing communities of practice. Communities of practice can integrate the weather, public health, air quality, emergency management, and other participants in heat-health planning and response—to remove the gaps between the provision, understanding, and use of information (see figure, below). For example, the heat-health information plan for the Catalonia region of Spain is comprised of professionals from public health services, primary health teams, hospitals, social care services, town councils, weather forecast services, pharmacies, and security forces. The plan requires groups to share information and coordinate along two lines of communication: internal communication amongst members of the community of practice, and external communication to the public and certain risk groups (WMO-WHO, 2015).

- *Considerations and adaptive strategies:*
    - Some cities have found that messaging from city government has limited penetration to at-risk populations. They advise that trusted messengers, especially those whose messages have an effective reach into the community, are most effective; these may include National Weather Service, broadcast meteorologists, physicians, and pharmacists.
    - Many cities in the U.S. are experimenting with multiple media for disseminating public health messages. These include billboards and highway electronic message signs, a variety of social media, television advertisements, radio announcements, hotlines, targeted phone calls, and general mobile phone alerts. The WHO (2008) cautions that while the Internet may be appropriate for informing medical practitioners, the individuals most at risk may not be frequent users.
    - With respect to pet owners who wanted to go to a cool place, but didn't want to leave their pets at home because they were afraid their pets might die, Olmsted County (Minnesota) found that, to improve their rigorous heat-health plan, they needed to work more closely with animal shelters, the humane society, veterinarians, and other organizations to provide affordable and effective alternatives for pet care during extreme heat emergencies (MDH, 2012).
    - Messaging caution is also advised, in order to not trigger false alarms and lose the trust of the public. Other promising advice on effective messaging includes a reminder that many people will not perceive that they are at risk, and that they are not motivated to be concerned about their well-being. However, these same individuals may be motivated by concern for loved ones, neighbors, and pets.

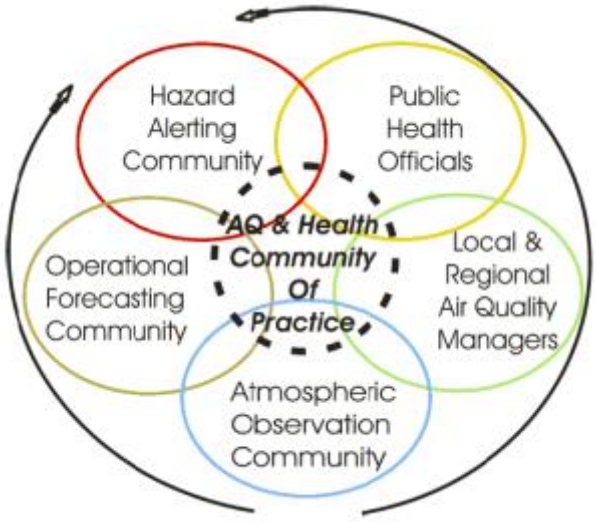

Figure: Example of an air quality and public health community of practice structure (WMO-WHO, 2015).

- *Key Collaborations*
  - A survey by White-Newsome et al. (2011) suggests successful community of practice collaborations between medical professionals, city and county departments (e.g., social services, parks & recreation, regional planning, public works), National Weather Service, NGOs (e.g., American Red Cross, United Way, Salvation Army), civic organizations (e.g., Rotary Club), meals on wheels, shelters, libraries, and fire and police departments.
  - In the Southwest, El Paso has collaborated with Wal-Mart, which has donated fans in heat emergency situations.
  - The San Francisco Department of Public Health receives support from agencies including Animal Care & Control, the San Francisco Unified School District, Neighborhood Emergency Response Teams, the Mayor's Office on Disability, and the Medical Reserve Corps (SFDPH, 2013).
  - For help planting trees, Hoverter (2012) suggests community partners including social organizations, such as garden clubs and civic groups, and local businesses, such as plant nurseries.
  - Several California state agencies have partnered together, such as the Department of Conservation, the Department of Fish and Wildlife, the Department of Food and Agriculture, and the Department of Housing and Community Development. The state has also partnered with cooling equipment suppliers (Brown et al. 2013).

A reduction in indoor heat exposure

The ability to cool off, especially during the evening, is critical in reducing heat-related illnesses and deaths. Most people spend a majority of their time indoors, and some are isolated; thus, reducing exposure to indoor heat can be crucial for saving lives. Studies suggest that air conditioning is an effective intervention; however, access to air conditioning, or the cost of using

air conditioning, can inhibit people from using this cooling strategy. In the short term, making cool spaces available, or providing access to mobile evaporative coolers, air conditioners, and fans (less effective) can help. The City of El Paso, Texas, sometimes in collaboration with Wal-Mart, successfully provides free fans to city residents during heat emergencies.

- *Considerations and adaptive strategies*:
    - Some cities encourage longer term heat exposure reduction measures, such as building design that includes external shading, passive cooling features (e.g., ponds, fountains), and additional building thermal mass. These features are well-tested in older traditional European buildings (WHO, 2008).
    - A particular challenge facing Arizona is that, in many parts of the state, extreme heat occurs as a chronic hazard, with dangerously high temperatures persisting throughout the warm season. Continual high nighttime lows do not allow the body to recover from the daytime heat, if no access to cooling is available. Vulnerable populations are at particular risk when nighttime temperatures remain high, as they typically do for several consecutive days in the summer in Arizona (Chuang et al. 2015) and Las Vegas.
    - By working with public and private sector partners, Minnesota has shown success with opening cooling centers at freely air-conditioned locations that the public already frequents, such as shopping malls, libraries, and movie theaters. Providing free transportation to these locations will further reduce risk to vulnerable populations (MDH, 2012).

Particular care for vulnerable population groups

Research has identified some particularly vulnerable sectors of the population, including: the elderly, people with pre-existing health conditions or mental health conditions, children ages 5 years and younger, people on certain medications, those with economic constraints that limit mobility and access to cooling, and socially isolated individuals (MDH, 2012). In addition, athletes, military personnel, and outdoor workers are often more vulnerable to extreme heat episodes, due to their high exposure to extreme heat.

- *Considerations and adaptive strategies*:
    - In Arizona, Latinos were increasingly vulnerable to heat stress while the number of vulnerable whites decreased because of both demographic shifts and intensified Urban Heat Island effects in traditionally minority neighborhoods (Chuang et al. 2015).
    - GIS mapping of multiple indicators of vulnerability, such as percent of elderly living alone, can help identify susceptible groups (e.g., MDH, 2012).
    - The buddy system has been a useful individual-to-neighborhood-scale approach, in order to ensure that the most vulnerable are not isolated during extreme heat events.
    - Many cities use emergency heat telephone lines (e.g., 211) to provide information during extreme heat events. Minnesota notes that a *reverse 911 call system* can be activated, so that numbers that call 911 during an extreme heat event can be dialed and notified of current information on weather forecasts and safety measures (MDH, 2012).
    - Follow-up with some high-risk individuals should be considered to ensure that tips are being followed and overexposure can be treated as early as possible. This

can be done by social and health workers, volunteers, church organizations, other nongovernmental agencies (e.g., Red Cross), Meals on Wheels, or the police (MDH, 2012).

Preparedness of the health and social care system

An important aspect of preparation for extreme heat events is preparing the health and social care community and allied partners and organizations. In advance of a heat-health warning, the best practice is to clearly define the specific procedures hospitals, clinics, and retirement and nursing homes should adopt before and during the high heat season, or in anticipation of a heat wave. WHO (2008) recommends that these actions be linked to heat-health warnings. In addition, care homes and residential care providers need guidance and standards for providing adequate air conditioning, cooling rooms, shade structures or tree plantings, and other measures to reduce exposure to extreme heat.

- *Considerations and adaptive strategies*:
    - Medical personnel often vacation during the summer time, the season of highest risk of extreme heat emergencies. It is critical to ensure that medical facilities have adequate staff during the summer
    - Adaptive strategies, such as cooling centers, can be undermined if they close early in the day, or are not adequately staffed on weekends.

Long-term urban planning

The Urban Heat Island (UHI) effect is a phenomenon in which urban areas are substantially warmer than surrounding rural areas due to a higher concentration of pavement and structures that reduce shade areas and absorb heat during the day and release it at night. Appropriate urban planning, in combination with a strong emergency response and preparedness plan, can reduce the UHI, and thus reduce the risks associated with extreme heat (Hoverter, 2012).

Most built-environment strategies combine the following elements: urban design (e.g., greenways, oases, transit-oriented design); cool roofs which reflect sunlight; cool pavements which reflect sunlight and absorb water (cooling nearby areas by evaporation); green roofs which absorb water and sunlight; and urban forest and tree planting programs, which provide shade and absorb water.

Three examples of implementation of these practices, including the partnerships involved in funding the programs, are in the table, below (excerpted from Hewitt et al., 2014).

City	**Agencies involved (lead agency)**	**Impacts of UHI mitigation**	**Entities that provide funding for city UHI programs**
New York	There are over 25 agencies involved in the writing and implementing of PlaNYC and its subsequent policies and programs.	By November 2013, 800,000 trees have been planted since 2007. In 2012 80,000 trees were planted and 63 green streets were completed. 5,753,560 square feet of roofs are cool roofs.	ConEdison (electric utility); other corporations; professional associations; building-owners; housing associations; local development corporations; nonprofits; coating and supply vendors;

Philadelphia	Parks and Recreation; Philadelphia Water Department; Philadelphia Corporation for Aging; Philadelphia Department of Public Health; The Office of Emergency Management; and the Mayor's Office of Sustainability	163 porous pavement projects totaling 72.3 acres; 80 green roofs totaling 16 acres, with 21.7 acres under construction across 60 sites	PENNVEST Loans; the Tookany/Tacony Frankford Watershed Partnership; Pennsylvania Horticultural Society; Energy Coordinating Agency; EnergyWorks; Philadelphia Gas Works EnergySense; Philadelphia Housing Authority; Philadelphia Housing Development Corporation
Phoenix	Office of Environmental Programs; Aviation Department; Department of Public Works; Parks and Recreation; Water Services; Street Transportation Department	52,000 square feet of cool roofs; 13% vegetative cover.; average of 92 days over 100 degrees annually	Arizona Public Service (electric utility); Arizona State Forestry Division; Arizona Community Tree Council; Office of Arts and Culture; Arizona Municipal Water Users Association; National Arbor Day Foundation; NOAA

- *Considerations and adaptive strategies:*
    - Many cities across the country have already established UHI-related goals, the most common of which is increasing urban tree canopy. Cities are also tracking progress using quantifiable metrics such as hospital visits and changes in temperature and vegetation. While many cities have implemented various combinations of these measures, most have not evaluated the success of the measures in reducing heat and elevated heat risk (Hewitt et al. 2014).
    - The *Cool Houston Plan* (HARC, 2004) is a great example of successful urban planning. Key strategies include:
        - Targeting rooftop and paving surfaces that are replaced or resurfaced every year.
        - Targeting surfaces most likely to change, such as parking lots.
        - Using incentives and regulations.
        - Actions that provide additional benefits and are affordable. For example trees are inexpensive and not only provide shade but improve property values, lower air conditioning costs, and help prevent flooding.
    - Most cities have voluntary programs, such as rebate and loan programs, and preferential permitting. Some cities have mandatory policies. Examples are in the table below (excerpted from Hewitt et al., 2014).

City	Type	Policy	Notes
Chicago	Voluntary	Vegetated roof, stormwater management.	Expedited green permits for construction involving a green roof, rainwater harvesting, solar roof, solar thermal, wind turbine, geothermal.
Dallas	Mandatory	Stormwater ordinance	Ordinance 28813 requires that all plots of construction must allow 70% of the land area to be permeable or capture water runoff for on-site infiltration. It also requires that ENERGY STAR roofs be installed on all roofs with slope of 2:12 or greater, except when a vegetated roof is installed.
Denver	Voluntary	Energy efficiency loans	Denver's Office of Economic Development provides low-interest loans for energy-intensive businesses to invest in renewable energy or energy efficiency projects.
Phoenix	Voluntary	Reflective roof voluntary measure	Administered by the Planning and Zoning Department, the Heat Island Mitigation voluntary requirements are located in the city-adopted International Green Construction Code of the International Green Building Council. For roofs with slopes less than 2:12, an SRI of 60 is required, and for slopes greater than 2:12, an SRI of 25 is required.
Sacramento	Mandatory	Reflective roof code	All California cities are now required under Title 24 to enforce new low-slope cool roof, insulation, and solar-ready requirements: (increase reflectance from 0.55 to 0.63 for new construction and alterations).

Real-time surveillance and evaluation

Surveillance of heat-related illness and death is primarily an activity conducted by public health agencies, who need timely health data to monitor the effectiveness of interventions. However, surveillance also requires the cooperation and coordination of city entities, such as fire, ambulance, and emergency management departments, 911 call centers, and public or private hospitals and clinics.

- *Considerations and adaptive strategies*: One study (Heaton et al. 2015) found that, generally, elderly populations have an increased probability of calling 911 with heat-related issues when compared with younger populations. However, in some racial and ethnic communities (e.g., Hispanic Americans), younger callers are more likely.

Monitoring and evaluation of process and outcomes

In general, there are two types of evaluations—process and outcome evaluations. Process evaluation is used to determine whether the plan was implemented well; that is, whether the partner agencies were aware of the plan, and whether the "mechanics" of the system worked adequately. Efficient practices for process evaluations include surveys of selected organizations and multi-agency seminars, or focus groups, to identify what measures can improve implementation of the plan. Outcome evaluation is used by public health agencies to see if

interventions saved lives and if there was acceptable reduction of health inequalities (WHO, 2008). The World Health Organization and World Meteorological Organization have excellent guidelines for evaluation (WHO, 2008; WMO-WHO, 2015).

References

Brown Jr, E. G., M. Rodriquez, and R. Chapman. 2013. *Preparing California for Extreme Heat*.

Chuang, W-C., A. Karner, N. Selover, D. Hondula, N.Chhetri, A. Middel, M. Roach and B.Dufour. 2015. *Arizona Extreme Weather, Climate and Health Profile Report.* A report prepared for Arizona Department of Health Services and the United States Centers for Disease Control and Prevention Climate-Ready States and Cities Initiative. http://www.azdhs.gov/phs/oeh/documents/arizona-extreme-weather-climate-and-health-profile-report-2015-executive-summary.pdf

Heaton, M. J., S. R. Sain, A. J. Monaghan, O. V. Wilhelmi, and M. H. Hayden. 2015. An Analysis of an Incomplete Marked Point Pattern of Heat-Related 911 Calls. Journal of the American Statistical Association **110**:123-135.

Hewitt, V., E. Mackres, and K. Schickman. 2014. Cool Policies for Cool Cities: Best Practices for Mitigating Urban Heat Islands in North American Cities. Report Number U1405. Washington, DC, American Council for an Energy-Efficient Economy and Global Cool Cities Alliance, 53 pp.

Houston Advanced Research Center (HARC), 2004. *Cool Houston! A Plan for Cooling the Region*. For clean air & quality of life benefits. July 2004. The Woodlands, TX: HARC, 46 pp. http://www.harc.edu/coolhouston

Hoverter, S. P. 2012. Adapting to Urban Heat: A Tool Kit for Local Governments. Harrison Institute for Public Law Georgetown Climate Center.

Minnesota Department of Health (MDH). 2012. *Minnesota Extreme Heat Toolkit*. Minnesota Climate and Health Program. Environmental Impacts Analysis Unit. June 2012. St. Paul, MN: Minnesota Department of Public Health, 43 pp. http://www.health.state.mn.us/divs/climatechange/

San Francisco Department of Public Health (SFDPH). 2013. *San Francisco Department of Public Health Extreme Heat Response Plan: An Annex to the SFDPH Emergency Operations Plan.* Program on Health, Equity and Sustainability. August 2013. San Francisco, CA: San Francisco Department of Public Health. 13 pp.

White-Newsome, J. L., B. Ekwurzel, M. Baer-Schultz, K. L. Ebi, M. S. O'Neill, and G. B. Anderson. 2014. Survey of county-level heat preparedness and response to the 2011 summer heat in 30 US States. *Environmental Health Perspectives* **122**:573-579.

World Health Organization (WHO). 2008. Heat-Health Action Plans Guidance. F. Matthies, G. Bickler, N. Cardeñosa Marin, and S. Hales (eds.). Copenhagen: WHO Regional Office for Europe, 45 pp.

World Meteorological Organization and World Health Organization (WMO/WHO). 2015. *Heatwaves and Health: Guidance on Warning-System Development*. G.R. McGregor, P. Bessemoulin, K. Ebi and B. Menne, (eds.). WMO-No. 1142. Geneva: WMO, 96 pp.