

Article

Participation and Engagement of Public Health Stakeholders in Climate and Health Adaptation

Erika Austhof ^{1,2,*} , Vjollca Berisha ³, Ben McMahan ^{2,4}, Gigi Owen ², Ladd Keith ^{2,5} , Matthew Roach ⁶ and Heidi E. Brown ^{1,2} 

¹ Department of Epidemiology & Biostatistics, Tucson, Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, AZ 85724, USA; heidibrown@email.arizona.edu

² Climate Assessment for the Southwest, University of Arizona, Tucson, AZ 85721, USA; bmcMahon@email.arizona.edu (B.M.); gigi@email.arizona.edu (G.O.); ladd@email.arizona.edu (L.K.)

³ Maricopa County Department of Public Health, Phoenix, AZ 85012, USA; Vjollca.Berisha@Maricopa.gov

⁴ Bureau of Applied Research in Anthropology, University of Arizona, Tucson, AZ 85721, USA

⁵ School of Landscape Architecture and Planning, University of Arizona, Tucson, AZ 85721, USA

⁶ Arizona Department of Health Services, Phoenix, AZ 85007, USA; matthew.roach@azdhs.gov

* Correspondence: barrette@email.arizona.edu

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Abstract: Stakeholder participation at the intersection of climate and health is essential to assess and plan for the human health impacts of current and projected climate-sensitive hazards. Using the Maricopa County Department of Public Health (MCDPH) Coalition on Climate Change and Public Health workgroup and the Climate Assessment for the Southwest (CLIMAS) program as examples, this paper describes the important role of scientist–public health stakeholder collaboratives in addressing the public health impacts of climate-sensitive hazards. Using the MCDPH and CLIMAS stakeholder groups, stakeholder connections were mapped to show relationships between the organization types and connections between scientists and public health stakeholders. Stakeholders, defined as meeting attendees, were primarily individuals from academic institutions (n = 175), government agencies (n = 114), non-profits (n = 90), and health departments (n = 85). Engaging public health stakeholders in transdisciplinary regional climate initiatives and addressing gaps in their networks helped these programs to develop more collaborative projects over time.

Keywords: public health practice; climate change; stakeholder engagement

1. Introduction

Stakeholder participation at the intersection of climate and health is essential to assess and plan for the human health impacts of current and future climate-sensitive hazards [1,2]. Climate-sensitive hazards are environmental events that pose risks to human health and could be affected by long-term changes in temperature, precipitation, and other weather conditions. These events occur at a wide range of time scales, spanning short-term events like dust storms to long-term events like drought. Climate-sensitive hazards are among many environmental determinants of health. They can create or worsen health conditions such as cardiovascular diseases, asthma, and other respiratory illnesses, and can lead to injury or premature death. The public health workforce is actively engaged in adaptation efforts [3,4] to impact these downstream human health effects of climate-sensitive hazards, and many are actively engaged in adaptation planning [5–7]. Responding to human health impacts requires a large, diverse network of stakeholders, including experts, local non-profits and businesses, government agencies, and tribal groups. These adaptation efforts cannot persist in silos; we must come together in order to see dramatic shifts in reducing impacts on human health [8]. Local and state public

health departments work with a wide range of individuals from academic institutions, hospitals and non-profit organizations, government agencies, and service organizations like utility companies. Therefore, while primarily public health organizations, they act as convening bodies to disseminate important information, accomplishing key adaptation activities for their regions with multisector climate and public health practitioners [9].

1.1. Stakeholder Participation at the Intersection of Climate and Health

Local and regional climate-sensitive hazard work is most effective when it is transdisciplinary. We define participation specifically as the action of stakeholders taking part in climate and health projects through involvement in professional meetings for training and capacity building on climate and health knowledge, higher-level meetings to promote increased scientific collaboration and knowledge coproduction, and transdisciplinary participation in workshops and joint authoring of reports to promote ownership and community agency. While there are many models of engagement [10–12], we define engagement here as public health departments connecting with stakeholders outside of the public health discipline through invitations to meetings, workshops, and higher-level meetings such as strategic planning initiatives. Participation and engagement in this work shares two key features: iterativity and co-production. Iterativity is an essential component in these scientist-stakeholder partnerships, which includes repeated interactions, production of useable science, and transdisciplinary work [13]. Climate scientists should engage with their local and state public health professionals to generate more collaborative regional adaptation and mitigation efforts. Successful use of iterativity in regional adaptation planning can lead to the development of more effective policies and higher levels of innovation for addressing regional climate variability and change. Coproduction, is a deliberate approach to building stakeholder networks in order to conduct collaborative and more effective research [14]. Through iterativity and coproduction, climate scientists working with public health professionals can understand the larger scale of climate impacts on human health, assess their projects and outcomes of the collaborative research, and more effectively translate their knowledge, thereby benefiting the stakeholder network [14,15].

1.2. Role of Public Health in Climate-Sensitive Hazard Work

Public health professionals working on climate-sensitive hazards come from many groups within a health department. Environmental health inspectors might increase the frequency of retail food inspections, while communicable disease investigators could conduct active surveillance for food-borne illnesses as drought and extreme events affect agriculture in the U.S. Southwest [3]. Emergency management managers might be involved in hazard mitigation plans with urban planners to make cities more walkable in order to decrease greenhouse gas emissions and increase physical activity, as is the case in Los Angeles and Miami-Dade counties [3]. Community health workers might talk to their clients about how the environment changes, for example, what they can do regarding changes to air quality and their effect on respiratory conditions, and provide them access to additional resources when needed during extreme weather events [3]. All or some of these professionals might engage in climate-sensitive hazard work, and it largely depends on where the funding for these initiatives resides in the department.

Successfully engaging public health professionals and working across sectors impacts how communities respond to their changing climate [16]. Local governments rely on public support to move initiatives forward and framing climate adaptation as a public health issue has promise. A recent survey found that 58% of Americans view global warming as a health issue, compared to the 54% who view it as an economic or social justice (24%) issue [17]. Another online survey found that framing climate change as a public health issue was most likely to produce the emotional reactions consistent with supporting climate change mitigation and adaptation [18]. Despite the potential for advancing local adaptation efforts with a public health focus, there is a need to better connect the public health profession and information of climate impacts on health to local adaptation efforts.

In an analysis of 44 local adaptation plans across the U.S., 86% of the plans identified public health as being impacted by climate change, but only 2% of the plans provided detailed descriptions of the actual public health vulnerabilities and impacts from climate change [19]. Globally, only 10% of the 401 urban areas with more than 1 million people sampled by Araos et al. [20] were found to report public health related climate adaptation initiatives. Current needs for health and adaptation identified in the study included lack of information-based adaptation initiatives, a limited focus on initiatives related to infectious disease risks, and lack of monitoring, reporting and evaluation [20].

In Arizona, public health departments engage in climate-related work through disaster preparedness—focusing on surveillance activities for extreme heat or mosquitoes, expanding their network for emergency management drills or through the Building Resilience Against Climate Effects (BRACE) program (Table 1). The Center for Disease Control and Prevention’s Climate and Health Program awarded the Arizona Department of Health Services (ADHS) with grant funding under the Climate-Ready States and Cities Initiative (CRSCI). The federal initiative helps state and city grantees build public health capacity against historical climate-sensitive hazards within their jurisdiction and plan for future challenges. ADHS has received three iterations of grant funding to build capacity. Under CDC-RFA-EH10-1006 in 2010–13, Arizona focused on addressing extreme heat challenges and focused on improving internal capacity. In 2013–2016, under a second round of funding through CDC-RFA-EH13-1305, ADHS implemented a CDC framework to address climate-sensitive hazards in addition to heat, such as drought, vector-borne disease, wildfires, flooding, and air quality. This work was aided by interagency service agreement contracts with local university climate expertise to complete the BRACE steps. Understanding climate data, both historical and projected, as well as developing disease models to project disease risk were tasks suited for skillsets not normally within a health department. These contracts provided funds to support staff time to support this work. ADHS secured two contracts with programs, advised by CDC [21] which could help complete the steps that had the needed subject matter expertise. The first contract was with the State Climatologist at Arizona State University (ASU), a position that aims to inform other government agencies on climate. The second contract was with the University of Arizona which housed the National Oceanic and Atmospheric Administration (NOAA) Regional Integrated Science and Assessment (RISA) program. Under the third round of funding (CDC-RFA-EH16-1602) from 2016–2021), ADHS is working with local partners to implement priority interventions for the hazards identified from the previous grant cycles [22]. ADHS secured intergovernmental agreement contracts with 3 local public health departments (Maricopa, Pinal, and Yuma Counties) based on county priorities, vulnerability, and staff availability. BRACE grant funds were provided for staff time to implement and lead pilot project interventions for their respective counties. ADHS continued interagency service agreements with the university staff who previously helped on the BRACE step reports to provide technical assistance to the counties and the state on activities. During the work, with limited funds from BRACE, one local health department, Pinal County Health Services District, applied and won additional funding for public health heat surveillance through the North American Commission for Environmental Cooperation [23], an intergovernmental organization that addresses environmental issues. Outside of formal contractual agreements, ADHS, the universities, and local health departments utilized information gained from national communities of practice, through organizations such as the Council of State and Territorial Epidemiologists, International Society for Disease Surveillance, Association of State and Territorial Health Officials either through webinars, workgroup facilitation, or travel support to relevant workshops. The aforementioned work utilizes the CDC’s BRACE framework. The Arizona Climate and Health Adaptation Plan outlines these activities utilizing the ten essential public health services [24] while the latest addendum to the 2018 adaptation plan highlights success stories throughout the state [7]. The BRACE projects occurring have been coordinating with other ongoing climate change work spearheaded by other departments, such as by providing input at strategic planning sessions, such as the Southwest Adaptation Forum [25], the University Climate Change Coalition (UC3) [26], and the State Hazard Mitigation Plan [27].

Table 1. Examples of climate and health adaptation work in Arizona. * indicates Lead Agency.

Title of Project	Project Reference	Stakeholders Involved
Evaluation of a Novel Syndromic Surveillance Query for Heat-Related Illness Using Hospital Data from Maricopa County, Arizona, 2015	[28]	Maricopa County Department of Public Health (Maricopa) *
Climate and Health Adaptation Plan; and addendum	[7,24]	Arizona Department of Health Services (ADHS) *, Maricopa, University of Arizona (UA), Arizona State University (ASU), Pinal County Public Health Services District (Pinal), Yuma County Health Services District (Yuma)
Special Weather Briefings and Statements from National Weather Service Forecast Offices in Arizona	[29]	National Weather Service (NWS) *
Assessment of Climate and Health Impacts on Vector-Borne Diseases and Valley Fever in Arizona 2017	[30]	UA *, ADHS
Assessing Adaptation Strategies for Extreme Heat: A Public Health Evaluation of Cooling Centers in Maricopa County, Arizona	[31]	Maricopa *, ADHS, ASU
Enhanced Surveillance of Heat-Related Illness in Pinal County	[32]	Pinal *, ADHS, UA
It's not the heat, it's the vulnerability: attribution of the 2016 spike in heat-associated deaths in Maricopa County, Arizona	[33]	ASU *, ADHS, Maricopa, NWS
Cross-Sector Management of Extreme Heat Risks in Arizona	[9]	ASU *, ADHS, Maricopa, NWS

1.3. Engaging Stakeholders

Engaging external stakeholders remains a key feature of transdisciplinary work but it is not always clear how programs do this successfully. The US government Accountability Office (GAO) released a report in 2015 assessing how the Department of Health and Human Services is addressing and planning for the risks of climate change to public health [34]. In this GAO study they found that states (1) have difficulty communicating about the public health risks of climate change, due to limited public awareness and complexity of the issue, (2) public health officials said they face challenges identifying health risks of climate change due to gaps in research and difficulties using the data, and (3) officials felt that they had insufficient local data on health outcomes, because states may not collect or have access to such data, or have insufficient staff resources for these activities. This paper addresses some of the challenges posed in the GAO report.

The objective of this paper is to describe scientist-public health stakeholder collaboratives in the U.S. Southwest. We use the two case studies of the Maricopa County Department of Public Health (MCDPH) Coalition on Climate Change and Public Health (CCCPH) workgroup and the Climate Assessment for the Southwest (CLIMAS) stakeholder group to describe (1) the stakeholder network framework and current projects, (2) best practices for engaging public health stakeholders in the U.S. Southwest, and (3) the challenges, successes, and lessons learned from this work. By sharing these case studies, other programs can use the techniques and lessons learned to engage external stakeholders in their own work. An analysis of the stakeholder network of these two groups highlights lessons learned and future directions for these programs. The purpose for describing this work is to demonstrate how engaging public health stakeholders in transdisciplinary regional climate initiatives can generate more collaborative adaptation and mitigation efforts, thereby reducing the human health impacts of climate change.

2. Experiments

2.1. Maricopa County Department of Public Health (MCDPH)

In the third cycle of the CRSCI funding, the Arizona Department of Health Services used part of the budget to support climate and health pilot projects in three counties. One of these projects is the stakeholder-driven strategic planning pilot project occurring in Maricopa County, Arizona. Maricopa County, Arizona is the state’s most populous county with over 4.3 million people (414.9 people per sq. mile). This county is the state’s largest metropolitan area, with majority White (55.4%) and Hispanic (31.1%) populations, and 13.5% of the population living in poverty [35]. Maricopa County experiences extreme weather including heat waves (128 days over 100 F in 2018), dust storms (3 clusters of dust storm events in the summer of 2018), drought (currently in a 12 year drought), wildfires (>\$4 million spent on fire suppression in Arizona in 2015 with a \$4 million budget to spend on fire suppression in Fiscal Year 2019), flooding (2 major flooding events), and poor air quality events (59 exceedance days in 2018). These climate-sensitive hazards pose a threat to public health and can lead directly to illness or death or worsen underlying health conditions.

In 2015, the Public Health Institute (PHI) selected MCDPH to join The Climate Change and Public Health Learning Collaborative for Urban Health Departments and to receive financial support to incorporate climate-sensitive hazard mitigation, adaptation, and resilience work into local public health department program practice. As part of this project, MCDPH hosted two CCCPH stakeholder meetings, on 16 November 2016 and 18 May 2017. Representatives from a diverse array of local community organizations, private businesses, government agencies, and academic institutions were invited based on their interest or organization’s interest in climate and public health. Subsequently, this funding enabled MCDPH to convene a network of key stakeholders from the previous two stakeholder meetings to establish the CCCPH. This workgroup developed a strategic plan from August 2017 to January 2018 with five priority actions for addressing environmental concerns affecting the health and well-being of the community. MCDPH published the final strategic planning report in 2018 [36]. The plan outlines five task forces described in more detail in Figure 1.

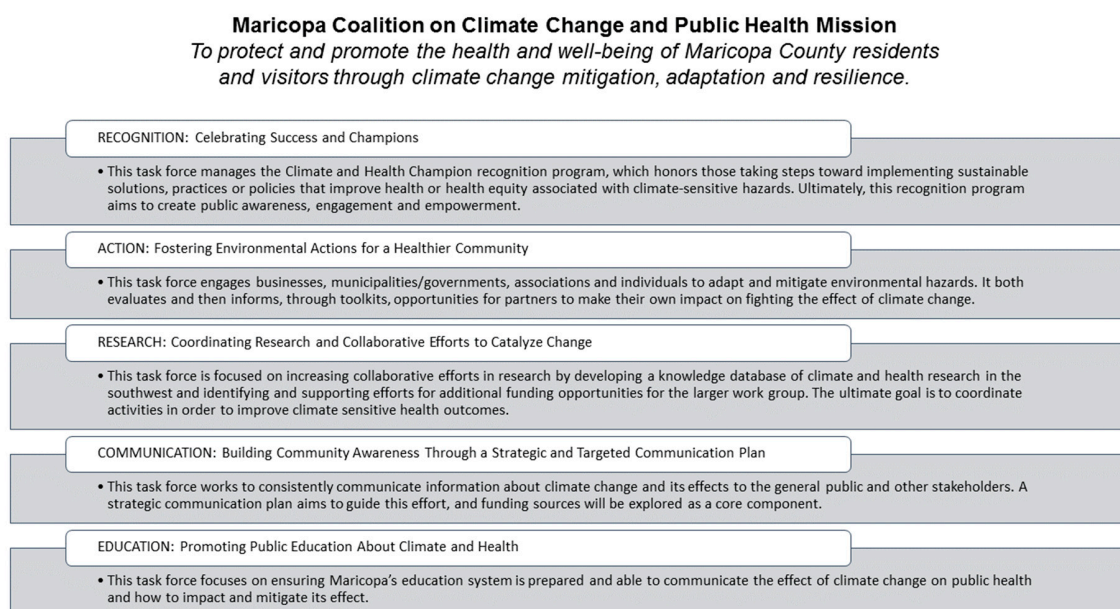


Figure 1. Maricopa County Department of Public Health (MCDPH) Coalition of Climate Change and Public Health Mission and Action Team descriptions.

2.2. Climate Assessment for the Southwest (CLIMAS)

CLIMAS is funded through the National Oceanic and Atmospheric Administration's Regional Integrated Sciences and Assessments program (NOAA-RISA). In 2019, 11 active RISA programs provide scientific support for regionally-specific issues regarding climate-sensitive hazards. While NOAA-RISA programs share a coherent identity under the guidance of the NOAA Climate Program Office (CPO), they are flexible and free to focus on issues that emerge from regional stakeholder concerns. Building and maintaining relationships with stakeholders is a core component of the NOAA-RISA [37] and CLIMAS programs [12].

Founded in 1998, CLIMAS is comprised of social and physical scientists at the University of Arizona and New Mexico State University. The program's mission is to build capacity in the U.S. Southwest to respond and adapt to regional climate stressors through scientific services, products, and tools that support decision making and climate policy. Scientists work with partners inside and outside academia to develop research questions, design and conduct research projects and communicate findings. Research projects are frequently guided by use-inspired science, knowledge co-production, and transdisciplinary frameworks for stakeholder engagement. CLIMAS research spans several different climate-related topics such as drought, water supply, wildfire, agriculture, and human health.

CLIMAS recognized early the need to include public health in their project portfolio. One of the first CLIMAS projects focused on climate connections to Valley fever, which later led to a project that modeled connections between climate, mosquitoes, and vector-borne disease. Based on this previous climate and health research, in 2015 ADHS reached out to CLIMAS researchers to collaborate on BRACE related projects. CDC recognized that the BRACE and NOAA-RISA networks represented a unique opportunity for use-inspired stakeholder science [21]. In particular, CLIMAS researchers provided ADHS with vector-borne disease projections and vulnerability assessments based on climate data [30,38]. ADHS used this technical expertise regarding health risks for Arizona in their adaptation planning. Throughout the course of the project, ADHS also hosted graduate student interns from the University of Arizona to physically and intellectually bridge academics and applications.

2.3. Stakeholder Mapping

The database of stakeholders was generated through three main means: (1) e-mail requests for participant or invite lists after a local climate- or environmental health-related event, (2) e-mail requests from stakeholder list managers, and (3) web searches for persons who have published climate and health literature, or who have self-designated their career interest in climate and health on LinkedIn, Research Gate, Open Researcher and Contributor ID (ORCID), or Google Scholar. Event and listserv managers gave permission for the stakeholder contact information to be added to this database and used for collaboration and research purposes. Only publicly available information was collected in the database; this is an ongoing and iterative process as stakeholders change positions or contact information changes. MCDPH conducted a gap analysis to identify areas within their stakeholder network that were missing. Results from that analysis are also shared.

The stakeholder database was coded to identify the agency the individual worked for at the time of spring 2019. Stakeholder relationships in the database were then mapped based on the number of attendees jointly attending the 13 events included in the database ($n = 569$, excluding individuals found through web searches). Network mapping was conducted in R Studio Version 1.1.463 using the package Matrix and visualized using ingraph to identify how individuals in the database connect with each other at local and regional meetings.

3. Results

We build upon previous contributions in the literature on the history [37] and accomplishments [7,12] of these collaborative programs, by highlighting a few key accomplishments

here. We also highlight how stakeholder mapping helped address gaps in collaborative efforts in each of the projects.

3.1. Maricopa County Department of Public Health (MCDPH)

Through the pilot grant funding, MCDPH developed a recognition program and awarded four awards in the Celebrating Success and Champions Program in the areas of Business, Organization, Individual, and Youth. From the list of nominees ($n = 27$), 12 new organizations were included in the CCCPH stakeholder workgroup. MCDPH is continuing this program into the second year with the addition of a Research category. The CCCPH workgroup has continued to have an annual meeting since inception; the 2018 meeting included 74 new stakeholders (76% of meeting attendees) who were not previously involved in the workgroup. MCDPH has also continued to expand its heat relief network and evaluated its heat-related communications to increase healthcare provider awareness of excessive heat warnings in the county.

3.2. Climate Assessment for the Southwest (CLIMAS)

The BRACE/CLIMAS connection supported several tangible interactions between university researchers and regional health departments. A coordinator at the University of Arizona provided academic support for the county pilot projects and helped advance the efforts utilizing the BRACE framework in Arizona by translating science into reports and actionable items for a range of stakeholders [7]. Exemplifying the collaboration, ADHS and UA researchers regularly present jointly or singularly using the same slide bank. Furthermore, in 2019, ADHS staff co-instructed and supervised students in a graduate-level public health course. Finally, the CLIMAS office provided graphic design staff to support translation of the scientific reports into more approachable documents, enabling users to more easily interact with the science through clear graphs, figures, and call-out boxes with key points.

3.3. Maintaining Stakeholder Lists

3.3.1. Maricopa County Department of Public Health (MCDPH)

MCDPH created a climate and health stakeholder database by building on existing contacts, recruiting new members, and continuously updating the list. Over the years MCDPH conducted heat-related studies including the evaluation of cooling centers in 2014, a community assessment for public health emergency response (CASPER) in 2015 and a homebound populations study in 2016 which all contributed an increasing number of stakeholders to the list. In 2015, MCDPH incorporated climate-sensitive hazard mitigation, adaptation, and resilience work into their local public health department program practice, so the existing contact list scope changed from a heat-focus to general climate and health stakeholders. In addition, the current database includes more variables to provide more detailed information such as the type of sector, types of initiatives, and funding they receive. The MCDPH's goal is to keep this directory up to date and make it available in a common friendly platform to all stakeholders. Maintaining this directory has been shown to be labor-intensive, therefore MCDPH has been working on simplifying this process and finding common process, which would be friendly for everyone. MCDPH has been discussing the possibility of distributing a brief survey on a semi-annual basis which would allow stakeholders to update their information in the directory.

3.3.2. Climate Assessment for the Southwest (CLIMAS)

The collection of invitation and registration lists at climate- and health-related events in the U.S. Southwest has helped expand the reach and impact of the health component of the CLIMAS program. This database originally started with the stakeholder list from MCDPH and has expanded to Pima County, Pinal County, and registrants from local and regional climate and health meetings. This database dates back to stakeholders from 2014 events but is regularly updated. Climate and health

events were defined as meetings or conferences where the main purpose of the event was to discuss and plan for human health impacts of climate-sensitive hazards. Periodically this stakeholder database is provided to CLIMAS and e-mails are added to the CLIMAS listserv through which they receive monthly climate newsletters, links to podcasts and blog posts, and information about CLIMAS events such as webinars and public talks. In this way, CLIMAS engages with these public health stakeholders and expands its network.

3.4. Stakeholder Mapping

The stakeholder databases from MCDPH and CLIMAS include 688 stakeholders. The agency types included: academic institutions (n = 175), government agencies (n = 114), non-profit organizations (n = 90), health departments (n = 85), emergency services (n = 51), park and forest services (n = 42), tribal organizations (n = 32), public or utility services (n = 25), independent consultants (n = 20), health services (n = 19), news agencies (n = 15), other (n = 13), and unknown (n = 7).

We mapped stakeholder connections (n = 569, with attendance of meetings) at the agency level (Figure 2) based on the number of agency type participants ‘meeting’ at events with other agency type participants. Connections between agency type were based only on the attendance lists from 13 climate and health events held from 2012 to 2018. Of the 13 events stakeholders attended and included in the stakeholder analysis, six occurred in Maricopa County, Arizona; five occurred in the City of Tucson, Arizona; and two occurred in the City of Denver, Colorado.

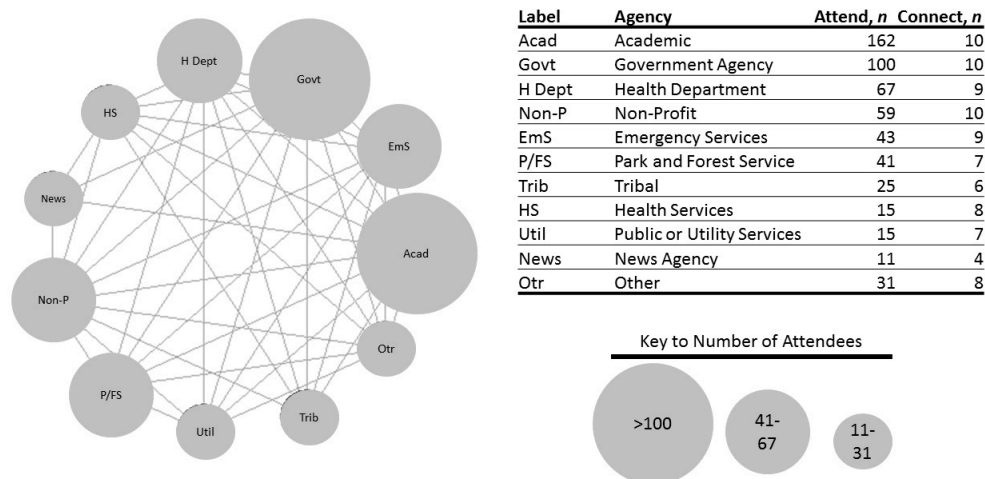


Figure 2. Bi-directional map of participants at 13 climate and health events from 2012–2018. The lines indicate that a member from the agency type attended a meeting with a member of another agency type. The size of the circles indicates the approximate number of participants attending all 13 events.

Academics (n = 162) and governmental employees (n = 100) were the most frequent meeting attendees within our database, and the most connected (both connected with all other entities). While health departments (n = 67), non-profit workers (n = 59), and emergency service workers (n = 43) were smaller in number, they were represented and highly connected. It is interesting to note that the health departments, often the hosts of these events, only had a missing connection with the news agencies in the events in our database.

4. Discussion

Gap Analysis and Platform Description

Periodic analysis of gaps within a stakeholder network either through mapping, or through assessment of stakeholder engagement is beneficial to ensure all voices are represented. As an example, MCDPH identified these gaps in organizations the network needs to be more robust: business

(private, for-profit, local, and non-profit), tribal partners, representatives and advocates in vulnerable populations (i.e., homeless, elderly, older women, pregnant women, and children), representative from local utility companies, and emergency management from city and county jurisdictions. These gaps were identified based on where Maricopa County would like to expand their scope of work in the future. Additionally, an action team within the CCCPH strategic planning workgroup took on the task of identifying stakeholders in these fields in order to expand the stakeholder network and communicate more effectively.

Working with other organizations and stakeholders increases credibility, expands the scope and reach of the organization's objective, and provides additional resources and expertise [39]. Other local health departments can use the frameworks shared here to develop their own or expand the scope of their current networks. The stakeholder database here aligns with other literature on the topic of types of stakeholders who might be engaged in public health and climate science. Ebi [40] explains key actors and their roles and responsibilities in adaptation interventions to climate-sensitive hazards; their Table 1 [41] includes many of the agency types in our database. Additionally, the "Climate Change, Health, and Equity: a guide for local health departments" report published jointly in 2018 by the Arizona Public Health Association, PHI, and the Center for Climate Change and Health [3] give many examples of agencies doing similar work as the stakeholders in this database. It is important to engage stakeholders in climate and health adaptation work as soon in the process as possible to ensure all voices are present and integrated into adaptation efforts. The variety of stakeholders present through the projects have each brought unique perspectives to help guide the future of projects and for planning in Arizona. For example, after the first state-wide heat meeting, stakeholders provided feedback to the conference organizers recognizing the need for news media and advocates for sharing stories of heat-related illness in Arizona to the public. The next year, MCDPH and ADHS worked with Arizona Public Media to release a series of stories [42] during the heat season and present their findings at the annual meeting. These stakeholders are represented in the $n = 11$, News Agency category, in Figure 2. These efforts helped raise awareness about the risks of heat-related illness to the public and supported the BRACE program in communication efforts. These efforts also helped to solidify participation and engagement in these efforts because this result came directly from stakeholder feedback.

Ideally, organizers invite new stakeholders to a kick-off meeting or an annual meeting of the network, but a focused phone conversation to introduce the project and solidify roles and responsibilities is also beneficial. Clear descriptions of roles and responsibilities of all members are vital to ensuring continuous engagement and buy-in from stakeholders, especially in a volunteer-led initiative as is the situation for the CCCPH. Through the stakeholder network MCDPH was able to co-produce a grant with one of the stakeholders within the network and is a recipient for a 2019–2020 North American Partnership for Environmental Community Action (NAPECA) grant from the Commission for Environmental Cooperation (CEC). This grant effort came directly from stakeholder feedback of needing a formalized means to continue engagement in the CCCPH efforts. The goal of this funding is to help sustain and strengthen engagement in the CCCPH efforts over time through (1) formalizing the CCCPH existing structure; (2) developing regionally coordinated implementation process to address extreme heat; and (3) developing a long-term sustainable structure for the coalition.

Identification of individuals interested in this work often occurs via online searches, or introductions via e-mail. In this digital age, communication and advertising of your professional goals, current jobs and skillsets are vital to ensuring invitation and inclusion in these types of stakeholder groups. Professional networking sites such as LinkedIn, ResearchGate, or ORCID allow for the integration of research interests and publications across platforms, but many lack the option to contact the professional directly without a subscription. A limitation of the stakeholder network is that many of the stakeholders were found through internet searches or by word-of-mouth during event planning. The stakeholder network may also be biased by the existing professional connections we had. Academic institutions often require faculty to complete annual CV or Biosketch updates, but many

staff members, graduate or undergraduate students who are interested in this field are not prompted or allowed to advertise their interests and skills.

5. Conclusions

Maintaining and fostering scientist–stakeholder relationships like the case studies shared here is paramount to catalyze collaborative efforts around climate impacts on public health and building resilience against current and projected health impacts. Analyzing and addressing gaps in their stakeholder networks helped each group develop more transdisciplinary work over time which is evident in the utilization of stakeholder feedback and the additional grant funding that was received to continue the CCCPH work. One barrier to these efforts is funding availability. Continuous funding for climate and health in the public health workforce is insufficient for many health departments [43]. In Arizona, funds for climate and health work often come through the ADHS from the CDC in the form of small grants for specific projects. As a result, jobs in climate and health tend to shift and change over time due to these funding challenges and priority needs and participation by public health professionals becomes difficult. Additional funding would help jurisdictions dedicate more staff time to these efforts and address some of the challenges public health officials expressed in the GAO report [34]. Additionally, by engaging with external stakeholders, public health departments can leverage financial and personnel support by writing transdisciplinary grants or co-producing proposals with their stakeholder networks. These funding opportunities can contribute to more collaborative efforts overall. Finally, policies that allocate continuous funding in this field will catalyze collaborative adaptation and mitigation efforts, thereby reducing the human health impacts of climate-sensitive hazards.

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