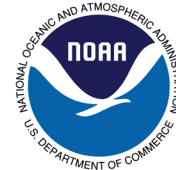


Drought and Public Health:

A Roadmap for Advancing Engagement and Preparedness

May 2023



Document prepared by the National Integrated Drought Information System (NIDIS) in partnership with key stakeholders.

Acknowledgements

This report was developed through a partnership with National Oceanic and Atmospheric Administration (NOAA)'s National Integrated Drought Information System (NIDIS) and the University of Nebraska Medical Center. Additional funding was also provided by the Claire M. Hubbard Foundation and Daugherty Water for Food Global Institute. We greatly appreciate the many Federal, state, and local partners who contributed their time and efforts to coordinate, inform, and participate in drought and public health workshops and interviews, which provided the material for the development of this document. The workshops, interviews, and one-on-one interactions provided rich material for development of this document.

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Suggested Citation: Bell, J.E., R.E. Lookadoo, K. Hansen, A. Sheffield, M. Woloszyn, S. Reeves & B. Parker. Drought and Public Health: A Roadmap for Advancing Engagement and Preparedness.

On the cover: Photo by: Webb Show Portland, Oregon 9/11/2020. Smoke from Oregon wildfires at Waterfront.

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Executive Summary



Drought is one of the costliest and deadliest climate-related disasters in the United States (NOAA, 2022), necessitating public health engagement at a national level.

Although drought is not typically thought of as a health hazard, the pathways to human health outcomes are prevalent and numerous. Examples include deteriorating mental health of farmers experiencing crop loss and respiratory issues from wildfires that were amplified due to drought conditions. Health outcomes from drought can be complex, and multiple partners with different expertise are needed to work collectively to address these issues. Integration of human health impacts from drought into drought planning and preparedness activities can help deliver early warning of potential drought-related human health threats and provide opportunities for mitigation to reduce risks.

To better understand these pathways, and actions that could be taken to reduce health impacts associated with drought, NOAA's National Integrated Drought Information System (NIDIS) supported the first comprehensive assessment of drought and health.

The objectives were to:

1. strengthen the linkages between drought and public health communities to identify opportunities for NIDIS to engage in drought-health partnerships and alliances;
2. continue to grow and coordinate a team of national and regional drought and health partners; and
3. develop regional public health partnerships through NIDIS's regional Drought Early Warning Systems (DEWS) to help inform the creation of communication tools and efforts on drought impacts.

One national summit and five regional workshops on the topic of drought and health were held between 2019-2022 to meet the above objectives. Participation at these workshops

included representatives of academic centers, federal agencies, state health, climate, and emergency management departments, and non-profit organizations. To supplement the information shared during the regional workshops, and in response to delays in the regional in-person workshops caused by the COVID-19 pandemic, one-on-one interviews were also conducted with state health departments across the United States. This report represents the culmination of knowledge gathering from those events and interviews, and provides insights into the connection between drought events and human health impacts with specific examples, and an overview of the principles of public health and engagement.

In addition, this report provides a list of key opportunities and recommended actions to advance drought and public health engagement and preparedness based upon extensive dialogue and feedback from academic and practitioner communities across drought and public health disciplines. These include:

Partnership and Collaboration

- Build a national drought and health community of practice as a platform for sustained engagement across disciplines.
- Expand public health representation, where possible, at drought-related meetings, and address the human health concerns of drought at health-related meetings.
- Provide regional and state opportunities for the drought and public health communities to interact and form relationships.
- Promote the increased adoption and utilization of predictive and early warning systems, such as syndromic surveillance systems or other public health monitoring systems that rapidly evaluate community health outcomes.
- Incorporate questions on drought impacts in community health needs assessments.
- Develop drought and health vulnerability assessments and mapping for observing drought impacts by region or state.

Communication and Outreach

- Develop impact-based communication resources for drought in areas of higher concern with a focus on human health impacts.
- Provide tailored population-specific materials vital to communicating the risk of drought on the health of vulnerable populations.
- Develop drought and health resources and toolkits for state and local health departments.
- Utilize Drought.gov and existing Center for Disease Control (CDC) websites as a platform for dissemination of information of drought and health resources.
- Utilize Agricultural Extension Services to reach and engage rural communities that are more susceptible to the health impacts from drought.

Interdisciplinary Research and Applications

- Improve understanding of drought indicators and their relationship to health outcomes and develop guidance needed on specific drought indicators and indices to be used for observing the health impacts of an event.
- Conduct a comprehensive review of past drought events to better define early warning signs of health impacts from drought.
- Improve understanding on how drought impacts individuals and/or communities utilizing private wells.
- Address barriers to data access and understanding for public health researchers and epidemiologists to effectively use drought data in research studies.

Planning and Preparedness

- Incorporate human health impacts and public health actions in drought vulnerability assessments and state or local drought plans.
- Utilize tabletop exercises for drought events to prepare for health impacts.
- Engage with tribal nations to address their unique needs regarding drought and the impacts to human health.
- Develop and create sample drought and health survey questions that could be added to a community health needs assessment.

This report is intended to inform and direct future efforts and investments in drought and public health by Federal, state, and local agencies, with the goal of mitigating the public health impacts of drought events.

Looking for an online resource for information on drought and public health?

The “Drought and Public Health” sector page on Drought.gov provides viewers an overview of this topic area including current drought conditions overlaid with public health data, a summary of key issues and drought impacts on public health, and links to resources to improve drought early warning for the public health sector.

Visit <https://www.drought.gov/sectors/public-health>



Introduction to Drought and Public Health

Research has demonstrated that drought is associated with an array of human health outcomes resulting from changes in the physical environment, including linking drought to chronic and infectious disease, food insecurity, and stress that leads to adverse mental health outcomes (Bell et al. 2018). Drought is a threat multiplier, as drought can reduce air quality, decrease water quality and quantity, increase risk of wildfire, and increase the likelihood of extreme heat. These changes in the environment have the potential to cause impacts on human health, as they are inextricably linked through a “One Health” lens. In addition, premature mortality and cardiovascular disease have been linked to drought-induced reduction in air quality (Berman et al. 2017). Unlike many other natural disasters, which tend to be more constrained on the temporal and spatial scale, drought can impact large, diverse areas and produce unique and cascading outcomes (Fuchs et al. 2014; Bell et al. 2015). Due to these issues, identifying the outcomes of drought on human health can be complex, and determining at-risk populations to mitigate impacts may vary based on local factors and social determinants of health.

NOAA plays a critical role in addressing linkages between extreme events and human health. In 2010, the NOAA Science Advisory Board’s Oceans and Health Working Group (OHWG) produced a report emphasizing NOAA’s contributions to the health community and charged the agency to establish a more coordinated approach across the line offices.

Findings include:

- There is an urgent and societal need for action to understand and mitigate human and organism health threats.
- NOAA needs to better quantify and communicate the benefits of its investments in activities related to the health of humans, aquatic organisms, and the environment.

¹One Health is a collaborative, multisectoral, and transdisciplinary approach—working at the local, regional, national, and global levels—with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment.

Drought and Heat

According to NOAA's calculation of billion-dollar disaster events to affect the United States from 1980-2022, drought has resulted in 4,256 deaths - second only to tropical cyclones. In this methodology, these deaths associated with drought are the result of heat waves, which are often closely related. In the last 30 years, during National Weather Service forecasted heat advisories and warnings, there was an associated average of 143 deaths per year, making heat the top weather-related cause of death. Although not all droughts are accompanied by a heat wave and not all heat waves are accompanied by a drought, this shows the complexity of drought-related mortality and one reason for public health intervention.

Although drought is not typically thought of as a health hazard, the pathways to human health outcomes are prevalent and numerous. Drought is specifically identified as an extreme condition in NOAA's One Health framework because of the linkages between environmental conditions and human and animal health. Population subgroups are especially pertinent in addressing health outcomes to drought, as demographic characteristics can increase community susceptibility to drought-related hazards (Lynch et al. 2020; Abadi et al. 2022). Populations reliant on agriculture for livelihoods or sustenance are vulnerable to food insecurity, malnutrition, and the accompanying adverse mental health effects when drought causes economic loss. Children and the elderly are both disproportionately affected by various drought-related health outcomes, such as air-, vector-, and waterborne diseases (Jalalzadeh Fard et al. 2022). Seniors living in care facilities also experience risk of morbidity due to water-related stresses on the energy grid and thus heating and cooling systems (CDC, 2012). Studies have also demonstrated that youths and working-age males are vulnerable to adverse mental health effects in rural areas (Vins et al. 2015). Reliance on small or inadequately maintained water systems puts populations at risk of morbidity from exposures to arsenic and/or other toxins in drinking water or limited water resources for hygiene and food washing (Sena et al. 2014; Lombard et al. 2021). Lastly, lowered surface water volumes put recreational water users at risk of waterborne disease and injury from swimming or boating accidents (CDC, 2010). While not confined to rural locations, oftentimes rural populations experience greater burdens from drought compared to populations in non-rural geographies. As illustrated by these examples, the health outcomes from drought can be complex, and multiple partners are needed to address these issues. By better understanding local social demographics and potential health risks, public health practitioners can work to develop prevention strategies that can reduce negative health outcomes from drought.

²NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2023). <https://www.ncei.noaa.gov/access/billions/>, DOI: 10.25921/stkw-7w73

³The CDC counts deaths differently. The CDC uses ICD-10 codes identifying excessive natural heat as one of the causes of death, concluding the number is 702 heat-related deaths per year (at any time).

⁴There have been two Presidentially declared Stafford Act major disaster declarations for drought, and two emergency declarations, all for insular areas experiencing significant agricultural losses. In these incidents, reduced access to food and water caused by drought created an immediate health and life-safety risk to the population, and therefore these declarations were issued. July 31, 2007: Federated States of Micronesia (EM-3276); April 3, 1998: Federated States of Micronesia (DR-1213); March 20, 1998: Marshall Islands (DR-1210); May 20, 1992: Federated States of Micronesia (EM-3093); <https://www.fema.gov/disaster/declarations>

A woman with blonde braids, wearing a dark cap and a yellow and black plaid shirt, is shown in profile, looking upwards and to the right. She is holding a corn cob and examining it. The background is a clear blue sky with some dry corn stalks in the foreground.

Stress from Drought

Individuals in agricultural communities are more reliant on environmental conditions to support their livelihoods than many other occupations. Droughts can disrupt agricultural production and cause financial losses, which directly impact farmers and ranchers. A study found that farmers in the Midwest were more likely to report feeling stressed during a drought event (Berman et al. 2021). Another study has shown an increase in deaths by suicide in rural and farming communities in Nebraska during drought events (Abadi et al. 2022). Due to this relationship, there are urgent needs to further educate and engage behavioral health professionals on this issue.

A starting point for public health practitioners to address health outcomes from drought is to build an improved understanding of these connections to health through networks of drought information providers. Due to the complexity of drought impacts on health, information sharing is key to assist public health officials in identifying strategies to address drought. Since every drought event has the potential to cause health impacts, public health officials should be included in drought planning and preparedness activities. Integrating public health into drought planning provides opportunities to understand and evaluate drought mitigation efforts for human health benefits. This work can also support public health interventions and educational activities that can help reduce health impacts. Likewise, integration of drought early warning and response information into public health processes is essential to ensure health professionals and emergency managers are prepared to help communities mitigate the impacts of a drought event.

Farmer controlling corn cob after extreme drought
Photo contributor: r.classen



Principles of Public Health and Engagement

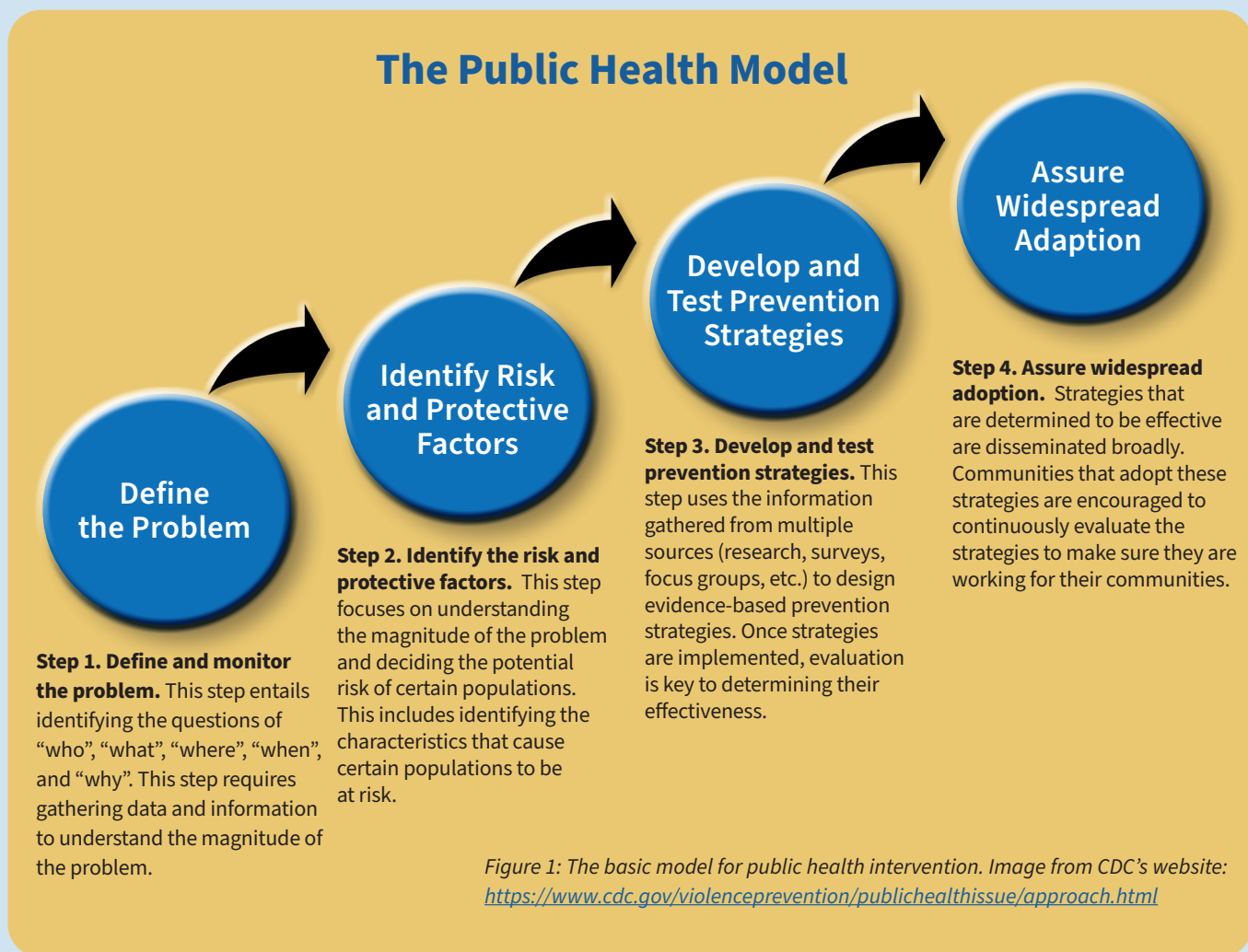
Public health is focused on the health, safety, and well-being of entire populations and their environments. Public health is based on multiple disciplines of science and relies on knowledge from a broad range of experts to identify and solve complex issues. What is unique to public health is that it focuses on prevention of injury and disease rather than the treatment of it. Since prevention is an integral part of public health, public health professionals implement educational programs, create policies, conduct research, and carry out services to prevent occurrences or recurrences of diseases and negative health impacts. They do so while striving to provide the maximum benefit for the largest number of people. That being the case, public health professionals can work at scales ranging from local to global, depending on the issue at hand.

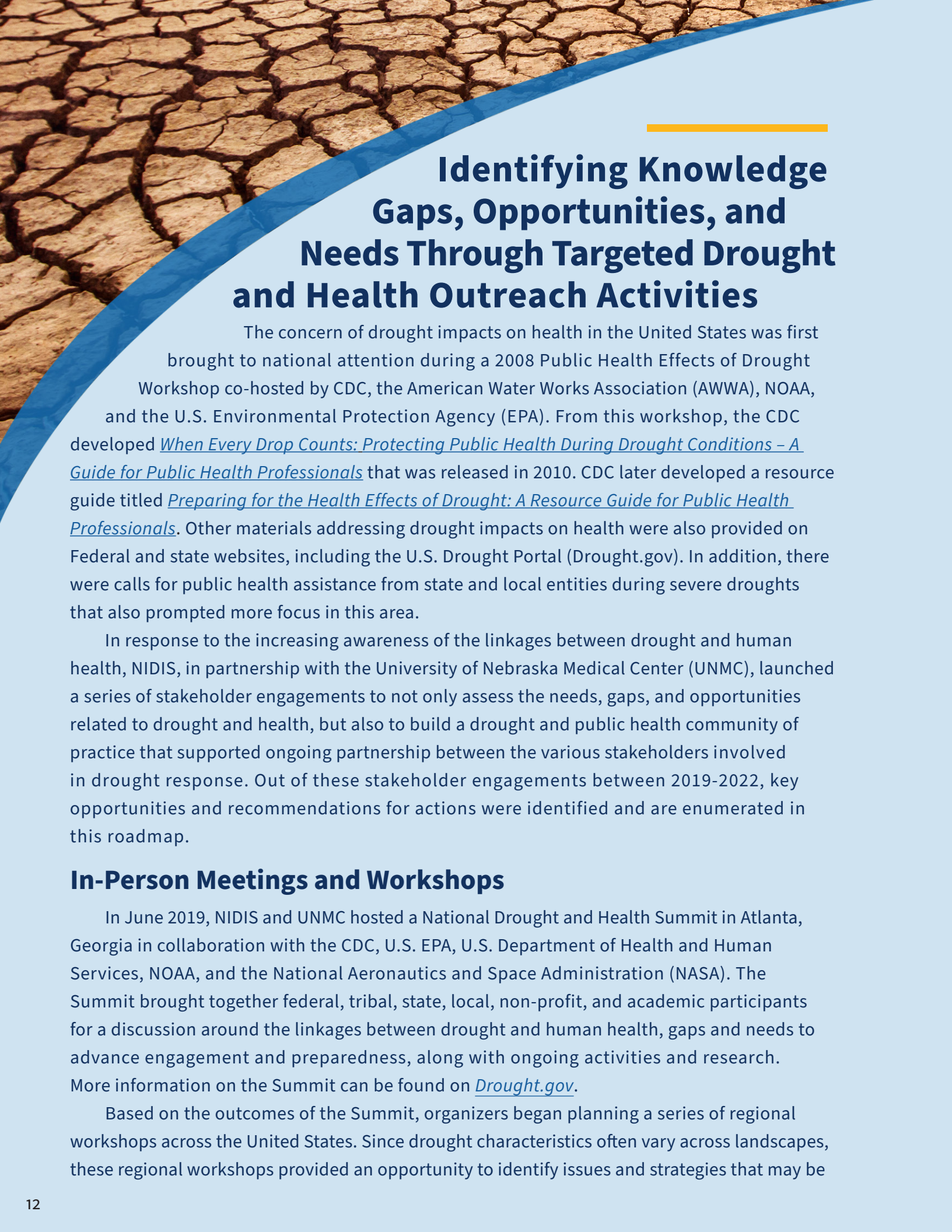
Public health is a complex yet comprehensive system, which can be fundamentally broken down into six parts: environmental health, community health, global health, epidemiology, biostatistics, and health policy and administration. Each field is important and has a strong influence on the public's health. Regarding drought and health, the field of environmental health has a significant role as the branch that focuses on the relationships between people and their environment. It aims to reduce chemical and other environmental exposures in the air, water, soil, and food, thereby mitigating associated health risks. By focusing on environmental health, it is possible to foster a healthier and safer environment for people and the communities they live in. However, each branch of public health has a role in addressing health threats associated with drought.

A Public Health Approach to Engagement

To serve communities, public health uses an intervention model that is rooted in the scientific method to develop prevention strategies and engage communities. This model serves as the basis of developing a roadmap to improve public health integration into drought planning efforts.

The public health model can assist the Nation in addressing the public health challenges that are caused by drought. Climatologists and non-health experts, in further understanding this model, can develop strategies which fit into this model that can be more effectively implemented and adopted by public health officials.





Identifying Knowledge Gaps, Opportunities, and Needs Through Targeted Drought and Health Outreach Activities

The concern of drought impacts on health in the United States was first brought to national attention during a 2008 Public Health Effects of Drought Workshop co-hosted by CDC, the American Water Works Association (AWWA), NOAA, and the U.S. Environmental Protection Agency (EPA). From this workshop, the CDC developed [*When Every Drop Counts: Protecting Public Health During Drought Conditions – A Guide for Public Health Professionals*](#) that was released in 2010. CDC later developed a resource guide titled [*Preparing for the Health Effects of Drought: A Resource Guide for Public Health Professionals*](#). Other materials addressing drought impacts on health were also provided on Federal and state websites, including the U.S. Drought Portal (Drought.gov). In addition, there were calls for public health assistance from state and local entities during severe droughts that also prompted more focus in this area.

In response to the increasing awareness of the linkages between drought and human health, NIDIS, in partnership with the University of Nebraska Medical Center (UNMC), launched a series of stakeholder engagements to not only assess the needs, gaps, and opportunities related to drought and health, but also to build a drought and public health community of practice that supported ongoing partnership between the various stakeholders involved in drought response. Out of these stakeholder engagements between 2019-2022, key opportunities and recommendations for actions were identified and are enumerated in this roadmap.

In-Person Meetings and Workshops

In June 2019, NIDIS and UNMC hosted a National Drought and Health Summit in Atlanta, Georgia in collaboration with the CDC, U.S. EPA, U.S. Department of Health and Human Services, NOAA, and the National Aeronautics and Space Administration (NASA). The Summit brought together federal, tribal, state, local, non-profit, and academic participants for a discussion around the linkages between drought and human health, gaps and needs to advance engagement and preparedness, along with ongoing activities and research. More information on the Summit can be found on [*Drought.gov*](#).

Based on the outcomes of the Summit, organizers began planning a series of regional workshops across the United States. Since drought characteristics often vary across landscapes, these regional workshops provided an opportunity to identify issues and strategies that may be

unique to each region and integrate the public health sector into the regional DEWS. Each of the in-person regional workshops concluded with a facilitated discussion, identical to the one held at the National Summit, to identify and analyze trends across workshops.

Workshop	When	Where	Attendees	Regional Topics
Midwest Drought and Human Health Workshop	November 2019	St. Paul, Minnesota	~40 attendees	Emergency response Mental health Water quality/quantity Tribal impacts
Southwest Drought and Human Health Workshop	February 2020	Tucson, Arizona	~40 attendees	Extreme heat Air quality Water quality/private wells Vector-borne diseases Tribal engagement
Carolinas Drought and Human Health Workshop	September 2020	Virtual	~20 attendees	Vector-borne diseases Mental health Drought indicators/definitions Vulnerable populations
Upper Missouri River Basin Drought and Human Health	April 2022	Bozeman, Montana	~40 attendees	Tribal engagement Health equity Mental health Water conservation
Pacific Northwest Drought and Human Health Workshop	October 2022	Portland, Oregon	~80 attendees	Environmental justice Air quality Wildfire Tribal engagement

Table 1. The regional Drought and Health Workshops hosted around the United States helped identify regional opportunities to address drought impacts on health. Each of these workshops had specific focuses based on local expertise

Regional workshop planning teams deliberately engaged a wide variety of partners to obtain a well-rounded perspective of the current state of drought knowledge in the public health field. Participants included subject matter experts, ranging from climate scientists to public health professionals, that worked for varying levels of government (federal, state, tribal and local), non-governmental organizations, and/or resource management organizations. The regional focus of the workshops allowed for geography-based similarities and differences to be observed.

See appendices for agendas from each regional workshop (Midwest, Appendix B; Southwest Appendix C; Carolinas, Appendix D; Upper Missouri Basin, Appendix E; Pacific Northwest, Appendix F).



2019 National Drought and Health Summit.

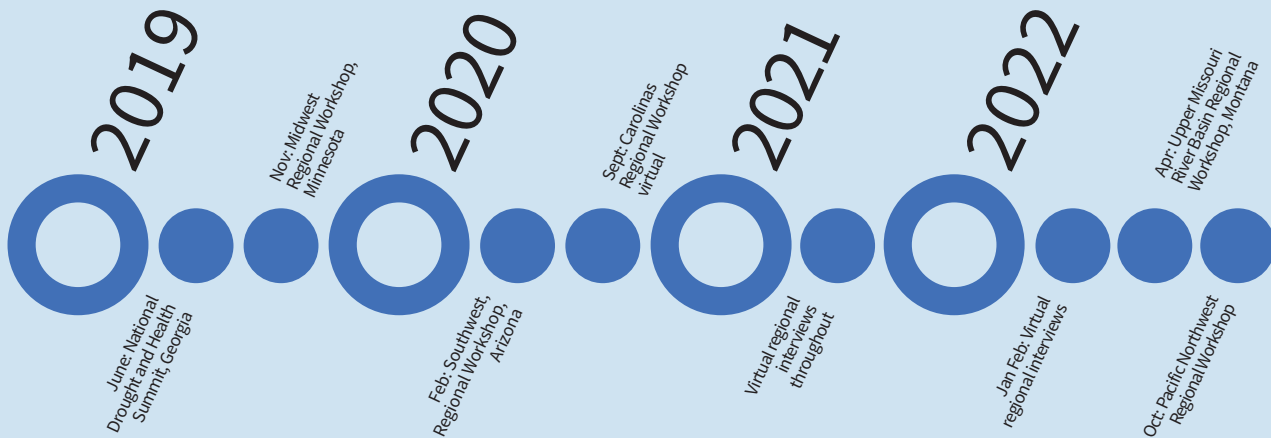


Figure 2. Timeline of drought stakeholder engagements

Interviews

To supplement the information shared during the regional workshops, and in response to delays in the regional in-person workshops caused by the COVID-19 pandemic, UNMC researchers conducted a series of drought and health-related interviews with state health departments across the United States. Rather than engaging all 50 states and five U.S. territories, researchers chose to focus on those states and entities that had received funding from the CDC through involvement in either the Building Resilience Against Climate Events (BRACE) program or the Environmental Public Health Tracking program. The interviews allowed for more focused, granular discussion with the state health departments, in contrast to the broader, conceptual discussions that took place at the regional workshops.

Additionally, the interviews created an opportunity for collaboration with states who were not a part of the regions where workshops were held. Interviews took place between June 2021 and February 2022, using the questions in Table 2. The results from the interviews are incorporated into the key opportunities and recommended action section.

Primary Question	Secondary Question
What impacts has drought had on your region?	N/A
Has drought caused other secondary impacts (such as wildfires, dust storms, heat waves, etc.)?	Specifically, has drought caused human health impacts in your region?
	Is that information available because of surveillance systems that are in place, or because of “one-off” research that has been done?
	What systems or data collection activities would need to be in place for you to answer that question?
What populations or communities in your region are most vulnerable to the impacts of drought?	What public health/emergency management/other agencies have a close working relationship with those communities?
	Do you have a working relationship with them?
Are you currently conducting any drought and human health activities in your region, and if so, what activities are you conducting?	What partners have you worked with regarding issues of drought and human health?
	What sources of funding support your drought and human health activities in your region?
If you have not yet, would you be interested in conducting drought and human health activities in your region? What activities would you want to see conducted in your region?	What resources would be helpful to you to address the human health impacts of drought?
	What partnerships would help make these activities happen?
What research do you think needs to be conducted relating to drought and health?	N/A

Table 2. Questions asked of state public health officials on addressing drought issues.



Key Opportunities and Recommended Actions

This section identifies specific opportunities for NIDIS and the broader drought and public health communities to implement, based upon feedback received from the National Drought and Health Summit, regional workshops, and interviews. The activities listed are framed under four focus areas (Partnership and Collaboration; Communication and Outreach; Interdisciplinary Research and Applications; Planning and Preparedness) and if implemented, are intended to strengthen the engagement of drought-focused entities with public health and other health-related stakeholders responding to drought and mitigate the human health risk from drought.

Partnership and Collaboration

- **Build a national drought and health community of practice as a platform for sustained engagement across disciplines.**

To effectively address the multi-faceted impacts of drought on human health, a broad range of stakeholders and experts need to be well-connected and have a means for real-time collaboration. Through the discussion at the Summit, regional workshops, and interviews, many participants were doing complementary work yet had not previously found a way to integrate their efforts. Creating a community of practice focused on drought and health would help provide a platform for engagement and sharing best practices. A network of collaborators across disciplines and entities, including climatology, public health, healthcare, emergency management, tribal governments, and Extension, would provide a more integrated approach to preparing for and responding to drought. A drought and health community of practice would be instrumental in conducting shared research and outreach initiatives, as well as creating guidance documents for best practices to assist local health departments that may not have the resources or access to climatologists or other drought-related entities in their planning efforts. The drought and health community of practice would also provide an opportunity for regular communication about current research and activities, as well as other relevant updates.

- **Expand public health representation, where possible, at drought-related meetings, and address the human health concerns of drought at health-related meetings.**

Regional drought networks should develop partnerships with public health practitioners and other professionals in the health community to provide tailored drought information. Coordinators of these networks need to be informed on their region's unique health threats and be able to effectively communicate these threats to professionals in the health community. This includes, but is not limited to, regional DEWS engagements such as annual/semi-annual meetings and webinars. In addition, regional networks could host

drought meetings that focus on public health, emergency management, and healthcare, and should include varied stakeholders from these professions.

- **Provide regional and state opportunities for the drought and public health communities to interact and form relationships.**

The workshops in Arizona and Minnesota produced local partnerships within their respective states that led to action. From the Minnesota workshop, the state climatologist made a connection with the state public health department which led to integration of health preparedness in the state's Drought Action Plan. Whereas the Arizona workshop produced a connection between two state agencies that led to the state's public health department being responsible for adding health into the state's water management plan. Continuing to offer these types of engagement opportunities will lead to improved integration of health into existing drought and water strategies.

- **Promote the increased adoption and utilization of predictive and early warning systems, such as syndromic surveillance systems or other public health monitoring systems, that rapidly evaluate community health outcomes.**

These systems quickly and continuously monitor health outcomes from hospital records and other sources of health-related data to identify patterns of disease. These types of centralized data systems can also be used for disease prediction and forecasting. There is an opportunity to utilize this type of analysis to better define early warning signs of health impacts from drought, which would lead to more accurate predictions of drought and its impacts on human health.

- **Incorporate questions on drought impacts in community health needs assessments.**

For example, CDC's Community Assessment for Public Health Emergency Response (CASPER) (see callout box) could be used on a more frequent basis to collect observations related to more acute drought events. More frequent deployment of CASPERs after drought events would increase knowledge of impacts for future assessments.

CASPERs for Drought

CDC's Community Assessment for Public Health Emergency Response (CASPER) is a rapid needs assessment for gathering information from households in disaster impacted areas. This information is used for planning, response, and recovery. CASPERs are not often used for evaluating the health impacts of drought. However, there are examples of CASPERs being used to assess how households in drought affected areas are dealing with issues such as dry wells, determine potential health impacts, and identify what assistance is needed. Mariposa and Tulare County, California in 2015 and 2016 used CASPERs for preparedness efforts ([see link for more information](#)). Crook County, Oregon performed a CASPER in 2017 for drought response ([see link for more information](#)).

-
- **Develop drought and health vulnerability assessments and mapping for observing drought impacts by region or state.**

Because impacts associated with droughts vary across the United States, vulnerability mapping should be conducted based on specific threats at the state or regional level. These maps will assist with identifying populations and communities that are more at risk of drought impacts on human health. Existing resources, such as [CDC's Environmental Health Tracking Network](#), [CDC's Social Vulnerability Index](#), and [EPA's Environmental Justice Screening and Mapping Tool](#), could also be used to identify areas of higher risk to drought impacts.

Communication and Outreach

A recurrent theme across workshop and interview discussions was the need for additional outreach materials and consistent messaging on drought and health. As public health officials are sometimes not familiar with the linkage between human health and drought, materials should first focus on providing basic information on drought and its potential health outcomes. A key activity moving forward would be to provide educational, common language materials for targeted audiences (e.g., public health, policymakers, healthcare professionals, etc.) so that all involved parties could have a better understanding of the nature of drought and its impacts on health, as well as their role in addressing those impacts. Materials should be updated regularly as we advance our knowledge on the linkages through research and collaboration.

- **Develop impact-based communication resources for drought in areas of higher concern with a focus on human health impacts.**

These communication resources could be used by public health departments across the region to educate their communities on how drought can affect human health.

- **Provide tailored population-specific materials vital to communicating the risk of drought on the health of vulnerable populations.**

Develop communication materials for specific populations (e.g., non-english speakers, lower income, rural residents, urban residents, tribal nations, etc.) that are more at-risk to health impacts of drought.

- **Develop drought and health resources and toolkits for state and local health departments.**

This could include easy-to-follow drought assessments tailored to the needs of public health. These tools would empower public health departments to address the potential health impacts of drought events more readily in their authority. These toolkits could include social media graphics, flyers, videos, and other resources to inform individuals about interventions to reduce health risks associated with drought.

-
- **Utilize Drought.gov and existing CDC websites as a platform for dissemination of information of drought and health resources.**

CDC and Drought.gov have web pages dedicated to drought and health. These webpages have a variety of educational materials to help inform public health professionals on drought. As more material is developed, it is important for coordination between these entities to ensure congruence.

- **Utilize Agricultural Extension Services to reach and engage rural communities that are more susceptible to the health impacts from drought.**

Land Grant Extension Services are already working on issues tangentially related to health impacts associated with drought. For example, North Dakota and Washington are already addressing issues associated with water quality and mental health. Integrating drought with Extension's current activities could help with improved message delivery.

Interdisciplinary Research and Applications

Reliable evidence and information can help inform public health decision-making during drought events. Research is a tool that can help provide that information. However, there is a lack of research associated with drought and health. There is a need for more research at the regional level to provide insight on disease occurrence and populations at-risk to drought events. Communicating research results to stakeholders will strengthen the regional community of practice and provide possibilities to further explore other health outcomes.

- **Improve understanding of drought indicators and their relationship to health outcomes, and develop guidance needed on specific drought indicators and indices to be used for observing the health impacts of an event.**

As there are dozens of drought monitoring indicators, it can be difficult for public health officials to understand what to follow or use. Indicators can perform better for some regions or have limitations. Evaluating health outcomes from different indicators at a regional level can help public health officials understand how to use this information. In FY20, NIDIS invested in research through its Coping With Drought grant competition entitled, "Evaluation of Drought Indicators for Improved Decision-Making in Public Health and Emergency Preparedness: Reducing Drought's Burden on Health" as a first step to better addressing this key research need. Learn more [here](#).

- **Conduct a comprehensive review of past drought events to better define early warning signs of health impacts from drought.**

The review should include public health impacts, where possible, and note any mitigation or intervention efforts that did happen, and contain regional distinctions to account for the differing regional characteristics of drought. This information will help public health professionals understand the potential threats that communities face

and provide a better opportunity to prepare and respond to drought. This review can also inform future research efforts on the mitigation of health impacts from drought.

- **Improve understanding on how drought impacts individuals and/or communities utilizing private wells.**

This has been an oft-noted concern of interviewed public health officials across the United States, where private wells are used frequently within rural communities. As these wells are unregulated, it is not immediately clear how drought events may impact both the water quality and water quantity. Further research into this issue could lead to greater understanding of drought's practical impacts on drinking water in rural communities and may require policy changes to ameliorate these concerns. Outcomes could also lead to improved water quality monitoring in private wells during times of drought.

- **Address barriers to data access and understanding for public health researchers and epidemiologists to effectively use drought data in research studies.**

These barriers often hamper the use of drought data, therefore resulting in fewer analyses to identify health outcomes. Drought data, like other climate data, are difficult to access without significant programming resources, and the data that is most well-known might not always be the most appropriate dataset to use. To improve usability, data should be formatted to meet the needs of the user and be compatible with their software. In the case of health studies, research is typically conducted at the county or census tract level with basic statistical software (SAS, SPSS, R, ArcGIS, and EXCEL). Developing User Guides on accessing drought information and understanding capabilities will also improve usability.

Planning and Preparedness

At each of the workshops, discussion occurred around the importance of adequately preparing for drought and its related impacts. Robust public health preparedness systems are already in place at the state and national level, but intersection between those systems and state climate offices does not regularly occur. As is echoed in other sections, improved relationships between these communities should lead to more comprehensive drought planning and preparedness measures.

- **Incorporate human health impacts and public health actions in drought vulnerability assessments and state or local drought plans.**

This will improve the understanding of the distinct needs and potential actions for a given state or region. This is also an opportunity to incorporate relevant research into these assessments and plans.

- **Utilize tabletop exercises for drought events to prepare for health impacts.**

Tabletop exercises are frequently used in public health and emergency management settings to prepare for future risks or hazards. By utilizing them for a climate-related threat, such as drought, public health and emergency management individuals can more readily understand the potential response efforts that may be necessary for a drought event.

- **Engage with tribal nations to address their unique needs regarding drought and the impacts to human health.**

One opportunity is to incorporate public health issues in activities related to implementing the [*NIDIS Tribal Drought Engagement Strategy*](#). Representatives of tribal communities should be included in discussions around drought planning, at the local, state, regional, and federal levels, to ensure that their needs are being considered and addressed.

- **Develop and create sample drought and health survey questions that could be added to a community health needs assessment.**

These could be tailored and deployed at regional and state levels. At times when CASPERs are not needed, standardized questions could be useful for public health officials to determine issues associated with drought. These questions could then be used to compare responses by region for better understanding of response and planning for drought.



Conclusion

The guided discussions at the drought and health workshops and the health department interviews, and the information shared at the National Drought and Public Health Summit, identified a desire and demand for coordination, connection, and education to expand drought awareness and actions more effectively into the field of public health.

No one organization or program can address all of the opportunities and recommended actions identified by the drought and public health community. This ‘Roadmap’ is intended to serve as user-driven guidance for future investments by federal, state, and local agencies, including NIDIS and CDC that are working at the drought-health nexus. NIDIS will also leverage and support these activities internally with existing efforts and activities, such as linking these opportunities to NOAA’s OneHealth initiative as well as the National Integrated Heat Health Information System (NIHHIS). Through shared understanding and dedicated resources, real progress can be made in meeting the goal to mitigate the human health impacts of drought events.

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Appendices

NIDIS and UNMC would like to thank each of the participating organizations and agencies who attended the 2019 Drought and Health Summit and the five regional workshops. Those organizations and agencies include:

Appendix A: Participating Organizations

Affiliated Tribes of Northwest Indians

All Nations Health Center

American Geophysical Union

Appalachian State University

Arizona Congressman Tom O'Halleran

Arizona Department of Health Services

Arizona Department of Water Resources

Arizona State Climate Office

Atlanta Regional Commission

Bad River Tribe

Benton County Health Department

Bureau of Reclamation (U.S. Department of Interior)

California Office of Environmental Health Hazard Assessment

California State University, Chico

Center for Disaster Philanthropy

Center for Disease Control and Prevention

Citizens for Clean Energy - Great Falls

Coalition of Communities of Color

Coalition of Communities of Color

Colorado College State of the Rockies Project



Community Food Bank of Southern Arizona

Confederated Salish and Kootenai Tribes

Confederated Tribes of Warm Springs Oregon

Council of State and Territorial Epidemiologists

Denver Post

Deschutes County Health Services

Desert Research Institute

Emory University

Florida State University

Fort Belknap Indian Community

Georgia Department of Public Health/Environmental Health

High Water Mark

Indiana Department of Homeland Security

Indiana State Department of Health

ISciences

Kentucky Climate Center

Kentucky Division of Water

Little Big Horn College

Lower Platte South Natural Resources District

Metropolitan North Georgia Water Planning District

Mille Lacs Band of Ojibwe

Mille Lacs County Community Health

Minnesota Department of Health

Minnesota Department of Natural Resources

Minnesota Homeland Security and Emergency Management



Minnesota State Climate Office

Missoula County, Montana

Montana Climate Office

Montana Department of Agriculture

Montana Department of Environmental Quality

Montana Department of Natural Resources and Conservation

Montana Department of Public Health and Human Services

Montana Disaster and Emergency Services

Montana Environmental Information Center

Montana Health Professionals for a Healthy Climate

Montana State University

Moorhead Public Service

National Academies of Science, Water Science and Technology Board

National Aeronautics and Space Administration (NASA)

National Drought Mitigation Center

Natural Resources Defense Council

Navajo Nation Water Management Branch

New Mexico Department of Health

New Mexico State University

Nez Perce Tribe

NOAA Carolinas Integrated Sciences & Assessments (CISA)

NOAA National Centers for Environmental Information

NOAA National Environmental Satellite, Data, and Information Service

NOAA National Weather Service (North Central River Forecast Center)

NOAA National Weather Service (several local offices)



NOAA North Carolina Institute for Climate Studies

NOAA Wisconsin Sea Grant

North Carolina State Climate Office

North Carolina State University

North Dakota State University

North State Planning and Development Collective

Northwest Portland Area Indian Health Board

Nueta Hidatsa Sahnish College

Office of the Washington State Climatologist

Ohio Emergency Management Agency

Ohio State University

Oregon Department of Human Services

Oregon Department of Land Conservation and Development

Oregon Environmental Council

Oregon Health and Science University/Portland State University School of Public Health

Oregon Health Authority

Oregon Institute of Technology

Oregon State University

Oregon Watershed Enhancement Board

Pala Band of Mission Indians

Pan-American Health Organization (PAHO/WHO)

PCUN (Pineros y Campesinos Unidos del Noroeste)

Pinal County Public Health Services District (Arizona)

PNW Just Futures Institute for Climate and Racial Justice

Portland State University



Proactive Blue Earth Services, LLC

Scripps Institution of Oceanography

Sicangu Oyate Land Office

South Carolina State Climatology Office

Southwest Hydrology & Hydraulics, LLC

Spokane Tribal Network

Standing Rock Sioux Tribe

State Climate Office of Ohio

Tohono O'odham Nation

Tribal Healthy Homes Network/Partnership for Air Matters

U.S. Department of Homeland Security/Cybersecurity and Infrastructure Security Agency (CISA)

U.S. Environmental Protection Agency

U.S. Geological Survey

University Corporation for Atmospheric Research

University of Arizona

University of Colorado Boulder

University of Houston

University of Illinois, Urbana-Champaign

University of Iowa

University of Minnesota

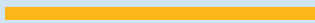
University of Montana

University of Nebraska Medical Center

University of North Carolina at Chapel Hill

University of Oregon

University of Oregon School of Law



University of South Carolina

Upper Mississippi River Basin Association

UrbanKind Institute

Verde

Washington State Department of Agriculture

Washington State Department of Health

Washington State University

Washington State University Skagit County Extension

Washington State University Vancouver

Western Kentucky University

Western Regional Climate Center

Willamette Partnership

Appendix B: Midwest Drought and Human Health Workshop Report Agenda

Midwest Drought and Human Health Workshop November 20 - 21, 2019 Science Museum of Minnesota – St. Paul, Minnesota

Meeting Goals

- To provide participants with a better understanding of the health impacts of drought
- To engage participants across academic, healthcare, public health, and other sectors to encourage cross-sector collaboration
- To discuss strategies for addressing and minimizing the health impacts of drought

Agenda: Wednesday, November 20, 2019

- 1:00 PM **Welcome and Introductions**
- 1:30 PM **Intersection between Drought & Human Health**
*Jesse Bell, PhD, Claire M. Hubbard Professor of Health and Environment,
University of Nebraska Medical Center College of Public Health*
- 2:30 PM **Break**
- 2:45 PM **Nuts and Bolts of Drought**
*Luigi Romolo, PhD, Minnesota State Climatologist,
Minnesota Department of Natural Resources*
- 3:15 PM **Use of Community Assessments for Public Health Emergency Response
(CASPERs) for Drought**
*Tesfaye Bayleyegn, MD, Senior Service Fellow, Team Lead, Disaster Epidemiology and Response
Team, Center for Disease Control and Prevention National Center for Environmental Health,
Division of Environmental Health Science and Practice*
- 4:00 PM **Facilitated Discussion**
*Keith Hansen, MBA & Rachel Lookadoo, JD
Center for Preparedness Education, University of Nebraska Medical Center*
- 4:30 PM **Adjourn**

Agenda: Thursday, November 21, 2019

- 8:00 AM **Welcome Back & Day 2 Overview**
- 1:30 PM **Intersection between Drought & Human Health**
- 8:45 AM **Exploring the Morbidity Impacts Associated with Drought Conditions in the US**
*Shubhayu Saha, PhD, Health Scientist,
Climate and Health Section, Centers for Disease Control and Prevention (CDC)*
- 9:15 AM **Role of NIDIS in Drought and Health**
*Molly Woloszyn, MS, Midwest DEWS Regional Coordinator, NOAA/National Integrated Drought
Information System*
- 9:30 AM **Minnesota Climate and Health Program/Climate Migrants**
*Brenda Hoppe, PhD, Senior Research Scientist, Minnesota Climate and Health Program,
Minnesota Department of Health*
- 10:15 AM **Break**

-
- 10:30 AM** **Mental Wellbeing for Agricultural Workers Dealing with Drought**
*Emily Wilmes, MEd, Extension Educator and Director,
Rural Stress Task Force, University of Minnesota Extension*
 - 11:00 AM** **Planning for Water Utility Resilience: Using CREAT 3.0 to Evaluate Adaptive Measures to Climate Change**
*Marc Pritchard, Water Plant Supervisor,
Moorhead Public Service*
 - 11:30 AM** **The Impact of Drought on Culturally Important Plants of First Peoples**
*Linda Black Elk, PhD, Ethnobotanist,
Mille Lacs Band of Ojibwe*
 - 12:00 PM** **Drought and Public Health Law**
*Betsy Lawton, JD, Senior Attorney, & Jill Krueger, JD, Director of Northern Region Office,
Network for Public Health Law*
 - 12:30 PM** **Lunch**
 - 1:30 PM** **Facilitated Discussion**
*Keith Hansen, MBA & Rachel Lookadoo, JD
Center for Preparedness Education, University of Nebraska Medical Center*
 - 4:00 PM** **Adjourn**

Appendix C: Southwest Drought and Human Health Workshop Agenda

Southwest Drought and Human Health Workshop

February 26-27, 2020

University of Arizona

Tucson, AZ

Meeting Goals

- To provide participants with a better understanding of the health impacts of drought
- To engage participants across academic, healthcare, public health, and other sectors to encourage cross-sector collaboration
- To discuss strategies for addressing and minimizing the health impacts of drought

Agenda: Wednesday, February 26, 2020

- 9:00 AM – 9:30 AM** **Breakfast (Provided)**
- 9:30 AM – 10:00 AM** **Welcome and Introductions**
- 10:00 AM – 10:50 AM** **Intersection between Drought & Human Health in the Southwest**
*Jesse Bell, PhD, Claire M. Hubbard Professor of Health and Environment,
University of Nebraska Medical Center College of Public Health*
- 11:00 AM – 11:50 AM** **How Do You Identify Drought in a Desert?**
*Nancy Selover, PhD, Arizona State Climatologist,
Arizona State Climate Office*
- 12:00 PM – 1:00 PM** **Lunch (Provided)**
- 1:00 PM – 1:15 PM** **Role of NIDIS in Drought and Health**
*Joel Lisonbee, MS, Drought Early Warning System Coordinator,
NOAA/National Integrated Drought Information System*

-
- 1:15 PM – 2:20 PM** **Drought and Health Special Topics Panel and Interactive Discussion**
 - **Air Quality** (David DuBois, PhD, New Mexico State Climatologist, New Mexico State University)
 - **Vector-Borne Diseases** (Kacey Ernst, PhD, Associate Professor & Program Director, Epidemiology, University of Arizona College of Public Health)
 - **NOAA/NWS Phoenix’s Heat Program Overview** (Paul Iñiguez, MA, Science and Operations Officer, NOAA/National Weather Service)
 - 2:30 PM – 3:20 PM** **Satellite-based Drought Reporting on the Navajo Nation**
Carlee McClellan, Senior Hydrologist, Navajo Nation Department of Water Resources
 - 3:30 PM – 4:30 PM** **Drought Planning Activity**
Keith Hansen, MBA, Director, Center for Preparedness Education, University of Nebraska Medical Center
 - 4:30 PM** **Adjourn**

Agenda: Thursday, February 27, 2020

- 9:30 AM -10:20 AM** **Connecting Science and Decision-Making to Manage Climate Risks**
Kathy Jacobs, MLA, Director, Center for Climate Adaptation Science and Solutions, University of Arizona
- 10:30 AM – 11:20 AM** **Overview of Drought and Health Work in the Arizona Department of Health Services**
Matthew Roach, MPH, Epidemiology Program Manager, Arizona Department of Health Services
- 11:30 AM – 12:30 PM** **Lunch (Provided)**
- 12:30 PM – 1:50 PM** **Drought and Health Special Topics Panel and Interactive Discussion**
 - **New Mexico Private Wells Water Quality and Drought Information and Resources**
(Rose Galbraith, MPH, Private Wells Program Manager Epidemiologist, New Mexico Department of Health)
 - **Public Health and Climate Adaptation Planning: Synergies and Opportunities**
(Mona Arora, PhD, Principal Research Specialist & Course Instructor, College of Public Health, University of Arizona)
 - **Valley fever: Clinical Spectrum and Risk of Getting it** *(John Galgiani, MD, Director, Valley Fever Center for Excellence, University of Arizona College of Medicine)*
 - **Engaging Arizona Tribal Communities in Environmental Public Health Work**
(Michael Allison, MBA/MPH, Native American Liaison, Arizona Department of Health Services)
- 2:00 PM – 2:50 PM** **Pima County – Preparing for and Managing Drought**
Kathleen Chavez, PE, Water Policy Manager, Office of Sustainability, Conservation, and Historic Preservation, Pima County
- 3:00 PM – 4:30 PM** **Facilitated Discussion**
Keith Hansen, MBA & Rachel Lookadoo, JD, Center for Preparedness Education, University of Nebraska Medical Center
- 4:30 PM** **Adjourn**

Appendix D: Carolinas Virtual Drought and Human Health Workshop Agenda

Carolinas Drought and Human Health Virtual Workshop September 23-24, 2020

Meeting Goals

- To provide participants with a better understanding of the health impacts of drought
- To engage participants across academic, healthcare, public health, and other sectors to encourage cross-sector collaboration
- To discuss strategies for addressing and minimizing the health impacts of drought

(Times are subject to change. All times are in Eastern Standard Time.)

Agenda: Wednesday, September 23, 2020

- 10:00 AM **Introductions**
- 10:15 AM **Intersection between Drought & Human Health**
*Jesse Bell, PhD, Claire M. Hubbard Professor of Health and Environment,
University of Nebraska Medical Center College of Public Health*
- 10:45 AM **Overview of Carolina Drought Events**
*Charles Konrad, PhD, Director of the Southeast Regional Climate Center (SERCC),
Co-PI Carolinas Integrated Science and Assessments (CISA),
Professor, Department of Geography, University of North Carolina at Chapel Hill*
- 11:00 AM **Facilitated Discussion**
*Keith Hansen, MBA & Rachel Lookadoo, JD
Center for Preparedness Education, University of Nebraska Medical Center*
- 12:00 PM **Adjourn Day 1**

Agenda: Thursday, September 24, 2020

- 10:00 AM **Recap of Day 1**
- 10:15 AM **Facilitated Discussion**
*Keith Hansen, MBA & Rachel Lookadoo, JD
Center for Preparedness Education, University of Nebraska Medical Center*
- 12:00 PM **Adjourn Day 2**

Appendix E: Upper Missouri River Basin Drought and Human Health Workshop Agenda

Upper Missouri River Basin Drought and Human Health Workshop

April 12-13, 2022
Montana State University
Bozeman, MT

Meeting Goals

- Provide participants with a better understanding of the health impacts of drought in the Upper Missouri River Basin
- Engage participants across academic, healthcare, public health, and other sectors to encourage cross-sector collaboration
- Showcase best practices on how to reduce health impacts from increasing drought conditions
- Discuss strategies for addressing and minimizing the health impacts of drought

Agenda: Tuesday, April 12, 2022

- 1:00 PM – 1:30 PM **Welcome and Introductions**
- 1:30 PM – 2:20 PM **Intersection between Drought & Human Health**
Jesse Bell, University of Nebraska Medical Center College of Public Health
- 2:30 PM – 3:20 PM **Overview of Drought Basics**
Kelsey Jencso, Montana Climate Office, W.A. Franke College of Forestry and Conservation
- 3:20 PM – 3:30 PM **Break**
- 3:30 PM – 4:20 PM **Foundational Frameworks and Policies of Drought Panel**
Michael Downey, Montana Department of Natural Resources
Nick Hagerty, Montana State University
Derf Johnson, Montana Environmental Information Center
- 4:20 PM – 4:30 PM **Day One Closing Thoughts and Adjourn**

Agenda: Wednesday, April 13, 2022

- 8:30 AM – 8:45 AM **Welcome Back & Day 2 Overview**
- 8:45 AM – 9:00 AM **Role of NIDIS in Drought and Health**
Britt Parker and Molly Woloszyn, NOAA/National Integrated Drought Information System, University of Colorado-CIRES
- 9:00 AM – 10:00 AM **Air Quality and Wildfires Panel**
Randy Ashley, Confederated Salish and Kootenai Tribes
Caroline Bean, Missoula County Climate Resilience Coordinator
Rob Byron, Montana Health Professionals for a Healthy Climate
- 10:00 AM – 10:20 AM **Break**
- 10:20 AM – 10:50 AM **Drought and Mental Health**
Mark Schure, Montana State University
- 11:00 AM – 12:00 PM **Water Quality and Quantity Issues Panel**
Miranda Meehan, North Dakota State University
Hannah Riedl, Montana DEQ
Adam Sigler, Montana State University
- 1:00 PM – 2:20 PM **Impacts of Drought on Tribal Nations Panel**
John Doyle, Little Big Horn College
Michael Durglo, Confederated Salish and Kootenai Tribes
Mari Eggers, Montana State University
Ruth Plenty Sweetgrass-She Kills, Nueta Hidatsa Sahnish College

2:20 PM – 2:30 PM	Break
2:30 PM – 4:30 PM	Facilitated Discussion of Next Steps <i>Keith Hansen & Rachel Lookadoo, University of Nebraska Medical Center</i>
4:30 PM	Adjourn

Appendix F: Pacific Northwest Region Drought and Human Health Workshop

Pacific Northwest Region Drought and Human Health Workshop

October 19-20, 2022

Portland, OR

Meeting Goals

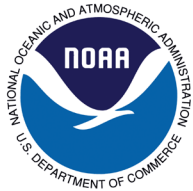
- Provide participants with a better understanding of the health impacts of drought in the Pacific Northwest
- Engage participants across academic, healthcare, public health, and other sectors to encourage cross-sector collaboration
- Showcase best practices on how to reduce health impacts from observed and projected increases in the frequency, duration, and severity of drought
- Discuss strategies for further addressing and minimizing the health impacts of drought

Agenda: Day 1, Wednesday, October 19, 2022

9:00 AM – 9:30 AM	Welcome and Introductions <i>Land Acknowledgement Statement by Ryan Sealy, Northwest Portland Area Indian Health Board</i>
9:30 AM – 10:20 AM	Intersection between Drought and Human Health <i>Jesse Bell, University of Nebraska Medical Center College of Public Health</i>
10:20 AM – 10:30 AM	Break (Coffee/Tea Provided)
10:30 AM – 12:00 PM	Environmental Justice and Drought <i>Alida Cantor, Portland State University</i> <i>Ira Cuello-Martinez, Pineros y Campesinos Unidos del Noroeste</i> <i>Melissa Haeffner, Portland State University</i> <i>Rose Poton, Oregon Water Futures Project</i> <i>Alai Reyes-Santos, Oregon Water Futures Project</i>
12:00 PM - 1:00 PM	Lunch (Provided)
1:00 PM – 2:20 PM	Drought Response Frameworks Panel <i>Gary Bahr, Washington Department of Agriculture</i> <i>Marnie Boardman, Washington Department of Health</i> <i>Curtis Cude, Oregon Health Authority</i> <i>Sheryl Howe, Washington Department of Health</i>
2:20 PM – 2:30 PM	Break
2:30 PM – 4:00 PM	Air Quality Panel <i>Kyle Chapman, Oregon Institute of Technology</i> <i>Courtney Farrell, California State University – Chico</i> <i>Dmitri Kalashnikov, Washington State University - Vancouver</i> <i>Diana Rohlman, Oregon State University</i>
4:00 PM – 4:50 PM	Facilitated Discussion (Identifying Issues and Challenges) <i>Tamara Wall, Desert Research Institute</i>
4:50 PM - 5:00 PM	Closing Thoughts and Adjourn

Agenda: Day 2, Thursday, October 20, 2022

- 9:00 AM – 9:15 AM **Welcome Back & Day 2 Overview**
- 9:15 AM – 9:45 AM **Role of NIDIS in Drought and Health**
Britt Parker, NOAA National Integrated Drought Information System/Cooperative Institute for Research in Environmental Sciences, CU-Boulder
- 9:45 AM – 10:40 AM **Observed and Projected Drought Conditions in the Pacific Northwest**
Nicholas Bond, Washington State Climatologist, University of Washington
Larry O’Neill, Oregon State Climatologist, Oregon State University
- 10:40 AM – 10:50 AM **Break (Coffee/Tea Provided)**
- 10:50 AM - 11:30 AM **Drought and Mental Health**
Don McMoran, Washington State University Extension
- 11:30 AM – 12:00 PM **Drought, Groundwater, and River Restoration**
Adell Amos, University of Oregon
- 12:00 PM – 1:00 PM **Lunch (Provided)**
- 1:00 PM – 2:30 PM **Impacts of Drought on Tribal Nations**
Gwen Carter, Nez Perce Tribe
David Close, University of British Columbia
Dan Martinez, Warm Springs Tribes
Gillian Mittelstaedt, Tribal Healthy Homes Network
Melodi Wynne, Spokane Tribal Network
- 2:30 PM – 2:40 PM **Break (Snacks Provided)**
- 2:40 PM – 4:30 PM **Facilitated Discussion (Focus on next steps, solutions, additional activities)**
Keith Hansen & Rachel Lookadoo, University of Nebraska Medical Center College of Public Health
- 4:30 PM **Closing Thoughts and Adjourn**



Document prepared by NIDIS
in partnership with key
stakeholders in
the region.

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