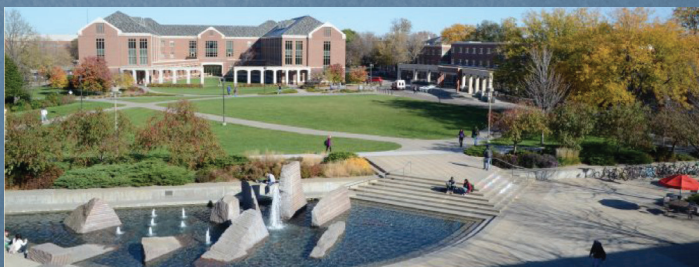
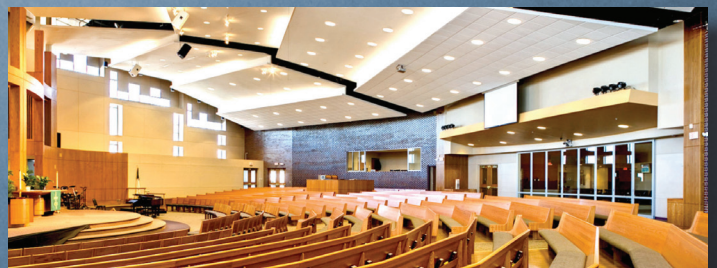
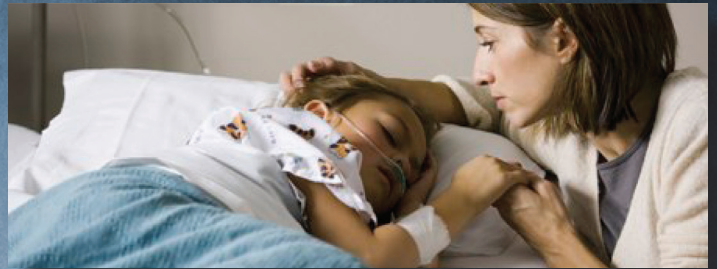


The Implications of Climate Change for Nebraska: Summary Report of Sector-Based Roundtable Discussions

(September-October 2015)



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Acknowledgments

This report is the result of the work of many individuals that contributed to the success of the series of eight sector-based roundtable events that were held in September and October of 2015. First and foremost, we would like to thank the organizers and the organizations they represent for their leadership in bringing together a diverse set of key stakeholders to discuss the implications of climate change on their sector. It was such a pleasure to work with such a dedicated group of individuals. Second, we would like to thank the more than 350 people who participated in these discussions for their insights as we seek to respond to our changing climate. The list of attendees is included with each roundtable report so you can appreciate the significant diversity that was represented in the discussions. These participants were engaged in the conversations and shared their ideas and concerns. Their contributions have resulted in a rich set of ideas and action items for all to consider as we continue this conversation in the months ahead.

We also wish to thank all of the staff of the School of Natural Resources at the University of Nebraska that contributed in so many ways in the planning and preparations that went into the organization of these meetings. In particular, this includes Mark Mesarch for his work on the preparation of the registration website, Greg Hutchison for recording and editing the keynote presentations, Tonya Bernadt and Nicole Wall for taking notes during the roundtable sessions, Jacki Loomis and Karen Jensen for their assistance with registration materials, Deborah Wood for her final edits to the report and Dee Ebbeka for the final layout and formatting of the report. It's such a pleasure to work with such competent and dedicated staff members.

Finally, we wish to thank Ronnie Green, NU Vice President and IANR Harlan Vice Chancellor of the Institute of Agriculture and Natural Resources, for his continued support of our efforts to bring science-based information about climate change and its implications to the citizens of Nebraska.

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Kimberly Morrow



Ken Dewey

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Introduction

In September 2014, the University of Nebraska published a report, *Understanding and Assessing Climate Change: Implications for Nebraska*¹. This comprehensive report summarized the current understanding of climate change science, projected changes in climate for Nebraska, and addressed the implications of these changes for some of the state's primary sectors. This report also documented many of the key challenges that the state will face as a result of climate change. A key takeaway message from the report was the need to identify those actions that need to be implemented now and in the coming years to avoid or reduce the deleterious effects of climate change on Nebraska through appropriate adaptation and mitigation measures. With this knowledge in hand, Nebraska will also be in a better position to take advantage of opportunities that may be associated with climate change. The report also suggested that "action now is preferable and more cost effective than reaction later."

The response to the report was overwhelmingly positive and spawned numerous activities, initiatives, and discussions related to efforts needed to respond to our changing climate and its implications for Nebraska's economy and environment. As a follow-on to the climate change report, the University of Nebraska organized a series of sector-based roundtable discussions on the implications of climate change on some of the key sectors that were discussed in Chapter 7 of the report. The goals of these roundtables were to raise awareness of the implications of climate change on these sectors, identify specific adaptation and mitigation actions that these sectors could initiate in response to our changing climate, serve as the starting point to develop a statewide climate change action plan, and identify potential cross-sectoral concurrence and conflicts associated with the implementation of specific adaptation and mitigation actions.

Roundtable Reports: Overview

The reports of the eight sector-based roundtables are included below. The organizers of these roundtables were provided with a suggested format for the report from their discussions, although they were also given the latitude to adapt this format to the discussions that ensued since the eight sectors are quite different and thus the outcomes would also be expected to be quite different.

In general, the agenda for each of the one-day roundtable events followed the format below:

- Introduction—goals and expected outcomes
- Overview presentation of the UNL climate change report and its key findings
- Keynote presentation from a sector expert
- Breakout group discussions focused on identifying priority actions, strategies, and programs for each sector in the following topical areas:
 - Adaptation—actions, including research, policy, and educational needs
 - Mitigation—actions, including research, policy, and educational needs
- Summary discussion/Wrap-up

Each of the roundtables addressed the following set of questions during the breakout sessions to ensure greater consistency in the output from each roundtable.

1. What are the key issues facing your sector as the effects of climate change become more pronounced in the decades ahead as highlighted in the UNL climate change report?
2. What are the primary steps that could be taken in your sector to reduce greenhouse gas emissions?
3. What is at risk in your sector from climate change? (Species, habitat, property, business model, earnings, people, etc.)

¹The report is available at <http://go.unl.edu/climatechange>.

4. What are the primary steps that could be taken in your sector to adapt to our changing climate?
5. What kinds of information do you need to move forward on addressing the implications of climate change for your sector?
 - a. What research or education gaps need to be filled?
 - b. Which research projects or educational programs would be the highest priority?
6. What policy options would help your sector to move forward on addressing the implications of climate change?
 - a. Are there existing laws/policies that should be modified?
 - b. Are new policies needed? If so, what issues would they address?

Rural Nebraskans Poll: Summary of Key Outcomes on Climate Change

The University of Nebraska conducts an annual poll of rural Nebraskans regarding their views on a wide range of topics. In advance of the 2015 poll, the editors of this report were asked to assist in the preparation of questions on climate change to be included in the poll. Questions regarding climate change have been included in previous polls but the view of those conducting the poll was that the questions used in the previous polls should be revised given the September 2014 UNL Climate Change Report and the high-level of press coverage the report and its conclusions had received throughout the state. The timing of this request was important as it preceded the conduct of the eight roundtable events that this report summarizes.

The results from the Rural Poll were received by the editors of this report in advance of the roundtables and a press release summarizing the results of the questions on climate change were released to the public just prior to the first roundtable. As a result, the views of rural Nebraskans expressed on the topic of climate change became a recurring focus of conversations during all eight of the roundtables. These poll results were also a catalyst for discussions around recommendations emanating from each of the roundtables, especially regarding possible next steps for implementing adaptation and mitigation actions within and across the various sectors covered by the roundtables.

We have included some of the key outcomes from the Executive Summary of the Rural Poll in this section of our report as a preface to the roundtable summaries, as references to the poll were repeatedly referred to during the roundtable discussions.

- ***Most rural Nebraskans believe the state should develop a plan for adapting to climate change in order to reduce its impact on agriculture, rural communities, forestry and natural resources. And, most rural Nebraskans agree that the University of Nebraska should be helping agricultural producers, rural communities and others to adapt to climate change.***
Over six in ten rural Nebraskans (61%) agree or strongly agree that Nebraska should develop a plan for adapting to climate change in order to reduce its impact on agriculture, rural communities, forestry and natural resources. Fewer than two in ten (17%) disagree with the statement. And, 63 percent of rural Nebraskans agree or strongly agree that the University of Nebraska should be helping agricultural producers, rural communities, and others to adapt to climate change. Fifteen percent disagree with that statement.
- ***Younger persons are more likely than older persons to agree that Nebraska should develop a plan for adapting to climate change in order to reduce its impact on agriculture, rural communities, forestry and natural resources.***
Almost seven in ten persons age 19 to 29 (69%) agree with this statement, compared to 58 percent of persons age 65 and older.

- ***Most rural Nebraskans received information relating to climate change from traditional media sources over the past year (the newspaper, television, or the radio). Many also received information from an article or story they found on the Internet.***

Three-quarters of rural Nebraskans (75%) listened to or read information relating to climate change from the newspaper, television or radio over the past year. Four in ten read information on climate change from an article or story they found on the Internet. One-quarter of rural Nebraskans (25%) received information from a post on social media. Just under two in ten rural Nebraskans (18%) say they have not listened to or read any information relating to climate change over the past year.

- ***Most rural Nebraskans trust experts regarding information about climate change and its potential impacts, such as University of Nebraska experts, scientists in general, and doctors and other public health experts.***

Seventy percent of rural Nebraskans somewhat or strongly trust University of Nebraska experts, 61 percent trust scientists in general and 55 percent trust doctors and other public health experts as sources of information about climate change. Many rural Nebraskans trust television weather reporters (48%), state agencies (43%), environmental organizations (39%) and federal agencies (33%). Most rural Nebraskans distrust social media and online blogs and podcasts as sources of information about climate change. And many rural Nebraskans distrust the mainstream news media as well as radio talk show hosts.



Ken Dewey



Addressing the Impacts of Climate Change on Ecosystems and Wildlife in Nebraska

Organized by:

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Summary of Key Issues²

Climate change is having significant impacts on species and ecosystems and these are likely to increase considerably in the future. Components of climate change affecting biodiversity in Nebraska include increasing temperature, changes in precipitation patterns, and increases in the frequency and intensity of storms, flooding, droughts, and wildfires. The impacts of climate change on species include changes in species distributions, alteration in the timing of annual life-cycle events, and disruption of ecological relationships. Climate change is also altering ecological processes such as fire and hydrologic regimes, which will affect species as well as ecosystem structure and function. In addition, climate change will exacerbate the effects of non-climate stressors such as habitat loss and fragmentation, pollution, and the spread of invasive species, pests, and pathogens. Many in the conservation community think that climate change will be one of the greatest challenges to conserving biodiversity in the coming decades.

Climate is one of the primary factors determining the distribution of wild plants and animals. There is good evidence from the past on how species respond when the climate changes. As the world warmed following the last ice age, species moved to higher latitudes or elevations, following a climate to which they were adapted. We are seeing the same pattern under the current climate change. Hundreds of studies around the world have documented species shifting their geographic ranges to higher latitudes, or upslope, in recent decades. As our climate continues to change, Nebraska will lose species whose southern limit of their range is here, while we will gain species from states to the south of us. Some of these new arrivals will no doubt be invasive species, pests, and pathogens.

Although some species will be able to respond to climate change by shifting their distribution, many will not. The current rate of change is many times faster than what occurred following the ice age. Species with limited ability to move, such as many plants and invertebrates, will simply not be able to keep up as the climate to which they are adapted moves on. In addition, the natural landscape, particularly here in Nebraska, is now highly fragmented

²Editor's Note: The report of this roundtable built upon the results of a previous meeting of the Nebraska Conservation Roundtable that met in April 2015 to discuss climate change adaptation and mitigation for the ecosystem and wildlife sectors. The Nebraska Conservation Roundtable group is organized under the leadership of the Nebraska Game and Parks Commission. The results reported here are more detailed than the other roundtable reports since this sector had the benefit of output from the previous meeting in which potential actions in the face of climate change were articulated and prioritized.

by human development such as cropland, highways, dams, and cities. This development forms a barrier to the movement of many species and will inhibit their ability to respond to climate change. Those species that cannot move to more suitable locations or otherwise adapt to changing conditions will likely face local extinction. Both range shifts and local extirpations will lead to changes in the species composition of natural communities, resulting in new communities that may bear little resemblance to those of today.

The changing climate is also affecting the timing of annual events in the life cycle of species. Numerous studies have documented recent shifts in the timing of events such as migration, insect emergence, flowering, and leaf out – all driven by the earlier arrival of spring. Species are not expected to respond uniformly to climate change. Thus, there are likely to be disruptions of ecological relationships among species as they respond to the changing climate in different ways and at different rates. For example, the timing of emergence of an insect pollinator may shift and become out of sync with the flowering time of its host plant. Disruption of species relationships may lead to local extirpations and have significant impacts on ecosystem structure and function.

Although all ecosystems in Nebraska will be affected by climate change, aquatic ecosystems (wetlands, lakes, streams, and rivers) may be the most highly impacted. Climate changes will alter both water quality and quantity. Increases in the frequency and intensity of high precipitation events, particularly in a landscape dominated by row crop agriculture, will lead to increased runoff of sediments, fertilizers, and pesticides into water bodies. Increased frequency of drought and heat waves, combined with increased human demand for water, will result in lower stream flows and an increase in the frequency of stream segments being de-watered and wetlands drying up. Finally, increases in air temperature will result in increases in water temperature, causing a reduction in suitable habitat for cold-water dependent species such as trout. In an analysis by the Nebraska Game and Parks Commission, mollusks, amphibians, and small stream fishes were found to be the most vulnerable to climate change of all groups of plants and animals considered.

Wildlife and Ecosystems Climate Change Response Framework

The following goals, strategies, and actions were identified to address climate change impacts on wildlife and ecosystems in Nebraska. The goals are focused on adaptation, greenhouse gas reduction (mitigation), education, research, and policy. This framework is designed to help inform the conservation and research communities as they address climate change and to serve as a foundation in the development of the wildlife/ecosystems portion of a state climate change response plan.

GOAL 1

Conserve and manage species and habitats to facilitate their persistence in the face of a changing climate (adaptation)

Strategy 1

Secure appropriate conservation status on areas to complete a functionally connected network of public and private conservation areas that will be resilient to climate change and allow the movement of species in response to climate change.

Actions

- A. Protect a set of core conservation areas that will provide the maximum range of habitats for maintaining biodiversity under the current and projected climate.
- B. Conserve and restore connectivity between core conservation areas to facilitate species migration, range shifts, and other transitions caused by climate change.

- Coordinate among conservation partners and government agencies to prioritize the scale and durability of protection for core areas and their connections.
- Incentivize private landowners to increase their protection of core areas and the connections between them.
- Protect multiple examples of core areas to build backup redundancy.

Strategy 2

Incorporate climate change considerations into existing and new management plans for protecting species and habitats. Use best available science to maximize adaptive capacity regarding projected climate changes and in developing vulnerability and risk assessments.

Actions

- A. Modify protection and recovery plans to accommodate migration as well as longer-term shifts in the geographic distribution of species, communities, and ecosystems associated with climate change and its effects.
- B. Take climate change into consideration when selecting species to include in restoration projects. Use climate models, range maps, and species distribution modeling to identify which species may be most suitable for future conditions at a site.
- C. Review and revise as necessary techniques to maintain or mimic natural disturbance regimes and to protect vulnerable habitats consistent with emerging conditions.
- D. Develop criteria and guidelines that foster the appropriate use of translocation, assisted relocation, and captive breeding as climate adaptation strategies.

Strategy 3

Manage species and habitats to protect ecosystem function, increase resiliency, and facilitate transition under a changing climate.

Actions

- A. Develop and implement best management practices to increase the resilience of ecosystems to climate change and associated stressors (e.g., increase in frequency and intensity of wildfires, floods; spread of invasive species, etc.).
- B. Develop and implement best management practices to facilitate species and ecosystem transition to new conditions under climate change.
- C. Where appropriate, actively and adaptively manage vulnerable species to ensure sustainability and maintain biodiversity, human use, and other ecological functions.
- D. Conserve genetic diversity by protecting diverse populations. Develop a failsafe strategy, including the collection of genetic material for populations subject to bottlenecks (e.g. long-term seed storage).

Strategy 4

Reduce impacts of non-climate stressors. These stressors will be exacerbated by climate change and/or can reduce the ability of species to cope with climate change.

Actions

- A. Slow and reverse habitat loss and fragmentation.
 - Collaborate with local governments to reduce and reverse habitat fragmentation and loss through comprehensive land use policies, zoning regulations, and other regulatory and non-regulatory approaches. Focus primarily on identified core conservation areas and connections between them.
 - Minimize impacts from renewable energy development by focusing siting of projects on already disturbed or degraded areas.
 - Identify options for redesign or removal of existing structures or barriers where there is the greatest potential to restore both aquatic and terrestrial connectivity.
- B. Maintain and improve water quality and quantity.
 - Increase restoration, enhancement, and conservation of riparian zones and buffers in agricultural and urban areas to minimize non-point source pollution.
 - Reduce ground and surface water withdrawals in areas experiencing drought and/or increased evapotranspiration. Promote water conservation and incorporate technology to reduce water use.
 - Work with federal, state, and county interests to identify potentially conflicting needs and opportunities and to reduce the incentives for sources of non-point source pollution.
 - Incorporate climate change into watershed level water management planning and regulation.
- C. Implement and improve programs to prevent, control, and eradicate (where possible) invasive species and manage pathogens.
 - Implement existing and develop new strategies and programs for rapid response to contain, control, or eradicate invasive species and pathogens. Use early detection and rapid response protocols at high-priority conservation areas.
 - Work with federal, state, and county agricultural interests to identify potentially conflicting needs and opportunities. Minimize ecosystem degradation resulting from pest, pathogen, and invasive species eradication and control efforts.

GOAL 2

Reduce greenhouse gas emissions and levels in the atmosphere in order to slow and halt climate change (mitigation)

Strategy 1

Develop and implement land use and habitat management approaches that reduce carbon emissions and increase carbon sequestration.

Actions

- A. Reduce grassland conversion to row crops, which releases large amounts of carbon over multiple years. Assist landowners in making grassland management economically sustainable.
- B. Develop and implement best management practices for managing natural habitats (grasslands, forests) to increase carbon sequestration and reduce carbon emissions, while maintaining conservation values. Different BMPs may be needed for conservation lands and working lands. Initially implement practices where they can influence neighbors and partners.

Strategy 2

Reduce the carbon footprint of state and federal natural resource agencies and private conservation organizations.

Actions

- A. Increase energy conservation (e.g. increase efficiency of buildings, vehicles, etc.) and use of renewable energy sources.
- B. Conservation agencies and organizations should set goals and a timeline for reduction to zero net emissions.

GOAL 3

Increase awareness and motivate action regarding climate change (outreach and education)

Strategy 1

Increase public awareness and understanding of climate impacts on natural resources, ecosystem services, and impacts to humanity. Increase public actions to mitigate and adapt to climate change.

Actions

- A. Engage human dimensions and social science professionals to understand peoples' current level of understanding and determine the most effective approaches and information to increase awareness about climate change.
- B. Develop and disseminate targeted outreach materials, programs, and articles to inform key audiences about climate change impacts to their lives and actions needed.
- C. Incorporate materials on climate change impacts and responses into state education standards for K-12 curriculum.
- D. Develop, and disseminate to landowners, best management practices for increasing carbon sequestration and reducing greenhouse gas emissions in farming and ranching operations. Provide technical assistance regarding economic incentives that are available to facilitate transition to these practices.
- E. Recruit a list of qualified speakers to give presentations about climate change in Nebraska and adaptation and mitigation strategies for a wide range of audiences.

- F. Work with those who manage areas where the public accesses nature (nature centers, state parks, national forests, etc.) to inform visitors and recreational users.
 - Provide information on climate change impacts and response strategies.
 - Lead by example. Implement green infrastructure at these sites (high-efficiency buildings, solar powered cabins, etc.) and use as an educational opportunity.

Strategy 2

Increase the climate change awareness and capacity of natural resource professionals and other decision makers and enhance their professional abilities to address climate change (e.g. design, implement, and evaluate adaptation programs).

Actions

- A. Develop a clearinghouse of training opportunities and climate change adaptation strategies and actions targeted toward the needs of resource managers and decision makers in Nebraska.
- B. Develop leadership in the conservation community (via social networks, early adopters) to increase effective implementation of climate change actions.
- C. Use existing training courses (e.g. Climate Smart Conservation) to increase the capacity of resource professionals to incorporate climate change into natural resource planning.
- D. Provide access to tools (web-based and others) that promote improved collaboration, interactive dialog, and resource sharing to minimize duplication of effort across jurisdictions.
- E. Provide training courses for natural resource professionals on techniques to help them better communicate with the public regarding climate change.

GOAL 4

Increase knowledge about the effects of climate change on biodiversity and approaches to addressing climate change (research, assessments, and monitoring)

Strategy 1

Conduct research into ecological aspects of climate change, including likely impacts and the adaptive capacity of species, communities and ecosystems, and their associated ecosystem services.

Actions

- A. Identify knowledge gaps and define research priorities via a collaborative process among federal and state agencies, conservation organizations, and academic researchers.
- B. Develop a framework for cross-disciplinary research and funding to address issues related to climate change, biodiversity, and ecosystems.
- C. Conduct studies to better understand species' responses to climate change in order to inform conservation planning and action.

- Use modeling approaches to assess potential changes in species distribution in response to climate change, including both at-risk and invasive species.
 - Assess existing and develop new modes to evaluate the interaction of climate change and species/ecosystems.
- D. Conduct research to evaluate the effects of alternative habitat management practices (e.g., fire, grazing, tree removal) on greenhouse gas emissions and sequestration.
- E. Conduct studies to understand the resilience of habitats/ecosystems to climate change. Where are the tipping points and stable states? When do you switch from fostering resilience to facilitating transformation?
- F. Initiate and support efforts to quantify the benefits of ecological services and natural systems at risk from climate change. Compare lifetime cost-effectiveness of nature-based versus engineered options for climate response to help identify cost-effective adaptation options.
- G. Evaluate the interaction of climate change and land use, and the potential impact to species.
- How does climate change influence patterns of land use, especially agriculture, and subsequent impacts to wildlife (e.g., changes in the amount of land cropped or the types of crops grown)?.
 - How does land use interact with climate change to affect species (e.g. habitat fragmentation reducing species abilities to shift their geographic distribution in response to climate change)?

Strategy 2

Identify areas for a functionally connected network of terrestrial and freshwater conservation areas that will facilitate the persistence of species in a changing climate.

Actions

- A. Identify a set of core conservation areas that represent the full spectrum of geophysical settings in the state (conserving the “stage”) as well as areas that may be more resistant to climate change and provide refugia. Preserving a range of physical habitats can protect biodiversity under both current and future climate change.
- Evaluate network design and assumptions to ensure they address the non-stationarity of the current climate.
- B. Identify areas to provide connectivity among these core areas to allow for the movement of species in response to climate change.
- C. Establish and maintain a comprehensive, inter-jurisdictional inventory of current conservation areas and candidate high-priority conservation areas in order to coordinate future conservation efforts. Coordinate priority setting and data sharing among conservation partners.

Strategy 3

Support and/or develop inventory, monitoring and observation systems to detect and describe climate impacts on species and ecosystems and evaluate effectiveness of adaption and mitigation actions. Where appropriate, use an adaptive management framework.

Actions

- A. Coordinate development and maintenance of integrated long-term, large-scale monitoring of early-warning indicators of species responses, including range shifts, population status, and changes in ecological systems functions and processes. This would include systems for early detection of newly arriving invasive species.
 - Develop programs to engage citizens in monitoring impacts of climate change on species and habitats (e.g. collaborate with the National Phenology Network).
- B. Use monitoring in an adaptive management framework to evaluate the effectiveness of specific climate adaptation and mitigation actions.
- C. Develop a clearinghouse (e.g. data portal) of information on past and current monitoring projects, to increase coordination among agencies and organizations.

GOAL 5

Enhance capacity to effectively address climate change (policy and funding)

Strategy 1

Work to influence existing, and develop new legal, regulatory, and policy frameworks to improve their usefulness to facilitate climate change adaptation, mitigation, research, and education approaches.

Actions

- A. Promote, help develop, and provide grassroots support for a multi-sector state climate change action plan with measurable goals and timelines for mitigation, adaptation, research, and education.
- B. Create more local, state, and federal support of renewable energy, energy conservation, and policies/legislation to reduce carbon emissions.
- C. Influence water policy to reduce conflicts between human and wildlife water needs in a changing climate.
- D. Integrate climate change impacts into existing legal, regulatory and policy frameworks, and develop new frameworks that govern species protection and natural resource management. Identify opportunities to clarify legislative intent as regulations are established or revised (e.g. floodplain management, IMPs, DNR policies).
- E. Review relevant existing legal, regulatory and policy frameworks and identify opportunities to eliminate incentives that facilitate conversion of natural habitats to other uses (e.g. federal agriculture policy influences on grassland loss).
- F. Identify and address conflicting management objectives within and among federal, state, and tribal conservation agencies; private landowners; and conservation organizations and seek to align policies and approaches wherever possible.

Strategy 2

Optimize use of existing, and develop new, conservation funding sources to design, deliver, and evaluate climate adaptation, mitigation, education, and research programs. Recognize these are long-term investments as opposed to short-term costs.

Actions

- A. Promote, and create options for, new sustainable government and non-governmental funding sources for climate change adaptation, mitigation, education, and research.
 - Promote and create revolving loan programs and other incentives to promote mitigation.
- B. Collaborate with federal, state and tribal agencies and private conservation partners to sustain authorization and increase appropriations for existing funding sources (e.g. Nebraska Environmental Trust, State Wildlife Grants).
- C. Review existing federal and state grant programs and revise as necessary to support funding of climate change adaptation, mitigation, education, and research. Include climate change considerations in the evaluation and ranking process of grant awards.

Next Steps

The Nebraska Conservation Roundtable is a consortium of state and federal natural resources agencies and non-profit conservation organizations working in Nebraska. One of the goals of the Roundtable is to facilitate collaboration among agencies and organizations to address conservation challenges that are too large for any entity to tackle individually. Climate change is one of the five large-scale challenges that the Roundtable has identified to address collaboratively. Nearly all of the Conservation Roundtable agencies and organizations participated in the UNL Wildlife and Ecosystems Climate Change Roundtable event. During the event, participants identified the highest priority actions in the above climate change response framework. The prioritized climate change response framework will help guide the Conservation Roundtable as they collaboratively address climate change in Nebraska.

An important resource for the continued conversation on the implications of climate change on ecosystems and wildlife is: Climate-Smart Conservation: Putting Adaptation Principles into Practice, National Wildlife Federation, 2014. http://www.nwf.org/~media/PDFs/Global-Warming/2014/Climate-Smart-Conservation-Final_06-06-2014.pdf.



Jim Swinehart

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Implications of Climate Change on Human Health in Nebraska

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Summary of Key Issues

Maintaining population health is a key element of any successful state response to climate change. Health considerations need to be integrated into all policy and planning responses. Since all social sectors affect health, plans to protect and enhance the health of Nebraskans during the next decades need to involve all sectors. The voice of health professionals, by educating the public about the health risks of climate change, is essential to promote public support for needed climate response policies. Since the next decades of change are likely to be challenging and a response to climate change needs to be urgent and immediate, planning to protect public health needs also to be substantial, speedy, and ambitious. Health planning should be a part of Nebraska's overall state plan for climate change.

Key Health Concerns

Generally, the current and potential effects of climate change on health globally have been well studied and surveyed for a variety of health conditions, several regional climate conditions, and a variety of climate effects on the environment. Health effects of climate change have been shown to be serious, widespread, and increasing as average temperature rises and precipitation patterns (e.g., amount, seasonal distribution and intensity) change.

The health effects have often been divided into *direct* effects of climate and weather (such as mortality during heat waves and storms), *indirect* effects (as mediated by culture, architecture, economics, etc.), and *interactive* (as where climate change aggravates other environmental hazards, such as ground level ozone). Specific populations have also been identified as especially *vulnerable* (such as the poor, sick, elders, and children). Health effects can also be usefully divided into *acute or episodic* (as from a flood or tornado), and *chronic* (such as aridity affecting water quality and scarcity).

Health effects are sometimes categorized by *health condition* (such as increased heart attacks), and also by *environmental cause* (such as heat waves giving rise to heart attacks). Some health effects are often identified as caused by the use of *fossil fuels* independent of their climate effects (such as mercury pollution from burning coal). Thousands of articles by health professionals and scientists have identified a wide range of health effects as already resulting from climate change and as likely to increase as the decades go by.

- *Extreme weather*: Tornadoes, floods, heavy rainfall, hail, and dust storms — leading to injuries, damage to health facilities, and chronic consequences (such as mold-related disease after floods).
- *Heat waves*: This is the largest cause of weather related deaths in the United States (Klinenberg 2015). Heat effects include such heat related conditions as stroke, asthma, delirium, coma, heart

failure, and excessive harm to vulnerable populations unable to escape to cool environments. Heat waves can be damaging to cattle and other domestic animals. Heat-stressed corn crops are likely to display increased growth of the carcinogen aflatoxin.

- *Forest and prairie fires:* These affect air quality and can cause evacuations, injuries, and harm to domestic and wild animals. Particulates and toxic chemicals are important ingredients of the fire-related effects.
- *Air quality:* Of concern, especially, are ground level ozone exposures aggravating lung disease, infant mortality, asthma, and cardiac conditions. Particulates, airborne chemicals, and pollen also have important health effects.
- *Oceanic change:* Concerns include rising sea levels, acidification, weather systems, fisheries, coral decline, and microorganisms, with a variety of health effects, including a particular concern for nutrition. These geographically distant impacts affect Nebraskans via food supply, migration, and weather patterns.
- *Water borne diseases:* Water quality in general is affected by climate, and such events as sewage overflows can spread dangerous diseases and increase populations of such vectors as rats and mosquitoes. Toxic algae, cryptosporidiosis, and giardiasis are expected to increase.
- *Water scarcity:* This affects everyone, especially agriculture and industry. Water quality tends to decline and chemical pollution tends to increase; also, dry conditions reduce the quality of life. Conflict over scarce water is a common factor in reduced social cooperation. Additionally, the increasing aridity of the tropical regions of the world is forcing populations to migrate northward in the Northern Hemisphere, producing demographic shifts in the U.S. Midwest.
- *Vector borne and other infectious diseases:* Malaria, dengue fever, and West Nile are moving poleward and up in elevation. Hantavirus is carried by rodents which can increase in arid conditions. Milder winters can allow the survival of infectious diseases and vectors previously not endemic to Nebraska. Contagion between agricultural animals and humans is also problematic. Human-to-human infections (such as HIV, TB, and measles) can also be expected to shift with population shifts.
- *Drought:* This can lead to several of the problems above and includes crop failure. Crop failures in Nebraska and regions from which Nebraskans draw their food supply can lead to increases in food prices and availability, thereby reducing nutrition.
- *Vulnerable populations:* The poor, the isolated, the elderly, children, and people with existing respiratory and cardiac conditions, have been widely identified as vulnerable to changing climate conditions. Also of concern are outdoor workers, such as agricultural workers, and participants in sports, such as high school football. Of particular concern in Nebraska is the health of Native Americans on isolated reservations, since populations cannot easily move away from drying land.
- *Mental health:* Diminishing life prospects can aggravate depression. Higher summer temperatures can also aggravate social conflicts and raise the level of violence. Scarcity requiring revising and setting material priorities can aggravate existing social conflicts among religions, economic sectors, and ethnicities. Weather extremes and disasters stimulate mental health crises.

Most of these effects are already being felt at least to some degree in the High Plains region and states contiguous with Nebraska. At first look, the changing climate conditions most pertinent to the health of Nebraskans are multi-year drought, heat waves, floods, high winds, water quality and scarcity, and impacts on animal husbandry and crops.

Few positive effects of climate change have been identified; thus, climate change threatens to reduce the population health status in most regions including Nebraska.

Seldom noted are the potential positive feedback effects of declines in health status on the capacity of Nebraskans to respond to climate change. For instance, declining nutrition aggravates other health vulnerabilities, and undernourished people will likely become less optimistic and productive. Meanwhile, means of keeping populations healthy and comfortable such as air conditioned stadiums, farm vehicles, homes, and work places will decrease Nebraska's energy efficiency and reduce our capacity to help mitigate climate change unless we shift rapidly to alternative non-carbon energy sources.

The list of likely conditions above omits less well understood health challenges likely to be important in the greater time frame of many decades to a century. Those who have considered the complex effects of climate change on societies at significantly higher global temperatures (about 4.0 degrees C and up) have noted potential collapse of organizations, governments, and economic enterprises, together with intensified conflicts over scarce resources. Many observers estimate that climate change, if unmitigated, will result in massive civilizational collapse (Diamond 2005; Ophuls 2012; Lynas 2008). While the health effects of collapse are massive and entirely reverse the demographic revolution of the last century, health effects are likely to be perceived as minor amid the wide scope of disaster.

It is thus important to have a sense of time frame for estimating the health impact of climate change. Currently, most planning for health programs and facilities typically falls into a five year period (more or less), while in contrast, most climate signals are obvious over decades. Nevertheless, our children now 15 years old will be 50 in 2050, and so expected powerful effects will affect existing generations as well as grandchildren and future generations.

One of the great challenges of a climate action plan is to redirect the dedication and energy of enough talented health professionals, leaders, and organizations now working within existing brief, temporal paradigms to effectively tackle the health-related challenges of a changing climate. Health problems will continue to emerge and escalate in severity over decadal and generational time spans. These changes must be planned for well in advance if we are going to be prepared to handle these challenges as they occur.

Mitigation Strategies

Health professionals can participate actively in public education and advocacy to support policies promoting mitigation.

- We can educate the public about the health effects of climate change on health and thus help to motivate public support for mitigation.
- We can identify a variety of *co-benefits* and win-win strategies that can both protect and improve health while reducing the fossil fuel costs of the economy. Health professionals, the Centers for Disease Control (CDC), the American Public Health Association (APHA), and other organizations have identified several co-benefits (Frumkin et al. 2008; Jackson and Shields 2008). These include:
 - Architecture, urban design, and public education to support walking and bicycling.
 - Improved nutrition through a higher ratio of consumption of vegetables to meat; community gardens and more local food consumption; and less consumption of processed foods, thereby raising the CO₂ efficiency of nutrition.
 - Increasing household efficiency of energy and water consumption.
 - Improving social connection among families, individuals, and groups.
 - Promoting social justice in order to maximize the impact of health measures.

Health facilities can reduce fossil fuel consumption and increase energy efficiency.

- Hospitals can contribute to mitigation by a wide variety of well identified measures: energy efficiency, closing incinerators, reducing the use of materials, improving supply chain, reducing duplication of complex laboratory and diagnostic devices (for instance, considering environmental costs when purchasing capital equipment), calculating environmental

externalities in health care costs, and so on (Guenther and Vittori 2013; Practice Greenhealth). World Health Organization (WHO) and Health Care Without Harm have outlined a seven point program for climate friendly hospitals (World Health Organization et al. 2011).

- As major energy consumers, educational medical centers can press energy providers to speed shifts to alternatives, work in partnership on co-generation (already being done by UNMC), and model healthy uses of energy for similar organizations.
- In the last century, health care progress has entailed increased complexity, expense, technology, and extent of therapies and products without much regard to environmental costs. Environmental pressures are likely to require development of more affordable health care and to force health professionals to set priorities on the most needed and effective services (Pierce and Jameton 2004).
- Although hospitals are probably the most intensive energy users in the health care sector, clinics, public health offices, educational facilities, health insurers, recreational facilities, cooling centers, and so on, also need to measure and manage their carbon footprint.

Any response to these issues requires close cooperation among clinicians, diverse health professions, hospital architects, facilities planners and managers, engineers, Group Purchasing Organizations (GPOs), manufacturers, pharmaceutical companies, supply chain managers, waste disposal, and insurers. Major educational medical centers, which are doubly challenged by their multiple functions, can and need to draw on guidelines already in place for educational institutions and hospitals, LEED criteria, and the like.

Adaptation Strategies

There are basically three forms of adaptation to meet changing health needs. These consist of the three elements of prevention prevalent in public health:

- *Primary prevention:* Through engineering, policy, and economics, keeping the Nebraska environment as healthy and safe as possible during multi-decadal change.
- *Secondary Prevention:* Being prepared to protect health and life during such expectable events as heat waves, floods, wildfires, epidemics, and storms (consequence mitigation strategies).
- *Tertiary Prevention:* Ensuring that adequate medical facilities are functioning to save lives and to reduce potential complications of injuries and disease.

A variety of actions and programs support these aims.

- Modeling, monitoring, tracking, and reporting health phenomena sensitive to a changing climate.
- Extending climate change education to all health professionals to prepare them to serve a wide range of climate related-health needs.
- Supporting emergency response teams, their expertise, and research.
- Designing a more affordable health care package that can be stable and widely available during periods of economic and social instability.
- Building and remodeling health care facilities to be more durable during emergencies (such as getting emergency generators out of hospital basements in potential flood areas), while at the same time improving their environmental and CO₂ efficiency.
- Preparing for multi-year drought health issues that are not emergent, but increasingly chronic or common.
- Increasing cooperation among health professionals and other technical professionals — such as engineers, architects, planners, agriculturists, water professionals, etc. — who have the main responsibility in designing facilities, planning, zoning, and institutions that support primary prevention. *It was the consensus of the roundtable participants that this is the most important area for health adaptation.*

- Ensuring that every health care and public health facility has a Climate Action Plan framed in coordination with statewide climate response activities.

Key elements of a Climate Action Plan combine adaptation and mitigation through strategic programming that integrates relevant research, teaching and service activities across organizations in ways that:

- Monitor and evaluate real and potential impacts of climate change on health parameters in Nebraska.
- Promote the inclusion of climate change adaptation strategies and awareness in academic programs and courses stressing the interdisciplinary and multi-campus nature of both problems and solutions.
- Advocate in Nebraska for community-level awareness and engagement relating to the health implications of climate change on Nebraskans.
- Advocate, through an inclusive and open dialogue with the business community in Nebraska, for the development and adoption of carbon mitigation strategies.

A general and overarching principle of a sound climate response is that adaptive measures should be undertaken in as mitigative a fashion as possible. For instance, since air conditioning is expensive in CO₂ terms, establishing cooling centers for vulnerable groups, as recommended by the CDC, is more efficient than increasing air conditioning in homes. Additionally, a climate responsive diet is one that is both healthy and carbon efficient. Primary prevention is generally less costly than tertiary.

Research Needs

Although modeling, monitoring, tracking, and reporting are well established public health functions and already conducted in many ways, these functions have not traditionally been designed to detect and to monitor health signals that respond over decades to changing background climate conditions with complex causal pathways to health. Designing such monitoring methods will be challenging and requires substantial expert input and judgment.

Thus, any climate action plan must include a stable committee of experts that meet at regular intervals.

Much work needs to be done to develop a clearer picture of some key questions:

- Which of the various health effects of climate change are most likely to be more deadly or chronically costly as compared to other climate effects? That is, should we worry more about heat events, asthma, or infectious diseases; and which of these will rise more steeply as time passes?
- What sorts of investments in public health policy and health care need to be made to respond to these changes? Where should we put our monitoring, prevention, and response money?
- Over time, depending on what global CO₂ management policies are adopted, how will these health effects be different? This is a question about the sensitivity of health conditions to prevailing temperatures (this is also sometimes termed the 'parameterization' question). For example, to what extent will a high CO₂ output scenario (in other words, a "business as usual" scenario; +8 degrees F by 2100; or an IPCC high end RCP 8.5) produce more health effects, such as asthma, as compared to a low output scenario (a global strong agreement scenario; +5 degrees F by 2100; IPCC RCP 6.0 or 6.5)?
- What time lags between climate changes and changed prevalence of health conditions are likely? What uncertainties are there in all of these judgments and projections; how large are the error bars? And, how should we prepare for the unexpected (Remais et al. 2014)?
- To what degree is climate change likely to affect the baseline of normal public health and medical concerns as compared to existing problems (for example, how much cancer fifty years from now is likely to be climate related)? We need to ensure that ordinary public health

activities (healthy infant programs, nutrition research and education, etc.) continue to be robust during this century of expected rapid change.

- Indeed, to ensure a "safe operating space for humanity" (Steffen et al. 2015), we must not allow our concern for climate change to overwhelm management of other environmental problems that may or may not be related to climate change, such as phosphorus and nitrogen pollution, stratospheric ozone, species diversity, toxic chemicals, and so on.
- In setting health priorities, we need to distinguish between events with extensive but small chronic effects and which fall below the public horizon of awareness, and those that may not be large in the long run, but have a large immediate effect (such as increasing aridity in the region as compared to the 2011 Joplin tornado). In principle, the standard ethics of public health favors concern for the former type of problem, while human psychology favors concern for the latter. Care will be needed in setting priorities in a defensibly principled manner.
- Adaption strategies will need to respect social justice for a variety of important reasons, including public support for and efficiency and effectiveness of adaptive measures. Demographic changes driven by climate change are likely to require such strategies to be highly dynamic as Nebraska's population changes in response to major global climate effects.
- Some kinds of research may warrant more investment than others. For example, most of the health conditions involved with climate change are common, well understood, and not new. So, basic research on disease mechanisms and treatment are not likely as important as meta-analyses and literature reviews. A large and increasing literature on the health impacts of climate change already exists. Although this body of research covers wide and diverse regions, populations, and conditions, there is not much need to recreate much of this research to localize it to Nebraska. Instead, this literature needs to be boiled down, condensed, and plausibly interpreted for application to Nebraska's conditions (which conditions will likely be similar to those in surrounding regions). The third National Climate Assessment is useful with an excellent health chapter (Luber et al. 2014).
- Some previous long-term studies may need to be reinterpreted once average temperature changes are introduced into the mix of factors. For instance, the Framingham studies tracked health conditions over a period long enough that some results may have been affected by climate changes in that region.
- Public health and acute care professionals need to respond to expected changes in diagnostic mix, frequency of conditions (such as asthma, food poisoning, insect bites), and migration (measles from Africa, dengue moving north, etc.).
- A sense of urgency is needed. Late adaptation and mitigation health measures will be futile after health problems have blossomed. A balance between established connections and likely consequences needs to be made with authority by those able to handle complex background data with mature judgment.
- Some likely areas of needed modeling and monitoring include: heat and outdoor activity, especially in sports, agriculture, and construction; breeding and genetic engineering in crop management and animal husbandry; mass casualty planning together with casualty mitigation research, education, and modeling; human-animal disease interactions; impact on the human microbiome; psychological responses to climate change; changes to air and water quality during drought; effects of rises in food prices related to climate change in regions from which Nebraskans import food.
- Often overlooked, but important, is better research on the risks and costs of presumptive health co-benefits of mitigation. For example, a less meat-centered, more natural local diet has hazards that need to be addressed. Bicycling, though healthy, risks a high accident rate. CDC proposals to handle heat emergencies (such as establishing cooling centers) may not be socially realistic.

The key to educational measures is to integrate the research with education. This is a two way street. While research on climate and health can be integrated into professional curricula, researchers need feedback from students and practitioners as to their climate education needs.

- Climate health is relevant at all levels of education. For instance, elementary and high school education can include health co-benefits, safe water conservation, environmentally healthy diets, and so on.
- Health professions education programs at all levels need to prepare students to cope with rapid global environmental change during the likely 40 to 50 years of their careers.
- Because most professional curricula are already overburdened, introducing climate issues into courses and materials needs to be appreciated as challenging. Curricular leadership and coordination is needed.
- Some material is now being published to help physicians advise patients on climate issues (Parker 2011). Similar material is needed for all health professions education programs.
- It is also helpful if health professionals can help architecture, engineering, and business programs integrate climate health programs into their curricula.
- Practitioners and educators need education on how their professional activities connect with and affect the capacity of organizations in which they work to maintain an effective climate action plan. For instance, education is needed on materials conservation and on supply and waste chains, and on how to participate in institutional control of these factors.

Many of these concerns are being developed and discussed through such organizations as:

Association for the Advancement of Sustainability in Higher Education (<http://www.aashe.org/>)

Practice Greenhealth (<https://practicegreenhealth.org/>)

Health Care Without Harm (<https://noharm.org/>)

Physicians for Social Responsibility (<http://www.psr.org/>)

Alliance of Nurses for Healthy Environments (<http://envirn.org/>)

American Public Health Association Environment Section

(<http://www.apha.org/apha-communities/member-sections/environment>) and many others.

Policy Steps

There was a consensus among roundtable participants that policies promoting healthy social infrastructure, community design, agriculture, industry, economics, and the like will have the most important effect on areas affecting health in the long run. In the words of analysts Evans and Stoddart, “Health depends on everything, all the time.” (Evans and Stoddart, 2003, p. 374) Thus, in a changing climate, policies affecting many aspects of life, government, agriculture, industry, and culture also affect health. It is thus important that a health voice be present in all public policy responding to climate change.

We recommend that Nebraska establish an overall, coordinated plan to respond in an ongoing way to climate change. Since all factors in a planned response are likely to affect health, health planning should be a significant component of any statewide climate response.

Health policy planning and coordination should include the following:

- Policies affecting agriculture, architecture, engineering, and planning need to include a formal consideration of how policies affect health during decades of climate change.
- Policy should be formulated in coordination with surrounding states and regions, which also are making similar Climate Action Plans and policies (for example, see Minnesota Department of Health, Climate and Health Program 2015).
- Review of health effects needs to be ongoing, at regular intervals, and receive sufficient resources to gather and interpret relevant information.

- Environmental / Health indexing is needed, similar to the STAR (Sustainable Tools for Assessing and Rating Communities) program (ICLEI et al. 2015), by which estimates of health gains in ratio to environmental costs are made by systematically combining measures of health conditions and environmental impact.
- Adaptation and mitigation often appear to conflict with the needs for economic growth, jobs, and the like. Policymakers need to find ways to reconcile these concerns, since good jobs and a healthy economy support health at least as much as environmental conditions.
- Some particular areas of concern for policy were mentioned by roundtable participants. These include: social justice; support for local horticulture; coping with dietary changes affecting the beef industry; re-assessing the value of the corn ethanol program; establishment of cooling centers in towns and cities; increased bicycling; protection for outdoor animal husbandry; maintaining water quantity and quality; improving air quality; gun control; asthma awareness; home storm and evacuation kits; improved mental health treatment facilities and more. Some of these areas are controversial, and a strong presence of well-informed health professionals is needed in the policy process.

Next Steps

Many adaptation and mitigation measures require high levels of technical participation and mature professional judgment, together with an ability to work well with other professions. A committee set up by the governor at the health department, with medical, emergency, and architecture/engineering leadership would be a good start.

Toward this end, some near-term steps include:

- Establishment of Climate Action Plans in health care and public health facilities.
- Stronger links between health care providers and waste, heating, air conditioning, ventilation, construction, transportation, and supply chain managers and professionals in health care and public health facilities.
- Initiating strong climate change education programs in health professions programs, especially public health.
- Strengthening links among climate-aware architects, engineers, and health professionals working on non-health institution projects (such as homes, public buildings, factories, etc.).
- Educating health professionals to become more active participants in building Nebraska's climate response.
- Working with other states (such as those in the CDC Building Resilience Against Climate Effects BRACE program), the federal government, and other organizations preparing similar reports identifying needs and the means to address them. Distant regions with similar climate challenges may make valuable contributions (such as the Gansu Province of China).
- Better informing the public about existing climate-relevant medical and public health programs, such the Center for Biosecurity, Biopreparedness and Emerging Infectious Diseases at the UNMC COPH); the UNMC Environmental Health Tracking Network; and the UNMC LiveGreen Sustainability Master Plan (UNMC et al. 2012).
- Building on this report to establish stronger links between the UNL climate related centers (including water centers, extension, etc.), so that needed information can be exchanged.
- Building recognition that keeping Nebraskans healthy during the next decades will be challenging, difficult, and ambitious and require high levels of informed inter-professional and inter-organizational cooperation.

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Implications of Climate Change on Nebraska's Forests and Fire

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Summary of Key Issues

With changing climatic conditions, an increasing number of warm dry days, and warmer nights during the summer months is expected. Wildfires in Nebraska are expected to increase in frequency because of drier conditions, with more fine fuels and more ignition from lightning storms. Combining drier conditions with higher fuel loads will lead to more catastrophic fires with erratic fire behavior and potentially large stand replacing fires within the state. These fires will be more severe, placing entire ecosystems at high risk. Further, the extreme fire conditions will place our forest communities, both rural and urban, at greater risk of damage from invasive species and noxious weeds. The stress of climatic change also poses a risk of increased disease and insect problems and a greater risk of mortality. In some cases the entire population of a particular species will be at risk.

In Nebraska, more than a third of the Pine Ridge forest has been lost to fire since 2000. Long-term solutions must be considered as these forests are not naturally regenerating under today's climatic conditions. In order to avoid the loss of this ecosystem, we must respond to these changes by re-planting environmentally adapted trees, not only for today's conditions, but more importantly the conditions we anticipate in the future.

It was noted by participants that frequent heavy rains and flooding place our riparian forest ecosystems at risk, further stressing these fragile systems.

The roundtable discussion identified the top forestry issues exacerbated by climate change that were identified as extremely important. These issues are listed in order of importance below:

- Increased frequency, severity and intensity of wildfires.
- Increased threat of native pests and non-native pests.
- Increasingly heavy fuel loads in the forests.
- Increasingly frequent and intense severe weather events including drought, heavy rains and extreme temperature fluctuations.

Primary Mitigation Actions or Strategies

America's forests provide for significant carbon storage with nearly 12% of the total carbon produced being removed and stored in our forest each year. Recognizing the value of this carbon sink will be critical to responding to climate change in Nebraska. Avoiding the conversion of forest areas to agricultural use or urbanization will be a key in our effort to manage and sequester carbon. Below are action items and key mitigation strategies provided in the roundtable discussion.

- Develop a carbon market for the long-term objective of carbon sequestration through tree planting in urban and rural environments.
- Identify, develop and implement management strategies and incentives to promote carbon sequestration.
- Utilize locally grown and produced Nebraska forest products for long-term carbon storage in buildings. Develop program support to move toward a carbon neutral budget in Nebraska via this carbon storage opportunity.
- Utilize and support “Clean” Renewables (e.g. hydro, solar, wind farms, biomass) with more integration into the “grid”, providing a carbon-neutral environment in Nebraska.
- Expand mitigation of severe wildland forest fires including defensible space-clearance next to houses, fuels reduction in forests and around properties (volunteer and “in kind” match for cost share), education, and grant writing to support wildfire mitigation investments and protect native ecosystems.
- Promote and plant green infra-structure in communities.
 - Increase carbon storage in community forests targeting 25-35% canopy cover in communities.
 - Increase energy conservation through energy saving tree programs.
- Engage and promote the bioenergy markets and utilization including carbon life cycle analysis with various storage and use models, including fossil fuels.
- Expand education and engagement of the public, including meaningful buy-in with overall statewide efforts toward a climate action plan and a carbon neutral society.
- Define, develop and demonstrate management strategies to better manage agriculture and prairie lands to help sequester carbon.
 - How do we include the importance of the soil, grasslands and wetlands in all of this?
 - What is the carbon life cycle of the various communities?
 - Make sure there is a voice for permanent prairie lands--not conversion to forests but complimentary management activities.
- Develop, demonstrate and implement Best Management Practices (BMPs) for forest resources to address the changing climate.
- Develop capacity for rural fire fighting organizations to keep fires small.
 - Develop firefighting capacity in the state to keep fires small and manageable.
 - Continue to manage and promote a fuels treatment program to reduce overstocked forest stands.
 - Utilize forest waste when possible by providing outlets for products.

The next step to move forward on these strategies would be to convene a forest management and implementation strategy committee to reduce the carbon footprint of Nebraska and develop BMPs and action plans for the above strategies. The Nebraska Forest Service should play a lead role in this effort along with key stakeholders in attendance.

Primary Adaptation Actions or Strategies

For the purposes of this roundtable discussion, adaptation was defined as anticipating the adverse effect and taking action to prepare for it, adjusting to conditions expected to harm or taking advantage of opportunities associated with the expected change in our forests. The group recognized that no one size fits all strategy is available. One general consensus was that redefining forestry goals and management approaches in advance of the expected change would reduce the risks to our urban and rural forest communities. Below are action items and key adaptation strategies provided in the roundtable discussion.

- Work with native and regionally adapted species to identify seed sources and specific genetics better suited for the anticipated changes in projected environmental conditions.
 - Develop a climate-based seed transfer system to become the basis for climate adaptation.
- Develop, promote and support a genetics program to provide environmentally adapted trees. Utilize proven seed sources for the current and projected conditions.
 - Maintain seed bank with Nebraska genetics for future reintroduction and development of superior stock adapted to future climatic conditions.
- Develop a “rapid response” team to address replanting, (e.g., immediate replant of burned areas and areas affected by other natural disasters, such as flood and storms).
- Develop a “triage” approach of knowing what forest resources are most important to protect. (Eco regional level as a possible metric.)
- Utilize and promote prescribed burning as a landscape level management tool now and in the future.
- How is this done with a hotter, drier, climate and more restrictive air quality standards?
- Build fire-resilient landscapes: conduct landscape wildfire risk assessments, and implement treatments on priority areas.

The next steps needed to move forward on these actions are the following:

- Develop seed genetics lab:
 - NFS, in working with partners, should seek to identify unique seed sources following extreme landscape-level events (drought, invasives etc.). Engage research interests to support the genetic selection and propagation for climate proven seed sources.
- Select and promote tree species provenance diversity with genetics from a more southerly seed source that is better adapted for drought and overall warmer conditions.
 - NFS and NSA can test plantings in arboretums around the state.

Research and Educational Projects

As the climate changes, a shift in the ecosystems and biodiversity of our forests will occur. Understanding trends and how the plant communities are likely to respond to the change will be key to the resilience of Nebraska’s forests. At risk are entire ecosystems like the ponderosa pine forest found in western Nebraska. With more intense and severe fires returning on about a 6 year cycle, we have seen the Pine Ridge ecosystem reduced to almost half of what it was 30 years ago. The roundtable participants have identified (below) a series of topics and tools to better landowners and land managers better understand and respond to a changing climate.

- Better understanding of how extreme events will affect forests; how to increase resilience in managed forests before and after events.
- NEMA is required to take climate variability into account when creating hazard management plans.
 - More information is needed on forest fire mitigation strategies.
 - We need to know what to expect in Nebraska’s forests in next 100 years as temperature and precipitation patterns change.
- A better understanding of the impact of changing climate on specific species and plant communities.
 - We need to identify which species are most susceptible to change.
 - What vegetative lifeforms (grasses, forbs, shrubs or trees) are most susceptible to change?
- Development of a good inventory of specific plant communities in order to document and manage plant communities and change.

- Vulnerability assessments are necessary first steps.
- Establish baselines for current regeneration rates and expectations.
 - What is happening in areas with lack of regeneration?
- Establish communication outlets to effectively engage the public with adaptation and mitigation strategies that provide meaningful management practices and opportunities for the general public.
- A study of vegetation types by latitude; what might be appropriate for new zones?
- Chadron area once purchased trees from northern nurseries because they were hardier. In retrospect, perhaps they should have purchased from the south.
 - We need research on how extremes impact various tree species.
- Creating and supporting Speaker's Bureaus to help define local actions and provide information to effectively engage a broader audience within the general public.
 - Provide scientific information in an understandable manner, present the facts.
 - More engagement and understanding by the public.
 - Become the trusted sources of information to reach local political leaders and civic groups.
 - Local workshops to help in visioning for the future.
- Develop a landowner toolkit for mitigation and adaptation options.
- More funding and action at the grassroots level for climate change that will impact education (e.g. "house gatherings" on the issues)
 - We need to continue to get "buy in" from stakeholders, provide them with information and share knowledge.

Additional data, modeling and research will assist our efforts at adapting to climate change and mitigating greenhouse gas emissions. The following actions would be most helpful:

- Develop models to identify likely tree species/cultivars/provenance for testing and planting trials, SNR, Agronomy-Horticulture, NSA and NFS would be likely to develop trials.
- Develop models to identify change in species distribution based on climate change projections in temperature and moisture regimes. IANR and NFS would be likely to develop models
- Inventory and monitor change (NFS, SNR, USFS, and NRDs).
 - Regeneration both natural and planted stock - determine change in success.
 - Identify planting techniques and seed sources that are more likely to be successful in changing conditions.
 - Identify planting stock that is most likely to be successful in hotter, dryer conditions.
 - Document change in species composition in various plant communities.
- Provide science-based information for elected officials, provided by NFS, Nebraska Emergency
- Management Agency (NEMA), federal agencies and non-governmental organizations (NGOs).
- Develop action plan for wildland fire response (NEMA and NFS).

Policy Steps

The roundtable discussion identified several key policy issues (listed below) as needed to move forward. The consensus of the group is that action is necessary because the status quo is no longer sufficient. Although the group does recognize that activities in forestry are long-term and we often do not have good knowledge of the outcomes of our activities in our lifetimes this should not stand in the way of addressing this issue. A key step moving forward is the need to develop and adopt a climate action plan for Nebraska. This plan will allow for various state agencies, partners and stakeholder to collaborate in an effort to develop strategies for mitigation and adaptation for a changing climate in Nebraska, thus allowing Nebraska to be proactive rather than reactive to the expected change.

- EPA regulation on PM 2.5 needs to be reviewed in light of the current climate models.
 - PM2.5 are tiny particles in the air that reduce visibility, cause the air to appear hazy and are harmful to human health when levels are elevated.
 - Review air shed collaboration in Idaho/Montana, review to understand the effectiveness of this program and applicability for Nebraska.
- The Natural Resources Conservation Service (NRCS) needs to look at varieties that are supported including guidance from the NFS.
- Policies need to be more inclusive and allow for diversity in approached and species choices-in forestry we won't know if we're wrong for 30 years.
- Increase collaboration and coordination among agencies, NGOs, landowners and the private sector.
- Revisions to windbreak policies and incentives need to be made. Disincentives are needed for activities that negatively impact the establishment and retention of windbreaks.
 - Review policy to include social benefits.
- Species adaptation information for leaders.
- Speaker's bureaus to help define local actions.
- Trusted sources of information to reach locals (within their own cultural practices).
- Local public workshops to help in visioning for the future.
- Landowner toolkits for mitigation and adaptation options.
- More funding and action at the grassroots level for climate change and impact education (e.g. "house gatherings" on the issues)-need to continue to get "buy in" from stakeholders.

The next steps needed to move forward on developing better policy for addressing climate change are the following:

- Increase collaboration between all prescribed burners and agencies to expand the burn days using a model similar to Idaho/Montana cooperative.
- Legislative review of air quality standards, work to increase collaboration between agencies, NGOs and the public.
- Adopt climate action plan to move action forward.
- What type of tax reform would best stimulate Nebraska's adaptation to climate change?
- Economic impact is important.
- Property values on forested lands are higher than values on non-forested lands.
- General public understands economic impact.

Next Steps

The roundtable participants recommended the development of a permanent forum that could provide an opportunity to move forward on these issues and allow for implementation of the strategies identified in the above comments.

Key stakeholders who should be included in future discussions are fire personnel from both volunteer fire departments and agencies, public works from large and small communities, park departments and/or tree boards from both large and small communities.

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Implications of Climate Change on Nebraska's Agriculture, Food and Water

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Summary of Key Issues

One of the sectors most sensitive to climate change is agriculture. Evidence has shown that agriculture in Nebraska and elsewhere is already being impacted by climate variability and change and weather extremes. These include diseases, pests and invasive species shifts; strains on water resources to meet agricultural, community and natural resource needs; and extremes in precipitation and temperature impacting the economic sustainability of all sectors of agriculture. Identifying and promoting strategies to improve agriculture resiliency are critical to this industry's economic and environmental sustainability. This report summarizes some of the important threats and proposed actions that have been identified by experts from diverse backgrounds in Nebraska, including scientists, educators, and stakeholders who participated in a roundtable discussion on October 19, 2015, to address the issue of mitigating and adapting to climate change in agriculture.

The impacts of climate variability and change and weather extremes on the agriculture sector are numerous and include:

- *Climate variability and extreme weather events:* Climate change is expected to permanently alter weather patterns, temperatures, and rainfall in several agricultural areas, with increased frequency and intensity of extreme weather events, floods, or extended periods of drought stress, adversely impacting the agriculture sector.
- *Crop production and yield:* Plants can operate at a range of environmental conditions; yield quantity and quality are expected to be impacted if weather patterns are permanently shifted outside the range of species tolerance in a region. There are several unknowns concerning climate change and its impacts on decision making related to cultural practices and cropping systems (e.g., seed selection, irrigation and fertilization practices, etc.), which will have impacts on the resiliency of agroecosystems and the economy of the region.
- *Livestock production:* There are anticipated threats to not only to grasslands and feed production, but also risks associated with animal performance and resilience to changes in climate and to weather extremes, especially temperature.

- *Grasslands resiliency*: Climate change is a threat to the integrity of the Nebraska Sandhills where changes in ecosystem services have already been reported, including losses in native grasses due to shifts in environmental conditions, anthropogenic management and drought, as well as increases in woody species encroachment and invasive species.
- *Pests, diseases and invasive species*: Studies have already shown an upward trend in increased occurrence and migration of pests, diseases and invasive species, further impacting the health of plants and animals, and impacting agroecosystem health and resilience.
- *Erosion and runoff*: Soil erosion, and runoff (manure, fertilizers and water) have been shown to increase as a results of weather extremes especially during high precipitation events.
- *Water resources*: Threats to water resources are real. Nebraska, which ranks first in the number of irrigated acres, will continue to see pressure on water resources grow with increases in the frequency and intensity of droughts and more temperature extremes.
- *Cost of production and impacts on food security and safety*: Changes in climate may impact the cost of food production and the availability of food for consumers at an affordable price, due to increased cost associated with farm management and farm input including water and fertilizers.
- *Livelihood of the population in Nebraska*: Economic losses will impact jobs and cause economic losses which will have a great impact on the rural communities.

Primary Mitigation Actions or Strategies

- ***Primary steps needed to reduce greenhouse emissions***
 - Need to work with other sectors to mitigate greenhouse house gases, and improve the natural environment for agriculture.
 - Need to better promote and expand alternative and renewable energy in Nebraska, especially the use of solar and wind energy.
 - Encourage better monitoring of greenhouse gas emissions from the agriculture sector and use innovative tools and technologies to minimize their impacts.
 - Prevent further conversion of native grasslands into crop lands, and develop tools to better assess the impacts of these conversations on ecosystem services.
 - Develop and implement tools to help farmers measure greenhouse house gas emission on their properties.
 - Create and implement policies to encourage better resource management.
- ***Next steps needed to move forward on each action/strategy***
 - Increase diversification of cropping and ranching practices (hedging your bets).
 - Use science based and innovative approaches to improve decision making on farms and ranches, and throughout the industry. For example, create feeding and shade structures for livestock, and incorporate renewable energy into these structures-- wind turbines can provide cooling for cattle, solar panel structures can provide shade. Select or develop crops that are better adapted to the new status quo.
 - Maintain or improve ecosystem services, like production, water quality and quantity, soil health, and habitat for the wildlife.
 - Create and implement policies to encourage better resources management.

Primary Adaptation Actions or Strategies

- ***Primary steps***
 - Diversify the production systems, practices and & landscapes (hedging your bets).
 - Take steps to maximize resiliency of soils (e.g., ability to hold and absorb moisture will be key in the future), and improve water and nutrient use efficiencies of crops, via either crop improvement or water management practices.

- Improve plant tolerance to abiotic and biotic stresses either through conventional breeding or the use of biotechnology; alter cropping systems to better fit the new status quo.
- Livestock adaptation to extreme weather events, through reduction of heat stress by using shade, water, and feed structures. Additional foraging strategies are needed like grazing row crops. Nebraska is already known for high rate of livestock death due to weather extremes and will have to adapt further.
- Promote research and education to train stakeholders on how to best manage for climate variability and change. “Business as usual” scenarios are not sufficient, research and education will need to emphasize systems-level approaches.
- We need to recognize that adaptation strategies vary, we need to employ a portfolio of strategies on multiple scales.
- Economic and financial resiliency are also important drivers in the decision making process. Insurance policies (e.g., farm bill) are critical for the future of this sector.
- Farmers’ decisions are economically motivated. We need to create more incentives for adaptation. Need to educate, then incentivize.

Next steps

- Involve local, state and federal agencies and universities in the development and implementation of adaptation strategies.
- Make information available to users.
- Promote and support research, and the development of high resolution climate models for agroecosystem.
- UNL Extension is a trusted source of information, and should be used to engage stakeholders, including the opportunity to connect with producers and multi-generational farmers who tend to look at longer-term scenarios.
- Continue to collect long-term data on local, and temporal based climate trends, and make these data available for research and decision making.

Policy Steps in Addressing Adaptation and Mitigation to Climate Change

- Introduce policies to support and promote agricultural practices that would take us into the future and would address climate change.
- Engage with public and private sector to address sustainability of agriculture into the future under increased demands for food and dwindling natural resources, and climate uncertainties.
- Improve the Farm Bill programs to encourage adaptation.
- Adopt agricultural practices that would reduce greenhouse emission and carbon footprints.

Next Steps

- Continue with the conversation on climate change with the various sectors and engage stakeholders.
- Promote research and science based education.
- Develop a climate change hub for Nebraska.

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Implications of Climate Change on Energy Availability, Use and Management in Nebraska

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Summary of Key Issues

The U.S. energy supply system is diverse and robust in its ability to provide a secure supply of energy with only occasional interruptions. However, the projected impacts of climate change will increase energy use in the summer and pose additional risks to a reliable energy supply. Changes in water availability, both episodic and long lasting, will constrain different forms of energy production. The risks from climate change in the energy sector are numerous and include:

- *Water and energy production infrastructure.* There will be threats to the energy infrastructure due to increased water temperature needed for cooling. Hydrological impacts to power generation must be considered. If we were to experience a multiyear drought, would a power generation plant be at risk of insufficient water and higher water temperatures with less efficient cooling capacity? Warming water temperatures will influence generation efficiency.
- *Electrical infrastructure.* Can the electrical system handle an increase in population growth? An increase in extreme weather events? Greater concentration of demand in peak periods? Summer peaks will be more extreme. Are we prepared to deal with increased energy needs along with increased energy costs? Our energy use will increase even without climate change.
- *Affordability of energy supply.* Complying with regulations will be costly and will require more money to be spent to reduce greenhouse gas emissions. This will add to the equation of the true cost of energy.
- *Consumer behavior and the cost of energy.* Consumer behavior needs to be mitigated. Individual response to new regulations that increase cost could precipitate customer anger and lack of understanding. There is a need for education about the true cost of energy.
- *Air quality change.* For example, outside air should be the “clean” air but this can change as temperatures rise. This will require action to prevent reversal of air flow.
- *Loss of jobs.* Loss of jobs in the energy sector will require new educational plans and retraining opportunities.

Primary Mitigation Actions or Strategies

- ***Primary Steps Needed to Reduce Greenhouse Gas Emissions and Levels in the Atmosphere***

- Quantify the true cost of energy and climate change.
- Change consumer behavior through improved education.
- Integrate energy systems to reduce energy loss and capture wasted energy.
- Increase energy project funding.
- Prioritize energy research and educational programs.
- Transform transportation infrastructure.
- Reduce greenhouse gas emissions.

- ***Next Steps Needed to Move Forward on Each Action/Strategy***

- *Quantify the true cost of energy and climate change.* Conduct a robust economic analysis to define the true cost of energy and climate change. Create new job training programs for those displaced by changing energy technology.
- *Change consumer behavior through improved outreach and education.* As part of consumer education, improve the translation and communication of energy-related research. Incorporate the results of the economic analysis into ongoing consumer education.
- *Integrate energy systems to reduce energy loss and capture wasted energy.* Reduce energy loss by promoting greater energy efficiency and the development of new ways of reducing the loss of wasted heat during energy generation.
- *Increase energy project funding.* Collaborations for future energy project funding should be encouraged at the state and national levels.
- *Prioritize energy research and educational programs.* National and state governments must prioritize energy-relevant research projects and educational programs for greater impact on climate change.
- *Transform transportation infrastructure.* Greater infrastructure is needed in public transportation since transportation is a large component of the overall greenhouse gas emissions in Nebraska. Electrification of all forms of transportation should be considered along with investments in charging stations for electric vehicles. Public transportation should be encouraged (e.g., bike paths and commuter rail between Lincoln and Omaha).
- *Reduce greenhouse gas emissions.* Promote greater use of methane digesters in rural and urban Nebraska.

Primary Adaptation Actions or Strategies

A number of steps could be taken in the energy sector to adapt to a changing climate.

- *Improve the energy efficiency in homes and businesses.* To assist in this process have utilities provide “On-Bill” financing for energy efficiency improvements. Consider the adaptation of “OPower” software which provides customers with better information about their energy consumption, along with personalized ways to save energy and money. OPower is a good model for encouraging energy efficiency. It has been shown to be effective in influencing behavior.
- *Evaluate wind proposals more carefully based on future climate projections.* Models show that wind speeds will decrease because of a decreased temperature differential between poles and the equator. Therefore, there are concerns about having a stranded asset in the future. The public’s increasing concern with health and noise issues related to wind farms needs to be addressed.

- *Improve utility risk management analysis.* Analysis should be conducted with the support of climatologists. Every utility needs a Risk Management team.
- *Work for the adoption of national solutions.* Solutions need to be universally applied, not just sector by sector or state by state. Regulations need to be open enough to invite various solutions. Utilities have better tools now to work on demand-side management, etc. These tools work better than regulation.
- *Maximize Nebraska's ability to develop alternative fuels.* Nebraska has tremendous potential for developing biofuels and wind energy and the potential to export these technologies and products. Proactive thinking is needed about these resources. However, we must be mindful of the next generation of biofuels and ensure potential solutions are consistent with building healthy soils.

Research and Educational Projects (to address adaptation and mitigation)

The cost of responding to the challenges of climate change will not be cheap. We will either pay now or pay later. However, it's not clear that consumers are willing to put up with less reliability which may result from implementing a greater percentage of renewable energy and the increased cost associated with it. Although Nebraskans say that they will pay more for renewables, the concept of climate change is overwhelming to the general public.

To circumvent this we need to start teaching energy efficiency, conservation, etc., in school to children at a young age. We need to educate the public on the long-term nature of CO₂ in the atmosphere. Education about the true cost of energy is needed. What is the proper allocation of the utility bill to the customer? How much should they pay to have access to the grid vs. how much should they pay for the energy they have been provided?

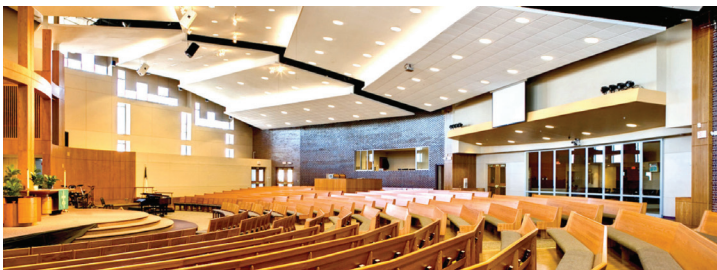
The public has major concerns about data sharing related to their home usage. As the energy industry moves toward decentralized energy delivery, consumers will need to be educated on how their data will be used and protected.

Policy Steps (to address adaptation and mitigation)

- ***Policy Options to Move Forward***
 - Policies are needed to support more renewable energy development and the corresponding development of new energy storage technologies that make renewable energy more effective.
 - Policies are needed for in-depth energy efficiency efforts.
 - Barriers to exporting wind energy need to be removed.
 - Barriers to renewable energy development need to be removed, e.g., net metering laws and red tape on locating and installing solar panels.
- ***Next Steps Needed to Move Forward on Each Policy***
 - Develop a shared vision about climate change and create partnerships between the public and private sectors. Improve the translation of research to the market/public. UNL should adopt a leadership position in translating and sharing research in a way that is understandable to the public and stakeholders.
 - Promote the Southwest Power Pool's ability to export energy more readily.
 - Promote the production of a more integrated grid across Nebraska and the United States.
 - Our wind energy incentives in Nebraska need to be comparable with our neighboring states. Utilities have purchased wind outside of Nebraska because it is less expensive.
 - A good net metering policy is needed.

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Climate Change in Nebraska: What Does It Mean for our Faith Communities?

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Summary of Key Issues

Climate change poses serious implications for Nebraska—to its agricultural productivity, its economy, its municipalities, and above all, its people. The faith community is a vibrant sector of life in Nebraska, with many people attending a house of worship frequently. Religious communities hold a moral authority and community binding that is very meaningful to a majority of the Nebraska population. Religious communities are in a unique position to speak about the risks of climate change, and also to care for people affected by the increasing effects of climate change.

The goal of the roundtable meeting for faith communities was to generate thoughtful, non-partisan and non-sectarian dialogue on how faith communities in Nebraska can respond to climate change in ways that are constructive, hopeful, community-based and healthy. As the effects of climate change worsen in coming decades, members of congregations across the state are likely to experience economic losses, emotional strain, property damage, health risks, and a disorientation to the natural world they have known. These changes will likely lead to great pastoral needs. Economic strain may lead to greater strain on church budgets. Effective pastoral leaders will anticipate these changes and prepare to best respond to congregational needs.

Many faith leaders feel that climate change is one of the most pressing moral issues of our time. As the norms by which our climate has operated over the last 150 years shift, major changes are in store for people in Nebraska and around the world. Human suffering will increase because of the multitudinous effects of climate change. The moral question becomes how do we prevent this suffering? And if we cannot prevent it, how do we lessen it? How do we care for each other in a world that is dramatically changing?

Key issues:

- **Climate change seen as controversial issue.** Climate change is seen as a controversial political issue that most pastors want to avoid discussing in their congregations for fear of creating conflict. There was an acknowledgement that churches run on tight budgets, and if members leave, it can create serious financial problems for a church.
- **Pastoral care needs.** Pastoral care is likely to increase in coming years as the effects of climate change may lead to economic strain from the agriculture industry, job losses, property damage, aggravation of health issues and mental health strain.
- **Aging structures, aging congregations.** Many churches in Nebraska are small and struggling. Many would have a hard time recovering from property damage to their buildings from extreme weather. If Nebraska's economy is impacted, that will have a direct effect on giving to Nebraska congregations—and many cannot afford a decrease.

- **Leadership.** Pastors expressed a desire to take moral leadership on this issue and to find ways to discuss it and work on it within congregations in ways that will not alienate members.
- **Faithful living.** The changes that are required of individuals and society to mitigate the risks of climate change are actually the same changes that are entailed in living more faithfully to one's tradition. Living less consumptive lifestyles, focusing more on the needs of others than of oneself, and understanding the interconnectedness of human and natural life are all core values of religious traditions that can also be effective means to curb greenhouse gas emissions. The group was surprised to find that the best ways to respond to climate change would also make stronger faith communities.
- **Scientific facts.** Pastors expressed an interest in learning the scientific facts of climate change from unbiased sources, in order to bypass the controversy perceived in the media and in politics.
- **Theology.** There was an interest in accessing theological messages that speak to the need to care for creation and which place the response to the current crisis in tradition.

Primary Mitigation Strategies

- **Talk about it.** Faith communities are places people come to talk about what is right and wrong. Talking about the risks of climate change from a moral and non-political perspective is a crucial way to shift social perception and encourage constructive action. Churches need to be able to create safe spaces to discuss this issue. They can model ways of speaking the truth with love. They can find ways to navigate the tension and encourage true dialogue. It was noted that it is difficult for an entire congregation to have a stance on an issue, but easier to encourage multiple conversations within the congregation. Some pastors are already preaching and teaching about climate change in their congregations, while others had been reprimanded by parishioners for bringing "politics" into church. Pastors identified several barriers to discussing climate change in their congregations: 1) a lack of science education on the part of many parishioners; 2) past negative experiences with the issue in the congregation; 3) hesitancy to make change in worship (for example, by incorporating a notion of caring for creation into the liturgy). At the same time, pastors expressed a willingness to find ways to have honest conversations within the church where there might be differences of opinion and an interest in learning from biblical and theological sources about how to address this issue.
- **Model environmental responsibility.** Faith communities can serve as role models for environmentally responsible living, for example: ride sharing, low-flow toilets and sinks, conservative thermostat settings, analyzing carbon footprint, composting, recycling, etc. Churches are called to stewardship in every portion of our lives. They can model a low-consumptive lifestyle.
- **Encourage the next generation.** All agreed that it is helpful to get young people in congregations involved. Many children are being taught the basics of environmental responsibility in school in a way their parents were not, and these children can be powerful teachers of the older generation. Their excitement and witness of the beauty of the natural world can spread. These are natural themes to incorporate into Sunday School curriculums as well.
- **Access resources.** Faith leaders expressed a desire for more resources on climate change to be used in faith communities. They need resources on the scientific basis of climate change, worship resources on creation care, guidelines for creating safe spaces for conversation and sharing with other pastors who are trying to discuss climate change with their congregations.
- **Provide an alternative to consumer culture.** The consumer culture in our society is a major stumbling block to more faithful living, congregational participation, and climate mitigation measures. Our culture tends to encourage more individualistic pursuits and the satisfaction of individual and temporary needs. There is a deep spiritual hunger that consumerism is not addressing. Our faith, however, calls us to think of others first, to act with humility and gratitude for life, and to serve others. Congregations and the climate would be healthier if people could live more in line with these foundational values.
- **Civic engagement.** Policies that cut greenhouse gas emissions can be supported by people of faith.

Primary Adaptation Strategies

- **Policy advocacy.** Faith leaders and members of congregations could take a more active role in advocating for policies that will protect people, generate more renewable energy, cut greenhouse gas emissions or help communities adapt to a changed climate.
- **Encourage people to reconnect to nature.** Most people are disconnected from the natural world these days. Everyone spends a great deal of time with screens. When we spend more time in nature, we care for it more.
- **Build a larger community.** When faith traditions come together, they have more power to inspire people and to create change.
- **Teach civic engagement as an aspect of faith.** Most religious groups already respond to issues of poverty, hunger and disaster. There is a need to align climate change with these other issues.
- **Reclaim the notion of stewardship.** Stewardship is a core theme in most Christian churches, but it most commonly refers to time, talents and treasure—or simply fundraising. The notion of caring for the ongoing health of creation should be reclaimed as part of the notion of stewardship. It was also expressed that the true meaning of “dominion” (Gen. 1:28) as “caring for” rather than “dominating” needs to be emphasized. It is possible to talk about stewardship in terms of love for one’s neighbor. Globalization has made the world smaller, and everyone is our neighbor now. One pastor noted that his members are good at “back yard stewardship,” but they lose folks when they start talking about care for the earth on a wider scale. It is helpful to talk about local connections – like watersheds and fertilizer and good water from the kitchen faucet. There is the possibility of taking advantage of global travelers in the congregation and the stories they may bring back from other parts of the world.
- **Practice good theology.** Many theological points were made throughout the roundtable discussions. It was acknowledged that theological reflection is needed at this time, and that messages and activities around congregations should be grounded in healthy theological reflection. Some of the ideas are these:
 - We need to make theological connections between the natural world, including land and agriculture, and sacred teachings.
 - We have to challenge the belief that some Christians have that climate change is a sign of the end times, that it is inevitable and ‘God’s will.’ That is tied to an over-emphasis on personal salvation at the expense of the natural world. This is a theology that completely leaves out God’s love of the whole of creation. The “prosperity gospel,” a belief that God’s favor will be shown by the growth of one’s personal wealth, is also at odds with climate conversations.
 - We can emphasize seeing ourselves as partners with God in creation. Seeing God’s love of humans and of the whole of Creation.
 - We can question how we understand the “Kingdom of God” - a full-bodied notion according to the New Testament. We have been living for 2000 years in the “end times”—how does this influence our understanding of where we are in history now, with climate change upon us?
 - We need to question the traditional theological notion that the world is “bad” and all things spiritual are “good.” Creation itself is part of the revelation of God; God reveals Godself to us through Creation. We need to remember the sacredness of Creation.
 - We are part of nature, part of Creation and not separate and not above. We can do a better job of understanding of our inter-connectedness with Creation.
 - The traditions of storytelling and relationship-building tell us what is important: the Creator and each other and creation. As faith leaders we need to foster these conversations.
 - It was noted that the core values of our traditions: love, truth, humility, service, compassion, are the same values that we need to foster in people in order to respond to the climate crisis. If people could grasp on to these, we would have healthier people, healthier churches and a healthier climate.

Research and Educational Projects Needed to Address Adaptation and Mitigation

- Basic scientific facts of climate change
- Resources on impacts of climate change on Nebraska
- Awareness of the lack of science education on the part of church members
- Awareness of the funded disinformation campaign to discredit climate change research
- Tools and curriculum to use in teaching
- Theological training to understand climate change from a theological viewpoint.

Policy Steps to Address Adaptation and Mitigation

- Updated building codes
- Statewide climate action plan
- Laws on water usage and management

Next Steps

Faith leaders were in favor of holding future gatherings to continue the conversation and to support each other in doing so. A high priority was receiving training in holding conversations about climate change with church members—including role-playing exercises. There was interest in joining together with other faith leaders to continue to explore how to take action on this issue. It was agreed that more resources were necessary to assist them in continuing their efforts—theological resources as well as scientific summaries of the issue. Guest presenters in worship and in education forums (for adults as well as children) would be welcome. Opportunities for lay leaders to take an active role in climate work would be welcome—recognizing that sometimes lay leaders have greater leverage in talking about this issue within a congregation than pastors do. There is a continuing need to connect global climate change to our own backyards by recognizing the changes to our own climate (the 2012 drought, the recent extreme precipitation events, flooding on the Platte, for example). It was suggested that congregations could join together to commit to going carbon neutral by a certain year. There was an acknowledgement of the importance of speaking the truth with love, which can be seen as a core aspect of faith.

Faith Leaders in Their Own Words

Following the roundtable, faith leaders were asked to give written responses to the question of which issues they thought were crucial in terms of the risks of climate change to faith communities. These responses are presented below.

I think the key issue for the faith community is the critical importance of dialogue on these issues. I feel strongly about Pope Francis' call for dialogue on the array of concerns in caring for our common home. However, with the enormous political differences in our communities, it is hardly imaginable that we will be able to serve in a dialogue with others in our culture.

I believe we must confront the culture of selfishness that is infiltrating our religious communities. More and more of our people are becoming wealthy and are aligned in their thoughts and lifestyle with the political right.

There is a challenge for our evangelization to be prophetic in ways people might experience a pastoral and loving call to a change of heart – an ecological conversion – which begins with compassion for our brothers and sisters who suffer.

Here are some of the key issues that my sector (leadership in a faith community, Roman Catholic in my case) faces as the effects of climate change become more pronounced in the decades ahead:

- *Regarding education, I will need to learn better how the traditions about Creator and creation in Scripture and subsequent tradition continue to speak to what it means to be a creature in covenantal relationship with God, my fellow human beings, and all other creatures on planet Earth.*

- *Preaching in a way that helps fellow believers respect all other creatures and their descendants in a way that mitigates the harm we have caused to the processes that comprise the gifts of creation.*
- *We'll need to celebrate liturgies in ways that help congregations grow in their awareness of creation and our place among all creatures, as the one species capable of acknowledging and responding to the Giver of all life.*
- *Helping fellow believers exercise what Catholics have come to call "faithful citizenship" will continue to be key. That means participating in public life in ways the consistently seek to foster the common good, with special attention to those who are marginalized and excluded.*
- *As basic resources become scarce, learning the skills of civil discourse, and dialogue will become increasingly important.*
- *We will need to engage in in the civic processes of our city, state, and country—indeed, in the international life of the world—to create public policy that ensures the rights to clean drinking water, clean air, education, and health care.*
- *More than ever, the challenges of thriving and working out potential conflicts nonviolently, will require the our young learn to think, reflect, listen, appreciate, dialogue, develop rational argument, interpret texts in context, have a sense of history—in other words, to engage in an educational process that has as much to do with wisdom as with practically. Classically, this has been known as a liberal education, a phrase now obscured by the contemporary use of the word liberal in journalism.*

As we've talked over the months preparing for this, I definitely feel the same challenges as I have from the start. First and foremost, our sector is filled with such diversity in terms of how congregations approach ministry. Some are highly political and downright partisan. Other congregations are politically averse. Some lack the skills to mediate conflict. Most are struggling to stay relevant and connected with a society that wants progress in every area except for their faith (i.e. they simply want to have church). Many clergy have no desire to learn more about emerging issues.

What I saw in the process of conversation, through both the roundtable discussions and the evening lecture, is that we learn about ourselves when we delve into questions of climate and ministry. This made me feel so incredibly hopeful.

My exchanges immediately after the roundtable showed me just how much work we have to do... and how difficult this work will be. The first exchange was on Friday afternoon when I returned to my office. Two staff members asked me about the conference. I shared with them some of what I had learned about climate change. One said, "Just hearing you talk is making me panic. I can't listen to this anymore!" The second interaction was the next morning with a retired high school teacher (learned and faithful), "I don't know if we can really believe all this research" was his reply. It was clear that he loves the Lord and wants to be a good steward... he just doesn't want to change his lifestyle. (Sigh!)

The greatest need I see in our sector is how to corral very different people who, in our venue, have little to no desire to be moved on this issue.

One of the things that I am trying to do is better training and coordination among faith groups in addressing the adaption to the new realities being brought about by Climate Change. We need to focus our efforts in three areas: prevention (by individual congregants and congregations), response to disasters (helping with a number of different areas of targeted expertise) and recovery (especially long-term since the response of government agencies and the response of many disaster response organizations mainly address the immediate crisis).

The key issues in terms of climate change and the faith community are the following:

Economic - the economic impact of climate change will obviously have impact on all communities, but especially rural communities due to the changes in agriculture across the state. That will impact churches that are funded based on voluntary giving. Churches will probably get smaller, need to work with neighboring churches (even ecumenically more

and more) to call pastors, do mission, etc. And more churches will probably close as population decreases.

As population decreases in rural areas, there will still be people who need spiritual care, social services, and the hope that churches provide. How will we provide those things with fewer resources and in more isolated areas?

Physical and psychological - the health impact of climate change will significantly affect everyone - again, needs will increase, but the faith community's resources will most likely be fewer.

Spiritual/Theological - Facing these kinds of challenges can cause people to despair. This is part of where I think the faith community can be helpful in that God meets people in despair - that's the Gospel of the Incarnation and Christ on the cross. And God brings life out of death, hope out of despair. Christian faith also moves us toward compassion and into community which can counter the isolation and promote communal efforts to combat Climate Change and work together in the midst of it ecumenically and through interfaith strategies.

Our religious community is conscious of environmental issue and works to respond to them. As climate change becomes more pronounced there will be greater responses required of a community who states this as one of their areas of action. Additionally, our sisters in Nebraska are connected to women religious communities around the globe, some of whom live in locations where the effects of climate change are already being felt. So the global awareness is being raised in this community and demands a response further than our immediate area.

Another issue is financial. This is an aging community that has many responsibilities for sisters who no longer work or who have health issues. Increased costs associated with climate change will additionally tax already stressed resources.

The health hazards associated with climate change can also be harder on an older population. This will be a concern as well.

List of Participants

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Tonya Bernadt	University of Nebraska–Lincoln, National Drought Mitigation Center
Eric Bostrom	Sheridan Lutheran Church
Emilie Bouvier	Minneapolis Area Synod, Evangelical Lutheran Church of America
Greg Bouvier	Sheridan Lutheran Church
Dan Flanagan	United Methodist Church
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Patty Forsberg	Sheridan Lutheran Church
Dennis Hamm, S.J.	St. John's Parish, Omaha
Nan Kaye-Skinner	Trinity Lincoln United Methodist
Tyler Mainquist	Nebraska Interfaith Power & Light
Kenneth Moore	Interchurch Ministries of Nebraska
Kim Morrow	Nebraska Interfaith Power & Light
Megan Morrow	Nebraska Synod, Evangelical Lutheran Church of America
Jeffrey Nelson	Episcopal Church of Our Savior
Mike Poulin	Sisters of Mercy West Midwest Community
Richard Randolph	Christ United Methodist Church
Kathy Thornton	Sisters of Mercy
Duane Westing	Homestead Presbytery, Christian Church/Disciples of Christ
Donald Wilhite	University of Nebraska–Lincoln



Institutional Responses to Climate Change: Implications for College Campuses in Nebraska

Organized by:

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Summary of Key Issues

Maintaining current building/facilities functionality as system demands push them beyond current design. As the temperature effects of climate change become more pronounced, the peak energy demands for maintaining comfort will increase, and the annual campus energy load will likely increase as well. The existing facilities comfort systems should therefore be upgraded to address the increased thermal stresses. Also, existing technologies will experience increased losses and inefficiencies due to basic thermodynamics outcomes of operating in warmer temperatures. Current designs will suffer because of shifting operating conditions. Electrical power load management, which always presents a challenge, will become more critical as conditions become more complex. The managers of these historic campuses have some capacity here; they often work to reimagine or re-engineer facilities for new use parameters. Campuses will need to invest in providing ample and necessary training to facilities and energy personnel such that they have the necessary skill sets and resources to deal with the added stress that comes with the changing climate.

Our ***current way of life is threatened*** by changing climate – these same climate disruptions will also affect campus and community landscapes, and supporting ecosystems. The USDA Plant Hardiness Zone Map does not fully address changes; the design standards developed with a stationarity assumption will need to be reviewed.

Volatility and risk management are terms finding their way into facilities management, whether the discussion is about supply chain, severe weather events, climate shifts, or predicting campus loads relative to changing business models (e.g., MOOC [Massive Open Online Course] and other educational pedagogical frameworks). The campus facilities management profession does not currently have adequate tools to proactively manage these risks. Current decision making processes about resource management need revision.

Facilities management has had several successes in energy efficiency and water conservation, but awareness of these successes is low. In some cases, university adoption of “green” technologies and practices offer great examples for others in the community, both to build understanding of what is possible, and to reinforce the role of the university as a community leader. ***Resources to support campus infrastructure maintenance and operations rarely seem sufficient to meet the need***, increasingly so with a general lack of awareness and understanding among stakeholders.

Primary Mitigation Actions or Strategies

- ***Universities are in a position to “take the politics” out of the climate change issue.*** Campus leaders can demonstrate by their actions that addressing climate change is an important job for the well-being of the institution and those it serves, that not acting to address climate change would be unreasonable and irresponsible. Experts from many disciplines can authoritatively communicate the reasons for action and provide the underlying research to develop suitable, feasible, and acceptable

solutions. Resources will be needed; all parties – faculty, staff and students – can improve the outcomes of their efforts given the right tools.

- **Develop a campus action plan.** First, measure contributions to climate change. Second, prioritize opportunities to mitigate contribution. A plan of action depends on a prioritization of responses to the greatest opportunities. In order to establish this, campuses need to (either on their own or in response to state or federal goals) first assess their contributions to climate change. Using an assessment of campus resource consumption rates compared to the availability of resources will help prioritize actions. Using existing scorecards for benchmarking such as the Sustainability, Tracking, Assessment and Rating System (STARS), or the Global Reporting Initiative (STARS) (<https://www.globalreporting.org/Pages/default.aspx>) available from Association for the Advancement of Sustainability in Higher Education (AASHE) will drive improved management of climate change impacts. Planning and measurement will steer limited resources to where need is greatest. Recycling does not have a significant climate change impact, for instance, while transportation choices do. A comprehensive evaluation and plan could shift current efforts to opportunities currently overlooked – such as more use of “waste heat” from low-grade energy sources.
- **Incite action in others.** Publicize results. Deploy actions through the extension service. The universities can lead action among others by walking the talk – and publicizing their successes. Not all campus stakeholders are aware of campus activity – not all communication channels are currently used, a new channel may be necessary. Campuses can tell the story of how climate change is a pervasive issue and how everyone has an opportunity to make an impact. Students represent a tremendous resource that is not fully utilized. Include more required student education on the subject and more information outside of classes – time on campus is a transition time for students so a large potential for positive outcomes is associated with this effort. Some off-campus resources exist to help tell success stories; consider the marketing contributions US DOE will offer campuses that sign up to the Better Buildings Challenge (<http://betterbuildingsolutioncenter.energy.gov/about-better-buildings-initiative>), for example.
- **Ensure the correct signals are in place.** One barrier to improved action within many universities is what is known as the split incentive – a situation where the landlord pays for energy use it and thereby reduces the incentive for tenants to manage their energy consumption. Iowa State University, among others, instituted a Resource Management Model (<http://planning.president.iastate.edu/finance/resource-management-model/policy-and-procedures/expenses>) to eliminate this split incentive, to encourage the building occupants to act more responsibly by having them pay more for their energy cost when they use more. The split incentive is just one policy example – **other policy barriers need to be identified and adjusted.** (See below)

One next step agreed to by attendees is to **keep the conversation going**. But the general desire to keep up the momentum requires an active champion, or cadre of champions, to actively promote the issue and spur others to stay involved in the discussion. Part of that comes from a summary report of these roundtables, part comes from a clear **call to action** that is endorsed by campus leadership.

Primary Adaptation Actions or Strategies

Most of the suggestions/primary steps are akin to mitigation strategies addressed above. To summarize the main ideas to adapt to our changing climate are: education and engagement practices that yield behavioral change in the campus community towards more pro-environment behavior and choices like biking to campus, recycling, and energy conservation. The educational institutes also need to adapt to peak load needs by changing the school year schedule or offering more online classes. The general consensus among the participants was that the educational institutes do not use the building capacity to the full extent. Campuses can **increase adoption of proven low-risk geo-engineering approaches** to both mitigation and adaptation, e.g., planting trees throughout campuses and surrounding communities. Topic experts can revise design standards to address the issue of non-stationarity and encourage the designers, buildings, and operators to “harden” infrastructure to reduce the risk of damage from weather and climate impacts.

Some of the necessary next steps are similar to mitigation strategies as mentioned above. Apart from what is mentioned above the participants also suggested the following:

- Use resources of the academic institution to the full extent. Academic institutions are unique in wanting to serve as a role model for others. Make sure that is marketed. Environmental stewardship is a key element of current student populations.
- Green building: Use latest technology while building new buildings that use relatively low energy and move towards building a net zero building. Net zero building is define as a building that consumes as much power as it generates within a calendar year.
- Create a Climate Action Plan: Most of the participants agreed as mentioned above to create a climate action plan. A full time staff at the Office of Sustainability can bring together administration, students, facilities, and other key stakeholders. However, a growing number of the participants vetted their concern about having a buy-in from administration before starting the process. The students also have an important role to play- especially at university housing, academic facilities, and recreational centers.

Research and Educational Projects

A good deal of campus information needs to be collected in order to establish a benchmark-able *status report* of where institutions are compared to where they need to be. This provides the basis for a publicly available scorecard. The specific information depends somewhat on the *measurement system* chosen. Research to ascertain the *appropriate metrics* is also needed. It may be better to evaluate using the Genuine Progress Indicator rather than the Gross Domestic Product (http://rprogress.org/sustainability_indicators/genuine_progress_indicator.htm), for example.

Market research would be helpful, such as a statewide poll and an institutional poll, to assess the cultural appetite for change. What are the sacred cows, where can changes be made, where are the pressure points, the places to intervene in the system?

Topic experts could review and assess existing laws and policy and provide input to policymakers about where changes in existing policies, regulations, and laws can improve mitigation and adaptation.

Communication of these complex issues – in a way that invites action and recognizes not all people are rational actors – is necessary. Research and development of a *climate communication strategy* that will help all campus citizens would be very helpful.

Policy Steps

Policies provide a tangible feedback mechanism that can encourage or discourage desired pro-environmental behaviors. *Examples of policy change opportunities:* Creating and installing shortened and simplified feedback loops would be useful. Looking at the underlying assumptions associated with common rules of thumb would help with everyday decision making (e.g., the oft used investment payback periods of <5 years which is roughly equivalent to a 20% rate of return). Many opportunities lie with aligning purchasing policies with the principles of Environmentally Preferable Purchasing (<http://www.epa.gov/greenerproducts>). Many organizations (<http://gofossilfree.org/commitments/>), universities (<http://gofossilfree.org/commitments/>) among them, have changed their policies to divest from fossil fuels. Two opportunities exist for universities: 1) for institutional investments to divest, and 2) give employees divestment options for their personal retirement – currently these options are limited by the institution. *Leadership* needs to step up and indicate a response to climate change is an institutional priority. Many faculty and staff would be willing to act, but do not think they have permission to do so. Campuses have adopted *unlimited growth as a business strategy* without evaluating whether this strategy is sustainable. It isn't. A shift to long-term thinking in evaluation protocols is necessary.

Next Steps

Many attendees indicated a willingness to participate in follow-on email list serve communication.

List of Participants

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Dave Aiken	University of Nebraska–Lincoln
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Implications of Climate Change on Nebraska's Urban and Rural Communities

Organized by:

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Summary of Key Issues

It is no longer reasonable for cities and towns in Nebraska to plan based upon historical weather patterns; instead, as they move into the future, they must plan for and adapt to the impacts of climate change. The September, 2014 publishing of the University of Nebraska-Lincoln's report, *Understanding and Assessing Climate Change: Implications for Nebraska* (hereafter "Implications for Nebraska Report") has helped all Nebraskans to better understand the implications and risks associated to a warming climate. More frequent high temperature extremes will mean higher peak energy demands, potential reliability risks, and stresses on low-income and elderly populations. Fewer and far more intense rain and snow events can increase local flooding. Digging out from major snowstorms will take longer and be more costly. And fewer hard frosts and longer growing seasons mean more insects and diseases that affect human health and plants and animals in the urban setting.

Residents of Nebraska's towns and cities expect their leaders to respond to these challenges, as they involve the basic expectations of local government. In poll after poll, including the most recent Rural Nebraska poll, a strong majority of voters and taxpayers feel state and local governments must prepare for climate change. Thus, Nebraska's urban and rural municipalities sit squarely at the intersection of climate change mitigation and adaptation policy in the years ahead.

On September 22, 2015 individuals representing both the urban and rural sectors attended the Implications of Climate Change on Nebraska's Urban & Rural Municipalities Roundtable. This roundtable enabled a discussion of the findings from the "Implications for Nebraska Report" specific to Nebraska's urban and rural municipalities, and was held in conjunction with the Nebraska League of Municipalities annual conference. The roundtable participants discussed and identified potential solutions for urban and rural municipalities to adapt to and mitigate the risks related to climate change for their communities, including a likely increase in the risk of drought, increased flooding from extreme precipitation events, increased air and water temperatures, consumer energy demand exceeding supply, and other areas of responsibility for local government.

This roundtable addressed the fact that, in the day-to-day operations of local government in Nebraska, there are opportunities for adaptation to and mitigation of risks related to climate change. When communities build neighborhoods and shopping malls, arenas and office buildings, the natural surface is changed greatly, with concrete and asphalt absorbing sunlight, shedding rainwater, and releasing heat. When they build streets and transportation systems, there will be an increase in greenhouse gas production and emissions. When they move energy and water across expanding service areas, they burn fossil fuels. And every day, towns and cities burn fuel, use materials, and create waste. All of this activity is at a local scale but one inexorably tied to the rest of our region, nation, and planet. This roundtable helped focus attention to this reality.

The roundtable featured an opening presentation by Don Wilhite, lead author for the UNL report, *“Understanding and Assessing Climate Change: Implications for Nebraska”*. Milo Mumgaard, recent senior aide for sustainability for City of Lincoln Mayor Chris Beutler, then discussed the City of Lincoln’s approach to adaptation and mitigation, focused on making it a priority for the City to reduce climate-related vulnerabilities for residents and businesses, and to better respond when impacts occur. Chris Anderson, City Administrator for Central City, then described Central City’s commitment to diversifying its energy supply to use more renewable energy and plan for future costs, including new community solar projects, and its leadership in this area for other smaller Nebraska communities. These presentations enabled participants to see how practical and cost-effective policies designed to address the impacts of climate change are both possible and already happening at the urban and rural level of government in Nebraska.

Through these presentations and the roundtable discussion, the participants recognized that while nothing in policy is ever easy, local governments in Nebraska are taking action, in both small and large ways, to plan for and deliver local efforts directed to the risks that lie ahead. The participants generally agreed that, at this point, there are three basic areas of necessary and continuing action steps.

First, there is a strong need for more timely, accurate, and specific information on climate change and its impacts to be distributed to local community members. There exists a great deal of misinformation in communities today, and this can effectively be addressed through the existing high credibility of leaders at the municipal level.

Second, the participants emphasized how local and state governments should use more pricing signals as to climate change adaptation and mitigation. Nebraskans respond to impacts on their pocketbooks, and want to be able to make their own economic choices as to the most appropriate and cost-effective approaches to preparing for climate change. In short, if it is cheaper over the long term, than do it. This means any policy actions should incorporate prices for services and utility rates that target and facilitate adaptations and conservation through clear and understandable economic impacts. Local governments and municipal utilities are well positioned to provide information to residents that makes common sense to people, especially basic information that go to people’s bottom line, both individually and as taxpayers.

Third, local governments must strive to get even more people, interests, and constituencies to the decision making table on local policies addressing climate change impacts. Participants agreed that politics must be removed as much as possible from any local policy decisions on climate change impacts, whether put into that context or merely good government planning for and addressing risk. It is evident that future action must include all points of view, provided there is a recognition these climate change impacts are occurring and must be addressed. Strong leadership at the local level will be critical to this effort to be even more inclusive.

As Nebraska’s urban and rural sectors move forward in adapting to and mitigating climate change in their day-to-day operations, it was recognized that although urban and rural municipalities do have differences, such as community population, access to natural resources, and economic infrastructure, municipal leaders at all levels have a responsibility to implement an action plan to mitigate or adapt to those risks that will significantly impact their community.

Three strong examples illuminate these risks from the discussion. First, participants in the roundtable discussed how rural municipalities in Nebraska are dependent upon groundwater. If decreasing water supplies leads to reductions in agriculture productivity, local communities and their economies suffer, and with no water the death of a rural community can occur. Second, both urban and rural municipalities need to be focused on the health of the citizens living in their community (e.g. cooling shelters, increased air pollution, respiratory conditions, and vector borne diseases to name a few). This includes land use decisions related to preparing for flooding for those located or moving into flood plains. Third, every Nebraska town and city has an infrastructure vulnerable to climate change impacts: energy peak load costs to communities, storm water and sewer capacity, urban forest

species of trees disappearing, and the costs associated with insuring this infrastructure can deal with future impacts. The participants actively and enthusiastically discussed these and other risks that local governments have responsibility for in Nebraska.

The following is a summary of the discussions held by the roundtable participants. During the roundtable facilitators asked specific adaptation and mitigation questions for attendees to strategize a way by which their municipalities can reduce the impacts related to climate change. Those responses were collected and compiled; while certainly not comprehensive, these ideas and options can help urban and rural municipalities in Nebraska to think about possible basic strategies to implement action in their communities.

This information from the roundtable, though, also reveals both the opportunities and the challenges regarding action at the local government level in Nebraska. Given the breadth of these opportunities for action, it is imperative to prioritize around a community's own day-to-day operations. Some communities may decide to focus on water supply or compact growth; others may see energy as their most significant opportunity; still others work on recycling or transportation. Nebraska municipalities are establishing their own local plans and targets for action in their own operations and communities. What makes the most sense for your town or city? This roundtable helped move this discussion and these decisions further forward, as the time for action is now.

Primary Mitigation Actions or Strategies

- *What are the primary steps that could be taken in your sector to reduce greenhouse gas emissions and levels in the atmosphere (e.g., carbon sequestration or renewable energy)?*
 - Infrastructure Infill
 - Transportation
 - Energy Efficiency
 - Municipal Policies
- *Next Steps Needed to Move Forward on Each Action/Strategy*
 - *Infrastructure Infill*- Municipal planning departments can help their community grow up instead of out. Infrastructure infill will help to reduce traffic congestion and allow efficient transportation options while reducing urban sprawl.
 - *Transportation*- Providing different modes of transportation help municipal residents to have access to a variety of options to reduce street congestion and increase air quality. Transportation options could include bike lanes and trails, consistent and reliable public transportation for short and long-term distances, walkable streets, and electric charge point stations for electric cars. Municipalities can also use technology to improve efficiencies of traffic flow for congestion mitigation and idle reduction and also move toward lower or no emission vehicles in their fleets.
 - *Energy Efficiency*- Energy efficiency saves residents, businesses, and municipalities' money while working to reduce peak energy demand costs. Energy efficiency can be achieved through consumer education, the implementation of energy efficient building codes, incentive programs for retrofitting commercial businesses and residential housing, and implementing revolving loan funds to provide homeowners with on bill financing to assist with costly upgrades such as a new furnace or air conditioner.
 - *Municipal Policies*- Implementing sustainability into a municipality's master plan by increasing departmental communication to prepare for extreme weather events that will affect the entire community. Additional communication will help to educate public officials and municipal residents about adaptation and mitigation plans needed to sustain the livelihood of their municipality.

Primary Adaptation Actions or Strategies

What are the primary steps that could be taken in your sector to adapt to our changing climate?

- Comprehensive Planning- Municipal and community planning projects would help to educate leaders and community members while working to create substantial goals such as energy savings and water conservation.
- Review Water Consumption- Analyze all of water going in and out of your municipality and surrounding region. Set goals to reduce water consumption with new technology (e.g. smart irrigation for residential, commercial and agriculture landscapes, turf removal, rain gardens, drought resistant landscaping) while reviewing the municipal water rate structure.
- Energy Consumption- Create a municipal plan to adopt renewable energy alternatives. This will provide a reliable back-up in case the peak demand exceeds peak production. A back-up energy system will help to mitigate public health concerns during extreme weather events (e.g. cooling stations during heatwaves).
- Community Education- Connecting with citizens will help to increase civic engagement towards the advancement in municipal goal setting and comprehensive planning.
- Partners- Partners for municipalities to consider working with across the state could include the University of Nebraska Extension Services, community educators (e.g. elementary, middle school, high school and college), Natural Resource Districts, The Rural Futures Institute, and local public health departments.

Research and Educational Projects (to address adaptation and mitigation)

The costs associated with climate change adaptation and mitigation will be significant for both urban and rural municipalities. Calculating the costs to incorporate conservation strategies in short and long term planning will help communities plan to become more resilient. Conservation upgrades may take a significant monetary investment initially but it can also mean that a community could survive if not thrive for future generations. But, where is the money? This is one area where both urban and rural communities will need additional assistance to discover funds or investment techniques that work best for efficient upgrades.

Policy Steps (to address adaptation and mitigation)

What policy options would help your sector to move forward on addressing the implications of climate change? Are there existing laws/policies that should be modified? Are new policies needed? If so, what issues would they address?

- Recycling advancements such as selective landfill bans on recyclable commodities, pay as you throw (PAYT) programs and increasing community recycling availability, education and efficiency.
- Work closely with climate scientists to anticipate severe weather events.
- Plant more and a greater variety of trees in and around the municipality and improve efforts to avoid tree removal for construction projects.
- Enhance watershed regulations to assist with groundwater recharge and to reduce damaging runoff into our waterways.
- Support charging stations for electric cars, increase public transportation options, continue to enhance bike lanes, encourage walkability and monitor traffic flow to reduce emissions.
- Upgrade street and business lighting to high efficient LED lights.
- Promote energy efficient retrofits for residential and business communities.

What role could your organization play in taking action on those mitigation strategies?

- Provide education and public awareness through focus groups, social media and municipal website.
- Setting community wide goals and follow through with them.
- Advocate and initiate ordinance modifications for improved energy efficiency, watershed protection and recycling initiatives.

Next Steps

Work with the University of Nebraska to continue the Roundtable events in order to form networks and bring additional sectors to the table through regular meetings and education sessions.

Are there stakeholders that are not present at this roundtable that should be included in future discussions?

- City/County Council Members
- Additional urban and rural decision makers
- State legislators and other state agency decision makers
- Funding/grant agencies

List of Participants

Dave Aiken	University of Nebraska–Lincoln
Chris Anderson	City Administrator, Central City
Mary Baker	Nebraska Emergency Management Agency
Tonya Bernadt	University of Nebraska–Lincoln, National Drought Mitigation Center
Ann Bleed	Lower Platte South Natural Resources District
Sandy Brown	City of Wayne Green Team
Jessica Burnett	Nebraska Cooperative Fish and Wildlife Research Unit
Kay Carne	Verdis Group
Michael DeKalb	Lower Platte South Natural Resources District
Willa DiCostanzo	City of Lincoln
Rachael Herpel	Rural Futures Institute, University of Nebraska
Glenn Johnson	Lower Platte South Natural Resources District
Lowell Johnson	City of Wayne
Logan Lamb	University of Nebraska–Lincoln
Dwight Livingston	City of North Platte
Kim Morrow	University of Nebraska–Lincoln
Milo Mumgaard	Legal Aid of Nebraska
Mitch Paine	Nebraska Department of Natural Resources
Dale Shotkoski	City of Fremont
Prabhakar Shrestha	University of Nebraska–Lincoln
Frank Uhlarik	City of Lincoln
Donald Wilhite	University of Nebraska–Lincoln

Synthesis of Roundtable Reports and Cross-Cutting Themes

The goal of this summary chapter is to identify some of the frequently recurring themes from the eight roundtable reports and to present some of the obvious next steps and recommendations from the participants. As we sorted through the detailed roundtable discussion summaries, we identified several recurring themes or conclusions and grouped them into major topical areas.

Water

Threats to Nebraska's water supply and quality are of foremost concern when assessing climate change impacts to the state. Concern about water availability and management in the future was a primary cross-cutting theme for all of the sector roundtables.

Increasing temperatures and high temperature stress days, an increased frequency, severity and duration of droughts, decreased soil moisture and lower water flows from reduced snowpack in the Rocky Mountains will conspire to put great strain on what has been an abundant water supply in Nebraska.

Competition for water resources from all sectors will likely occur based on these projected changes. These conflicts will become more dramatic in the coming decades and, especially, towards the third quarter of the 21st century. A key concern is how Nebraska will allocate water resources in the future to reduce or avoid conflicts between sectors. The state must promote water conservation and incorporate technology to reduce water use. All sectors should work with federal, state, and county interests to identify potentially conflicting needs related to water quality and quantity.

The system of Natural Resource Districts in Nebraska is a great benefit to our state. Most NRDs are already proactively managing water resources in their watersheds. However, roundtable participants noted the need for the NRDs and the Department of Natural Resources to become more proactive in incorporating projected changes in climate into their watershed management plans.



Adam Liska

If decreasing water supply (both surface and ground water) leads to reductions in agriculture productivity, the state's economy will suffer. The vitality and sustainability of rural communities in particular will be in jeopardy. There is a need to be proactive in anticipating these challenges.

Hydrological impacts to power generation must also be considered. The energy infrastructure will be strained due to increased demand for electricity (largely from irrigation and air conditioning on the hottest days). In addition, electrical generation plants dependent on water for cooling may be strained. A

multi-year drought could put a power generation plant at risk of insufficient water and higher water temperatures with less efficient cooling capacity. Clearly, stresses to Nebraska's electrical infrastructure affect all sectors.

Flooding due to intense rainfall events is a concern for all sectors. In one example of a cross-cutting action that could benefit multiple sectors, restoration, enhancement, and conservation of riparian zones and buffers in agricultural and urban areas would mitigate flooding impacts downstream, minimize non-point source pollution, and restore wildlife habitat.

Agriculture and Food

Climate change is currently altering, and will continue to alter weather patterns and the occurrence of extreme climate events such as droughts, floods, heat waves and high intensity rainfall events. These changes have important implications for the agricultural sector. Although plants can operate at a range of environmental conditions, yield quantity and quality are expected to be affected negatively, especially if changes in climate result in conditions that are outside the range of species' tolerance. Although there are unknowns concerning climate change and how producers will respond (i.e., changing management practices, cropping systems), projected changes in climate will have profound effects on the resiliency of agroecosystems and the economy of the state. It is critical that we take steps to maximize resiliency of soils (e.g., ability to hold and absorb moisture will be key in the future), and improve water and nutrient use efficiencies of crops, via either crop improvement or water management practices.

It is likely that changes in climate will impact the cost of food production and its availability to consumers at an affordable price because of the increased cost associated with farm management and farm input, including water and fertilizers. Concerns were also expressed about the impacts of climate change on food security.

Adam Liska



Land Use Management

How land is used, and what is grown upon it, may need to change significantly in an altered climate. In the future, Nebraska's climate may not be as amenable to the monoculture corn cropping system currently in place. Agricultural innovations and adaptations will surely be needed to retain the state's prominence in agricultural productivity.

There is a notable opportunity in Nebraska's agricultural lands and grasslands for significantly mitigating carbon dioxide in the atmosphere: carbon sequestration through plant matter.

Land use and habitat management approaches that reduce carbon emissions and increase carbon sequestration should be developed and implemented across the state. The importance of soil health, grasslands and wetlands deserve serious consideration. Prairie lands, already severely compromised, need to be preserved and managed in complimentary ways with agricultural land in order to promote soil health, preserve habitat and sequester carbon. It will become increasingly important to consider the carbon lifecycle of various land use systems and to manage accordingly.

There is a need to educate landowners on the impacts of climate change and the benefits of carbon sequestration for their soil health and productivity. Toolkits could be developed for landowners with examples of mitigation and adaption strategies. Education and incentives have been proven to be effective models for change in this sector.

As the climate shifts, plant hardiness zones are shifting northward. Species that once were found only south of Nebraska are now being found in the state, and species that used to grow in the state are now being found north. In this context, it is important to improve our understanding of how climate change will impact specific species and plant communities. Some vegetative forms are more vulnerable than others. Growers and forest management professionals should work with native and regionally adapted species to identify seed sources and specific genetics better suited for the anticipated changes in environmental conditions.

Participants noted that we have already seen significant changes in the frequency and intensity of extreme precipitation events. These events have increased soil erosion and the runoff of manure and fertilizers into surface water sources. We need to develop improved strategies to better manage these systems as the frequency and intensity of extreme precipitation events continue to increase.

Energy

Nebraska's energy generation, use and management affects all sectors. Historically, the energy sector has been responsible for about 40% of carbon emissions nationwide, so this sector is of prime importance in reducing greenhouse gas emissions.



Adam Liska

Nebraska has impressive resources for renewable energy in wind, solar and biofuels. These energy sources should be much further developed and integrated into existing energy generation portfolios to ensure reliability. These technologies and products could be exported for economic benefit. By reducing carbon emissions from coal-fired power plants, increasing energy from renewable sources and implementing carbon sequestration in soils, Nebraska could make remarkable progress toward becoming carbon neutral.

However, renewable energy development needs to be done wisely. The placement of wind and solar facilities needs to be carefully considered so that they do not endanger wildlife and ecosystems. Maps have been created for wind developers of particularly sensitive areas of the state for migratory birds and other wildlife. These areas should be avoided. Biofuels have tremendous potential, but if they come at the cost of the further destruction of prairie grasslands and soil health, it will not be a net gain. Biofuels also place considerable pressure on the state's water resources. Renewable energy development needs to be done in a way that honors conservation measures.

Invasive Species

Research has already demonstrated an upward trend in increased occurrence and migration of pests, diseases and invasive species as the climate changes. This is due to species migrating northward as climate zones shift, warmer temperatures preventing winter die-off, extended warm seasons allowing for the proliferation of pests, and other factors. The changes are impacting the health of plants and animals, and impacting the health and resilience of agroecosystems. These changes also have implications for human health, as allergies and insect-borne disease increase.

It will become increasingly necessary to implement and improve programs to manage pathogens and to prevent, control, and eradicate (where possible) invasive species.

Health & Well-Being

Roundtable participants noted that maintaining population health is a key element of any successful state response to climate change. Health effects of climate change have been shown to be serious, widespread, and increasing as average temperature rises and precipitation patterns (e.g., amount, seasonal distribution and intensity) change. The voice of health professionals, by educating the public about the health risks of climate change, is essential to promote public support for needed climate response policies. Since the next decades of change are likely to be challenging and a response to climate change needs to be urgent and immediate, planning to protect public health needs also to be substantial, speedy, and ambitious. Health planning should be a part of Nebraska's overall state plan for climate change.

Climate change will have significant effects on the health and well-being of Nebraskans in ways that cut across sectors. Heat stroke risk, aggravated respiratory conditions from pests and air pollution, and vector borne diseases are just a few of the health impacts likely to occur. As flooding will become an increasingly important concern, flood preparation and management will be necessary, including the prevention of water-borne diseases. Both urban and rural municipalities should focus on the health of the citizens living in their communities.

Participants noted that the health implications of climate change are not well known by the public. Therefore, educational efforts need to be implemented to improve the public's understanding of this issues. In addition, we need to enhance monitoring and modeling of areas such as the implications of increasing temperature on outdoor activities, including agriculture, sports, construction, etc. There will also be changes in air and water quality, especially during drought periods, psychological responses, and human-animal disease interactions. Economic losses to Nebraska businesses and families are a major concern. With economic loss, of course, comes a decrease in quality of life, health and well-being.

Urban and rural municipalities need to be focused on the health of the citizens living in their community (e.g. cooling shelters, increased air pollution, respiratory conditions, and vector borne diseases to name a few). This includes land use decisions related to preparing for flooding for those located in or moving into flood plains.

Information Needs

A recurring theme in all of the roundtable discussions was the need to provide unbiased information on climate change. Because of the highly unusual political conflict surrounding the issue, there have been delays and in some cases moratoriums for key sectors to work through the implications of climate change. There is a critical need for respected and unbiased providers of information to cut through the political "clutter" surrounding the issue and provide usable and relevant information to key sectors immediately.

A goal for all sectors is to increase public awareness and understanding of climate change and its impacts on natural resources, ecosystem services, and impacts to humanity. This could be achieved through the development of a list of speakers (i.e., Speaker's Bureau) to give presentations on climate change and potential adaptation and mitigation strategies in the state. The purpose of this effort would be to provide science-based information in an understandable manner to enhance public understanding of the issue and to engage these diverse audiences in state-wide planning activities. Other activities, such as local workshops, could also be helpful in building awareness about climate change.

Some sectors are in a position to act as trusted sources of information themselves. The University of Nebraska, as well as other colleges and universities, are in a position to provide unbiased and respected information. Experts from many disciplines can authoritatively communicate the reasons for action and provide the underlying research to develop suitable, feasible, and acceptable solutions. The University of Nebraska could, in concert with other university and college campuses, develop a climate change "hub" for Nebraska which would provide the most current and relevant climate data, track mitigation and adaptation efforts statewide, and serve to facilitate progress among various sectors. The need for the University of Nebraska to continue leadership in this area was clear.

Nebraska Extension is a trusted source of information and should be used extensively to engage diverse stakeholders, especially agricultural producers and other decision makers.

Climate Action Plan

A prominent theme throughout the discussions for all of the roundtable was the need for the state to develop a climate action plan in order to proactively deal with current and projected changes in our climate and its implications for our citizens and environment. There was support for promoting, developing, and supporting

a climate action plan with measurable goals and timelines for mitigation, adaptation, research, and education. Since all factors in a planned response are likely to affect public health, health planning should be a significant component of any statewide climate response.

A state climate action plan should include an evaluation of current frameworks to address climate change in Nebraska, and call for the development of new ones to meet the needs of the future. These frameworks may include legal, regulatory, policy, market-based, and individual actions. A climate action plan must bring together all relevant state agencies as well as representatives of Nebraska agriculture and business communities, key organizations, universities, federal agency representatives and non-profit organizations working on proactive responses to climate change. These key constituencies must engage in a process of working together to identify the most effective mitigation and adaptation strategies to implement in their respective sectors.

Roundtable participants suggested that a climate action plan should integrate research, teaching and outreach activities related to climate change mitigation and adaptation across organizations. Sectors such as agriculture, ecosystems, energy and health are especially important due to the cross-cutting nature of these sectors and their importance to the state economy and environment. In addition, the following themes were also noted in the roundtable conversations: promoting the inclusion of climate change adaptation strategies in university academic programs and stressing the interdisciplinary nature of both problems and solutions; advocating community-level awareness and engagement relating to the health implications of climate change on Nebraskans; and advocating, through an inclusive and open dialogue with the business community in Nebraska, the development and adoption of carbon mitigation strategies.

These suggestions are a helpful start, but the actual details of a state climate action plan will need to take shape by a thorough and integrated process from engaged stakeholders.

New studies are needed to quantitatively assess risks to various sectors in Nebraska. Real and potential impacts of climate change on health parameters need to be studied, monitored and evaluated. Economic risks to Nebraska's economy need to be assessed. In academic programs, climate change adaptation strategies should be included and the interdisciplinary nature of both problems and solutions should be stressed.

At all levels, informed inter-professional and inter-organizational cooperation will be necessary in order to successfully adapt to the predicted changes to Nebraska in coming decades. In some cases, a mitigation/adaptation strategy on the part of one sector may conflict with the needs of a different sector. These potential conflicts should be foreseen and mitigated. In other cases, there may be confluence between sectors, where a mitigation/adaptation strategy benefits multiple sectors. Managing water resources and improving soil health are two of the areas which would provide the most benefit across sectors.

Although there are costs associated with the development of a climate action plan, the economic, environmental and social costs of inaction will be much greater.

Concluding Thoughts and Recommendations

It was clear throughout all of the roundtable events that there were grave concerns about how climate change would affect Nebraska's economy, environment and the social well-being of its citizens. Current and more dramatic projected changes in our climate pose a serious threat to the state and must be addressed proactively by elected officials, local and state governments and institutions of higher education. The results of the Poll of Rural Nebraskans resonated with all of the participants and helped to confirm the urgent need for action and the widespread support for such action.

Several key recurring themes or takeaway messages from the roundtables were:

- Roundtable discussions around the sectors included in the fall 2015 series represent only the first attempt to engage stakeholders to discuss the implications of climate change on their sector. It is essential to continue these discussions with the stakeholders that participated in this roundtable and also to expand the number and diversity of stakeholders engaged in the conversation. This process should be an integral part of the development of a state climate action plan. The University of Nebraska should continue to provide leadership for the continuation of this process.
- Participants recommended additional roundtables be organized that focus on sectors or topics such as youth, the business community, water, and insurance. A Youth Summit has already been planned for January 2016 to begin to address the concerns of this generation regarding actions necessary to prepare for future changes in climate.
- The University of Nebraska and other institutions of higher education in the state must play a prominent and active leadership role in the conduct of research in support of the identification and implementation of adaptation and mitigation actions, including policy alternatives to facilitate our response to climate change, and in building awareness of the implications of climate change on the state. These institutions should collaborate to enhance existing educational programs and develop new and innovated educational efforts. Nebraska Extension must also provide leadership in the dissemination of this information to diverse audiences across the state. The solution to the successful adoption of effective adaptation and mitigation measures in the face of a changing climate requires an interdisciplinary approach that engages all relevant and interested departments and units across the University of Nebraska system, as well as on other college campuses, public and private. Many universities in the Big Ten Conference and around the country have created research and educational centers or institutes that focus on the development of educational programs and building interdisciplinary research teams and networks to address fundamental questions associated with climate change. The University of Nebraska should investigate the efforts of other institutions and adapt these approaches to the specific needs of Nebraska. The University of Nebraska should consider investing in the establishment of a research and education center that focuses on climate change.
- The State of Nebraska should move forward immediately in the development of a climate action plan, engaging stakeholders throughout the process. The experiences of many other states that have already developed climate action plans should be integrated into this process in order to build on the lessons learned in these states. Given the expertise of the University of Nebraska and the leadership provided to date, it should be actively engaged in the development of a climate action plan and provide leadership for that process.



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