



CLIMATE SCIENCE RESEARCH IN THE UNITED STATES AND U.S. TERRITORIES:

SURVEY OF SCIENTIFIC PUBLICATIONS
FROM SELECTED PUBLIC UNIVERSITIES
(2014-2018)

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**Climate Science Research In the United States And U.S. Territories:
Survey of Scientific Publications From Selected Public Universities
(2014-2018)**

Written by the National Council for Science and the Environment

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EXECUTIVE SUMMARY

Emerging research on climate science has strong potential to inform local, state-based, and national-level climate policies. In every state, public universities invest in scholarship and education to advance fields such as climate modeling, climate impacts, adaptation, and more. Increasingly, climate science has been integrated into coursework on sustainability, energy, engineering, architecture, business, and even political science. This research has strong potential to inform local, state, and national-level climate policies. However, decision-makers often lack an understanding of the locally relevant research that is taking place right in their own states and districts. Mobilizing this science to inform decision-making can enhance resilience and help prepare for a future that is increasingly challenged by climate impact.

To meet this demand, in the spring and summer of 2019, the **National Council for Science and the Environment (NCSE)** conducted a rapid-paced landscape analysis of climate-related scientific research published within the past five years at selected public research institutions across the United States. The goal of this effort was to provide a rigorous and politically unbiased assessment of the scope and breadth of climate-related scientific research at selected public universities and to determine key themes and areas of focus in specific geographic areas.

NCSE's study used a well-recognized method of bibliometric analysis to identify **10,004 papers** published at the **80 public universities** between **2014-2018** that focus on climate-related science. The study identified research that constitutes climate-related science through keyword analysis of titles and abstracts of published journal articles through [Web of Science](#), a comprehensive platform that enables searches across 9,200 journals, encompassing 1.7 billion cited references from over 159 million records. This report represents a first effort at a longer inquiry by NCSE into climate-related science and education across the United States.



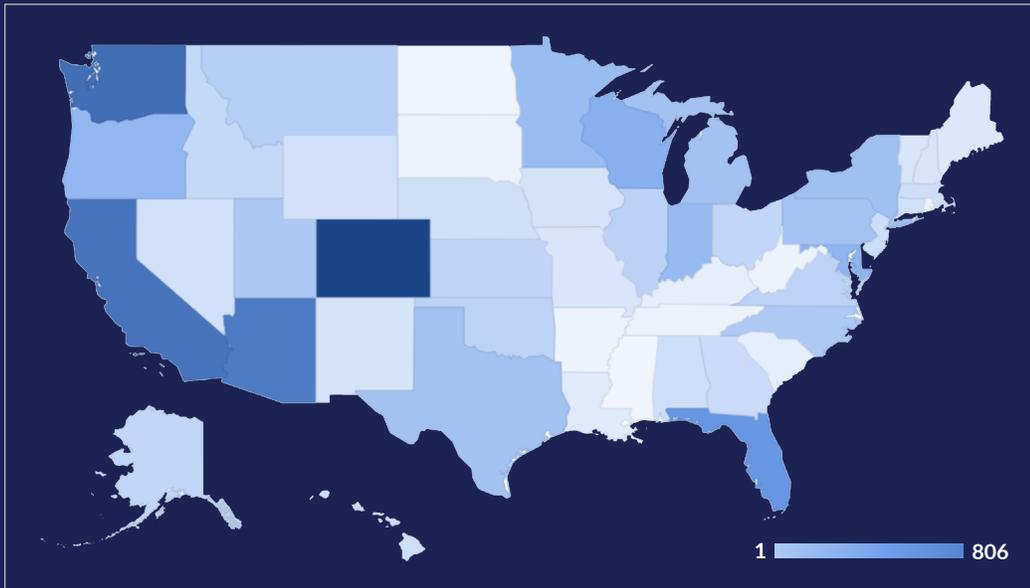


Figure 1: The map shows the distribution of climate science research papers in each state. The mean number of papers per state over the five-year period between 2014-2018 was 185.

NCSE's study generated four key findings:

1. At public universities in **each of the 50 states**, as well as the District of Columbia, Guam, the U.S. Virgin Islands, and Puerto Rico, scientific researchers have published climate-related science in the last 5 years (2014-2018), with a mean number of **185** peer-reviewed journal articles in each state.
2. **Regionally, scientists are studying locally relevant topics.** Within public universities in each state, researchers are studying topics that relate to that state's social, economic, and/or ecological systems.
3. **Climate science research increasingly focuses on impacts.** Keyword analysis reveals emerging topics that underscore emphasis on climate impacts such as drought and extreme heat, with a growing focus on adaptation strategies and resilience.
4. Universities **do not provide comprehensive and uniform access** to these resources through online repositories. University websites are highly variable in terms of the information they provide related to climate science research on campus. Some universities offer databases of climate experts, while others do not openly mention climate science as a field of study. Locally-produced research can help decision-makers respond to local climate-related issues and may invoke more trust with local constituencies, but ready access to this information by decision-makers remains a challenge.

NCSE's initial study provides a rigorous and unbiased assessment of the breadth of climate-related science research across the higher education complex. This work is intended to serve decision-makers today, and inform future policies that focus on adaptation and resilience by providing locally relevant insight. By showing the scope of climate science research, decision-makers will see trends related to climate-related science that transcend the politics and political leadership of a state to inform robust decisions for a more sustainable future.

INTRODUCTION

Over the past two decades, the rate of climate science research and education in the United States has grown exponentially.¹ In every state, public universities invest in scholarship and education to advance fields such as climate modeling, climate impacts, adaptation, and more. Increasingly, climate science has been integrated into coursework on sustainability, energy, engineering, architecture, business, and even political science. Emerging research has strong potential to inform local, state-based and national-level climate policies, but decision-makers lack a clear picture of the climate science research that is taking place at a state-by-state level, nor do they have the ability to connect science published in academic journals to inform solutions to regionally specific climate-induced challenges, such as drought, heat vulnerability, flooding, or wildfires.

Climate scientists are studying a wide diversity of topics. They are measuring carbon dioxide and other greenhouse gas emissions. They are studying carbon cycling and the impacts of a changing carbon cycle. They are studying the impacts of climate change on the nation's food security, crop yields, heat-stress, health impacts, soil erosion; on water resources, including water quality, balance, river basins, drought, precipitation, mountain snowpack; on impacts to critical infrastructure, such as sea level rise on coasts and on subtropical islands to the impact of permafrost thaw on subarctic rivers. Finally, researchers are also studying the social science of climate change, including changing attitudes, polarization, opinions, beliefs, and their impacts on framing in the media and on decision-making.

NCSE launched this study to understand to what extent each state in the United States is currently conducting research in climate-related science, and what focus that this work takes. Specifically, the goal of this analysis was to understand how public universities contribute to national, regional, and local knowledge of climate-related science. While this study finds great variation in volume and scope, we find that scientists at public institutions in **every** state and territory have published in climate-related science in the last five years (2014-2018). Furthermore, a closer examination of keywords from these publications reveals that research at these public institutions examines questions that are highly relevant on a local level, and that connect to a national and international body of climate-related science.

APPROACH AND METHODS

UNIVERSITY SELECTION

NCSE selected a subset of public universities to include in this report, relying on data from the [Carnegie Institute for Higher Education](#), which offers a widely recognized framework for describing institutional diversity in U.S. higher education. The study includes universities in each of the 50 states and U.S. territories that fall into either or both of the following categories: (1) the university is the largest (as of Fall 2017 enrollment) land-grant institution in their state and/or (2) the university has the highest enrollment (as of Fall 2017 enrollment) in the state, with the highest level research designation in that state. Additionally, this study includes universities affiliated with the state climatology office. For each state, the largest university that fits a category is included. For some states there is overlap; for example Louisiana State University is the state's largest land-grant institution, largest public, high-level research institution, and hosts the state climatology office. Other states have a separate institution for each category: University of Alabama, Tuscaloosa (the main campus) is Alabama's largest public, high-level research institution, Auburn University is the state's largest land-grant institution, and University of Alabama, Huntsville, hosts that state's climatology office.

NCSE chose to focus on land-grant universities based on their creation by statute in each state and rich tradition of researching and communicating locally relevant scientific information to stakeholders. The largest, highest-level public research institutions are included with the knowledge that state university systems vary widely, and the largest land-grant institution may have different focal areas than the largest and highest-level research institution. This study identifies the highest-level research institution because not every state or territory has a formally designated R1 university, as defined by the Carnegie Classification system.

Finally, this study includes universities affiliated with state climatology offices to ensure inadvertent omissions of obvious sources of state-specific climate research. While nearly all states have some version of a state climatology office, they are not all clearly affiliated with a university, and instead are sometimes hosted by a state Department of Natural Resources or similar Executive Branch body.

WEB OF SCIENCE SEARCHES

NCSE initially approached this effort by examining online repositories for climate-related research associated with each university (e.g. websites, faculty webpages, and university-based expert databases for journalists). However, it became quickly apparent that there was a high degree of variability between universities and most universities do not host obvious online repositories for climate-related work, focusing on climate change or otherwise. Additionally, climate-related research can span departments from computer science to biology to gender studies. Faculty who study complex climate-related problems often work in interdisciplinary teams that touch many parts of a given university. University websites often include a searchable database of experts available for contact via a landing page for journalists, and climate change is a searchable topic within these databases. However, these listings are not exhaustive for people contributing to climate-related science on that campus. Moreover, states show clear regional differences in the relative visibility of climate-related scientific research on university websites and faculty biographies.

For these reasons, NCSE identified that the most rigorous approach would be to identify peer-reviewed articles indexed to the university affiliation of the authors through [Web of Science](#), a widely recognized, publisher-independent global citation database, which contains over 1.7 billion cited references from over 159 million records.²

To efficiently understand current research in each state, NCSE searched for peer-reviewed articles indexed to the university affiliation of the authors. In addition to the topic and title searches, this study limits the results by (1) date: 2014-2018, (2) type: peer-reviewed article or review, and (3) university name, using the Web of Science “organization-enhanced” feature to narrow results to the main campus of the universities selected using the specific criteria outlined above.

CLIMATE-RELATED KEYWORD SEARCH QUERIES

The scope of this study intends to capture both climate science (e.g. meteorological or atmospheric science), as well as impacts of climate change on social, natural, and built systems (e.g. drought, heat vulnerability, flooding). Determining the appropriate search terms to capture both types of science requires a more nuanced approach.

NCSE’s analysis relied on established bibliometric methodology³ to establish a set of search terms intended to identify works of climate-related science. The intent of this study is not to limit results to either exclusively climate change work, or to the physical and atmospheric aspects of climate science. To make this distinction, NCSE’s study does not include the climate change synonyms, such as “greenhouse gas.” In order to ensure that an author would identify their research as climate-related, this study searches for titles that must include a variation on the word climate (by utilizing truncation in the search: *climat* to include terms like climatology, acclimate, climates, paleoclimate etc.)

Then we use the search terms that Haunschild identified as subtopics of climate change research, adding three terms that NCSE selected to reflect words that appear more in the context of climate impacts since 2016: resilience (*resilien*), management (manag*), and response (*respon*). Through trial runs with this protocol, we identified certain terms to exclude to avoid confounding results.

Below is a list of subtopics and keywords that were included in the analysis:

SUB-TOPIC	KEYWORDS
Adaptation	*adapt*, *manag*, *mitigat*, *resilien*, *respon*
Atmosphere	*aerosol*, *atmosph*, *cloud*, *storm*, *wind*
Biomass	*agricultur*, *biomass*, *food*, *forest*, *plant*, *soil*, *species*, *vegetat*
Climate Model	*calculate*, *certain*, *model*, *predict*, *simulat*
Continental Water	*flood*, *lake*, *precipitat*, *rainfall*, *river*
Ice and Snow	*frost*, *glacier*, *ice*, *snow*
Impacts	*effect*, *impact*
Ocean Currents	*el-nino*, *elnino*, *enso*, *nao*, *north atlantic oscillation*, *southern oscillation*, *Walker circulation*
Oceanic Water	*marin*, *ocean*, *sea*
Vulnerability	*risk*, *vulnerab*
NOT	safety climate, person-job, person-organization, employee attitudes, workplace satisfaction, worker satisfaction, organizational, campus climate, school climate, family climate, food service

Table 1: This table shows examples of the kinds of keywords that were included in the analysis. NCSE mirrored the research methodology of Haunschild, et. al. 2016, but added several custom keywords to capture a focus on adaptation and impacts (e.g. management and resilience).

KEYWORD ANALYSIS

To analyze the results from the Web of Science search, NCSE used [VOSviewer](#)⁴, a free software tool available for analysis and visualization of text data, and constructing and visualizing bibliometric networks. The program finds author- and Web of Science-assigned keywords, tallies occurrences, and calculates a link strength based on the number of times each keyword occurs with other keywords. To analyze the results from the Web of Science search, NCSE used [VOSviewer](#)⁵, a free software tool available for analysis and visualization of text data, and constructing and visualizing bibliometric networks. The program finds author- and Web of Science-assigned keywords, tallies occurrences, and calculates a link strength based on the number of times each keyword occurs with other keywords. For this analysis, we use this ranking in three steps.

First, this study analyzes keywords for each region as identified by the Fourth National Climate Assessment (NCA4).⁶ Cross-referencing keywords based on NCA4 enables grouping focused on climatic and climate impact similarity. Additionally, this benchmarking allows for comparison of the issues identified in the Fourth National Climate Assessment to the quantity and scope of the research being done in the areas impacted by those regionally specific issues.

For each regional dataset, comprised of the results from universities in that region, we exported the most frequently occurring keywords, capping the results at the 150 words most with the highest “link strength” as calculated by VOSviewer. Because of the variation in number of papers returned for a region, the minimum number of times a keyword needed to occur in order to be considered for the calculation was different, but generally was set at three occurrences.

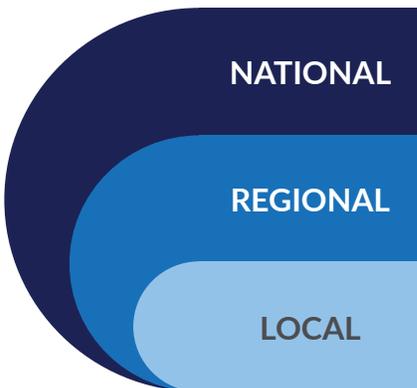
Then regional data were compiled into one list, in order to determine which keywords were found frequently in at least half of the regions, as a proxy for nationally-relevant terms, such as “precipitation” and terms that are common to the research but not particularly indicative of trends, such as “model”. This list of words that occur in at least half of the regions comprises what this study considers as the national-level data.

Finally, we used VOSviewer to analyze data for each state and territory by combining the results from the selected universities in that state or territory. To include more specific terms, we lowered the occurrence threshold for each state or territory dataset until at least 50 keywords were returned. For some regions, like the Pacific and Caribbean, this meant that some keywords only needed to occur once to be included. For some states like California, a minimum of three occurrences yielded greater than 150 keywords. In this case, the top 150 keywords were exported based on the VOSviewer link strength algorithm. In effect, this study examines between 50 and 150 of the most relevant keywords from each state’s climate-related science papers from the

last five years to examine the scope of research.

From these 50-150 keywords, many terms will also be represented in the region-specific and national-level data, because those datasets are comprised of the same results, but on different geographic scales.

In order to better understand local and regional specificity, we sort the keywords for each state and compare them to their presence or absence on the regional and national lists. Thus, the most locally specific words would not occur on the regional or national level, and words that occur in a state and regional dataset but not on the national level may indicate research on a regionally-relevant topic. From this comparison, this study presents the top keywords in the national and regional categories for each state, as well as the local-only keywords that speak to the topical scope of research at each state's public institutions.



NATIONAL	Keyword occurs in 5 or more regions (out of 10) indicates national relevance or broad climate-science relevance
REGIONAL	Keyword occurs in state and region data, but in 3 or fewer other regions (out of 10) indicates regionally significant topic
LOCAL	Keyword occurs in the state data indicates a particular focus of researcher/s at that institution, may indicate a topic of local-scale significance

Figure 2: To tease out locally and regionally specific keywords, this study presents the top keywords in national and regional categories for each state, as well as local-only keywords. This gives an indication of the topical scope of research in each state's public institutions. See also state-specific one-pagers in Appendix II.

RESULTS AND ANALYSIS

NCSE's analysis identified **10,004** papers published at the 80 public universities between 2014-2018. In 52 of the 54 states and territories "climate change" is the most frequently occurring keyword in the search.⁷ The volume of research (in the 5-year period) produced ranged from **1** article at the University of the District of Columbia to **806** in Colorado, from Colorado State University, Fort Collins and the University of Colorado Boulder. The mean number of articles or reviews published in a state at the selected universities is 185. The analysis found the most papers at universities in the Southwest region, with 2436 across the region. On the other end, the U.S. Caribbean published the fewest climate-related papers between 2014-2018.

	NUMBER OF UNIVERSITIES	SUM OF RESULTS IN REGION
Alaska	1	170
Hawai'i and U.S. Affiliated Pacific Islands	2	144
Midwest	10	1736
Northeast	13	1655
North Great Plains	7	562
Northwest	5	1086
Southeast	22	1562
Southern Great Plains	5	615
Southwest	12	2436
U.S. Caribbean	3	41
Total	80	10004

Table 2: This table shows the number of papers by region from 2014-2018, as cross-referenced to the regions of the Fourth National Climate Assessment. See regional summaries in Appendix I for more detail.

NCSE's analysis identified 13 keywords as present among the most relevant 150 words in all 10 regions. In general, these terms refer to broad topical areas and, notably, are not all the same as the keywords used in our retrieval process.

State-specific information reflects the papers returned for all selected schools in that state (see Appendix 1 for detailed state-by-state analysis). We filtered results for each university in Microsoft Excel, and hand-sorted results that might be off-topic. Of those filtered results, anything not clearly related to climate science is not included in the analysis. Because the goal of the study is to understand the full scope of recent climate-related science, the study erred toward inclusion of additional articles when developing search terms, filtering for possibly irrelevant articles, and choosing which articles to remove from the dataset.

Significantly, we find that the thematic areas that scientists are studying match locally and regionally significant problems. This underscores this study's key finding that scientific research serves as a valuable resource for decision-makers seeking to address the impacts of climate change in their areas of jurisdiction. In Appendix 1, we analyze in more depth the results of the state-by-state keyword results according to the regions identified by the National Climate Assessment. This provides a more detailed assessment of the extent to which public universities are researching locally relevant issues with respect to climate change and climate change impacts.

KEYWORD	OCCURRENCES
<i>carbon</i>	222
<i>ecosystem</i>	251
<i>biodiversity</i>	274
<i>vegetation</i>	300
<i>vulnerability</i>	317
<i>responses</i>	365
<i>trends</i>	366
<i>dynamics</i>	370
<i>precipitation</i>	807
<i>variability</i>	895
<i>model</i>	1056
<i>temperature</i>	1138
<i>climate change</i>	2430

Table 3: This table shows the top occurring keywords in study. Additional analysis draws out local and regionally significant areas of study.

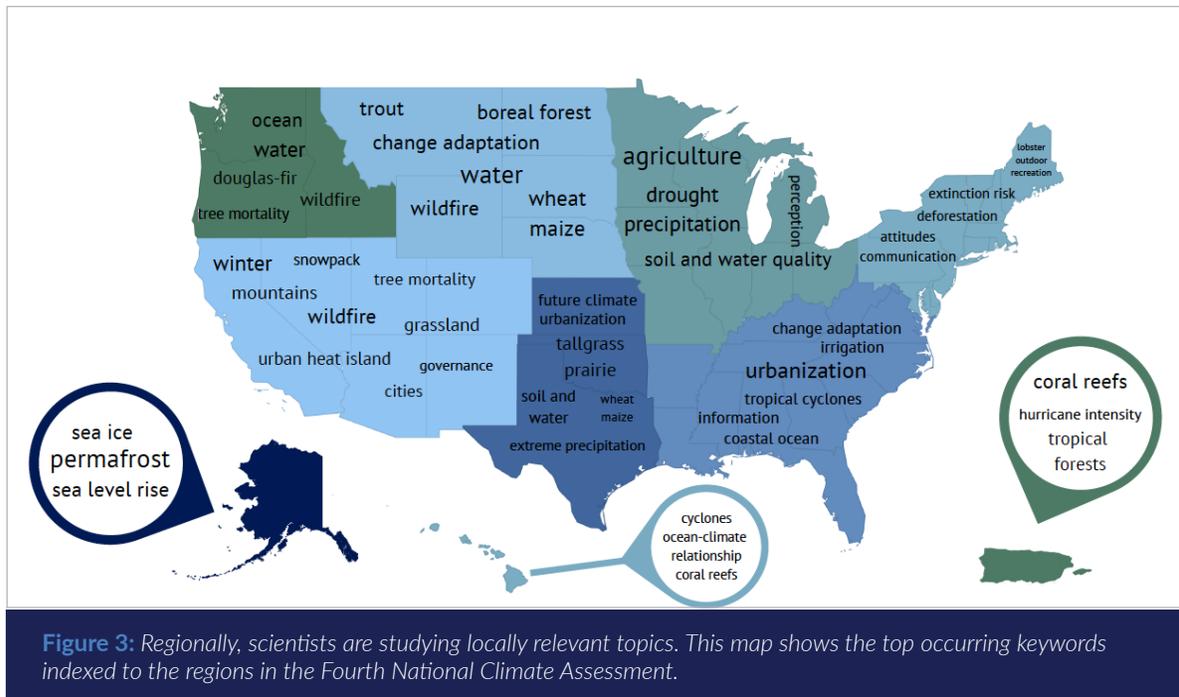


Figure 3: Regionally, scientists are studying locally relevant topics. This map shows the top occurring keywords indexed to the regions in the Fourth National Climate Assessment.

Using the mapping feature in VOSViewer, this effort also explored how keywords relate to each other. VOSViewer calculates a link strength score, represented in the weight of a line and represents the number of occurrences of a word, with the size of its node in relation to other keywords. Additionally, VOSViewer uses an algorithm to cluster words into topical areas. Cluster mapping helps reveal the relationship between different terms and can be used to show the emergence of different keywords over time, showing how the emphasis of research evolves over time.

Significantly, we find that **the emphasis of climate science research is changing over time**. Over the past five years, scientists have begun emphasizing studies that focus on climate impacts in addition to more fundamental climate science. The examples below shows how cluster analysis can show both the relation between keywords and the emergence of different keyword prevalence over time.

REGIONAL ANALYSES BASED ON FOURTH NATIONAL CLIMATE ASSESSMENT REGIONS

In the sections that follow, NCSE examines the results of the state-by-state keyword results according to the regions identified by the Fourth National Climate Assessment (NCA4). The goal of this analysis is to assess the extent to which public universities are researching locally relevant issues with respect to climate change and climate change impacts.

The NCA regions include: **Northeast, Southeast, U.S. Caribbean, Midwest, Northern Great Plains, Southern Great Plains, Northwest, Southwest, Alaska, and Hawai'i and U.S.-Affiliated Pacific Islands.**

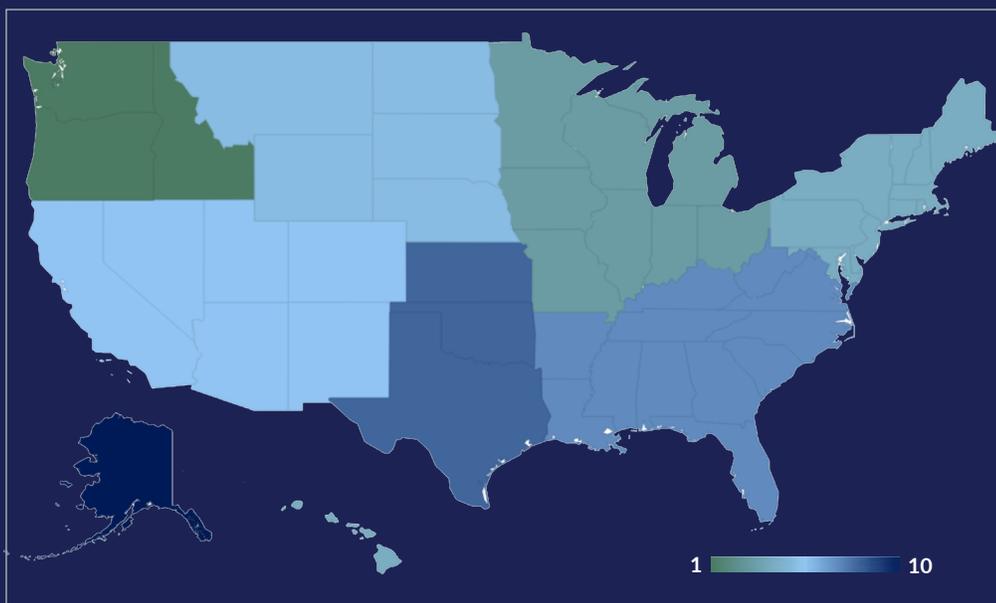


Figure 5: This map shows the breakdown of regions based on the Fourth National Climate Assessment (NCA4). NCSE indexed regionally findings against the regions as delineated by NCA4.

NORTHEAST

The Northeast region includes Connecticut, Delaware, the District of Columbia, Maryland, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. This region includes large cities, coastline, and agricultural areas.

NCSE's study incorporates data published at 13 Northeast public universities. Using search terms described above, the search returned **1685** total climate-related papers (peer-reviewed articles and reviews) published at these five universities between 2014-2018.

Following “climate change”, the most frequently occurring keyword in papers published in the Northeast is “impact” (196 occurrences). This indicates that a large proportion of climate-related research in the Northeast focuses on climate impacts. Viewing a map of co-occurring keywords in Northeast papers, impact connects across a broad range of topics, suggesting that **researchers are studying impacts in the context of human and natural dimensions and their intersections.** “Impact” connects with land use, water, and runoff. Their matching color on the map indicates they are clustered together, suggesting that one area of study for climate-related researchers in the Northeast covers the relationship between land use and water quality. An additional cluster (shown in gray) centers around biodiversity and species distribution, suggesting that research focuses on how climate impacts the ranges and abundance of species. Notably, “phenology”, the study of the seasonal patterns of plants, e.g. spring flowering time, occurs in this cluster. The Fourth National Climate Assessment (NCA4) highlights the significance of changing seasonality in the Northeast, as milder winters and earlier springs have negative impacts on tourism, farming, and forestry, which the Northeast is already experiencing.⁸

NCA4 also references deforestation as a major concern for the Northeast. Publications over the last 5 years in the Northeast include the keyword “deforestation” 14 times, “forest management” 11 times, and “forest” 50 times. Recent climate-related science at public universities in the Northeast focuses on forests, as indicated by focus in this area by the Northeast Climate Science Center and the University of Massachusetts at Amherst.

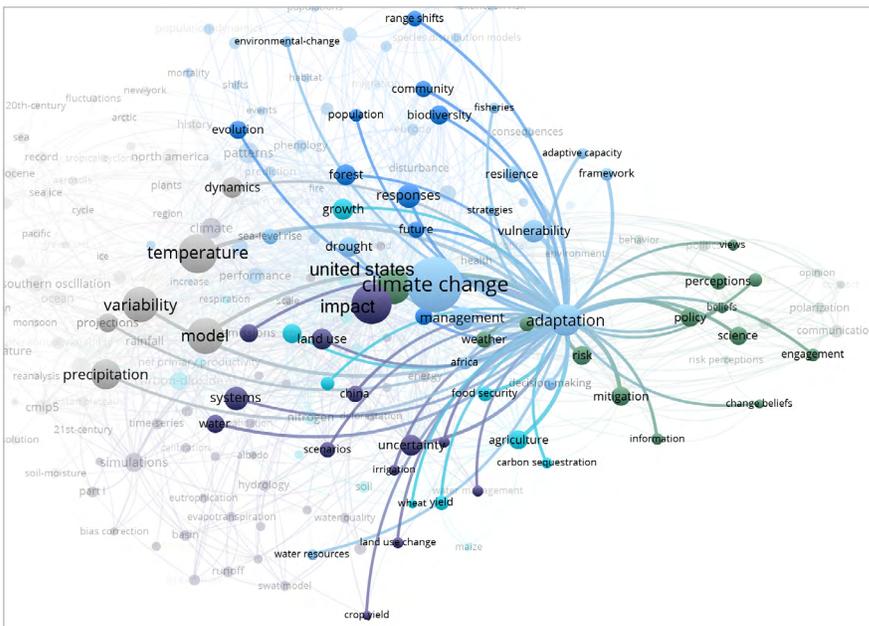


Figure 8: “Adaptation” is another significant keyword in the Northeast, one that connects with all other topical clusters in the region.

mitigation, adaptation, policy, and knowledge. **Climate-related research in the Northeast includes decision-making in relation to environmental conditions, science, and resilience.**

Another significant keyword for the Northeast is “adaptation”. When mapped based on co-occurrences, adaptation connects with all of the topical clusters for the Northeast: communication and policy (green); agriculture and food security (aqua blue); land use, water, and impacts (purple); biodiversity and responses (dark blue); and resilience and management (light blue). **In the Northeast, climate-related science includes attention to adaptation to environmental changes including temperature, precipitation, drought, and land use change, by ecosystems, species, social systems, and humans.⁹**

NORTHEAST

STATE	NUMBER OF PAPERS	UNIVERSITIES	KEYWORDS
Connecticut	128	University of Connecticut, Storrs	<i>climate change adaptation, regional climate modeling, agriculture, infectious diseases</i>
District of Columbia	1	University of the District of Columbia, Washington	<i>Urban, tree, environmental filter</i>
Delaware	48	University of Delaware, Newark	<i>Coastal ocean, carbon export, newspaper coverage, renewable energy, urban heat island</i>
Maine	103	University of Maine, Orono	<i>National parks, outdoor recreation, climate modeling</i>
Massachusetts	137	University of Massachusetts-Amherst, Amherst	<i>Hydropower, future changes, water resources, change impacts, community, water management, decision-making</i>
Maryland	314	University of Maryland-College Park, College Park	<i>Food, air quality, boreal forests, climate data, remote sensing</i>
New Hampshire	122	University of New Hampshire, Durham	<i>Environmental concern, environmental views, forests, carbon</i>
New Jersey	144	Rutgers University, New Brunswick	<i>Fisheries, framing, engagement, deforestation, extreme events</i>
New York	273	-Cornell University, Ithaca -University at Buffalo, Buffalo	<i>Risk perception, communication, farmers, extinction risk, agriculture</i>
Pennsylvania	251	Pennsylvania State University, University Park	<i>Infrastructure, population mobility, gender, farmers, urbanization, decision-making</i>
Rhode Island	57	University of Rhode Island, Kingston	<i>Ocean acidification, seaports, river discharge, tropical cyclones, climate, adaptation, disease</i>
Vermont	107	University of Vermont, Burlington	<i>Forest management, adaptation, change beliefs, carbon sequestration, water quality</i>

To understand the human dimension of agriculture, we identify that the term “farmers” occurs 15 times in the Midwest region, which is the only region where “farmers” appears at the regional scale. Scientists studying farmers in the Midwest are studying them in association with mitigation, drought, United States, adaptation, and climate change.

The Fourth National Climate Assessment (NCA4) lists changes to agriculture in its key findings for the Midwest, noting that the Midwest produces a majority of food and animal feed. Without technological advances, we can anticipate a decline in agricultural productivity if extreme temperatures continue to rise and precipitation events continue to change in intensity and frequency.¹⁰

Of the keywords that occurred most frequently within the Midwest region but occurred in less than half of all of the regions, “quality” is the number one keyword—“quality” occurred 33 times in papers from the Midwest, thereby accounting for nearly half of the 77 total occurrences across the dataset. **When climate-related scientists in the Midwest write about quality, they write about soil and water quality, alongside SWAT models (Soil and Water Assessment Tool), impacts, adaptation, management, and climate change.**

KEYWORD	OCCURRENCES
<i>agriculture</i>	51
<i>food security</i>	33
<i>swat model</i>	31
<i>land use change</i>	29
<i>maize</i>	27
<i>farmers</i>	15
<i>Agricultural references</i>	186

Urbanization appears as a region-scale keyword in four total regions, including the Midwest. **In the Midwest, when climate-related scientists focus on urbanization, it is alongside land cover, Soil and Water Assessment Tool modeling, precipitation, change impacts, and climate change.** Closely related keywords include runoff, Great Lakes, hydrology, and streamflow, indicating that researchers are focused on how urbanization may impact water resources and quality in the Midwest. This aligns with predictions in NCA4 that a combination of stressors including increasing temperatures and land-use change could threaten natural resources such as the Great Lakes and the ecosystem services they provide, such as clean drinking water, flood control, and recreational opportunities.¹¹

MIDWEST			
STATE	NUMBER OF PAPERS	UNIVERSITIES	KEYWORDS
Illinois	188	University of Illinois, Urbana-Champaign	<i>Genetic diversity, precipitation extremes, wind, tree populations, buildings, CO2 emissions</i>
Indiana	289	- Indiana University-Bloomington, Bloomington - Purdue University, West Lafayette	<i>Yield, production, models, maize, corn; farmers, soil erosion, sediment, biofuels, plant growth, climate sensitivity; grassland</i>
Iowa	117	Iowa State University, Ames	<i>Decision-making, beliefs, communication, information, engagement, education; corn, maize, tallgrass prairie, switchgrass, soybean, land use</i>
Michigan	254	- Michigan State University, East Lansing - University of Michigan, Ann Arbor	<i>Communication, public opinion, risk perception, heat-stress, snow, switchgrass, wetlands, extinction risk, fish</i>
Minnesota	281	University of Minnesota, Twin Cities	<i>Caves (speleothem, stalagmite), tree ring analysis (dendrochronology), paleoclimate record; photosynthesis, ecosystem services; U.S. migration</i>
Missouri	109	University of Missouri, Columbia	<i>Spring maize, smallmouth bass, crop yields, fresh-water fishes; landscape models, habitat models</i>
Ohio	170	The Ohio State University, Columbus	<i>Wetlands, forest management, corn, wildfire, wheat; carbon sequestration; beliefs, opinion, future consequences, self control</i>
Wisconsin	328	University of Wisconsin, Madison	<i>Ice cover, permafrost, snow, boreal forest, tree mortality, habitat loss</i>

Examining the keywords that occurred most frequently in papers published during 2014-2018 at the five Northwest universities selected makes clear that public universities in the Northwest focus on some of the issues highlighted by the NCA4, and other issues highly relevant to the people and ecosystems of the Northwest. Looking at a map of keywords found most often in the Northwest, we can highlight the regionally specific term “pacific northwest” and highlight all co-occurring keywords (Figure 10). We see that in the Northwest, researchers are studying forests, wildfires, drought, and Douglas-fir—a key tree species in Pacific Northwest forests both for the economy and the ecosystem. These topics align with the NCA4 Key Messages 1 and 3. Researchers are also studying water issues, evidenced by the terms “hydrology”, “river-basin”, “streamflow”, “water resources”, and “water temperature”. Again, this aligns directly with what the Fourth National Climate Assessment identified as essential to predicting and understanding the impacts of climate in the Northwest.

One area of study less apparent in the keyword analysis but noted multiple times in the NCA4 is the expected impacts to indigenous and underserved communities and individual health. Further research is warranted into the scope and volume of the social dimension of climate-related research. We can see that the keyword “vulnerability”,

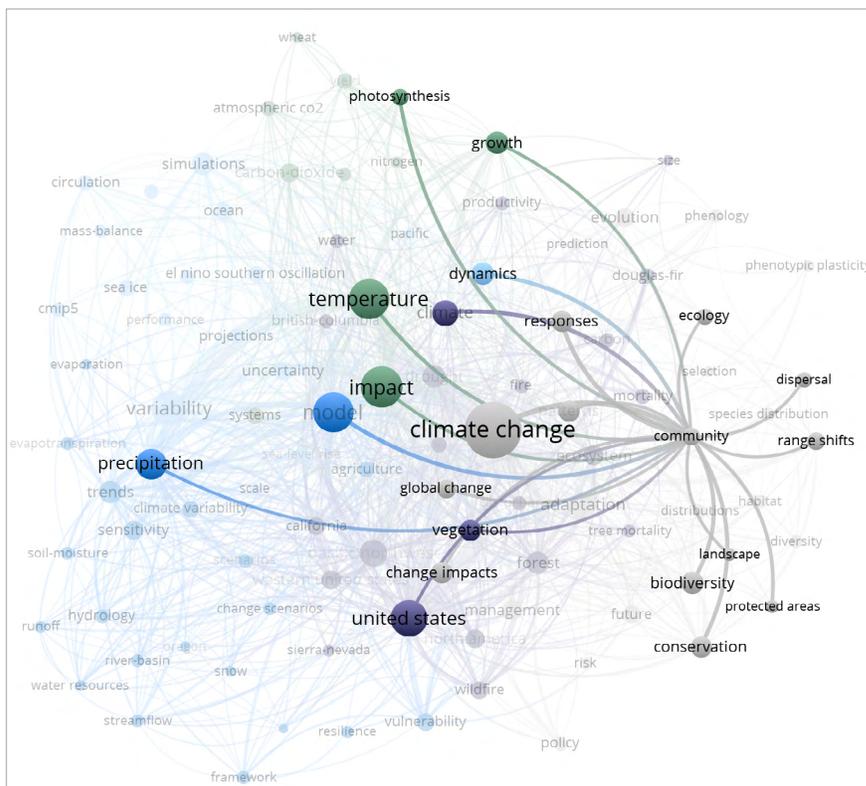


Figure 11: Research on the social dimensions of climate change impact is an emerging area of focus, according to the NCA4. Though most of the keyword analysis indicates a research focus on ecological communities, research on climate change impacts in human, especially indigenous communities, is an area to watch.

“change impacts”, and “health” appear in the list of the most relevant keywords for the Northwest. However these keywords can refer to ecological as well as human communities. Notably, looking at a map of Northwest keywords and highlighting “community” we see that it is linked largely with ecosystem-focused words (Figure 11).

NORTHWEST			
STATE	NUMBER OF PAPERS	UNIVERSITIES	KEYWORDS
Idaho	164	- University of Idaho, Moscow - Boise State University, Boise	<i>Burned area, bark and pine beetles, fire severity; Greater Yellowstone Ecosystem, declining mountain snowpack</i>
Oregon	300	Oregon State University, Corvallis	<i>Mountain snowpack and declining mountain snowpack; coral reefs, silviculture, lodgepole pine, Douglas-fir, swiss pine cast; deglaciation</i>
Washington	622	- University of Washington, Seattle - Washington State University, Pullman	<i>Fisheries, Columbia River Basin; tree mortality, wildfire; cropping systems; behavioral implications</i>

NORTHERN GREAT PLAINS

The Northern Great Plains region includes Montana, North Dakota, South Dakota, and Wyoming.

Our study incorporates data from 7 public universities in the Northern Great Plains region. Using specified search terms (see detailed methodology in Appendix 2), this study found **562** papers (peer-reviewed articles or reviews) published between 2014-2018 by researchers at these seven universities.

Because of the range in the number of papers across the universities, words from Montana, Nebraska, and Wyoming are more represented than words from the Dakotas. There are only 8 keywords shared across all 5 states: climate change, united states, temperature, precipitation, impact, model, and climate. Papers from Montana and Wyoming refer to Yellowstone National Park and its ecosystem, while papers from North and South Dakota refer to the Prairie Pothole Region. Though “agriculture” occurs 5 times in papers published at Montana institutions, it does not occur in papers from Wyoming, and, wheat, maize, and corn only make the list of most relevant keywords in Nebraska and the Dakotas. Words referencing the sagebrush ecosystem and salmon and trout occur frequently enough to make the list of most relevant words for the region, however they only appear in papers from Wyoming and Montana. Climate-related science takes on different foci within states in the Northern Great Plains. **This work suggests that within each state there is recent climate-related research at public institutions on topics that are highly relevant on a state level—whether that be corn, prairie, or a national park in that state.**

In the Northern Great Plains, water resources are a significant area of climate-related study, evidenced by the appearance of terms ranging from ecohydrology to groundwater recharge. Water resources in the region are central to species conservation, agriculture, recreation and tourism, and indigenous communities. When mapped, water use efficiency occurs in a cluster with words related to ecosystem gas and nutrient exchange, and is strongly linked with stomatal conductance, forest, drought, climate change, and elevated CO₂. This suggests that water research includes understanding the relationship between a changing environment and water in a forest ecosystem.

CARIBBEAN

The Caribbean region includes Puerto Rico and the US Virgin Islands. This region is characterized by its biodiverse islands in the Caribbean Sea with rich cultural heritage.¹⁶

Our study incorporates data published at three Caribbean public universities: University of Puerto Rico, Mayagüez, University of Puerto Rico, Rio Piedras, and University of the Virgin Islands. Using our search terms (see detailed methodology in Appendix 2), we found **41** total climate-related papers (peer-reviewed articles and reviews) published at these three universities between 2014-2018.

Because we returned comparatively few papers for the Caribbean region it is more difficult to see connections across papers that signal a broad trend in research. Tallying the number of times a given keyword occurs does not speak as clearly to granular trends. Instead we look to what keywords we see in general and, when mapped, what clusters of keywords can tell us about areas of study for researchers in the Caribbean.

Researchers in the Caribbean are studying topics relevant to the people and ecosystems of the Caribbean, especially changes to the ocean, tropical forests, and coral reefs.

As is true for all other regions, climate change is the most frequently occurring keyword for the last 5 years of climate-related research papers in the Caribbean. Behind climate change, we see other nationally-relevant trends that are also highly relevant to the U.S. Caribbean. Temperature, El Niño Southern Oscillation, ocean, rainfall, sea surface temperature, sea-level rise, agriculture and drought are some of the keywords that refer to topics underscored in the Fourth National Climate Assessment (NCA4) as significant in the Caribbean. The U.S. Caribbean can expect average rainfall to decline, with extreme rainfall events becoming more common. The combination of these can increase flooding hazards and, especially when combined with saltwater intrusion from sea level rise, can decrease freshwater availability.

Coral reefs are an important resource for tropical islands because they support fisheries and tourism activities, and they act as a barrier that can mitigate the impact of coastal storms. In the keyword analysis for the Caribbean we see that researchers are studying the stressors of coral reef ecosystems—ocean acidification caused by high levels

of atmospheric carbon and increased sea surface temperatures.¹⁷ Researchers are studying the relationship between coral reef mortality and hurricane intensity as well as coral diseases, coral bleaching, and potential impacts. Figure 17 and Figure 18 show the network of terms for “reef” and “coral reefs”, respectively.

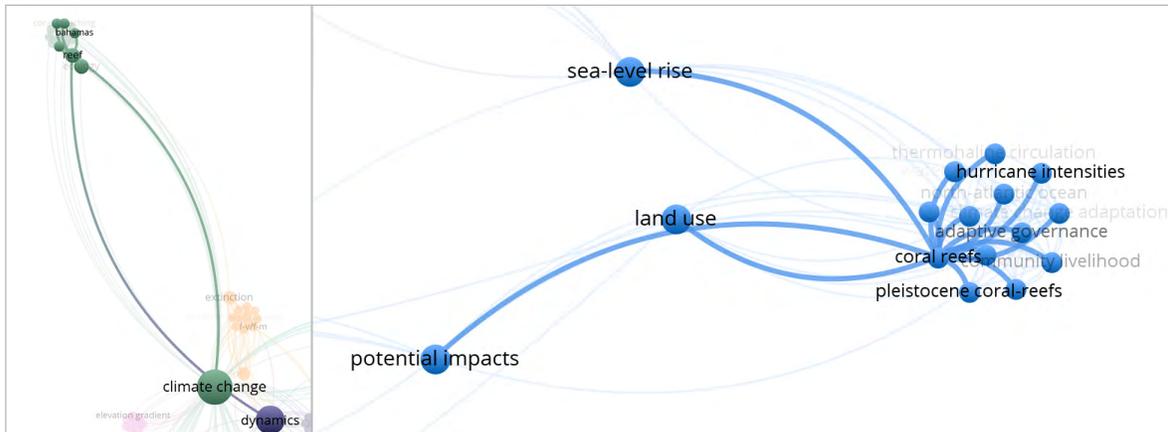


Figure 17 & 18: Keyword analysis of the link between coral reefs and climate impacts highlights a potential challenge for decision-makers trying to access locally relevant research. In this case, two papers that both focus on coral reefs do not appear as linked in the analysis, due to a lack of standardized keywords (e.g. “reef” v. “coral reef”).

Looking at these two figures, we know that reef refers to coral reefs, yet the two papers are not directly connected in the network map. A lack of standardized keywords could present a challenge for policy- and decision-makers with limited science capacity attempting to access locally-relevant research about topics like coral reefs.

Tropical forests are also a topic of interest for climate-related research in the U.S. Caribbean. In our analysis we see 11 occurrences of forest-related keywords. Viewing a keyword network map, we see that “tropical forests” is tied to keywords like “biomass”, “carbon”, “biodiversity”, and “responses” (Figure 19). This indicates that climate-related research on tropical forests at public institutions in the U.S. Caribbean focuses on the carbon dynamics of those forests, as well as the organisms in those ecosystems. The Amazon region is also highlighted as being connected to tropical forests, indicating that researchers publishing at universities in the U.S. Caribbean are either using or collecting data on ecosystems in other tropical regions. In fact, “Africa” occurs as a keyword 4 times compared with “Puerto Rico” which occurs 5 times and “U.S. Virgin Islands” which occurs once.

Selected analysis of keyword clusters aligns with the key messages from the NCA4 that relate to drought, challenges in water management, extreme heat, drought, and tree mortality.

Water resources emerges as Key Message 1 in NCA4, underscoring the challenges associated with intensifying droughts, flooding, deteriorating infrastructure, groundwater depletion, and an increasing demand for water from a growing population. The keyword clusters below (Figures 21 and 22) illustrates the complexity of precipitation in relation to climate change in the Southwest region. Variable precipitation combined with increasing temperatures links directly to increasing vulnerability for people living in the Southwest region. The continued availability of water will undeniably remain a driving force for climate adaptation in the Southwest. **A key focus of scientific research in the Southwest region focuses on the impacts to people and ecosystems from heat, drought, wildfires, and flooding.**

Clear and direct linkages between tree mortality, drought, and climate change emerge from the keyword analysis. **Scientists in the Southwest region are studying tree mortality and working to understand the linkages between tree mortality and climate change.** Though concerns about the impact of climate change on agriculture and links to wildfire damage, the emphasis on tree mortality that has emerged from our analysis of scientific research does not appear as strongly in NCA4. Therefore, this may reflect a leading edge, both for scientific research and application of research for decision-making.

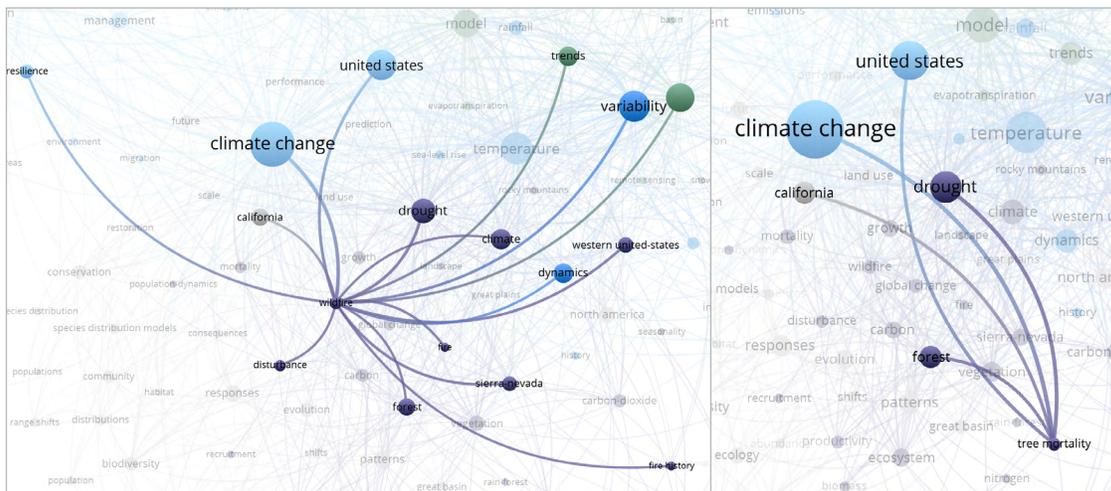


Figure 21 & 22: Wildfire and tree mortality emerge as leading areas of research in association with climate impacts in the Southwest region.

SOUTHWEST

STATE	NUMBER OF PAPERS	UNIVERSITIES	KEYWORDS
Arizona	563	- Arizona State University-Tempe, Tempe - University of Arizona, Tucson	<i>urban heat-island, thermal comfort, changing climate, climate change adaptation, heat, mountains, fire history, tree mortality, great basin, precipitation, drought</i>
California	593	- University of California-Berkeley, Berkeley - University of California-Los Angeles, Los Angeles	<i>greenhouse-gas emissions, mediterranean climate, future changes, atmospheric rivers, yosemite-national-park, water-balance, rainfall variability, climate extremes, snowpack, extreme precipitation, sierra-nevada, wildfire, tree mortality</i>
Colorado	806	- Colorado State University-Fort Collins, Fort Collins - University of Colorado Boulder, Boulder	<i>tallgrass prairie, ponderosa pine, rocky mountains, irrigation, climate extremes, tree growth, wildfire, drought</i>
Nevada	131	- University of Nevada, Reno - University of Nevada, Las Vegas	<i>winter precipitation, mojave desert, restoration, eutrophication, climatic water deficit, complex terrain, sagebrush</i>
New Mexico	115	- New Mexico State University, Las Cruces - University of New Mexico, Albuquerque	<i>speleothem, mixed-conifer forests, irrigation, stand-replacing fire, yellowstone-national-park, cave, stalagmite</i>
Utah	228	- Utah State University, Logan - University of Utah, Salt Lake City	<i>pollen, charcoal, american pika, survival, oxygen, greater sage-grouse, polarization</i>

SOUTHEAST

STATE	NUMBER OF PAPERS	UNIVERSITIES	KEYWORDS
Alabama	140	- Auburn University, Auburn - The University of Alabama, Tuscaloosa - University of Alabama in Huntsville, Huntsville	<i>groundwater, southern united-states, aquaculture, atlantic multidecadal oscillation, baseflow, coastal ocean, southern appalachian mountains</i>
Arkansas	51	University of Arkansas, Fayetteville	<i>dendrochronology, mountains, potential evapotranspiration, tree rings, thermal habitat</i>
Florida	434	- Florida State University, Tallahassee - University of Central Florida, Orlando - University of Florida, Gainesville	<i>heat stress, crop modeling, climate impacts, drought tolerance, rainfall availability, Everglades, cyanobacteria</i>
Georgia	150	University of Georgia Athens	<i>stalagmite, speleothems, social vulnerability, networks, water temperature, bull trout, ocean acidification</i>
Kentucky	70	- University of Kentucky, Lexington - Western Kentucky University, Bowling Green	<i>geographic adaptation, nitrogen deposition, induced range contraction, plecoptera, seasonality</i>
Louisiana	89	Louisiana State University and Agricultural & Mechanical College, Baton Rouge	<i>Gulf of Mexico, Mississippi River Delta, coastal wetlands, erosion, pollen, organic carbon, land-cover change</i>
Mississippi	42	- Mississippi State University, Mississippi State - University of Mississippi, Oxford	<i>greenhouse-gas emissions, dengue, fever, aegypti, rice, watershed, malaria</i>
North Carolina	223	North Carolina State University at Raleigh	<i>atmospheric chemistry, air-quality, climate data record, forest management, flowering phenology, skepticism</i>
South Carolina	72	- Clemson University, Clemson - University of South Carolina-Columbia, Columbia	<i>coastal, forecasts, warming, energy budget, invasive species</i>
Tennessee	54	- Tennessee State University, Nashville - The University of Tennessee-Knoxville, Knoxville	<i>community structure, public health, food webs, tree rings, fire history, household food security, tornado</i>
Virginia	186	- University of Virginia-Main Campus, Charlottesville - Virginia Polytechnic Institute and State University, Blacksburg	<i>river, phosphorus, transport, tree mortality, eutrophication</i>
West Virginia	51	- Marshall University, Huntington - West Virginia University, Morgantown	<i>river discharge, tree growth, cholera, infectious disease, lodgepole pine</i>

may affect its key function of storing carbon (carbon sequestration), which further reduces its function.

Scientists in the Southern Great Plains are studying climate impacts on food systems, sea level rise, as well as impacts to unique ecosystems in this region, such as the tall grass prairie in Oklahoma.

Studies also highlight impacts of severe weather and extreme weather events and their linkages to impacts such as harmful algal blooms. Overall, this region is vulnerable in diverse ways and the effort of university research in this region reflects this diversity.

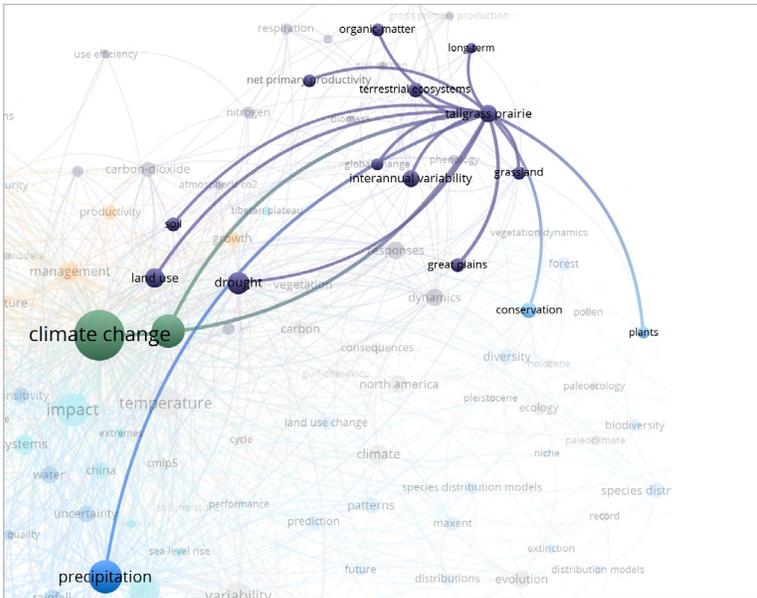


Figure 27: Tall grass prairie is a unique ecosystem in the Southern Great Plains and significant for carbon sequestration. Research in this region focuses on specific climate impacts to tall-grass prairie systems.

SOUTHERN GREAT PLAINS			
STATE	NUMBER OF PAPERS	UNIVERSITIES	KEYWORDS
Kentucky	173	- Kansas State University, Manhattan - University of Kansas, Lawrence	<i>speciation, pollen, transmission, plain, bighorn basin, tolerance, arabidopsis-thaliana, rice</i>
Oklahoma	183	- Oklahoma State University- Main Campus, Stillwater - University of Oklahoma- Norman Campus, Norman	<i>deciduous forest, temperate steppe, switchgrass, tallgrass prairie, grassland, great plains, supercell</i>
Texas	256	Texas A&M University-College Station, College Station	<i>climate change adaptation, river-basin, cover change, precipitation extremes, us agriculture, flood frequency, water quality, extreme precipitation, irrigation</i>

HAWAI'I AND GUAM

The Pacific region includes Hawai'i and U.S-Affiliated Pacific Islands, including Guam. This region includes a vast ocean territory and more than 2,000 islands that vary in elevation. The region supports globally important marine and terrestrial biodiversity, as well as tremendous cultural diversity (over 20 indigenous languages are spoken). The islands support diverse livelihoods, including tourism, fishing, agriculture, military jobs, and industry.²¹

Our study incorporates data published at two of Region public universities. Using our search terms (see detailed methodology in Appendix 2), we found **144** total climate-related papers (peer-reviewed articles and reviews) published at these two universities between 2014-2018.

The NCA4 highlights several key threats to the Pacific region from climate change. Core among these are rising sea levels, rising temperatures, and increased risk of extreme drought or flooding.

Scientific research in the Pacific region focuses on both atmospheric drivers of climate change as well as impacts to ecosystem services, such as biodiversity and fisheries. To this end, our analysis identifies studies that focus on keywords such as atmospheric circulation, sea surface temperature, and ocean-climate interactions, but also studies that focus on coral reefs, rainforest, fisheries, and sea-level rise. Of particular note (highlighted in the cluster analysis below), is the **connection between coral reefs, climate change impact, food security, and economic production (e.g. tourism).**

The NCA4 highlights the impacts of climate change on indigenous communities, including threats of rising sea levels, diminishing water availability, and threats to the transmission and protection of traditional knowledge and practices. This analysis did not uncover a lot of papers focused in this area, but anticipate that it will be an area of future research need.

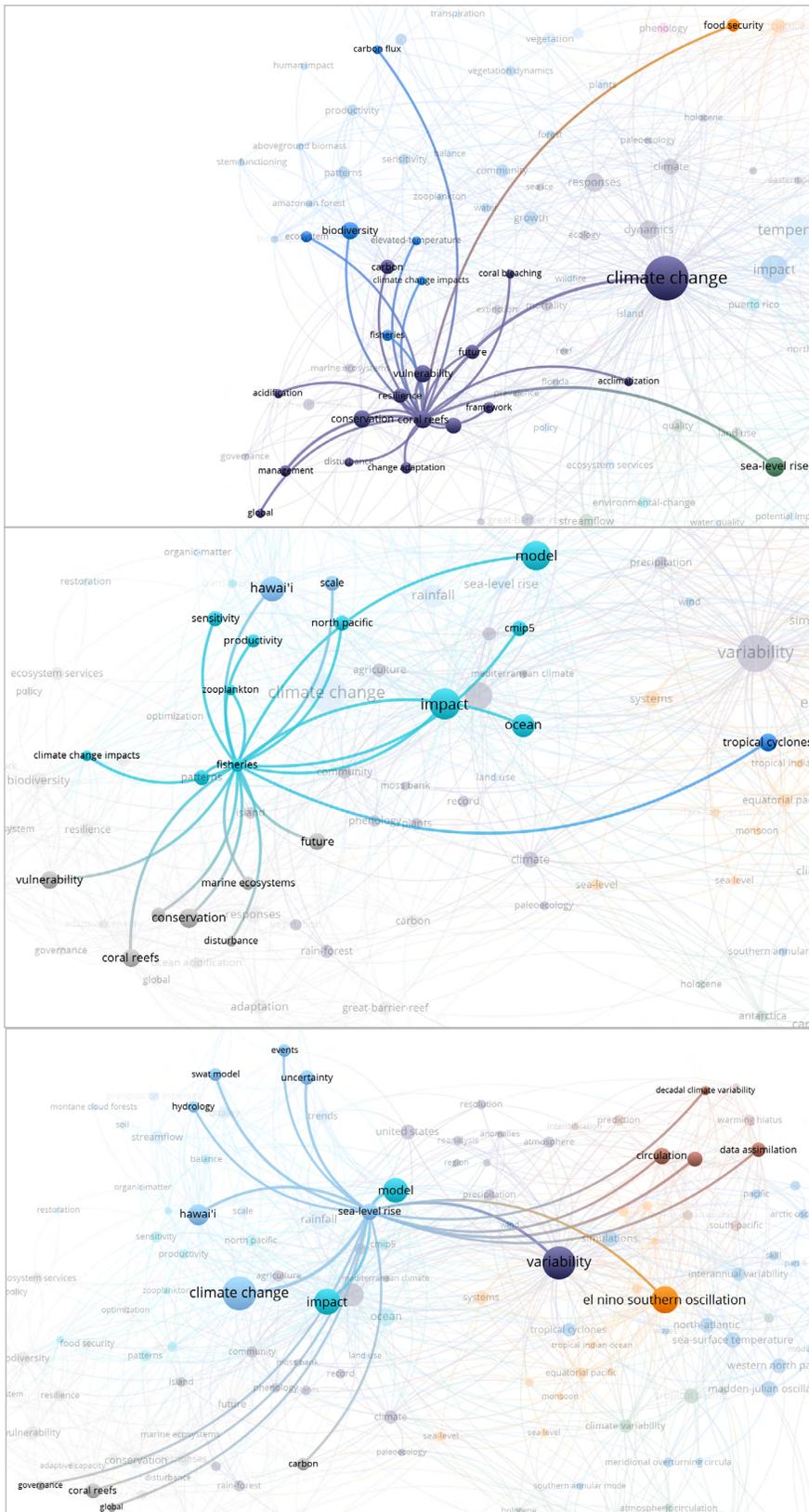


Figure 28, 29 & 30: Research in Hawai'i and Guam focuses on climate impacts to marine systems and economically significant fisheries resources, as well as ocean-climate interactions, rainforests, and sea-level rise.

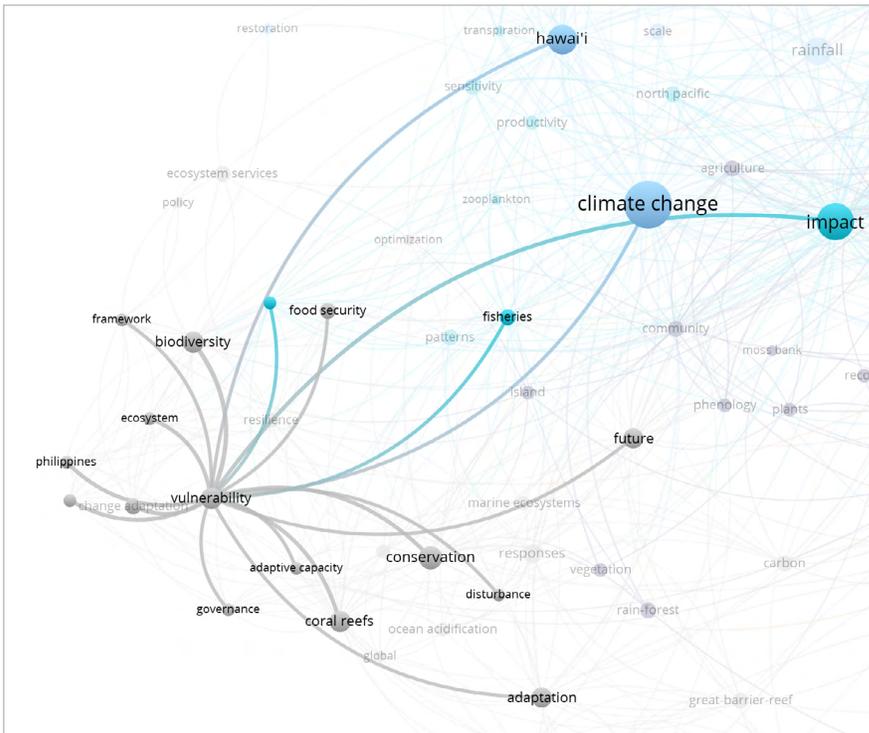


Figure 31: Vulnerability, as it relates to food security, governance, and adaptive capacity, is emerging as a key research theme.

HAWAI'I AND GUAM			
STATE	NUMBER OF PAPERS	UNIVERSITIES	KEYWORDS
Hawai'i	139	University of Hawai'i at Manoa	tropical pacific, tropical cyclones, coral reefs, rain-forest, streamflow, sea-level rise
Guam	5	University of Guam, Mangilao	ocean thermal structure, calcite precipitation, cave ventilation, pacific tropical cyclone, sea-surface-temperature

LOOKING AHEAD

NCSE's study offers a first, broad-brush analysis of the quantity and scope of climate-related science in a selected group of public universities across the United States and territories. This high-level analysis produced several key findings and has identified some clear areas for future efforts.

To recap key findings:

- Scientists are studying climate science and the impacts of climate change in **every state and territory in the United States.**
- **Regionally, scientists are studying locally relevant topics.** Within public universities in each state, researchers are studying topics that relate to that state's social, economic, and/or ecological systems.
- Climate science research increasingly focuses on **impacts.**
- **Locally-produced research** can help respond to local climate-related issues.

In the future, this study could be expanded and deepened in several important ways:

- Include all research universities across the U.S., instead of only a selected subset.
- Conduct an additional, separate analysis of climate science education at research universities across the U.S., using a different but complementary methodological approach.
- Develop a more robust analysis of the emergence of different keywords over time. This could provide a closer examination of how the research enterprise is evolving with respect to climate science research and provide decision-makers with an evidence base to guide local action.

- Conduct a deeper analysis of the papers identified through keyword searches to better understand field of study, social networks, and paper impact factor.
- Examine regional and state-based differences for specific keywords. For example, does the word “adaptation” identify a different body of research in the Midwest as compared to the Northeast.
- Dive deeper into the cross-organization collaboration networks— how are scientists collaborating between institutions, domestically and internationally.
- Explore role of federal funding, as well as university-federal collaborations in climate-related science research.
- Study differences between urban and rural areas. This study may under-represent the prevalence of urban issues, such as “urban heat islands,” because land-grant universities tend to be concentrated in rural areas. We anticipate that urban issues associated with extreme heat are growing in prevalence.

NCSE's initial study provides a rigorous and unbiased assessment of the breadth of climate-related science research across the higher education complex. This work is intended to serve decision-makers today, and inform future policies that focus on adaptation and resilience by providing locally relevant insight. By showing the scope of climate science research, decision-makers will see trends related to climate-related science that transcend the politics and political leadership of a state to inform robust decisions for a more sustainable future.

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APPENDIX 1: **STATE-SPECIFIC** **ONE-PAGERS**

Climate-related science at public universities



National Council for
Science and the Environment

ALABAMA

REGION: SOUTHEAST

OVERVIEW	
Auburn University <i>Land Grant University</i>	77
University of Alabama, Tuscaloosa <i>Largest</i>	37
University of Alabama, Huntsville <i>State Climatology Office</i>	26
<i>Specialized Climate Institutes or Centers</i>	
International Center for Climate and Global Change Research (Auburn)	-
Earth System Science Center (U of Alabama)	-
Total Papers	140

KEYWORDS	
<i>Local</i>	Groundwater
	Southern United States
	Soil Erosion
<i>Regional</i>	Urbanization
	Water Quality
	Catchment
	Regional Climate
	Terrestrial Ecosystems
<i>National</i>	Impact
	Temperature
	Precipitation

LOCALLY RELEVANT RESEARCH

With extensive rivers and forests, and a high rural population, Alabama faces flooding, soil erosion, and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Auburn and Alabama University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



National Council for
Science and the Environment

ALASKA

REGION: ALASKA

OVERVIEW	
University of Alaska, Fairbanks <i>Land Grant University</i>	170
<i>Specialized Climate Institutes or Centers</i>	
The Alaska Climate Research Center	-
Alaska Climate Adaptation, Resource Center	-
Ocean Acidification Research Center	-
Total Papers	170

KEYWORDS	
<i>Local</i>	Permafrost
	Arctic
	Sea Ice
	Pink Salmon
<i>Regional</i>	Arctic
	Interior Alaska
	Canada
	Northern Alaska
<i>National</i>	Temperature
	Variability
	Ecosystem

LOCALLY RELEVANT RESEARCH

With vast ice coverage and biodiversity, and a low rural population, Alaska faces rising temperatures, melting of polar ice caps, and wildlife loss.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Alaska, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



National Council for
Science and the Environment

ARIZONA

REGION: SOUTHWEST

OVERVIEW	
University of Arizona, Tucson <i>Land Grant University</i>	343
Arizona State University, Tempe <i>Largest, State Climatology Office</i>	220
<i>Specialized Climate Institutes or Centers</i>	
Southwest Climate Adaptation Science Center (U of Arizona)	-
Center for Climate Adaptation Science and Solutions (CCASS) (U of Arizona)	-
Julie Ann Wrigley Global Institute of Sustainability (Arizona State University)	-
Total Papers	563

KEYWORDS	
<i>Local</i>	North American Monsoon
	Heat Island
	Monsoon
	Phoenix
<i>Regional</i>	Dendroclimatology
	Dendrochronology
	Governance
<i>National</i>	Sustainability
	Temperature
	Variability
	Precipitation

LOCALLY RELEVANT RESEARCH

With a desert climate and unique geology formations, Arizona faces water shortages and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Arizona and Arizona State University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



National Council for
Science and the Environment

ARKANSAS

REGION: SOUTHEAST

OVERVIEW	
University of Arkansas, Fayetteville <i>Land Grant University, Largest</i>	51
Arkansas Natural Resources Commission <i>State Climatology Affiliation</i>	-
<i>Specialized Climate Institutes or Centers</i>	
University of Arkansas Resiliency Center	-
Total Papers	51

KEYWORDS	
<i>Local</i>	Dendrochronology
	Droughts
	Intensification
<i>Regional</i>	Fish
	Classification
	Global Warming
<i>National</i>	Impact
	Temperature
	Precipitation

LOCALLY RELEVANT RESEARCH

With extensive rivers and proximity to the Gulf of Mexico, and a high rural population, Arkansas faces flooding, wildlife depletion, and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Arkansas and the Arkansas Natural Resources Commission, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



National Council for
Science and the Environment

CALIFORNIA

REGION: SOUTHWEST

OVERVIEW	
University of California, Los Angeles <i>Largest</i>	247
CA Department of Water Resources <i>State Climatology Office</i>	-
University of California, Berkeley <i>Land Grant University</i>	346
<i>Specialized Climate Institutes or Centers</i>	
Center for Climate Science (UCLA)	-
Emmett Institute on Climate Change & the Environment (UCLA Law)	-
Institute of Environment and Sustainability (UCLA)	-
Climate Readiness Institute (UC Berkeley)	-
Berkeley Energy and Climate Institute (UC Berkeley)	-
The Center for Law, Energy & the Environment (UC Berkeley)	-
Total Papers	593

KEYWORDS	
<i>Local</i>	Atmosphere
	Southern California
	Greenhouse Gas Emissions
<i>Regional</i>	Global Warming
	Sierra Nevada
	Wildfire
	Feedbacks
	Cycle
<i>National</i>	Energy
	Temperature
	Impact
	Variability
	Precipitation

LOCALLY RELEVANT RESEARCH

With its location and its diverse biome, and a high urban population, California faces wildfire, droughts, and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the CA Department of Water Resources and University of California Los Angeles and Berkeley, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



National Council for
Science and the Environment

COLORADO

REGION: SOUTHWEST

OVERVIEW	
University of Colorado Boulder <i>Largest</i>	485
Colorado State University, Fort Collins <i>Land Grant University, State Climatology Office</i>	321
<i>Specialized Climate Institutes or Centers</i>	
North Central Climate Adaptation Science Center (CU Boulder)	-
Cooperative Institute for Research in Environmental Sciences (CU Boulder)	-
Colorado Climate Center (Colorado State)	-
Total Papers	806

KEYWORDS	
<i>Local</i>	Colorado Front Range
	Greenland
	Atmosphere
<i>Regional</i>	Sea Ice
	Western United States
	Wildfire
	Rocky Mountains
<i>National</i>	Temperature
	Variability
	Impact

LOCALLY RELEVANT RESEARCH

With mountain ranges and extreme temperatures, and a high urban population, Colorado faces environmental degradation and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Colorado State University and the University of Colorado Boulder, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



National Council for
Science and the Environment

CONNECTICUT

REGION: NORTHEAST

OVERVIEW	
University of Connecticut, Mansfield <i>Land Grant University, Largest, State Climatology Office</i>	128
<i>Specialized Climate Institutes or Centers</i>	
Adapt CT	-
Climate Corps	-
Total Papers	128

LOCALLY RELEVANT RESEARCH

With its climate location, and a high urban population, Connecticut faces extreme weather conditions, flooding, and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Connecticut, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Sea
	Sea Ice
	Extinction Risk
	Deforestation
	Water Management
<i>Regional</i>	Communication
	Attitudes
	Polarization
	Decision Making
	Engagement
<i>National</i>	Impact
	Temperature
	Variability
	Adaptation



National Council for
Science and the Environment

DELAWARE

REGION: NORTHEAST

OVERVIEW	
University of Delaware, Newark <i>Land Grant University, Largest, State Climatology Office</i>	48
<i>Specialized Climate Institutes or Centers</i>	
Disaster Research Center	-
Center for Climate Research	-
Total Papers	48

KEYWORDS	
<i>Local</i>	Carbon Export
	Carbon Dioxide Concentration
	Urban Heat Island
<i>Regional</i>	Southern Ocean
	Coastal Ocean
	Southern United States
	Gulf of Mexico
<i>National</i>	Impact
	Variability
	Temperature
	Trends

LOCALLY RELEVANT RESEARCH

With its proximity to the coast and forest land, and a high urban population, Delaware faces extreme weather conditions, flooding, and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Delaware, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

DISTRICT OF COLUMBIA

REGION: NORTHEAST

OVERVIEW	
University of the District of Columbia, Washington <i>Largest</i>	1
<i>Specialized Climate Institutes or Centers</i>	
Center for Sustainable Development and Resilience	-
Total Papers	1

KEYWORDS	
<i>Local</i>	Ecosystem Service
	Environmental Filter
	Legacy
	Macroecology
<i>Regional</i>	Biodiversity
	Landscape
	Forest
	Urbanization
<i>National</i>	Vegetation
	Diversity
	Landscape

LOCALLY RELEVANT RESEARCH

With a humid climate and a high urban population, Washington, DC faces increased susceptibility to storms and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of the District of Columbia, Washington, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



National Council for
Science and the Environment

FLORIDA

REGION: SOUTHEAST

OVERVIEW	
University of Central Florida, Orlando <i>Largest</i>	33
University of Florida, Gainesville <i>Land Grant University,</i>	300
Florida State University, Tallahassee <i>State Climatology Office</i>	101
<i>Specialized Climate Institutes or Centers</i>	
National Center for Integrated Coastal Research (University of Central Florida)	-
Florida Climate Institute (U of Florida, Gainesville)	-
Center for Ocean-Atmospheric Prediction Studies (Florida State University)	-
Total Papers	434

KEYWORDS	
<i>Local</i>	Abundance
	Heat Stress
	Crop Modeling
	High Temperature Stres
<i>Regional</i>	Land Use
	Ecosystem
	Responses
<i>National</i>	Temperature
	Impact
	Growth
	Precipitation

LOCALLY RELEVANT RESEARCH

With a strong agricultural sector and coastal location, and a high urban population, Florida faces natural disaster, water security issues, and erosion.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Florida State University, and the Universities of Central Florida and Florida, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



National Council for
Science and the Environment

GEORGIA

REGION: SOUTHEAST

OVERVIEW	
University of Georgia, Athens <i>Land Grant University, Largest</i>	150
Georgia Department of Natural Resources <i>State Climatology Office</i>	-
<i>Specialized Climate Institutes or Centers</i>	
Climate Research Laboratory (U of Georgia)	-
Georgia Initiative for Climate and Society (U of Georgia)	-
Total Papers	150

KEYWORDS	
<i>Local</i>	Stalagmite
	Speleothems
	Social Vulnerability
<i>Regional</i>	Populations
	Ecosystem Services
	Fish
	Global Warming
	Carbon Sequestration
<i>National</i>	Temperature
	Impact
	Variability
	Drought

LOCALLY RELEVANT RESEARCH

With dense forests and its subtropical climate, and a high rural population, Georgia faces loss of biodiversity and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the Georgia Department of Natural Resources and the University of Georgia, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

GUAM

REGION: PACIFIC

OVERVIEW	
University of Guam, Mangilao <i>Largest</i>	5
<i>Specialized Climate Institutes or Centers</i>	
Pacific Islands Climate Adaptation Science Center	-
Total Papers	5

LOCALLY RELEVANT RESEARCH

With its biodiversity and location, and a high rural population, Guam faces loss of coral reefs and rising sea level.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of University of Guam, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Long Term Trends
	Mass Balance Observations
	Ocean Thermal Structure
	Wind Speed Trends
	Calcite Precipitation
<i>Regional</i>	Western North Pacific
	South Pacific
	Coral Reefs
<i>National</i>	Madden Julian Oscillation
	Meridional Overturning Circulation
	Sea Surface Temperature



National Council for
Science and the Environment

HAWAI'I

REGION: PACIFIC

OVERVIEW	
University of Hawaii at Manoa <i>Land Grant University, Largest, State Climatology Office</i>	139
<i>Specialized Climate Institutes or Centers</i>	
Institute for Sustainability and Resilience	-
<i>Total Papers</i>	139

LOCALLY RELEVANT RESEARCH

With island features and a low rural population, Hawaii faces rising sea levels, weather extremes, and natural disasters.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Hawaii, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Tropical Pacific
	Western North Pacific
	Equatorial Pacific
	North Pacific
	Great barrier Reef
<i>Regional</i>	El Nino Southern Oscillation
	Sea Level Rise
	Tropical Cyclones
	Coral Reefs
<i>National</i>	Variability
	Impact
	Temperature
	Rainfall

IDAHO

REGION: NORTHWEST

OVERVIEW	
Boise State University <i>Largest</i>	29
University of Idaho, Moscow <i>Land Grant University, State Climatology Office</i>	135
<i>Specialized Climate Institutes or Centers</i>	
Hazard and Climate Resiliency Consortium (Boise State University)	-
Center for Resilient Communities (University of Idaho)	-
Total Papers	164

KEYWORDS	
<i>Local</i>	Burned Area
	Bark Beetles
	Spatiotemporal Patterns
	Fire Severity
<i>Regional</i>	Wildfire
	Regimes
	Sierra Nevada
	Yellowstone National Park
<i>National</i>	Impact
	Temperature
	Variability
	Precipitation

LOCALLY RELEVANT RESEARCH

With protected land and the Rocky Mountains, and a high rural population, Idaho faces environment degradation, rising temperatures, and a loss of agriculture.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Boise State University and the University of Idaho, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

ILLINOIS

REGION: MIDWEST

OVERVIEW	
University of Illinois at Urbana-Champaign <i>Land Grant University, Largest, State Climatology Office</i>	188
<i>Specialized Climate Institutes or Centers</i>	
Midwestern Regional Climate Center	-
Institute for Sustainability, Energy, and Environment	-
Total Papers	188

KEYWORDS	
<i>Local</i>	Tropical Cyclones
	Genetic Diversity
	Tree Populations
	Atmosphere
<i>Regional</i>	Buildings
	Photosynthesis
	Stomatal Conductance
	Acclimation
<i>National</i>	Energy
	Uncertainty
	Temperature
	Variability
	Precipitation

LOCALLY RELEVANT RESEARCH

With high risk for tornados and a reliance on agriculture, and a high urban population, Illinois faces more severe storms and destruction of agricultural land.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Illinois at Urbana-Champaign, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

INDIANA

REGION: MIDWEST

OVERVIEW	
Indiana University, Bloomington <i>Largest</i>	87
Purdue University <i>Land Grant University, State Climatology Office</i>	202
<i>Specialized Climate Institutes or Centers</i>	
Center for the Study of Global Change (Indiana University)	-
Environmental Resilience Institute (Indiana University)	-
Purdue Climate Change Research Center	-
Total Papers	289

KEYWORDS	
<i>Local</i>	Crop Yield
	Soil Erosion
	Sediment
	Decomposition
<i>Regional</i>	Farmers
	Information
	Urbanization
	Thermal Acclimation
	Maize
<i>National</i>	Precipitation
	Impact
	Adaptation

LOCALLY RELEVANT RESEARCH

With an agriculture industry and large mass of lakes, and a high rural population, Indiana faces rising temperatures and loss of farmable land.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Purdue and Indiana University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

IOWA

REGION: MIDWEST

OVERVIEW	
Iowa State University, Ames <i>Land Grant University, Largest</i>	117
Iowa Department of Agriculture and Land Stewardship <i>State Climatology Office</i>	-
Total Papers	117

KEYWORDS	
<i>Local</i>	Decision Making
	Resolution
	Beliefs
	Assessment Tool
<i>Regional</i>	Maize
	Grassland
	Calibration
	Rates
<i>National</i>	Agriculture
	Impact
	Precipitation
	Temperature

LOCALLY RELEVANT RESEARCH

With a reliance on agriculture, and a high rural population, Iowa faces environment degradation, natural disasters, and poor growing conditions.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the Iowa Department of Agriculture and Land Stewardship and Iowa State University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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KANSAS

REGION: MIDWEST

OVERVIEW	
University of Kansas, Lawrence <i>Largest</i>	86
Kansas State University, Manhattan <i>Land Grant University, State Climatology Office</i>	87
<i>Specialized Climate Institutes or Centers</i>	
The Weather Data Library (Kansas State)	-
Total Papers	173

KEYWORDS	
<i>Local</i>	Speciation
	State
	Pollen
	Transmission
<i>Regional</i>	Wheat
	Maize
	Tallgrass Prairie
	Maxent
	Soil Carbon
<i>National</i>	Temperature
	Impact
	Species Distribution

LOCALLY RELEVANT RESEARCH

With extensive agriculture and flat plains, and a high rural population, Kansas faces loss of agricultural land and increased weather extremes.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Kansas State and the University of Kansas, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KENTUCKY

REGION: SOUTHEAST

OVERVIEW	
University of Kentucky, Lexington <i>Land Grant University, Largest</i>	53
Western Kentucky University <i>State Climatology Office</i>	17
<i>Specialized Climate Institutes or Centers</i>	
Kentucky Climate Center (University of Kentucky)	-
Total Papers	70

KEYWORDS	
<i>Local</i>	Induced Range Contraction
	Modis
	Conservation Biology
	National Park
<i>Regional</i>	Seasonality
	Organic Matter
	Pollution
	Stomatal Conductance
	Quality
<i>National</i>	Regional Climate
	Impact
	Temperature
	Model

LOCALLY RELEVANT RESEARCH

With moderate temperatures and a high rural population Kentucky faces environmental degradation and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Kentucky and Western Kentucky University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

LOUISIANA

REGION: SOUTHEAST

OVERVIEW	
Louisiana State University, Baton Rouge <i>Land Grant University, Largest, State Climatology Office</i>	89
<i>Specialized Climate Institutes or Centers</i>	
Center for Coastal Resiliency	-
Southern Regional Climate Center	
Total Papers	89

KEYWORDS	
<i>Local</i>	Gulf of Mexico
	World Map
	Mississippi Delta
	South China Sea
<i>Regional</i>	Catchment
	Florida
	Classification
	Long Term Trends
	Tropical Cyclones
<i>National</i>	Impact
	Sea Level Rise
	Variability
	Vegetation

LOCALLY RELEVANT RESEARCH

With extensive coastal areas and high susceptibility to storms, and a high rural population, Louisiana faces flooding, extreme weather and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Louisiana State University, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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MAINE

REGION: NORTHEAST

OVERVIEW	
University of Maine, Orono <i>Land Grant University, Largest, State Climatology Office</i>	101
<i>Specialized Climate Institutes or Centers</i>	
Climate Change Institute	-
George J. Mitchell Center for Sustainability Solutions	
Total Papers	101

KEYWORDS	
<i>Local</i>	New Zealand
	West Antarctica
	Greenland
	National Park
<i>Regional</i>	Climate Modeling
	Abundance
	New England
<i>National</i>	Competition
	Impact
	Variability
	Temperature

LOCALLY RELEVANT RESEARCH

With cold temperatures and large forests, and a high rural population, Maine faces deforestation and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Maine, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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MARYLAND

REGION: NORTHEAST

OVERVIEW	
University of Maryland, College Park <i>Land Grant University, Largest, State Climatology Office</i>	310
<i>Specialized Climate Institutes or Centers</i>	
Center for Disaster Resilience	-
Center for Global Sustainability	-
Total Papers	310

KEYWORDS	
<i>Local</i>	Modis
	Satellite
	Resolution
	NDVI
	Remote Sensing
<i>Regional</i>	Validation
	Energy
	Land
	Sea
<i>National</i>	Temperature
	Model
	Impact
	Variability

LOCALLY RELEVANT RESEARCH

With extension water networks and sea life, and a high urban population, Maryland faces rising sea levels and loss of biodiversity.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Maryland, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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MASSACHUSETTS

REGION: NORTHEAST

OVERVIEW	
University of Massachusetts, Amherst <i>Land Grant University, Largest</i>	137
<i>Specialized Climate Institutes or Centers</i>	
Northeast Climate Science Center	-
Center for Resilient Metro-Regions	-
Total Papers	137

KEYWORDS	
<i>Local</i>	Hydropower
	Future Changes
	Sediments
	Optimization
<i>Regional</i>	Water Management
	New England
	Decision Making
	Quality
	Sea Ice
<i>National</i>	Variability
	Impact
	Adaptation
	Management

LOCALLY RELEVANT RESEARCH

With coastal area and a high urban population, Massachusetts faces sea level rise and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Massachusetts, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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MICHIGAN

REGION: MIDWEST

OVERVIEW	
Michigan State University, East Lansing <i>Land Grant University, Largest, State Climatology Office</i>	254
<i>Specialized Climate Institutes or Centers</i>	
Center for Global Change & Earth Observations (CGCEO)	-
<i>Total Papers</i>	254

KEYWORDS	
<i>Local</i>	Communication
	Climate Change Adaptation
	Framing
	Species Richness
	Dendrochronology
<i>Regional</i>	Information
	Quality
	Engagement
	Maize
	Great Lakes
<i>National</i>	Impact
	Model
	Temperature
	Adaptation

LOCALLY RELEVANT RESEARCH

With its rivers and lakes, and a high rural population, Michigan faces issues with water and air quality.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Michigan State University, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

MINNESOTA

REGION: MIDWEST

OVERVIEW	
University of Minnesota, Twin Cities <i>Land Grant University, Largest, State Climatology Office</i>	281
Minnesota Department of Natural Resources <i>State Climatology Office</i>	-
<i>Specialized Climate Institutes or Centers</i>	
Resilient Communities Project	-
Institute of the Environment	-
Total Papers	281

KEYWORDS	
<i>Local</i>	Speleothem
	Stalagmite
	International Migration
	Asian Monsoon
<i>Regional</i>	Photosynthesis
	Population
	Environmental Change
	Acclimation
	Thermal Acclimation
<i>National</i>	Variability
	Temperature
	Impact
	Precipitation

LOCALLY RELEVANT RESEARCH

With a sizeable mining industry, vast amount of rivers, and a high urban population, Minnesota faces loss of wildlife, water quality, and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of University of Minnesota and the Minnesota Department of Natural Resources, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

MISSISSIPPI

REGION: SOUTHEAST

OVERVIEW	
University of Mississippi, Oxford <i>Largest, State Climatology Office</i>	7
Mississippi State University, Starkville <i>Land Grant University</i>	35
Total Papers	42

LOCALLY RELEVANT RESEARCH

With the Mississippi River, its low elevation, and a high rural population, Mississippi faces flooding and damage to agricultural land.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Mississippi State University and the University of Mississippi, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Rice
	Greenhouse Gas Emissions
	Hydraulic Conductivity
	Numerical Modeling
	Watershed
<i>Regional</i>	Change Scenarios
	Water Quality
	Photosynthesis
	Sediment
<i>National</i>	Temperature
	Impact
	Swat Model
	Drought



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MISSOURI

REGION: MIDWEST

OVERVIEW	
University of Missouri, Columbia <i>Land Grant University, Largest, State Climatology Office</i>	109
<i>Specialized Climate Institutes or Centers</i>	
Missouri Climate Center	-
Total Papers	109

LOCALLY RELEVANT RESEARCH

With rich plant and wildlife, and a high urban population, Missouri faces loss of biodiversity and extreme weather conditions.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Missouri, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Landis Pro
	Northeast China
	Forest Landscape Model
	Succession
	Spring Maize
<i>Regional</i>	Dispersal
	Abundance
	Sustainability
	Environmental Change
<i>National</i>	Temperature
	Impact
	Precipitation



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MONTANA

REGION: NORTHERN GREAT PLAINS

OVERVIEW	
Montana State University, Bozeman <i>Land Grant University, Largest</i>	92
University of Montana, Missoula <i>State Climatology Office</i>	112
<i>Specialized Climate Institutes or Centers</i>	
Montana Forest & Conservation Experiment Station	-
Total Papers	204

KEYWORDS	
<i>Local</i>	Range
	Fire Severity
	Columbia River Basin
<i>Regional</i>	American Pika
	Wildfire
	British Columbia
	National Park
<i>National</i>	Local Adaptation
	Temperature
	Vegetation
	Conservation
	Forest
	Biodiversity

LOCALLY RELEVANT RESEARCH

With its wildlife and preserved land, and a high rural population, Montana faces loss of its flora and fauna.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Montana State University and the University of Montana, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

NORTH CAROLINA

REGION: SOUTHEAST

OVERVIEW	
North Carolina State University at Raleigh <i>Land Grant University, Largest, State Climatology Office</i>	223
<i>Specialized Climate Institutes or Centers</i>	
Southeast Climate Adaptation Science Center	-
<i>Total Papers</i>	223

KEYWORDS	
<i>Local</i>	Atmospheric Chemistry
	Air Quality
	Parameterization
	Model Evaluation
	Surface Ozone
<i>Regional</i>	Attitudes
	Water Quality
	Resources
	Regional Climate
<i>National</i>	Model
	Temperature
	Impact
	Precipitation
	Forest

LOCALLY RELEVANT RESEARCH

With a humid environment and coastline, and a high urban population, North Carolina faces erosion and flooding.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the North Carolina State University, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



NORTH DAKOTA

REGION: NORTHERN GREAT PLAINS

OVERVIEW	
North Dakota State University, Fargo <i>Land Grant University, State Climatology Office</i>	27
University of North Dakota, Grand Forks <i>Largest</i>	18
<i>Specialized Climate Institutes or Centers</i>	
North Dakota Agricultural Experiment Station (North Dakota State)	-
Global Institute of Food Security and International Agriculture (North Dakota State)	-
Center for Regional Climate Studies (University of North Dakota)	-
Total Papers	45

KEYWORDS	
<i>Local</i>	Cities
	Local Government
	Change Mitigation Policy
	Implementation
<i>Regional</i>	Mississippi River
	Great Plains
	Flow
	Hybridization
<i>National</i>	British Columbia
	Model
	Land use
	Adaptation
	Trends

LOCALLY RELEVANT RESEARCH

With its fertile soil and natural resources, and a high rural population, North Dakota faces loss of farmland, and more temperature extremes.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the North Dakota State University and the University of North Dakota, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

NEBRASKA

REGION: NORTHERN GREAT PLAINS

OVERVIEW	
University of Nebraska, Lincoln <i>Land Grant University, Largest, State Climatology Office</i>	135
<i>Specialized Climate Institutes or Centers</i>	
High Plains Regional Climate Center	-
<i>Total Papers</i>	135

LOCALLY RELEVANT RESEARCH

With its susceptibility to tornadoes and large forest area, and a high rural population, Nebraska faces worsening natural disasters and destruction of farmable land.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came the University of Nebraska, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Information
	Conductivity
	Hybrid Maize
	Global Climate
	Diversification
<i>Regional</i>	Wheat
	Maize
	Temporal Stability
	Water Content
	Groundwater Recharge
<i>National</i>	Variability
	Temperature
	Precipitation
	Drought

NEVADA

REGION: SOUTHWEST

OVERVIEW	
University of Nevada, Reno <i>Land Grant University, State Climatology Office</i>	83
University of Nevada, Las Vegas <i>Largest</i>	48
<i>Specialized Climate Institutes or Centers</i>	
Safe And Resilient Communities (University of Nevada)	-
Desert Research Institute	-
Total Papers	131

KEYWORDS	
<i>Local</i>	Winter Precipitation
	Alaska
	Mojave Desert
	Geopotential Height
<i>Regional</i>	Great Basin
	Western United States
	Sierra Nevada
	North Atlantic Oscillation
	Snow
<i>National</i>	Temperature
	Precipitation
	Variability

LOCALLY RELEVANT RESEARCH

With desert climate and a large quantity of mines, and a high rural population, Nevada faces water quality issues and pollution.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Nevada, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

NEW HAMPSHIRE

REGION: NORTHEAST

OVERVIEW	
University of New Hampshire, Durham <i>Largest, State Climatology Office, Land Grant University</i>	112
<i>Specialized Climate Institutes or Centers</i>	
Center for Infrastructure Resilience to Climate	-
Sustainability Institute	-
Total Papers	112

KEYWORDS	
<i>Local</i>	Environmental Concern
	Organic Matter
	Storage
	Organic Carbon
	Stomatal Conductance
<i>Regional</i>	Respiration
	Views
	Politics
	Polarization
	Water Quality
<i>National</i>	Temperature
	Model
	Impact
	Nitrogen

LOCALLY RELEVANT RESEARCH

With its sizeable forests and mountains, and a high rural population, New Hampshire faces deforestation and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of New Hampshire, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

NEW JERSEY

REGION: NORTHEAST

OVERVIEW	
Rutgers University, New Brunswick <i>Land Grant University, Largest, State Climatology Office</i>	141
<i>Specialized Climate Institutes or Centers</i>	
New Jersey Agricultural Experiment Station	-
Center for Environmental Prediction	-
Center for Resilient Landscapes	-
Rutgers Climate Institute	-
Total Papers	141

KEYWORDS	
<i>Local</i>	Recruitment
	Framing
	Fisheries
	Atmospheric Circulation
	Extreme Events
<i>Regional</i>	Engagement
	Polarization
	Communication
	Deforestation
<i>National</i>	Impact
	Temperature
	Adaptation

LOCALLY RELEVANT RESEARCH

With its small size and proximity to New York City, and a high urban population, New Jersey faces traffic related pollution and urban sprawl as well as water runoff.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Rutgers University, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

NEW MEXICO

REGION: SOUTHWEST

OVERVIEW	
University of New Mexico, Albuquerque <i>Largest</i>	74
New Mexico State University, Las Cruces <i>State Climatology Office, Land Grant University</i>	41
<i>Specialized Climate Institutes or Centers</i>	
Resilience Institute (University of New Mexico)	-
Utton Transboundary Resources Center	-
Total Papers	115

KEYWORDS	
<i>Local</i>	Speleothem
	Mixed Conifer Forests
	Irrigation
	Landis II
<i>Regional</i>	Carbon Dynamics
	Wildfire
	Terrestrial Ecosystems
	Grassland
<i>National</i>	Great Basin
	Precipitation
	Temperature
	Variability
	Drought

LOCALLY RELEVANT RESEARCH

With its desert climate and high presence of mines, and a high urban population, New Mexico faces water scarcity and pollution.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of New Mexico State University and the University of New Mexico, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

NEW YORK

REGION: NORTHEAST

OVERVIEW	
University of New York at Buffalo <i>Largest</i>	27
Cornell University, Ithaca <i>Land Grant University, State Climatology Office</i>	235
<i>Specialized Climate Institutes or Centers</i>	
Northeast Regional Climate Center	-
Cornell Institute for Climate Smart Solutions (CICSS)	-
Total Papers	262

KEYWORDS	
<i>Local</i>	Psychological Distance
	Risk Perception
	System Mode
	Beliefs
	Aerosols
<i>Regional</i>	Communication
	Global Warming
	Engagement
	Distribution Models
	Extinction Risk
<i>National</i>	Impact
	Temperature
	Variability
	Adaptation

LOCALLY RELEVANT RESEARCH

With its climate and large size, and a high urban population, New York faces issues with water access and air quality.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of New York and Cornell University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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OHIO

REGION: MIDWEST

OVERVIEW	
Ohio State University, Columbus <i>Land Grant University, Largest, State Climatology Office</i>	170
<i>Specialized Climate Institutes or Centers</i>	
Byrd Polar and Climate Research Center	-
Sustainability Institute at Ohio State	-
Total Papers	170

KEYWORDS	
<i>Local</i>	Sequestration
	Flow
	Wetlands
	Coverage
	Corn
<i>Regional</i>	Quality
	Energy
	Carbon Sequestration
	Polarization
	Abundance
<i>National</i>	Impact
	Temperature
	Variability
	Precipitation

LOCALLY RELEVANT RESEARCH

With its location and climate, and a high urban population, Ohio faces pollution and loss of agricultural land.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Ohio State University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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OKLAHOMA

REGION: SOUTHERN GREAT PLAINS

OVERVIEW	
University of Oklahoma, Norman <i>Largest, State Climatology Office</i>	120
Oklahoma State University, Stillwater <i>Land Grant University</i>	63
<i>Specialized Climate Institutes or Centers</i>	
National Institute for Risk and Resilience (U of Oklahoma)	-
Center for Risk and Crisis Management (U of Oklahoma)	-
OU Climate Science Center (U of Oklahoma)	-
Total Papers	183

KEYWORDS	
<i>Local</i>	Deciduous Forest
	Temperate Steppe
	Soil Respiration
	Carbon Dioxide Exchange
	Light Use Efficiency
<i>Regional</i>	Tallgrass Prairie
	Terrestrial Ecosystems
	Net Ecosystem Exchange
	Respiration
	Grassland
<i>National</i>	Precipitation
	Impact
	Temperature
	Variability

LOCALLY RELEVANT RESEARCH

With high biodiversity and geographic diversity, and a high urban population, Oklahoma faces droughts and loss of farmland.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Oklahoma State University and the University of Oklahoma, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

OREGON

REGION: NORTHWEST

OVERVIEW	
Oregon State University, Corvallis <i>Land Grant University, Largest, State Climatology Office</i>	300
<i>Specialized Climate Institutes or Centers</i>	
Oregon Climate Change Research Institute	-
Total Papers	300

KEYWORDS	
<i>Local</i>	Wave Climate
	Pacific Decadal Oscillation
	Microclimate
	Coral Reefs
	Herbivory
<i>Regional</i>	Pacific Northwest
	Douglas Fir
	Southern Ocean
	Wildfire
	Sea Ice
<i>National</i>	Variability
	Model
	Temperature

LOCALLY RELEVANT RESEARCH

With its natural resources and rich geographic diversity, and a high urban population, Oregon faces loss of wildlife and deforestation.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Oregon State University, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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PENNSYLVANIA

REGION: NORTHEAST

OVERVIEW	
Pennsylvania State University <i>Land Grant University, Largest, State Climatology Office</i>	251
<i>Specialized Climate Institutes or Centers</i>	
Center for Climate Risk Management	-
Total Papers	251

KEYWORDS	
<i>Local</i>	Infrastructure
	Gender
	Population Mobility
	Farmers
<i>Regional</i>	Attitudes
	Decision Making
	Urbanization
	Energy
<i>National</i>	Temperature
	Model
	Impact
	Variability

LOCALLY RELEVANT RESEARCH

With history of mining and fracking and a high urban population, Pennsylvania faces environmental degradation and pollution.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Pennsylvania State University, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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PUERTO RICO

REGION: CARIBBEAN

OVERVIEW	
University of Puerto Rico, Mayagüez <i>State Climatology Office</i>	23
University of Puerto Rico, Rio Piedras <i>Largest</i>	15
<i>Specialized Climate Institutes or Centers</i>	
Coastal Resilience Center (UPR, Mayaguez)	-
Caribbean Atmospheric Research Center (UPR, Mayaguez)	-
Total Papers	38

KEYWORDS	
<i>Local</i>	Tropical Forests
	Rain Forest
	Reef
	Regional Climate
	Tree Growth
<i>Regional</i>	Puerto Rico
	Caribbean
	Tropical Atlantic Sector
<i>National</i>	Temperature
	Variability
	Dynamics
	El Niño Southern Oscillation

LOCALLY RELEVANT RESEARCH

With a tropical climate and island location, and a high urban population, Puerto Rico faces increased threat from natural disaster and destruction of its land.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Puerto Rico, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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RHODE ISLAND

REGION: NORTHEAST

OVERVIEW	
University of Rhode Island, South Kingstown <i>Land Grant University, Largest</i>	57
Rhode Island Department of Environmental Management <i>State Climatology Office</i>	-
<i>Specialized Climate Institutes or Centers</i>	
Coastal Resources Center	-
Rhode Island Climate Change Collaborative	-
Coastal Green and Resilient Infrastructure Project	-
Total Papers	57

KEYWORDS	
<i>Local</i>	Ocean Acidification
	Seaports
	River Discharge
	Tropical Cyclones
<i>Regional</i>	Vibrio Cholerae
	Sea
	Monsoon
<i>National</i>	Impact
	Vulnerability
	Adaptation
	Variability

LOCALLY RELEVANT RESEARCH

With its location, and a high urban population, Rhode Island faces loss of coastline and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Rhode Island and the Rhode Island Department of Environmental Management, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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SOUTH CAROLINA

REGION: SOUTHEAST

OVERVIEW	
University of South Carolina, Columbia <i>Largest</i>	35
South Carolina Department of Natural Resources <i>State Climatology Office</i>	-
Clemson University <i>Land Grant University</i>	37
Total Papers	72

KEYWORDS	
<i>Local</i>	Impact Cluster Photo
	Vulnerability
	Variability
	Farmers Response
<i>Regional National</i>	Future
	Sea Surface Temperature
	Range Shifts
	Runoff
	Catchment
<i>National</i>	Temperature
	Impact
	Drought
	Adaptation

LOCALLY RELEVANT RESEARCH

With its coastline and susceptibility to earthquakes and storms, and a high rural population, South Carolina faces flooding, pollution and loss of wildlife.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the South Carolina Department of Natural Resources, University of South Carolina, and Clemson University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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SOUTH DAKOTA

REGION: NORTHERN GREAT PLAINS

OVERVIEW	
South Dakota State University, Brookings <i>Land Grant University, Largest, State Climatology Office</i>	54
<i>Total Papers</i>	54

LOCALLY RELEVANT RESEARCH

With a reliance on agriculture and a high rural population, South Dakota faces droughts and loss of farmland.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of South Dakota, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Information
	Conductivity
	Simulation Mode
	Hybrid Maize
<i>Regional National</i>	Wheat
	Maize
	Temporal Stability
	Water Content
	Groundwater Recharge
<i>National</i>	Variability
	Temperature
	Precipitation
	Drought



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TENNESSEE

REGION: SOUTHEAST

OVERVIEW	
The University of Tennessee, Knoxville <i>Land Grant University, Largest</i>	54
Tennessee Climatological Service <i>State Climatology Office</i>	-
<i>Specialized Climate Institutes or Centers</i>	
Center for Ultra-Wide-Area Resilient Electric Energy Transmission Networks	-
Total Papers	54

KEYWORDS	
<i>Local</i>	Precipitation
	Responses
	Drought
<i>Regional</i>	Disturbance
	Land Use
	Resources
	Risk
	Performance
<i>National</i>	Temperature
	Precipitation
	Responses
	Drought
	Emission

LOCALLY RELEVANT RESEARCH

With agriculture and chemical and electrical exports, and a high rural population, Tennessee faces water pollution and loss of farmable land.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Tennessee and the Tennessee Climatology Service, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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TEXAS

REGION: SOUTHERN GREAT PLAINS

OVERVIEW	
Texas A&M University, College Station <i>Land Grant University, Largest, State Climatology Office</i>	256
<i>Specialized Climate Institutes or Centers</i>	
Institute for Sustainable Communities	-
Environmental Science Institute	-
Total Papers	256

KEYWORDS	
<i>Local</i>	Climate Change Adaptation
	Frequency
	Surface Temperature
	Feedbacks
	Air Pollution
<i>Regional</i>	Atmosphere
	Attitudes
	Catchment
	Water Quality
	Summer Monsoon
<i>National</i>	Impact
	Precipitation
	Temperature
	Variability

LOCALLY RELEVANT RESEARCH

With extreme geographic diversity and natural resources, and a high urban population, Texas faces drought, pollution, and waste accidents/spills.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Texas A&M University, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

UTAH

REGION: SOUTHWEST

OVERVIEW	
Utah State University, Logan <i>Land Grant University, State Climatology Office</i>	116
University of Utah, Salt Lake City <i>Largest</i>	112
<i>Total Papers</i>	228

KEYWORDS	
<i>Local</i>	Pollen
	Charcoal
	Survival
	Oxygen
<i>Regional</i>	Great Basin
	Sierra Nevada
	Rocky Mountains
	Seasonality
	Wildfire
<i>National</i>	Impact
	Variability
	Precipitation
	Patterns

LOCALLY RELEVANT RESEARCH

With natural resources and warm climate, and a high rural population, Utah faces rising temperatures, water scarcity, and over-extraction of natural resources.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Utah State University, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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VERMONT

REGION: NORTHEAST

OVERVIEW	
University of Vermont, Burlington <i>Land Grant University, Largest, State Climatology Office</i>	107
<i>Specialized Climate Institutes or Centers</i>	
Center for Research on Vermont	-
Gund Institute for the Environment	-
Total Papers	107

KEYWORDS	
<i>Local</i>	Change Beliefs
	Adoption
	Experience
	Dendrochronology
<i>Regional</i>	Forest Management
	Carbon Sequestration
	Competition
	Water Quality
<i>National</i>	Adaptation
	Impact
	Agriculture
	Temperature

LOCALLY RELEVANT RESEARCH

With its small size and mountainous region, and a high rural population, Vermont faces loss of biodiversity and environmental destruction.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Vermont, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

VIRGINIA

REGION: SOUTHEAST

OVERVIEW	
Virginia Polytechnic Institute and State University, Blacksburg <i>Land Grant University, Largest</i>	113
University of Virginia, Albemarle County <i>State Climatology Office</i>	73
<i>Specialized Climate Institutes or Centers</i>	
Global Change Center (Virginia Polytechnic Institute)	-
Environmental Resilience Institute (UVA, Albemarle)	-
Total Papers	186

KEYWORDS	
<i>Local</i>	River Basin
	Water Resources
	Hydrology
	Rainfall
<i>Regional</i>	Drought
	Policy
	Urbanization
<i>National</i>	Land Use Change
	Model
	Precipitation
	Temperature
	Swat Model

LOCALLY RELEVANT RESEARCH

With biodiversity and a coastline, and a high rural population, Virginia faces increased damage from storms and loss of wildlife.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Virginia and the Virginia Polytechnic Institute and State University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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VIRGIN ISLANDS

REGION: CARIBBEAN

OVERVIEW	
University of the Virgin Islands, Charlotte Amalie <i>Largest</i>	3
<i>Specialized Climate Institutes or Centers</i>	
Center for Marine and Environmental Studies	-
Total Papers	3

LOCALLY RELEVANT RESEARCH

With coral reefs and an island environment, and a high rural population, the Virgin Islands face increasingly powerful storms and wildlife destruction.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of the Virgin Islands, chosen because of its research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Bahamas
	Climate Extreme
	Climatic Shift
	Ocean Acidification
	Phase Shifts
<i>Regional</i>	Coral Bleaching
	Daily Precipitation
	Daily Temperature
	Disease
<i>National</i>	Ecology
	Mortality
	Precipitation



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WASHINGTON

REGION: NORTHWEST

OVERVIEW	
Washington State University, Pullman <i>Land Grant University</i>	120
University of Washington, Seattle <i>Largest, State Climatology Office</i>	502
<i>Specialized Climate Institutes or Centers</i>	
Climate Impacts Group (UW)	-
Joint Institute for the Study of Atmosphere and Ocean (UW)	-
Total Papers	622

KEYWORDS	
<i>Local</i>	Amplification
	Feedbacks
	Spread
	Ensemble
	Global Warming
<i>Regional</i>	Pacific Northwest
	Sea Ice
	Photosynthesis
	Dispersal
<i>National</i>	Temperature
	Variability
	Adaptation

LOCALLY RELEVANT RESEARCH

With an expansive wilderness and water resources, and a high urban population, Washington faces water and air pollution.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Washington State University and the University of Washington, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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WEST VIRGINIA

REGION: SOUTHEAST

OVERVIEW	
West Virginia University, Morgantown <i>Land Grant University, Largest</i>	47
Marshall University <i>State Climatology Office</i>	4
Total Papers	51

KEYWORDS	
<i>Local</i>	River Discharge
	Tree Growth
	Vibrio Cholerae
<i>Regional</i>	Calibration
	Fish
	Local Adaptation
<i>National</i>	Temperature
	Drought
	Precipitation
	Conservation

LOCALLY RELEVANT RESEARCH

With its mountainous terrain and a high rural population, West Virginia faces erosion and water pollution as well as environmental degradation from mining coal.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of Marshall and West Virginia University, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).



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WISCONSIN

REGION: MIDWEST

OVERVIEW	
University of Wisconsin, Madison <i>Land Grant University, Largest, State Climatology Office</i>	328
<i>Specialized Climate Institutes or Centers</i>	
Nelson Institute Center for Climatic Research	-
Total Papers	328

LOCALLY RELEVANT RESEARCH

With its history of agriculture and mining, and a high urban population, Wisconsin faces water quality issues and rising temperatures.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Wisconsin, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Physiology
	Atmosphere
	Range
	Ice Cover
	Laurentian Great Lakes
<i>Regional</i>	Population
	Protected Areas
	Abundance
	Ecosystem Services
<i>National</i>	Temperature
	Impact
	Conservation
	Precipitation



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WYOMING

REGION: NORTHERN GREAT PLAINS

OVERVIEW	
University of Wyoming, Laramie <i>Land Grant University, Largest, State Climatology Office</i>	124
<i>Total Papers</i>	124

LOCALLY RELEVANT RESEARCH

With mountain ranges and mineral extraction, and a high rural population, Wyoming faces loss of habitat and increased pollutants.

To understand how research at public institutions can help policy-makers respond to those issues, NCSE examined what climate-related work came out of the University of Wyoming, chosen because of their research classification, enrollment size, and/or land grant status over the last 5 years (2014-2018).

KEYWORDS	
<i>Local</i>	Sagebrush
	Colorado
	Greater Sage Grouse
	Yellowstone National Park
<i>Regional</i>	Forest
	Disturbance
	Fire
	Patterns
<i>National</i>	Precipitation
	Sensitivity
	Impact



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APPENDIX 2:

DETAILED

METHODOLOGY

This Appendix provides additional detail on detailed search and analysis methodology in Web of Science and VOS Viewer.

SEARCH TERMS

NCSE collected data from Web of Science Core Collection which includes the ABC databases, on June 11-13, 2019. A paper published by Haunschild et al. (2016) largely informs the bibliometric data collection methods and analysis using VOSviewer.

NCSE chose the Web of Science Core Collection to collect search results because each entry is indexed by organization, allowing a more accurate search for specific universities. The search settings for each university are as follows:

1. Title: *climat*
2. AND Topic: *atmospher* OR *aerosol* OR *cloud* OR *wind* OR *storm* OR *ice* OR *glacier* OR *snow* OR *frost* OR *ocean* OR *sea* OR *marin* OR *lake* OR *river* OR *flood* OR *precipitat* OR *rainfall* OR *el-nino* OR *elnino* OR *southern oscillation* OR *enso* OR *Walker circulation* OR *north atlantic oscillation* OR *nao* OR *biomass* OR *agricultur* OR *food* OR *soil* OR *forest* OR *plant* OR *species* OR *vegetat* OR *model* OR *calculat* OR *simulat* OR *predict* OR *certain* OR *adapt* OR *respon* OR *mitigat* OR *manag* OR *resilien* OR *impact* OR *effect* OR *risk* OR *vulnerab*
3. NOT Topic: "safety climate" OR "person-job" OR "person-organization" OR "employee attitudes" OR "workplace satisfaction" OR "worker satisfaction" OR "organizational" OR "campus climate" OR "school climate" OR "family climate" OR "food service"
4. Custom Year Range: 2014-2018
5. AND Organization-Enhanced: e.g. Oregon State University
6. AND Document Type: Article OR Review

In order to find the most relevant climate-related research, we used the search term *climat* in the title. This left and right truncation ensured that terms such as paleoclimate and climatology were included in results.

Keywords were chosen primarily from Haunschild 2016, with additional words to reflect new topical areas, such as respons* (to include response or responses) and resilien* (to include resilient and resilience). The Haunschild approach differs in that it searches for complex keywords associated with climate change specifically. In order to get a more broad sense of climate-related work this study uses the search terms from climate change subtopics and did not include the climate change synonyms: (greenhouse gases; *climat* chang* [climate/climatic change/changes/changing]; *climat* warming* [climate/

climatic]; *global temperature* [temperature/temperatures]; *global warming*; *greenhouse gas* [gas/gases]; *greenhouse effect* [effect/effects]; *greenhouse warming*)

After choosing these keywords, initial test searches returned some irrelevant results. As a first step to remove those, the following keywords were excluded from the results: “safety climate” OR “person-job” OR “personorganization” OR “employee attitudes” OR “workplace satisfaction” OR “worker satisfaction” OR “organizational” OR “campus climate” OR “school climate” OR “family climate” OR “food service”.

To reflect the most recent work in the climate-related science arena at public institutions, NCSE includes papers found during 2014-2018, with 2019 excluded because new papers appeared daily during the search period. Web of Science Core Collection offers the unique feature of searching by organization. NCSE chose the exact organization name from the Web of Science organization-enhanced index.

Additional Methodological Notes: This report includes both articles or reviews to narrow the search only to substantial contributions to climate related research. This report refers to all articles and review results as “papers” for simplicity. After downloading search results, a filtering process removed irrelevant results. This was done by filtering for titles and keywords established through an iterative process of reading the titles and keywords of results and narrowing for ones that did not fit. These include:

school

emotion

educat

motivat

student

value

instruct

work

job

Additionally, a search for titles with acclim* produced a list from which to remove irrelevant titles, per Haunschild 2016. This step further illustrates the complexity of the field of climate-related science. For example, as the social psychology field of motivational climate was a frequent result topic that needed to be removed, but if we removed all papers dealing with motivation and climate, the study would have unintentionally removed relevant papers, such as this one from University of Tennessee Knoxville’s NSF-DOE Center for Ultra-Wide-

Area Resilient Electrical Energy Transmission Networks (CURENT), “Exploring the factors and motivations influencing heating behavioral patterns and future energy use intentions in the hot summer and cold winter climate zone of China” (Cui, Ying; Yan, Da; Chen, Chien-fei 2017).

Once the filter as described above was applied to a university’s results, we manually sorted papers to remove irrelevant results.

VOSVIEWER ANALYSIS

NCSE used VOSviewer – a free software made to visualize scientific networks – to analyze the bibliometric information in results from Web of Science. This study primarily focuses on the co-occurrence of words in titles and abstracts. VOSviewer was set to count all co-occurrences of words or phrases even within the same paper (full counting as opposed to binary counting). VOSviewer mines text for “noun phrases” (terms), meaning nouns or adjective-noun pairs, and then returns a list ranked by relevance of terms, essentially based on how often these terms occur in a title or abstract together, relative to how often other term pairings occur.

VOSviewer then uses an algorithm to map “clusters” of related terms and the relative strength of the links between terms. This study uses the VOSviewer default threshold for a term to be included in the ranked list of a minimum of 10 occurrences, with the exception of files that returned greater than 10,000 terms, wherein the minimum threshold is 15 occurrences. Analysis for each state includes the top 10 most relevant of those terms that occur at least 10 (or if $n > 10,000$ terms, 15 times) in the titles and abstracts of relevant papers from selected universities.

SOURCES USED FOR METHODOLOGY

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