RESILIENCE AND ADAPTATION ACTION TEAM
MINNESOTA CLIMATE ADAPTATION PARTNERSHIP

CLIMATE PROJECTION DATA FOR MINNESOTA

Pictures courtesy of the University of Minnesota Extension

Climate Projection Data for Minnesota:

Opportunities of climate data to accelerate climate resilience efforts across the State

Introduction

Understanding Minnesota's exposure to climate risks—from changing precipitation and drought patterns to shifting growing seasons and warming winters—requires the use of future climate information. One barrier to climate adaptation planning in Minnesota is the scarcity of climate data for the variables and at the temporal and spatial scales that are necessary for regional and local resilience-related decisions. To date, much of the available climate projection data generated for Minnesota are isolated to small areas (e.g. incomplete coverage for the state), not easily accessible or usable by end-users, or not yet publicly available.

"Dynamically downscaled" climate projection data refers to climate projections that are simulated at a high resolution (e.g. over a few square miles) for many decades into the future using advanced computer modeling techniques. These data are generated by using output from global climate models, which typically only make projections at the 60-mile (100 km) scale, to drive regional climate models. Regional downscaling techniques are essential for generating projections of future climate for the Midwest region because the Great Lakes, which have a strong influence on regional climate, are poorly represented in global climate models but can be accounted for in regional modeling efforts (e.g. Briley et al., 2021; Minallah and Steiner, 2021).

The University of Minnesota generated preliminary climate projection data for the state of Minnesota at ~6 mile (10 km) resolution for two time periods – mid-century and end-of-century. These data include variables such as temperature, precipitation, and evapotranspiration (Liess et al., in prep.), some of which have been added to the Department of Natural Resources' Climate Explorer Tool. While informative for many purposes, the available 10 km data have some limitations. First, they were designed specifically for a water resources-related application and research on invasive species, so they were not generated with a broad cross-section of end-users in mind. Further, for some applications, 10 km is considered too coarse to inform certain planning, design, and risk-management decisions at the local and regional level. Additionally, new global climate model data are now available (Eyring et al., 2016) for use in downscaling efforts, and the downscaling method has been improved, especially for urban and lake effects (Skamarock et al., 2019).

At the time of writing, proposed legislation is under consideration to generate higher resolution data (~2.5 mi or 4 km) for the entire state using the newest generation of global climate model outputs.

Climate modeling techniques are advancing and the demand for these data is growing across many sectors in the State. As a first step to understand climate projection data needs and uses, a working group of the State of Minnesota Resilience and Adaptation Action Team, made up of state agency staff and external partners, designed and distributed a survey for potential end-users. This survey aimed to better understand the level of interest in these data across different sectors and practice areas in Minnesota, the types of information end-users need, and potential sources and providers of these climate projection data. The original survey used the term "dynamically downscaled climate information (DDCI)" in lieu of climate projection data. Hereafter we will use DDCI for consistency with the survey's original language and structure. Below are our preliminary findings.

Survey Results

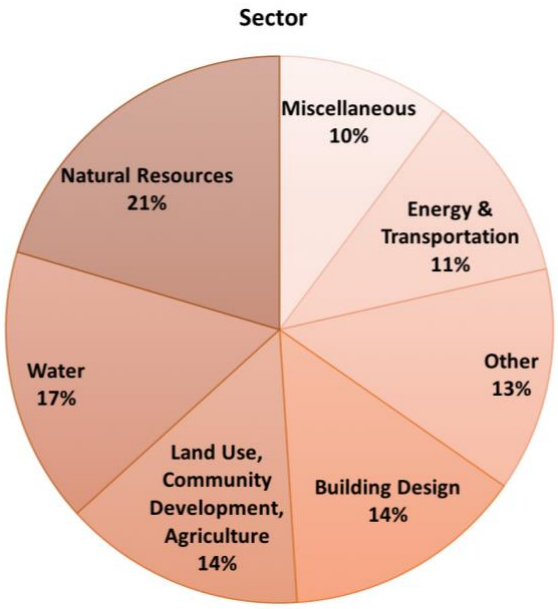
The survey was distributed by email between December 2020 and January 2021. To gather input from a diversity of sectors, targeted communications were sent to key sectors including agriculture, local/regional/tribal/state governments, and building, engineering, and climate and adaptation researchers and practitioners. The following are examples of key groups to which the survey was distributed:

- American Planning Association (APA) - Minnesota
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) - Minnesota
- Minnesota Association of Watershed Districts
- Minnesota GreenStep Cities and Tribal Nations
- Minnesota Climate Adaptation Partnership
- U.S Green Building Council - Minnesota
- Departments across the University of Minnesota
- Departments and agencies across the State of Minnesota

Responses and Demographics

The survey received 218 responses. Most of the respondents work for either state or local government (51%), or for private industry and consulting firms (39%). The remainder of respondents work in academia, for non-profit organizations, for the federal government, for tribal entities, or are not employed (Figure 1a). Respondents categorized their professional role as engineers (23%), administrators (20%), scientists (14%), and policy makers (14%), with architects, teachers, researchers, students, and consultants making up the remaining 29% (Figure 1b). The distribution of organization size was bimodal, with the majority (51%) having more than 100 staff, 26% having less than 10 workers, and only 19% having between 11 and 99 employees (Figure 1c).

a



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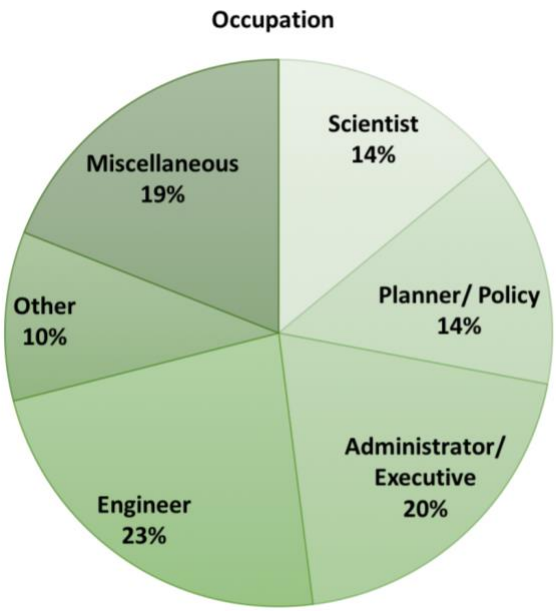

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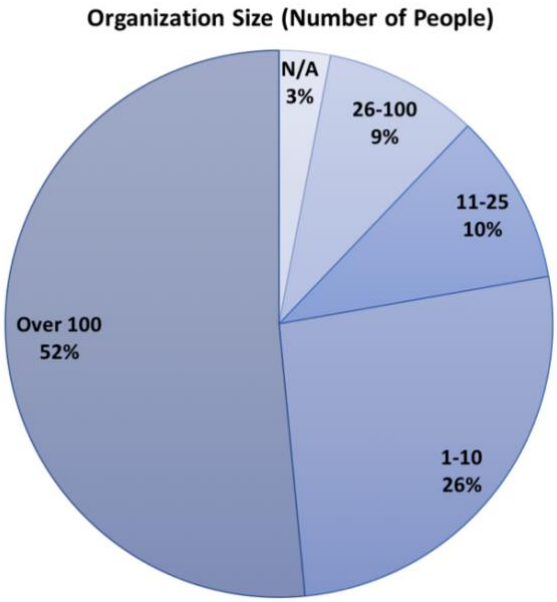

Figure 1: Respondents' participation by sector (a), occupation (b), and organization size (c). "Other" refers to the answer option "Other" in the survey, while "Miscellaneous" refers to the sum of all answers that were chosen by less than 10% of respondents and binned together for chart legibility.

Modeling Focus and Proposed Use

The majority of respondents (60%) had little or no understanding of DDCI. Despite this limited awareness, 82% of respondents indicated that these data would be important for their organizations. Proposed uses for the data varied, but are largely grouped into the following categories: *building and infrastructure design; water quality, runoff, and flooding; city policy and planning; education and outreach; continued research; resource management; human health and well-being; consulting; and agriculture*. Precipitation and temperature were the most desired variables, with annual, seasonal, and monthly timescales preferred.

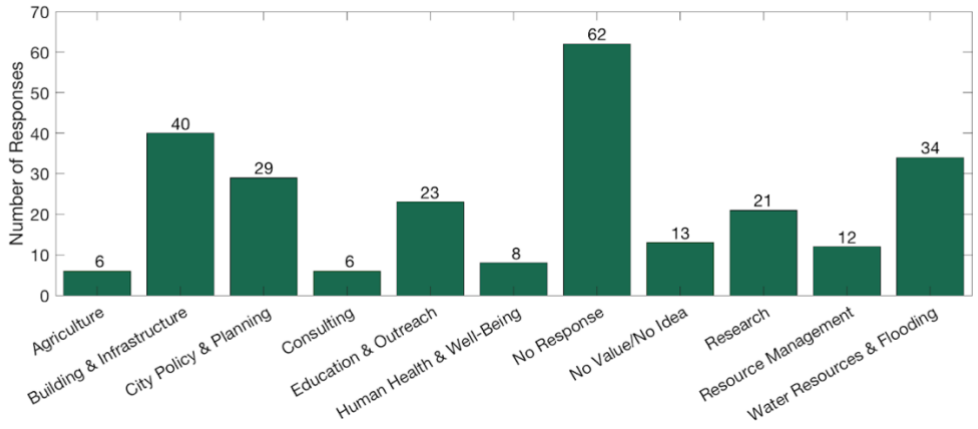

Figure 2: Number of responses that mentioned the defined category as a proposed use for DDCI. Proposed uses are in alphabetical order, and the number of responses is enumerated above each bar. Note that the sum of the number of responses is greater than 218, because the response was in a short-answer format and some individuals mentioned more than one potential use.

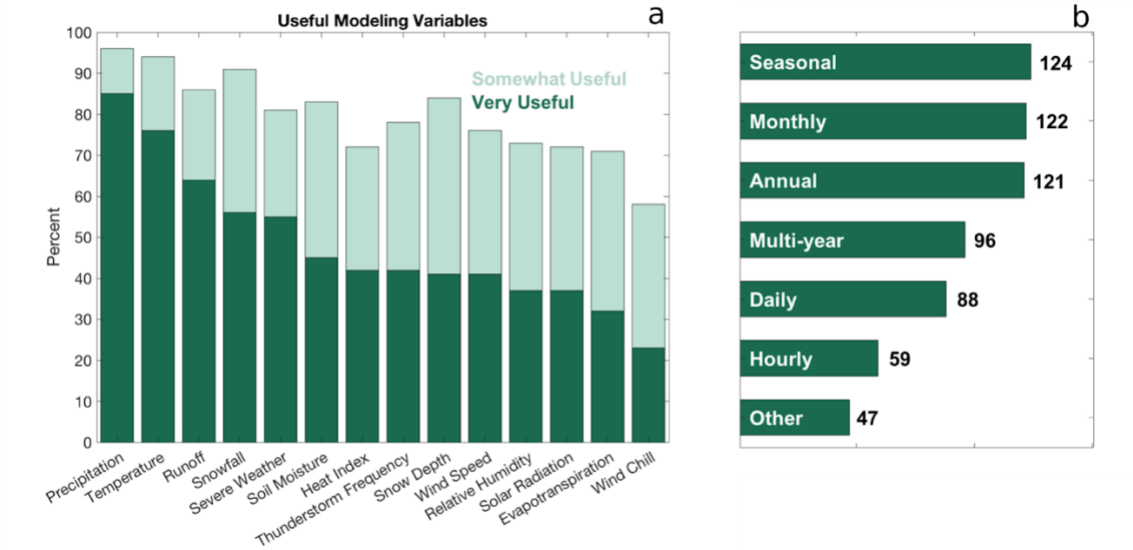

Figure 3: Summary of preferred model variables (a) and timeframes (b). (a) The percent of respondents who thought each model variable would be useful, with percent "Very Useful" in dark green and percent "Somewhat Useful" in light green. Variables are sorted from left to right by percent "Very Useful". (b) Preferred timeframes, with the number of respondents who chose each time period enumerated at the end of the bar. Respondents were able to select multiple timeframes.

Project Funding and Management

Overall, survey respondents felt that the financial responsibility for the project should be shared between the State and Federal government, an academic institution, and non-profit organizations. Respondents were overwhelmingly in agreement (93%, n=199) that data should be free for the public, with 78% (n=167) thinking that the data should be open access, and 15% (n=32) arguing that a free membership would be preferable in order to track data usage.

With regards to project leadership and long-term maintenance of the data, more than any other option, the University of Minnesota was the preferred entity to lead the project (44%, n=94) and maintain the data (36%, n=77). The University of Minnesota has the necessary research capacity to lead the project, particularly within the College of Food, Agricultural and Natural Resource Sciences and Extension, and the required computing, data processing, and storage infrastructure within the Minnesota Supercomputing Institute to generate and maintain high-resolution data. Further, the University houses the Minnesota Climate Adaptation Partnership (MCAP) and associated climate change Extension program, providing a dedicated mechanism for the required dissemination, training, capacity building and technical expertise to support the use and application of these data. Critically, MCAP has strong connections with State agencies, Federal agencies, and the private and public sectors to support broad dissemination of these data.

An online data repository will be required, where data can be continuously updated and downloaded in a variety of formats given the diverse set of users and applications of DDCI. While the University is a likely home for these data and associated interactive web tools and training resources, the DDCI should be disseminated to the public through multiple means and tools, and resources should be co-created with target end-users to ensure accessibility and use.

Future Work and Next Steps

Many survey respondents were unsure of how to use DDCI. This motivates the development of training opportunities to raise awareness of the data's generation and potential use, and case studies to demonstrate how these climate data support adaptation and climate change-related planning efforts. Based on this survey and discussions with practitioners and members of MCAP, we propose the following next steps and investment areas related to DDCI for Minnesota:

- A continued push for the generation of a comprehensive set of DDCI for Minnesota is still needed. Current data available through the DNR portal provide a starting point, but we need to leverage our State’s technical expertise and capacity to advance this critical data resource;
- More training and awareness raising are needed. We recommend providing webinars or workshops about DDCI to showcase how these data are generated and how they can be used as part of the "toolbox" of climate adaptation and resilience decisions. Ideally these convenings would leverage existing spaces, such as the MCAP webinar series, professional society gatherings, and conferences. Meeting people where they are would increase reach and potential impact as well as provide opportunities for different sectors to contribute to the development, design and potential uses of DDCI. These convenings should feature the

UMN-generated DDCI presented in the DNR Climate Explorer Tool as an entry point for using and interpreting DDCI;

- A derivative product from these workshops and webinars could include a video mini-series and tutorials that break the DDCI-related information into "digestible" pieces to serve as long-term resources for practitioners;
- Case studies showing DDCI "in action" are needed to help build support and provide necessary education around the use of DDCI. We suggest developing a series of case studies from different sectors showcasing how DDCI is used in real-world applications. These case studies could feature some Minnesota examples, as well as examples from other regions, and could follow a similar format to the case studies developed by the Water Utility Climate Alliance's Case Studies for Engineers; and
- The Climate Data Community of Practice (CoP) created by the Minnesota Department of Health should continue to provide an ongoing forum for knowledge exchange and peer learning. This CoP is an important resource for knowledge sharing and peer-to-peer learning and can evolve as climate models and adaptation practice expand and evolve in the future.

Future surveys should be designed to sample the full spectrum of industry in Minnesota. Survey responses were dominated by a few sectors, such as government, architecture/engineering, and consulting, with less input from academia, agriculture, and tribal representatives, for example. The data here provide a broad overview of how DDCI can be useful to a variety of Minnesotans, and they motivate projects that can begin immediately. To achieve a more comprehensive understanding, however, it is important to conduct focused surveys and interview targeted groups in detail.

Key Take-aways

1. Interest for dynamically downscaled climate projection data is high, with more than 80% of survey participants indicating that it would be important to them or their organization.
2. Proposed uses range from stormwater modeling and infrastructure planning to education and outreach.
3. End users want these data freely accessible.
4. Most respondents think funding should be shared across state, federal, non-profit, and academic entities.
5. There is a preference for the University of Minnesota to lead the development, delivery and maintenance of these data. The preference for UofM leadership was larger than for any other group.
6. Case studies, training opportunities and support for a long-term community of practice are recommended to help support climate projection data use across Minnesota. This is particularly important as the State accelerates its investment and prioritization of resilience and climate-smart decision making.

References

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About this Project

This survey and summary was produced by the Resiliency and Adaptation Action Team Dynamically Downscaled Climate Information workgroup and the Minnesota Climate Adaptation Partnership.

For more information please contact:

Dr. Heidi Roop
Minnesota Climate Adaptation Partnership
University of Minnesota
hroop@umn.edu

Jeffrey Meek
Minnesota Department of Transportation
Jeffrey.Meek@state.mn.us

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UNIVERSITY OF MINNESOTA

MCAP Minnesota Climate Adaptation Partnership