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State Service Foresters' Attitudes Toward Using Climate and Weather Information When Advising Forest Landowners

J. Stuart Carlton, James R. Angel, Songlin Fei, Matthew Huber, Tomas M. Koontz, Brian J. MacGowan, Nathan D. Mullendore, Nicholas Babin, and Linda S. Prokopy

Climate change threatens the health of global forests. Integrating climate information into forest management can help with climate change adaptation but doing so requires extensive engagement between scientists, practitioners, and decisionmakers. Forestry advisors are an important source of forest management information for many private landowners. However, little is known about forestry advisors' attitudes toward using and delivering climate and weather information. We surveyed state service foresters in the midwestern United States to assess their information needs and attitudes toward incorporating climate and weather forecasts into their practices. Most respondents (70%) indicated that they could find the short-term weather information they needed to advise landowners. Only 26% indicated that they could find the long-term climate information they needed. A majority of respondents indicated they would be interested in receiving long-term climate information. Results suggest that service foresters are open to using climate forecasts and information. Work needs to be done to ensure that the information presented is valuable to and usable by foresters.

Keywords: climate change, adaptation, service foresters, private landowners

Shifting temperature and precipitation patterns associated with climate change threaten the health of global forests (Christensen et al. 2007). Climate change not only will have direct effects on forest ecosystems through rising temperatures and shifts in precipitation patterns but also will have indirect effects by increasing the frequency of drought, wildfire, and insect outbreaks, while reducing tree vigor (Fettig et al. 2013). Tree species and populations that lack the genetic variability to adapt or the ability to adjust to new environments may be lost (Bellard et al. 2012). As drought and other weather-driven abiotic stressors increase or are amplified in a changing climate, increases in the frequency and severity of forest disease outbreaks could occur (Berg et al. 2006, Sturrock et al. 2011, Vose et al. 2012). Climate change, along with other factors, could also influence forest dynamic processes, causing a significant shift in forest composition (Fei and Steiner 2007, Nowacki and Abrams 2008, Fei et al. 2011). Forestland owners and those who advise them will have to chose from a number of short- and long-term adaptive strategies, from species selection to assisted migration (Williams and Dumroese 2013).

Improved integration of climate information into forest management can help private forest owners adapt to climate change, reduce the risk of economic loss, increase profits, and improve short- and long-term decisionmaking (Vose et al. 2012). Climate change-related tools and information are available to service foresters at both the national and regional levels. For example, at the federal level, the USDA Forest Service

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Affiliations: *J. Stuart Carlton (carltons@purdue.edu), Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN. James R. Angel (jimangel@illinois.edu), Division of Illinois State Water Survey, Institute of Natural Resource Sustainability, University of Illinois. Songlin Fei (sfei@purdue.edu), Department of Forestry and Natural Resources, Purdue University. Matthew Huber (matthew.huber@unh.edu), Department of Earth and Atmospheric Sciences, Purdue University; current affiliation: Department of Earth Sciences, University of New Hampshire and the UNH Institute for the Study of the Earth, Oceans, and Space. Tomas M. Koontz (koontz.31@osu.edu), The Ohio State University, School of Environment and Natural Resources. Brian J. MacGowan (macgowan@purdue.edu), Department of Forestry and Natural Resources, Purdue University. Nathan D. Mullendore (nmullend@purdue.edu), Department of Forestry and Natural Resources, Purdue University. Nicholas Babin (nbabin@purdue.edu), Department of Forestry and Natural Resources, Purdue University. Linda S. Prokopy (lprokopy@purdue.edu), Purdue University.*

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Climate Change Resource Center has developed the Template for Assessing Climate Change Impacts and Management Options (TACCIMO).[1] To ensure regional relevance, various tools and portals have also been developed, such as the University of Washington's Pacific Northwest Climate Maps[2] and the Wisconsin Initiative on Climate Change Impacts (WICCI).[3]

However, producing and integrating climate information into management decisionmaking require extensive engagement among scientists and decisionmakers (Agrawala et al. 2001, Lemos and Morehouse 2005, McNie 2007), a difficult task that requires stakeholder buy-in. The extent to which private forest landowners are willing to use this type of information and engage in these types of processes is not well understood. Grotta et al. (2013) found that family forest owners in the northwestern United States are often skeptical of climate science, particularly climate change models. The findings of Grotta et al. (2013) suggest that family forest owners will be more receptive to this type of information if the research is transparent and specific to local conditions and if the recommendations are framed as strategies to increase forest resiliency. There is also evidence from the agricultural sector that farmers are using limited weather and climate information when making decisions and would be willing to increase their use of such information if it meets their perceived needs (Arbuckle et al. 2013). Agricultural advisors have been found to be receptive to incorporating weather and climate information into their practices, potentially presenting an opportunity to engage in weather and climate information coproduction (Prokopy et al. 2013). State service foresters may serve a comparable role in forest management.

State service foresters (known in some states as district foresters) are public employees who advise forest landowners on management. Service foresters are important points of contact for state forestry agencies, the most common source of advice for family forest owners (Butler 2008). Family forest owners, defined as families, individuals, trusts, estates, family partnerships, and other unincorporated groups of individuals who own forestland (Butler 2008) collectively own more than 60% of the privately held forest in the United States. Service foresters are in many ways analogous to agricultural advisors and might also be a good audience for weather and climate outreach in the forestry sectors. However, little is known about forestry advisors' current use of or willingness to use climate and weather information as they advise private landowners. In addition, little is known about what climate and weather information forestry advisors want or need. In this exploratory study, we use survey research to investigate midwestern US service foresters' attitudes toward finding and using weather and climate information.

Methods

We administered a survey to a census of state service foresters in Illinois, Indiana, Missouri, and Ohio to assess current climate and weather information needs. Survey questions were developed by the authors based on extensive prior quantitative and qualitative work about agricultural advisors' attitudes toward climate change adaptation (e.g., Prokopy et al. 2013). The first part of the survey consisted of seven closed-ended questions about foresters' use of and interest in using climate and weather information when providing advice to landowners. The closed-ended questions used a 5-point Likert-type scale from "strongly disagree" to "strongly agree." Specific question wordings are given in Table 1. Descriptive statistics for the closed-ended questions were calculated with Stata 12.

The second part of the survey consisted of open-ended questions about whether landowners seek information to help them deal with extreme weather events, whether landowners discuss climate change with them, and what types of weather or climate information would help them do their job. Responses to the first two open-ended questions were coded by the primary author as either "yes" or "no" and were then recoded by another researcher. Responses to the third open-ended question were read by the primary author to establish response categories and were then coded both by the primary author and another researcher (Miles et al. 2014). Scott's Pi reliability (Scott 1955), which estimates intercoder agreement, accounting for agreement by chance alone, was calculated between the two coders before any disagreements were rectified. Coefficients of $\geq$0.80 are generally acceptable; values of $\geq$0.90 are ideal.

Names and e-mail addresses for all service foresters (n = 107) were obtained by searching each state's Division of Forestry website in March 2013. An initial contact e-mail with a link to the survey was sent to all service foresters listed on agency websites. Follow-up e-mails were sent 1 and 2 weeks later. The survey was administered in March–April 2013 via Qualtrics survey software.

Results

Seventy-six of the 107 service foresters responded to the survey, a 71.0% response rate. Because of the high response, no nonresponse checks were performed.

Closed-Ended Questions

The results of the closed-ended questions are presented in Table 1. Most respondents agreed that they could find the short-term weather information they need to advise landowners (69.6% agree or strongly agree; mean 3.58 of 5). Only 26.1% (mean 2.94) agreed or strongly agreed that they could find the long-term climate information they need to advise private landowners. Although most respondents agreed that they would use long-range outlooks of climate-related risks for tree species (66.7% agree or strongly agree; mean 3.51), only around half

Management and Policy Implications

Integrating climate and weather information into forest management practices can increase resilience to climate change by reducing the risk of economic loss, increasing profits, and improving short- and long-term decisionmaking. However, there is a need for information brokers to receive weather and climate information from climate scientists and interpret it for forest landowners. This article suggests that state service foresters are well suited for this role, because they frequently interact with private landowners and seek both medium- and long-term climate forecasts and information to help when they advise landowners. Future work needs to focus on the best way to help service foresters and other forestry advisors serve as information brokers by determining the best format and method for delivering climate forecasts and information. In addition, further work needs to be done to understand the barriers to incorporating this type of climate information into forestry consultations. By working closely together, forestry advisors and climate scientists can help to increase the resilience and long-term profitability of privately held forests.

Table 1. State service foresters' current climate and weather information needs (n = 76).

Item	Mean (SD)*	Strongly disagree (%)	Disagree (%)	Neither agree nor disagree (%)	Agree (%)	Strongly agree (%)
I can currently find all of the short-term weather information I need to advise private landowners on forestry decisions.	3.78 (0.92)	1.5	8.7	20.3	49.28	20.3
I can currently find all of the long-term climate information I need to advise private landowners on forestry decisions.	2.94 (0.91)	2.9	30.4	40.6	21.7	4.4
I would be interested in long-range climate outlooks to help me advise landowners of forest vulnerability to climate change.	3.29 (1.10)	10.1	10.1	30.4	39.1	10.1
I would be interested in learning about forest practices that can increase resilience to climate change.	3.61 (1.02)	7.3	5.8	27.4	58.0	11.6
I would like to have information about extreme weather in the next 5–10 yr to help me advise landowners on timber management.	3.46 (1.11)	10.1	5.8	23.2	49.3	11.6
If available, I would use long-range outlooks of climate suitability for different tree species.	3.33 (1.04)	7.3	13.0	26.1	46.4	7.3
If available, I would use long-range outlooks of climate-related risks for tree species (such as changes in pests or diseases).	3.51 (1.01)	7.3	8.7	17.4	59.4	7.3

* Responses on a 5-point Likert-type scale: 1 = strongly disagree, 5 = strongly agree.

(53.6% agree or strongly agree; mean 3.33) thought that they would use long-range outlooks of climate suitability for different tree species.

Open-Ended Questions

The first open-ended question asked whether landowners sought information about extreme weather events. Scott's Pi reliability for this question was 0.93. Twenty-nine of 62 respondents (46.8%) indicated that landowners sought information about extreme weather events. However, many (11 of 29, 37.9%) of those responses indicated that landowners typically only sought this information after extreme weather events, as exemplified by this quote: "After a big storm, landowners often call with questions about the health of their trees—they often call us for information."

The second open-ended question asked whether the respondents discussed climate change with landowners. Scott's Pi reliability for this question was 0.91. Twenty-eight of 62 respondents (45.2%) reported discussing climate change with landowners. Some respondents indicated hesitance to discuss climate change with landowners because of the controversy surrounding the issue, as illustrated by this quote: "(I don't discuss it) unless they bring it up. So many people get turned off when you start to talk about 'global warming': they think it's all political."

The third open-ended question asked the respondents what types of weather or climate information would help them do their jobs. Categories that were mentioned by more than one respondent are listed in Table 2 and are described below.

Table 2. Types of weather and climate information desired by respondents (n = 76).

Type of weather or climate information	% respondents
Seasonal and intermediate-term climate forecasts	41.9
Long-term future climatic conditions	17.7
Insect and disease pattern changes	9.7
Accurate short-term forecasts	9.7
Historical comparisons	9.7
Forest climate response and vulnerability	8.1
Future extreme events	8.1

Column values do not sum to 100% because responses could be categorized in multiple categories.

Seasonal and intermediate-term climate forecasts describes interest in near-term (<5-year) weather and climatic conditions, such as whether or not the coming winter will be much colder than average or the likely precipitation patterns for the spring. This includes forecasts of fire weather and drought for the upcoming season. Scott's Pi reliability for this category was 0.91.

Long-term future climatic conditions describes interest in future climatic conditions and trends. This is often focused on trends, such as 5- to 10-year rain patterns, fire trends, and long-term temperature shifts. Scott's Pi reliability for this category was 0.88.

Insect and disease pattern changes describes information on potential changes to insect and disease outbreaks under changing climatic conditions such as the impacts of shifting winter weather patterns and other climate phenomena. Scott's Pi reliability for this category was 0.84.

Accurate short-term forecasts describes interest in accurate temperature and/or precipitation forecasts for the next 1–2 weeks. Scott's Pi reliability for this category was 0.83.

Historical comparisons indicates an interest in historical weather and climate data to compare with current conditions. Scott's Pi reliability for this category was 0.86.

Forest climate response and vulnerability describes interest in information about how the forest is likely to be affected by future warming or cooling trends. This includes concern about the response of individual tree species to predicted climate conditions. Scott's Pi reliability for this category was 0.85.

Future extreme events describes interest in future extreme events (beyond the upcoming season) such as prolonged drought or fire. Scott's Pi reliability for this category was 0.87.

Discussion

The results indicate that many of the service foresters surveyed were interested in using weather and climate information to help them advise landowners. The majority of respondents (69.6% agree or strongly agree) were interested in information about forest practices to increase resilience to climate change. The open-ended questions indicated that desired information ranged from seasonal drought and fire forecasts to models of long-term shifts in weather patterns. This interest implies that many foresters are concerned about the impacts of climate change on the landowners they advise. As the responses to the open-ended questions indicate, though, the interest about climate impacts ranges from immediate impacts to longer-term concerns.

Although the respondents indicated stronger interest in medium and long forecasts and models, most respondents (69.6% agree or strongly agree) indicated that they could currently find the short-term weather information they need to provide advice. This fact, combined with the answers to open-ended questions indicating that respondents were interested in increased weather forecast accuracy, implies that at least some advisors are currently incorporating short-term weather information as they advise forest landowners. Prior research found that short-term forecasts were important to agricultural advisors (Prokopy et al. 2013); this study suggests, perhaps unsurprisingly, that forestry advisors think short-term weather information is important for providing advice as well.

Opportunities for Outreach

The results suggest opportunities for outreach about forestry and climate change. Nearly 70% of respondents agreed or strongly agreed that they would be interested in learning about forest practices that can increase resilience to climate change. The open-ended responses indicated that some of the foresters are interested in learning about the response of specific tree species to climate change and how the forest is expected to respond to predicted climate change. However, the fact that most respondents indicated that forest landowners do not seek out climate and weather information raises the question of whether landowners are getting this information in a management context and, if so, from where. This might indicate an additional opportunity for educating landowners.

It is important to note that many respondents expressed disinterest in receiving or learning about climate information. For example, 30.4% of respondents strongly disagreed, disagreed, or were uncertain that they would be interested in learning about forest practices that can increase resilience to climate change. Similarly, 50.7% of respondents strongly disagreed, disagreed, or were uncertain that they would be interested in long-range climate outlooks to help them advise landowners of forest vulnerability to climate change.

There are several potential explanations for the relatively high number of respondents who are not interested in learning or being provided information related to climate. It is possible that the climate information they have received to date has not been useful or not specific to the region, reducing their interest in this type of information. Relatedly, it is possible that the respondents do not believe that they have the capacity to help forest landowners adapt to climate change, either because climate change is a wicked problem (i.e., unsolvable) or because the scope of the advice they typically provide is insufficient to spur significant climate adaptation. This latter possibility is supported by prior research in which belief in the ability to adapt to climate change was an important factor in whether or not Swedish forest owners took adaptive action (Blennow and Persson 2009). Another potential explanation is that there is a (political, social, or organizational) cost to incorporating this type of information for service foresters. In the former two cases, those who develop climate forecasts and tools for foresters need to carefully plan outreach in a way that emphasizes the usefulness of the forecasts and tools. Forestland owners often have mixed perceptions or skepticism about climate science, particularly regarding the extent to which research is driven by politics, money, or ideology (Grotta et al. 2013). These attitudes and beliefs may discourage service foresters from delivering and promoting climate-related management practices. Future research should explore the implicit barriers to using climate information and how to overcome them.

Respondents were more able to find and were more interested in receiving short-term rather than long-term weather and climate information. These results may reflect the primacy of immediate, actionable information relative to longer-term concerns, but they may also indicate that service foresters believe they operate on a different time scale than climate modelers. These two groups may be able to work together to coproduce information and tools to help climate adaptation, but connecting them will require collaboration to ensure that the weather and climate information being produced is useful and usable to different audiences. Time frame is important: if foresters will not or cannot give advice based on 30- to 50-year projections, then the value of those projections is limited. This survey did not ask detailed questions about which time frames are important to service foresters. Future work analyzing the most useful time scales for forest climate forecasts would be valuable.

There are a number of potential explanations for the relatively low interest in accessing and using long-term climate information. First, existing tools and information portals may be difficult to understand or use. Second, many of these existing tools are either not customized for the region or not applicable at the forest management scale. The development or improvement of online decision support tools probably will increase the use of long-term climate change information in forest management on private lands. Tools will be most effective if they are user-friendly and able to be operated by advisors who are not experts in climate science, specific to regional forest cover types, and provide specific recommendations at a spatial and temporal scale appropriate for making forest management decisions. However, because the results of this study suggest that advisors may not be aware of existing resources, the adoption of decision support tools to address long-term climate change-related forest management issues may ultimately rely on professional development and training.

Desire for Historical Information

In the open-ended questions, 9.7% of respondents indicated that they were interested in historical weather information. Although 9.7% is a low number of respondents, it may be meaningfully high because of the open-ended nature of the question and the fact that no particular answers were prompted. The interest in historical information, both in terms of data for analysis and analogs to current conditions, is similar to findings in a prior study of agriculture advisors (Prokopy et al. 2013). The fact that multiple sectors have indicated the importance of historical data may shows that presenting information in historical terms is an important framing mechanism for discussing weather events and the impacts of climate change. It has been proposed that geographical analogs (i.e., regions that are geographically similar to a given area) might be effective tools for climate communication (e.g., Veloz et al. 2012): comparing projections to historical analog years may also be effective.

Foresters as Audience for Climate Change

Given the increasing importance of incorporating climate and weather information into forest management (Vose et al. 2012), it is critical to communicate this information to key stakeholders such as forest landowners. However, the source either developing or communicating climate change information can influence the response to the information. For example, Oregon forest landowners generally did not trust what they read or heard in mass media about climate change. The same group also expressed distrust in scientific information and the scientific community but did recognize specific people as credible sources of information (Grotta et al. 2011). Advisors like the ones surveyed in this study may be a receptive and appropriate audience for future climate outreach. In addition, many forest advisors may be well-positioned to pass on knowledge about climate and forestry to forest landowners, because almost half of the respondents said landowners come to them for information about extreme weather events and about 45% said they discussed climate change with landowners. Prior research (for review, see McNie 2007) indicates that useful climate information must be perceived as salient, credible, and legitimate. The public's trust in specific individuals and advisors' receptiveness to incorporating climate information suggest that retaining qualified, trusted service foresters and offering training and support in the use of climate information may help increase the perceived salience, credibility, and legitimacy of climate change information, helping private landowner adaptation to climate change.

However, trust, or lack thereof, may not explicitly determine the level of climate change dialogue between advisors and forest landowners. Future work might explore the discrepancies between foresters and private landowners who discuss climate change and those who do not, because the differences might provide valuable information for designing outreach and planning coproduction of climate information and adaptation tools. In addition, although this survey suggests the types of information foresters might seek, it does not address the best processes or mechanisms for making this type of information available to them. Future work should explore the best delivery methods to ensure that climate information is useful to foresters.

Conclusion

One of the difficulties in providing climate information to forest landowners, advisors, and decisionmakers is finding information that is relevant and usable, rather than just increasing the supply of scientific information (McNie 2007). This study shows several specific areas of interest to service foresters in the midwestern United States, namely practices to increase resilience in climate change, information on extreme events, and species-specific risk outlooks. More generally, this study shows that service foresters are receptive to using climate information and are potentially an important audience for future engagement.

However, many foresters' lack of access to or interest in long-term weather and climate information might be problematic. Trees are long-lived, foundational species for many ecosystems, supporting species diversity and ecosystem processes and services. Long-term climate information is essential to help forests remain resilient in a climate that is changing rapidly relative to tree lifespans. Foresters' interest in and use of this information need to be supported by developing new and maintaining existing user-friendly, region-specific, and management-applicable tools to address long-term climate change-related forest management issues. As others have pointed out (e.g., Fettig et al. 2013), a collaborative, multidisciplinary effort between forest managers, forest advisors, and scientists is required to promote long-term learning, adaptation, and resilience.

Endnotes

1. Template for Assessing Climate Change Impacts and Management Options: www.fs.fed.us/ccrc/tools/taccimo.
2. Pacific Northwest Climate Maps: cses.washington.edu/cig/maps/.
3. Wisconsin Initiative on Climate Change Impacts: www.wicci.wisc.edu/.

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