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Abstract: This article compares responses from two surveys in Florida to estimate how climate literacy has evolved as a result of the partnership of the Southeast Climate Consortium with the Cooperative Extension Services for diffusion of climate information. A 32-question survey was developed and posted to the Internet in 2004 and again in 2009. We found that climate knowledge evolved over the 5-year interval in two principal ways. Knowledge and willingness to use and provide information to end users increased on average, and agents had refined what types of climate information are actually useful and to what extent for their clients.

Introduction

Seasonal climate variability plays an important role in the production risks faced by farmers. A consortium of seven universities, four of which are land-grant institutions, the Southeast Climate Consortium (SECC) is an organization dedicated to the application of climate sciences to helping farmers manage risks associated with seasonal climate variability and long-term climate change (Fraisse, Breuer, Zierden, & Ingram, 2009). Information provided includes seasonal forecasts based on El NiÃ±o-Southern Oscillation (ENSO) and a wildfire forecast based on the Keetch-Bryam Drought Index (KBDI).

The El NiÃ±o Southern Oscillation (ENSO) phenomenon is the strongest driver of interannual climate variability around the world and affects crop production in many regions. ENSO phases are characterized by sea surface temperature anomalies in the eastern equatorial Pacific Ocean that produce effects on seasonal climate at great distances in many regions of the world, including the U.S. Gulf Coast (Ropelewski & Halpert, 1996; Cane, 2001). The Keetch-Byram drought index is a continuous reference scale for estimating the dryness of the soil and duff layers of the forest floor (Brenner, 1991).

Early in 2004, the SECC decided to work with the Florida Cooperative Extension Service (FCES) as a boundary organization and hired the first climate Extension specialist in the country. Boundary organizations are defined as third parties, intermediary organizations, brokers, and information intermediaries that are in between technology developers and end users or stakeholders. They act in diffusion, in support of decision-making, in setting standards, and in technology evaluation (Howells, 2006; Miller, 2001; Mantel & Rosegger, 1987). They also play the role of catalysts of change such as initiating change within science networks and more targeted end users (Callon, 1994; Callon, 1980). The Florida Cooperative Extension Service serves a two-way boundary role between a research consortium—the SECC—and farmers in the state of Florida.

Several researchers stress that intermediaries can play useful roles in helping farmers interpret and apply scientific forecasts (Ingram, Roncoli, & Kirshen, 2002; Nelson, Holzworth, Hammer, & Hayman, 2002). The SECC has chosen to work with county Extension faculty because of the influence they are likely to have on the adoption of climate forecasts among their local clientele. Another reason for this choice was that the FCES could play a feedback role by gathering suggestions from farmers and relaying them to the scientists.

Seasonal climate forecasts have shown promise in determining planting dates, irrigation needs, crop types, fertilization, and planting varieties. Expected market conditions, pests and diseases, and the need for farm insurance for upcoming seasons can all be estimated using seasonal forecast (Fraisse, Zierden, Breuer, Jackson, & Brown, 2004). In Florida, participatory methods were used to elicit input into the development of a Web-based decision support tool <AgroClimate.org> that enables farmers and Extension agents to explore, for example, the yield impacts of crop management responses to forecast climate scenarios (Breuer, Cabrera, Ingram, Broad, & Hildebrand, 2008; Jagtap et al., 2002).

This article presents results from two surveys—conducted by researchers from the SECC in 2004 and 2009—of Extension agents' attitudes, knowledge of, and willingness to use and recommend climate variability information. The goal of the study was to summarize and analyze the evolution of responses regarding climate of Florida Extension agents over time. The specific objectives of the study were to determine Extension agents' knowledge and attitudes of seasonal climate forecasts and measure the evolution of these variables after a 5-year period An additional objective was to take an impartial look at FCES as a boundary organization for the SECC to determine future strategies with regard to the diffusion of seasonal climate variability forecasts.

Methods

A survey instrument with 32 questions was designed and uploaded to the Internet in 2004. Two emails were sent out to the target audience requesting they fill in the survey. Participation was voluntary and anonymous. The sample population of respondents in 2004 was 166 Extension agents (N = 166). A second, identical survey was conducted with the same target audience (a purposive sample) in 2009. This survey was also conducted over the Internet. Respondents numbered 119 in 2009 (N = 119).

Although the sample population was purposive, they were—by definition—a diverse group. This assumption rests on the fact that Florida has a very diverse agricultural sector. Thus, agents included were from fields such as winter vegetables, row crops, tropical and sub-tropical fruit, pasture and livestock, ornamentals, forestry, and dairy production, among others. All agents have access to high-speed Internet connections, and many offer education to multiple production sectors or to several counties. Results were statistically analyzed for significance. Survey data is available upon request from the first author.

Findings

All findings reported in this section are based on response numbers of 166 in 2004 and 119 in 2009. The demographics of the two samples were quite similar. In both surveys, the respondents reported working on a wide variety of agricultural, water, and forestry issues. In 2004, only 50% (N=83) stated that it is helpful to know the coming season's climate. By 2009, 85% (N=101) felt that this information was helpful.

Extension agents' knowledge of seasonal climate variability and its potential applications was explored. On average, knowledge and positive attitudes toward the use of seasonal climate forecasts increased some 40% over a 5-year period. Responses showed that agents had good knowledge of ENSO-driven climate patterns when it came to precipitation. Responses about temperature variations among the three ENSO phases were less encouraging except for the neutral phase. The percentage of numbers that disagreed fell from 18% in 2004 (N=30) to 14.5% in 2009 (N-17). As far as seasonal temperatures aiding in predicting freeze events, the percentage of respondents that agreed that it was possible fell from 67.5% in 2004 (N=112) to 32.7 in 2009 (N=39).

Agents were asked if they specifically accessed Agroclimte.org and which forecasts interested them. The KBDI wildfire risk tool remained constant, whereas use of the El NiÃ±o â— La NiÃ±a phase forecast rose significantly. The number of agents who consult the farmer's almanac fell. This is a behavioral change worthy of highlighting. The number of agents who wished to provide climate forecast advice to their clients remained constant at 50% (N=83 in 2004; N=60 in 2009). As far as the medium for delivering climate information, the notable change was a higher number of agents citing meetings as the best option. Email as a medium for diffusion also grew in the opinions of the sample population over the 5-year period.

The sample population was asked who is more likely to benefit from the use of climate forecasts to be more successful. Responses revealed that row crop farmers rose; vegetable farmers remained stable; nursery operators dropped; and orchard growers dipped slightly from 2004 to 2009. In addition, livestock producers nearly doubled 5 years after the baseline survey. The potential for successful use by water resource managers rose from 58% (N=96) to 72% (N=86), while Extension agents felt that climate forecasts would be helpful for their own use rose from 79% in 2004 (N=131) to 87% (N=103) in 2009. Potential use by fire managers and tourist industries fell, whereas potential positive use by landscapers remained fairly constant at just over 50%.

Because of the large number of cattle producers in Florida, agents were asked a similar question referring to this activity. These activities grew in the opinion of the sample population between 2004 and 2009: storage planning, field rotation, stocking rate, feed purchases, herd size, marketing, and labor costs. The number of agents who said that climate forecasts were not useful fell from 7% (N=4) to 4% (N=5) over the 5-year period of study.

Conclusions and Implications

Caution should be used when attempting to extrapolate results of the study to other areas; however the case study does offer interesting insights, some of which are likely to be generalized and transferable. Extension agents in Florida are aware of the existence of an inter-annual climate phenomenon called El NiÃ±o, Neutral, or La NiÃ±a years and its potential impacts on their clientele's work. Awareness is an important first step in any diffusion process. Awareness increased from 2004 to 2009 in general.

Most of the Extension agents consult weather forecasts on a daily basis and rely on them on a weekly basis. The habit of consulting weather forecasts is promising in that a habit is already formed and this pattern might be extended to climate forecasts. This fact along with a vast majority agreement on the usefulness of climate forecasts indicates Extension agents in Florida are highly likely to use climate information. These tendencies rose from 2005 to 2009.

Extension agents prefer translated applications of ENSO forecasts rather than purely climatic forecasts, although they perceive the reliability of the prediction decreases during the translation process. They requested forecasts to be at least correct 75% in 2004, rising to 80% in 2009. This is a threshold above which agents can confidently recommend. Agents have had 5 years of time in which confidence in the forecasts slowly built up.

The fact that Extension agents would prefer forecasts that have already been interpreted rather than purely climatic predictions supports the information and formats available on AgroClimate.org. An interesting finding was that agents knew about precipitation changes in their areas during different ENSO phases but were not sure about temperature changes. This is perhaps due to agents' actually experiencing wetter or drier conditions as producing effects they could see plainly. Conversely, small temperature changes during different ENSO phases may be more difficult to detect and internalize as personal experiential knowledge. A small increase or decrease in average temperatures does not typically affect the crops grown in Florida (except for freezes).

The 2004 survey served as a baseline to which future surveys could be compared. The 2009 survey was precisely a follow-up that we used to measure the evolution (devolution) of the FCES as a useful and powerful boundary organization. Results indicate that the SECC indeed has chosen the appropriate boundary organization with which to work. It is useful to note that the FCES is a dynamic, constantly shifting group of human beings (aside from a service). The opinions, degree of knowledge, and willingness to use seasonal climate forecasts over time evolves as each member of the FCES considers whether climate information will be useful for his or her clientele. The general upward trend of knowledge, willingness to use, and potential adaptations further confirm that climate literacy continues to grow among members of the FCES.

Our results support earlier work by Cash, Borck, & Patt, (2006), who found that for communication and adaptations to be effective in response to seasonal climate information based on El NiÃ±o Southern Oscillation (ENSO), the science-intermediary-end user communities should work together toward co-production of knowledge. One of the keys to success may involve understanding and managing the boundaries between science and policy and across disciplines, scale, and domains of knowledge to create information that credible, and legitimate to multiple audiences (Cash, Borck, & Patt, 2006).

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