RESEARCH ARTICLE

J. For. 114(5):524–531
http://dx.doi.org/10.5849/jof.15-033

biomass, carbon & bioenergy

Nonindustrial Private Forest Landowner Beliefs Toward Climate Change and Carbon Sequestration in the Southern United States

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Carbon storage utilizing forests is one of the most important strategies for implementing climate change mitigation. Considering the potential of carbon storage in forests owned by nonindustrial private forest (NIPF) landowners, it is imperative to understand their views regarding climate change and carbon sequestration. This study segments NIPF landowners in the southern United States on the basis of their beliefs toward climate change and carbon sequestration. A K-means cluster analysis was used to segment their climate change and carbon sequestration beliefs into three broad clusters: skeptic, supportive, and neutral landowners. The results indicated that a majority of southern landowners (47%) held neutral beliefs, whereas the proportions of supportive and skeptical clusters were 35 and 18%, respectively. These belief clusters differ with respect to landowner income and education as well as their landownership and management characteristics. In terms of the future impact of climate change, 40% of landowners in the supportive cluster expected timber yield to fluctuate more than 5% on average but only 12% in the skeptic cluster expected it, whereas 24% of landowners in neutral cluster anticipated the same impact. Results of this study provide insights on the current beliefs of NIPF landowners toward climate change and carbon sequestration as well as strategies for effectively communicating climate change and carbon sequestration information to them.

Keywords: family forest, risk perception, cluster analysis, attitudes, communication

Scientists have documented that human-induced greenhouse gas emissions have largely contributed to environmental changes such as warming of the atmosphere and oceans, changes in water cycles, and increases in global mean sea level (Intergovernmental Panel on Climate Change 2014). Climate change is expected to impact forest species distribution, productivity, and the frequency and intensity of disturbance regimes (Kirilenko and Sedjo 2007, Vose et al. 2012). Synthesis of documented changes and future predictions has led to scientific consensus that with the current unabated increase of greenhouse gases into the atmosphere, climate change will accelerate during the century (Intergovernmental Panel on Climate Change 2014). However, these research findings are not accepted by large segments of the American public (Leiserowitz et al. 2012). Such dismissal of the unequivocal scientific consensus on climate change and its causes is largely political rather than based on any factual evidence (Morris et al. 2014).

Over the last few decades, large-scale, long-term land-use practices have gained attention as an option for climate change mitigation (Murphy et al. 2009, Stone 2009). Forest carbon sequestration is one of the most effective strategies for mitigating greenhouse gases in the atmosphere (Malmsheimer et al. 2008). Forests provide this ecosystem service along with additional contributions such as clean water, biomass resources, timber, and habitat. The US Environmental Protection Agency (2013) estimated that land use, land-use change, and forestry activities sequester approximately 15% of total CO_2 emission in the United States, and the sequestration rate increased by 18% between 1990 and 2012. With appropriate cli-

Received March 10, 2015; accepted December 28, 2015; published online February 11, 2016.

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Acknowledgments: *Funding for this study was provided by the Pine Integrated Network: Education, Mitigation, and Adaptation Project (PINEMAP), a Coordinated Agricultural Project funded by USDA National Institute of Food and Agriculture Award #2011-68002-30185. Also, we acknowledge the Forest and Wildlife Research Center, Mississippi State University.*

mate change mitigation and carbon sequestration policy, there is a potential to increase forest carbon storage in the southern United States (Adams et al. 2011, Galik et al. 2013).

In the southern United States, nonindustrial private forest (NIPF) ownership of forestland is prevalent, and the ownership group controls 58% of the total forest acreage (Butler and Wear 2013). Galik et al. (2013) estimated that NIPF landowners store about 60% of the regional forest carbon under private ownership, and there is a potential to increase carbon storage on NIPF lands with longer rotations or management interventions. However, the degree of landowner participation in climate change mitigation and carbon sequestration activities largely depends on their attitudes toward climate change and carbon sequestration (Lindsay et al. 2011, Miller et al. 2012, Thompson and Hansen 2013). In addition, each individual landowner's belief about an object is related to his or her attitude because of the evaluative aspects of each belief, and the attitude could be described in terms of his or her salient beliefs and subjective evaluations as described in the expectancy-value model (Fishbein 1963). In other words, landowner belief toward climate change and carbon sequestration is an important covariate on his or her attitude-behavior relationship. Furthermore, the theory of planned behavior predicts that a positive attitude toward an act or behavior, favorable social norms, and a high level of perceived behavioral control are the best predictors for forming a behavioral intention and a displayed behavior or an act (Fishbein and Ajzen 2010). Influencing landowner beliefs and attitudes toward climate change and carbon sequestration could contribute to affecting their intention and participation behavior toward climate change mitigation activities in the southern United States. Moreover, persuasive communication strategies intended to influence landowner beliefs and attitudes (Ajzen 1992) would be required for connecting with landowners. Understanding NIPF landowner beliefs toward climate change and carbon sequestration is therefore critical for promoting forest carbon sequestration in this region. Grotta et al. (2011) found varying degrees of skepticism about climate change among family forest owners in the Pacific Northwest. Similarly, Thompson and Hansen (2013) found that only 37% of NIPF landowners in the United States held a positive attitude toward enrollment in carbon trading. Based on a survey of the American public, the Leiserowitz et al. (2012) report segments climate change beliefs and attitudes of the American public into alarmed, concerned, cautious, disengaged, doubtful, and dismissive.

The goal of this study is to identify beliefs toward climate change and forest carbon sequestration of NIPF landowners in the southern United States. The specific study goals are the following: to segment NIPF landowners into distinct clusters based on their beliefs toward climate change and carbon sequestration; to compare differences among the belief clusters in terms of the respondents' socioeconomics, forest property characteristics, and risk perception; and to identify major information sources and preferred communication formats for landowners in each segment. This study will be helpful in designing and implementing future climate change and carbon sequestration policy and programs involving NIPF landowners in the southern United States.

Methods

Study Area

The study involved NIPF landowners with forestlands in selected southern states. Counties in the selected 11 states[1] without any loblolly/shortleaf (*Pinus taeda/Pinus echinata*) or longleaf/slash (*Pinus palustris/Pinus elliottii*) pine group as defined by the US Department of Agriculture (USDA) Forest Service Forest Inventory and Analysis Program were excluded from the study area. Tennessee was not included because of its relatively smaller pine forest area. A contingent rating scenario included in our survey questionnaire required enough responses from NIPF landowners with pine forest types, but due to the lack of such an exclusive database of the landowners, counties lacking the forest types were excluded. The names and addresses of NIPF landowners were purchased from ListGIANT,[2] a private database vendor that compiles landowner lists based on county tax roll records. The database included information and corresponding addresses of the owners as well as the location of their forest properties. Thompson and Hansen (2013) also used the same vendor database for their NIPF forest carbon sequestration study.

Data

To determine the appropriate sample size for the mail survey, we considered expected response rate, population size, desired precision, and other factors as described in Dillman's tailored design method (Dillman 2007) for statistical analyses. Based on this, 5,000 NIPF landowner addresses were randomly selected from the database for the final survey. To finalize the survey instrument, a draft survey instrument was sent to forestry experts active in the field of NIPF landowners for their comments. Subsequently, the survey was pretested among NIPF landowners at two separate County Forestry Association meetings in Jefferson Davis and Lee counties in Mississippi. Comments received from the pretests were used to revise the survey instrument.

The survey instrument included three sections: forestland characteristics, environmental preferences, and socioeconomic details. The forestland characteristics questions were related to landowners' property size and type, ownership goals, and forest management strategies. Their climate and carbon sequestration belief statements were included in an environmental preference section, and the last section included their income, education, and demographics related questions.

Management and Policy Implications

Nonindustrial private forest (NIPF) landowners' diverse belief types and skepticism toward climate change and carbon sequestration could be barriers to successful development and implementation of policies and programs related to climate change mitigation and adaptation. This study suggests that there is a need for reaching out to landowners with education and consultation programs related to climate change and carbon sequestration, including local impacts of climate change. Extension agents and service professionals are better suited to communicate this information to landowners; however, a tailored communication approach based on landowner belief types would be more effective and a realistic approach to meet landowner needs. In particular, landowners with a neutral belief type could be a major landowner group in which to focus outreach programs to reduce controversy and improve the effectiveness of such programs.

The survey was then conducted in the fall of 2013 following Dillman's tailored design method (Dillman 2007) for conducting mail surveys. We conducted three mailings to increase the response rate. The time between successive mailings to the nonresponding landowners was approximately 3–4 weeks. Each mailing included an individually signed cover letter, a survey questionnaire, and a postage-paid return envelope. In addition, a reminder postcard was sent to nonresponding landowners before the second and third mailings were conducted.

Nonresponse Bias

To identify potential nonresponse bias, two different analysis approaches were used. First, a comparison was made between responding and nonresponding landowners in terms of four key questions from the survey. A random sample of 50 nonresponding landowners were contacted by telephone and asked key questions related to their forestland size, management behavior, climate change attitude, and education. A comparison of *t*-test results was made between the two samples. The other approach included a nonresponse bias test using late-responding landowners ($n = 100$) as proxies for nonrespondents. In addition, the socioeconomic variables gender, age, education, and income were compared with the Butler and Leatherberry (2004) and Butler et al. (2014) description of southern landowners.

Statistical Analysis

Respondent ratings of climate change and carbon sequestration statements were used to segment landowners into distinct belief clusters. The clustering approach used a Likert scale rating of the statements from 1 (strongly disagree) to 5 (strongly agree) with 3 indicating a neutral category. Respondents scoring a response for an individual statement on a numerical scale between 1 to 5 indicated landowner strength of belief toward each statement. Missing, invalid, or incomplete responses were not included in the analysis. Incomplete responses were removed on a case-by-case basis.

As a first step to clustering, hierarchical cluster analysis was conducted to explore the potential number of clusters. The Ward's minimum variance method, which minimizes within sums of squares distance between clusters was used to identify clusters of reasonable proportions. Then, a graph plot of within-groups sums of squares against the number of clusters was computed. There was a sharp decrease in sums of squares from one to three clusters but little decrease after three clusters, which suggested a potential three-cluster solution. Now, we conducted nonhierarchical K-means analysis, which relies on Euclidean distances between cluster centers. K-means clustering has been the common approach for NIPF landowner segmentation studies with Likert scale data (Salmon et al. 2006, Majumdar et al. 2008, Surendra et al. 2009, Kuipers et al. 2013). In this method, the final cluster centers are the means of observations assigned to each cluster at complete convergence. Minimization of the sums of squares distances from cluster means ensures that observations very close to each other get grouped into the same cluster, whereas the relatively distant observations fall into separate clusters. However, K-means clustering could be sensitive to data order or initial selection of the centroid. The often recommended approach for K-means clustering is to attempt multiple random initial configurations and use the best one as the centroid (R Core Team 2013). In addition, this option requires invoking a seed function to ensure that the results are reproducible. As suggested by R Core Team (2013), we specified 25 initial random configurations for selecting the initial seed. The R software package NbClust, which compares 30 different indices to determine number of clusters and suggests the best clustering option (Charrad et al. 2014), was used for this data set. It is one of the recent R software packages available for determining optimal numbers of clusters and validating the results. As in the hierarchical method, it also suggested that this data set was best suited for a three-cluster solution. In addition, a statistical comparison was made among clusters in terms of selected key variables not included in clustering for validating cluster numbers. The key variables were socioeconomics (age, income, education, gender, forest management plan availability, future plan to harvest, and absentee ownership), forest property characteristics (total acres and parcel numbers), and risk perception (rating the risk of losing trees from natural disaster and expected climate change impact on average timber yield). The analysis of variance (ANOVA) Tukey procedure was conducted to test the statistical difference among clusters for continuous variables, and the Pearson χ^2 test of independence was conducted to test the association among clusters for categorical variables. In addition, their current sources of forestry information and preferred formats to receive such information were summarized in graphical form for each belief segment. The list of landowner forestry information sources and preferred formats was adopted from Salmon et al. (2006).

Results

There were 4,671 usable addresses after accounting for bad addresses, deceased individuals, and those with no forestland from 5,000 randomly selected addresses. A total of 735 completed survey questionnaires were returned resulting in a response rate of 15.8%. Thompson and Hansen (2012) also had a similar response rate (15.9%) on a nationwide study of NIPF landowner attitudes toward carbon sequestration and trading. There could be several reasons for the low response rate in our study. One of the reasons could be the complicated contingent rating scenario that was built into the survey instrument. In addition, the political sensitivity of the climate change issue may have contributed to the lower response rate. The survey instrument also included items that required a substantial understanding about climate change and carbon sequestration as well as detailed information about landowner forest management operations; some landowners may have lacked interest or sufficient knowledge to complete the survey. Results from the nonresponse bias tests showed that there was no statistical difference ($P > 0.10$) between responding and nonresponding landowners, suggesting that nonresponse bias was not a concern. The average age of the respondents was 64 years, whereas the proportion of landowners younger than 45 years was less than 5%. The most frequent income category was annual household income greater than $75,000, with 9% of landowners reporting less than $25,000 income. The most frequent education category was high school or GED (30%), whereas 34% of respondents had a high school or less education and 29% held an undergraduate degree. The respondents were mostly male (83%). Generally, these results are similar to those reported in Butler and Leatherberry (2004) and Butler et al. (2014) that NIPF landowners were mostly male, relatively older, and affluent and have more frequent formal education such as a high school and/or undergraduate degree.

Table 1. Distribution of NIPF landowners in the Likert scale rating of climate change and carbon sequestration statements in a mail survey (n = 616) in the southern United States.

Statement	Rating scale (%)				
	1: Strongly disagree	2: Disagree	3: Neutral	4: Agree	5: Strongly agree
Human activities are contributing to climate change	4	5	26	49	16
Climate change is scientifically proven	10	14	37	31	8
Climate change will substantially affect my forest	8	17	49	22	4
Carbon sequestration is an effective way to mitigate climate change	3	5	50	36	6
Carbon sequestration on my forestland aids in mitigation of climate change	3	5	51	36	5
Carbon sequestration could generate additional revenue for me	2	9	59	26	4
I am interested in exploring carbon sequestration opportunities on my forestland	5	7	43	33	12

Table 2. NIPF landowner belief clusters based on Likert scale rating of climate change and carbon sequestration statements, and mean value of their ratings in each statement by belief clusters.

Statement	Belief clusters		
	Skeptic	Supportive	Neutral
Human activities are contributing to climate change	2.5	4.1	3.7
Climate change is scientifically proven	1.5	3.7	3.2
Climate change will substantially affect my forest	1.8	3.3	3.0
Carbon sequestration is an effective way to mitigate climate change	2.6	4.0	3.1
Carbon sequestration on my forestland aids in mitigation of climate change	2.6	4.0	3.0
Carbon sequestration could generate additional revenue for me	2.9	3.6	2.9
I am interested in exploring carbon sequestration opportunities on my forestland	3.0	4.1	3.0

Table 3. Number and percentage of NIPF landowners, average age, average acres of forest land, and average parcel numbers by belief clusters in the southern United States.

Item	Belief clusters		
	Skeptic	Supportive	Neutral
Cluster (n)	112	218	286
Cluster (%)	18	35	47
Average acres of forest land	258.3	369.7*	245.1*
Average number of forest parcels	1.9	2.2*	1.7*
Average age (yrs)	64.9	63.9	65.0

* Statistical difference between belief clusters in ANOVA posthoc Tukey significance test at the $\alpha = 0.10$ level.

Cluster of Landowner Beliefs

The distribution of answers to the seven statements related to climate change and carbon sequestration formed the basis for segmenting landowner belief types. The proportion of landowners on the "neutral" rating scale varied from 26 to 59%, depending on the statement. The "neutral" rating was the highest value for all but the statement "Human activities are contributing to climate change," which had "agree" at its highest rating (Table 1). Among those who preferred to have an opinion, a relatively higher proportion of landowners were in the "agree" or "strongly agree" rating category than in the "disagree" or "strongly disagree" scale.

The clusters were labeled skeptic, supportive, and neutral based on the mean value of their rating to each climate change and carbon sequestration statements provided in the survey (Table 2). The rating scale was between 1 and 5 indicating "strongly disagree" to "strongly agree," so the average values indicated strength of belief in each statement by cluster membership. Because of the nature of cluster analysis to maximize between-cluster variations, the mean values of each statement were significantly different among clusters at a 1% significance level. In the supportive cluster, the mean value of the rating in each of these statements was clearly greater than the mean values in other clusters. Conversely, the mean values in the skeptic cluster were the lowest or equal compared with the mean response of landowners in the other clusters. The landowners in the neutral cluster varied around scale 3 ("neutral" category) for the majority of the statements. For the statement "Climate change will substantially affect my forest" landowners in the supportive and neutral clusters exhibited the lowest differences in their means. The skeptic and neutral clusters exhibited similar mean values for the statement "Carbon sequestration could generate additional revenue for me." Similarly, the skeptic and neutral clusters had similar interests toward exploring carbon sequestration opportunities in their forestland.

The skeptic, supportive, and neutral clusters included 18% (n = 112), 35% (n = 218), and 47% (n = 286) of the respondents, respectively (Table 3). Landowners varied between clusters in terms of total acres of forestland and number of parcels or unconnected forest properties they own. From the ANOVA Tukey test, the neutral and supportive clusters were statistically different ($P < 0.10$) in terms of forestland acreage. The average forestland size was 369.7 acres for supportive landowners, 258.3 acres for skeptic landowners, and 245.1 acres for neutral landowners. Similarly, the neutral and skeptic clusters were significantly different ($P < 0.10$) in terms of number of parcels owned. However, there was no significant difference ($P > 0.10$) in the average landowner age among the three clusters. The average age of landowners was between 63 and 65 years in all three clusters.

Landowner income ($\chi^2 = 22.88$; $P < 0.0001$) and education ($\chi^2 = 36.55$; $P <$

Table 4. Percentage of NIPF landowners in each belief cluster associated with various categories of income, education, gender, absentee ownership, availability of forest management plan, and plan to harvest in the southern United States.

	Belief cluster (%)				
	Skeptic	Supportive	Neutral	χ^2	*P* value
Income				22.88	<0.0001
<$25,000	20	13	22		
$25,000–$75,000	30	28	40		
>$75,000	50	59	38		
Education					
Some school	9	3	4	36.55	<0.0001
High school or GED	28	20	38		
Associate degree	10	12	11		
Bachelor's degree	30	30	29		
Graduate	14	22	11		
Professional	9	13	7		
Gender				2.12	0.34
Female	14	15	19		
Male	86	85	81		
Primary residence at <50 miles				1.09	0.57
Yes	87	88	85		
No	13	12	15		
Availability of forest management plan				6.01	0.04
Yes	25	31	21		
No	75	69	79		
Plan to harvest in next 5 yr				6.63	0.03
Yes	32	38	27		
No	68	62	73		

Table 5. NIPF landowner perception of risk associated with losing trees from natural causes and expected impact of climate change on timber yield by belief clusters in the southern United States.

	Belief clusters (%)				
Question	Skeptic	Supportive	Neutral	χ^2	*P* value
Rate degree of risk associated with losing your trees from natural causes				3.02	0.93
1 (least risky)	15	13	16		
2	31	34	36		
3	36	35	30		
4	14	13	13		
5 (very risky)	4	5	5		
Expected climate change impact on average timber yield				38.90	<0.0001
Decrease >10%	1	5	2		
Decrease 5–10%	2	17	8		
Neither increase nor decrease	88	60	76		
Increase 5–10%	6	14	11		
Increase > 10%	3	4	3		

0.0001) differed significantly among clusters, but gender ($\chi^2 = 2.12$; $P > 0.34$) did not. More landowners in the skeptic and supportive clusters than in the neutral cluster were in the higher income category (Table 4). In the neutral cluster, 40% of landowners had an annual household income category of $25,000-$75,000 per year, whereas 50 and 59% of landowners in the skeptic and supportive clusters earned greater than $75,000 per year. Similarly, the most frequent education type for the neutral cluster (38%) was high school or GED, but a bachelor degree was the most frequent category for the skeptic and supportive clusters (30% and 30%, respectively). In other words, at least 47% of the landowners in the skeptic and neutral clusters had less than a bachelor degree (some school, high school, and associate degree), whereas only 35% in the supportive cluster were in that education category. This indicates that landowners in the supportive cluster had relatively higher education than those in neutral and skeptic clusters. Noticeably, the majority of landowners, more than 81% within each cluster type, were male.

In addition, landowner clusters were significantly different for availability of forest management plan ($\chi^2 = 6.01$; $P < 0.04$) and future plan to harvest ($\chi^2 = 6.63$; $P < 0.03$) but not for residence distance ($\chi^2 = 1.09$; $P > 0.57$). The clusters were statistically different for the forest management plan availability, although the majority landowners, irrespective of cluster type, did not have a forest management plan. Among the three clusters, 31% of landowners in the supportive cluster had a forest management plan compared with 25 and 21% in the skeptic and neutral clusters, respectively. In terms of their plan to harvest within the next 5 years, 38% of landowners were in the supportive cluster compared with 32 and 27% in the skeptic and neutral clusters, respectively. However, there was no significant statistical difference among clusters in terms of nonabsentee ownership (i.e., primary residence at less than 50 miles).

Risk Perception

Table 5 presents the measure of statistical difference among clusters in terms of the two risk perception questions. The perception of risk associated with losing their forest from natural disturbances was not significantly different ($\chi^2 = 3.02$; $P > 0.93$) among the clusters. Less than 18% of landowners in each cluster considered their forestry investment at some risk from natural disasters such as fire, insects, hurricanes, or other natural causes. However, clusters differed significantly ($\chi^2 = 38.90$; $P < 0.0001$) in terms of their opinion about the expected impact of climate change on average timber yield. In the neutral cluster, 14% expected average timber yield to increase by more than 5%, whereas another 10% believed the yield will decrease by the same percentage due to climate change. In the supportive cluster, 18% believed that average timber yield could increase by more than 5% due to climate change, while 22% believed it could decrease in the same proportion. In the skeptic cluster, 9 and 3% expected either an increase or decrease in the average timber yield, respectively. In the skeptic cluster, 88% considered no change in timber yield due to climate change, whereas 60% in the supportive cluster expected so. In all three clusters, the proportions of landowners expecting neither an increase nor decrease in average timber yield due to climate change varied between 60 and 88%.

Communication Strategy

Respondents indicated they obtain forestry information from a variety of sources. The five primary forestry information sources preferred by NIPF landowners in-

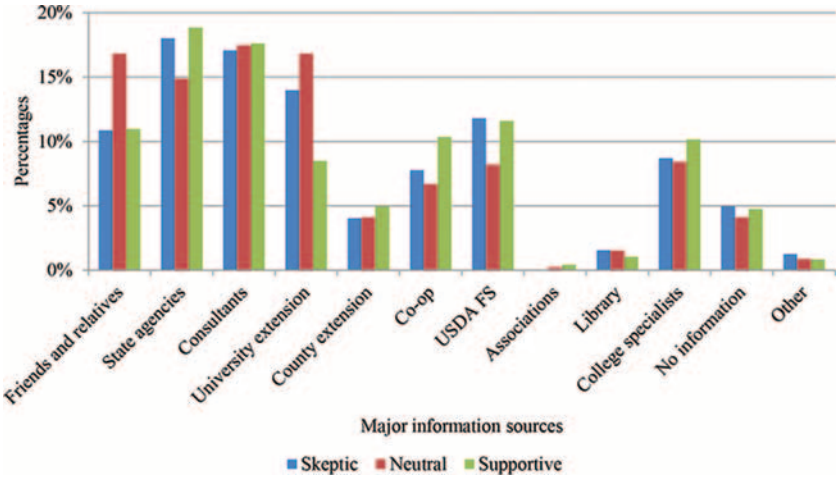

Figure 1. Percentage of NIPF landowners and their major sources for forestry information by belief clusters in the southern United States.

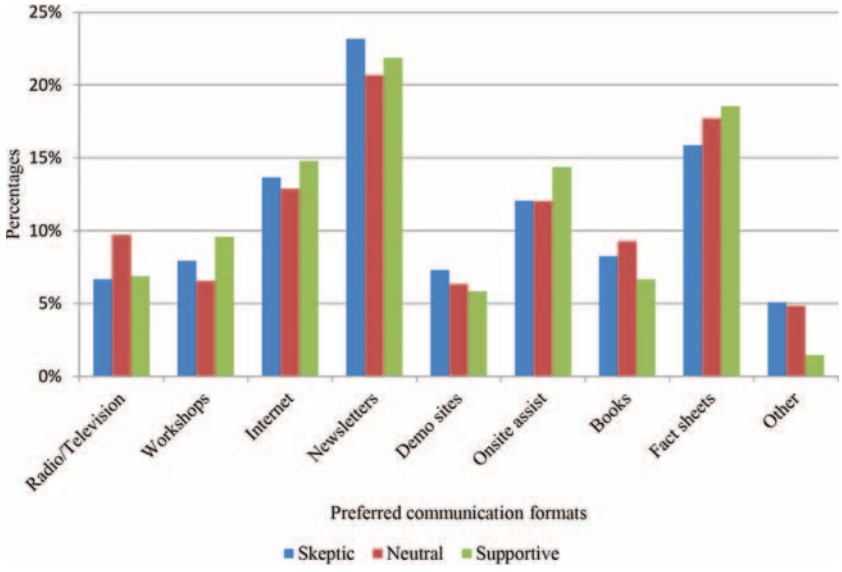

Figure 2. Percentage of NIPF landowners and their preferred formats for receiving forestry information by belief clusters in the southern United States.

clude state forestry agencies, forestry consultants, university extension services, friends and relatives, and the USDA Forest Service (Figure 1). Landowners in the neutral cluster relied more on friends and relatives (17%), forestry consultants (17%), and university extension services (17%) for forestry information, whereas the landowners in the skeptic cluster relied on state forestry agencies (18%), forestry consultants (17%), and university extension services (14%). Similarly, landowners in the supportive cluster relied more on state forestry agencies (19%), forestry consultants (18%), and the USDA Forest Service (12%). It is worth highlighting that about 5% of landowners in all three clusters indicated they did not receive any forestry information.

In all three clusters, the most preferred formats for receiving forestry information were periodic newsletters (>20%), brochures/booklets/factsheets (>15%), the Internet (>10%), and onsite assistance (>10%) (Figure 2). Traditional communication formats such as newsletters and factsheets were still the most favorable formats. Printed formats were preferred to online and onsite assistance.

Discussion

This study indicates that NIPF landowners in the southern United States held various beliefs toward climate change and carbon sequestration. There could be multiple explanations for the variation in belief. First and foremost, their personal beliefs and experiences or observations related to climate change impacts could be different. The southern region spans from Virginia to East Texas, so the observed impacts of climate change across this geographic distribution would be certainly different (Wear and Greis 2013, Klepzig et al. 2014, Melillo et al. 2014, Guldin et al. 2015). The climate forecasts anticipate that temperature will increase over the entire South, but changes in precipitation will differ across the region (Wear and Greis 2013). Landowners residing in coastal areas such as Florida and Louisiana might experience rising sea levels, salt water intrusion, and coastal land loss, whereas those in further inland regions could have a different experience (Klepzig et al. 2014, Melillo et al. 2014). On the contrary, it is quite possible that some landowners may not have observed any changes or do not attribute those experiences to climate change. In addition, the belief and perceptions of other individuals or organizations on which NIPF landowners rely for forestry information might differ with regard to climate change and carbon sequestration (Morris et al. 2014). The divergence in belief among information sources might also be contributing to the difference. More importantly, NIPF landowners in our study might have a varying degree of access to extension services for climate change outreach and education resources or the difference in their degree of access to scientific information could play a role in the multiple belief types. Considering the current sensitivity of the climate change topic in politics and evolving carbon trading markets in the United States, the divergence in NIPF beliefs toward climate change and carbon sequestration is quite expected.

The various belief types of NIPF landowners were segmented into three clusters, namely neutral, skeptic, and supportive, but a significant proportion, 47% were neutral with regard to climate change and carbon sequestration. The high proportion of landowners remaining in the neutral cluster could be attributed to three major reasons. First, climate change impacts in the southern United States are still mild compared with those in western regions (Melillo et al. 2014, Guldin et al. 2015), and landowners' personal observations about the changes in their local environment may not be distinctive enough to attribute to climate. After all, personal experience is more important than the acquired knowledge in influencing a per-

son's attitude and behavior (Lachapelle et al. 2012). In addition, landowners receive information from both scientific and nonscientific sources including various media outlets. These various sources might be biased toward their own inherent ideological, financial, or political agenda (Morris et al. 2014). Also, we need to be cognizant of the fact that it is a challenging task to convey the complex and multidisciplinary science of climate change and carbon sequestration in simplified terms to landowners while keeping the basic scientific essence unaltered. In fact, local predictions of climate change impacts differ, depending on scenarios and models involved, thus further complicating the task of extension professionals.

According to the Fishbein theory of planned behavior, landowners associated with different belief segments should have various behavioral intentions toward climate change mitigation and carbon sequestration (Fishbein and Ajzen 2010). In addition, the results suggest that these belief segments differ with respect to the respondents' socioeconomics, forest property characteristics, and expected climate change impact. We found that landowner belief segments differ in terms of income and education but not in terms of age and gender. Higher proportions of landowners in the supportive cluster reported family incomes greater than $75,000 per year than in the neutral or skeptic clusters. Similarly, a higher proportion of landowners in the supportive cluster held a bachelor or higher degree than in the skeptic or neutral cluster. Earlier studies analyzing NIPF willingness to manage for carbon sequestration in the Great Lake States found positive relationships between income, education, and interest toward carbon sequestration (Lindsay et al. 2011, Dickinson et al. 2012, Miller et al. 2012). This finding means that more educated and higher income landowners could be expected to hold positive beliefs toward climate change and carbon sequestration. However, there was no significant difference among the three clusters in terms of absentee ownership, but they differ in terms of availability of a forest management plan and a plan to harvest in the next 5 years. The majority of landowners in each cluster neither had a management plan nor did they plan to harvest in the next 5 years, but of those responding positively to both questions, a relatively higher proportion were in the supportive cluster. Considering the availability of forest management plans and future harvest plans as proxy variables indicative of active managers, a relatively higher proportion of active managers held positive beliefs toward climate change and carbon sequestration. Compared with landowners in the other two clusters, landowners in the supportive cluster tend to hold higher total acres and larger parcel numbers indicating that a large number of acres could potentially be available for climate change mitigation and carbon sequestration initiatives in the southern United States.

It is interesting to note that the belief clusters differ in terms of expected climate change impact on average timber yield but not in terms of current risk of losing their forest from natural disturbances. More than two-thirds of the landowners in each cluster considered their trees to be at low risk when evaluating the probability of natural disturbances such as hurricanes, tornado, fire, or other natural disturbances. This implies that most landowners do not think their forestry investment is risky. However, our belief clusters differ in terms of their expected climate change impact in the next 30 years. Less than 12% of landowners in the skeptic cluster considered either "increases" or "decreases" in average timber yield due to climate change impact likely. It is not surprising that very few skeptic landowners expected any change in their timber yield. In the supportive and neutral clusters, 40 and 24%, respectively, expected their average yield to fluctuate in the next 30 years. However, higher proportions of landowners, irrespective of cluster type, preferred the status quo option to fluctuations in average yield due to climate change. This observation implies that even if the landowners held various beliefs toward climate change, the majority of the landowners in the South are still uncertain about the future impacts of climate change on their forests and suggests that future extension programming should include the potential local impacts of climate change in education and outreach information and emphasize adaptation and mitigation activities.

Furthermore, landowners received forestry information from a variety of sources but their major sources of forestry information included state agencies, forestry consultants, university extension services, friends and relatives, and the USDA Forest Service. Results indicate that landowners relying more on informal sources than on institutional sources for forestry information are more likely to be neutral about climate change and carbon sequestration. In addition, newsletters and factsheets were the most preferred formats for climate change information. Measells et al. (2005) found similar results related to preferred formats for receiving forestry information by landowners in Arkansas, Mississippi, Tennessee, and Louisiana. About 13% of the landowners in each cluster indicated the Internet as their preferred format for forestry information. Considering the complexity of climate science, climate change extension formats need to be kept simple and factual for the landowners (Grotta et al. 2011); therefore, the Internet, the use of which could be expected to grow in the future, would be more helpful for presenting the complex content of climate change in a simplified format easily accessible to landowners.

Conclusions

The study highlights existing climate change and carbon sequestration belief types of NIPF landowners in the southern United States and identifies major forestry information sources to approach these belief segments. The study would be helpful to those designing future climate change adaptation and mitigation activities as well as identifying more receptive clients for future extension outreach and education programming. Although these findings are unique to the respondents who participated in our study, they can be useful in understanding the spectrum of NIPF landowners throughout the United States regarding climate change and carbon sequestration. However, this study includes measures of both climate change belief and management to define clusters. These beliefs might be separate indicators of landowner perspective on climate change. In this study we did not evaluate them separately. As a result, it might be difficult to separate whether the climate change-supportive group is truly different from the groups with other belief perspectives. In addition, in terms of future research work and possibilities, the significant number of neutral landowners is especially important. The value of attitude theory and assessment of strengths in beliefs and attitudes suggests there might be strong potential to recruit these landowners. Findings from this study suggest ways that may be conducive for connecting with landowners. This study adds to our understanding about the beliefs of one of the dominant landownership groups in the southern United States and points to a new area of fruitful research

for climate change adaptation and mitigation research.

Endnotes

1. Alabama, Arkansas, East Oklahoma, East Texas, Georgia, Florida, Louisiana, Mississippi, North Carolina, South Carolina, Virginia. East Oklahoma and East Texas are part of the states.
2. For more information, see www.listgiant.com.

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