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Interpersonal Climate Change Communication in Florida Using Quantile Regression

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Abstract

Climate change is described as a potentially catastrophic phenomenon with the capacity to disrupt agricultural production, economies, health systems, education, and infrastructure, among other systems. In Florida, climate change is a concern because of the state's extensive coastline and its influence on the economy, as well as residents' safety and well-being. As early as 2007, researchers forecasted that vulnerable wetlands, mangroves, fisheries, and coastal infrastructure in Florida may be significantly damaged or destroyed by 2060. Climate change communication (CCC) is described as a complex problem that requires several layers of attention, especially in achieving the desired outcome of behavior change. Previous research suggested that climate change communicators would be more effective if they understood their audiences and their communication capacities. The purpose of the study was to determine the impact of demographic factors on social communication for residents of Florida. A survey was used to collect the data through an address-based sampling (ABS) method, where a total of 318 usable responses were received from Florida residence 18 years or older. A latent construct for describing social communication (Social Communication Index [SCI]) was created as the dependent variable and was tested against eight variables using a quantile regression approach. Using quantiles in 0.1 intervals, the results showed that knowledge, age, income, newspaper use, urbanicity, and race affected the SCI in one or more quantiles. Social media, sex, and religiosity were insignificant throughout all quantiles. While most of the results align with previous research, there is the need for further probing into social communication on climate change to ensure that audience segments are provided with climate change information through the channels they primarily use.

Keywords

Climate Change Communication, Quantile Regression, Florida, Coastline,

Social Communication

1. Introduction

In 1992, the Rio Declaration created an impetus for the world to address climate change, as scientists described the phenomenon as potentially catastrophic (Bertolotti & Catellani, 2014; Colombo, 2017). Climate change has impacted global development by affecting infrastructure, agricultural production, poverty, health, education, and fueling conflict (Elia et al., 2015). Psychological distance, public uncertainty, the perception that there is less chance of direct impact, and the idea that timing of the impact is set in the distant future were a few of the reasons highlighted in the literature that pointed to miscommunication about climate change (Brügger, 2020; Jones et al., 2017; Loy & Spence, 2020; Morrison et al., 2018; Ouariachi et al., 2017; Pong, 2021; Romsdahl, 2020; Schuldt et al., 2018; Wang et al., 2018).

Climate change communication (CCC) is described as a complex problem that requires several layers of attention, especially in achieving the desired outcome of behavior change (Johnson, 2012; Wibeck, 2014). While discussions on CCC started in the mid-1990's (Chadwick, 2018), the CCC movement was suggested to be initiated by James Hansen in 2005 who provided urgency to the issue (Bowen, 2008; Robbins, 2020; Russill, 2008; Russill & Nyssa, 2009; Van der Hel et al., 2018). Since then, research on CCC has focused on media reports (Kunelius et al., 2017), social media (Anderson & Huntington, 2017; Boulianne et al., 2020; Lindsey et al., 2018), and public interaction (Pong, 2021; Tàbara et al., 2017) among others. CCC was described as a niche area of study, and even in 2018, almost 20 years after the tipping point, CCC is still described as a fairly new area of research (Chadwick, 2018), as well as a micro-field of research (Ballantyne, 2016). The Common difficulty with CCC, as proposed by researchers, is the issue of personal relevance (Devkota & Phuyal, 2018; Pong, 2021). Nevertheless, researchers and communication scientists were interested in audience segmentation research to propose effective communication strategies for CCC (Hine et al., 2014). Climate change communicators would potentially be more effective if they better understood their audiences, and their communication capacities (Chadwick, 2018).

In Florida, climate change is a concern because the state's coastline is influential on the economy, residents' safety, and population well-being. A significant portion of Florida's economy is based on tourism (Atzori et al., 2018), fishing (Lorenzen et al., 2017; Paukert et al., 2016), and coastal infrastructure (McAlpine & Porter, 2018; Shen et al., 2016), which are suggested to be threatened by climate change. As early as 2007, researchers forecasted that vulnerable wetlands, mangroves, fisheries, and coastal infrastructure in Florida may be significantly damaged or destroyed by 2060 (Stanton & Ackerman, 2007). To compound the

CCC issue, a news release by Earth Justice (an environmental group) in 2015 said that state workers are being prohibited from saying the phrases "climate change" and "global warming" during former Governor Scott's administration (Korten, 2015). Additionally, the frequency and intensity of natural disasters fueled by climate change are suggested to increase in the future (Field, 2018; Middelbeek et al., 2014; Woodward & Samet, 2018). For example, the 2017 hurricane season had 17 named storms and 10 hurricanes, where six of those 10 hurricanes labelled as major hurricanes (Trenberth et al., 2018; Wint, 2019) while the 2020 season had 30 names storms, 14 hurricanes, and 7 major hurricanes. The average Atlantic hurricane activity includes 12 storms and six hurricanes (Trenberth et al., 2018).

The current study is unique from previous climate communications studies covered in this paper by way of the analyses used. Hine et al. (2014) evaluated approximately 20 CCC audience segmentation studies and outlined methodologies used therein. Hine et al. (2014) found that the researchers used various cluster analyses, latent profile analysis, and group screening, but not QR. Several other authors used qualitative approaches to identify different trends and approaches in CCC (Ballantyne, 2016; Chadwick, 2018; Ouariachi et al., 2017). Researchers that used QR for climate change analyses used variables that were akin to, but not directly parallel with the demographic variables presented in the current study because of their objectives. The intensity and frequency of disasters, as well as associated costs (NOAA, 2022), fueled by climate change are also increasing, while some researchers underscore CCC fatigue and psychological distance as a hindrance to communicating about climate change. Because Florida is vulnerable to climate change, and audience segmentation research is important for messaging, the researchers in the current study sought to determine the demographic attributes that are influencing social communication of climate change in Florida.

Purpose and Objectives

The purpose of the study was to determine the impact of demographic factors on social communication for residents of Florida. Specific objectives were as follows:

Objective 1 (O1): Determine the demographic attributes that impact social communication of climate change.

Objective 2 (O2): Determine the impact of demographic factors as different levels of social interaction.

2. Literature Review

In previous research on climate change communication, demographic factors around the issue have been relatively consistent, especially on factors like age, religion, knowledge, and income. In a study on how leaders communicate about climate change in urban cities, Boussalis et al. (2018) found that leaders in places with high vulnerabilities to climate change are more likely to communicate about it. Florida was described as a highly vulnerable state because of the increased intensity of weather-related disasters due to climate change, and its dependence on the coastline for socio-economic activity (Atzori et al., 2018; Lorenzen et al., 2017; McAlpine & Porter, 2018; Paukert et al., 2016). In a study on 1006 individuals, Detenber et al. (2016) looked at the Six Americas Scale to assess climate change communication in Singapore. The Six Americas ranged from *alarmed* to *dismissive*, with four other distinct segments in between (Maibach et al., 2011). In the study by Detenber et al. (2016), 95% of the respondents fell into three main categories: concerned, disengaged, and passive. Their research found that the average age of someone in the *concerned* category was 39.91 years and had the highest income. This concerned group relied on traditional mass media to slightly higher than average amount but has engaged in a fair amount of communication about the environment (Detenber et al., 2016). However, this group is also neutral in the idea that their friends and family are trustworthy sources of information on climate change.

In alignment with other literature, mass media was found to be the predominant information channel for climate change (Anderson, 2011; Barkemeyer et al., 2017; Bolsen & Shapiro, 2018; Forchtner et al., 2018; Nerlich et al., 2010; Pong, 2021; Russill & Nyssa, 2009). Additionally, newspaper analyses have been conducted to understand the framing of climate change messages since this medium was widely used (Anderson, 2011; Devkota & Phuyal, 2018; Duan et al., 2017). Anderson (2011) observed that newspapers have a major agenda setting effect because of their influence on the discourse of prominent topics. However, in the farming community, Devkota and Phuyal (2018) found that newspapers were not a significant variable for farmers' awareness of climate change issues. Though national newspapers were found to be considered trustworthy sources, reliance on newspapers as a primary source for accurate information is most common among adults with graduate degrees, and those 65 and older (Chadwick, 2018). Loy and Spence (2020) found that text news on climate communication reduced the psychological distance when compared to video communication on climate change with text input. They concluded that their sample (n = 400) from the United Kingdom and Bangladesh also preferred local news to reduce psychological distance on climate change.

In the study by Detenber et al. (2016), members of the disengaged group are slightly older than the concerned group, with an average of 42.48 years. However, the researchers found that they were below the average education level, as well had a lower income than the concerned group (Detenber et al., 2016). This group was least likely to trust their social groups in communicating about climate change and believe that citizens are not responsible for reducing climate change (Detenber et al., 2016). The passive group was the oldest in the Detenber et al. (2016) study, was the least educated, and had the lowest incomes. However, traditional news was their most dependable source on climate change communication, and has done a significant amount of pro-environmental communication Detenber et al. (2016). In terms of social communication, this group are the most likely to believe their friends and family on issues of climate change.

Researchers have discussed audience segmentation based on age, income, education, and race, among other attributes in the market for CCC (Arbuckle et al., 2017; Badullovich et al., 2020; Detenber et al., 2016; Duan et al., 2021; Hine et al., 2017; Khadka et al., 2021; Pong, 2021; Thomas et al., 2019; Wonneberger et al., 2020).

Concerning age, Arbuckle et al. (2017), Morrison et al. (2018) in an Australian study, and Leiserowitz et al. (2021) found similar results as Detenber et al. (2016), where older individuals tend to be unconcerned or dismissive about climate change. However, Leiserowitz et al. (2021) also found that younger, more educated women tend to be in the *alarmed* category. Duan et al. (2021) found that age was significant in explaining an indifidual's climate change behavior, as well as their climate change concern. In a study by Hine et al. (2017) age was used as a significant covariate in the social dimensions of psychological distance on climate change, as well as climate change concern. Expanding on the literature on gender, younger women being more emotive and involved in climate change issues was found by Stevenson et al. (2018), who stated that this aligned with previous research on gender. Morrison et al. (2018) also highlighted individuals with lower levels of education, and lower incomes tend to be less concerned or dismissive about climate change.

Ballantyne (2016) found that public understanding of climate change was tied to people's knowledge on the topic. Previous research on knowledge and media suggests a connection between media representations and scientific representations of climate change. This also speaks to the fundamental misconception that making climate change information available increases knowledge on the issue (Ballantyne, 2016; Chadwick, 2018; Nerlich et al., 2010; Ouariachi et al., 2017; Sakellari, 2015). Devkota and Phuyal (2018) found that knowledge on climate change was significant on farmer's awareness of the issue, but only in certain areas. Researchers also found that the perception of climate change risk was tied to knowledge (Aksit et al., 2018). In investigating exposure to cinematographic representations of climate change, Sakellari (2015) found that exposure to this medium of information only motivated behavior change in the short term, but failed to have a long-term impact.

Ecklund et al. (2017) found that association between religion and climate change views were almost entirely accounted for by political affiliation and ideology. Leiserowitz et al. (2021) also stated that religion plays an important role in politics. In this light, political ideology can be a proxy for religiosity and vice versa. Thomas et al. (2019) suggested socioeconomic status, race may play a role in interacting with climate change, as some individuals may not have the resources to focus on the issue. Regarding race, Leiserowitz et al. (2021) found that 57% of African Americans were in either concerned or alarmed categories, and 49% White

Americans were in either the concerned or alarmed categories. However, Latinos were more expressive that humans caused global warming than non-Latinos, making them more susceptible to communicate about climate change (Leiserowitz et al., 2021).

3. Methodology

A survey was used to collect data for this research through an address-based sampling (ABS) method. A third-party vendor provided the addresses. The survey was initiated in November 2016 to collect data on Florida residents that were older than 18. Most of the items on the survey were previously used in survey research on climate change (Leiserowitz et al., 2010, 2015; Maibach et al., 2009), ensuring a measure of validity and reliability. The ABS was comprised of two replicates: the first replicate had 1500 addresses, and the second replicate had 500 addresses. The survey using the first replicate was executed by mailing an initial survey packet in November 2016, followed by a reminder postcard, then a second survey packet, and final survey packet ended the process in January 2017. The second replicate was executed using a "web push" approach (Dillman et al., 2014) where a web uniform resource locator (URL) and personal identification number (PIN) was mailed to potential respondents. This replicate was initiated in January 2017. Of the 2000 ABS invitations, 25 surveys were completed online, and 293 were completed by postal mail for a total of 318 usable responses 17.0% response rate (AAPOR, 2016).

A latent construct for describing social communication was created as the dependent variable for this study. The Social Communication Index (SCI) is calculated as an average of the amount an individual communicates about climate change based on social interaction data collected. Items from the survey included telling people about climate change in the previous six months (Variable 1 [V1]); the amount of information shared with friends and colleagues (Variable 2 [V2]); the frequency of discussions with friends on climate change (Variable 3 [V3]), and the likelihood to be asked about climate change compared to friends (Variable 4 [V4]). These questions used unipolar scales, with responses for V1 having a three-point scale ranging from "told no one" to "told a lot of people" ranging from one to three points respectively. The second item (amount of information shared) used a four-point scale ranging from "give no information" to "give a great deal of information" ranging from one to four points respectively. The third question (frequency of discussion with friends) used a five-point scale ranging from "very often to never" ranging from one to five points respectively. Lastly, the fourth question used (likelihood to be asked about climate change) also used a five-point scale, but the range moved from "extremely likely" to "not at all likely" ranging from one to five points respectively. Participant SCI scores were calculated as the simple average of the numeric values of the responses to the identified questions. Averaging Likert scale scores is a common practice in quantitative research (Garas et al., 2018; Layfield et al., 2020; Saudek et al., 2018;

Wulandari & Inoue, 2018). Recent research shows averaging Likert scores from as little as four questions (Gadoth et al., 2021), and as much as 23 (Erni et al., 2021). Responses for two of these questions (frequency of discussion and likelihood to be asked about climate change) were reverse coded to ensure all the questions ranked social communication from the lowest value to the highest value.

The test for reliability indicated strong internal consistency for the SCI, with a median Cronbach's Alpha value of 0.853 for the ten imputations (see Imputing Missing Data below). The percent of common variance accounted for by the SCI construct was an average of 70.69% for V1 across all imputations. The average communalities across all imputations showed that 80.3% of V1, 68.3% of V2, 77.1% of V3, and 57.0% of V4 were accounted for by the extracted latent construct. Average factor loadings across all imputations were 0.896, 0.826, 0.778 and 0.755 for V1, V2, V3, and V4 respectively.

Similar procedures were conducted for Religiosity and the Knowledge index. Religiosity was operationalized using six items including attendance at religious functions, which was adopted from AP-NORC (2015; see also Huber and Huber, 2012). The other five items asked about the frequency of praying, thinking about religious issues, reading religious materials, participating in religious activities, and supporting a religious organization financially. The items on praying and thinking about religious issues were drawn from Huber and Huber's (2012) Centrality of Religion Scale, while the others were added to reflect religious practices in the US (Lisa Lundy, personal communication, December 7, 2020). These five items used a five-point scale ranging from "never" to "very often". The six-point scale of religious service attendance ranged from "more than once a week" to "never" and was reverse coded to allow all responses in the religiosity variable to run in ascending order. Average Cronbach's alpha was 0.903 for the Religiosity index. The knowledge index was created by calculating the average of the responses of 10 true/false knowledge items on climate change adapted from Leiserowitz, Smith, and Marlon's (2010) study. Items included "global warming will cause some places to get wetter, while others will get drier", "the earth is actually cooling, not warming" and "the Earth's climate has changed naturally in the past, therefore humans are not the cause of global warming". Average Cronbach's alpha was 0.740, while the average variance loadings were 33.1% for V1, 13.55% for V2, and 12.52% for V3 across all imputations.

3.1. Data Analysis Procedures

3.1.1. Procedures for Imputing Missing Data

The item missing pattern was examined and characterized as arbitrary (Schafer & Graham, 2002). Two-stage multiple imputation (Berglund, 2010) was used to estimate missing values for interval and ordinal variables. American Communities Survey 5-year data at the ZCTA5 level was used as auxiliary data in the imputation procedure for the ABS data. The multiple imputation procedure was conducted with SAS Proc MI, version 9.4 to create 10 imputations.

3.1.2. Procedures for Weighting the ABS Data

Because coverage error and nonresponse error can be exacerbated by low response rates, the imputed data sets were weighted to reflect population parameters for Florida (Biemer & Christ, 2008). The SPSSINC Rake procedure (IBM SPSS Statistics 25 2017) was employed to calculate weights. Raking variables included Sex, Hispanic Ethnicity, Race, Age, and Educational Attainment. Values for the control totals were obtained from the American Communities Survey 5-year estimates for 2015.

3.1.3. Quantile Regression

Quantile regression (QR) was first proposed by Koenker and Bassett (1978) who based the concept on the L_1 method (minimization of weighted deviations) (Eide & Showalter, 2007; Gallego-Álvarez & Ortas, 2017; Hübler, 2017; Koenker & Hallock, 2001; Salman et al., 2019; Zietz et al., 2008). QR can be described as dividing data into observations based on defined interval criteria set by the researcher (Gallego-Álvarez & Ortas, 2017). For the 0.5 quantile (the median), symmetric weights are used, but for other quantiles, like the 0.1 quantile, asymmetric weights are applied (Gallego-Álvarez & Ortas, 2017; Zietz et al., 2008). One advantage of QR is that, unlike OLS, QR can be used to explain the determinants of the dependent variable at any point in the distribution (Gallego-Álvarez & Ortas, 2017; Hübler, 2017; Zietz et al., 2008). That is, instead of providing an averaged view of the data using OLS, one can evaluate relationships at a single point, and between different points of the data (Moutinho et al., 2017). Another advantage of QR over OLS is that QR is more robust to non-normal errors and outliers (Gallego-Álvarez & Ortas, 2017; Hübler, 2017; Moutinho et al., 2017; Niemierko et al., 2019; Salman et al., 2019; Zietz et al., 2008). Additionally, QR is less sensitive to heteroscedasticity since the standard errors of the coefficients are estimated by bootstrapping, and eliminates distributional assumptions (Hübler, 2017; Moutinho et al., 2017; Salman et al., 2019; Zietz et al., 2008). Niemierko et al. (2019) stated that having different regression line slopes at different quantiles also helps with heteroscedasticity.

For this study, preliminary analysis revealed that the OLS model suffered from heteroscedasticity and, thus, QR analysis was conducted to determine the behavior of the SCI at different quantiles in relation to the independent variables. Defining quantiles for research depends on the researchers' objectives. However, quantile regressions are common (Buchinsky, 2008; Eide & Showalter, 2007; Zietz et al., 2008). Other QR intervals used by researchers include quantiles in 0.05 intervals (Hübler, 2017; Wang et al., 2019), 0.10 intervals (Salman et al., 2019; Zietz et al., 2008), 0.2 intervals (Niemierko et al., 2019), and unequal spreads (Gallego-Álvarez & Ortas, 2017; Tan & Wang, 2017; Xu et al., 2017). For this study, quantiles at every 0.1 interval were used in the analysis. The QR analysis was done using SPSS.

SPSS does not provide pooled results for the QR analysis with imputed datasets. After consulting with statistician S. Roy (personal communication, January

12, 2021) simple averages of the ten imputations were recommended as a pseudo pooled result. Average calculations were applied to R2 per quantile, R2 across all quantiles, parameter effects per quantile, and *p*-values per quantile. Trendline analysis was also conducted when a variable was significant in five or more quantiles. This allowed for reporting the average change in a variable per quantile.

4. Results

The SCI variable had a mean of 2.024 based on the pooled results of the ten multiple imputations (**Table 1**). Standard deviations for the SCI ranged from 0.719 (imputation 8) to 0.740 (imputation 9), with an average of 0.729. Descriptive statistics for the indexed and continuous variables are presented in **Table 1**. SCI scores, frequencies and percentages are presented in **Table 2**. Descriptive statistics for the independent variables are presented in **Table 3**.

Table 1. Descriptive data for indexed and continuous variables used in the QR analysis. Represents the average across imputations.

Variable	Mean	Std. Deviation	Minimum	Maximum
Social Communication Index (SCI)	2.024	0.729	1.00	4.00
Age (in years)	46.65	17.54	18	93
Knowledge Index	0.71	0.24	0.00	1.00
Religiosity Index	2.86	1.11	1.00	5.00

Note: Data in this table is based on the pooled results for the descriptive output.

Table 2. SCI scores, frequencies, and percentages based on the average across imputations.

Social Communication Index (SCI) Score	Frequency	Percent
1	36.1	11.3
1.25	42.5	13.4
1.5	28.4	8.9
1.75	36.9	11.6
2	35.6	11.2
2.25	40.0	12.6
2.5	33.5	10.5
2.75	17.7	5.6
3	24.1	7.6
3.25	10.5	3.3
3.5	5.8	1.8
3.75	2.7	0.9
4	4.1	1.3
Total	318	100

Table 3. Descriptive data for variables used in the QR analysis.

Variable	Category	Frequency	Percent
Income	Less than $25,000	53.3	16.8%
	$25,000 - 49,000	117.0	36.8%
	$50,000 - 74,999	48.4	15.2%
	$75,000 - $149,000	70.5	22.2%
	$150,000 - 249,999	12.6	4.0%
	$250,000 or more	16.2	5.1%
Race	White	241.7	76.0%
	Black	32.9	10.3%
	Asian	21.2	6.7%
	Other race	22.2	7.0%
Social Media	No	95.3	30.0%
	Yes	222.7	70.0%
Newspaper	No	186.5	58.6%
	Yes	131.5	41.4%
Sex	Female	164.4	51.7%
	Male	153.6	48.3%
Urbanicity	Urban	81.3	25.6%
	Suburban	129.5	40.7%
	Rural	107.3	33.7%

Note: Data in this table is based on the pooled results for the descriptive output.

Predictors of Social Communication on Climate Change

The average R^2 across all imputations was 0.292, where the lowest average R^2 per quantile was 0.259 (0.1 quantile), and the highest average R^2 per quantile was 0.326 (0.8 quantile) (see **Table 4**). Results of the quantile regression showed that Knowledge, age, income, newspaper use, urbanicity, and race significantly affected the SCI in one or more quantiles. Social media, sex, and religiosity were insignificant throughout all quantiles. Newspaper use was significant across all quantiles, and parameter estimates showed that not using newspapers reduced the SCI by an average of 0.603. *P*-values ranged from <0.001 to 0.007. Trendline analysis showed that the parameter estimates for newspapers reduced by an average of 0.114 between quantiles. Across all quantiles, the newspaper variable had a negative effect on SCI, where the largest impact occurred in the 0.8 quantile (−0.927, p-value ≤ 0.001), and the smallest impact occurred in the 0.1 quantile (−0.312, p-value ≤ 0.001).

Knowledge was significant across all quantiles except the 0.4 and 0.5 quantiles.

Knowledge had a positive impact on the SCI throughout all significant quantiles, where the average impact was 0.871, the largest impact occurred in the 0.9

Table 4. QR results: parameter estimates and p-values of model variables across quantiles. Pseudo R^2 is represented in last row.

Quantiles	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	2.096*	2.079*	2.181*	2.424*	2.521*	2.350*	2.522*	2.824*	2.422*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)
Knowledge Index	0.634*	0.648*	0.598*	0.579	0.579	0.789*	0.934*	0.994*	1.497*
	(0.049)	(0.008)	(0.029)	(0.093)	(0.167)	(0.045)	(0.050)	(0.005)	(0.042)
Age	−0.018*	−0.014*	−0.011*	−0.013*	−0.012*	−0.007	−0.007	−0.009	−0.005
	(0.000)	(0.000)	(0.024)	(0.020)	(0.045)	(0.159)	(0.132)	(0.062)	(0.484)
Income	−0.081	−0.105*	−0.118	−0.129	−0.115	−0.116	−0.094	−0.061	−0.064
	(0.060)	(0.028)	(0.095)	(0.070)	(0.127)	(0.104)	(0.078)	(0.239)	(0.420)
Religiosity	0.080	0.038	0.001	0.013	0.030	0.018	−0.037	−0.041	−0.031
	(0.109)	(0.330)	(0.406)	(0.446)	(0.393)	(0.656)	(0.406)	(0.387)	(0.556)
No Social Media	−0.076	0.025	−0.010	−0.010	−0.088	−0.088	−0.021	0.051	0.080
	(0.365)	(0.448)	(0.585)	(0.543)	(0.536)	(0.391)	(0.419)	(0.372)	(0.624)
No Newspapers	−0.312*	−0.356*	−0.437*	−0.495*	−0.625*	−0.694*	−0.764*	−0.927*	−0.915*
	(0.000)	(0.003)	(0.001)	(0.024)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)
Male	−0.172	−0.063	0.005	0.022	−0.013	−0.065	−0.115	−0.199	−0.281
	(0.186)	(0.430)	(0.689)	(0.492)	(0.488)	(0.573)	(0.308)	(0.098)	(0.276)
Urban	−0.101	0.057	0.231	0.366*	0.613*	0.672*	0.574*	0.394	0.531
	(0.413)	(0.558)	(0.126)	(0.044)	(0.004)	(0.001)	(0.000)	(0.065)	(0.062)
Suburban	−0.161	−0.079	0.056	0.166	0.312	0.387	0.461*	0.415*	0.497*
	(0.146)	(0.417)	(0.513)	(0.282)	(0.127)	(0.063)	(0.000)	(0.003)	(0.046)
Other Race	0.388	0.437	0.546	0.597	0.644	0.705*	0.944*	1.021*	0.802*
	(0.182)	(0.153)	(0.178)	(0.092)	(0.120)	(0.030)	(0.000)	(0.000)	(0.047)
Asian	−0.176	−0.301	−0.474*	−0.758*	−0.995*	−0.960*	−0.935*	−0.874*	−0.873
	(0.265)	(0.197)	(0.050)	(0.012)	(0.000)	(0.001)	(0.000)	(0.000)	(0.060)
Black	0.178	0.261	0.254	0.157	0.026	0.128	0.229	0.193	0.250
	(0.256)	(0.137)	(0.201)	(0.473)	(0.450)	(0.477)	(0.297)	(0.348)	(0.322)
Pseudo R^2	0.259	0.282	0.294	0.277	0.281	0.294	0.312	0.326	0.301

Note: White and rural are the reference categories for race and residence variables, respectively. Figures represent averages across 10 imputations. * = significant parameter estimates, p-values appear in brackets (<0.05), Pseudo R^2 is represented for each quantile in the last row.

quantile (1.497, p-value = 0.042), and the smallest impact occurred in the 0.3 quantile (0.598, p-value = 0.029). P-values ranged from <0.005 to 0.050. Trendline analysis of the significant quantiles revealed that Knowledge increased the SCI by an average 0.200 between quantiles. Age was significant for quantiles 0.1 through 0.5, where the parameter estimates were −0.018 (p-value ≤ 0.001), −0.014 (p-value ≤ 0.001), −0.011 (p-value = 0.024), −0.013 (p-value = 0.020), and −0.012 (p-value = 0.045) respectively. Income was only significant at the 0.2 quantile, where the parameter estimate was −0.105 (p-value = 0.028).

Collectively, Race was significant for quantiles 0.3 through 0.9. Individual races affected the SCI differently. Being Black (in comparison to the reference category of white) did not impact the SCI at any quantile. Being Asian negatively affected the SCI from quantiles 0.3 through 0.8. The average impact of the Asian race was −0.833, where the highest impact occurred at quantile 0.5 (−0.995, p-value ≤ 0.001), and the lowest impact occurred at the 0.3 quantile (−0.474, p-value = 0.050). Similarly, income was only significant at the 0.7 quantile, where the impact on SCI was −0.132 (p-value ≤ 0.001). Religiosity was significant at quantiles 0.1 and 0.2, where the parameter estimates were 0.165 (p-value ≤ 0.001) and 0.108 (p-value = 0.020). The Urbanicity variables collectively affected the SCI at quartiles 0.4 through 0.9. The suburban category was significant at quantiles 0.4 through 0.7, where the SCI was higher by 0.336 (p-value = 0.044), 0.613 (p-value = 0.004), 0.672 (p-value = 0.001), and 0.574 (p-value < 0.001), respectively, relative to rural residents. The urban category was significant at quantiles 0.7, 0.8, and 0.9, where the impact to the SCI was by 0.461 (p-value < 0.001), 0.415 (p-value = 0.003), and 0.497 (p-value = 0.046).

The slope of the parameter prediction lines per quantile was generally associated with the average impact on SCI. For example, the parameter prediction lines for knowledge were upward sloping for all the quantiles, even though some gradients were steeper than others. The slopes of the prediction lines also changed across imputations but followed the trend (positive or negative).

5. Discussion & Conclusion

The QR analysis revealed that newspaper usage was significant across all quantiles where using newspapers increased the SCI. The parameter estimates for newspaper use generally decreased until the 0.7 percentile, after which the values began to increase. This finding aligns with previous findings by other researchers like Anderson (2011), Devkota and Phuyal (2018), and Duan et al. (2017) on newspapers being important for CCC. For the current study, newspaper use was more important for more active communicators on climate change than less active communicators. Knowledge was significant across most quantiles and had the largest average impact on the SCI. Knowledge on climate change was identified as an important element of climate change communication (Ballantyne, 2016; Chadwick, 2018; Devkota & Phuyal, 2018; Nerlich et al., 2010; Ouariachi et al., 2017). However, the sharp increase (1.497 SCI points) at the 0.9 quantile suggested that knowledge on climate change influences communication at higher levels of socialization. Nevertheless, knowledge had an average impact on the SCI of 0.871, at least 25% of a respondent's social communication score, considering the maximum SCI score was 3.5. Trendline analysis showed that knowledge increased by 0.200 between quantiles, indicating that as average knowledge increased, the SCI increased.

Age was significant at the lower levels of SCI (quantiles 0.1 through 0.5) and had a negative impact. The significance at the lower levels of social communication aligns with research that suggests older individuals are less engaged with climate change (Arbuckle et al., 2017; Detenber et al., 2016; Leiserowitz et al., 2021). However, some researchers stated that younger individuals, who are likely to be more impacted, contribute more to climate change discussions (Ortega-Egea et al., 2014), while others stated that older individuals with more knowledge on the issue may communicate more (Habtemariam et al., 2016). As for this study, based on the distribution of the Florida population, the assertions by authors like Leiserowitz et al. (2021). When compared to White individuals, Black communities do not significantly share any information about climate change. This contradicts Leiserowitz et al. (2021) who found that more than 50% of African Americans were concerned or alarmed. However, Asian individuals communicate significantly less when compared to White individuals throughout most of the SCI (quantiles 0.3 to 0.8). Additionally, other races share significantly at the higher levels of social communication. Previous research highlighted that White individuals are less likely to be concerned with the environment or climate change when compared to other races, where socioeconomic status and economic inequalities as some reasons (Pearson et al., 2017; Schuldt & Pearson, 2016). Further, other studies found race to be significant in relation to climate change issues, vulnerabilities to climate change regulations, and adaptability were concerns (Azong & Kelso, 2021; Hansen et al., 2013; Semenza et al., 2008).

In previous studies, women were reported to be more involved in climate change issues than men (Chadwick, 2018; Holmberg & Hellsten, 2015; McCright, 2010; Scannell & Gifford, 2013). However, sex was not significant at any quantile in the current study. Compared to being from a rural area, being from an urban area was significant at the higher levels of SCI, where a positive impact was observed. Being from a suburban area was also significant at the mid-range of the quantiles (0.4 to 0.7) and had a positive impact when compared to individuals from a rural area. Nevertheless, the location of the respondent had substantial influence on social communication on climate change, which also aligns with previous research (Jenkins et al., 2018). Income was only significant at the 0.2 quantile. Individuals with higher income were identified to spend more on climate mitigation strategies and may be also talking more about the issue (Rahu & Ali, 2017). However, income had a negative effect on the SCI, which contradict those results.

Climate change communication on social media was researched by various authors (Bennett et al., 2021; Harris et al., 2016; Lorenzon et al., 2021; Rahman et al., 2021). The results of the current study suggest that using social media does not impact social communication on climate change in Florida. Some authors identified that social media presents a space for articulating, identifying, and experiencing for various views on climate change which can transition from an online presence to a physical presence (Anderson & Huntington, 2017; Shearer & Grieco, 2019). However, the literature describes communicating online is different than communicating in person. Further investigation into how social media impacts social communication should be conducted as per the contemporary social media market.

In conclusion, the Social Communication Index was created to determine the demographic characteristics of Florida residents who were likely to communicate about climate change. By using a quantile regression analysis, the SCI was tested against eight demographic variables across nine quantiles in 0.1 intervals. Regarding O1, the results of the study showed that knowledge, age, income, newspaper use, race, and urbanicity were significant in, at least, one quantile. Religiosity, sex, and social media use were insignificant across all quantiles in this model. Pervious research is consistent with most of the results. However, for the variables that were insignificant across all quantiles, further investigation is warranted as previous research differs from these results.

Regarding O2, the results showed that, at different significant quantiles, variables had different impacts on the SCI. For variables that allowed for trendline analysis, the average change from quantile to quantile was sharp. However, some variables showed parameter effects in the quantiles that had no pattern, while others showed peaking around the 0.5 quantile. As mentioned, this is an advantage of QR: gaining a better understanding of the effects at different levels of social communication. The results of this study can add to the body of research on climate change CCC, but with the focus on social communication. Additionally, adding more variables that are common across the literature, like other forms of media, education, and political affiliation, can provide more robust results. The current study also is also focused on Florida. Replicating the study across other states may confirm the current results. Finally, many researchers compare results of an OLS model to a QR model. Future research can focus on examining a functional OLS, and comparing that to a QR model for SCI.

This research adds to the body of knowledge concerning CCC in a unique way: creating a variable that focuses on social communication among individuals. The results of the current study can inform the direction communicators, like campaigners, journalists, and policy makers, as they attempt to target different audiences with specific climate change information. Specifically for policy makers, this research highlights the audience segment that can assist with accessing and spreading the right information about climate change. Additionally, this research adds to the literature that presents climate communication as a social process, similar to Ballantyne (2016). Moving forward, collecting new data for current trends in social communication on climate change would inform future needs of social communicators.

Limitations

The sample size obtained for the study was smaller than planned and this reduced the likelihood of finding significant but weak effects for some demographics. In addition, the low response rate can result in bias for variables not included in the weighting procedures (Biemer & Christ, 2008). The SCI variable used a simple average approach on questions that varied on the scales used (three-point to five-point). A weighted average approach may have allowed for each question to have the same weight in the SCI variable. Another limitation of the study concerns the variables used. Most of the variables were demographic variables coupled with a few other variable types. Focusing more closely on communication variables may have been beneficial in the analysis. Finally, the data is from 2016-2017 and with recent events, climate change experiences and opinions, as well as communication practices may have shifted.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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