

Articles

Climate Change Vulnerability and Policy Support

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Climate scientists note that the effects of climate change vary regionally. Citizen willingness to absorb the costs of adaptation and mitigation policies may correspond with these place-specific effects. Geographic information systems (GIS) analytic techniques are used to map and measure survey respondents' climate change risk at various levels of spatial resolution and precision. Spatial data are used to analyze multiple measures of climate change vulnerability along with demographic, attitudinal, and perception-based variables derived from a representative national survey of U.S. residents to predict variation in support for interventionist climate change policies. Ordinary Least Squares (OLS) regression results show that objective risk measures explain a modest amount of variation in our dependent variable. The effect of risk perception on climate policy support is far more robust. Of all variables examined, the extent to which citizens regard climate change as threatening to their material well-being drives support for costly climate change policies.

Keywords climate change, global warming, policy support, risk perception, vulnerability

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Political interest in addressing the threats associated with climate change and variability is increasing at all levels of governance. Mounting evidence that human activities are responsible for temperature increases over the past century (Oreskes 2004) and recent international conventions highlighting the importance of taking precautionary action have contributed to a growing commitment by many countries to mitigate or adapt to the adverse impacts of global climate change (Roberts et al. 2004). Most precautionary strategies focus on reducing greenhouse gas emissions, but also include, among other options, restricting development in floodplains and sub-sea-level elevations, preventing the buildup of fuel loads in forests, and protecting vulnerable coastal communities (Titus 1986; 1998). Such policy responses are designed to increase the resilience of human and natural systems to climate change and variability.

Despite the importance of public acceptance of any measure that involves broad-scale policy change, researchers are only beginning to understand what factors motivate the public to support government initiatives aimed at reducing the risks of climate change. Previous studies have focused primarily on the influence of attitudinal and traditional socioeconomic characteristics in explaining willingness to support costly government efforts to slow or reverse warming trends (see O'Connor et al. 1999; Cameron 2005; Berk and Schulman 1995; Kempton 1993; Berk and Fovell 1999). These models rarely or only superficially include data measuring the degree to which individuals are physically at risk from the negative impacts of climate change.

This study is based on the ecological assumption that a person's physical vulnerability to climate change may be a pertinent factor in explaining his or her support for government climate change policies. Climate scientists note that the effects of climate change vary regionally and across demographic and economic groups (Scheraga and Grambsch 1998). Impact assessments (Watson et al. 1997) on climate change forecast place-specific disturbances in agricultural yield, economic development, loss of habitat and species, water supply, weather-related mortality, and recreational activities (Scheraga and Grambsch 1998). Climate models indicate that the risks of doing nothing or policy inaction are manifestly higher for some regions and sectors of the economy than others, just as socioeconomic models show that the transition costs of policy enactment are distributed unevenly by place (i.e., macroeconomic forecasts; computable general equilibrium models). The willingness of citizens to absorb the costs of adaptation and mitigation policies may correspond with these place-specific distributional effects of climate change. Therefore, we explore whether physical place matters in prediction of climate change policy support.

We use geographic information systems (GIS) analytic techniques to map and measure survey respondents' climate change risk at various levels of spatial resolution and precision. Using existing spatial data, we analyze multiple measures of climate change vulnerability along with demographic, attitudinal, and perception-based variables derived from a representative national survey to predict variation in support for interventionist climate change policies. This approach allows us to: (a) empirically test theoretical propositions by environmental social scientists on the determinants of environmentally significant behavior; (b) shed light on the physical factors triggering public perception and behavior; (c) develop and analyze a more fully specified model predicting willingness to support costly climate change policies; and (d) provide direction to policy makers on how to garner public acceptance for government initiatives meant to reduce the adverse impacts associated with climate change.

Our investigation is organized into four sections. First, we review literature on the types and causes of environmentally significant behavior. We follow Paul Stern's (2000) meta-analytic framework of environmentally significant behavior to organize our literature review. Second, we detail our research design—primary and secondary data collection, variable operations, and spatial configurations are discussed. Third, we present and discuss regression results. Finally, we revisit theoretical claims in relation to results and suggest lines of future inquiry.

Environmentally Significant Behavior: Definition, Types, and Causes

Social scientific literature is replete with theories, models, and hypotheses of environmental behavior. Paul Stern (2000) has developed an analytic framework that coherently organizes this literature into typologies of behavior and variables that predict variation in behavioral types. Stern's classification scheme of behaviors and predictors is based on research that shows that different types of environmental behavior are governed by different ensembles of attitudes, personal capabilities, and contextual forces (see Dietz et al. 1998; Korfiatis et al. 2004; Poortinga et al. 2004; Tarrant and Cordell 1997; Manzo and Weinstein 1987; Clark et al. 2003; McKenzie-Mohr et al. 1995; Karp 1996; Allen and Ferrand 1999).

A behavior is environmentally significant if it directly or indirectly causes environmental change. The empirical target is "the extent to which [a human activity] changes the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere itself" (Stern 2000, 408). Behaviors that directly impact climate change include, among other things, energy conservation and the purchase of commodities with positive inbuilt climate responses (i.e., purchase of efficient automobiles, insulating homes, using public transportation). Behaviors that indirectly impact climate change include individual preferences and actions toward climate change policies and regulations, psychological motivations for climate-sensitive behaviors, acts of environmental citizenship, and laws and treaties that regulate production modalities with externalities harmful to climate systems. Behaviors that directly or indirectly impact the environment are meaningful if undertaken with the expressed intent of changing the environment. Stern (2000) argues that behavioral intentions are triggered by features of social context (i.e., interest rates, price signals, policy instruments, and social networks), and conditioned by qualities residing in actors (i.e., human capital).

Efforts to operationally define and measure environmentally significant behavior can be organized on two dimensions to derive three environmentally meaningful types of behavior (Stern 2000). These behaviors include environmental activism, private-sphere environmentalism, and nonactivist public behaviors. Our article is concerned with nonactivist public behavior—citizen willingness to incur personal costs by supporting policies designed to reduce human impact on climate systems. Climate change policies are personally costly because citizens are required to pay higher prices for consumer items, face tax penalties for climate unfriendly behaviors, and must forfeit freedoms to oblige rules that regulate climate sensitive conduct. Climate change policy support is a behavior that indirectly impacts the environment, but carries potentially large societal effects because policies "change the behaviors of many people and organizations at once" (Stern 2000, 409). Given the nonlinear nature of climate systems, and the potential for unexpected and rapid climate change

(Scheraga and Grambsch 1998), policy interventions may be the only significant insurance against climate change.

Stern (2000) identifies four types of causal variables commonly used in the literature: *attitudinal variables*, *personal capability variables*, *contextual variables*, and *habits and routines*. Our discussion (and analyses that follow) is restricted to the first three types of causal variables, highlighting behavioral literature that pertains specifically to global warming and climate change.

First, *attitudinal variables* include general dispositions toward the environment (i.e., ecological worldview), behavior-specific norms and beliefs, nonenvironmental attitudes (i.e., egoistic vs. social-altruistic), and perceived costs and benefits of environmental action that economize and integrate value orientations. This suite of variables performs well in prediction of environmentally significant behaviors (see Buttel 1987; Dunlap 1991; Gigliotti 1992; Clark et al. 2003). For example, Hines et al. (1987), in a meta-analysis of 51 empirically based studies, report a sizable correlation between attitudinal variables and environmental behavior.

Numerous attitudinal studies use the New Ecological Paradigm (NEP) scale to predict general environmental behaviors. The NEP scale contains a battery of questions on resource scarcity, the intrinsic value of nature, and human dominion over the environment (see Dunlap et al. 2000). These questions measure a person's general disposition toward the biophysical world. Studies routinely show that persons scoring high on the NEP scale (reflecting greater concern for the environment) are more likely to engage in proenvironmental behaviors (Blake et al. 1997; Clark et al. 2003; Stern et al. 1999). Bord et al. (1998) find that persons regarding the biophysical world as "fragile" are more likely to voluntarily adopt behaviors and support policies that mitigate the anthropogenic causes of climate change.

Behavior-specific norms and beliefs predict only certain types of environmentally significant behavior. For example, Poortinga et al. (2004) show that specific concern for climate change has a significant effect on climate policy support (i.e., nonactivist public environmentalism) and transport energy use (i.e., private-sphere environmentalism). Likewise, Jaeger et al. (1993) find that concern for global warming predicts climate-relevant environmental action. Stern et al. (1999) suggest that general attitudinal dispositions and behavior-specific norms and beliefs can be arranged sequentially, with general values causally prior to specific beliefs.

Another attitudinal variable emphasized in the literature is the perceived risks and benefits of action or inaction. NEP measures emphasize altruism as a motive for action, whereas this subset of risk perception attitudinal variables favors more conventional concepts of self-interest and rational action. Risk perception studies show that individuals are more likely to engage in environmentally significant behaviors if they perceive the risks of nonaction as high, if they regard an environmental phenomenon as threatening to their personal welfare, or if they perceive the personal benefits of action as higher than the perceived costs in time, money, and effort. There is considerable evidence for this *value expectancy* theory of behavior (Mohai 1985; Rohrschneider 1990; Samdahl and Robertson 1989; Lubell et al. 2006). For example, studies show that persons aware of (or perceiving) the harmful consequences of an environmental problem are more likely to adapt behaviors that mitigate the problem (Stern et al. 1999; Clark et al. 2003; Black et al. 1985). Studies using analogous measures of perceived harm (Manzo and Weinstein 1987; McKenzie-Mohr et al. 1995) and perceived risk (Der-Karabetian et al. 1996; Wakefield et al. 2001) arrive at similar conclusions. Numerous studies also show that perceived risk is a strong indicator of

citizen willingness to pay the costs of climate change adaptation and mitigation (McDaniels et al. 1996; Stedman 2004; Berk and Schulman 1995).

The second type of causal variable is *personal capability*. This suite of variables emphasizes an individual's perceived and actual environmental knowledge, the skills and human capital required for environmental action, the perceived ability of a person to positively affect environmental outcomes, and whether a person ascribes responsibility to him- or herself for action. The capability to pay the costs of environmentally significant behavior is related to the flexibility of time and budget constraints on action (Brady et al. 1995; Lubell et al. 2006). Scholars typically use social demographic variables as indicators of personal capability like educational attainment and income. Persons of higher education are more likely to absorb the costs of environmental action because they tend to possess more civic skills, assimilate environmental information more quickly, and are better able to target their activities (Gale 1986). Quantitative personal capability studies on climate change indicate that knowledge of the causes of climate change and level of educational achievement positively predict climate-relevant behaviors and behavioral intentions (Jaeger et al. 1993) as well as support for greenhouse gas referenda (O'Connor et al. 2002). Lubell et al. (2006) find that education and climate change knowledge affect the frequency of citizen engagement in climate friendly behaviors. However, qualitative studies show increased knowledge of the causes of climate change may, in fact, reduce citizen willingness to support policy initiatives (Read et al. 1994a; 1994b).

More proximate estimates of personal capability focus on personality characteristics and perception. Perceived efficacy is a powerful predictor of environmental behavior. Geller (1995) finds that individuals with higher personal control and optimism are significantly more likely to support environmental preservation efforts. Lubell et al. (2005; 2006) find that perceived personal influence predicts participation in air-quality activism, and influences participation in behaviors that mitigate human impact on climate systems. Persons high in perceived efficacy perform what Opp (2001) calls a "cognitive illusion" whereby estimates of personal influence are substantially greater than reality. This cognitive trick increases the probability that an individual will engage in collective behavior (Finkel, Muller, and Opp 1989). The predictive power of personal capability variables is supported by Hines, Hungerford, and Tomera's (1987) meta-analytic results on the positive relationship between internal loci of control/perceived efficacy and environmental behavior. They report a corrected correlation coefficient of .365 ($SD = .121$)—the highest among variable domains examined.

The third (and our final) type of causal variable of environmentally significant behavior is *contextual forces*. Stern (2000) provides a list of contextual variables that predict environmental behavior like community norms and expectations, legal or institutional rules that contour behavior, built environment constraints, and an array of social and political factors. Stern's concept of context is decidedly sociological. Numerous studies confirm the effects of social context on behavior. Huckfeldt and Sprague (1987; 1991) argue that involvement in discussion networks provides individuals with solidarity benefits and positive reinforcements for civic participation. Others note that discussion networks link persons to beneficial weak ties that expose them to recruitment networks and information signals that increase their willingness to engage in climate change activism (Lubell et al. 2005b). Jaeger et al. (1993) find that the contextual variable of social network interest in climate

change independently predicts participation in climate-relevant behaviors like energy conservation.

At higher levels of analysis, Lubell et al. (2005) find that civic context affects individual participation in global warming activism. Persons residing in social-capital-rich localities (i.e., higher rates of civic participation) are more likely to engage in global warming activism. Such localities, Lubell et al. (2005) argue, provide individuals with more opportunities for collective action, decrease the costs of movement formation and persistence, and instill a local sense of viability in group action as a behavioral strategy. All these social contextual signals function to counter free-riders incentives. Cross-national studies of environmental behavior note the likely effects of political economic context. Guerin et al. (2001) compare recycling behaviors in 15 European countries. Their hierarchical, multilevel analysis shows that country-level membership in environmental associations, waste policies, and levels of deforestation modulate individual level propensities to participate in recycling.

An important element of context overlooked in the literature is the physical environment. As Dunlap and Catton (1979; 1994) argue, social scientists are philosophically committed to the Durkheimian dictum that social facts (i.e., environmental behavior) must be explained by other social facts (i.e., cognition, demography, and social context). This approach abstracts human behavior from physical context, downplaying the reciprocity between nature and human social organization. In recent years, the philosophical reluctance to address the effects of physical context on behavior has dissipated in social science. However, few rigorously designed studies exist.

Qualitative studies on contaminated communities show that grass-roots environmental movements are more likely to arise in environmentally distressed localities (Bullard 1990; Cable and Degutis 1991; Cable and Benson 1993). Drori and Yuchtman-Yar's (2002) study of three municipalities in Israel/Palestine—Jerusalem, Tel Aviv, and Haifa—finds that environmental perceptions correspond predictably with environmental risks. Similarly, Brody et al. (2004) show that when controlling for socioeconomic and geographic contextual variables, residential proximity is a significant factor in explaining knowledge and perception of water bodies in San Antonio. Blake's (2001) study of residents in British Columbia finds that spatial variation in environmental problems predicts participation in environmental causes and support for collective action to reverse environmental deterioration. Berk and Schulman (1995) show that willingness to pay the costs of global warming prevention depends on the severity of hypothetical climate scenarios considered. Last, Berk and Fovell (1999) compare contingent valuations of residents in two microclimates in Los Angeles—coastal versus inland valley communities. Modest significant differences obtain between communities on willingness to pay for climate change mitigation, with valley residents less concerned.

Climate change models generated by the Hadley Center in the United Kingdom and the Canadian center for climate modeling and analysis, on which the U.S. national climate change assessment is based (Melillo et al. 2000), identify probabilistic future scenarios on the basis of past trends. Despite the inherent uncertainties in forecasting effects, there are several physical impacts associated with climate change in North America that most prediction models agree on. These impacts have a regional logic, and include rise in the heat index, increasing levels of precipitation, increased extreme weather events, and sea-level rise (Houghton et al. 2001). Based on these expected impacts, multiple indicators of physical vulnerability associated

with climate change can be derived, such as the concentration of CO₂ and other greenhouse gases, warming trends, increased climate variability, changes in the frequency and the intensity of natural hazards, and flooding associated with inundation of low-lying coastal communities (McCarthy et al. 2001). These indicators of climate change vulnerability can be mapped and possibly linked to variation in willingness of citizens to assume the costs of climate change prevention policies. Our primary objective in this article is to test this linkage and extend the literature's notion of contextual forces by consideration of physical context measures. In the next section we discuss research design elements of data collection, model specification, variable operations, and hypotheses.

Research Design

Data Collection

Survey data are derived from a national telephone survey of randomly selected adults in the United States conducted from July 13 to August 10, 2004. The survey instrument was designed by research scientists at the Institute for Science, Technology, and Public Policy at Texas A&M University. The survey probed a wide array of citizen attitudes and behaviors on global warming and climate change. Telephone interviews were performed in English, averaging 37 min to complete. Based on the American Association for Public Opinion Research outcome calculator IV, the response rate was 37% and the cooperation rate was 48%. Overall, 1093 interviews were completed, constituting $\pm 3\%$ sampling error.¹

Respondents are placed in their true location on Earth using x and y coordinates by tying their addresses to a 2000 U.S. Census Bureau TIGER line file. Of 1093 persons interviewed, a sample of 511 respondents (for whom complete records were available) was analyzed representing a broad range of physical and geographical settings. The majority of respondents are drawn from coastal and urban areas, where the population of the United States is most densely concentrated. With each respondent located in geographic space, spatial analytical techniques are used to examine physical vulnerability to climate change within the study area. Spatial data were derived from numerous sources, including the Hazard Research Lab at University of South Carolina, the Energy Information Administration, the National Climatic Data Center, and Applied Geographics Solutions, Inc. In the next subsections, variable operations and model expectations are detailed (see Table 1 for summary of hypotheses).

Table 1. Variables hypothesized to predict climate change policy support

Attitudinal variables		Personal capability variables		Contextual variables	
Agency competence	+	Gender	–	Network interest	+
New ecological values	+	Perceived efficacy	+	Environmental citizenship	+
Risk perception	+	Education	+	Natural hazard casualties	+
		Household income	+	Sea-level rise risk	+
		Knowledge	+	Carbon dioxide emissions	–
				Temperature trend	+

Dependent Variable Measurement

The *climate policy support* ($\alpha = .855$) variable sums 11 items (see Table 2 for summary statistics on scale constructs). Survey respondents were asked to indicate their level of support (4-point scale; 1 = strongly oppose, 4 = strongly support) for climate change policies such as the imposition of taxes on industry and

Table 2. Summary statistics and alpha scores for variable constructs

Scale and scale items	Item total correlation	Alpha	Mean	SD
Climate Change Policy Support		.855	2.98	.433
Market incentives to reduce industry emissions	.391			
Tax on industries that contribute to climate change	.669			
Tax on individuals that contribute to climate change	.599			
Educate the public on human causes of climate change	.630			
Ratify the Kyoto Protocol	.661			
Increase energy efficiency in industry	.613			
Develop renewable energy sources	.461			
Reduce methane in agriculture	.586			
Protect coastal settlements and water supplies	.333			
Require fuel-efficient vehicles	.618			
Increase the price of fossil fuels	.435			
Agency Competence		.849	6.44	1.97
Competence of U.S. EPA	.746			
Competence of NOAA	.697			
Competence of IPCC	.713			
Risk Perception		.843	2.71	.645
Risk to health	.718			
Risk to finances	.685			
Risk to immediate environment	.729			
New Ecological Values		.727	2.89	.425
Approaching limit of people the earth can support	.459			
Humans interfere with nature often disastrous	.493			
Environmental crisis impending	.524			
Plants and animals have right as humans to exist	.335			
The earth is spaceship with limited room and resources	.413			
The balance of nature is delicate and easily upset	.616			
Must consider future generations	.261			
Perceived Efficacy		.667	2.71	.524
Actions have influence climate change	.571			
Action will encourage others on climate change	.381			
Humans responsible for climate change	.496			
Network Interest		.732	.954	.414
Talked with family about climate change	.645			
Talked to friends about climate change	.701			
Anyone asked opinion on climate change	.493			
Anyone offered opinion on climate change	.422			

individuals to reduce emissions, ratification of the Kyoto Protocol, price controls on fossil fuels, development of renewable energy sources, protection of coastal settlements and water supplies, and energy efficiency mandates. Support for such policy instruments reflects willingness among respondents to assume lifestyle restrictions and to pay for costly reforms to political economic design.

Independent Variable Measurement

Attitudinal Variables

Three attitudinal variables are used to model climate change policy support. An abbreviated version of the New Ecological Paradigm (NEP) scale developed by Dunlap et al. (2000) is employed to estimate general environmental concern. The *new ecological values scale* ($\alpha = .727$) averages responses on 7 items derived from the revised NEP Scale. Respondents were asked indicate agreement (4 = strongly agree; 1 = strongly disagree) with statements on resource scarcity, human impacts on nature, and ethical responsibility toward nonhuman life. As with previous literature, the ecological values measure is expected to behave positively in regression modeling. Because bureaucratic agencies translate citizen preferences into policy action, respondents were asked whether they believe agency actors like the U.S. Environmental Protection Agency are competent enough to solve the problem of climate change (0 = not at all competent; 10 = completely competent). Our *agency competence* ($\alpha = .849$) variable averages responses for three items. Individuals with higher regard for the competence of agency actors are hypothesized more likely to support interventionist climate change policies. Last, climate change *risk perception* ($\alpha = .843$) is a 3-item measure averaging respondent agreement (4 = Strongly agree; 1 = Strongly disagree) with statements on the threat of global warming and climate change to personal health, financial, and environmental welfare.

Personal Capability Variables

Various personal capability variables are measured, both demographic and perception-based. Education, income, and gender variables appear in our model. *Education* is measured on a 6-point scale, ranging from elementary school (1) to postgraduate degree (6). *Household income* has an 11-point scale with \$10,000 intervals (1 = less than \$10,000; 11 = more than \$100,000). For *gender*, female = 0 and male = 1. Because environmental behavior studies typically indicate that women more readily support environmental and climate initiatives (see Blake et al. 1997; Dietz et al. 1998; Barkan 2004; Zelezny et al. 2000; Diekmann and Preisendorfer 1998), we expect gender to behave negatively in prediction modeling. Consistent with previous quantitative literature, education and income are hypothesized to be positively associated with policy support.

Measures on climate change knowledge and perceived efficacy are included. Climate change *knowledge* is measured by two true/false questions: "Nitrous oxide is a greenhouse gas" and "The major cause of increased atmospheric concentration of greenhouse gases is burning of fossil fuels." *Perceived efficacy* ($\alpha = .667$) is a 3-item measure, estimating the perceived ability of a respondent to influence climate change outcomes, to induce others to behave in ways that mitigate human sources of climate change, and whether a respondent accepts climate change as a human responsibility. Knowledgeable and efficacious respondents are assumed more likely to willingly pay the costs of climate change mitigation and adaptation.

Contextual Variables

Two social contextual variables are measured. *County environmental citizenship* is derived from the MRI Consumer Behavior Survey. Researchers at Applied Geographic Solutions, Inc., have configured MRI household records to various levels of political, administrative, and statistical scale. A Mosaic coding technology based on a cluster algorithm (i.e., iterative relocation) is used to derive geo-demographic profiles of areas. The underlying logic of geo-demographic segmentation is that people gravitate to localities with people of similar interests, means, and backgrounds. The Mosaic system is discussed more thoroughly at www.appliedgeographic.com. Our *county environmental citizenship* is a ratio measure. MRI survey respondents were asked to indicate whether they participated in environmental groups and causes in the last 12 months. The county rate was derived by dividing the total number of adult respondents indicating yes to this question by the total number of adults 18 years of age and older residing in the county. The second social contextual measure is *network interest*. This variable is comprised of 4 items ($\alpha = .732$). Two questions measure the frequency of communication between respondents and their families and friends on global warming and climate change, and two questions measure whether anyone has ever asked for or influenced a respondent's opinion on global warming and climate change.

Based on climate change impact literature, four physical context variables are measured: weather, proximity of respondents, natural hazards, and human-induced hazards. We calculated a *temperature trend* variable based on a correlation between time (year) and the number of days exceeding average temperature from 1948 to 2005. Temperature exceedance was derived from U.S. Heat Stress Index Data, collected by the National Climatic Data Center, Asheville, NC. Time-series 85th percentile exceedances of average apparent temperature for a 1-day period were mapped and intersected with the location of survey respondents. Each respondent was assigned the attributes of their respective climatic division. Respondents residing in a climatic division with a statistically significant correlation ($p < .05$) between time and the number of days exceeding average temperature were assigned the corresponding coefficient. All others were assigned a score of zero. A *natural hazard casualty* variable was calculated by summing reported injuries and fatalities from natural hazard events at the county level. The variable was logarithmically transformed for skew and unequal variation. Data were collected from the Spatial Hazard Events and Losses Database for the United States (SHELDUS) from January 1, 1960, to July 31, 2004. Using GIS analytical techniques, the data was intersected with the location of survey respondents.

A dichotomous *sea level rise/inundation risk* variable was calculated by identifying respondents living within 1 mile of the nearest coastline—a cautiously conservative radius—that also have negative relative elevation to the coast. Respondents at risk were assigned a 1; all others were assigned a 0. Relative elevation was computed as the difference between the respondent's elevation and the elevation of the nearest point location on the coast. Insofar as respondents reason rationally in terms of risk signals from physical place, we expect these mentioned parameters to positively predict respondent willingness to absorb the policy costs of climate change prevention. Finally, human-induced risk was measured as the estimated *total carbon dioxide emissions* at the state level using the State Energy Data tables 2001 reported by the Energy Information Administration (2001). Each respondent was assigned the respective state emission attributes. Because the policy costs of climate change

mitigation and adaptation fall unevenly by region, persons residing in high emission areas are expected to be less supportive of climate change policies because of higher expected policy enactment costs.

Results

Table 3 reports OLS regression results for prediction of climate change policy support. Model performance is relatively strong for survey data, with about 42% of variation in climate change policy support predicted by the variable pool. With one major exception, variables perform as hypothesized. Beginning with attitudinal measures, individuals who perceive climate change as harmful to their personal welfare are significantly more likely to support climate change mitigation and adaptation policies. In fact, risk perception is the strongest predictor of policy support in our model ($\beta = .244$, $p = .000$). The new ecological values measure is also positively associated with climate change policy support ($\beta = .183$, $p = .000$). Citizens with an integrated concern for intergenerational equity, carrying capacity, and resource scarcity, and who regard the biosphere as deserving of moral consideration, are more willing to assume the costs of climate change prevention. Finally, respondents with higher regard for the competence of bureaucratic agencies to solve the problem of climate change appear more likely to support potentially costly state interventions ($\beta = .124$, $p = .001$). Overall, this subset of attitudinal variables is statistically powerful, covering approximately 75% of the explanatory weight of the regression equation.

Table 3. OLS regression model predicting climate change policy support

	<i>B</i>	SE	Beta	<i>t</i>	Significance	Tolerance	Variance Inflation Factor (VIF)
Attitudinal variables							
Agency competence	.027	.008	.124	3.424	.001	.915	1.093
New ecological values	.188	.045	.183	4.173	.000	.627	1.595
Risk perception	.165	.030	.244	5.509	.000	.611	1.637
Personal capability variables							
Gender	-.097	.032	-.110	-3.028	.003	.903	1.107
Perceived efficacy	.159	.038	.191	4.229	.000	.591	1.692
Education	.032	.014	.086	2.276	.023	.834	1.199
Household income	-.002	.006	-.010	-.274	.784	.849	1.178
Knowledge	.059	.022	.101	2.717	.007	.872	1.146
Social contextual variables							
Network interest	.073	.042	.069	1.740	.083	.754	1.326
Environmental citizenship	4.435	3.337	.047	1.329	.185	.947	1.056
Physical contextual variables							
Natural hazard casualties	.027	.014	.069	1.945	.051	.949	1.054
Sea-level rise risk	-.463	.171	-.096	-2.703	.007	.954	1.048
Carbon dioxide emissions	-.079	.045	-.062	-1.769	.077	.978	1.023
Temperature trend	.245	.113	.076	2.167	.031	.968	1.033
Constant	1.209	.212		5.695	.000		

Note. Adjusted *R* square, .419. Standard error estimate, .3329658. *F*, 25.933.

Our block of personal capability variables has predictive value in explaining policy support. Perceived efficacy significantly predicts the dependent variable, second only to risk perception in explanatory power ($\beta = .191, p = .000$). This result is consistent with established literature showing that individuals with high internal loci of control are more supportive of policy action, reflecting a greater willingness to assume the costs of mitigating the anthropogenic sources of climate change. Similarly, citizens knowledgeable of the causes and features of climate change are significantly more likely to support climate change policies ($\beta = .101, p = .007$). On average, respondents with a greater understanding of the causes and potential consequences of global warming and climate change appear more supportive of policy initiatives to address this threat. Socio-demographic proxies of citizen capability to absorb policy costs behave as predicted. As with environmental concern literature (Davidson and Freudenberg 1996; South and Spitze 1994; Steel 1996), women express significantly greater support for climate change policy interventions than men ($\beta = -.110, p = .003$). Last, results on human capital estimates are mixed. Education is positively related to climate change policy support, second to gender among demographic proxies in predictive power ($\beta = .086, p = .023$). Closer inspection of the relationship between education and policy support reveals an interesting nonlinearity. With each unit increase in educational attainment the willingness to absorb the costs of policy enactment increases, except for the unit change from high school graduate to vocational school graduate. Individuals with a vocational or trade designation are least likely to support climate change policy interventions. Finally, household income is insignificant in predicting policy support ($p = .784$).

Contextual variables seem to partially validate the ecological assumption that place matters in explaining environmentally significant behavior. Features of social context appear to matter less than physical context in predicting policy support. A modest positive correlation exists between policy support and the county environmental citizenship rate, but the relationship is insignificant with statistical controls ($\beta = .047, p = .185$). Network interest is positively associated with climate change policy support ($\beta = .069$), but the relationship is significant only at the .10 alpha level. Tentatively, the more connected a person is to social networks interested in climate change, the more likely it is that he or she is willing to support costly policy interventions.

On physical context variables, respondents in areas undergoing statistically significant change in temperature are more likely to support costly climate change policies ($\beta = .076, p = .031$). Citizens appear alert or sensitive to the risks of warming, and warming signals appear to increase one's propensity to assume the costs of prevention. In fact, our temperature trend variable rivals the more traditional measure of education in explanatory power. Similarly, a significant positive relationship obtains between our natural hazards casualty measure and policy support ($\beta = .069, p = .051$). Persons who reside in localities with higher frequencies of natural calamity and extreme weather events (i.e., floods, hurricanes, and drought) are more likely to submit to aggressive climate policy reforms. These two "fingerprints" of climate change vulnerability may constitute the clearest, most visible signals from the physical environment affecting citizen willingness to pay the costs of policy enactment. In fact, as a group, respondents in areas on the higher end (at least one standard deviation from the mean) on both our temperature change and natural hazards casualty variables score highest on our climate change knowledge measure.

The same cannot be said for our sea level rise/inundation risk measure. This variable significantly predicts climate change policy support, but in the opposite

direction hypothesized. Respondents living within 1 mile of the nearest coastline at negative relative elevation to the coast are less (not more) likely to support government-led climate initiatives ($\beta = -.096, p = .007$). Extending the risk radius to 2 and 3 miles (where the collateral effects of inundation are likely to be highest) does not change the direction of the coefficient. Compared to risk-insulated others, persons in this at-risk class are of slightly higher education and income, are lower in knowledge, and are more likely to attend religious services. However, these differences do not supersede statistical chance, nor does inclusion of these variables cancel the negative value on policy support. This finding does not bode well for policy advocates of climate change mitigation because individuals at greatest risk of inundation are among the least willing to absorb the costs of reform.

Finally, as predicted, citizens in states with higher levels of carbon dioxide emissions appear less likely to support personally costly climate change policies ($\beta = -.062, p = .077$). States with higher CO₂ emissions face higher transition costs with the enactment of policies designed to reduce anthropogenic stressors on climate change. In other words, the penalties of climate policy reform are likely to burden high emitters of CO₂ more in absolute dollars. Respondents in high-emission states may thus be sensitive to these differential costs.

Conclusion

In this article, we examined the partial correlates of citizen support for costly public policy instruments designed to reduce the negative impacts associated with climate change. We deployed Stern's (2000) framework on the types and causes of environmentally significant behavior, examining a specific class of behavior Stern defines as "nonactivist public behavior." We organized correlates of climate policy support into three variable domains—attitudes, capabilities, and context. To the existing list of contextual variables, we added a series of measures on physical context. Our inclusion of physical context measures is based on the theoretical assumption that physical place, however modest in effect, patterns attitudes and behavioral propensities toward climate change. Results modestly support this assumption.

Climate scientists and policy analysts forecast the risks of climate change, both ecological and socioeconomic, as having a regional logic. That is, the risks of climate change are distributed nonrandomly by place. The Intergovernmental Panel on Climate Change (Watson 2001, 9) reports: "Projected climate change will have beneficial and adverse effects on both environmental and socio-economic systems." At-risk localities (facing greater adverse effects) are "fingerprinted" by temperature change and variability, histories of extreme weather events, and proximity to coastlines. We assumed that persons in areas with such physical risk characteristics would rationally express higher support for climate change mitigation policies. Performance of these climate change vulnerability measures in our regression model is mixed. Respondents appear sensitive to temperature trend signals and natural hazards. These relatively visible features of climate change significantly predict citizen willingness to pay the costs of climate change prevention.

On the other hand, coastal residents within 1 mile of, and at negative relative elevation to, the nearest coast are surprisingly less of supportive climate change policies. On data we collected, little distinguishes this class of at-risk persons from the rest of the sample. Our best explanation for this result is that at-risk coastal residents may have a stronger sense of subjective immunity. That is, coastal residents appear

less subjectively threatened by a host of ecological risks. Data show that at-risk coastal residents are significantly less concerned on a range of ecological risks from genetically modified organisms (4.60 vs. 4.87), from pollution (4.83 vs. 7.15), and for the environment generally (5.67 vs. 7.27). Lower concern on ecological risks may have an objective dimension. For example, data on stationary sources of air pollution from the U.S. EPA National Emissions Inventory on harmful air pollutants show that at-risk coastal residents have (on average) lower levels of exposure to harmful pollutants compared to the sample as a whole (14,679,605 vs. 19,682,770 tons). Therefore, coastal residents may willingly trade the risks of sea-level rise/inundation associated with climate change for the quality-of-life advantages associated with coastal residence. The perceived benefits of living in an area vulnerable to sea-level rise supersede the perceived risks associated with living on the coast.

Compensation differential analyses routinely show that individuals willingly accept lower wages and higher housing prices for locations adjacent to an ocean or Great Lake coast (see Gyourko and Tracy 1991; Blomquist *et al.* 1988). According to Rappaport and Sachs (2003, 5), the United States is increasingly a coastal nation, with coastal counties host to over 50% of U.S. population and a disproportionate share of total civilian income. Aggregate population density data from 1880 to 2000 indicate a steady increase in coastal settlement, particularly along Atlantic and Pacific coasts. Together with our survey results, this migration trend deepens the puzzle for climate policy advocates. Insofar as coastal residents trade the risks of sea-level rise/inundation for quality-of-life benefits, and coastal life reduces one's propensity to support climate change risk mitigation efforts, the country faces a potentially catastrophic misalignment of individual and group incentives. As individuals are pulled to coastal life by quality-of-life incentives (Haurin 1980), a greater percentage of the population is drawn into the risk of sea-level rise/inundation.

As with the management of all environmental risks, the costs of climate policy reform (particularly instruments aimed at reduction of atmospheric concentration of CO₂) burden some localities more heavily than others. Our model therefore estimates the costs of policy enactment with place data on total CO₂ emissions. We assumed that variation in citizen willingness to absorb the costs of policy action is predicted by the place-specific differential costs of policy compliance associated with tonnage of CO₂ emissions. As predicted, we find that persons residing in high-emission areas are less likely to support climate policies. Taken together, these physical context measures outperform the more traditional social context measures in the literature.

Although objective risk measures explain a modest amount of variation in our dependent variable, the effect of risk perception on climate policy support is far more robust. Of all variables examined, what drives support for costly climate change policies is the extent to which citizens regard climate change as threatening to their material well-being. Our data indicate a faint correspondence between climate change risk perception and physical vulnerability measures. In fact, inclusion of physical vulnerability measures in our regression model does little to dampen the size of the risk perception coefficient. This finding conforms to decades of research on the discontinuities between perceived and scientifically defined risk (see Freudenberg 1988). This discontinuity is especially significant in our study because it suggests respondents who are most vulnerable to the impacts associated with climate change are not necessarily those who perceive it as the greatest risk.

Another theoretical reason for the tight coupling of risk perception and policy support stems from the basic functions of policy design and implementation.

According to Anthony Giddens (1994; 1999), the enterprise of modern government is best understood as risk management. Governments devise schemes to guard against dangers of social and natural disorder. Public policy instruments are risk management devices. They function as a form of public insurance, a means of dealing with the predictable hazards of modernity by pooling resources, spreading the costs, and distributing benefits efficiently and/or equitably. By this logic, it is reasonable to find a partial correlation between risk perception and support for policy instruments that are risk averting by design. Likewise, because bureaucratic actors are responsible for policy execution, we find a significant relationship between individual regard for the competence of policy actors to solve climate change and support of risk mitigation policies.

Several personal capability variables are also significant predictors of willingness to support climate change policies. Specifically, respondents with greater knowledge of the causes of the climate change problem, including that humans are part of this problem, are more likely to support policy interventions. These results are somewhat inconsistent with previous studies that show there is a general confusion about the meaning and underlying causes of global climate change (Kempton 1991; Dunlap 1998) and that knowledge of the causes of climate change does not necessarily translate into greater policy support (Read 1994a; 1994b). Our finding has important policy ramifications because awareness of the problem, on average, is linked to support for policy actions. A critical component of any policy or program geared toward mitigating the adverse impacts of climate change must therefore include education of the voting public. Increasing awareness of the climate change issue and communicating the results of scientific findings and to the public will be an important part of an effective policy initiative at any level of government. Furthermore, because there appears to be a disconnect between those most physically vulnerable to potential adverse impacts and those who perceive the risk and are knowledgeable about the causes of climate change, education programs must be spatially targeted. Increasing awareness among those most likely to experience impacts of climate change and be affected by actions to mitigate the problem (i.e., low-lying coastal residents) can lead to greater support of potentially costly policies.

Although this study provides important information on the factors motivating willingness to support climate change policies, it should be considered a starting point for understanding the topic, particularly with respect to the impact of physical contextual characteristics. Additional research is needed before any conclusions can be made on the degree to which physical vulnerability plays a role in influencing perceptions, support for policy initiatives, and the implementation of policies related to climate change. First, more measures of physical vulnerability need to be incorporated in explanatory models. Our study only considers four contextual variables, whereas multiple measures covering several categories of impact would result in a more robust analysis. Second, we were limited to using existing data sets compiled at different levels of spatial aggregation. For example, casualty data were compiled at the county level while CO₂ emissions were only available at the state level. Future studies should rely on more spatially precise and consistent data to reduce the chances of statistical bias in results. Third, our study is limited to a random sample of individuals, making it difficult to extend the findings to larger geographic areas. Additional research should be conducted that characterizes and maps the relative physical vulnerability of the entire United States. Only through this approach will we be able to accurately identify hotspots of climate change vulnerability where

policy initiatives should take place. Finally, our study uses a telephone survey to understand what motivates individuals to support policy change. Given the complex physical and sociological nature of the topic, future research is needed involving in-depth case studies. Such studies could explore the role of framing and mass communication processes that influence citizen perceptions of climate change that, in turn, underwrite their willingness to support policy action. Case study analysis of specific jurisdictions would provide a clearer contextual picture of why citizens and communities are willing to adopt costly measures to reduce the threat of climate change.

Note

1. The majority of survey participants are female (55.6% vs. 44.4% male). The average age is 47.31 (SD = 16.40), and the range is 18–90. About 37% of respondents hold a college or postgraduate degree, and 2.5% have no high school diploma. The racial distribution of the sample is predominately white non-Hispanic (84.1%), followed by African American (8.1%), Hispanic (5.4%), Native American (1.2%), and Asian American (0.2%). On self-reported political ideology, 42.0% of respondents regard themselves as conservative, compared to 32.7% leaning liberal. Compared to the national U.S. Census figures, our sample is older in on average age (45.43 vs. 32.3), better educated (1/5 of Americans are without a high school diploma), and undercounts males (44.4% vs. 49.1%), African Americans (8.1% vs. 12.3%), Hispanics (5.4% vs. 12.5%), and Asian Americans (0.2% vs. 3.6%).

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