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Exposure, Resources, and Place: Associations of Perceived Weather-Related Challenges, Financial Hardship, and Residential Context with Environmental Worry in the United States

Research Article

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Abstract

Environmental worry is an important affective dimension of environmental risk perception, yet relatively little research has examined its simultaneous associations with perceived environmental conditions, financial hardship, and residential context. Guided by environmental psychology, social vulnerability theory, and place scholarship, we examine environmental worry using three conceptual domains: Exposure (Perceived Weather-Related Challenges), Resources (financial hardship), and Place (residential context). Using the 2024 4R-Stat Baseline Survey (N = 13,240) data, we examined differences in environmental worry across residential settings and U.S. regions and assessed the independent associations of demographic characteristics, financial hardship, and Perceived Weather-Related Challenges with environmental worry. Broad geographic region was not significantly associated with environmental worry, whereas residential setting showed a clear gradient, with urban residents reporting higher environmental worry than suburban and rural residents. Perceived Weather-Related Challenges showed the largest standardized association with environmental worry, while financial hardship and residential setting were also associated with environmental worry. Younger respondents, women, and respondents from racial and ethnic minority groups reported higher environmental worry. Education was not significantly associated with environmental worry. The final model explained 8.1% of the variance; exploratory interaction terms jointly added only 0.4 percentage points. Because financial hardship is not equivalent to economic worry, these cross-sectional findings do not constitute a direct test of the finite-pool-of-worry hypothesis. The findings describe social and residential differences in environmental worry and identify questions for future research on Perceived Weather-Related Challenges, economic circumstances, and residential context.

Keywords: Environmental Worry; Financial Hardship; Perceived Weather-Related Challenges; Residential Context; Environmental Risk Perception

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Introduction

Weather- and climate-related hazards increasingly affect communities by disrupting infrastructure, livelihoods, health, and everyday life, although the magnitude and nature of these impacts vary across hazards and locations [1]. Beyond their physical consequences, these changes also influence how people perceive environmental risks and respond emotionally to them [2,3]. Environmental worry refers to affective response to perceived environmental threats, reflecting the degree to which individuals worry about environmental conditions affecting the places where they live [4]. Understanding environmental worry is therefore important not only for environmental psychology but also for environmental sociology, geography, public health, and environmental policy because emotional responses influence risk perception, preparedness, mitigation behaviors, adaptation, and public support for environmental action.

Unlike eco-anxiety, which may involve functional impairment or clinically significant distress, environmental worry is generally regarded as a normal emotional response, rather than a psychopathology, that may motivate adaptive engagement with environmental issues [2,5-8]. Research in environmental psychology further demonstrates that affective responses often influence environmental judgments independently of factual knowledge or cognitive assessments of risk [9-11]. Consequently, understanding who experiences greater environmental worry, and under what circumstances, has become increasingly important for both environmental research and public policy.

Although environmental worry is typically measured at the individual level, considerably less attention has been devoted to understanding how broader social and environmental contexts shape these emotional responses [5,8]. Existing studies have linked environmental worry to climate emotions, demographic characteristics, environmental experiences, and environmental risk perception, but these correlates have generally been examined independently rather than within a unified framework [2,3,12-16]. As a result, relatively little is known about the extent to which perceived environmental conditions, household resources, and residential context are jointly associated with environmental worry.

Three complementary perspectives guide this study. Environmental psychology emphasizes affective and experiential influences on environmental judgments. Social vulnerability scholarship highlights the role of economic resources and inequality in shaping environmental risks, and place scholarship emphasizes how environmental change is interpreted within residential and community contexts [10,11,17-22]. In the present study, environmental change refers broadly to perceived weather- and climate-related conditions that respondents identify as affecting the places where they live.

Taken together, these perspectives suggest that environmental worry is likely associated with three broad conceptual domains, each aligned to a perspective. Although environmental worry may reflect concerns about environmental issues operating at multiple spatial scales, ranging from local environmental conditions to broader climate change, the present study focuses on conditions respondents perceive as affecting the places where they live. The first, Exposure, is operationalized as respondents' perceptions of weather-related challenges affecting where they live, reflecting perceived local environmental conditions rather than objectively verified physical exposure to hazards. The second is Resources, operationalized through financial hardship. The third is Place, operationalized through residential setting; broader geographic region is included as a statistical control.

Previous research provides support for each of these domains individually. Studies of environmental risk perception have consistently found that perceived environmental experiences are associated with stronger emotional responses to environmental hazards, although the strength of these relationships varies according to the type of environmental event and the outcomes examined [15,16,23]. Similarly, research grounded in social vulnerability and environmental justice has shown that environmental burdens are disproportionately experienced by populations facing economic disadvantage and structural inequities, suggesting that financial hardship may intensify emotional responses to environmental disruption [24-26]. Place-based research likewise demonstrates that residential environments influence both objective environmental conditions and the social interpretation of environmental change, making residential context an important but often underexamined dimension of environmental worry [22,27,28].

Despite these advances, relatively few studies have simultaneously examined Perceived Weather-Related Challenges, financial hardship, and residential context within a large sample of adults from across the United States. Integrating these domains offers a broader understanding of how environmental worry is socially and spatially patterned while connecting environmental psychology, environmental sociology, hazards geography, and public health within a single analytical framework.

Accordingly, this study examines environmental worry using data from the 2024 4R-Stat Baseline Survey. Guided by an integrated conceptual framework, we examine whether environmental worry differs across U.S. regions and residential settings, whether financial hardship and Perceived Weather-Related Challenges are associated with environmental worry after accounting for demographic characteristics, and which focal domain indicator demonstrates the strongest standardized association with environmental worry.

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Background and Literature Review

Weather-related disruption can affect communities through physical damage, health, household finances, and psychological wellbeing [29-31]. These impacts are not distributed evenly but vary according to environmental conditions, available resources, and characteristics of the places where people live [17,18]. Understanding emotional responses to these conditions is therefore an interdisciplinary problem spanning environmental psychology, environmental sociology, hazards geography, and public health. The following sections review the literature on Environmental Worry, Exposure, Resources, and Place, and integrate these perspectives into the conceptual framework guiding the present study.

Environmental Worry as an Affective Response to Environmental Change

Environmental worry is an affective dimension of environmental concern [4]. Whereas environmental concern encompasses beliefs and evaluations about environmental threats, environmental worry reflects emotionally charged apprehension about environmental conditions and uncertain futures [2,8,32]. Although seriousness, concern, and worry are sometimes used interchangeably, they are conceptually distinct, just as eco-anxiety is distinct, and individuals may express concern without experiencing persistent worry [3] or anxiety. Verplanken and Roy found that habitual ecological worry was not associated with psychopathological worry and was instead linked to constructive environmental tendencies, while Ojala et al. concluded that climate-related worry can represent a normal and potentially adaptive response to environmental threats [2,33]. Together, these findings support distinguishing environmental worry from psychopathology.

Environmental worry is important because affect influences judgment and behavior. The risk-as-feelings framework proposes that emotional reactions to risk can diverge from cognitive evaluations and influence decision making, while the effect heuristic suggests that affective responses shape subsequent assessments of risks and benefits [10,11]. Consistent with these perspectives, van der Linden found that experiential and affective factors were important predictors of climate-change risk perception alongside sociocultural values and norms [3]. Because lay judgments are influenced by perceived rather than objective hazards, environmental worry cannot be inferred directly from objective environmental exposure [34]. Climate-related worry has also emerged as a population mental-health concern, particularly among younger people, and may co-occur with economic and housing insecurity [12,31,35]. Consequently, understanding how Exposure, Resources, and Place are associated with environmental worry has important implications for environmental policy and public health.

Exposure: Perceived Weather-Related Challenges and Environmental Worry

The Exposure domain is operationalized as perceived weather-related challenges affecting respondents' local environments. The domain captures respondents' reports of weather-related conditions where they live, not verified physical exposure to hazards. Prior research suggests that direct experience with environmental hazards is frequently, though not uniformly, associated with environmental risk perception. Respondents reporting personal experience with flooding expressed greater concern about climate change, perceived it as less uncertain, and reported greater confidence in their ability to mitigate its effects [15]. However, these relationships vary across hazards. Whitmarsh found that flood victims did not consistently attribute their experiences to climate change, whereas air-pollution victims expressed stronger pro-environmental values than non-victims, suggesting that associations between environmental experience and environmental responses depend on hazard type, attribution, and the outcome assessed [16,23].

Recent research indicates that weather-related disruption often coincides with financial strain and psychological distress [30,31,36]. Together, these findings suggest that Perceived Weather-Related Challenges and economic circumstances may be jointly associated with environmental worry, although causal direction remains unresolved.

The relationship between environmental experience and environmental worry is not uniform, however. Although experiential factors consistently contribute to climate-risk perception, their effects vary depending on the outcome being examined [3]. Duan and Bombara, for example, found that personal experience with wildfires was associated with climate-change engagement only indirectly, through increased negative emotions and reduced psychological distance, with these pathways differing by political orientation and subjective knowledge [37]. Together, these findings suggest that associations between weather-related experiences and environmental worry depend on how exposure is measured and which response dimension is assessed [23].

Resources: Financial Hardship and Social Vulnerability

Social vulnerability scholarship holds that susceptibility to environmental harm is shaped by social and economic inequality rather than by physical hazards alone [17,18]. Tierney similarly argued that disasters reflect broader social and institutional processes, including economic inequality and inadequate risk regulation [19]. Material pathways linking financial hardship with weather-related strain are well documented. Temperature extremes disproportionately increase household energy burdens among low-income households and residents of energy-inefficient housing, while housing constraints

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and limited access to assistance can increase vulnerability to urban heat [26,27,38]. Economic and housing insecurity have also been associated with climate-related psychological distress [31]. Together, these findings provide a basis for expecting financial hardship to be positively associated with environmental worry, although the present study does not examine the underlying mechanisms.

Whether financial hardship reduces or amplifies environmental worry remains an open empirical question. Weber's finite-pool-of-worry hypothesis proposes that limited attentional and emotional capacity may cause concern in one domain to displace concern in another [39]. Evidence from European regions suggests that environmental and economic concerns may sometimes compete, particularly during concurrent environmental and economic shocks [40]. However, the present study does not directly test this hypothesis because difficulty paying bills measures material hardship rather than economic worry, and the cross-sectional design cannot evaluate changes in competing concerns over time. Instead, the finite-pool hypothesis serves as an interpretive contrast to the social vulnerability perspective, which suggests that financial hardship and environmental worry may coexist.

Demographic disparities are also relevant to environmental worry. Environmental justice scholarship demonstrates that environmental burdens are unevenly distributed across socially disadvantaged and racial and ethnic minority communities [24,25,41]. Together, these perspectives suggest that environmental worry may also vary across socially disadvantaged groups, although this expectation represents an inference tested in the present study rather than a direct conclusion of prior research.

National survey research indicates that racial and ethnic minority groups and lower-income Americans often express environmental concern equal to or greater than that of White and higher-income Americans, despite widespread public underestimation of these concerns [14]. Women likewise report somewhat greater climate-change knowledge and concern than men [13]. Demographic findings are nonetheless mixed. van der Linden reported weak or inconsistent associations between income, age, education, and climate-risk perception, while Hornsey et al. found that political orientation, values, and worldviews were stronger predictors than sociodemographic characteristics [3,42]. Because beliefs, risk perceptions, concern, and affective responses represent distinct constructs, whether these demographic patterns extend to environmental worry remains an empirical question. Financial hardship may also operate differently from income as a measure of current material circumstances rather than socioeconomic position.

Place: Residential Context and Environmental Worry

Place scholarship suggests that perceptions of environmental threats are shaped by where people live [20-22]. In the present study, Place is operationalized using self-reported urban, suburban, or rural residence.

Urban environments present distinctive hazards, including urban heat islands and impervious-surface flooding, and residents recognize and express concern about these conditions [27,38]. Community-based studies further suggest that climate concerns correspond with neighborhood environmental exposures and social vulnerability and that climate exposure, social vulnerability, and mental-health distress may become increasingly concentrated over time [28,43]. Together, these findings suggest that urban residential contexts may shape environmental worry through both environmental conditions and social context.

Rural and remote communities face a different pattern of environmental vulnerability, characterized by greater dependence on climate-sensitive livelihoods, more limited infrastructure, and reduced adaptive capacity [44,45]. Reviews of the literature indicate that climate change can undermine material security, social cohesion, cultural identity, and mental health in these communities [44,46]. Housing quality and tenure further influence vulnerability by affecting thermal protection, energy efficiency, and displacement risk [26,47].

Place can be represented through multiple geographic dimensions. Broad geographic region reflects large-scale climatic and cultural variation, whereas self-reported urban, suburban, or rural residence captures settlement context, including differences in environmental conditions, infrastructure, and social interpretation [21]. Social vulnerability likewise varies across both geographic regions and settlement contexts [18]. Examining both residential setting and geographic region therefore provides a limited test of the spatial patterning of environmental worry, while recognizing that these measures do not capture neighborhood-level environmental conditions or objective environmental exposure.

Toward an Integrated Framework

Across these literatures, Exposure (Perceived Weather-Related Challenges), Resources (financial hardship), and Place (residential context) each have plausible associations with environmental worry. However, few studies have examined these three conceptual domains simultaneously within a large sample of adults across the United States. Ojala et al. likewise emphasized the importance of understanding climate emotions within their social and place-based contexts [2]. The present study addresses this gap while recognizing that its cross-sectional, self-reported measures cannot establish causal mechanisms or objective environmental exposure.

Taken together, prior findings are mixed. Associations between environmental experiences and environmental responses vary across

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studies, and demographic correlates are often modest relative to values, ideology, and affect. Some inconsistency likely reflects differences in the outcomes examined, including beliefs, risk perceptions, concern, worry, anxiety, and behavioral engagement. The remaining empirical question is whether the conceptual domains of Exposure, Resources, and Place retain independent associations with environmental worry after adjusting demographic characteristics and geographic region.

Accordingly, this study addresses three research questions

RQ1. Does environmental worry differ across residential settings and broad U.S. geographic regions?

RQ2. After adjusting for demographic characteristics and geographic region, are Perceived Weather-Related Challenges, financial hardship, and residential context independently associated with environmental worry?

RQ3. Which focal predictor representing the Exposure, Resources, and Place domains shows the strongest standardized association with environmental worry?

(Figure 1) illustrates the conceptual framework guiding the study.

(Figure 1). Conceptual framework of environmental worry as a socially and spatially situated response. The conceptual domains of Exposure (Perceived Weather-Related Challenges), Resources (financial hardship), and Place (residential context) are examined as correlates of environmental worry. Demographic characteristics and geographic region are included as statistical control variables. The dotted link between Financial Hardship and Residential Context depicts the Resources × Place interaction represented by the Financial Hardship × Residential Context terms tested in Model 3; additional exploratory interaction terms are described in Methods.

Methods

Data Source and Sample

The 4R-Stat Baseline 2024 Survey was a collaborative effort between the U.S. Regional Rural Development Centers and Auburn University [48]. Conducted during 2024 and 2025, the survey assessed household, business, and community well-being. Quota sampling was nested within states, with targets for rural–urban residence, household type, gender, age, and race/ethnicity informed by U.S. Census data and adjusted for regional characteristics and recruitment feasibility. The project's technical documentation specifies an overall target of 18,288 respondents; the released dataset contained 18,596 respondents, although attainment of individual demographic quotas was not reported. Most data were collected through Qualtrics' online panels, with participants recruited through sources including website intercepts, member referrals, targeted email lists, and social media. Panel providers generally offer participation incentives, such as cash, reward points, or other benefits, but the project team confirmed that study-specific incentive amounts and a survey response rate are unavailable. Data-quality procedures included three attention-check questions and required-response fields; incorrect attention-check responses did not automatically result in exclusion. The dataset was de-identified before public release to protect participant confidentiality.

The original dataset included 18,596 respondents from all 50 U.S. states. Perceived Weather-Related Challenges were a key variable in the present study, and the analyses focused on respondents reporting at least one challenge. Respondents who reported no challenges (n = 5,081) or refused to answer the item (n = 275) were excluded, yielding an analytic sample of 13,240 respondents, a reduction of 5,356 (28.8%). Reporting no challenges was a substantive response rather than missing data; its exclusion reflects the analytic scope of the study. Although the survey sought broad demographic and geographic participation, the resulting analytic sample is national in scope but is not treated as nationally representative of U.S. adults.

Respondents ranged in age from 18 to 99 years (M = 48.94, SD = 16.71). Race/ethnicity was represented by three dummy variables identifying Black, Hispanic, and other racial/ethnic minority respondents, with White respondents serving as the reference category. Smaller racial/ethnic groups were combined into an "Other race/ethnicity" category because of limited subgroup sample sizes. The sample was 55% women, 70% identified as White, 15% as Black/African American, 8% as Hispanic/Latino, and 5% as other. Thirty-four percent reported a high school diploma/equivalent or lower, 52% were married or coupled, and 47% reported annual household incomes below $50,000.

Region was categorized according to the U.S.D.A. Regional Rural Development Centers (Northeast, North Central, South, and West). For regression analyses, the West region served as the reference category. About 30% of the respondents were from the Southern region, about 22% each were from the North Central and Northeastern regions, and 27% were from the Western region. With respect to residential location, 38% were living in an urban area, 39% in a suburban area, and the remaining 23% in a rural area.

Measures

Environmental worry was measured using nine items assessing concerns about air pollution; pollution of rivers, lakes, and reservoirs; drinking water pollution; soil quality; litter and waste dumping; extreme high temperatures; extreme low temperatures; drought; and flooding. The items represent a broad range of local environmental concerns rather than severe hazards alone; litter and waste dumping were retained as concerns about local environmental

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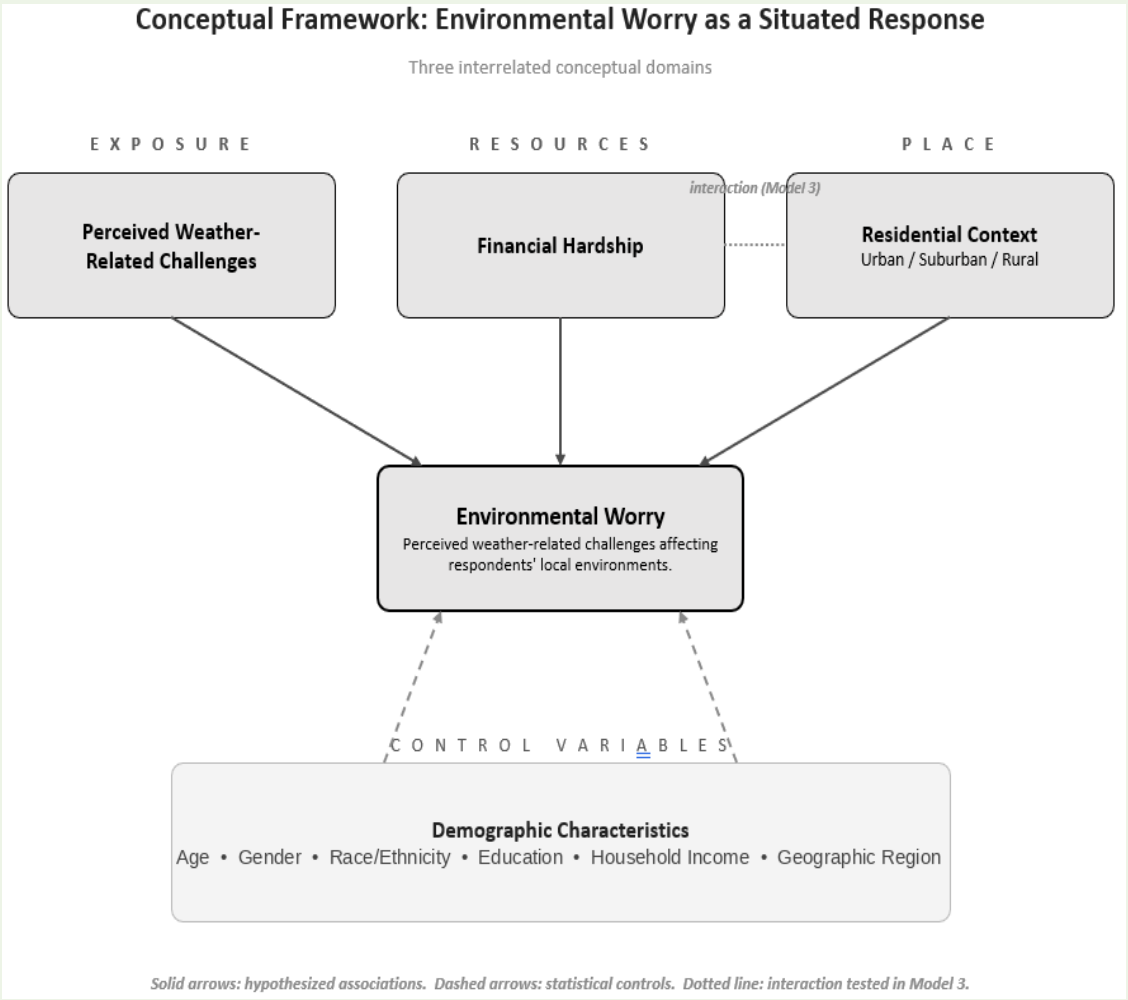


Figure 1: Environmental worry as a situated response.

quality. Responses ranged from 1 ("not at all") to 5 ("a great deal"). The Kaiser–Meyer–Olkin measure of sampling adequacy (.93) and Bartlett's test of sphericity ($\chi^2 = 57{,}642$, df = 36, $p < .001$) supported the suitability of the data for factor analysis. Exploratory factor analysis using maximum likelihood extraction yielded a single factor with an eigenvalue of 4.57, accounting for 50.8% of the total variance; thus, rotation was not performed. All nine items loaded strongly on the factor, with loadings ranging from .607 to .791. Internal consistency was high (Cronbach's α = .90). These findings provide preliminary support for a common dimension and the internal consistency of the composite, but do not independently establish its construct or discriminant validity. Accordingly, the items were summed to create a single composite environmental worry score (range = 9–45, M = 23.55, SD = 7.12), with higher scores indicating greater environmental worry.

Perceived weather-related challenges were measured by asking respondents to select all weather-related challenges affecting where they lived from a list of seven events and another category: increased rainfall, sea-level rise, prolonged drought, wildfires, flooding, hurricanes, and temperature changes. The dataset recorded selection of "other" but contained no accompanying text specifying the challenge. Responses, including selections of "other," were summed to create a count of reported challenges ranging from 1 to 8. Forty-three percent of respondents reported one challenge, 28% reported two, 18% reported three, and 11% reported four or more. The composite was treated as a count of the distinct weather-related challenges respondents perceived as affecting where they lived, that is, the breadth of perceived local weather stress, rather than as a measure of exposure to, or the severity of, any single hazard. A count was used because several of the listed events commonly occur together or share meteorological drivers (for example, hurricanes, flooding, and increased rainfall), and because the item asked about perceived local conditions rather than specific events. Because the seven events differ in physical character, spatial extent, and relevance to coastal versus inland locations, the composite cannot identify which hazards are

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most closely associated with environmental worry.

Financial hardship was measured using a single item assessing how often respondents had trouble keeping up with household bills during the previous 12 months, with responses on a 5-point scale ranging from "never" to "every month." Higher scores indicated greater financial hardship.

The control variables were measured using standard survey questions. Educational attainment and annual household income were recorded in ordered, interval groupings, a common approach in survey research.

Data Analysis

Following descriptive analyses, two one-way analyses of variance (ANOVAs) with Scheffé post hoc tests were conducted to examine differences in environmental worry across geographic regions and residential settings (N = 13,240). Scheffé's test was chosen because it is a conservative method for controlling Type I error when conducting multiple group comparisons [49].

Hierarchical multiple regression was used to examine the independent associations of demographic characteristics, financial hardship, residential context, and Perceived Weather-Related Challenges with environmental worry. This approach allows predictors to be entered in theoretically informed blocks, enabling the assessment of the incremental contribution of weather-related challenges after accounting for demographic, economic, and residential factors [49]. Financial hardship was included as the primary indicator of economic strain because subjective assessments capture aspects of "individuals' lived economic circumstances" and well-being that household income alone may not reflect [50]. Household income, however, was also included to account for economic resources distinct from perceived hardship. The correlation between household income and financial hardship was statistically significant but modest ($r = -.245$), supporting their inclusion as related but distinct indicators of economic circumstances. Model 1 included demographic characteristics, household income, financial hardship, residential context, and geographic region. Model 2 added Perceived Weather-Related Challenges. Model 3 added interaction terms between financial hardship and residential context, Perceived Weather-Related Challenges and residential context, and financial hardship and Perceived Weather-Related Challenges to examine whether these associations varied across residential contexts or levels of financial hardship. Geographic region was retained as a control variable because the literature provided little theoretical basis for expecting these associations to differ across broad U.S. regions. Continuous predictors (financial hardship and perceived weather-related challenges) were mean-centered before creating interaction terms to facilitate interpretation and reduce multicollinearity.

Results

The preliminary ANOVA examining regional differences in environmental worry was not statistically significant, $F_{(3, 13236)} = .52$, $p = .67$, $\eta^2 < .001$. In contrast, the ANOVA examining differences by residential location was statistically significant, $F_{(2, 13237)} = 81.69$, $p < .001$, $\eta^2 = .012$, indicating that environmental worry followed a clear gradient across residential contexts. Respondents living in urban areas reported the highest levels of environmental worry, followed by suburban residents, while rural residents reported the lowest levels. Post hoc comparisons indicated that all pairwise differences between rural, suburban, and urban groups were statistically significant.

Hierarchical regression results are presented in Tables 1 and 2. Model 1 was statistically significant,$F_{(13, 13226)} = 45.77$, $p < .001$, explaining 4.3% of the variance in environmental worry. Adding Perceived Weather-Related Challenges in Model 2 improved model fit, $\Delta R^2 = .034$, $\Delta F_{(1, 13225)} = 485.48$, $p < .001$, increasing the explained variance to 7.7%.

In Model 2, Perceived Weather-Related Challenges showed the largest standardized association with environmental worry ($\beta = .187$, $p < .001$). Financial hardship remained a significant positive predictor ($\beta = .141$, $p < .001$), indicating that respondents experiencing greater economic strain reported higher levels of environmental worry. Younger respondents reported significantly greater environmental worry than older respondents ($\beta = -.048$, $p < .001$), and women reported higher levels than men ($\beta = .031$, $p < .001$). Relative to White respondents, Black ($\beta = .044$, $p < .001$), Hispanic ($\beta = .032$, $p < .001$), and respondents in the oher race/ethnicity category ($\beta = .020$, $p = .019$) reported significantly greater environmental worry. Urban ($\beta = .114$) and suburban ($\beta = .045$) residents also reported significantly greater environmental worry than rural residents (both $p < .001$). Household income, geographic region, and education were not

Table 1: Hierarchical Regression Models Predicting Environmental Worry.

Model	Predictors Added	R^2	Adj. R^2	ΔR^2	F/ΔF	*p*
1	Demographic characteristics, including household income, residential context, geographic region, financial hardship	.043	.042	.043	F = 45.77	<.001
2	+ Perceived Weather-Related Challenges	.077	.076	.034	ΔF = 485.48	<.001
3	+ Two-way Interaction Terms	.081	.079	.004	ΔF = 10.66	<.001

Note: N = 13,240 in all models, calculated from the residual degrees of freedom and number of predictors. Model 1 reports the overall F test; Models 2 and 3 report F-change tests. Test degrees of freedom (df_1, df_2) were (13, 13,226), (1, 13,225), and (5, 13,220), respectively.

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Table 2: Hierarchical Multiple Regression Predicting Environmental Worry. Reference categories were White, male, West region, and rural setting.

Predictor	Model 1 β	Model 2 β	Model 3 B	SE	Model 3 β	95% CI	*p*
Black	.033	.044	.937	.183	.045	[.578, 1.296]	<.001
Hispanic	.027	.032	.872	.233	.032	[.415, 1.330]	<.001
Other race/ethnicity	.017	.020	.599	.249	.020	[.111, 1.088]	.016
North Central	−.003	.002	.119	.174	.007	[−.221, .460]	.492
Northeast	−.002	.009	.239	.176	.014	[−.105, .583]	.174
Southern	.001	.005	.152	.166	.010	[−.174, .479]	.360
Urban	.115	.114	2.196	.190	.150	[1.823, 2.569]	<.001
Suburban	.048	.045	.920	.187	.063	[.553, 1.286]	<.001
Female	.026	.031	.472	.122	.033	[.232, .711]	<.001
Age	−.065	−.048	−.020	.004	−.048	[−.028, −.013]	<.001
Education	.027	.006	.023	.041	.005	[−.056, .103]	.566
Household Income	.009	.011	.001	.001	.011	[−.001, .003]	.173
Financial hardship (FH)	.147	.141	.550	.089	.111	[.375, .725]	<.001
Perceived Weather-related Challenges (PWC)		.187	.938	.053	.164	[.834, 1.042]	<.001
FH × PWC			−.024	.019	−.012	[−.061, .014]	.219
FH × Urban			.368	.108	.045	[.155, .580]	<.001
FH × Suburban			.109	.108	.013	[−.103, .320]	.315
PWC × Urban			−.301	.053	−.062	[−.404, −.198]	<.001
PWC × Suburban			−.156	.053	−.032	[−.261, −.051]	.003

Note: Standardized coefficients (β) are reported for Models 1–3; unstandardized coefficients (B), standard errors (SE), 95% confidence intervals (CI), and p values are shown for Model 3. Model 3 VIF values ranged from 1.003 to 4.627.

significantly associated with environmental worry.

Model 3 added the interaction terms and produced a small increase in explained variance, $\Delta R^2 = .004$, $\Delta F_{(5, 13220)} = 10.66$, $p < .001$, increasing the total explained variance to 8.1%. Three interaction terms were statistically significant. The interaction between financial hardship and urban residence was positive ($B = .368$, $\beta = .045$, $p < .001$), indicating that the association between financial hardship and environmental worry was stronger among urban residents than among rural residents. The interactions between perceived weather-related challenges and urban residence ($B = -.301$, $\beta = -.062$, $p < .001$) and suburban residence ($B = -.156$, $\beta = -.032$, $p = .003$) were negative, indicating that the association between perceived weather-related challenges and environmental worry was weaker among urban and suburban residents than among rural residents. Neither the interaction between financial hardship and suburban residence ($p = .315$) nor the interaction between financial hardship and Perceived Weather-Related Challenges ($p = .219$) was statistically significant.

Multicollinearity diagnostics for the final model indicated tolerance values ranging from .216 to .997 and variance inflation factor (VIF) values ranging from 1.003 to 4.627, suggesting no severe multicollinearity among the predictors. The highest VIF was observed for financial hardship, which was included both as a main effect and in interaction terms in the final model; this overlap can increase standard errors and reduce the precision of coefficient estimates but does not, by itself, indicate biased estimates.

Overall, Perceived Weather-Related Challenges had the largest standardized coefficient in Model 2; this is a descriptive comparison, and differences between coefficients were not formally tested. Financial hardship and residential context were also associated with environmental worry. The final model explained 8.1% of the variance, leaving approximately 91.9% unexplained, indicating modest explanatory power despite statistical significance in this large sample. Although three interaction terms were statistically significant, all five interaction terms jointly added only 0.4 percentage points of explained variance. This increment cannot be attributed to any individual interaction, and the moderation findings should be considered exploratory.

Discussion

This study examined environmental worry using an integrated conceptual framework encompassing three complementary domains: Exposure, Resources, and Place, operationalized through Perceived Weather-Related Challenges, financial hardship, and residential context, respectively. Using a large sample of adults from across the U.S., the study evaluated the independent associations of these focal indicators with environmental worry while adjusting for demographic characteristics and geographic region. Four principal findings emerged. First, Perceived Weather-Related Challenges demonstrated the largest standardized association with environmental worry. Second, financial hardship remained independently associated with greater environmental worry after accounting for perceived weather-

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related challenges and other covariates. Third, residential setting, but not broad U.S. geographic region, was associated with environmental worry, with urban residents reporting greater worry than suburban and rural residents. Finally, three exploratory interactions suggested variation in associations across residential contexts, but the five interaction terms jointly added only 0.4 percentage points of explained variance.

Collectively, these findings support conceptualizing environmental worry as a socially and spatially situated response rather than solely an individual psychological characteristic. Although environmental worry is experienced at the individual level, the results suggest that it is associated with perceptions of local environmental conditions, material resources, and residential context. This integrated framework extends approaches that focus primarily on demographic characteristics or climate-related emotions by emphasizing the independent associations of Exposure, Resources, and Place. The observed demographic patterns, with greater environmental worry among younger respondents, women, and racial and ethnic minority respondents, are likewise consistent with prior evidence on the social patterning of environmental concern [13,14,35].

Exposure: Perceived Weather-Related Challenges and Environmental Worry

The Exposure domain, operationalized as perceived weather-related challenges, demonstrated the largest standardized association with environmental worry. Respondents reporting a greater number of Perceived Weather-Related Challenges also reported higher environmental worry after adjusting for demographic characteristics, financial hardship, residential context, and geographic region. This finding is consistent with previous research demonstrating that perceived environmental conditions are associated with emotional responses to environmental risks [15,23,37].

These findings should not be interpreted as evidence that objective environmental exposure directly increases environmental worry. Rather, the present study assessed respondents' perceptions of weather-related challenges, which may reflect direct experience, observations within their communities, media exposure, or broader awareness of local environmental conditions. Because the source of these perceptions cannot be identified, the Exposure association is best read as an association between two appraisals, perceived local weather-related challenges and environmental worry, rather than as evidence about environmental conditions themselves. This reading is consistent with previous work suggesting that affective responses to environmental risks are shaped by perceived rather than objective environmental conditions [3,10,11], but it also means that part of the association may reflect a shared tendency to notice and worry about environmental problems (see Limitations).

Although Perceived Weather-Related Challenges demonstrated the largest standardized association, the overall variance explained remained modest, suggesting that environmental worry is influenced by additional factors such as values, ideology, media exposure, and prior experiences [3,42]. The modest explanatory power of the model is therefore consistent with the multifactorial nature of environmental worry and underscores the importance of examining additional psychological, social, political, and contextual determinants in future research.

Resources: Financial Hardship and Environmental Worry

The Resources domain, operationalized as financial hardship, remained independently associated with environmental worry after accounting for Perceived Weather-Related Challenges and other covariates. This finding is consistent with social vulnerability scholarship, which emphasizes that environmental risks are experienced across social and economic contexts [17-19]. Individuals experiencing financial hardship often have fewer resources with which to prepare for, respond to, or recover from environmental disruptions, making environmental threats potentially more consequential. The independent association between financial hardship and environmental worry likewise aligns with environmental justice perspectives emphasizing that environmental risks and vulnerabilities are embedded within broader systems of social inequalities [24,25,41].

These findings should not, however, be interpreted as a direct test of the finite-pool-of-worry hypothesis [39,40]. Financial hardship is not equivalent to economic worry, and the cross-sectional design cannot determine whether financial and environmental concerns compete with or reinforce one another. Instead, the findings are more consistent with the proposition that material vulnerability and environmental worry may coexist. Longitudinal studies that directly access multiple domains of worry are needed to distinguish between these competing theoretical perspectives.

Place: Residential Context May Matter More Than Broad Region

For the Place domain, residential context was independently associated with environmental worry, whereas broad U.S. geographic region, included as a statistical control, was not. Respondents living in urban areas reported greater environmental worry than those living in suburban and rural settings. This pattern is consistent with previous research suggesting that environmental perceptions are more closely related to local environmental conditions than to broad geographic classifications [28,36]. These findings suggest that residential context may be more closely associated with environmental worry than broad regional classifications, which may obscure meaningful variation in local environmental conditions and lived experiences.

These findings are consistent with place scholarship emphasizing

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that environmental perceptions develop within everyday social and environmental contexts [20-22]. Although residential setting is not a direct measure of place attachment or place identity, it appears to serve as a useful contextual indicator of how environmental conditions are experienced. Future research incorporating neighborhood-level environmental characteristics, objective environmental indicators, and direct measures of place attachment would help clarify these relationships.

Exploratory Interactions by Residential Context

The interaction analyses suggested that the association between financial hardship and environmental worry was stronger among urban than rural respondents, whereas the association between Perceived Weather-Related Challenges and environmental worry was weaker among urban and suburban than rural respondents. Although three interaction terms were statistically significant, the five-term interaction block added only 0.4 percentage points of explained variance ($\Delta R^2 = .004$). This small increment applies to the block as a whole, not to the financial hardship × urban interaction alone. These findings provide limited incremental explanatory value and should be interpreted as exploratory and in need of replication.

One possible explanation for the financial hardship × urban interaction is that urban environments present greater concentrations of environmental hazards, infrastructure vulnerabilities, housing constraints, or energy-related costs that increase the salience of environmental conditions among financially constrained households [26,27,38,46]. Differences in environmental communication, neighborhood conditions, or access to adaptive resources may also contribute. Because these mechanisms were not measured directly, they remain speculative. Replication using nationally representative samples and studies incorporating objective measures of environmental exposure and neighborhood characteristics will be important before drawing broader conclusions.

Environmental Worry as an Adaptive Response

An important implication of these findings is that greater environmental worry should not automatically be interpreted as a negative psychological outcome. Previous research distinguishes environmental worry from clinically significant anxiety, suggesting that moderate environmental worry may motivate information seeking, preparedness, and engagement with environmental issues [2,33]. However, the present study did not assess adaptive behaviors or psychological functioning and therefore cannot determine whether higher environmental worry reflects constructive engagement or emotional distress. Rather, the findings are compatible with conceptualizing environmental worry as a normal affective response, while prior research suggests that such worry may under some circumstances motivate adaptive engagement.

Limitations

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes conclusions regarding temporal ordering or causality. Although Perceived Weather-Related Challenges, financial hardship, and residential context were associated with environmental worry, the analyses cannot determine the direction of these relationships. Longitudinal research is needed to examine how environmental worry changes over time and in response to evolving environmental conditions.

Second, the study relied on self-reported measures. The Exposure indicator captured respondents' perceptions of local weather-related challenges rather than objectively verified environmental exposures. These perceptions may reflect personal experience, media coverage, community discussions, or broader environmental awareness. Reliance on self-report also raises the possibility of shared method variance: respondents with a greater general tendency to worry may report both higher environmental worry and more weather-related challenges, potentially inflating the observed associations. The contribution of shared method variance was not quantified and cannot be ruled out. In addition, three challenges, drought, flooding, and temperature changes, have corresponding items in the environmental worry scale. This overlap in content may have strengthened the association between the measures and warrants consideration when interpreting the relative strength of the Exposure indicator. Although the worry items showed high internal consistency, this does not independently establish content or discriminant validity; the composite should be interpreted as a broad measure of worry about local environmental conditions rather than a validated measure specific to severe hazards or climate anxiety.

The challenge count captured the breadth of reported challenges rather than their severity, frequency, or duration and combined events differing in physical characteristics, spatial extent, and geographic relevance. Associations with environmental worry may therefore vary across challenge types. Responses in the "other" category were retained, but accompanying descriptions were unavailable, preventing assessment of whether they fit existing categories or represented distinct challenges. Furthermore, because respondents reporting no challenges were excluded, the findings describe associations among those reporting at least one challenge. No imputation or sensitivity analysis was conducted to assess the effect of the exclusions. This restriction may have influenced the estimated associations and limits their applicability to respondents reporting none; selection bias cannot be ruled out.

Future research should include the full range of responses, assess challenge severity and frequency, and examine individual challenges or groupings with similar physical characteristics. Integrating subjective perceptions with objective environmental

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indicators, including linking respondents to hazard or disaster data when geographic information more precise than state of residence is available, would help distinguish perceived challenges from documented exposures. Where feasible and consistent with participant confidentiality, making descriptions of "other" responses available in public datasets would support interpretation, appropriate recoding, and identification of additional challenge types. Regression diagnostics do not resolve these measurement and sample-selection concerns. Future studies should assess the robustness of the findings using alternative measures and analytic approaches, complemented by more detailed exposure data and samples that include respondents reporting no weather-related challenges.

Third, environmental worry is likely influenced by factors not available in the present dataset, including political ideology, environmental values, trust in scientific institutions, prior disaster experience, media exposure, social networks, place attachment, and individual psychological characteristics. General worry, negative affectivity, and anxiety were not controlled, and these and other omitted factors may account for part of the observed associations. The modest variance explained by the regression models is consistent with the multifactorial nature of environmental worry and highlights the importance of examining additional psychological, social, political, and contextual determinants in future research.

Fourth, several racial and ethnic groups with small sample sizes were combined into an Other race/ethnicity category to improve statistical stability. This approach may obscure potentially important differences in environmental and weather-related experiences among groups, including American Indian/Alaska Native, Native Hawaiian, and Pacific Islander populations. Findings should therefore be interpreted with caution. Future research should examine these groups separately when possible and may benefit from qualitative approaches that provide a deeper understanding of their experiences.

Finally, residential context served as a broad indicator of Place rather than a direct measure of neighborhood characteristics or place attachment, and the four geographic regions could not capture local environmental variation. Similarly, the interaction terms jointly explained little additional variance and should be considered exploratory until replicated using nationally representative samples and more detailed measures of environmental conditions and community characteristics.

Implications

The findings identify several questions for future research on environmental communication, adaptation planning, and community resilience. Because the study examined cross-sectional associations rather than interventions or behavioral outcomes, it cannot establish the effectiveness of particular communication or preparedness strategies.

First, the association between Perceived Weather-Related Challenges and environmental worry provides a basis for testing whether communication focused on locally recognizable conditions differs from broader messaging in its relevance, comprehension, or influence on preparedness.

Second, the association between financial hardship and environmental worry suggests examining whether economic circumstances shape how households receive and act on environmental information, including whether material support affects their ability to undertake preparedness activities.

Third, differences across residential settings warrant research on whether communication needs and responses vary among urban, suburban, and rural populations.

Finally, although prior research suggests that environmental worry can accompany constructive engagement, the present study did not assess preparedness, adaptive behavior, or community resilience. Longitudinal and intervention studies are needed to determine when worry is associated with constructive action or distress and whether communication or support strategies influence these outcomes.

Conclusion

Environmental worry is often conceptualized as an individual emotional response to environmental change, yet the present findings suggest that it is also associated with broader environmental, social, and spatial contexts. Using an integrated framework, this study found that Perceived Weather-Related Challenges, financial hardship, and residential context were each independently associated with environmental worry, with Perceived Weather-Related Challenges showing the strongest standardized association. Residential setting, but not broad geographic region, was also associated with environmental worry. Together, these findings suggest that environmental worry may be understood in part as a socially and spatially situated response to perceived environmental conditions.

By integrating perspectives from environmental psychology, social vulnerability theory, and place scholarship, this study highlights the value of examining Exposure, Resources, and Place simultaneously rather than in isolation. Future research should incorporate objective environmental indicators, neighborhood-level characteristics, and longitudinal designs to better understand how environmental worry develops and influences adaptation, resilience, and public engagement. Understanding environmental worry within its broader social and environmental context may help inform more effective environmental communication, adaptation planning, and resilience-building efforts.

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Statements and Declarations

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Ethics Approval. This study analyzed de-identified data from the 2024 4R-Stat Baseline Survey, a publicly available dataset. The current analysis was determined to be exempt from institutional review board oversight by Purdue University #2023-1420.

Consent to Participate. Informed consent for the original data collection was through an electronic consent process in which participants indicated their agreement to continue before proceeding with the online survey.

Consent to Publish. Not applicable. The manuscript does not contain individually identifiable data or images.

Data Availability. The 4R-Stat Baseline Survey 2024 public-use dataset is available through the U.S. Regional Rural Development Centers and Auburn University. Analytic code used in the current analyses is available from the corresponding author upon reasonable request.

Use of AI-assisted tools. The authors used AI-assisted tools to support citation verification, reference formatting, and language editing of the author-drafted manuscript. All conceptual work, data analysis, interpretation, and final content decisions were made by the human authors, who take full responsibility for the accuracy and integrity of the manuscript.

Author Contributions. All authors contributed to the study conception and design. C. McNeill and M. E. B. Garrison led the conceptualization. M. E. B. Garrison conducted the statistical analysis and drafted the Methods, Data Analysis, and Results sections; C. McNeill drafted the remaining sections of the initial manuscript and revised M. E. B. Garrison's initial draft. E. Ponce-Garcia, S. K. Yadav, N. Bushra, and R. V. Rohli contributed to writing, editing, and critical review. All authors commented on and revised subsequent versions of the manuscript and read and approved the final version.

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