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RESEARCH ARTICLE

A decade of climate change concern in India: Determinants of personal and societal climate concern

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ABSTRACT

Scientists have called for a culturally relevant investigation of factors impacting public climate concern to devise relevant behavioural and policy interventions. Although India will be adversely affected by climate change, there is a shortage of models that track changes in Indian climate concern across time. The study tracked the growth of climate concern from 2006 to 2020 and identifies determinants of personal and societal climate concern. Secondary analyses of survey data from the International Science Survey and World Values Survey (2006-2020, N = 9254), were conducted to predict climate concern across the year, environmental protection versus economic growth preferences, and socio-demographic variables. Within responses from 2020 (N = 3176), the predictive role of anthropogenic climate change beliefs, trust in scientists, adequate government action, collective efficacy, environmental protection preferences, and sociodemographic variables were evaluated to understand personal and societal climate concern. Binary logistic regression found that climate concern increased significantly from 2006 (2.6%) to 2020 (89.5%) and was predicted by education and preferences for environmental protection. Multiple regression results identified personal climate concern as predicted by education, anthropogenic climate change beliefs, trust in scientists, and environmental protection preferences; while government action beliefs and favouring left-wing affiliation predicted societal climate concern. There was mixed support for the political polarization of climate concern. The study shows an increase in Indian climate change concern over the past decade, with personal and societal climate concern being influenced by different psychological characteristics. Important implications for future climate communication research and social policy development are discussed.

Keywords: India; climate change concern; environmental concern; climate change beliefs; political polarization; climate communication

1. Introduction

India is adversely affected by the changing climate with an increased probability of floods, and wildfires[1], a 3.5% increase in poverty rates[2], increases in public health concerns like vector-borne diseases[3] and increase in psychological concerns such as depressive symptoms due to climate variability[4]. Climate policy, adaptation, and mitigation strategies are not only determined by expert opinion of how dangerous climate change can be but also the concern of the lay public[5,6]. Environmental or climate change concern refers to "the degree to which people are aware of environmental problems and support efforts to solve them and/or indicate

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willingness to contribute personally to their solution"[7]. Previously, public perception of climate change concern has been linked to behaviour change [8] policy support[9] and collective action [9,10], all of which are imperative to reach Goal 13 of the Sustainable Development Goals (SDGs) i.e. Climate action[11].

With growing scientific consensus about the impacts of climate change[12], public concern and worry have also grown globally across the decade[13,14]. This concern has been markedly higher in developing countries, than developed ones[15,16]. A steady increase can be seen in the literature on viewing climate change as a 'risk' in China[17–20], Vietnam[21] and India[22,23]. Laypersons in China (88%), Japan (97%) and India (94%) have on average reported higher climate concern as compared to Americans (75%)[24]. In the Indian public, Leiserowitz et al.[22] replicated their seminal work on audience segmentation of risk profiles into 6 categories of climate change concern: the informed, experienced, undecided, unconcerned and indifferent. Such a study highlights the importance of conducting region-specific research to identify patterns in public perceptions, like the case of 'informed' and 'experienced' Indians who report higher climate risk perception, and higher support for climate policy and were more likely to report personally experiencing climate change. Region-specific research can be especially powerful when designing evidence-based behavioural interventions for climate mitigation that are culturally sensitive[25]. However, a comprehensive look at how public climate change concern in India has changed over the last decade has not been conducted. A bird's eye view of climate concern measurement that is country-specific also enables Indian researchers, policy advisors and government officials to develop country-specific and evidence-based interventions.

However, the empirical literature is divided into varied operationalizations of concern, such as "worry", "perceived seriousness", and "risk perception"[26–28]. These differences raise important questions about how specific measurement of public climate concern relates to different behavioural or policy outcomes. Based on the "hierarchy of concern" (HoC) model developed by Van der Linden[29], risk perception is a multidimensional construct informed by a motivational/affective component in addition to generalized worry or concern judgments. Since the current study utilizes large-scale survey data on public perceptions, it views "concern" measurements as sufficient markers of general concern about the changing climate[29]. Climate change concern and risk perception are discussed reciprocatively when discussing links to behavioural or policy-related outcomes. Inferences presented in the results and discussion section of this study refer only to the larger literature on climate change concern, and not affective risk evaluations.

Within climate risk perception literature, there is a conceptual difference between determinants of self versus other-oriented risks[30]. Previous research finds personal and societal risk perceptions to have different psychological antecedents[31–33].Cognitive factors such as knowledge of cause, impact and responses were significant predictors of societal risk perception, but not of personal risk perception. On the other hand, personal climate change risk perception was better predicted by personal experience with extreme weather events and sociocultural influences (i.e., norms, values)[33]. Understanding this difference may be imperative to linking climate concern literature to predicting policy preferences and adaptive behaviour in the private sphere (such as recycling) and collective action behaviours (e.g., environmental activism, financial support to sustainability initiatives)[34]. While initial findings of Van der Linden[33] display the difference in determinants of personal and societal climate risk perception, these constructs may not be mutually exclusive as they are evaluations made towards a common threat (i.e., climate change). The interconnectedness of personal and societal climate change risk assessments has not been statistically tested before. Therefore, the current study not only identified determinants of personal and societal climate change concern but also tested for personal and societal concern as predictors of each other.

To address the lack of region-specific research that highlights changes in climate change concern in a South Asian context, the current study aimed to track the growth of climate change concern in India from 2006

to 2020 through secondary analyses of nationally representative surveys. Additionally, the study identified the specific determinants of personal and societal climate change concern, as predicted by sociodemographic, cognitive and sociocultural factors.

2. Literature review

2.1. Sociodemographic factors

The relationships between socio-demographic characteristics (such as education, age and gender) with climate change beliefs are inconsistent. While some studies find that individuals with higher education report higher climate risk perception[19,35,36], others find a negative relationship[37,38] or no relationship[39,40]. The relationship between age and climate concern is also inconsistent with some reports finding a small negative correlation[35,41], some reporting no effect[39,42] and some reporting a positive correlation[38]. There is strong support for females reporting higher risk perception compared to males, despite minimal gender differences in trust in institutions[43] perhaps due to their heightened disaster preparedness[44]. Political ideology and affiliation have consistently predicted climate concern in American samples, perhaps due to the partisan media exposure about climate change[45] but this is a less-established relationship for non-American contexts[46]. Birch[47] conducted a systematic analysis of how political polarization impacts environmental attitudes across 42 countries and found that while the left-right party divide amplifies polarization of environmental attitudes, it is limited to contexts where left-wing identification is associated with support for environmental protection. A left-right partisan divide in India may not be an apt conceptualization of the political context. Therefore, the current study views political party identification as the dominant Bhartiya Janata Party (BJP) or Indian National Congress (INC) in comparison to climate concern. Considering the conflicting evidence on the role of sociodemographic factors (such as age, gender, education and political affiliation) on climate change concern and perception of risk due to climate change, the current study evaluates the role of these sociodemographic factors in impacting climate concern across the decade and personal and societal evaluations of risks.

2.2. Cognitive factors

A review of previous literature finds that "mental models"[48,49], self-report measures of perceived knowledge[41], objective measures of knowledge[33,50] and beliefs of human-caused climate change[51,52] are some cognitive factors linked to public perceptions of climate change concern. However, knowledge itself has had mixed findings; with some studies finding a positive and significant effect[41,53] and others finding a negative or no relationship with risk perception[54]. The current literature is divided by varied measurements of knowledge (self-report versus objective), such that self-report measures display limited reliability[55], and limited cognizance of the relationships between knowledge and concern judgements in non-western populations[13]. Moreover, previous studies find that education (as a proxy of knowledge) acts as a significant predictor of climate change risk perception[36].

Attributions of climate change to human processes (i.e., anthropogenic climate change beliefs) or natural processes are also an important predictor[52], not only for the perceived seriousness of climate change as a threat but also for actions taken to reduce climate change[56,57]. Such beliefs about the causes of climate change may be unique: for example, more than half of the American population believes climate change is happening but is not convinced of human causes[58]. Perceptions of human-caused climate change also significantly impact the perceived severity of consequences of extreme weather events such as the 2017 hurricanes in the US[51]. Considering that beliefs of human-caused climate change have been a robust antecedent to climate change concern[26,37,52,59], the current study evaluates its role as a predictor of personal and societal climate concern.

2.3. Socio-cultural factors

Two theories integrate socio-cultural factors into predicting personal risk perception: namely social amplification of risk[60,61] and the cultural cognition thesis[62,63]. While the former theory posits the influence of social systems and structures through norms, the latter argues that differences in attitudes towards climate policy or behaviour are rooted in cognitive values. Sufficient evidence supports both arguments: with descriptive and prescriptive norms influencing adaptive household energy behaviour[64]; and, cultural worldviews (e.g., individualism versus egalitarianism[18]) and personal values (e.g., biospheric, altruistic and egoistic[65,66]) significantly impacting risk perceptions. A tangential theory from the field of politics and economics posits that "environmentalism" is a post-materialistic value that is characteristic of communities from wealthy nations[67]. Beyond the role of affluence, such preferences have also been divided on political ideology lines. For example, in the US, conservatives favour economic growth over environmental [68]. But this may not be universal as across countries, public concern for climate change was independent of national affluence[69] and environmental concern fell with increasing economic wealth in another study[70]. In India, Leiserowitz et al.[22] found that most individuals believed in environmental protection, even at the cost of economic growth. Considering the contrasting findings in global and Indian literature, the current study aims to validate this relationship between environmental protection versus economic growth preferences and climate change concern across the last decade.

Societal assessments of climate concern are deeply informed by social reference groups[71]. Scientists are found to be a reliable source of information on the climate in the US and trust in them is linked to climate concern. Malka et al.[37] find climate concern to be highest in individuals who trusted scientists, those who were democrats and those who had higher knowledge about human-caused climate change. The Indian public reports scientists (58-88%) as their most trusted source of information on global warming, as compared to other sources such as the national or state government[22]. Trust in governments and perceived collective efficacy have also predicted higher climate risk perception[72,73] and water conservation behaviour and policy preferences in the Indian population[74]. Therefore, trust in scientists and government action beliefs were explored as key determinants of public climate concern in India.

Collective efficacy has been linked to intentions to engage in[75] and actual pro-environmental behaviour such as sustainable consumption[76]. Collective efficacy refers to the extent to which people believe their community to be effective in reaching its goals[77]. The inclusion of collective efficacy in predicting societal climate concern in the current study is a reflection of a growing literature that finds evidence for a social model of pro-environmental action. Previously, collective efficacy has predicted pro-environmental attitudes in the Chinese public[78].

2.4. Current study

The study aims to answer the following research questions: RQ1: *How has climate concern changed from 2006 to 2020 in India?* RQ2: *What are the determinants of personal climate concern in 2020?* RQ3: *What are the determinants of societal climate concern in 2020?* To answer RQ1, we analyse survey datasets from 2006 to 2020 and hypothesize (H1) that there will be a significant variance in climate concern, as explained by measures of time of survey, environmental protection beliefs and sociodemographic characteristics. Borrowing from the climate change risk perception[33] model, the current study harnesses a nationally representative dataset from the International Science Survey (2019-2020[79]) to identify variance in personal and societal climate change concern. The study hypothesized that variance in personal climate concern (H2) and societal climate concern (H3) would be better explained (i.e., R^2 change from zero) by the present model including socio-demographic (age, gender, education, political affiliation), cognitive (human-caused climate change

beliefs) and socio-cultural factors (trust in scientists, beliefs of adequate government action, societal climate change concern, environmental protection beliefs, collective efficacy) better than the null model.

The current study will expand the literature on environmental/climate change concern in the developing world, specifically India. To devise country-specific policy or future research recommendations, the current study views climate concern across the last decade and in the recent past (2020). Following previous literature, the current study also tests if there is a difference in predictive characteristics behind personal and societal concern.

3. Materials and methods

3.1. Participants

Data for this study was drawn from 3 waves of surveys (2006-2009, 2010-2014, 2019-2020) in India (N = 8780, Missing = 474). Respondents were drawn from Wave 5 (N = 2000[80]) and Wave 6 (N =4078[81]) of the World Values Survey and the International Science survey (N = 2829, Missing = 346[79]). Across the full dataset, 33.5% responded 'Yes' and 66.5% responded 'No' to a forced dichotomous treatment of climate change concern. 53.4% of participants were men and 46.6% were women, with the population ranging from 18 – 97 years of age (M = 40.7, SD = 14.8). There was a slight majority of individuals with no formal education (25.2%, N = 2208) or complete/incomplete primary school education (23.3%, N =2047). About 22.3% had complete/incomplete secondary school education (N = 2054), 14.6% had university-level education (N = 1285) and only 14.2% had some form of technical or professional training (N = 1258). In 2019-2020 survey participants ranged from 18 to 97 years in age (M = 39.6, SD = 15.25), out of 44.5% were males and 53.73% were females. See **Table 1** for descriptive statistics of survey respondents across 2006 to 2020 survey dataset.

3.2. Procedure

The study received ethical approval from the authors' university institutional review board (CU: RCEC/00595/03/24). Secondary data from 2006-2012 surveys was drawn through multi-stage stratified random sampling targeting 18 out of 28 Indian states in 2006; and 28 out of 30 Indian states in 2010[80,81]. Data was collected through standardized questionnaires administered through face-to-face interviews. Data from the International Science Survey (2019-2020[79]) was sampled through multistage area probability design where urban and village areas in metropolitan and rural areas were divided into 315 primary sampling units (PSUs). All waves of the survey were conducted in regional languages such as Hindi, Tamil, Bengali, etc. The current study employed secondary data analysis on the measures relevant to the study of climate change concern in India. Measures and their operationalization for the analysis are mentioned in section 3.3.

3.3. Measures

Across 2006-2020 surveys, respondents were surveyed on climate change concern ('What is the 1st choice for the most serious problem in the world' or 'Do you consider global climate change to be a very serious, somewhat serious, not too serious, not serious at all problem?'), preference for environmental protection versus economic growth and socio-demographic variables (age, gender, education). The 2019-2020 survey retained the abovementioned climate change concern assessments as personal climate change concern and included additional questions relevant to climate change such as belief in anthropogenic climate, societal climate concern ("Do you think global climate change is affecting where you live a great deal, some, not too much or not at all?") beliefs of adequate government action, collective efficacy, trust in scientists and political affiliation to right-wing (Bhartiya Janata Party) or left-wing (Indian National Congress) parties. Measures of personal climate concern, societal climate concern, belief in anthropogenic climate change and trust in scientists were measured on 4-point Likert scales ranging from 1 (Not at all, not a problem) to 4 (Very serious problem, A

great deal/ A lot). Other variables (e.g., preference for environmental protection, gender, education) were categorical response variables. To establish comparability of responses across two different question formats across the 2006 to 2020 datasets, the responses to climate change concern were dichotomized Such that, responses to "Environmental pollution" in the 2006-2012 surveys were coded as "Yes" and all other responses (poverty, gender discrimination, poor sanitation and inadequate education) were coded as "No ". In the 2019-2020 dataset, responses to "Do you consider climate change to be a…" of "very serious" or "somewhat serious" were coded as "Yes" and responses of "not too serious" and "not at all serious (problem)" were coded as "No". A full list of variables and how they are measured is available at: https://osf.io/tv42h.

3.4. Power analyses

The dataset contained sufficient power for logistic regression models according to estimations from G*Power[82]. A post priori estimation of sample size found that N = 138 would be sufficient for a small effect size (d = 0.09) with power of 0.8 and $\alpha = 0.05$. The current dataset had a sample size of N = 9254 (2006-2020) with N=2939 responding 'Yes' to if global climate change was a serious problem and N = 5841 individuals responding 'No'. The 2019-2020 dataset also shows sufficient power with N = 3175, where 2584 individuals responded 'Yes' and 301 responded 'No' on climate change concerns.

4. Results

4.1. Climate change across the decade

Survey responses were tested for significant differences in climate concern (yes or no) across sociodemographic factors such as age, gender, education and preference for environmental protection. As seen in **Table 1**, there is a gradual decrease in climate scepticism (responses marked "no") and a gradual increase in climate change concern (responses of "yes") from 2006 to 2020. The chi-square test of association found a strong significant association between years of the survey and individuals who responded 'yes' to climate concern, χ^2 (2) =6085, p =1.0^{e-15}, Cramer's V =0.83. We conducted Kruskal-Wallis one-way ANOVA and chi-square tests of association, respectively, to identify significant associations between climate concern and age (χ^2 (1) = 31.1, p = 2.48^{e-8}, η^2 = .003), education (χ^2 (4) = 465, p = 1.0^{e-15}, Cramer's V = 0.23), gender (χ^2 (1)= 30.9, p = 2.70^{e-8}, Cramer's V = 0.059, Odds Ratio= [1.18, 1.41]) and preference for environmental protection over economic growth (χ^2 (1) = 44.9, p = 2.09^{e-11}, Cramer's V = 0.07, Odds Ratio = [0.62, 0.77]).

Table 1. Descriptive statistics of climate concern from (N=8780) 2006-2020 in international science survey and world values survey.

Predictors	**Climate Concern**	
	Yes (33.5%)	**No (66.5%)**
Year		
2006	0.5%; N = 48	20.3%; N = 1780
2010	3.5%; N= 307	42.8%; N = 3760
2019	29.5%; N = 2584	3.4%; N = 301
Gender		
Female	17%; N = 1493	29.6%; N = 2599
Male	16.5%; N = 1446	36.9%; N = 3238
Age	M =39.5; SD = 15.0	M =41.2; SD = 14.6;

Highest educational qualification		
No formal education	6.8%; N =594	18.4%, N = 1614
Primary school	9.2%; N = 809	14.1%; N = 1238
Technical / professional training	2.3%; N = 198	12%; N = 1054
Secondary school	10.9%; N = 954	11.5%; N = 1006
University level	4.3%; N = 377	10.4%; N =908
Preference for		
environmental protection	27%, N = 1932	41.3%, N = 2955
Economic growth	9.9%, N = 711	21.8%, N = 1599

Binary logistic regression was used to predict climate change concern (yes) or scepticism (no) using participants' age, highest education, year of survey (2006, 2012, 2020), gender (male or female) and preference for environmental protection or economic growth. Out of N = 8780, 66.5% of individuals reported 'No' to climate concern and 33.5% reported 'Yes'. The overall model was found to be significant $\chi^2(9) = 5566$, $p = 1.0^{e-16}$, $R^2_N=0.74$ and could correctly predict whether participants were classified in the 'Yes' (87.5%) or 'No' (94.6%) group. Out of the predictors, age ($p = 0.011$) and gender ($p = 0.191$) were not significant predictors of climate change concern. The odds ratio of individuals reporting climate concern as 'Yes' in 2012 ($B = 1.002$, $SE = 0.17$, $p = 2.16^{e-8}$) and 2019 ($B = 5.80$, $SE = 0.18$, $p < .001$) were significantly higher compared to 2006. Education was a significant predictor such that those with technical/professional training ($B = 0.66$; $SE = 0.15$, $p = 3.08^{e-5}$), secondary school education ($B = 0.84$, $SE = 0.144$, $p = 4.9^{e-9}$) and university-level education ($B = 0.76$, $SE =0.16$, $p = 2.88^{e-6}$) were more likely to report climate concern than those with no formal education. There was a slightly significant difference in climate concern reported by those with primary school education and no formal schooling ($p = 0.008$). Lastly, a preference for environmental protection ($B = 0.69$, $SE = 0.09$, $p = 3.12^{e-12}$) predicted higher climate change concern compared to a preference for economic growth across the decade.

4.2. Personal climate concern

Personal climate change concern in 2019-2020 was significantly associated with beliefs in anthropogenic climate change ($r = 0.24$, $p < .001$, see **Table 2**（See Appendix) , beliefs of adequate government action ($r = 0.06$, $p = 1.17^{e-3}$), societal climate concern ($r = 0.15$, $p = 3.6^{e-15}$), trust in scientists ($r = 0.10$, $p = 1.51^{e-7}$), education ($r = 0.12$, $p = 5.85^{e-11}$) and environmental protection over economic growth beliefs ($r = -0.12$, $p = 2.11^{e-10}$). We found no significant relationships between personal climate concern and age, collective efficacy, favouring right-wing Bhartiya Janata Party (BJP), favouring left-wing Indian National Congress (INC). Therefore, finding little support for the polarization of personal climate concern due to political party affiliation.

Multiple linear regression evaluated personal climate concern as explained by socio-demographic (gender – male or female, education), knowledge-based (belief in anthropogenic climate change) or socio-cultural factors (trust in scientists, societal climate change concern, adequate government action beliefs, preference for environmental protection over economic growth). Supporting H2, the overall model predicting personal climate concern in 2020 was significant, $F (10, 1990) = 24.3$, $p = 1.97^{e-16}$. All of the predictors together explained 10.4% (Adjusted $R^2=0.104$) of the total variance. However, the model was not a satisfactory fit indicating that other culture-specific measurements may be required for a holistic picture of personal climate change concern. **Table 3** contains confidence interval, standardized coefficients, and t estimates for all

predictors. Completing university-level education, belief in anthropogenic climate change, and a preference for environmental protection over economic growth were the strongest predictors of personal climate concern. While societal climate concern, secondary school education and trust in scientists were weaker predictors. Beliefs of adequate government action, gender and education at primary or technical/professional schools were not significant predictors of personal climate change concern.

Table 3. Model estimates for predictors of personal climate concern.

Predictors	β	t	p	Lower CI	Upper CI
Trust in scientists	0.07	3.36	7.71^{e-4}	0.07	0.03
Belief in human-caused climate change	0.20	8.97	<.001	0.16	0.25
Adequate government action	0.03	1.63	0.10	-0.007	0.08
Societal climate concern	0.01	4.29	1.80^{e-5}	0.01	0.05
Environmental protection versus economic growth	-0.22	-4.35	1.3^{e-5}	-0.32	-0.12
Education (primary School)	-0.05	-0.42	0.67	-0.05	-0.28
Education (technical/professional training)	-0.007	-0.10	0.91	-0.007	-0.14
Education (secondary school)	0.17	2.55	1.05^{e-2}	0.04	0.31
Education (university level)	0.32	3.81	1.39^{e-4}	0.15	0.48
R	0.33				
R^2	0.10				
Adjusted R^2	0.10				
RMSEA	0.59				
p	1.97^{e-16}				

Note: Standardized coefficients (lower and upper confidence intervals) are reported. Dummy coding reference levels for favour right-wing was 'favour', favour left-wing was 'favour', education was 'no formal education', gender was 'male' and 'Environmental protection' for environmental protection over economic growth beliefs.

4.3. Societal climate concern

Societal climate change concern in India was significantly associated with personal climate change concern ($r = 0.15$, $p = 3.6^{e-15}$), beliefs in human-caused climate change ($r = 0.17$, $p < .001$), adequate government action beliefs ($r = 0.14$, $p = 4.01^{e-13}$), collective efficacy ($r = 0.04$, $p = 3.76^{e-2}$) and favouring the left-wing, $t(2392) = 2.83$, $p = 4.68^{e-3}$, $d = 0.11$. There were no significant associations of societal climate change concern with age, favouring right-wing political party (BJP), education, gender, trust in scientists or preference for environmental protection over economic growth.

4.7% of the total variance in societal climate concern was significantly predicted, $F(5,1848) = 18.3$, $R = 0.21$, $R^2 = 0.047$, $p < .001$, through personal climate concern, beliefs of anthropogenic climate change, beliefs of adequate government action, collective efficacy, and political affiliation to the left-wing (INC). Results from multiple regression identified that an increase in societal climate concern was predicted strongly by personal climate change concern ($B = 0.13$) and beliefs in anthropogenic climate change ($B = 0.14$). Adequate government action ($B = 0.095$), favouring left-wing political party (INC) ($B = -0.09$, $p = 0.021$) were weak predictors while collective efficacy did not significantly predict societal climate change concern. **Table 4** displays standardized estimates and t-values for societal climate change concern. Similar to personal climate

change concern, the overall model for societal climate change concern did not display a satisfactory fit, indicating avenues for future research to include culture-specific measurements.

Table 4. Model estimates of societal climate concern.

Predictors	β	t	p	Lower CI	Upper CI
Personal climate concern	0.095	4.06	5.09^{e-5}	0.04	0.14
Belief in Human-caused climate change	0.127	5.40	7.4^{e-8}	0.08	0.17
Adequate government action	0.097	4.27	2.03^{e-5}	0.05	0.14
Collective efficacy	-0.424	-0.82	0.413	-0.14	0.05
Oppose left-wing (INC)	-0.10	-2.30	0.021	-0.19	-0.01
R	0.21				
Adjusted R^2	0.044				
RMSEA	0.85				
p	<.001				

Note: Standardized coefficients (lower and upper confidence intervals) are reported. Dummy coded reference level for collective efficacy was 'low' and for favour left-wing was 'favour'.

5. Discussion

The current study probed the growth in Indian public beliefs of climate change concern from 2006 to 2020 by identifying how sociodemographic factors and environmental protection over economic growth beliefs were linked to climate concern. Additionally, the study identified differing antecedents of personal and societal climate concern in 2019-2020. Taken together, the results of this research provide a bird 's-eye view of how public climate concern has changed in India across the decade and explores how personal and societal concern regarding climate change may be different in the recent past.

5.1. Climate change concern across the decade

Answering RQ1, the study finds that climate change concern in India has increased steadily from 2006 (2.62% of participants chose 'environmental pollution' as the most serious problem') to 2020 (89.6% said 'global climate change was a serious/very serious problem'). The lower priority of environmental pollution in 2006 as compared to other issues such as poverty or inequality is similar to findings in developing countries such as Egypt[83]. This is reflected by India's needs to focus on creating jobs, developing strong infrastructure and promoting long-term and equitable economic growth as primary priorities before advancing sustainable development[84]. However, Indian climate concern mimics the global increase in public opinion about climate change as compared to developed nations[16,79,85]. While it may be beyond the scope of this study, the increase in global climate concern over the years can be attributed to a combination of factors. Direct experiences with natural disasters such as hurricanes[86,87] and perception of abnormally warm or cool temperatures[88,89] have played a significant role. An increase in the salience of climate change as an issue may be due to the partisan divide and political polarization of climate beliefs in America[90,91], spilling into global media.

The first hypothesis aimed to identify predictors of climate change concern from 2006 to 2020. Across the decade, a significant positive effect of education on climate change concern was found, adding support to previous work[35,36,40] and in contrast to previous non-significant findings by Kellesdt et al.[54]. Hoffmann and

Muttarak[44] attribute this to the disaster preparedness and anticipation that education brings, which can replace the need to directly experience natural disasters to develop higher threat evaluations of climate change. In the current dataset, the effect of education on public climate concern across the decade was in line with previous literature, such that those with secondary school, professional/technical training and university-level education expressed higher concern than those with no formal education or primary education across 2006 to 2020. Therefore, our findings add support to the evidence that discusses how increasing knowledge about environmental issues may be linked to increases in climate change concern and risk perception[18,35,36]. However, climate change concerns did not significantly differ across age or gender in an Indian sample, adding support to previous non-significant findings[39,42]. Future research should continue to explore the impact of different levels of education, encouraging information-based intervention mixes and communication devices that have contributed to the increase in climate concern among the Indian population.

The preference for environmental protection over economic growth significantly predicted growth in climate change concern across the decade in this dataset. This is similar to the audience analysis conducted by Leiserowitz et al.[22] where most Indians tended to prioritize environmental protection over economic growth. The study's findings further contradict the postmaterialist values hypothesis[67], suggesting that even in developing countries where economic affluence may be contested with environmental protection, the general public may express concern and prefer environmental conservation. In conclusion, this study emphasizes the increasing climate change concern in India and profiles females, individuals with secondary school, professional/technical training or university-level education, and those prioritizing environmental protection over economic growth as expressing higher levels of concern.

5.2. Personal and societal climate change concern in 2020

The second research question investigates the predictors of personal climate change concern in 2019-20. Interestingly, climate change concern was the highest in 2020. Personal climate concern was significantly higher with higher education (similar to[35,36]). Even so, personal climate concerns were not significantly different across age, gender or political affiliation to a left-leaning Indian National Congress (INC) or a right-leaning Bhartiya Janata Party (BJP). While the political polarization of climate change concern is an often-replicated effect in American samples[45,92], it finds little support in Europe[46] and far less in other countries of the world[36]. The absence of such an effect in an Indian sample could be attributed to the fact that issues of environmental protection and biodiversity loss aren't politically polarized issues in the Indian media, as much as they are in American media[93]. Both the INC and BJP have included sustainability issues such as river water conservation, environmental protection, and natural resource conservation as part of their election manifestos since 2014 (for a detailed analysis of sustainability issues in electoral policies, see[94]). Alternatively, these contrasting results could be due to the treatment of political affiliations as two independent dichotomized variables where individuals could favour both BJP and INC at any given time. However, further research is required to explore the role of political identification (across economic and cultural dimensions) on climate change beliefs in India and its potential impact on policy support and pro-environmental action.

Education has had a complex impact on personal climate concern. Higher education was significantly associated with higher personal climate change concern but only secondary school or university-level education was a significant predictor. Previous work on climate change concern in India[22] highlights that the "informed" (high-income, upper caste and highly educated individuals) and the "experienced" (least wealthy group, most religious, with most personal experience of global warming effects) report higher levels of worry about global warming and express policy support for environmental protection over economic growth. In comparison, the "undecided" (middle-income, university-level education, low religiosity), the "unconcerned" (average income, education, religiosity) and the "indifferent" (lower caste, low religiosity) report lower

concern for global warming and less or no support for environmental protection policy over economic growth. The complex effects of education are in line with findings in global literature that although education itself may be linked with higher climate change concern across time[35,36] due to disaster preparedness[44], pro-environmental action and policy support may be better predicted by specific knowledge factors of cause, consequence and action to be taken to mitigate or adapt to climate change concern[29,95]. Perhaps this is due to the complex interaction of income, social class[96], and minority group identification[97] that elongates the gap between knowing about climate change, being concerned about the climate and feeling personally responsible and equipped to mitigate the causes of climate change. Future research should prioritize the specific measurement of cause or consequence knowledge measurement concerning climate change beliefs and their relationship with pro-environmental behaviour.

As argued by Tyler and Cook[30] and Van Der Linden[33], personal and societal risk perceptions and concern about climate change are predicted by different determinants. The third research question of our study probed the predictors of Indian societal climate change concern in 2020. While personal climate concern was significantly related to education, trust in scientists, beliefs of anthropogenic climate change and preference for environmental protection; societal climate concern was significantly related to belief in adequate government action and favouring left-wing party affiliation along with beliefs of human-caused climate change and personal climate concern. Similar to Van Valkengoed and Steg[53], the current sample observed that societal assessments of climate concern are impacted strongly by the measures taken by the government to address issues of sustainability. In our study, individuals reported higher personal climate concern as compared to other-oriented or societal climate concern, unlike the work of Leiserowitz[6]. Our findings add to the ongoing discussion of placing personal and societal assessments of "concern" into the larger hierarchy of concern model[29]. Personal climate change concern significantly correlated with societal climate change concern ($r = 0.15$). While these constructs may be informed by varying antecedents, they are independent and inter-dependent constructs and future research could focus on replicating such inter-relationships and identifying how determinants load onto personal and societal concern as distinct factors contributing to a global concern or risk perception index.

This study is not without its limitations. While nationally representative secondary data was synthesized, much of this evidence remains self-reported and further causational evidence through experimental or longitudinal data is required to understand cause-effect relationships of how factors such as anthropogenic climate change beliefs, and environmental protection may impact concern and future behaviour or policy support. However, echoing Van der Linden[29], understanding how India views climate change and adaptative or mitigatory behaviour would be best informed by measures of specific knowledge (such as causes, consequences or responses to climate change) and a deeper observation of normative influence and values on pro-environmental attitudes and behaviour. Future research in India should build on such correlational evidence to conduct region-specific replications to map climate risk profiles and generate experimental evidence that can tease apart the relationships between personal and societal risk assessments/ concern and their impact on pro-environmental behaviour and/or policy support.

6. Conclusion

Climate concern has been found to significantly impact how individuals adapt, mitigate, and engage with policy about climate change. Although global literature finds that personal and societal assessments of viewing climate change as a threat are different, it has been seldom replicated in the Global South. The study's findings unfold the significant increase in climate change concern over the last decade in India, strongly associated with individuals' education and a preference for environmental protection over economic growth. In line with

previous literature, personal and societal climate concern was predicted by varying psychosocial antecedents. While personal concern was significantly predicted by prior education, belief in human caused climate change, trust in scientists and a preference for environmental protection; social climate concern was predicted by beliefs about adequate government action and a political left-wing affiliation. These findings hold crucial implications for future climate communication, promoting pro-environmental behaviour, and prioritizing policy mixes to promote communal sustainable behaviour change. Nevertheless, the current study is cautious about making strong conclusions from self-report correlational evidence. Future research may build on developing regional and sub-regional assessments of climate change beliefs that can inform culturally sensitive interventions to promote sustainable behaviour. Additionally, they may employ novel methodologies (both experimental and qualitative) to develop a nuanced understanding of the links between climate change beliefs and pro-environmental behaviour in India. To conclude, this study not only provides a succinct understanding of public perceptions of climate change concern in India but also paves the way for developing empirically supported interventions and social policies for sustainable behaviour change.

Author contributions

Conceptualization, AI; Formal analysis, AI; Resources, AI and AJK; Data curation, AI; Writing—original draft preparation, AI; Writing—review and editing, AJK; Visualization, AI; Supervision, AJK.; All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

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Appendix

Table 2. Correlation matrix of predictor variables with personal climate change concern.

	Personal climate change concern	**Anthropogenic climate change**	**Adequate government action**	**Social climate change concern**	**Trust in scientists**	**Education**	**Environmental protection versus economic growth**	**Age**	**Gender**	**Collective efficacy**	**Favour right wing (BJP)**	**Favour left wing (INC)**
Personal climate change concern												
Anthropogenic climate change	0.24***											
Adequate government action	0.06**	0.14***										
Social climate change concern	0.15***	0.17***	0.14***									
Trust in scientists	0.09***	0.05**	0.07***	0.01								

Education	0.12***	0.07***	-0.03	0.02	0.02						
Environmental protection versus economic growth	-0.12***	-0.08***	-0.02	-0.03	-0.02	-0.09***					
Age	-0.08	-0.02	-0.010	-0.001	0.001	-0.32***	0.04*				
Gender	-0.02	-0.01	-0.01	-0.01	-0.05**	-0.18***	0.03	-0.05***			
Collective efficacy	-0.02	0.005	0.008	0.04*	-0.07***	-0.02	0.10***	0.02	-0.02		
Favour right-wing (BJP)	-0.004	-0.02	-0.13***	0.01	-0.11***	-0.02	0.02	0.04*	-0.01	0.09***	
Favour leftwing (INC)	0.01	-0.01	-0.009	-0.05*	0.04*	-0.01	-0.04	0.04*	0.01	-0.08***	-0.11***

Note: '***' $p < .001$, '**' $p < .01$, '*' $p < .05$.