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Political divide in climate change opinions is stronger in some countries and some U.S. states than others: Testing the self-expression hypothesis and the fossil fuel reliance hypothesis

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ABSTRACT

Despite the accumulation of evidence for the human causes of climate change, there is still a political divide in climate change opinions. Importantly, the strength of this political divide appears to vary across countries and across states within the United States. In this research, we proposed the self-expression hypothesis and the fossil fuel reliance hypothesis to explain these cross-national and within-country variations. We expected that the strength of the political orientation-climate change opinions link to be stronger among countries and states with a stronger emphasis on self-expression, higher levels of fossil fuel consumption, and greater economic interests associated with fossil fuels. We tested these hypotheses with two international data sets (Studies 1 and 2) and a U.S. state-level data set (Study 3). We found supporting evidence for the self-expression hypothesis and mixed evidence for the fossil fuel reliance hypothesis; fossil fuel consumption was related to a larger political divide between countries but a smaller political divide between states within the United States. These findings highlight the need to consider the role of cultural and socio-ecological factors in the political divide in climate change opinions. As we observed both similarities and differences between the two levels of analysis, our findings also suggest the need to consider how these factors modulate the influence of political orientation on climate change opinions both within and between countries.

1. Introduction

While there is mounting evidence of the happening and anthropogenic causes of climate change, public opinions on climate change are still diverse (e.g., Capstick et al., 2015). According to the *Yale Climate Opinion Maps 2021* (Marlon et al., 2022), while 57% of US adults considered climate change to be caused by human activities, 30% considered it to be a consequence of natural changes. Globally, *The Peoples' Climate Vote* study by UNDP and University of Oxford (United Nations Development Programme, 2021) found that while 64% of people from 50 countries see climate change as a global emergency, the remaining 36% do not. This diversity of climate change opinions creates barriers for policymakers to garner the public's support for mitigation and adaptation actions (Jewell & Cherp, 2020). Climate change skeptics may reject implementation of climate policies and prefer public investment in sectors other than climate change mitigation. The public discourse centered around skepticism may also erode the perceived consensus of climate change concern among the public, which in turn discourages citizens who are concerned about the issue from talking about it and taking action (Lorenzoni et al., 2007; Reser & Swim, 2011).

Political orientation is known to be a factor behind the diversity of climate opinions (e.g., Bliuc et al., 2015; Unsworth & Fielding, 2014). Studies have found that politically right or conservative were more skeptical about climate change than were politically left or liberal-leaning individuals (e.g., McCright & Dunlap, 2011; for meta-analysis, see Cruz, 2017). The magnitude of this political divide appears to vary across countries (e.g., Hornsey et al., 2018; McCright et al., 2016) and across states within the United States (Mildenberger et al., 2017). These findings give rise to two interrelated questions: To what extent does the political difference in climate change opinions vary across socio-cultural contexts? Further, how can we explain such variations? In the present research, we answer these two questions by using a framework that considers the joint influence of individual factors and socio-cultural contextual factors (i.e., a socioecological approach; e.g.,

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Chan, 2020; Chan & Tam, 2021; Tam & Chan, 2017). We examine how socio-cultural factors influence the strength of the relationship between political orientation and climate change opinions.

1.1. The political divide in climate change opinions

Climate change opinions can be operationalized in terms of climate change beliefs and climate change concerns (for a review, see Capstick et al., 2015). Climate change beliefs refer to the extent to which people believe in the occurrence (whether it is happening), the human causes (whether human activities or natural changes cause it), and the scientific certainty of climate change (whether scientists believe in the happening of climate change) (e.g., Howe et al., 2019). Climate change concerns refer to the extent to which people are worried about climate change and consider it to be a severe threat (e.g., Lee et al., 2015). Some researchers also adopt the term "skepticism" to refer to the negative end of climate change opinions (e.g., Tranter & Booth, 2015).

Regardless of the specific types of opinions measured, researchers observed a relationship between political orientation and climate change opinions. For example, the *2018 Partisan Climate Opinion Map* showed that 79% of the Democrats were convinced of the human cause of climate change, whereas only 35% of the Republicans were so (Mildenberger et al., 2020). Similarly, while 85% of the Democrats were worried about climate change, only 40% of the Republicans were so (Mildenberger et al., 2020). Correlational studies also replicated this political divide; liberal (or politically left) individuals reported higher levels of climate change concerns and beliefs than did conservative (or politically right) individuals, regardless of gender, education level, and income (e.g., McCright & Dunlap, 2011; Tranter, 2013).

Nevertheless, the political divide of climate change opinions also appears to be less robust in some countries. For example, among the 14 western countries that Tranter and Booth (2015) analyzed, seven showed a non-significant political orientation-climate change skepticism association – Austria, Finland, France, Germany, Spain, Sweden, and Switzerland. Three other studies directly compared the magnitude of the influence of political orientation on climate change opinions across a wide range of countries. McCright et al. (2016), using the Eurobarometer data, found that political orientation was unrelated to climate change belief and support for mitigation actions in 11 former communist countries in Eastern Europe. Similarly, with the European Social Survey data, Poortinga et al. (2019) found a significant variation in the association between political orientation and climate change opinions across Southern, Northern, Western, and Central and Eastern regions in Europe. They also found that such an association was weaker in Central and Eastern European countries. Lastly, Hornsey et al. (2018) conducted a cross-national survey study that involved both Western (e.g., the United States, United Kingdom, Canada) and non-Western countries (e.g., Brazil, India, Japan). They found that the association between political orientation and climate change skepticism varied significantly across the 25 countries studied, and this association was much more pronounced in the United States than in other countries.

Notably, Mildenberger et al. (2017) also found a substantial variation in the political difference in climate change belief across different states within the U.S. Although this finding does not reveal a cross-national variation, the cross-state difference once again highlights the importance of considering societal or contextual factors when it comes to appreciating the effect of political orientation.

In all, the magnitude of the political divide in climate change opinions seems to vary across societal contexts. It thus poses a question as to under what societal contexts the political difference may arise. To date, this question remains underexplored, as past studies predominantly used samples from European countries only (except for Hornsey et al., 2018). More importantly, the literature still lacks a unified explanation for the observed cross-regional variations. Both McCright et al. (2016) and Hornsey et al. (2018) explained such variations with reference to the concept of salience of climate change in the political discourse. McCright et al. (2016) observed that among former communist countries in Europe, climate change was a less salient political issue. Hornsey et al. (2018) contended that the salience of climate change as a political issue is associated with the vested economic and political interests associated with fossil fuels. Accordingly, the political divide in climate change opinions would be more pronounced among countries with stronger fossil fuel reliance. This proposition was tested with carbon dioxide emission as a country-level proxy. Despite offering critical insights into understanding the cross-regional variations, these studies are yet to consider the role of the broader cultural and socio-ecological factors in shaping processes other than the salience of political discourse. Furthermore, we believe that carbon dioxide emission alone does not fully reflect the vested interests associated with fossil fuel reliance. The present investigation fills these gaps by considering cross-cultural psychology and socio-ecological psychology perspectives. It is worth noting that there have already been a number of cross-national comparisons of climate change opinions; however, these studies mostly considered political orientation to be a fixed (rather than random) variable (e.g., Kvaløy et al., 2012; Smith et al., 2017) and did not really investigate to what extent the association between political orientation and climate change opinions covary with different societal factors.

1.2. The self-expression and fossil fuel reliance hypotheses

We hypothesize that the link between political orientation and climate change opinions varies across socio-cultural contexts with (1) different levels of emphasis on self-expression and (2) different degrees of fossil fuel reliance in the consumption and production ends. We derive these two hypotheses by considering how cultural and socioecological factors interact with the psychological processes that drive the political divide in climate change opinions. In the following, we refer to these hypotheses as *the self-expression hypothesis* and *the fossil fuel reliance hypothesis*, respectively.

The self-expression hypothesis concerns the influence of cultural contexts on the guiding roles of values and ideologies. Political orientations are a constellation of values and ideologies. Previous studies have revealed that conservative individuals endorse more conservation values (versus openness to change values), self-enhancement values, free-market ideology, system-justification, and human dominance over nature than do liberal individuals (e.g., Campbell & Kay, 2014; Hennes et al., 2016; Schwartz et al., 2010). These values and ideologies are less aligned with climate change and its mitigation, thus, leading to less supportive climate change opinions (Campbell & Kay, 2014; Hennes et al., 2016). Importantly, how much people base their climate change opinions on their values and ideologies depends on the cultural context (Boer & Fischer, 2013; Chan, 2020). In societies with a strong emphasis on self-expression, individuals are encouraged to express themselves and base their decisions on personal preferences. Accordingly, personal values and ideologies serve as crucial guidance of attitudes and behaviors. By contrast, in societal contexts with a strong emphasis on norm compliance, individuals are encouraged to adjust their attitudes and behaviors according to social norms. The guidance function of personal values and ideologies becomes less important in determining attitudes and behaviors. This cross-cultural difference in the emphasis on self-expression has been well documented in previous studies (e.g., Fischer & Boer, 2015; Kim & Sherman, 2007). In the context of environmental attitudes, several studies have found a stronger (weaker) association between personal values and pro-environmental attitudes or behaviors among societies with a stronger (weaker) emphasis on self-expression (e.g., Boer & Fischer, 2013; Chan, 2020; Chan et al., 2019). We thus expect that political orientation would have a weaker association with climate change opinions in cultural contexts that place less weight on self-expression.

To test this hypothesis, we need to identify indexes that allow us to capture the cross-cultural variations in the emphasis on self-expression. We refer to the cross-cultural psychology literature and identify two

candidates – individualism-collectivism and cultural looseness-tightness. In cross-cultural psychology research, the most widely studied societal-level factor that explains the contrast between self-expression and norm compliance is individualism-collectivism (Hofstede et al., 2010). Collectivism refers to a cultural emphasis on collective goals and interests and a cultural preference for tightly-knit group relations, whereas individualism refers to an emphasis on personal goals and a preference for loosely-knit group relations. People in collectivistic societies tend to emphasize fitting into in-groups, and they are ready to adjust themselves according to contextual cues (e.g., social norms; Markus & Kitayama, 1994). They tend to evaluate inconsistency of the self across situations in a positive light (e.g., Suh, 2002), which implies the importance of behaving in a context-dependent manner. For example, in societies with high levels of collectivism, individuals are more likely to adjust their opinions according to the social norms rather than always uphold the same support or skeptic attitude. In all, the guidance function of internal attributes (including political orientation) is less applicable in collectivistic cultures. Thus, we expect that the influence of political orientation on climate change opinion is stronger (weaker) in societies and states with stronger individualism (collectivism).

Another socio-cultural factor that is of relevance is cultural tightness. In tight cultures, there are clear social norms, and deviance from norms is generally not tolerated. Accordingly, in societies with high levels of cultural tightness, we should also expect a weaker guidance function of personal values and ideologies. By contrast, in loose cultures, given the loose social norms, individuals' personal values should be more relevant in guiding their attitudes and behaviors. Findings from recent research support this expectation (e.g., Chan, 2020; Elster & Gelfand, 2021). We thus also expect a stronger (weaker) political orientation-climate change opinion link in societies and states with higher levels of cultural looseness (tightness). It is noteworthy that the concept of individualism-collectivism and cultural tightness varies across societies and within societies (e.g., Harrington & Gelfand, 2014), which makes it a useful tool for explaining the cross-national and cross-regional variations of the political difference in climate change opinions.

The fossil fuel reliance hypothesis concerns the influences of fossil fuel production and consumption on the formation of climate change skepticism among political conservatives. The link between political orientation and climate change opinions can be seen as a consequence of the politicized political discourse surrounding the problem of climate change (Brulle, 2014; McCright & Dunlap, 2003) that is driven by motivated defense against the solution to climate change (i.e., solution aversion; Campbell & Kay, 2014). Climate change mitigation requires the reduction of greenhouse gas emissions, which necessitates a shift from the consumption of fossil fuel energy sources (e.g., coal, petroleum, natural gas) to that of clean and renewable energy sources (e.g., solar, wind, and hydropower). This shift is unwelcome for people and corporations who have economic and political interests associated with fossil fuel production and consumption (e.g., manufacturing industries that rely on fossil fuels for power generation). Research studies have observed a link between conservative think tanks advocating climate change skepticism and corporates' economic interests in both the United States (e.g., Brulle, 2014; McCright & Dunlap, 2003) and European countries (e.g., Almiron et al., 2020). It is possible that these think tanks are more active in countries and states that have stronger fossil fuel reliance thereby produce a more skeptic political discourse in these regions, giving rise to a more pronounced political divide in climate change opinions. Furthermore, the regulation of greenhouse gas emissions often involves interventions into the market from the government (e.g., carbon cap and trade, carbon tax). Political conservatives may perceive such direct interventions as a threat to their free-market ideology, which in turn motivates them to not only reject the solution of climate change but perhaps also categorically deny the notion of climate change at all (Campbell & Kay, 2014). Lastly, for countries and regions that heavily consume fossil fuels, the happening of climate change implies the need to rapidly change people's way of living as a response. This change could be seen as more discomforting and inconvenient for politically conservative individuals, as they tend to be more resistant to change than do their politically liberal counterparts (White et al., 2020). Based on the above analysis, we expect that political orientation would have a stronger association with climate change opinions among societies with heavier reliance on fossil fuel.

Hornsey et al. (2018) found a stronger association between climate change skepticism and political orientation among societies with higher levels of per capita carbon emission, a proxy of fossil fuel reliance. However, we contend that carbon emission alone may not be sufficient in capturing the vested political and economic interests associated with fossil fuel reliance. We aim to test the fossil fuel reliance hypothesis by using societal-level and state-level indices that more thoroughly capture the economic interests associated with the production of fossil fuel (i.e., the economic value generated by fossil fuel production and by the industrial sector) and the consumption of fossil fuel (i.e., consumption of energy per capita, emission of carbon dioxide per capita). That is, we simultaneously consider both the production and consumption aspects of fossil fuel reliance. We consider this distinction between production and consumption to be critical. In addition to being associated with vested political and economic interests, fossil fuel consumption reflects the extent to which people rely on fossil fuels as primary energy sources in their consumption behaviors in daily life. Reducing fossil fuel reliance thus requires people to accept changes in both socio-political systems (e.g., energy infrastructure) and their personal lifestyles (e.g., transportation choices). The installation of alternative energy sources (e.g., wind power plants) may also create changes in neighborhoods and landscapes. Such changes can represent a system threat to politically right-leaned/conservative people. By testing economic interests and fossil fuel consumption simultaneously, we aim to provide a more nuanced understanding of how fossil fuel reliance influences the political divide in climate change opinions.

1.3. Overview of the present study

To test the self-expression and fossil fuel reliance hypotheses, we directly compared the strength of the political orientation-climate change opinion association across countries with data from two international social surveys – the Voice of the People Survey (VOPS; Gallup International Association, 2010) and the Environment Module III of the International Social Survey Programme (ISSP; ISSP Research Group, 2012) – and across states within the U.S. with data from the Partisan Climate Opinion Map (Mildenberger et al., 2017). These datasets covered different countries and measured climate change opinions in different ways; using them enable us to conceptually replicate our findings and strengthen the robustness of our findings. The within-state analysis enables us to eliminate the unmeasured between-country differences (e.g., political system, language, shared historical relationship) and can serve as a complementary method to validate our hypothesized accounts. The current research was not pre-registered. All datasets we referred to are publicly available. We have reported all results (main and supplementary analyses) transparently in both the results section and the supplementary document.

2. Study 1 (VOPS data)

2.1. Method

We collected the individual-level data from the Voice of the People survey (VOPS). This survey was administered in 2007 by the Gallup International Association. In total, the data included 63 countries and 62,183 adult participants (aged 18 years and above). In most countries, a nationally representative sample was used. However, in some developing countries, due to limited research conditions, only participants from urban regions or major cities were recruited. In addition to the

measures reported below, we also included gender, age, the highest level of education attained, and total household family income as the covariates. Data necessary for our analysis were available in only 52 of the countries. Supplementary Table S1 shows the countries/regions involved in the present analysis. Supplementary Tables S3 and S4 show the standardized scores of country-level variables and the zero-order correlations between these variables respectively.

Climate change concern. We identified a single-item measure that captured to what extent an individual perceived the negative impact of climate change ("Global warming is having a serious impact now in the area where I live"). Participants reported on a 4-point scale the extent to which they agreed or disagreed with the statement (1 = disagree strongly to 4 = agree strongly). A higher score indicated stronger climate change concern.

Political orientation. Political orientation was measured by one item: "What is your personal ideological/political leaning?" Participants reported their political orientation on a 5-point scale (1 = Very Left Wing to 5 = Very Right Wing). A higher score indicated a more right-wing (or conservative) orientation. This left-right self-placement measure has been widely used in public opinion surveys (Kroh, 2007) and is a valid measure in predicting political differences in public opinions of social and environmental issues (e.g., Taniguchi & Marshall, 2018; Tranter & Booth, 2015). Supplementary Table S1 shows the distribution of political orientation by the countries/regions in the study.

Individualism-collectivism. We obtained the country-level scores of individualism-collectivism (IC) from Hofstede et al. (2010), which is a widely adopted database for cross-cultural comparisons (e.g., Chan et al., 2019; Eom et al., 2016; Tam & Chan, 2017). A higher score indicated a higher level of individualism (or a lower level of collectivism).

Cultural looseness-tightness. We obtained the country-level scores of cultural looseness-tightness from Uz (2015), which has been used in previous studies in comparing the relationship between environment-related variables between countries (e.g., Chan et al., 2022; Tam & Chan, 2017). A higher score indicated a higher level of cultural looseness.

Fossil fuel consumption. We identified three indicators to capture fossil fuel consumption in 2007: energy use per capita (Our World in Data, 2022a), fossil fuel consumption per capita (Our World in Data, 2022b), and carbon dioxide emission per capita (Our World in Data, 2022c). As the three indicators were strongly correlated (*r*s ranged from 0.78 to 0.96), we also computed an overall score for fossil fuel consumption by first standardizing each indicator and taking the average of them.

Economic interest associated with fossil fuel. We identified multiple indicators to capture the economic interest linked to fossil fuel consumption in two aspects. The first concerns the economic values generated from fossil fuel consumption. As fossil fuel has been heavily used in the industrial sector, we used the percentage of GDP produced in industry and the percentage of employment in the industrial sector as proxy indicators (World Bank, 2022a; 2022b). These two indicators were weakly correlated ($r = .15$). The second concerns economic values generated from fossil fuel production. We used the merchandised fuel exports and the total natural resource rent as proxy indicators (World Bank, 2022c; 2022d). These two indicators were strongly correlated ($r = 0.76$). We thus computed an average score to indicate the economic values of fossil fuel production.

National wealth. We included national wealth as the societal-level covariate. We obtained the log-transformed gross-domestic-product (GDP) per capita from the World Bank (2022e). A higher score indicated a higher level of national wealth.

2.2. Results

To examine our hypotheses, we conducted a series of multilevel analyses. In each set of analysis, we included climate change concern as the outcome variables, political orientation as the Level-1 predictor variable, and other demographic variables as the Level-1 covariates. At the country-level (Level-2), we included cultural factors (i.e., individualism-collectivism and cultural looseness-tightness), the fossil fuel consumption factor, and economic interest factors (i.e., economic values of fossil fuel production, percentage of GDP produced in industry, and employment in the industrial sector) as the predictors of the intercept and also the slope of political orientation. We first included the three sets of factors separately. Next, we included the consumption and economic interest factors simultaneously to contrast the effects of consumption with economic interest. Lastly, to explore the unique effect of the country-level factors, we included the three sets of factors simultaneously. In all analyses, we included the log-transformed GDP per capita as the country-level covariate. Supplementary Table S7 displays the results for the models that had each country-level factor included separately.

Our results showed that political orientation (higher = more right-leaned) was negatively related to climate change concern, and this association varied between societies (see Fig. 1). It indicates that political light-leaned individuals were less likely to express concern about climate change. Table 1 shows the results of the multilevel analyses. Supplementary Figs. S1 and S2 illustrate the significant cross-level interaction effects. For the cultural model, we found that the political orientation x individualism-collectivism was negative and significant, indicating that the strength of the political divide in climate change concerns was stronger among societies with higher levels of individualism. The political orientation x cultural looseness-tightness was non-significant. It was negative and significant when it was tested separately (see Supplementary Table S7). For the consumption model, we found that political orientation x fossil fuel consumption was negative and significant, indicating also a stronger negative link between political orientation and climate change concerns among societies with higher levels of fossil fuel consumption. To offer a direct comparison with the findings of Hornsey et al. (2018), the political orientation x carbon dioxide emission was also significant when included separately (see Supplementary Table S7). For the economic interest factors, none of the interaction effects was significant. The results remained consistent when each factor was considered separately (see Supplementary Table S7). When the consumption and economic interest factors were included in the model simultaneously, the political orientation x fossil fuel consumption remained negative and significant. Lastly, considering all factors simultaneously, the political orientation x individualism-collectivism interaction and the political orientation x fossil fuel consumption interaction remained negative and significant. This overall model should be interpreted with caution, however. Only 28 countries/regions had the full information of all the variables; the statistical power of the study for detecting the cross-level interaction effect could be limited. We thus opted for interpreting the findings based on the separate models. Overall, these findings support the self-expression hypothesis and the consumption aspect of the fossil fuel reliance hypothesis. We did not observe any evidence that supports the link between the economic interest associated with fossil fuels and the political divide in climate change opinions.

3. Study 2 (ISSP data)

One limitation of Study 1 is that political orientation was measured in a self-reported left-right orientation. It is possible that individuals in different countries interpret this left-right orientation differently. In Study 2, we obtained data from the Environment module III of the International Social Survey Programme (ISSP Research Group, 2012). Political orientation was coded in two steps. First, in each country, researchers asked participants to report either which party they felt close to or which party they would vote for if there was an election. Next, experts of the ISSP research group coded the extent to which the party was left-leaned or right-leaned (1 = far left to 5 = far right) for each

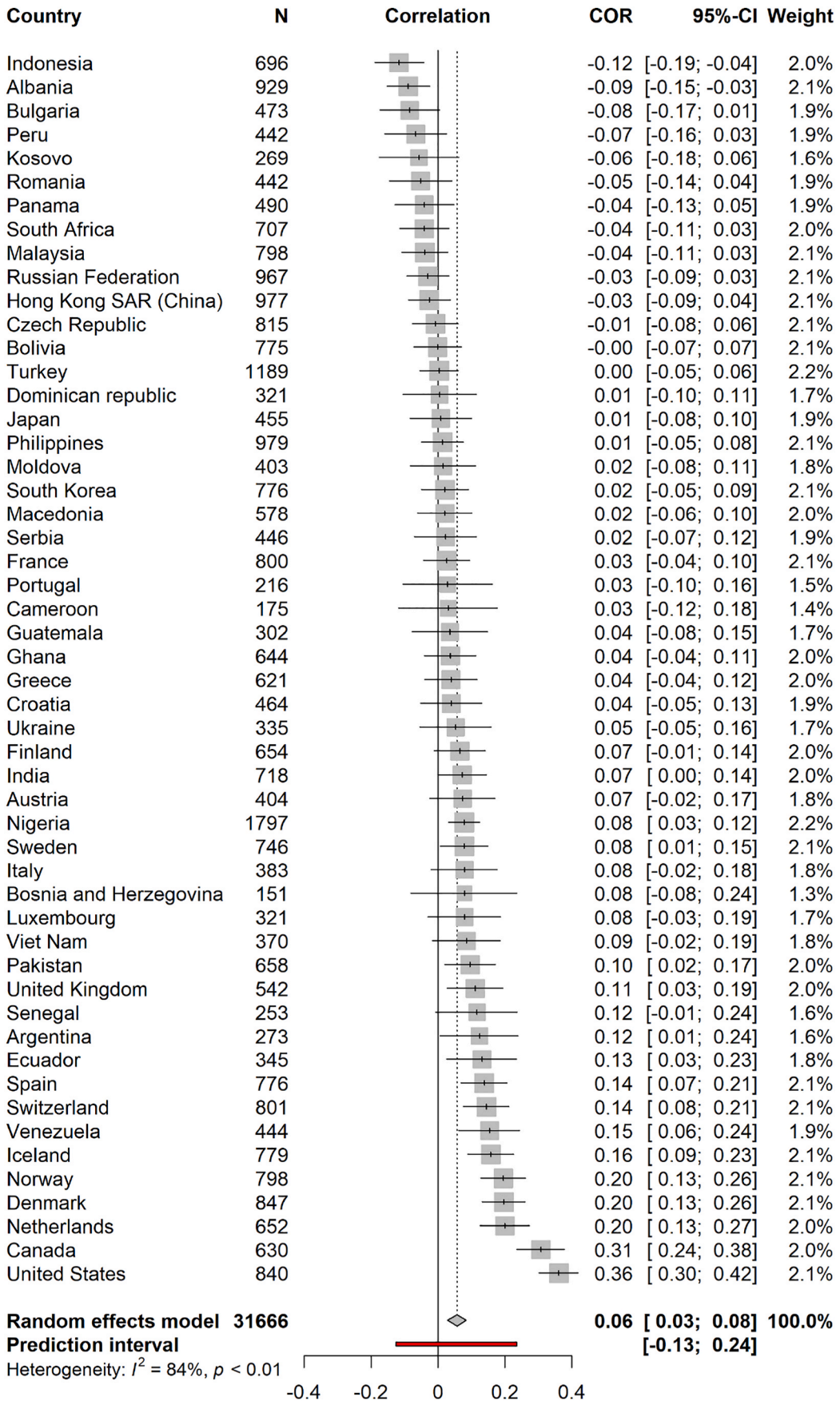

Fig. 1. Correlation between political orientation and climate change concern between countries (Voice of the People Data; Study 1).
Higher political orientation score = Left-leaned.

Table 1
Results of multilevel models with the VOPS data (Study 1).

	Cultural Model			Consumption Model			Economic Interest Model		
	b (SE)	*p*	95% *CI*	*b* (SE)	*p*	95% *CI*	*b* (SE)	*p*	95% *CI*
Individual-level covariates									
Gender	−.06 (.01)	.000	[-.09, −.04]	−.05 (.01)	.000	[-.07, −.03]	−.04 (.01)	.000	[-.06, −.02]
Age	.02 (.01)	.032	[.00, .03]	.02 (.01)	.008	[.00, .03]	.02 (.01)	.000	[.01, .03]
Education	.03 (.01)	.004	[.01, .05]	.03 (.01)	.001	[.01, .05]	.04 (.01)	.000	[.02, .05]
Income	−.01 (.01)	.229	[-.03, .01]	−.02 (.01)	.014	[-.04, .00]	−.01 (.01)	.073	[-.03, .00]
Main effect									
Political orientation	−.05 (.02)	.002	[-.08, −.02]	−.07 (.02)	.000	[-.10, −.04]	−.06 (.01)	.000	[-.08, −.03]
Individualism-collectivism	−.27 (.07)	.000	[-.40, −.14]						
Cultural looseness-tightness	.02 (.06)	.723	[-.09, .14]						
Fossil fuel consumption				−.14 (.08)	.081	[-.30, .02]			
Economic values of fossil fuel production							−.07 (.07)	.324	[-.21, .07]
Percentage of GDP produced in industry							−.06 (.05)	.233	[-.17, .04]
Employment in industrial sector							.05 (.05)	.363	[-.06, .15]
GDP per capita	.13 (.08)	.091	[-.02, .28]	−.01 (.09)	.877	[-.19, .16]	−.18 (.05)	.000	[-.27, −.08]
Interaction effect: Political orientation x									
Individualism-collectivism	−.09 (.02)	.000	[-.14, −.05]						
Cultural looseness-tightness	.01 (.02)	.596	[-.03, .05]						
Fossil fuel consumption				−.06 (.02)	.011	[-.10, −.01]			
Economic values of fossil fuel production							−.01 (.02)	.673	[-.05, .03]
Percentage of GDP produced in industry							.01 (.01)	.555	[-.02, .04]
Employment in industrial sector							.02 (.01)	.158	[-.01, .05]
GDP per capita	.00 (.03)	.914	[-.05, .05]	−.01 (.02)	.817	[-.05, .04]	−.05 (.01)	.000	[-.08, −.02]
Intercept	3.06 (.05)	.000	[2.96, 3.16]	3.05 (.06)	.000	[2.93, 3.17]	3.08 (.04)	.000	[2.99, 3.17]

	Consumption vs. Economic Interest			Full Model		
	b (SE)	*p*	95% *CI*	*b* (SE)	*p*	95% *CI*
Individual-level covariates						
Gender	−.05 (.01)	.000	[-.07, −.03]	−.06 (.01)	.000	[-.09, −.04]
Age	.02 (.01)	.006	[.00, .03]	.01 (.01)	.060	[.00, .03]
Education	.03 (.01)	.001	[.01, .05]	.03 (.01)	.007	[.01, .05]
Income	−.02 (.01)	.028	[-.04, .00]	−.01 (.01)	.266	[-.03, .01]
Main effect						
Political orientation	−.08 (.02)	.000	[-.11, −.04]	−.07 (.02)	.000	[-.11, −.04]
Individualism-collectivism				−.27 (.06)	.000	[-.39, −.15]
Cultural looseness-tightness				.01 (.06)	.863	[-.11, .13]
Fossil fuel consumption	−.13 (.08)	.089	[-.28, .02]	−.01 (.06)	.920	[-.13, .12]
Economic values of fossil fuel production	.01 (.09)	.946	[-.18, .19]	−.19 (.09)	.046	[-.37, .00]
Percentage of GDP produced in industry	−.12 (.06)	.049	[-.24, .00]	−.09 (.07)	.216	[-.22, .05]
Employment in industrial sector	.08 (.06)	.165	[-.03, .20]	.04 (.05)	.432	[-.05, .13]
GDP per capita	−.09 (.09)	.326	[-.27, .09]	.00 (.10)	.993	[-.20, .20]
Interaction effect: Political orientation x						
Individualism-collectivism				−.08 (.02)	.000	[-.12, −.04]
Cultural looseness-tightness				.02 (.02)	.379	[-.02, .05]
Fossil fuel consumption	−.06 (.02)	.008	[-.10, −.02]	−.06 (.02)	.002	[-.10, −.02]
Economic values of fossil fuel production	.01 (.03)	.754	[-.04, .06]	.03 (.03)	.323	[-.03, .08]
Percentage of GDP produced in industry	.00 (.02)	.793	[-.03, .04]	.01 (.02)	.617	[-.03, .05]
Employment in industrial sector	.03 (.02)	.078	[.00, .06]	.02 (.01)	.145	[-.01, .05]
GDP per capita	.00 (.03)	.946	[-.05, .05]	.05 (.03)	.132	[-.01, .11]
Intercept	3.07 (.06)	.000	[2.95, 3.20]	3.05 (.06)	.000	[2.93, 3.16]

country (see Supplementary Table S2 for the detail). Accordingly, political orientation measured in the ISSP data does not rely on participants' subjective interpretation.

3.1. Methods

The survey was administered between 2009 and 2011. In total, the data included 32 countries and 45,199 participants (aged 15 years and above). In most countries, a nationally representative sample was used. In addition to the measures reported below, we also included gender, age, the highest level of education attained, and total household family income as the covariates. Only 30 countries had the data necessary for conducting our analysis. Supplementary Table S2 shows the countries/regions involved in the present analysis. Supplementary Tables S5 and S6 show the standardized scores of the country-level variables and the zero-order correlations between these variables respectively.

Climate change opinions. We measured climate change opinions in two ways. First, we identified a single-item measure that directly asked participants to report the extent to which they considered the rise in temperature caused by climate change to be dangerous for the

environment (1 = not dangerous at all to 5 = extremely dangerous). Second, we adopted Tranter and Booth's (2015) method to create a proxy measure of climate change skepticism. More specifically, we created a binary measure based on two items. The first item is the aforementioned single-item measure on the danger of rise in temperature to the environment. The second item is the extent to which participants considered the claims about environmental threats were exaggerated (1 = agree strongly to 5 = disagree strongly). We coded participants as climate change skeptics if they reported a score of two or below for both questions (see Tranter & Booth, 2015). This binary coding represents a joint condition of rejecting climate change threat and the veracity of environmental threats. Our findings remained consistent when an average score was used.

Political orientation. As noted earlier, political orientation was coded by ISSP researchers in each country on a 5-point scale (1 = far left to 5 = far right). A higher score represented a more right-leaned orientation. Supplementary Table S2 shows the distribution of political orientation in each country.

Country-level variables. We obtained the same individualism-collectivism and cultural looseness-tightness indexes as in Study 1. We obtained the 2009 data for the consumption factors (i.e., energy consumption per capita, fossil fuel consumption per capita, and carbon dioxide emission per capita), economic interest factors (i.e., fuel exports, total natural resource rent, the percentage of GDP produced in industry, the percentage of employment in the industrial sector) and national wealth (GDP per capita) from the same source (World Bank and Our World in Data). Same as Study 1, we created an overall score for fossil fuel consumption (*r*s ranged from 0.78 to 0.96) and economic values of fossil fuel production ($r = 0.62$).

3.2. Results

We conducted two sets of multilevel analyses following the same procedure as in Study 1. As climate skepticism was a binary outcome variable (skeptic = 1), we conducted multilevel logistic regression analyses. Political orientation (higher score = more right-leaned) was negatively related to climate change opinions, indicating that politically right-leaned individuals were less likely to consider climate change as

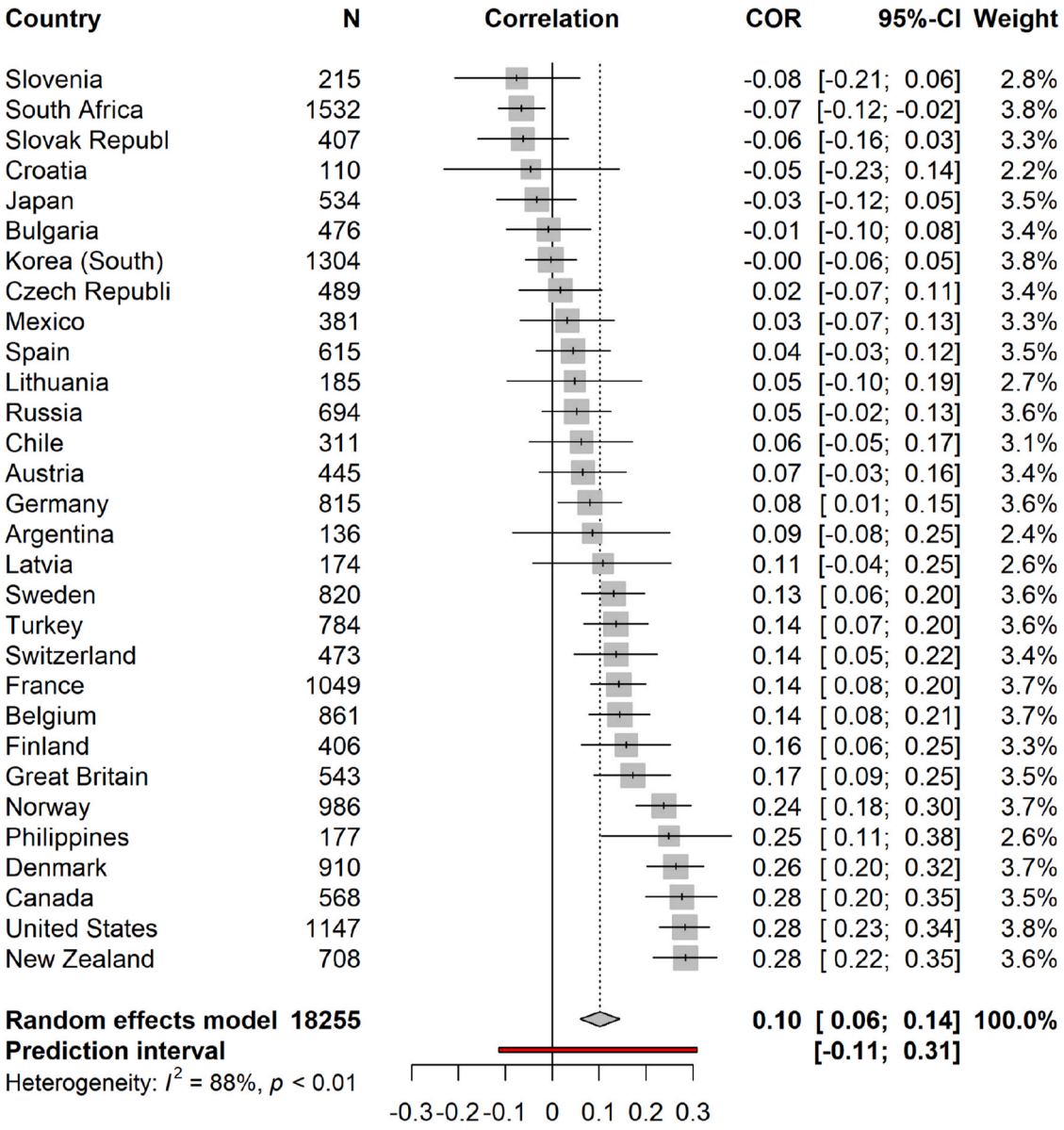

Fig. 2. Correlation between political orientation and climate change concern between countries (International Social Survey Programme Data; Study 2). Higher political orientation score = Left-leaned.

dangerous. Also, politically right-leaned individuals were more likely to be climate skeptics than were politically left-leaned individuals. The association between political orientation and climate change opinions also varied between societies (see Fig. 2). We presented the results of the multilevel models in Tables 2 and 3. Supplementary Figs. S3–S5 visualize the significant cross-level interaction effects. Supplementary Table S7 shows the results for the models that included each country-level predictor separately. Consistent with Study 1, when each set of factors was considered separately, individualism-collectivism and fossil fuel consumption were related to a stronger link between political orientation and climate change opinions. These findings support the self-expression hypothesis and also the consumption aspect of the fossil fuel

Table 2
Results of multilevel models with ISSP data and climate change concern as the outcome variable (Study 2).

DV: climate change concern	Cultural Model			Consumption Model			Economic Interest Model		
	b (SE)	*p*	95% *CI*	*b* (SE)	*p*	95% *CI*	*b* (SE)	*p*	95% *CI*
Individual-level covariates									
Gender	−.12 (.02)	.000	[-.15, −.09]	−.14 (.01)	.000	[-.17, −.11]	−.14 (.01)	.000	[-.17, −.11]
Age	.00 (.00)	.000	[.00, .00]	.00 (.00)	.000	[-.01, .00]	.00 (.00)	.000	[-.01, .00]
Education	.04 (.01)	.000	[.03, .05]	.04 (.01)	.000	[.03, .05]	.04 (.01)	.000	[.03, .05]
Income	.00 (.01)	.889	[-.02, .02]	.00 (.01)	.890	[-.02, .01]	.00 (.01)	.855	[-.02, .01]
Main effect									
Political orientation	−.10 (.02)	.000	[-.13, −.06]	−.11 (.02)	.000	[-.15, −.07]	−.12 (.02)	.000	[-.15, −.08]
Individualism-collectivism	−.24 (.05)	.000	[-.35, −.13]						
Cultural looseness-tightness	.04 (.04)	.367	[-.05, .13]						
Fossil fuel consumption				−.05 (.06)	.415	[-.16, .06]			
Economic values of fossil fuel production							−.06 (.05)	.275	[-.16, .05]
Percentage of GDP produced in industry							.10 (.06)	.063	[-.01, .21]
Employment in industrial sector							.00 (.05)	.949	[-.09, .09]
GDP per capita	−.02 (.06)	.773	[-.13, .09]	−.14 (.06)	.029	[-.26, −.01]	−.14 (.05)	.005	[-.24, −.04]
Interaction effect: Political orientation x									
Individualism-collectivism	−.12 (.02)	.000	[-.17, −.08]						
Cultural looseness-tightness	.02 (.02)	.190	[-.01, .06]						
Fossil fuel consumption				−.06 (.02)	.011	[-.11, −.01]			
Economic values of fossil fuel production							−.02 (.02)	.225	[-.06, .01]
Percentage of GDP produced in industry							.03 (.02)	.207	[-.01, .06]
Employment in industrial sector							.07 (.02)	.000	[.04, .10]
GDP per capita	.05 (.03)	.039	[.00, .10]	.01 (.03)	.625	[-.04, .07]	.00 (.02)	.968	[-.04, .04]
Intercept	3.87 (.04)	.000	[3.79, 3.94]	3.84 (.05)	.000	[3.74, 3.93]	3.84 (.05)	.000	[3.75, 3.93]

	Consumption vs. Economic Interest			Full model[a]		
	b (SE)	*p*	95% *CI*	*b* (SE)	*p*	95% *CI*
Individual-level covariates						
Gender	−.14 (.01)	.000	[-.17, −.11]	−.12 (.02)	.000	[-.16, −.09]
Age	.00 (.00)	.000	[-.01, .00]	.00 (.00)	.000	[.00, .00]
Education	.04 (.01)	.000	[.03, .05]	.04 (.01)	.000	[.03, .05]
Income	.00 (.01)	.866	[-.02, .01]	.00 (.01)	.906	[-.02, .02]
Main effect						
Political orientation	−.12 (.01)	.000	[-.15, −.09]	−.10 (.01)	.000	[-.12, −.09]
Individualism-collectivism				−.24 (.08)	.001	[-.39, −.09]
Cultural looseness-tightness				.03 (.05)	.467	[-.06, .13]
Fossil fuel consumption	−.05 (.06)	.386	[-.16, .06]	−.01 (.06)	.822	[-.12, .10]
Economic values of fossil fuel production	−.04 (.05)	.433	[-.15, .06]	.00 (.05)	1.000	[-.11, .11]
Percentage of GDP produced in industry	.10 (.06)	.059	[.00, .21]	.02 (.07)	.741	[-.11, .15]
Employment in industrial sector	.01 (.04)	.899	[-.08, .09]	−.04 (.04)	.306	[-.11, .04]
GDP per capita	−.10 (.07)	.123	[-.23, .03]	.00 (.08)	.955	[-.15, .16]
Interaction effect: Political orientation x						
Individualism-collectivism				−.09 (.02)	.000	[-.13, −.06]
Cultural looseness-tightness				.02 (.01)	.042	[.00, .04]
Fossil fuel consumption	−.06 (.02)	.000	[-.10, −.03]	−.05 (.01)	.000	[-.07, −.02]
Economic values of fossil fuel production	−.01 (.02)	.680	[-.04, .02]	.01 (.01)	.592	[-.02, .03]
Percentage of GDP produced in industry	.03 (.02)	.093	[.00, .06]	.01 (.02)	.697	[-.02, .04]
Employment in industrial sector	.07 (.01)	.000	[.04, .10]	.06 (.01)	.000	[.04, .08]
GDP per capita	.04 (.02)	.030	[.00, .08]	.08 (.02)	.000	[.05, .12]
Intercept	3.83 (.05)	.000	[3.75, 3.92]	3.87 (.04)	.000	[3.80, 3.95]

Note.
[a] The covariance of the random intercept and slope has set to be independent; model did not converge when the covariance was freely estimated. The estimation needs to be interpreted with caution. South Africa was excluded from the above analyses, given that there was small variation in the political orientation (see Supplementary Table S2). Our findings remained consistent when South Africa was included.

Table 3
Results of multilevel models with ISSP data and climate skepticism as the outcome variable (Study 2).

DV: climate skepticism (1 = skeptic)	Cultural Model			Consumption Model			Economic Interest Model		
	b (SE)	*p*	95% *CI*	*b* (SE)	*p*	95% *CI*	*b* (SE)	*p*	95% *CI*
Individual-level covariates									
Gender	.72 (.07)	.000	[.58, .87]	.72 (.07)	.000	[.59, .85]	.72 (.07)	.000	[.59, .85]
Age	.01 (.00)	.002	[.00, .01]	.01 (.00)	.000	[.00, .01]	.01 (.00)	.000	[.00, .01]
Education	−.06 (.03)	.040	[-.12, .00]	−.06 (.02)	.013	[-.11, −.01]	−.06 (.02)	.015	[-.11, −.01]
Income	−.05 (.04)	.233	[-.13, .03]	−.04 (.04)	.223	[-.11, .03]	−.04 (.04)	.263	[-.11, .03]
Main effect									
Political orientation	.23 (.06)	.000	[.11, .35]	.24 (.07)	.000	[.11, .37]	.26 (.06)	.000	[.13, .38]
Individualism-collectivism	.82 (.14)	.000	[.53, 1.10]						
Cultural looseness-tightness	−.23 (.12)	.053	[-.45, .00]						
Fossil fuel consumption				.09 (.17)	.609	[-.25, .43]			
Economic values of fossil fuel production							.07 (.16)	.685	[-.25, .38]
Percentage of GDP produced in industry							−.21 (.17)	.217	[-.55, .13]
Employment in industrial sector							−.12 (.14)	.395	[-.40, .16]
GDP per capita	−.09 (.15)	.566	[-.39, .21]	.29 (.20)	.134	[-.09, .68]	.26 (.16)	.092	[-.04, .57]
Interaction effect: Political orientation x									
Individualism-collectivism	.26 (.08)	.001	[.11, .42]						
Cultural looseness-tightness	−.04 (.06)	.560	[-.16, .09]						
Fossil fuel consumption				.15 (.06)	.017	[.03, .27]			
Economic values of fossil fuel production							.05 (.07)	.424	[-.08, .18]
Percentage of GDP produced in industry							−.06 (.07)	.368	[-.19, .07]
Employment in industrial sector							−.17 (.06)	.009	[-.29, −.04]
GDP per capita	.05 (.10)	.622	[-.14, .24]	.12 (.08)	.127	[-.03, .27]	.13 (.07)	.059	[-.01, .26]
Intercept	−3.65 (.11)	.000	[-3.87, −3.43]	−3.55 (.16)	.000	[-3.86, −3.24]	−3.54 (.15)	.000	[-3.83, −3.25]

(Continued)	Consumption vs. Economic Interest			Full model		
	b (SE)	*p*	95% *CI*	*b* (SE)	*p*	95% *CI*
Individual-level covariates						
Gender	.72 (.07)	.000	[.59, .85]	.72 (.07)	.000	[.58, .87]
Age	.01 (.00)	.000	[.00, .01]	.01 (.00)	.003	[.00, .01]
Education	−.06 (.02)	.015	[-.11, −.01]	−.06 (.03)	.045	[-.12, .00]
Income	−.04 (.04)	.244	[-.11, .03]	−.05 (.04)	.236	[-.13, .03]
Main effect						
Political orientation	.25 (.05)	.000	[.14, .36]	.25 (.06)	.000	[.14, .37]
Individualism-collectivism				1.00 (.19)	.000	[.63, 1.38]
Cultural looseness-tightness				−.23 (.12)	.045	[-.46, .00]
Fossil fuel consumption	.11 (.17)	.539	[-.23, .44]	−.16 (.13)	.226	[-.42, .10]
Economic values of fossil fuel production	.03 (.17)	.854	[-.30, .36]	−.05 (.14)	.716	[-.32, .22]
Percentage of GDP produced in industry	−.22 (.17)	.207	[-.55, .12]	.24 (.17)	.168	[-.10, .58]
Employment in industrial sector	−.13 (.14)	.362	[-.41, .15]	−.01 (.10)	.877	[-.20, .17]
GDP per capita	.18 (.20)	.383	[-.22, .57]	.03 (.20)	.897	[-.36, .41]
Interaction effect: Political orientation x						
Individualism-collectivism				.26 (.09)	.004	[.08, .44]
Cultural looseness-tightness				−.02 (.05)	.723	[-.11, .08]
Fossil fuel consumption	.19 (.05)	.000	[.09, .28]	.09 (.06)	.091	[-.01, .20]
Economic values of fossil fuel production	.01 (.06)	.830	[-.10, .12]	.01 (.08)	.945	[-.14, .15]
Percentage of GDP produced in industry	−.06 (.05)	.234	[-.17, .04]	.11 (.08)	.208	[-.06, .27]
Employment in industrial sector	−.17 (.05)	.001	[-.28, −.07]	−.18 (.05)	.001	[-.28, −.07]
GDP per capita	.02 (.07)	.808	[-.11, .14]	−.01 (.09)	.954	[-.18, .17]
Intercept	−3.53 (.15)	.000	[-3.82, −3.24]	−3.66 (.11)	.000	[-3.88, −3.45]

Note. South Africa was excluded from the above analyses, given that there was small variation in the political orientation. Our findings remained consistent when South Africa was included.

reliance hypothesis. Unexpectedly, among the economic interest variable, employment in the industrial sector was related to a weaker link between political orientation and climate change opinions. These findings remained consistent when we included both consumption and economic interest factors simultaneously. Altogether, we only found evidence that supports the consumption but not the economic interest aspect of the fossil fuel reliance hypothesis.

4. Study 3 (within-country analysis)

Findings of Study 1 and Study 2 evidenced the cross-national variation of the political divide in climate change opinions. More importantly, we found that individualism-collectivism and fossil fuel consumption predicted this variation. In Study 3, we aimed at extending our investigation to the cross-regional variation of the political divide within the United States.

4.1. Methods

We obtained the data from the Partisan Climate Opinion Map (Mildenberger et al., 2017). Mildenberger et al. (2017) generated this opinion map based on a pooled dataset of 15 climate change opinion surveys conducted between 2008 and 2016. All these surveys involved a nationally representative sample in the U.S. We obtained the state-level data, which contained the information on the percentage of the agreement to a series of climate change questions by Democrats (versus Republicans) in each state.

Climate change opinions. Climate change opinions were measured in four items that reflect climate change beliefs and concern. These items captured the happening of climate change ("Do you think the global warming is happening"), the human causes of it ("Assuming global warming is happening, do you think it is caused mostly by human activities"), the scientific consensus about its happening ("Most scientists think global warming is happening"), and climate change concern ("How worried are you about global warming"). The opinion map provided data on the percentage of agreement or worriedness for each state. We computed the political divide by subtracting the score of republicans from the score of democrats.

State-level predictors. We obtained the state-level individualism-collectivism index from Vandello and Cohen (1999) and the state-level cultural looseness-tightness index from Harrington and Gelfand (2014)[1]. Previous studies have demonstrated the validity of these state-level cultural factors in understanding the state-level differences in attitudes and behaviors (e.g., Harrington & Gelfand, 2014; Lu et al., 2021). We identified the total fossil fuel-based energy consumption per capita and carbon dioxide emission per capita as the proxies for measuring fossil fuel consumption at the state-level. Lastly, we identified the total fossil fuel production as the proxy for measuring economic interest, with the assumption that a higher amount of fossil fuel production reflects a stronger economic interest in fossil fuels. All the state-level energy and emission data were obtained from the U.S. Energy Information Administration. We included per capita GDP as the state-level covariate, in which we obtained the data from the U.S. Bureau of Economic Analysis.

4.2. Results

We conducted a series of multiple regression analyses to test our hypotheses. In each analysis, we included the differences in the state-level percentage of agreement/worriedness to each climate change opinions item as the outcome variable, and the state-level individualism-collectivism, cultural looseness-tightness, fossil fuel-based energy consumption, carbon dioxide emission, and fossil fuel production as the predictor variables. For all analyses, we included state-level per capita GDP as the covariate variable. Table 4 shows the results. As expected, individualism-collectivism and cultural looseness-tightness were positive and significant predictors of the state-level political differences in climate change opinions, indicating a larger political divide among states with higher levels of individualism and cultural looseness. Unexpectedly, fossil fuel-based energy consumption and carbon dioxide emission were negatively related to the state-level political differences in climate change opinions (except for the happening of climate change), indicating a smaller political divide among states with higher levels of fossil fuel consumption. Lastly, the production of fossil fuels was a positive and significant predictor, indicating a larger political divide in climate change opinions among states with a larger amount of fossil fuel production.

We conducted a follow-up exploratory analysis to examine the correlation between the state-level climate change opinions and the three sets of predictors for Democrats and Republicans separately. Table 5 shows the results. We found that higher state-level individualism was related to lower state-level pro-climate change opinions among Republicans and higher cultural looseness was related to higher state-level

Table 4
Results of multiple regression analyses with state-level data (Study 3).

Political difference in	Happening of climate change				Human-caused of climate change				Perceived scientific consensus				Worried about climate change				Harm people in US			
	b (SE)	Beta	*p*-value	95% *CI*	*b* (SE)	Beta	*p*-value	95% *CI*	*b* (SE)	Beta	*p*-value	95% *CI*	*b* (SE)	Beta	*p*-value	95% *CI*	*b* (SE)	Beta	*p*-value	95% *CI*
Intercept	31.44 (.40)		.000	[30.64, 32.24]	33.81 (.51)		.000	[32.77, 34.85]	30.37 (.51)		.000	[29.34, 31.39]	40.74 (.61)		.000	[39.51, 41.97]	35.42 (.43)		.000	[34.56, 36.28]
Individualism-collectivism	1.40 (.43)	.39	.002	[.53, 2.26]	1.32 (.56)	.22	.023	[.19, 2.45]	1.75 (.55)	.29	.003	[.64, 2.86]	1.54 (.66)	.26	.024	[.21, 2.88]	1.22 (.46)	.28	.012	[.28, 2.15]
Cultural looseness-tightness	1.70 (.56)	.48	.004	[.57, 2.82]	3.09 (.72)	.52	.000	[1.64, 4.55]	2.92 (.71)	.48	.000	[1.48, 4.35]	3.03 (.86)	.51	.001	[1.30, 4.75]	.82 (.60)	.19	.177	[-.39, 2.03]
Fossil fuel based energy consumption	.15 (.50)	.04	.765	[-.85, 1.15]	−2.57 (.64)	−.43	.000	[-3.86, −1.27]	−2.28 (.64)	−.38	.001	[-3.55, −1.00]	.32 (.76)	.05	.674	[-1.21, 1.86]	−2.67 (.53)	−.62	.000	[-3.74, −1.59]
CO_2 emission	−.55 (.49)	−.16	.261	[-1.53, .43]	−1.28 (.63)	−.22	.048	[-2.55, −.01]	−1.59 (.62)	−.26	.014	[-2.85, −.34]	−2.14 (.75)	−.36	.006	[-3.64, −.63]	−1.11 (.52)	−.26	.040	[-2.16, −.05]
Production of fossil fuel	.71 (.49)	.20	.155	[-.28, 1.70]	1.97 (.64)	.33	.003	[.69, 3.25]	1.47 (.63)	.24	.024	[.20, 2.73]	2.00 (.75)	.34	.011	[.48, 3.52]	1.17 (.53)	.27	.032	[.10, 2.23]
GDP per capita	−.64 (.51)	−.18	.217	[-1.67, .39]	.20 (.66)	.03	.763	[-1.14, 1.54]	.39 (.65)	.07	.551	[-.93, 1.71]	−.75 (.79)	−.13	.348	[-2.33, .84]	.49 (.55)	.11	.383	[-.63, 1.60]
Adjusted R^2	.380				.672				.650				.474				.507			

Note. All predictor variables were standardized at the state-level to facilitate the interpretation of the coefficient.

Table 5
Results of multiple regression analysis with state-level data by partisanship.

State-level:	Happening of climate change				Human-caused of climate change				Perceived scientific consensus				Worried about climate change				Harm people in US			
	b (SE)	Beta	*p*-value	95% *CI*	*b* (SE)	Beta	*p*-value	95% *CI*	*b* (SE)	Beta	*p*-value	95% *CI*	*b* (SE)	Beta	*p*-value	95% *CI*	*b* (SE)	Beta	*p*-value	95% *CI*
Panel A: Republican																				
Intercept	50.29 (.35)		.000	[49.58, 51.00]	30.93 (.34)		.000	[30.25, 31.60]	33.14 (.28)		.000	[32.57, 33.72]	32.38 (.32)		.000	[31.73, 33.03]	36.22 (.28)		.000	[35.66, 36.79]
Individualism-collectivism	−1.18 (.38)	−.34	.003	[-1.96, −.41]	−1.25 (.37)	−.45	.001	[-1.99, −.51]	−1.30 (.31)	−.45	.000	[-1.92, −.68]	−1.37 (.35)	−.42	.000	[-2.07, −.67]	−1.24 (.31)	−.46	.000	[-1.86, −.63]
Cultural looseness-tightness	1.50 (.49)	.43	.004	[.51, 2.50]	.32 (.47)	.12	.505	[-.64, 1.27]	1.28 (.40)	.44	.002	[.48, 2.08]	1.44 (.45)	.45	.003	[.53, 2.35]	1.66 (.39)	.61	.000	[.86, 2.45]
Fossil fuel based energy consumption	−.61 (.44)	−.18	.173	[-1.50, .28]	.29 (.42)	.10	.501	[-.56, 1.13]	−.25 (.35)	−.08	.491	[-.96, .47]	−.37 (.40)	−.11	.368	[-1.17, .44]	.41 (.35)	.15	.244	[-.29, 1.12]
CO_2 emission	.32 (.43)	.09	.458	[-.55, 1.19]	.23 (.41)	.08	.580	[-.60, 1.06]	.17 (.35)	.06	.636	[-.53, .86]	.42 (.39)	.13	.286	[-.37, 1.22]	.31 (.34)	.12	.368	[-.38, 1.01]
Production of fossil fuel	−.03 (.43)	−.01	.945	[-.91, .85]	−.35 (.42)	−.13	.408	[-1.19, .49]	−.14 (.35)	−.05	.694	[-.84, .57]	−.17 (.40)	−.05	.671	[-.97, .63]	.08 (.35)	.03	.821	[-.62, .78]
GDP per capita	1.34 (.45)	.38	.005	[.42, 2.25]	.99 (.43)	.36	.028	[.12, 1.87]	1.13 (.36)	.39	.003	[.39, 1.86]	1.15 (.41)	.36	.008	[.31, 1.98]	.49 (.36)	.18	.181	[-.24, 1.22]
Adjusted R^2	.487				.251				.532				.505				.462			
Panel B: Democrat																				
Intercept	81.73 (.34)		.000	[81.03, 82.42]	64.74 (.52)		.000	[63.69, 65.78]	63.51 (.47)		.000	[62.55, 64.47]	73.13 (.61)		.000	[71.90, 74.35]	71.65 (.33)		.000	[70.98, 72.31]
Individualism-collectivism	.21 (.37)	.05	.577	[-.54, .96]	.07 (.56)	.01	.899	[-1.07, 1.21]	.45 (.52)	.06	.390	[-.59, 1.49]	.17 (.66)	.03	.794	[-1.16, 1.51]	−.02 (.36)	−.01	.949	[-.75, .70]
Cultural looseness-tightness	3.20 (.48)	.74	.000	[2.22, 4.17]	3.41 (.73)	.56	.000	[1.94, 4.88]	4.20 (.67)	.60	.000	[2.85, 5.54]	4.47 (.86)	.68	.000	[2.74, 6.19]	2.48 (.46)	.55	.000	[1.55, 3.42]
Fossil fuel based energy consumption	−.46 (.43)	−.11	.290	[-1.33, .41]	−2.28 (.65)	−.38	.001	[-3.59, −.97]	−2.52 (.59)	−.36	.000	[-3.72, −1.33]	−.04 (.76)	−.01	.956	[-1.58, 1.49]	−2.25 (.41)	−.50	.000	[-3.08, −1.42]
CO_2 emission	−.23 (.42)	−.05	.590	[-1.08, .62]	−1.05 (.64)	−.17	.106	[-2.33, .23]	−1.43 (.58)	−.20	.018	[-2.60, −.26]	−1.71 (.75)	−.26	.026	[-3.22, −.21]	−.79 (.40)	−.17	.056	[-1.61, .02]
Production of fossil fuel	.68 (.43)	.16	.118	[-.18, 1.54]	1.63 (.64)	.27	.015	[.33, 2.92]	1.33 (.59)	.19	.029	[.15, 2.51]	1.83 (.75)	.28	.019	[.32, 3.35]	1.25 (.41)	.27	.004	[.42, 2.07]
GDP per capita	.70 (.44)	.16	.123	[-.20, 1.59]	1.19 (.67)	.20	.082	[-.16, 2.54]	1.52 (.61)	.22	.017	[.29, 2.75]	.40 (.79)	.06	.612	[-1.18, 1.99]	.98 (.43)	.22	.027	[.12, 1.84]
Adjusted R^2	.685				.632				.770				.573				.736			

Note. All predictor variables were standardized at the state-level to facilitate the interpretation of the coefficient.

pro-climate change opinions among both Republicans and Democrats. Importantly, the two consumption factors were negatively related to state-level climate change opinions among Democrats only. Fossil fuel production was positively related to state-level climate change opinions among Democrats only. These findings suggest the possibility that the smaller (larger) state-level political divide was owing to the lower (higher) levels of state-level climate change opinions among Democrats in states with higher levels of fossil fuel consumption (production). It appears that the less positive state-level climate change opinions among Republicans were unrelated to the consumption and production of fossil fuels. Overall, our findings support the self-expression hypothesis. We observed mixed findings for the fossil fuel reliance hypothesis and these findings were inconsistent with Studies 1 and 2.

5. General discussion

The purpose of this research is to investigate how the strength of the political divide in climate change opinions varies across sociocultural contexts. Consistent with previous studies (e.g., Hornsey et al., 2018), we observed that the link between political orientation and climate change opinions varied between societies and between states within the U.S. Importantly, we found that such variations were related to cultural factors and fossil fuel consumption. Cross-nationally, we found consistent evidence that the political divide in climate change opinions was more pronounced in societies with higher levels of individualism and fossil fuel consumption. Within the U.S., we also found a stronger political divide in state-level climate change opinions among states with higher levels of individualism, cultural looseness, and fossil fuel production. Overall, these findings echo the recent call for cultural and socio-ecological factors in understanding the relationship between personal factors and pro-environmental orientations (including environmental concern and behavior) (e.g., Chan, 2020; Chan & Tam, 2021; Eom et al., 2016; for a review, see Tam & Milfont, 2020). We put forward that understanding the political divide in climate change opinions must take into account the influences of cultural and socio-ecological factors. Furthermore, as we observed both similarities and differences between the two levels of analysis, our findings suggest the need to consider how these factors modulate the influence of political orientation on climate change opinions both between regions within a country and between countries.

Previous studies have proposed two explanations for the cross-national variation of the political divide in climate change opinions. First, the weak or negligible association between political orientation and climate change opinions can be seen as a lack of political salience in the climate change discourse in some countries (e.g., Eastern European countries; see McCright et al., 2016). Second, Hornsey et al. (2018) suggested that this variation is attributable to the vested economic and political interests associated with fossil fuel. Climate change mitigation essentially dampens these interests. As a reactance, corporations and politicians organize campaigns and fund research studies that criticize the happening and human causes of climate change (e.g., the George C. Marshall Institute; Oreskes & Conway, 2008). Consequently, it makes the political debate more salient in a country.

We directly tested this fossil fuel reliance hypothesis by using indices of fossil fuel consumption and economic interests associated with fossil fuel consumption and production. By delineating the influence of fossil fuel consumption with the economic interests associated with fossil fuel reliance, the present research provides a more nuanced understanding of how fossil fuel reliance relates to the political divide in climate change opinions. Our findings suggest that fossil fuel consumption is a more robust predictor of the cross-national variation in the political divide than its associated economic interests in fossil fuel production and the industrial sector. These findings imply the possibility that the political divide in climate change opinion is fuelled by the aversion to changing lifestyles and energy sources. Indeed, if a country has a strong reliance on fossil fuels as the primary energy source, transiting to renewable and greener energy requires drastic changes in energy infrastructures and policies, and even has negative impacts on the landscape and people's lifestyle (Ekins, 2004). Such changes may thus represent a system threat to politically right/conservative people, leading to less supportive climate change opinions.

We also proposed a third account for explaining the cross-national variation – the self-expression hypothesis. We contend that the guidance function of values and ideologies underlying political orientation becomes more relevant to people's environmental attitudes when the societal culture emphasizes self-expression. We found supporting evidence to this account across the two cross-national studies (Studies 1 and 2) and also the within-country study (Study 3). Interestingly, we observed that among societies with higher levels of collectivism, both politically left and right was equally concerned about and believed in climate change (see Supplementary Figs. S1 and S3). This observation is consistent with the self-expression hypothesis that the influence of political orientation would be smaller when social norms guide the formation of social attitudes. Accordingly, both politically left-leaned and right-leaned individuals showed similar levels of climate change concern and beliefs. Indeed, we also observed that on average, higher collectivism was also related to higher levels of climate change concern and beliefs, suggesting that a pro-climate change opinion is probably more normative in societies with high collectivism.

There are two unexpected findings. First, within the U.S., state-level fossil fuel production was negatively and fossil fuel consumption was positively related to the state-level political divide in climate change opinions. Our follow-up exploratory analyses revealed that at the state-level, the variation of the political divide was related to the differences in the state-level climate change opinions among Democrats in states with different levels of fossil fuel consumption and production. The state-level climate change opinions were unrelated to fossil fuel reliance among Republicans. We speculate that within the U.S., the skeptical view of climate change is deeply ingrained in the political discourse among Republicans. Republicans in different states may have similar exposure to climate change information, regardless of the levels of fossil fuel reliance in each state. Consequently, the state-level fossil fuel consumption and production may not have an additional effect on the aggregated state-level climate change opinions among Republicans. Our findings may reflect that Democrats are more sensitive to the consumption and production of fossil fuels within their states. We speculate that people may develop an aversion to climate change when they need to make substantial changes in their daily life to largely reduce fossil fuel consumption and carbon emissions. Consequently, on average, people are more likely to dismiss the severity and human cause of climate change in states with higher levels of fossil fuel consumption. Democrats living in these states may either be influenced by such an aversion or the dismissive social norms of climate change. Nevertheless, it is crucial to note that the observations and speculations are based on state-level analysis rather than individual-level or cross-level analysis. We are thus cautioned not to over-interpreting or over-generalizing these patterns to individual-level process. Future studies are needed to examine how fossil fuel reliance would influence Democrats' and Republicans' climate change opinions with both individual-level and state-level data.

Second, in Study 2, we observed a weaker link between political orientation and climate change opinions among societies with a higher percentage of employment in the industrial sector. This observation is inconsistent with the fossil fuel reliance hypothesis. We did not replicate this finding with other indicators of the economic values associated with fossil fuel reliance and in Study 1. Accordingly, we believe that this pattern of findings should be interpreted with caution. Although the employment in the industrial sector reflects the economic values generated from fossil fuel reliance (Huh & Kim, 2021), it may also capture the employment created by green technologies and industries (e.g., bioenergy; Berndes & Hansson, 2007). It is therefore critical for future studies to replicate these findings with indicators that can capture different aspects of economic values associated with fossil fuel reliance.

The present investigation has several limitations. First, as we adopted a cross-sectional correlational design, our findings did not provide evidence of the causal influence of the socio-cultural contexts. Future studies would benefit from conducting laboratory experiments that can simulate the influence of the socio-ecological contexts in determining the political orientation-climate change opinions link. Relatedly, although we have selected the most relevant factors (i.e., individualism-collectivism and cultural looseness-tightness) in capturing the cultural emphasis on self-expression, it should be noted that these factors could bear psychological meanings other than such an emphasis. Given that our findings are cross-sectional and correlational, we are unable to ascertain that our findings can only be interpreted through the notion of self-expression emphasis. To rule out alternative explanations, again, future studies would benefit from using an experimental design in which the salience (versus inhibition) of the cultural emphasis on self-expression is directly manipulated. Second, the operationalization of climate change opinions differed between the three studies. The differences observed between the studies could be related to the differences in the level of analysis (countries versus states) and the differences in the operationalization of climate change opinions. Lastly, in Studies 1 and 2, we measured political orientation with a 5-point left-right measure, which might be less sensitive to detect the variability of the leftist versus rightist political orientations. Despite this, our findings are still consistent with Hornsey et al. (2018), in which the authors used a 9-point scale to measure the left-right and liberal-conservative political orientation. Future studies would benefit from using a more sensitive measure to capture the variability of political orientation cross-nationally.

Endnote

1. We acknowledge the possibility that the level of individualism-collectivism might have changed with the socio-political changes over time, as this index has not been updated since its first publication in 1999. Yet, recent studies have demonstrated that this index is still a useful predictor of human behaviors at the state-level (e.g., social comparison emotion search on Google: Baldwin & Mussweiler, 2018; state-level mask wearing behavior during the COVID-19 pandemic: Lu et al., 2021) and individual-level (mask wearing behavior: Kemmelmeier & Jami, 2021) at more recent times. We thus deemed this index appropriate as an indicator of state-level individualism-collectivism.

Author attribution

Hoi-Wing Chan: Conceptualization, Methodology, Formal analysis, Investigation, Writing – Original draft preparation. Kim-Pong Tam: Conceptualization, Investigation, Writing – Reviewing and Editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2023.101992.

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