

Investigating climate change-related perceptions that hinder stakeholders' willingness to protect the ocean

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Abstract:

While community and stakeholder support for marine and coastal ecosystem conservation policies is important, there is a shortage of multinational studies examining how perceptions of climate change impact stakeholders' willingness to protect the ocean. Therefore, this study, employing Mindsponge theory and Bayesian Mindsponge Framework analytics, examines which climate change-related perceptions can hinder the willingness to support marine protection efforts, addressing a gap in existing literature. Our findings reveal that perceived high socio-economic costs for climate change mitigation (i.e., society is doing too much to address climate change and responses to climate change can damage the country's economy) and high potential of technologies in addressing climate change (i.e., new technologies can solve climate change) can hinder stakeholders' willingness to support ocean protection actions. Based on these results, we suggest a comprehensive strategy supporting climate change mitigation, marine conservation, and socio-economic growth simultaneously. The study also highlights the danger of exceptionalism, which refers to the risky tendency of relying too heavily on technology to solve environmental challenges, posing a significant risk to both climate change mitigation and marine protection efforts. We propose fostering collaborative partnerships, incorporating indigenous knowledge, and promoting ecocentrism to ensure globally informed, locally relevant, and impactful marine conservation.

Keywords: Bayesian Mindsponge Framework analysis framework, environmental policy, exceptionalism, marine and coastal ecosystem, Mindsponge theory, stakeholder support.

Classification numbers: 4.1, 7

1. Introduction

The unsustainable exploitation of marine resources, driven by population growth, has raised significant concerns about biodiversity and the overall health of marine ecosystems. These ecosystems, which have been important for human progress throughout history, are now facing unprecedented threats. Millions of people rely on marine resources for their livelihoods, as the sea is considered a rich source of food and contributes significantly to global food security [1]. However, overfishing, habitat loss, pollution, and the impacts of climate change are

among the numerous challenges threatening the marine environment [2]. For instance, the disturbance caused by local human activities leading to the loss of seagrass beds can result in altered sediment surfaces and the degradation of biogeochemical environments, exacerbating the impacts of climate change on coastal areas [3]. These impacts include ocean acidification, temperature fluctuations, and rising sea levels.

Over recent years, research attention has increasingly focused on public support for coastal and marine conservation. This highlights the critical role of diverse stakeholders, such as local communities,

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businesses, governments, NGOs, and scientists [4, 5]. Studies emphasise understanding various factors that shape community awareness and consciousness, thereby influencing support for marine and coastal conservation [2]. These factors include economic interests, cultural values, social norms, and personal experiences with the marine environment. Additionally, demographic characteristics such as age, education, and income significantly influence environmental attitudes, with younger and more educated individuals typically showing greater support for conservation initiatives [6]. Moreover, cultural and social influences, including traditions and community practices, play important roles in shaping attitudes towards marine conservation [7].

Recently, researchers have also hinted at the impacts of stakeholders' climate change-related perceptions on their support for marine conservation efforts. M.H. Nguyen, et al. (2023a) [8] showed that stakeholders who understood the benefits of preserving marine and coastal ecosystems for human well-being, climate, and weather were more likely to support policies focused on marine protection. Research conducted in Siacca, Italy, indicated that individuals' perceptions of climate change, their increased involvement in addressing the issue, and their heightened concerns about its potential impacts on marine fish resources are correlated with a greater willingness to financially support efforts aimed at mitigating climate change's effects on fish resources [9]. A. Galati, et al. (2021) [10] confirm a similar trend - coastal community members who demonstrate more positive attitudes towards climate change are more likely to financially support the protection of fish resources and the marine ecosystem. Additionally, the interactions between stakeholders' perceptions of the benefits of aquatic ecosystems, their knowledge, and their emotions about climate change also influence their support for marine protection initiatives [11].

However, limited research has focused on the specific negative impact of climate change-related perceptions on attitudes toward marine conservation. As socio-economic perceptions have been found to affect people's attitudes toward marine protection, it is expected that certain socio-economic perceptions related to climate change could hinder willingness to support marine protection. Additionally, technology-related perceptions can also be a potential factor hindering stakeholders' willingness to support marine

protection. In today's rapidly advancing technological context, there is a prevailing perception that innovation and technological solutions can adequately address environmental challenges [12]. This perspective is reinforced by the development of various green technologies, such as renewable energy sources, energy-efficient devices, and sustainable materials [13]. However, this perspective often overlooks the interconnected nature of environmental issues, where actions in one area can have widespread consequences in others [14]. Climate change presents a significant challenge that demands multifaceted solutions. While creativity, science, and technology are valuable tools in addressing climate change, they cannot be solely relied upon [15].

Protecting the ocean and its ecosystems is crucial because it plays a significant role in regulating the Earth's climate, absorbing carbon dioxide, and providing essential resources and services to humanity [16]. Acknowledging the ocean's crucial role not only enables the development of more effective strategies to combat climate change but also extends beyond reducing emissions and transitioning to renewable energy sources. This includes the conservation of marine habitats, addressing ocean acidification, and promoting sustainable fishing practices.

Failure to prioritise the protection of the ocean could have severe consequences, not only for marine life but also for the stability of the entire planet's climate system [17]. This highlights the need to examine whether the perception that technological innovation can address climate change can hinder stakeholders' willingness to support marine protection.

Although there has been an increase in research on public support for marine protection policies, some major research gaps still require attention. The impact of contextual factors on public support for coastal and marine conservation varies significantly across countries [18, 19]. Contextual differences encompass social, cultural, political, economic, and historical factors [20, 21]. If scientific results can be generalised to countries with different contexts, it could help make policies more effective and reduce research costs. Therefore, a cross-national study that identifies trends generalisable to countries with different contextual factors is needed [22]. Even when common trends cannot be found, multinational research efforts can assist in identifying contextual factors that may have differential effects across countries, thereby guiding

future research efforts. Understanding these factors allows policymakers and decision-makers to design more effective and targeted strategies that resonate with various stakeholder groups. This, in turn, can strengthen support and cultivate a stronger sense of connection and responsibility towards marine preservation. To address the gaps mentioned above, the current study aims to use the Mindsponge theory, which describes how people perceive and process information [23, 24], to address the following research questions:

Question 1: Does the perception of technology's benefits in addressing climate change (e.g., developing technology to help address climate change) reduce stakeholders' willingness to protect the ocean?

Question 2: Do perceptions of the socio-economic costs associated with combating climate change (e.g., the belief that responding to climate change will harm economies and societies already actively addressing the issue) reduce stakeholders' willingness to protect the ocean?

The research article is presented according to the following structure. First, the introduction clearly states the importance of the research problem in protecting ocean and coastal ecosystems and the research questions. Details of the Bayesian Mindsponge Framework analysis method, statistical model, and data specifics for 42 countries are described in Section 2. The results discussion and conclusions are then presented in sections 3, 4, and 5.

2. Research methodology

2.1. Theoretical basis and hypotheses

The Mindsponge theory is a psychological and social theory of the mind developed from mindsponge mechanisms and the most recent findings in biology, ecology, and neuroscience [23, 25]. This theory is based on an information-processing approach to studying the human mind. This approach views information as the foundation on which practice is constructed, allowing for the investigation of complex phenomena requiring multidisciplinary knowledge. Various studies have used this theory as a theoretical foundation to study social psychological phenomena, including environmental and conservation psychology [8, 26-31].

Mindsponge theory was chosen as the theoretical framework for this study because it can clarify the

interconnected components of our complex topic. Mindsponge theory provides a new information processing perspective that complements and clarifies existing theories and conceptual frameworks in psychology and sociology, e.g., The theory of planned behaviour [32]. In the context of this study, Mindsponge theory helps explain the factors that hinder stakeholders' willingness to protect the ocean.

Specifically, this theory views the mind and the environment as two main domains. The mind is considered an information-gathering and -processing system. At the same time, the environment is conceptually a larger and more encompassing information-processing system (e.g., Earth system, social system, etc.) that contains the human mind. The main goal of the mind is to prolong the system's existence in one way or another, such as through survival, growth, and reproduction. The mind consists of three main parts: mindset, a buffer zone (or comfort zone), and a multi-filtering system (Fig. 1). The mindset is defined as the collection of highly reliable information or core values in the human mind; the buffer zone is the conceptual space where information is temporarily stored before being reviewed and evaluated by the multi-filtering system.

Information integration and discrimination are two main functions of the multi-filter system. When sensory systems absorb information from the environment into the mind, the information is processed in two different ways. Absorbed information will be synthesised and absorbed into the mindset if it is consistent with core values (or highly reliable information) contained in the recipient's thinking. However, suppose the new information differs significantly from the core values or trusted information. In that case, the new information must undergo a rigorous review and evaluation process to determine the costs and benefits of accepting or rejecting the emerging information (or replacing the existing information with new information).

In general, in cases where new information is considered potentially beneficial, it will be accepted into the core of the mind and influence thinking, thereby further influencing filtering processes, thoughts, and subsequent behaviour. In cases where it is deemed inappropriate or costly, the information will be discarded. In cases where the perceived cost and benefit do not have a clear difference, it will be stored in a buffer and used for later evaluation when there is enough necessary information [24].

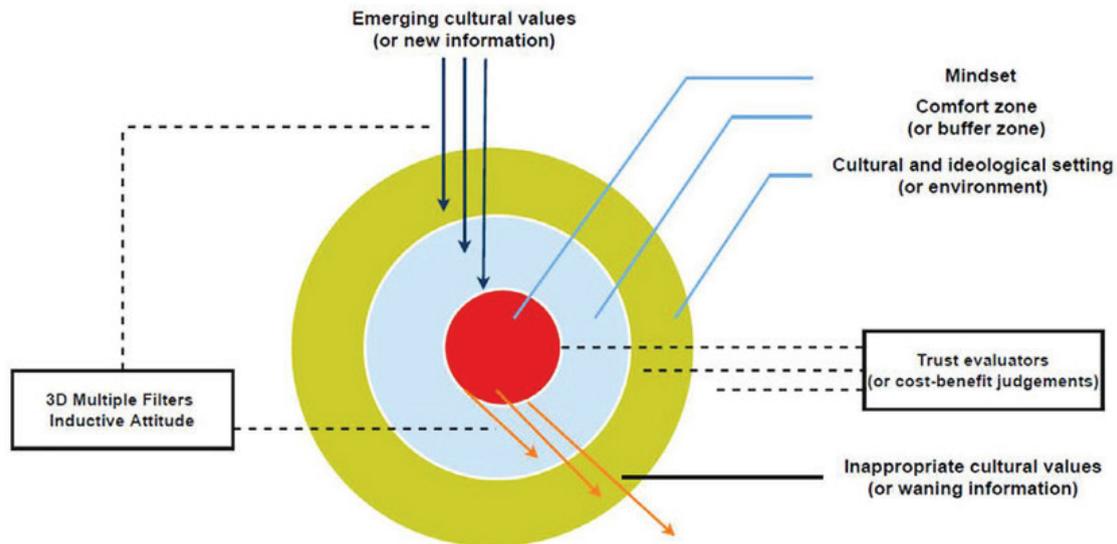


Fig. 1. Conceptual diagram of the mindsponge mechanism. Retrieved from M.H. Nguyen, et al. (2021) [33] under CC BY-SA 3.0.

Based on the information processing principles of Mindsponge theory, we assume that for individuals to be willing to protect the ocean, information related to marine protection must be absorbed into their mindset. However, for this information to be absorbed into the mindset, it must be evaluated by the mind as beneficial. If the mind, based on the information already present, deems the protection of the sea as costly, the relevant information may be limited in the absorption process or even eliminated from the mind.

To address the issue of climate change, nature conservation, including marine conservation, is considered one of the significant solutions, alongside technological development (e.g., clean energy, carbon capture technology, electrification, etc.). Therefore, if an individual's mind contains information that technological development will help solve the problem of climate change, other methods might be deemed less beneficial for addressing climate change. Therefore, they may be less inclined to seek and absorb information related to other solutions for climate change, including marine protection. Hence, we made the first hypothesis (H):

H1: Individuals who think new technology can be developed to solve adverse environmental changes will be less willing to protect the ocean.

In addition, protecting the ocean demands a great amount of time, effort, and resources (including money), but an individual's time, effort, and resources are finite. Therefore, even if individuals know the importance of combating climate change, they can only allocate a

portion of their time, effort, and resources to combat it. Suppose an individual's mind contains information that society is already making significant efforts to address the impacts of climate change. In that case, it will tend not to absorb and may eliminate information related to solutions to combat climate change, including marine protection, to save time, effort, and resources. Based on this, we made the second hypothesis:

H2: Individuals who believe that society is doing much to address the impacts of climate change will be less willing to protect the ocean.

Along with this logic, if individuals feel that actions to combat climate change require sacrificing or reducing current benefits (including economic benefits), their minds will tend to eliminate information related to solutions to combat climate change, including marine protection. Based on this, we made the third hypothesis:

H3: Individuals who believe that responses to climate change will harm the country's economy will be less willing to protect the ocean.

2.2. Model building

2.2.1. Variable selection and theoretical basis

The dataset used in the present study was a product of the MaCoBioS project (Biodiversity and Coastal Ecosystem Services in a Changing World), funded by the European Commission H2020. Data were collected through an online survey accessible on the Qualtrics internet platform from 16 November 2021,

to 16 February 2022. The questionnaire is available in English, French, Spanish, and Italian. The survey interface was adapted to the device used. The final dataset has a total of 709 respondents and is stored on Mendeley Data as “Survey_Fonsecaetal_07122022.xlsx” [34].

The survey was designed for public stakeholders interested in marine and coastal ecosystems, climate change, and ecosystem management. The questionnaire included questions about attitudes, responses to climate change, socio-demographic information, and the importance of and threats to coasts, oceans, and animals. It was initially tested on a sample of 20 people. Most questions require a response, while demographic questions offer a “prefer not to answer” option. Participation was optional, and respondents were allowed to exit the survey and return later to complete it. Participant information is kept confidential, ensuring respondents’ IP addresses, location data, or contact information are not recorded.

Snowball sampling was applied to find a suitable target group for the survey due to the difficulty of accessing population groups related to marine and coastal ecosystems, climate change, and ecosystem management [35]. Specifically, the survey was widely shared on MaCoBioS’s social media pages (i.e., Twitter and Instagram). Furthermore, the surveyors also contacted 105 organisations involved in conservation, tourism/recreation, and fishing/seafood in multiple countries (e.g., UK, Norway, Ireland, France, Italy, Spain, Bonaire, Martinique, and Barbados) to ask them to share the survey with their members.

Furthermore, because the project aims to conduct a cross-national survey of coastal and marine communities’ perceptions of climate change, human impacts, and the values and management of marine and coastal ecosystems, it is not feasible to conduct other types of sampling (e.g., stratified or random sampling) due to the high costs involved [36]. Therefore, the sample collected is not representative but only has a reference value.

In the present study, we used four variables to build the model (one outcome variable and three predictor variables). The outcome variable is *ProtectOceans*, representing respondents’ willingness

to protect the ocean. The three predictor variables represent factors that potentially hinder support for coastal and marine ecosystem conservation: *TooMuchSocialEffort*, *TechasEnvironSolution*, and *NegativeImpactonEconomy*. A detailed description of these variables is presented in Table 1.

Table 1. Description of variables.

Variables	Description	Variable type	Variable level
<i>TooMuchSocialEffort</i>	Society is doing too much to address the impacts of climate change	Numerical	1. Strongly disagree 2. Disagree 3. Average 4. Agree 5. Strongly agree
<i>TechasEnvironSolution</i>	People do not need to worry about climate change as new technologies will be developed to help address adverse environmental changes	Numerical	1. Strongly disagree 2. Disagree 3. Average 4. Agree 5. Strongly agree
<i>NegativeImpactonEconomy</i>	Actions to respond to climate change will damage my country’s economy	Numerical	1. Strongly disagree 2. Disagree 3. Average 4. Agree 5. Strongly agree
<i>ProtectOceans</i>	I am willing to support actions to protect the ocean, even if it requires consuming less seafood and paying a higher price for it	Numerical	1. Strongly disagree 2. Disagree 3. Average 4. Agree 5. Strongly agree

2.2.2. Statistical model

To test our hypotheses about social, technical, and economic factors constraining stakeholders’ willingness to protect the ocean, we built the model as follows:

$$ProtectOceans \sim normal(\mu, \sigma) \tag{1.1}$$

$$\mu_i = \beta_0 + \beta_1 * TooMuchSocialEffort_i + \beta_2 * TechasEnvironSolution_i + \beta_3 * NegativeImpactonEconomy_i \tag{1.2}$$

$$\beta \sim normal(M, S) \tag{1.3}$$

The probability around the mean value μ is represented by a normal distribution, whose width is determined by the standard deviation σ . μ_i is the willingness level of stakeholder i to protect the ocean; $TooMuchSocialEffort_i$ is stakeholder i ’s agreement

level that society is doing too much to address climate change; TechasEnvironSolution_i is i's agreement level that new technologies will be developed to help address adverse environmental changes; and NegativeImpactonEconomy_i is stakeholder i's agreement level that taking action to respond to climate change will cause damage to the country's economy.

Model 1 has five parameters: the intercept β_0 , the coefficients β_1 - β_3 , and the standard deviation of "noise", σ . The coefficients of the predictor variables are distributed as a normal distribution around the mean denoted M with the standard deviation denoted S.

2.2.3. Analysis and validation

This research paper uses the Bayesian Mindsponge Framework method to analyse and test the proposed hypothesis based on the Mindsponge theory [24, 37]. The Bayesian Mindsponge Framework method is used for several reasons.

First, the method combines the theoretical reasoning power of Mindsponge theory and the inferential advantages of Bayesian analysis because both are highly compatible in nature [37].

Second, Bayesian inference evaluates all values probabilistically, allowing for reliable predictions with parsimonious models [38].

Third, Bayesian inference has several advantages over the frequentist approach; for example, it allows users to use credible intervals to interpret results instead of p-values. The reproducibility crisis is related to the variability of p-values [39].

Due to the exploratory nature of this study, uninformative priors were used to provide as little information as possible before estimation. Once the model was estimated, we used the Pareto smoothed importance sampling leave-one-out (PSIS-LOO) diagnosis to test the model's fit to the data [40, 41]. Specifically, the k-Pareto value in PSIS-LOO diagnosis is used to evaluate the model's fitness. Typically, a model is considered to fit the data when the k value is less than 0.5.

Before interpreting the estimated results, the convergence of the Markov chains must be checked. The convergence of the Markov chains can be tested using statistical values, such as the effective sample size (n_eff) and the Gelman-Rubin coefficient (Rhat), and diagnostic plots, such as the trace plots. The n_eff value represents the number of non-autocorrelated iterative samples generated during the stochastic

simulation. If the n_eff value is greater than 1000, we can consider the Markov chain to be convergent, and the effective samples are enough to support reliable inference [42]. The Rhat value—often called the potential scale reduction factor or the Gelman-Rubin shrinkage factor—is used to evaluate the convergence of a Markov chain [43]. If the Rhat value exceeds 1.1, the model does not converge. Typically, the model is considered convergent if Rhat=1.

The Bayesian analysis in this study was performed using the bayesvl package on R software. This package is chosen for its user-friendly interface, ease of use, and capacity to generate visually appealing and intuitive graphics [24, 44]. For the sake of research transparency and reducing research and reproducibility costs, we have stored all data and computer code on OSF.

3. Results

A detailed description of the surveyed respondents' characteristics is presented in Table 2.

Table 2. Socio-demographic description.

	Value	Frequency	Percentage(%)
Age	18-30 years old	216	30.47
	31-40 years old	185	26.1
	41-50 years old	133	18.76
	51-60 years old	105	14.81
	>60 years old	62	8.74
Gender	Female	360	50.78
	Male	336	47.39
Educational level	High/secondary school or equivalent	66	9.31
	Bachelor's degree (e.g., BA, BSc)	153	21.58
	Master's degree (e.g., MA, MSc, MRes, MEd)	291	41.05
	Doctorate (e.g., PhD)	172	24.26
Country's income level	Low income	5	0.71
	Low middle income	14	1.97
	Upper middle income	30	4.23
	High income	659	92.95

The participants surveyed, as detailed in Table 2, come from diverse backgrounds and engage in various activities such as tourism, recreation, conservation, management, scientific research, and food production, including fishing and seafood production. Their diversity encompasses multiple countries and cultural contexts, enriching the dataset by incorporating a wide range of perspectives and offering valuable insights into the multifaceted perspectives and

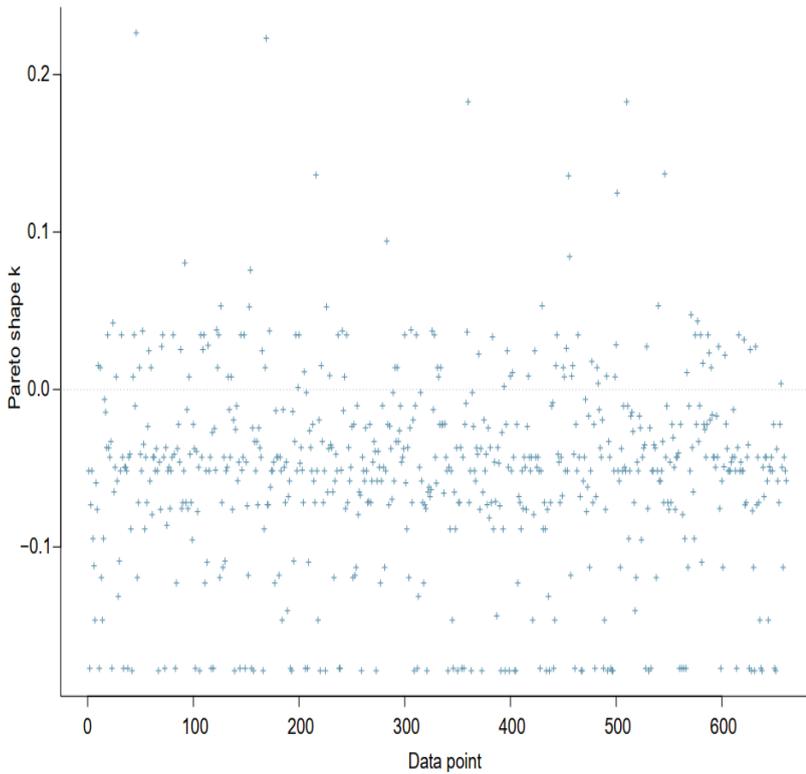


Fig. 2. Model 1's PSIS-LOO test.

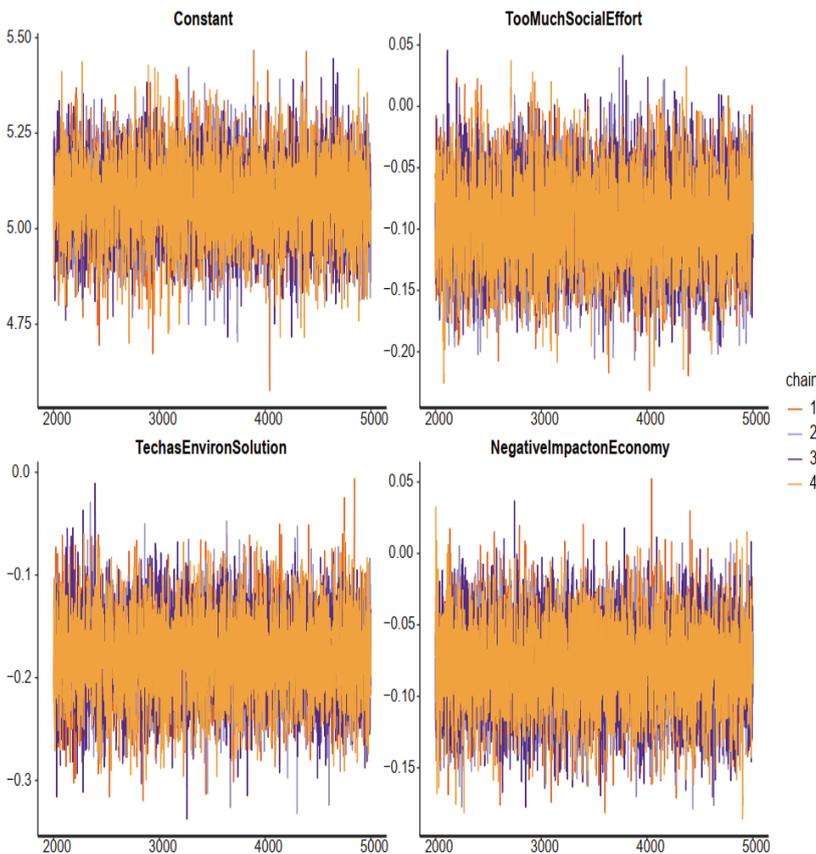


Fig. 3. Model 1's trace plot.

priorities concerning marine protection efforts. Out of the 709 stakeholders who participated in the survey, the majority (92.95%) were from high-income countries, followed by stakeholders from upper-middle-income, lower-middle-income, and low-income countries, representing 4.23, 1.97, and 0.71%, respectively. Additionally, the age distribution among respondents includes a diverse range, with significant representation from younger demographics. Over 56% of respondents fell between the ages of 18 and 40, while 33.57% were aged between 41 and 60, and those older than 60 made up 8.74%. This diversity enables a thorough examination of generational attitudes towards marine conservation. Furthermore, the survey demonstrates gender balance, with substantial involvement from both men and women, ensuring inclusivity and comprehensive representation in data analysis. Specifically, females comprise 50.78%, while males account for 47.39%. Moreover, the educational attainment of respondents was notably high, with approximately two-thirds holding at least a master's degree. Only 9.31% of respondents reported having the highest level of education as high/secondary school or equivalent. This breadth of expertise is valuable for addressing marine conservation issues effectively.

Building on the detailed participant description, the results section continues with an assessment of Model 1's goodness of fit using the PSIS-LOO plot (Fig. 2), indicating a favourable fit between the model and the data, with all k values below 0.5.

The estimated results of Model 1 are shown in Table 2. The effective sample size ($n_{eff} > 1000$) and Gelman-Rubin shrinkage factor ($Rhat=1$) confirm the convergence of the Markov chain, enabling the interpretation of simulated posterior distributions of the model coefficients. Additionally, the healthy mixing of the Markov chain around the central equilibrium point, as illustrated in Fig. 3, also confirms the convergence.

Table 3. Estimated results of model 1.

Parameters	Mean	Standard deviation	n_eff	Rhat
Constant	5.07	0.10	6986	1
TooMuchSocialEffort	-0.09	0.04	7341	1
TechasEnvironSolution	-0.18	0.04	8639	1
NegativeImpactonEconomy	-0.08	0.03	8128	1

The estimated posterior distributions in Table 3 reveal negative associations between stakeholders' perceived high social and economic costs of addressing climate change and their willingness to support ocean protection ($M_{\text{TooMuchSocialEffort}} = -0.09$ and $S_{\text{TooMuchSocialEffort}} = 0.04$; $M_{\text{NegativeImpactonEconomy}} = -0.08$ and $S_{\text{NegativeImpactonEconomy}} = 0.03$). The negative association between the perceived benefits of technology in addressing climate change and the willingness to support ocean protection is also discovered ($M_{\text{TechasEnvironSolution}} = -0.18$ and $S_{\text{TechasEnvironSolution}} = 0.04$).

Specifically, the results imply that individuals who agree more with the statements "society is doing much to address the impacts of climate change", "new technologies will be developed to help address adverse environmental changes", and "taking action on climate change will damage my country's economy" are less willing to protect the ocean.

Figure 4 visually illustrates the posterior distributions of Model 1's coefficients, validating the reliability of the negative associations of *TooMuchSocialEffort*, *TechasEnvironSolution*, and *NegativeImpactonEconomy* with *ProtectOceans*. Specifically, the dark blue lines of each coefficient, represent the 89% highest posterior density interval, lie entirely on the negative side of the horizontal axis. These illustrations suggest that *TooMuchSocialEffort*, *TechasEnvironSolution*, and *NegativeImpactonEconomy* have at least an 89% probability of being negative.

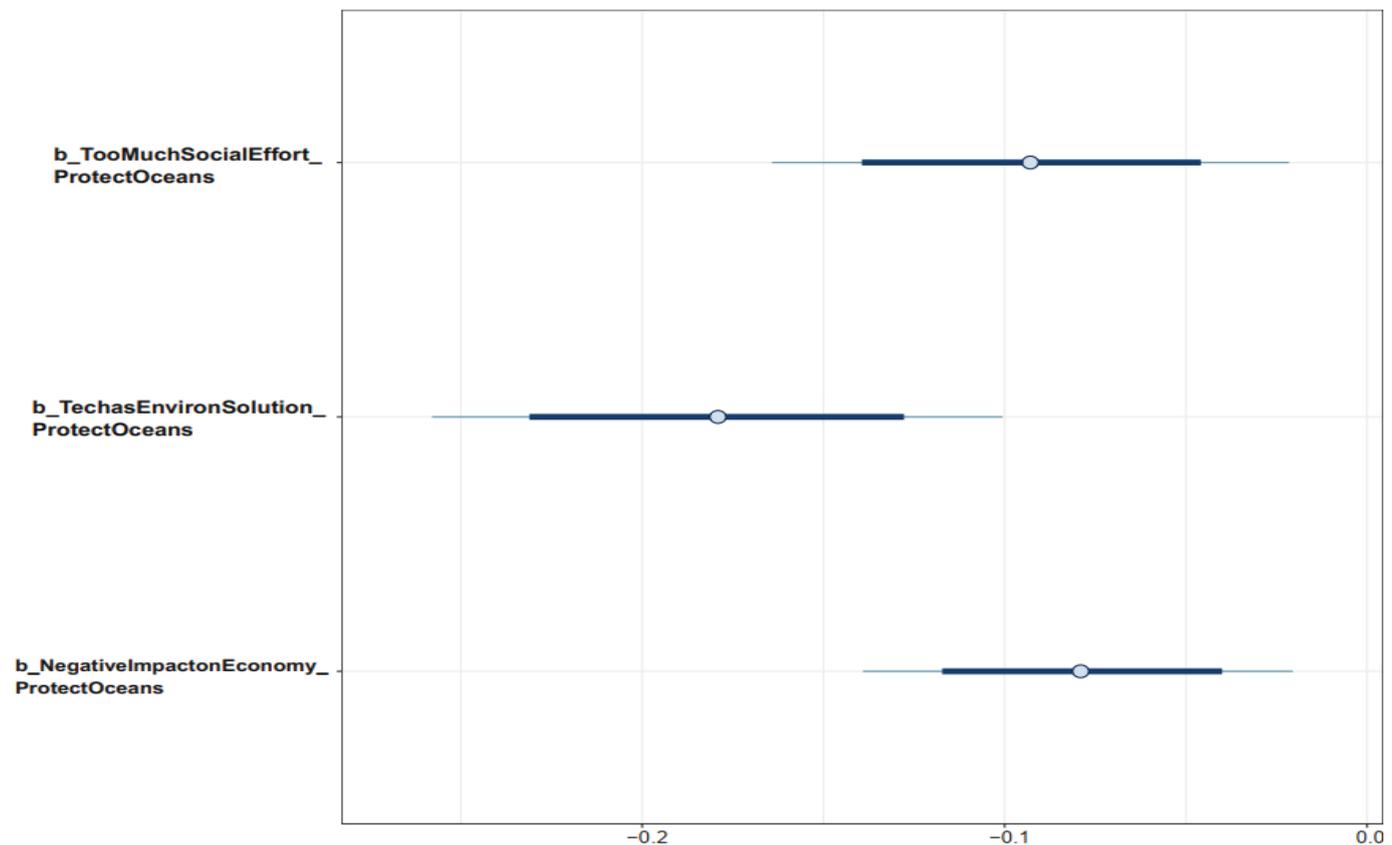


Fig. 4. Posterior distributions of model 1's coefficients.

4. Discussion

By utilising Mindsponge theory and Bayesian Mindsponge Framework analytics, this study examines the relationships between perceptions of climate change-related perceptions and willingness to support marine protection. Its results contribute to the field of environmental psychology and marine conservation. By exploring these psychological dimensions, our findings confirm that some climate change-related perceptions can significantly hinder stakeholders' willingness to support marine protection efforts. Specifically, stakeholders who perceive high socio-economic costs associated with combating climate change are less supportive of marine protection efforts. Additionally, those who perceive the benefits of technology in addressing climate change also show decreased support, thus validating our hypotheses.

The confirmation of our hypotheses has some implications, particularly for policymakers dedicated to fostering pro-environmental behaviours that protect marine environments. Firstly, our study's findings highlight the critical demand for effective marine conservation policies and their alignment with key social and economic sectors associated with marine ecosystems. Policymakers are encouraged to design measures that protect the environment, mitigate climate change, and simultaneously contribute to national social and economic goals, creating a balanced approach. Otherwise, stakeholders will be less likely to support conservation efforts due to their concerns of socio-economic trade-offs [45].

Secondly, the study brings attention to a concept called exceptionalism, which suggests that relying solely on technology can solve climate change. It highlights the significance of acknowledging and understanding perspectives that isolate humans from the ecosystems integral to existing policies, programs, and campaigns [46]. To tackle these challenges, it is essential to implement various key measures. One example is promoting multi-stakeholder collaboration, fostering partnerships among scientists, policymakers, local communities, and conservation organisations. This approach not only enhances decision-making and participation in citizen and community sciences [47] but also mitigates the narrow focus associated with an exceptionalist viewpoint, which tends to isolate humans from ecosystems. By fostering a more comprehensive and inclusive approach to environmental conservation

[48], it promotes collaboration and understanding across diverse stakeholders. Additionally, recognizing and integrating indigenous knowledge will provide valuable insights into advancing sustainable living and cultivating harmonious coexistence with nature [46, 49].

Furthermore, advocating for ecocentrism is important as it recognises the value of every component within an ecosystem, thereby deepening our understanding of life's interconnectedness [50]. This approach aligns with the significance of comprehensive environmental education, which is crucial in nurturing a society with ecological consciousness. Through such education, individuals can better appreciate the intricate relationships within ecosystems and develop a greater sense of responsibility towards environmental stewardship.

To reinforce this perspective, we propose that to gain public support for marine and coastal protection, the content of disseminated environmental information should highlight the importance of marine and coastal ecosystems in improving human welfare, regulating climate and weather, and mitigating climate change [8]. At the same time, it is necessary to take advantage of different information transmission channels so that relevant parties can increase access to information about climate change, thereby raising awareness about protecting marine and coastal ecosystems and its long-term socio-economic and cultural benefits to people [51, 52]. In the long term, these perceptions will form the foundation for building an eco-surplus culture [29, 52-54].

Incorporating these suggestions into policymaking might ensure that marine conservation interventions are globally informed, locally relevant, and impactful [55]. By considering the interconnectedness between environmental, cultural, economic, and technological factors, policymakers can enhance the effectiveness of their initiatives, promoting a holistic understanding of marine conservation and fostering sustainable practices that benefit the environment, society, and economy. These efforts are crucial steps towards achieving global environmental sustainability goals, such as the EU's carbon neutrality target outlined in initiatives like the European Green Deal.

However, it is important to acknowledge several limitations of the current study for transparency and integrity [56]. Firstly, while the dataset includes respondents from 42 countries, the majority are from

Europe, particularly France and Italy, which may limit the generalisability of the findings to non-European regions. Nevertheless, this dataset represents an exploratory effort to incorporate non-European perspectives into a global approach. Secondly, potential bias may arise from the self-selection of survey respondents, as those who participate may already hold specific opinions or beliefs about environmental issues, impacting the generalisability of the findings. Awareness of these limitations is essential when interpreting the study's results and their relevance to a broader population.

5. Conclusions

In conclusion, this study explores the relationships between climate change-related perceptions and the willingness to support marine protection. It employed Mindsponge theory and Bayesian Mindsponge Framework analytics to explore the psychological dimensions of marine conservation. Our findings validated hypotheses suggesting the negative effects of perceived high social and economic costs for addressing climate change and the perception of technologies as solutions for climate change on the willingness to support ocean protection. Based on these findings, we call for a balanced approach that can simultaneously contribute to climate change mitigation, marine conservation, and socio-economic development. Additionally, the study highlights the risk of exceptionalism, which can undermine the effectiveness of climate change mitigation and marine protection due to the strong belief in the capability of technologies to solve environmental problems. Strategies such as multi-stakeholder collaboration, indigenous knowledge integration, and the promotion of ecocentrism are proposed to make marine conservation efforts globally informed, locally relevant, and impactful.

CRedit author statement

Phuong-Tri Nguyen: Conceptualisation, Writing - Original draft preparation, Project administration; Minh-Phuong Thi Duong: Formal analysis, Writing - Original draft preparation, Writing - Reviewing and Editing; Hong-Hue Thi Nguyen, Viet-Phuong La: Methodology, Software, Visualisation, Data curation; Minh-Hoang Nguyen: Conceptualisation, Formal analysis, Writing - Reviewing and Editing; Quan-Hoang Vuong: Conceptualisation, Validation, Supervision.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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