frontiers | Frontiers in Climate

TYPE Original Research
PUBLISHED 14 March 2024
DOI 10.3389/fclim.2024.1290999

OPEN ACCESS

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RECEIVED 08 September 2023
ACCEPTED 20 February 2024
PUBLISHED 14 March 2024

CITATION
Hilser H, Hiraldo L, Moreau C, Draiby A, Cox E, Andrews MG, Winks L and Walworth NG (2024) Public engagement and collaboration for carbon dioxide removal: lessons from a project in the Dominican Republic. *Front. Clim.* 6:1290999. doi: 10.3389/fclim.2024.1290999

Public engagement and collaboration for carbon dioxide removal: lessons from a project in the Dominican Republic

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Despite an increase in literature on public perceptions of carbon dioxide removal (CDR), there remains a paucity of evidence describing the social and developmental processes involved in the implementation of projects *in-situ*. This research illustrates a case study documenting a planned research project for coastal enhanced weathering—a form of ocean alkalinity enhancement—in a remote, rural area of the Northwestern Dominican Republic, a Small Island Developing State particularly at risk from climate change impacts. This paper is a collaboration between the company responsible for the project (Vesta) and researchers located in the Dominican Republic and the United Kingdom, We draw upon 2 years' worth of surveys, interviews, focus groups, group information sessions, and reflexive documentation by the Dominican Republic researchers, to present a first-hand account of local community responses to the planned research project and to coastal enhanced weathering and climate change more broadly. We discuss themes of climate vulnerability, justice, and adaptive capacity through the lens of the collaborative governance and social diffusion principles that the project was designed with. We also reflect on a program of outreach and participatory activities which was established to support community development in the areas surrounding the field trial site, as informed by exploration of community needs drawn from the research.

KEYWORDS

climate justice, coastal enhanced weathering, environmental justice, negative emissions technologies, ocean-based techniques, responsible innovation, Small Island Developing States (SIDS)

Introduction

Anthropogenic climate change is causing unprecedented alterations to the Earth's climate and is posing a significant threat to ecosystems and human communities worldwide. Numerous studies indicate a >50% chance that global temperatures will reach or surpass 1.5°C between 2021 and 2040, with most scenarios highlighting the need for

Carbon Dioxide Removal (CDR) strategies in addition to emissions reductions (IPCC, 2022, 2023). The results of the Peoples' Climate Vote (United Nations Development Programme, 2021), the world's biggest ever survey of public opinion on climate change, illustrate that urgent climate action has broad support amongst people around the globe, across nationalities, age, gender, and education level, with the most popular policies being conserving forests and land, though little light was shone on the global opinions of proposals for CDR.

Public perception is a critical consideration in the implementation of CDR technologies (Cox et al., 2020; Shrum et al., 2020). However, knowledge and awareness remains low in many countries, and the literature displays a significant lack of evidence from the Global South and a general deficiency of context-specific and site-specific data, especially concerning novel CDR techniques (Smith et al., 2023). Public perception of carbon removal is highly influenced by framing, which means that attention must be paid to the communication strategies used, both in research and implementation. Important frames identified in the literature include the analogies and metaphors used to communicate the technologies, the nature-technology divide in valuing CDR, overestimations of potential emissions-reduction, and communication gaps regarding the social aspects of CDR (Bellamy and Raimi, 2023).

Maher and Symons (2022) provide further context on the global political landscape for CDR, emphasizing the need for governance and accountability mechanisms that respond to social and environmental justice impacts and social appraisal concerns. CDR researchers are increasingly recognizing the significance of environmental and climate justice (Schlosberg and Collins, 2014; Pozo et al., 2020; Batres et al., 2021), yet empirical research on the social and ethical aspects of deploying CDR in the Global South remains scarce (Waller et al., 2023). Inequities embedded in climate change risk highlight the unfairness that those who contribute the least to greenhouse gas emissions often bear the brunt of its consequences. Authors note the "double inequality" where communities contributing least to climate change also have the lowest capacity to resist and recover (Barrett, 2013). Recently, authors have suggested that this is actually a triple injustice, because of injustices and inequities brought about by maladaptive climate mitigation programs (Lehmann and Tittor, 2023). For example, the CDR literature notes the inequities created by bioenergy and afforestation projects, which in the worst cases have resulted in land grabs (Gough et al., 2018; Sovacool et al., 2022); thus there is a real risk that attempts to mitigate the double inequality via CDR projects in climate-vulnerable areas could end up exacerbating the issues they seek to solve. Consequently, justice considerations are crucial in addressing climate change causes and impacts, including the development of innovative technologies and interventions (Batres et al., 2021).

One of the major gaps in our knowledge is how to effectively work with local communities in the implementation of CDR approaches. CDR strategies could have social and economic impacts on local communities; as such, it is critically important to engage and involve local communities in the decision-making process to ensure that their perspectives and concerns are addressed. Effective engagement requires a comprehensive understanding of the social, cultural, and economic contexts of local communities, including their existing practices and habitat use patterns. CDR techniques such as ocean alkalinity enhancement (OAE) involve changes to coastal environments and potentially marine habitats, and therefore it is important to examine interlinkages between these contexts and environmental interactions. Furthermore, it is important to recognize that power imbalances may exist between different stakeholders, and to develop mechanisms for meaningful participation (Stringer et al., 2006; Reed et al., 2009). Likewise, it is important to develop context-specific approaches that consider the unique challenges faced by, for example, Small Island Developing States (SIDS) and build capacity for effective and equitable decision-making processes (Jaschke and Biermann, 2022).

In this respect, collaborative governance may aid in the implementation and growth of effective CDR technologies, by involving the participation of stakeholders and local communities in decision-making processes (Scobie, 2016; Lezaun et al., 2021). However, collaborative governance is often more challenging in the Global South (Scobie, 2018), where governments may lack capacity, civil society organizations may be marginalized, and local communities may have limited resources and opportunities to participate in decision-making processes (Banerjee, 2003; Jaschke and Biermann, 2022). The climate crisis is a crisis of justice as much as it is a crisis related to the biogeochemical environment, and as such, calls for a reframing of climate, and broader environmental justice debates (Sultana, 2021). As a form of environmental justice, climate justice has three components: equitably distributed environmental risk, recognition for people's diverse needs and experiences, and participation in the political processes that create and manage environmental policy (Schlosberg, 2007). Accordingly, distributive justice is concerned with who bears the costs and who enjoys the benefits ("who gets what?"). Procedural justice is concerned with the fairness of processes through which decisions get made ("who gets heard, and how?"). Finally, recognition justice is concerned with the extent to which actors are granted status and legitimacy to take part ("who counts?"; See and Wilmsen, 2022; Sovacool et al., 2022). Localized and collaborative governance aligns with procedural justice, with the intentional inclusion of all stakeholders in decision-making processes (Sovacool and Dworkin, 2015).

Sociotechnical considerations for ocean alkalinity enhancement

This paper documents a community engagement process and the local attitudes toward a planned coastal enhanced weathering (CEW) research project in the Dominican Republic (DR). CEW is a form of ocean alkalinity enhancement (OAE), whereby silicate minerals such as olivine are added to coastal zones to enhance ocean alkalinity (Hartmann et al., 2013). Grinding the minerals into small grain sizes increases their reactive surface area to volume ratio, sequestering atmospheric CO_2 through the generation of alkalinity, with the additional benefit of counteracting local ocean acidification (Meysman and Montserrat, 2017). The

company responsible for the project, Vesta, is a Public Benefit Corporation[1] based in San Francisco and nationally registered in the DR, which first started researching CEW as a non-profit in 2019. Although ultimately Vesta did not place any olivine in the coastal environment in the DR (i.e., no field pilot was carried out, explained in more detail in the following section), the organization still engaged in scientific research and collaborations in the DR related to ecotoxicology, ecology, (bio)geochemistry, and social sciences.

While ocean-based CDR techniques propose to offer potential solutions to reducing greenhouse gas concentrations in the atmosphere, they also raise significant social, ethical, and governance challenges (Cox et al., 2021; Bellamy et al., 2022). Currently, our ability to anticipate societal outcomes is constrained by limited understanding of the impacts of OAE on marine ecosystems, as well as challenges establishing monitoring, reporting, and verification (Nawaz et al., 2023a). Cooley et al. (2023) outline the public concerns that would need to be addressed if OAE and other ocean-based CDR approaches were to be deployed at scale, and argue that factors affecting public acceptance include attitudes toward risk in general, beliefs about the ocean, perceptions of OAE techniques as "natural," and trust in the people and institutions managing OAE. Cox et al. (2021) use insights from analogous techniques to argue that ocean-based CDR may encounter heightened risk perceptions amongst members of the public, due to heightened affective responses alongside perceptions of the ocean as an open, interconnected system. Nawaz et al. (2023b) examined public attitudes toward four ocean-based CDR techniques, finding that perceived severity and urgency of climate change predicts greater comfort with all four, while views of marine environments as adaptable, fragile, and manageable vary in predicting both greater and lesser comfort. Their paper also highlights the limitations of generalized survey research and proposes more locally contextualized research, since different projects will have different formulations, associated practices, and life cycles. Finally, Hilser et al. (2023) advocate for the integration of actors from the Global South in CDR innovation, emphasizing that such inclusion would enhance ethical and governance aspects, and suggest that participatory, deliberative, and localized governance approaches in Small Island Developing States (SIDS) can inform strategies for ethical CDR solutions aligned with climate justice principles.

The objectives of the CEW research project as a whole were to identify the prospects and barriers for collaboration, as initiatives shift from ideation to the development of laboratory and field approaches for future pilots of highly novel CDR techniques "on the ground." The importance of participating in inter-organizational knowledge exchange networks that facilitate cross-disciplinary learning is underscored through collaboration in the establishment of adaptive capacities within communities that rely on natural resources. This paper presents the outcomes from a series of public engagement events and activities which were carried out in advance of the planned CEW research project.

Dominican Republic—Climate change action in a Small Island Developing State

Since the first Global Conference on Sustainable Development of Small Island Developing States (SIDS) adopted the Barbados Programme of Action (United Nations, 1994), SIDS now comprise 52 small countries and territories in the tropics and low-latitude sub-tropics. While there is much diversity in SIDS' physical and human geographies, the United Nations (2005) describes how all display some level of similarity in terms of sustainable development. SIDS are particularly susceptible to the detrimental effects of climate change, such as sea level rise, hurricanes, and altered rainfall patterns (Nurse et al., 2014). These climate characteristics, combined with the socioeconomic circumstances of SIDS, make them among the most vulnerable nations in the world to climate change (Scandurra et al., 2018). Unfortunately, due to their geographical locations, SIDS will likely continue to experience environmental insecurity as they are at the forefront of climate change effects caused primarily by industrialized countries. Even though SIDS typically contribute $<1\%$ of total emissions, they are disproportionately affected by climate change (Kelman and West, 2009). The Caribbean region, comprising 23 SIDS, suffers from a marked asymmetry between contribution to global GHG emissions and climate vulnerability (Bárcena et al., 2020). In 2021 it was hit by a record-breaking 30 tropical storms including six major hurricanes, with 50% of the population (about 100 million people) living within 1.5 km from the coast.

Despite being the most vulnerable in the climate crisis, SIDS have played an essential role in raising awareness about climate change. They have been crucial in urging global leaders to take action to address climate change and were among the first to call for placing climate change on the agenda of the UN Security Council (Mead, 2021). SIDS have been influential in advocating for a stronger response to climate change on a global scale, taking a leading role in highlighting the urgent need for action to protect the environment and those most vulnerable to its consequences. This illustrates how a prevalent focus on "vulnerability" of particular locations or communities can obscure the leadership role they often play in responding to climate threats (Robinson and Wren, 2020; See and Wilmsen, 2022).

The Dominican Republic (DR) is a developing country in the Caribbean, classified as upper-middle income. It is ranked as one of the 10 most vulnerable and exposed areas in the world in relation to climate change effects, particularly extreme temperatures, changes in precipitation patterns, ocean acidification, projected sea level rise, and increases in tropical storm activity (USAID, 2013). The DR has one of the fastest-growing economies in the Latin America and the Caribbean region, and is an active player in the international climate regime. The DR's Nationally Determined Contribution (NDC) commits to a 25% reduction in greenhouse gas emissions by 2030 compared to 2010 levels (Gobierno de la República

1 A Public Benefit Corporation is a for-profit corporate entity which pursues positive impacts to society, workers, the community, and the environment, as part of its legally defined goals.

Dominicana, 2020). The NDC also stipulates a commitment to a participatory and inclusive process, although specific details and mechanisms are not defined (WWF, 2020). The DR has been working on a Gender and Climate Change Action Plan (UICN, 2018) to enhance climate resilience and address gender inequity by empowering local representatives. Concurrently, its involvement in the Initiative for Climate Action Transparency fosters transparent and participatory climate governance through international collaborations and policy training. Such initiatives respond to global calls for greater transparency, citizen participation and localized, collaborative governance on climate action.

The DR was primarily selected for the CEW trial by Vesta for the following reasons: (1) It offered ideal environmental conditions for olivine dissolution due to year-round, warm seawater temperatures; (2) The sedimentological conditions were optimal for carbon removal, with beaches consisting of silicate-dominant sand comprised of relatively small grain sizes; (3) Olivine is a natural component of numerous regional rock formations in the region, such as the peridotites and gabbros of the Puerto Plata Basement Complex (Huerta et al., 2012); (4) The potential site had conditions favorable to the scientific study of olivine dissolution, consisting of two nearly identical bays experiencing the same oceanographic conditions, with calm waters, favorable for measuring changes in sediment transport and seawater chemistry.

In addition, however, the research project provided a unique opportunity to explore the social and ethical issues surrounding CEW in SIDS, including interrogating whether and how research can support local adaptation through inclusive methods of implementation (Morrow et al., 2020; Lezaun et al., 2021). For any actual olivine field deployment, CEW requires ongoing monitoring as olivine minerals continue to dissolve over time, which, in turn, necessitates a robust program with local, regional, and national communities to ensure ecological safety and efficacy of the project. The history of climate interventions in the Global South clearly identifies issues with capacity-building, including a serious need to learn from the mistakes of the past by implementing genuine co-production processes with local communities and stakeholders (Trisos et al., 2021; See and Wilmsen, 2022; Lehmann and Tittor, 2023). Such processes are especially important when there are still natural and social science knowledge gaps. In addition, documenting and providing a platform for the public to share their opinions on this novel CDR technique may assist in developing political mandates and action on much-needed CDR regulations. It may also help researchers and practitioners to understand the extent to which social and ethical concerns around CDR identified in the Global North, such as mitigation deterrence, are salient in the context of SIDS such as the DR (Markusson et al., 2018).

Methods

Working closely with members of Guzman Abajo and surrounding communities in the DR, Vesta's social science research rests upon two central pillars: (1) investigating awareness about climate change and CEW with olivine through social science research and (2) developing a comprehensive community outreach program together with the community. When conducting scientific research in a coastal SIDS community, the overriding imperative should be to avoid entrenching inequities and to challenge outmoded and unethical research paradigms (Mutua and Swadener, 2004; Healey et al., 2021). A cycle of inclusion, openness and receptivity should be maintained. Social research and engagement at Vesta in the DR were led by a local female leadership team made up of a community engagement manager, a community engagement coordinator, and a senior regional manager.

The research was initially planned to take place before and after Vesta's olivine placement in the area, thus adopting a quasi-experimental approach comparing pre- and post- datasets. However, due to local site conditions identified during the initial phase of the CEW research project, it transpired that the site was likely not conducive for efficient olivine dissolution and therefore not suitable for carbon removal. As such, the field trial was canceled before any olivine was placed, although Vesta continued to conduct ecological and biogeochemical laboratory studies in the region. The decision to discontinue the localized field research led to a modification of the social science research to a cross-sectional design, which involved collecting data from specific representative community groups affected by or influential to the CEW research in the area. Ethical approval for this project was supported by the University of Exeter's ethics committee, in accordance with the Economic and Social Research Council guidelines. Consent forms which outlined the ethics, safety, rights, and safeguards of agreeing to the research were read aloud then signed by all participants in Spanish. Monetary remuneration was not provided for participants to prevent potential biases, perceptions of unfairness, and undue influence, with alternative non-monetary incentives such as traditional hamper gifts and equipment for their community groups offered to ensure fair and voluntary participation. It is worth noting that one group that did not respond to inclusion in the research were cattle ranchers due to their reluctance to partake in the questionnaire because of bad past experiences with questionnaires and land issues in general.

Socio-demographic and attitudinal baseline surveys

An initial baseline survey used semi-structured interview questionnaires with participants drawn from a non-probability sample of the local population identified through a chain referral method (Bryman, 2021).This involved selecting individuals as key informants referred to by local representatives and based upon criteria discussed with the community leaders (gatekeepers) representing the key target groups within the local community (Newing, 2010). Questionnaires were conducted in a remote rural area of the DR, Northwest of Puerto Plata, in the Guzman Abajo neighborhood. Participants ($N = 42$) were qualitatively interviewed whilst interviewers filled out paper and electronic questionnaires (see Supplementary material) to assess the socio-demographic and situational profiles of the local communities, and the current knowledge, attitudes, and behaviors toward the project and toward climate change. The common messages and narratives were captured through transcribed audio recordings and in daily field notes accompanying the open-ended questions of the interviews, which were used to complement stripe coding

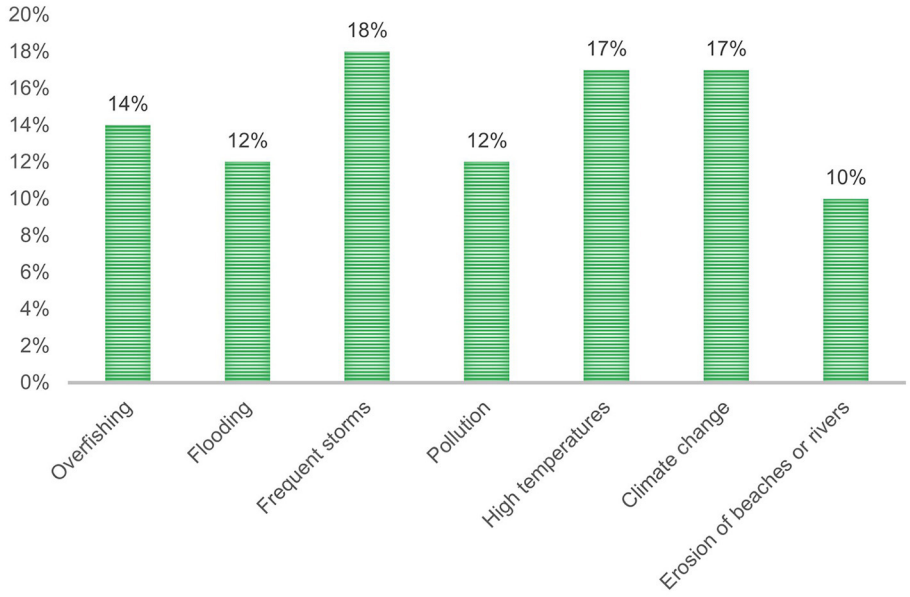

FIGURE 1
Percentage of survey respondents ($n = 42$) who reported "worrying" or "very worrying" levels of concern for environmental impacts that affect their quality of life.

using NVivo software (V12) to identify trends and patterns from the dialogue.

Community working groups

Local community members affected by and influential to the project must be listened to, understood, and involved in decision-making processes through regular and structured outreach and engagement activities (Jacobson et al., 2015). An initial stakeholder mapping exercise identified appropriate groups to engage and their respective relationship to the project. The deliberative and inclusive process involved grouping stakeholders in terms of specific dimensions related to the management and engagement with local resources (for example, influence, power, and importance), through open discussion and collective, formal ranking exercises (Govan et al., 2013). The identified groups consisted of a women's collective, fisherman's group, beach guardians (stewards from Chiquita and Los Cocos beaches), local government representatives (Municipal District), educational and religious leaders, a handicraft group, a cattle rancher group, and the neighborhood council.

After the initial baseline surveys were conducted, the second research phase involved focus groups involving these key groups, facilitated by Vesta staff and community members. Six focus group sessions were held in the DR throughout 2021 and 2022. The groups involved discussions with between 10 and 12 individuals about the project's development, encouraged feedback on any insights or queries from the broader cross-sections of the communities, and included topics about climate change, socio-cultural significance of the coastal habitat, perceptions of (and engagement with) the CEW project, and other themes which were requested by the community representatives. These meetings aimed to understand the communal processing of notions and social constructs to generate meaning (Morgan and Morgan, 1997), and are regarded as a powerful method to provide rich understandings of certain social issues and socially constructed discourses (Agar and MacDonald, 2008).

To address the unique concerns of all representatives of the local communities, the focus groups were established as working groups, encouraging members to review the information they were receiving, voice concerns, ask questions and make suggestions. Insights from the groups were communicated back to the management team to review recommendations and adapt approaches accordingly through a reflexive process. A continuous feedback loop was ensured by responses being reviewed by the project team and responses were again relayed to the working groups at follow up- sessions, where appropriate inviting input from stakeholder representatives relevant to the query or concern were raised. The project team thoroughly examined the responses and subsequently relayed them back to the working groups during follow-up sessions whilst actively seeking input from relevant stakeholder representatives. By adapting the communication approach and fostering direct interactions, the team established meaningful relationships and received valuable feedback, which significantly contributed to the overall development of the project and aligned with the principles of collaborative governance of the technology as it developed via the CEW research.

Qualitative interviews

Immediately following each focus group session, qualitative interviews were held with a chain referral sample of representatives from each of the local targeted community groups ($N =$

10). These interviews aimed to understand the stories and personal perspectives that underpin the responses to the baseline questionnaires and focus groups. The interviews were almost exclusively participant-led and included only a few guiding questions. Thematic focus guided discussions, providing a framework while participants had significant control in shaping the discourse within those boundaries. Specifically, the role of the interviewer is acknowledged as influential in initially shaping the interview dynamics by guiding the general setting, introducing follow-up questions, and utilizing non-verbal gestures to facilitate a responsive and open dialogue with participants. Interviews continued until no new or significantly relevant data or patterns emerged, or the category became well-developed and validated (Strauss and Corbin, 1998). Ten community members from the stakeholder groups were interviewed to understand in more detail their respective backgrounds, context, ideas, perspectives, motivations, life stories and perceptions of the environment and climate change concepts. The qualitative interviews also served as an opportunity to understand the realities of climate change impacts already experienced within the community and their mandatory adaptations to them in order to sustain their livelihoods.

The research design and implementation were iteratively shaped through ongoing collaboration between researchers and community members. Survey questions were revised in consultation with local leaders and key informants, with particular focus on ensuring cultural relevance. Working groups were formed based on stakeholder input, actively involving community representatives in project decision-making. Focus group themes were determined collaboratively, aligning discussions with community priorities identified in baseline survey interviews.

Qualitative data from the information sessions, focus groups and qualitative interviews were collected using note taking during the sessions. This included systematically written, typed, filmed, recorded, and photographed material all taken with consent. This was analyzed alongside daily field notes taken by Vesta's DR researchers. Qualitative data was analyzed using NVivo (V12) to identify common themes. Daily notes were recorded and written down by hand, then written "up" and eventually "out" (Madden, 2010) and synchronized into NVivo, importing all notes directly into the system to be immediately available for exploration, with insight into relationships between the research themes and guiding concepts (Flick, 2009). Comparative analyses were performed through framework matrix coding queries, comparing coding at nodes for sub-groups, following Applied Thematic Analysis (ATA) processes, a type of inductive analysis of qualitative data (Guest et al., 2013). Notable benefits of ATA as a pragmatic approach are that it is well-suited to medium to large data sets, the interpretation is supported by the data and it can be used to study topics other than the individual experience (Guest et al., 2011).

Results

Socio-demographic and attitudinal baseline survey results

In the baseline survey, the median age range for responses was 46–55, with a 50:50 representation of male and female respondents ($N = 42$), and a wide range of main income sources from construction to education, with fishing representing the most common main income source ($N = 8$). All respondents stated that they had observed changes in climatic conditions over time. Direct resource users, such as farmers and fishermen, were more likely to report feeling the impacts of these changes on their livelihoods than non-direct resource users. Those with more supportive attitudes (pleased/very pleased) toward Vesta tended to be from older (72%) male (56%) participants, with higher-than-average education for the sample (high school or above; 61%).

Seventy-six percent of respondents had heard about climate change, and all participants expressed concerns about the potential future impacts of climate change. Climate change, frequent storms and high temperatures were the top three environmental impacts reported to affect respondents' quality of life (Figure 1). When asked to what extent they felt climate change threatens their personal health and safety, 19% replied it was threatening, and 40% very threatening—this proportion increased to 57% within the lowest income bracket. Seventy-one percent however, were unaware of the effect of greenhouse gases, ocean acidification, CEW, or principles of climate justice. The study found that people surveyed have the highest confidence in their friends, family, and community members when it comes to addressing climate change, while having the least confidence in government officials or private sector entities that come to the area (Figure 2). Television was the most common source of information about climate change, at 60% of responses, and only five respondents were aware of any government initiative for climate adaptation in the DR, citing tree planning, protection from Saharan dust storms and renewable energies. Interestingly, only one-third of survey respondents stated that they believe climate change to be caused by human activity, although 98% believe that atmospheric temperature has increased in the DR.

Among those who were aware of private sector initiatives for climate change adaptation, multiple references were made of the local Guzmancitos 48.3 MW wind power project, the largest of its kind in Central America, located in the Puerto Plata Province. This project is run by Poseidon Renewable Energies with ∼30 turbines provided by Vestas Wind Systems, which with the similar name to Vesta resulted in some confusion with the community. Following this, when asked about confidence levels for governance of CDR, over a third of responses (35%) were confident in foreign entities, while almost half (48%) expressed a lack of confidence in government initiatives. Follow up questions inquired if the community benefited from the presence of foreign entities in the area: responses were not explicit in answering if they were beneficial and typically focused on job opportunities or the ongoing expectation of economic gain for the community due to the presence of the local wind power project (82%).

Less than a fifth (19%) of those surveyed knew about Vesta previously, with only three respondents having knowledge of the project's intentions, and when asked about their attitude toward the presence of Vesta in the area, respondents either replied as indifferent (57%), pleased (29%) or very pleased (14%), with no-one reporting displeasure. Only 14% of female respondents (from total $N = 21$) had knowledge of Vesta prior the survey, compared to 43% of male respondents (from total $N = 21$), who responded with varying levels of knowledge about Vesta's intentions, ranging from no knowledge through to an understanding of the project representing some form of

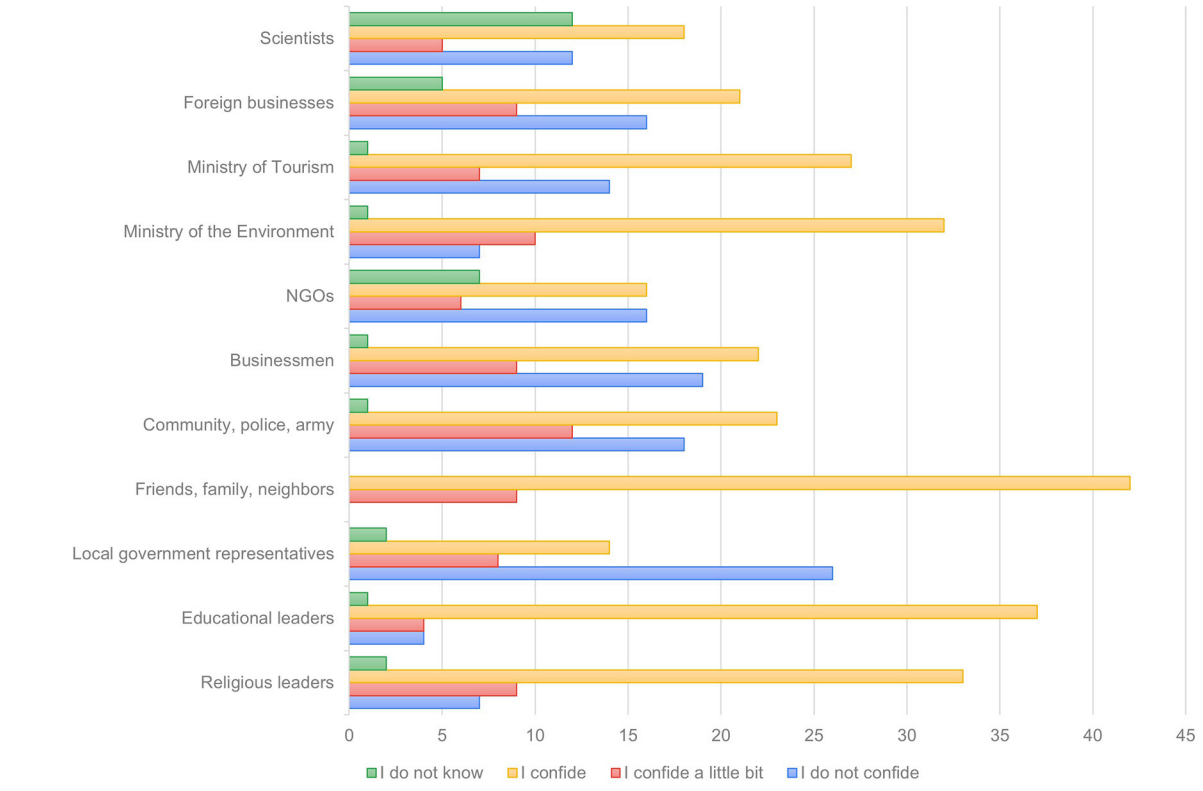

FIGURE 2
Respondents' levels of confidence in various key stakeholders relevant to collaborative governance of carbon dioxide removal in Dominican Republic.

environmental initiative. Male respondents were generally more pleased about the presence of Vesta in the area (48% pleased or very pleased), whereas female respondents were more likely to be indifferent (63%). Specific concerns raised by participants included the presence of scientists and film crews, and the taking of sediment, seagrass, and marine life samples. In general, participants were interested in the project and wanted to know more, with 95% opting to continue receiving information on a weekly basis.

Focus group and qualitative interview results

The following section presents pooled findings from the six focus group sessions and 10 qualitative interviews. Thematic areas were extracted from the transcripts and the accompanying daily consolidated notes and coded accordingly across seven main themes (Table 1), which were then utilized as a node structure for the coding of all transcripts and daily consolidated notes.

Socio-demographic-cultural and structural

Many community members said that they have been unable to sustain themselves by pastoral or horticultural agriculture practices, as is traditional in the area. The research revealed a decline or diversification in livelihoods, with participants reporting that 10 years ago there were 15–20 fishermen in Guzman Abajo and now there are only 6–7 regular fishermen. The fishermen and other members of community groups interviewed reported declines in fish and in biodiversity in general. Socio-demographic considerations of income levels, occupation types, and access to resources appeared to influence the community members' views and openness for participation in the project. Those with lower incomes may see the project as a potential economic opportunity, offering employment or economic growth in the community, while individuals in climate-sensitive sectors, like agriculture or fishing, seem to view the project as a means to address challenges brought about by changing climate conditions. Access to resources, such as land or water, may also influence views, as those with limited access might perceive the project as a way to mitigate vulnerabilities. Cultural factors, including community relationships with the environment and historical practices, could shape openness to the project, with traditions influencing attitudes toward environmental initiatives. Historical experiences, particularly with prior sustainable projects, may impact receptiveness, with positive past experiences fostering support and negative experiences leading to skepticism or resistance. Furthermore, we observed that variations in educational backgrounds influenced the level of comprehension among community members regarding the ecological and climate implications of the initiatives. It is important to note that effective communication strategies play a crucial role in fostering mutual understanding between project stakeholders, and that any lack of understanding may be attributed to both the participants and the project's communication approach.

TABLE 1 Thematic areas emergent from applied thematic analysis of qualitative trends within focus group and qualitative interview results.

Order	Name of theme	Details
1	Socio-demographic-cultural and structural	Age, gender, social norms, cultural influence, and perceived behavioral control
2	Climate change perception, impacts and sources of influence	Understanding and perceptions of climate change and presumed impacts, divine/anthropogenic sources of influence
3	Vulnerability and adaptive capacity, and intended personal legacy	Sense of being exposed to impacts of climate change and ability to adapt at local/global levels
4	Responsibility for environment and community	Sense of their role as contributing to the climate crisis and ways to remediate
5	Trust and expectations in the project	Including the project legacy, stated needs and aspirations of community
6	Knowledge, attitudes, beliefs	Toward climate change, and understanding of Vesta's aims and main activities
7	Governance and inclusion	Participative governance, steering committee, regulations, inclusion within the process

Gender dynamics may have played a role in the public perceptions shared within the sessions, with women having distinct viewpoints possibly due to their often more direct engagement with community activities such as the handicrafts and women's community groups. Consistent with the survey results reported above, women were less familiar with Vesta beforehand. It was shared, and observed directly, that men in the community generally exhibited more positive attitudes toward Vesta's presence, while younger women tended more toward indifference. Overcoming cultural biases, particularly toward the women on the project's community engagement team from outside the community, was seen by participants as a mutually rewarding experience that fostered trust. Notably, the empowerment felt by women in the community was evident through an upcycling textile workshop co-created with Vesta's support, identified by the community as an appropriate means of pursuing sustainable livelihoods, addressing the impact of climate change on traditional income sources. Focus groups also discussed structural factors, including existing social hierarchies and decision-making processes, dissecting who held authority in the community, which could impact the acceptance and implementation of CEW in the area. Conversations revealed how power dynamics and influence among different groups within the community could significantly shape perceptions. The identification of key community stakeholders though these discussions, including local government representatives, community leaders, and influential groups, helped to provide further insights into the potential drivers or barriers influencing openness to embracing innovative environmental initiatives, as shared in this paper.

Climate change perception

All focus group and interview respondents said that they noticed changes in weather and ecosystem conditions, many of whom were gravely concerned about the impacts of such: "*Everything has changed. There are no fish anymore. I ask myself if the end of the world is near*" Sandy Vasquez, member of the Beach Guardian group. Direct resource users felt that these changes directly affected their work and all shared apprehensions about the worsening effects of climate change in the future: "*Climate change and increasing heat has caused more Sargasso [a type of brown, floating algae] than before. Biodiversity has also been damaged drastically and there is noticeably less coral cover in the last 10 years along the coastline*," Raul Vasquez, member of the fisherman's group.

Eight out of the 10 interviewees expressed belief in anthropogenic climate change. that said, some interviewees also expressed belief in natural or divine forces causing such impacts:

> "*I think that we must be ok with what is happening. These are God's things. We must be ok with what God does. This is what we tell ourselves every day. If it is not raining, we must be ok with it because God knows. These are the words we tell each other*" Diogenes Holguín, Community Leader, and appointed Mayor of Guzmán Abajo.

Specific localized effects were also made apparent: "*Yes, a lot of it is man-made. Look at that project as I told you [referring to the turbines]. What a mess those people have made. That also contributes to climate change. Man has a lot of influence on climate change even if you don't believe it*" Luis Humberto Vasquez, Neighborhood Council vice president. Indeed, experiences with prior sustainable projects influenced receptiveness to community development initiatives, particularly the negative reactions to the Guzmancito wind power project.

Vulnerability and adaptive capacity

Vulnerability aspects identified included geographical location (e.g., coastal areas prone to sea-level rise and storms), economic dependence on climate-sensitive sectors (e.g., agriculture, fisheries), limited access to resources, and inadequate infrastructure. Those who are more vulnerable may see CDR as a potential avenue to address these challenges. A majority of the community members interviewed in Guzman Abajo have had to look for alternative sources of income due to climate change.

> "*I am worried because everything is disappearing in the ocean. Before you could eat fish daily but now you can't, it's very difficult*" Erizelda Vásquez, Leader of the Women's Group.

Only two respondents have been able to subsist with their original source of income—one young fisherman and an elderly man receiving tourism revenue at the beach. Most interviewees had

to supplement their income from agriculture with other activities because of prolonged drought. *"Before there were many trees and there were a lot of hills, that's why I think that before it rained a lot. But not now- now they have deforested a lot… When the dry season comes, the farm crops and grass dies due to lack of water. This is very sad."* Sandy Vasquez, Beach Guardian group.

Most expressed that the community lacks the capacity or resources to deal with climate change effects, though there was an indication of faith in the resilience of the community regarding some of the impacts. Some have dug wells to access water because of the drought, but there remains insufficient water availability and funding for adequate infrastructure. One participant believed that the community has been able to deal with climate change effects and has become more resilient by working together and finding alternative sources of income as a community, for example a tourist stand catering to cruise ship tourists that go on safaris or carry out other tourism activities in the area. Another perceived climate change to be the long-term effect of industrialization, expressing that there is little choice but to adapt: "*We are living the effects of climate change and try to live and survive however we can*" Dulce Vásquez, Women's Group.

Dust was reported as a major issue in their community and largely attributed to the activities of the wind project. Participants felt that such projects should have more environmental responsibility to the local area:

> *"You know the trees and the hills that these people have destroyed! This is bad for the environment, because it is not going to rain, because if they are cutting down the few trees that exist, where is a cloud going to form and how is the rain going to fall? So that is harmful to the environment, very harmful"* Luis Humberto Vasquez, Neighborhood Council vice president.

Trust and expectations in the project

Many participants expressed distrust and lack of reliance on the government: "*Guzmán Abajo does not have a godfather and godmother, the government does not help us*," Member of fishermen's group. However, most respondents stated that they had no personal issues with the Vesta project being conducted in the area, and additionally perceived the other community members to be supportive and with little in the way of concerns, skepticism or objections about the project's impacts: "*I am happy because we are helping the world and doing things that we did not know about. We have not even started with the deployment of olivine and everything is going very well. God is in the sky and will help us*" Diogenes Holguín, Community Leader and appointed mayor of Guzmán Abajo. Diogenes changed his mind about climate change during the project through continuous focus groups and information sessions and is now convinced that it is anthropogenic.

Most respondents were keen to learn more about the science and any opportunities to be involved that may emerge. All asserted a desire to receive more information about climate change and to be able to explain the concepts to others in the community. They all stated their interest in becoming ambassadors for Vesta (a role including carrying an identity for the project and active participation at outreach events) and supported the idea to implement a climate change module into secondary school curriculums such as in Cambiaso, which was then carried out by the community engagement team as stated.

There were clearly expectations from those who participated in the research and who had been involved in the program, in terms of the benefits that the program has the potential to bring to the community, and possibly a sense in the progress emergent from the developmental support for the area: "*I thought that in 10 years the community would be worse, but now with all these projects that are coming I see how everything is progressing*" Erizelda Vasquez, Member of the Neighborhood Council and leader of the Women's Group.

Suggestions were made for the project team to distribute summary information sheets to raise awareness and access to information regarding the project and climate change after the suggestions were made during the focus group sessions and interviews. This was then carried out in the second information session for community members to refer to at any time in their households to help cement the abstract concepts about Vesta, climate change, CDR, CEW and olivine.

> "*Anything they need from us, we will support them. If they need men, by the time they put the olivine we will be there*" German, Neighborhood Council.

> "*We are happy that you are coming to the community and teaching us all these climate change concepts and about your project. It is important to us and without you we would not learn them because no one comes around to teach us or explain*" Diogenes Holguín, Community Leader, and appointed mayor of Guzmán Abajo.

Knowledge, attitudes, and beliefs

Similar to the survey, the majority expressed cautious support for the Vesta project, although some also voiced skepticism regarding the project's potential ability to assist them in establishing sustainable livelihoods. The women's group conveyed a desire for a community engagement program to assist with this. Two participants expressed discomfort at the lack of monetary remuneration.

Community perceptions of CDR initiatives were influenced by awareness of climate change and its mitigation, as well as by potential economic benefits through job creation and sustainable practices. Beliefs about the ocean and perceptions of naturalness in the techniques and those managing the technologies were discussed as important considerations. This was closely aligned with concerns about environmental impacts on water, biodiversity, and health, and considerations of cultural and ancestral ties. Apprehensions emerged concerning potential disruptions that might arise due to large-scale CDR undertakings, particularly among those heavily reliant on natural resources for sustenance (e.g., fishermen and farmers). While most expressed support or indifference to potential negative impacts from the project, the potential repercussions on

water availability, biodiversity, and traditional land and coastal utilization emerged as sources of worry. Participants shared cultural values of environmental stewardship, concerns about the social and economic equity implications of environment and development projects, and a desire for inclusive and transparent decision-making processes that consider community needs and aspirations while ensuring effective mitigation of carbon emissions.

Overall however, a substantial portion of the research participants displayed a marked enthusiasm for climate impact mitigation endeavors. The project was also perceived by many participants as a potential economic prospect for the community, with the notion of engaging in government or foreign projects for sustainable marine management being viewed as a means to generate employment opportunities and invigorate local economies. Some expressed pride that unique research that could influence climate change on a global level was to take place on their local beaches. Many had read up on Vesta's operations via social media and had observed CDR initiatives on the television and internet, and there was general enthusiasm to learn more about the program:

> "*Of course, when someone like you shows up, we are very grateful because we learn and also have the desire to learn. People ask if you are coming and so when they find out… everyone goes! Because they go to learn about things they have never heard about. There are people here that want to learn. Everyone that came here today has a desire to learn and to listen to what you are saying*" Diogenes Holguín, Community Leader, and appointed mayor of Guzmán Abajo.

Collaborative governance and inclusion

Participants of the focus groups expressed enthusiasm in being involved in the governance of the CEW technique, and widespread openness for inclusion. The aim of the social science framework for action includes creating a platform where community members feel free and open to comment on Vesta's work, provide input into approaches and voice any concerns. The project team fed back recommendations and key info from the working groups to Vesta management to review research recommendations and adapt accordingly, in addition to the participation and training of local ambassadors. While acknowledging the potential bias in the correlation between those supporting training and those interested in project association, this approach received support and appreciation from prominent community leaders.

There was also some indication of the presence of the project fostering positive cohesion within the community:

> "*The lack of connection within the community members causes sadness. This is changing with your presence and the community feels more connected. Your communication with everyone is causing things to change*" Diogenes Holguín, Community Leader and appointed mayor of Guzmán Abajo.

While appreciation for the working groups was regularly expressed, establishing genuine inclusivity in decision-making across various layers of the governance structure, notably within the steering committee, presented considerable challenges, mainly due to logistical constraints, communication issues, and time availability. The dissemination of project objectives both on and off site was challenging due to the community's remote location, and the limited educational background of its members. A sustained commitment was required to foster transparent dialogue with community representatives and individuals who raised queries or apprehensions. Regular follow up from the Vesta team endeavored to prevent community members feeling marginalized, particularly during periods of dissent related to political affiliation and national elections which caused at times an unsettled atmosphere within the community, and instances of discomfort expressed at the lack of monetary remuneration. These instances of dissent highlighted the importance of not only recognizing the external factors influencing community dynamics but also the necessity of developing strategies to navigate these challenges. This underscores the project's commitment to a continuous improvement process, demonstrating the resilience and adaptability required for effective community engagement in diverse and dynamic settings. However, such efforts were complicated by disruptions due to the COVID-19 pandemic, cultural nuances such as punctuality, community bereavements and attendant rituals, and also the challenging climatic conditions and dusty environment in the region. Furthermore, the remote field setting meant a 4-h round trip to the site for field operations, constraining the regularity of site visits.

The participants relayed their desires for localized governance and inclusion in CDR initiatives in the DR. For them, this encompassed aspirations for the following: active involvement in decision-making processes; access to comprehensive project information; assurance of economic growth through job opportunities; environmental safeguards; equitable distribution of benefits; preservation of cultural values; empowerment in monitoring and evaluation; and educational programs. Addressing these desires became essential conditions for fostering trust, collaboration, and effective implementation of CDR initiatives in the region.

Discussion

This paper contributes to a body of research on public perceptions of CDR, which is thus far entirely lacking in perspectives from SIDS, despite their place at the forefront of both climate impacts and climate action. Our research responds to increasing calls to utilize place-based research to investigate local perspectives on OAE (Nawaz et al., 2023a) particularly in the Global South (Sovacool, 2023). Pouponneau (2023) highlights the marginalization of SIDS in academic literature, particularly regarding blue economy initiatives. SIDS are often treated as a homogeneous group without recognizing their diversity. Furthermore, the lack of representation and knowledge production by and with SIDS leads to their general invisibility in scholarly works. This reveals an ongoing inequity between countries with and without research capacity, echoing calls for more vigorous research within SIDS and a broader recognition of the diversity of SIDS perspectives (Benzaken et al., 2022). We argue that collaborative governance should be implemented across communities to support

OAE in the DR. This involves engaging with local stakeholders, including fisherfolk and community leaders, to design and implement OAE projects that meet both environmental and social goals. The goal is for the communities to be able to identify and address potential challenges and leverage points for participation, to ensure the project benefits are shared equitably (Morrow et al., 2020; Batres et al., 2021). While challenging and still in its infancy, this approach recognizes the importance of local knowledge and engagement in designing effective solutions that benefit both the environment and the people who depend on it (cf. Robinson and Wren, 2020; Waring et al., 2023).

According to Haas et al. (2023), a general lack of inclusion in ocean governance can be attributed to existing power structures and the exercise of power within forums aimed at promoting inclusion and cooperation. Indeed, the climate justice literature points out that governance dynamics in the Caribbean must be understood through the history of exploitation, resource extraction, and economic marginalization, which continues to impact climate responses (Smith and Rhiney, 2016). Avoiding consideration of the underlying political economy tends to obscure important questions about the social justice implications of inequality (Popke et al., 2016). There is a growing body of literature showing how adaptation and mitigation programs may actually exacerbate inequalities, because such programs are often deeply political and are subverted by the powerful, including powerful members of the community itself (Barrett, 2013; Andersen et al., 2016; See and Wilmsen, 2022). In this project, we attempted to embed principles of collaborative governance and participatory justice, as outlined in the preceding sections. Yet there are inherent limitations to the extent to which a single project can tackle or overcome embedded injustices and inequalities in access to power and resources. It is important to consider the structural context, a crucial fourth dimension of climate justice, in addition to procedural, distributional and recognition aspects (See and Wilmsen, 2022). Despite a participatory and collaborative approach on the ground, the project did not attempt to tackle such structural issues. Social systems also involve structures and processes which are shaped by privilege and uneven power relations, and these affect the way in which individuals can respond (Baptiste and Rhiney, 2016). In this study, powerful actors within the community emerged as a prominent voice in the community engagement and in our results section above—for example, Diogenes Holguín, the Mayor of Guzman Abajo. We attempted to mitigate this, for example by setting up a women's group and promoting transparency in communication and governance structures (cf. Waring et al., 2023); however, it is important to recognize that the collaborative governance approach of this project may have inadvertently acted to drown out other voices, including those which project staff were not even aware of, revealing a possible underlying tension between objectives of collaborative governance and climate justice (see also Riggs et al., 2021; Ng et al., 2023). Overall, the project going forward will need to recognize that one project cannot overcome centuries of power imbalance, and to be aware of our role in potentially perpetuating such imbalances.

By giving the community a means and a right to contest the project, we attempted to mitigate the triple injustice identified by Lehmann and Tittor (2023) using a collaborative governance approach. In addition, the triple injustice has a major distributional aspect, because communities often bear the impacts of climate mitigation projects whilst the profits accrue to foreign or multinational entities. Therefore, going forward there will be a need to reflect on the way in which any financial benefits (for instance, carbon credits) are distributed, and to embed principles of procedural and recognition justice in how such decisions are made. Although such distributional issues did not emerge as a strong theme in the analysis, community members did voice some anticipation that the project would create jobs in the local area, due to confusion with the wind farm project with a similar name, and therefore there is a risk that distributional misgivings could emerge if expectations are not met or managed (cf. Ng et al., 2023). In addition, two participants expressed discomfort at the lack of monetary remuneration for involvement in the project going forward; this decision made by Vesta could have created barriers to participation amongst those in need of an income for their time, although the reflexive handling of dissent played a crucial role in the project's overall responsiveness and adaptability to the dynamic nature of the community context.

Key findings from this study include an increasing concern about localized climate change effects, livelihood stability, and poverty cycle dynamics. Identified risks involve concerns over unintended ecological impacts, clashes with present land applications, uncertainties about the efficacy and economic feasibility of untested technologies, and implications for social fairness. Several of these are in line with broader concerns about CDR and weathering techniques which are highlighted by global experts (Sovacool et al., 2022), with specific local concerns relating to the disruption which is already occurring to traditional uses of land and sources of income. Yet participants in both the interviews and focus groups also generally showed strong support for the project's aims, and toward global responses to climate change, despite limited awareness of the anthropogenic origins of climate change and a prevailing belief in natural or divine causes.

Environmental education was highlighted as a key component to fostering widespread community support and participation in CEW development. Our results suggest that there is a need for awareness-raising campaigns and education initiatives to improve understanding and knowledge about climate change and its impacts, particularly in rural locations (Kabisch et al., 2017). Of course, this should not be undertaken with instrumental goals in mind: increased knowledge about climate change should be viewed as a fundamental good in its own right, contributing toward community empowerment, rather than as an attempt to make communities more favorable toward climate interventions. Our results also indicate the importance of building trust and collaboration with local communities and establishing strong partnerships to address climate change effectively, as well as transparency and participation in the governance of CDR technologies at multiple levels wherever feasible (Spalding et al., 2023). An essential aspect of this process involves second-order reflexivity, as highlighted by Schuurbiers (2011), whereby the underlying value systems and theories influencing CDR governance are subject to critical examination. It is crucial to define and tackle context-specific challenges related to CDR approaches, ensuring that responsibilities and burdens are distributed fairly, with a strong focus on community involvement in decision-making, as emphasized by Batres et al. (2021).

We found that participants most positive toward CDR were typically older, male, and high-income or high education, in common with studies from other parts of the world (e.g., Bellamy, 2022). However, all types of participants expressed a strong desire to support initiatives that may provide both local and global resilience in the face of climate change. This finding is supported by studies which have indicated how under worsening climate impacts, public attitudes increasingly favor climate action (Nawaz et al., 2023b; Nayna Schwerdtle et al., 2023), and that communities vulnerable to climate impacts may be more supportive of novel interventions such as CDR (Sugiyama et al., 2020). Intended personal legacies shared by community members involved in this study revealed their desires to leave a positive mark on their community and the environment for future generations. This could be driven by a commitment to uphold traditional values, a wish to be remembered as proactive environmental stewards, or a deep-seated sense of duty toward the wellbeing of their community; the intertwining of these notions of responsibility and legacy may plausibly influence community members' engagement, support, and perspectives on CDR initiatives. We identified high levels of trust in friends, family, and fellow community members, stemming from the belief that these individuals are deeply invested in the local environment and possess a genuine understanding of the unique challenges faced by their specific community. In contrast, government officials and private sector entities were viewed with skepticism and disillusionment due to past experiences, particularly the local onshore wind project, in a form of attitudinal "spillover" effect (Jaschke and Biermann, 2022; Westlake et al., 2023).

However, once it was understood that the CEW project bore no relation to the wind power developer, these misconceptions faded, with respondents also perceiving other community members to be broadly supportive. This may give an indication of trust in the visibility of the social engagement being carried out, although of course may also reflect a bias of the interview conditions, because the social position of participants may well have shaped their response. Some of the voices expressing considerable positivity about the project may have been due to their desire to be involved in the project going forward, or because they expected future personal or political benefits. Our study participants were largely self-selecting, due to the place-based nature of the study which involved a small, rural community. The limited sample size means that our capacity to make categorical comparisons and generalizations is restricted—in particular, the final in-depth interviews only included 10 respondents, and further research would greatly benefit from including more voices from different segments of the community. The participants' varying educational backgrounds and literacy levels were identified as factors influencing their understanding of climate implications, potentially contributing to decreased engagement among certain community members. It is crucial however, to recognize the significance of local knowledge and ensure that information exchange is a bidirectional process. In addition, fostering genuine inclusivity in decision-making within the steering committee proved challenging, due to logistical constraints, communication issues, and time availability. In future research, an ethnographic approach with ongoing field research on the ground could help to foster trust and improved deliberation (Zandlová and Cada, 2023), although this may be more challenging to resource. Finally, a major challenge was around the interplay of the social science research and the CEW field trial because the olivine placement was ultimately canceled for geophysical reasons. This necessitated a major shift away from a pre/post pseudo-experimental design to a cross-sectional one, illustrating the challenges which can occur with interdisciplinary research on novel techniques "on the ground." Although the eventual research design was not entirely congruent with what had originally been intended, the social science research contributed to an understanding of public perceptions of coastal CDR and novel climate interventions in a remote rural area of the DR.

While the focus of this paper centered on approaches to generate collaborative governance among different communities of stakeholders with an environmental justice lens, we acknowledge that addressing the legal implications of our work is important, particularly since statutes for OAE are still being developed. Please see the following papers for a deeper discussion on governance topics relevant to ocean-based CDR (GESAMP, 2019; Webb, 2020, 2021; Cox et al., 2021; Webb and Silverman-Roati, 2023). So far, the only ocean-based CDR approach that is specifically considered by legal instruments, such as the London Protocol, is ocean iron fertilization with coastal approaches such as CEW generally not being mentioned. Because of this, Vesta needed to assess how to best proceed according to existing local statutes in the DR, and thus engaged with local regulatory authorities that subsequently guided the entire process. As this project was the first of its kind, a bespoke permitting approach needed to be developed by the DR Ministry of Environment, working with a local law firm and climate consultant. During the baseline studies, Vesta hosted an 8-h workshop with the Ministry of Environment and Climate Change Council to introduce information regarding CEW, Carbon Credits frameworks, and Measuring, Reporting, and Verification (MRV) methods. The overall intention was to use the resultant framework, alongside the public engagement and collaborative governance approaches described above, as a foundation for subsequent field pilots. In addition, it could serve as a possible template for any projects by other organizations in the region, and to help inform the broader development of future governance for ocean-based CDR activities in the DR and elsewhere. Taken together, the OAE research and resulting legal and community governance frameworks undertaken by Vesta and local stakeholders serve a significant empirical step toward conducting OAE activities in local jurisdictions, as broader statutes continue to be developed to regulate ocean-based CDR.

Conclusion

The Caribbean faces significant risk from the impacts of climate change, and the Dominican Republic (DR) is one of the most vulnerable countries globally, despite contributing relatively little to global greenhouse gas emissions. Climate justice must be considered when implementing any climate intervention, including both the risks and potential benefits of carbon dioxide removal (CDR), and critically its governance. In this paper, we explore public perceptions and social acceptance of Coastal Enhanced Weathering projects, particularly focusing on the integration

of local ownership, participation, and governance. Through a case study in a rural and remote area of the DR, we examine how these elements shape community perspectives. This research contributes to a body of research on public perceptions of CDR, which is thus far entirely lacking in perspectives from Small Island Developing States (SIDS), despite their place at the forefront of both climate impacts and climate action. Community perceptions of CDR initiatives were shaped by people's understanding of climate change and its mitigation, and by perceived economic advantages and employment opportunities in a community which is experiencing rapid changes to local subsistence practices and economies due to climate change. In addition, perceptions were shaped by concerns over environmental effects on water, biodiversity, and health, and the importance of cultural responsibilities to community and to the natural environment. We emphasize the inclusion of vulnerable and relatively uneducated groups in rural and coastal communities who are most vulnerable to climate change, ensuring they can be heard and developing trusting relationships while countering potential negative perception spillover from previous development programs in the area. We emphasize the importance of participatory approaches to societal appraisal and reflect on the potential challenges and opportunities in the establishment of CDR initiatives.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding authors.

Ethics statement

The studies involving humans were approved by Vesta, with support in development from University of Exeter. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

HH: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. LH: Methodology, Writing – review & editing, Data curation, Investigation, Project administration. CM: Data curation, Investigation, Methodology, Project administration, Writing – review & editing, Conceptualization, Resources, Supervision. AD: Investigation, Methodology, Project administration, Writing – review & editing. EC: Methodology, Writing – review & editing, Supervision, Writing – original draft. MA: Funding acquisition, Resources, Supervision, Writing – review & editing. LW: Conceptualization, Writing – review & editing. NW: Conceptualization, Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. EC received funding from EPSRC under the UK Energy Research Center (grant EP/S029575/1), Natural Environment Research Council (NERC) under the GGR Hub (grant NE/V013106/1), and the Leverhulme Trust under project research (grant RC-2015-029).

Acknowledgments

We are grateful to the community of Guzman Abajo for their continued involvement, in particular Diógenes Holguín, Altagracia Vásquez, Dulce Vásquez, Luis Humberto Vásquez, Guillermo Vásquez, Félix Vásquez, Sandy Vásquez, Erizelda Vásquez, and María Paulino Vásquez. We thank RAUDO (Environmental Network of Dominican Universities), UNPHU (Pedro Henríquez Ureña National University), PUCMM (Pontificia Universidad Católica Madre y Maestra), and ANAMAR (Maritime Authority) for their academic and technical collaboration. Finally, we are very grateful to the Ministry of Environment and Natural Resources for enabling these studies.

Conflict of interest

This research was funded by Vesta. Vesta staff were involved in all aspects of the research, including the conceptualisation and design of the research, writing, review and editing of the manuscript. CM, LH, AD, MA, and NW are employees of Vesta, an international Public Benefit Corporation researching the potential of enhanced weathering experiments in the Dominican Republic, where it is nationally registered as a Dominican Public Benefit Corporation. AD and LH are Dominican and CM currently resides in the Dominican Republic. HH and LW have been contracted to consult on the social science framework for Vesta representing environmental education consultancy Lestari LLP, UK.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fclim.2024.1290999/full#supplementary-material

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