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Climate-smart ocean planning in small island developing states—exploring pathways in Dominica

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Climate change is recognised as a major challenge for marine spatial planning (MSP), requiring innovative climate-smart planning approaches. Small Island Developing States (SIDS) are particularly vulnerable to climate change impacts, such as rising sea levels and intensified extreme weather events. It is crucial to enhance the capacity of systems to respond to such effects, thereby increasing climate resilience of SIDS. This study identifies barriers and pathways to integrate climate change considerations into MSP in the Commonwealth of Dominica (Dominica), a SIDS and large ocean state in the Eastern Caribbean. A qualitative document analysis of climate-relevant policies, reports and Dominica's Integrated Coastal Master and Marine Spatial Plan (CMSP) was conducted, augmented by semi-structured interviews. The results reveal that the CMSP considers climate change while placing a stronger emphasis on adaptation measures as opposed to mitigation measures. However, plan implementation and revision, as well as contextual factors, such as human and financial resource constraints, present the greatest barriers to climate-smart ocean planning in Dominica. It is argued that climate-smart ocean planning in SIDS must take a holistic view, acknowledging the limited opportunities for applying flexible, adaptive and long-term planning while emphasising the development of context-specific, feasible solutions.

As the climate crisis advances, marine ecosystems and human livelihoods are increasingly challenged by intensified extreme weather events, ocean warming and acidification, and rising sea levels[1]. Anthropogenic activities have led to global warming of 1.1 °C above 1850–1900 levels in 2011–2020, resulting in severe losses and damages to nature and people[1]. To further reduce adverse impacts, states have agreed to limit global warming to 1.5 °C[2]. However, the developments of projected global greenhouse gas emissions indicate that warming will likely exceed this objective[1].

The impacts of climate change (CC) lead to shifts in marine ecosystem services and ocean uses, demanding new approaches to planning and managing the ocean space. Marine governance and spatial planning must recognise CC as an impactful, cross-cutting issue requiring innovative, flexible and adaptive strategies in ocean planning initiatives[3]. Over the past two decades, Marine Spatial Planning (MSP) has been gaining momentum in coastal and island states across the world as a practical approach to sustainable ocean management. In MSP, the best available data and knowledge are analysed through a participatory process to inform the temporal and spatial distribution of ocean uses to achieve ecological, economic, and social objectives[4]. Although CC is recognised as a significant challenge to MSP[5], a knowledge-action gap exists between having sufficient knowledge about CC and a lack of action, requiring integrated solutions for addressing this wicked problem[6].

Scholars have widely emphasised the need for mainstreaming CC into MSP or 'climate-smart MSP,'[7–10] referring to 'approaches in MSP that integrate climate change considerations into planning evidence (including adaptation needs), support efforts to reduce or capture greenhouse gases (climate mitigation) and help to reduce negative impacts of climate change (climate adaptation)[7,10].' Over the last two decades, the prevalence of CC-related MSP objectives has increased[11]. Yet, despite increased attention, theorised CC considerations often fail to translate into specific actions and are, therefore, commonly missing in planning realities[7]. Furthermore, most studies to date have been conducted by researchers from the Global North, applying a developed-country lens[3,5,7,8,12,13]. This study breaks new ground by investigating climate-smart ocean planning from a small island developing state (SIDS) perspective. SIDS are especially exposed to ocean changes[14] and are particularly environmentally and economically vulnerable[15,16], making increasing climate resilience paramount. Their reliance on the ocean for sustainable development has led some countries, including the Commonwealth of Dominica (Dominica), to choose to identify themselves as a large ocean state[17,18]. In this work, resilience refers to '[the] capacity of

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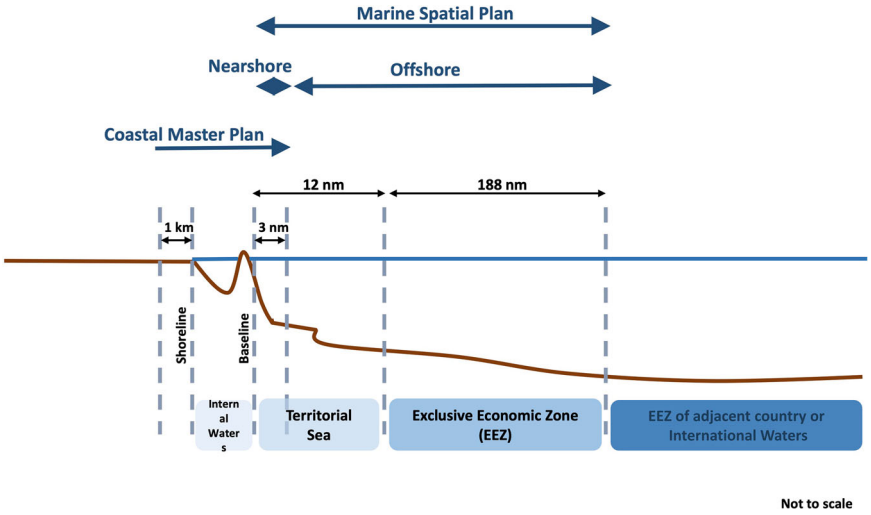


Fig. 1 | Dominica's Spatial Planning Jurisdictions.

interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation[19].'

This paper focuses on a case study of Dominica (Box 1) The country is classified as highly vulnerable to CC, even compared to its Caribbean SIDS neighbours[20,21]. Simultaneously, it is among the world's countries contributing least to global emissions[1]. Due to its position within the Atlantic hurricane belt, the country has experienced two devastating storms in recent years: Tropical Storm Irma in 2015 and Category 5 (i.e., winds of 252 km/h or higher) Hurricane Maria in 2017. The latter led to severe economic losses[14], estimated at 1.37 billion USD or 226% of the country's Gross Domestic Product (GDP)[22]. Tropical storms and hurricanes are expected to increase in intensity and frequency with ongoing CC[1,20], as well as other adverse impacts, including ocean acidification, relative sea level rise, elevated sea surface temperatures and changes in ocean circulation, rainfall intensity and patterns[21]. Alterations to ecosystem services, including changes in migratory patterns of fish species, adversely impact the provision of fish for consumption[23,24]. Additionally, coral bleaching and algae accumulation affect the health of marine and coastal ecosystems and decrease the recreational value of coastal and marine waters, resulting in declining revenues in the fisheries and tourism sectors[25,26]. The cost of no action against CC impacts is estimated to lead to loss and damages equivalent to 77% of Dominica's GDP by 2100. This has pushed the country to accelerate efforts towards achieving climate resilience. In 2017, after Hurricane Maria, the then-prime minister announced during a speech at the United Nations (UN) General Assembly that the country had ambitions of becoming the world's first climate-resilient nation by 2030[20].

The MSP process in Dominica was carried out under the framework of the Caribbean Regional Oceanscape Project (CROP), a World Bank-funded initiative commencing in 2017. Dominica´s Coastal Master and Marine Spatial Plan (CMSP)[27], scheduled for implementation between 2020 and 2035, is divided into two parts: 1) the coastal master plan and 2) the marine spatial plan[27].

Firstly, the coastal master plan component of the CMSP presents 15 prioritised projects designed to facilitate the transition to a Blue Economy.

Secondly, the marine spatial plan includes a detailed nearshore zoning plan of the coastal area and a conceptual offshore zoning framework. The nearshore marine zoning framework (the area up to the 200 m contour depth or three nautical miles from the baseline, whichever is further) (Fig. 1) comprises five categories, each a priority designated use, not exclusive use, with a degree of flexibility in determining the mix of uses within a zone (CMSP: Figure B3-7, *Recommended Zoning Scenario*[27]). The offshore zoning framework applies beyond the nearshore area up to the limits of the Exclusive Economic Zone (EEZ)[27] (Fig. 1) and comprises three oceanic zones based on relative depth from the surface of the ocean (photic, pelagic, submarine); and conceptual marine zoning designations, similar as used in the nearshore zoning framework (CMSP: Figure B3-8, *Offshore Marine Zoning Framework*[27]).

To examine the CCocean planning nexus, this study undertakes a qualitative document analysis of CC-related policies and Dominica's CMSP[27] in combination with semi-structured interviews. It looks at how CC was factored into the CMSP's methodology, investigates the contents of the national policies and the CMSP[27] regarding CC and goes on to identify barriers and pathways to implementing climate-smart ocean planning. Adopting a SIDS perspective, the opportunities for increasing climate resilience through mitigation and adaptation measures in planning are investigated. The research is guided by the following questions: 1) How are CC risks addressed in Dominica's climate-relevant national policies and action plans? 2) Which aspects of these existing policies are reflected in the CMSP? 3) What are existing barriers preventing effective integration of CC adaptation and mitigation measures in Dominica's CMSP, and what are potential pathways to achieving this?

Results

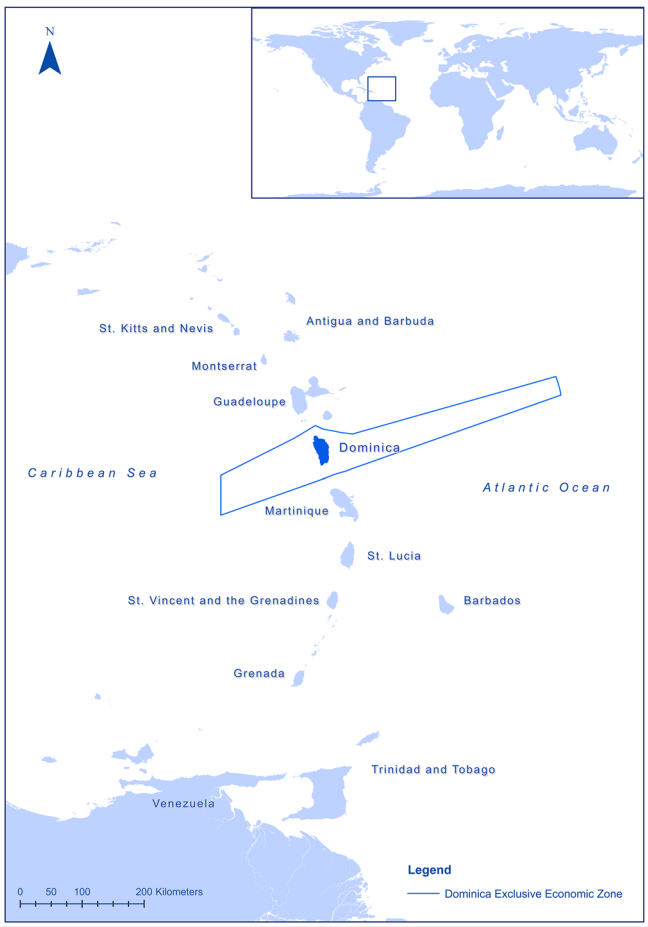
Climate Change Integration in the Risk Assessment Mapping of the CMSP

CC is an integral part of Dominica's CMSP. Both components of the CMSP, the marine spatial and the coastal master plan, make use of a risk assessment mapping (RAM), undertaken to identify 'hotspots' in the coastal area that were most vulnerable to the impacts of a changing climate[27]. The RAM comprises three components: 1) human-related activities as identified by an EBM-DPSER (Ecosystem Based Management, Drivers-Pressures-State-Ecosystem-Services-Response) model; 2) ecosystems with various species and ecological state components; and 3) CC impacts on ecosystems and their inhabitants[27] with insight from the Intergovernmental Panel on Climate Change (IPCC)[14].

For the risk hotspot analysis, combined risks of interactions between human activities, the coastal and marine ecosystem and CC were depicted in a risk assessment map for the nearshore coastal area (CMSP: Figs. B2–1, *Risks in the Nearshore Coastal Area*[27]). The map illustrates regions with elevated risk levels, where higher risk values indicate a greater risk of conflicts arising from competing uses. For example, one hotspot identified is Canefield, where natural gas and petroleum industries are located close to the coast, implying a high risk of contamination with rising sea levels. The RAM was developed employing a risk scoring approach, which incorporated a CC risk factor

Box 1 | I The Commonwealth of Dominica

Located in the Caribbean archipelago, surrounded by the waters of the Atlantic Ocean and Caribbean Sea (Box Fig. 1), Dominica is a mountainous volcanic island nation with an area of 754 km² and an EEZ of 28,552 km² (land to sea ratio of 1:38). The island is a part of the Caribbean large marine ecosystem, a global marine biodiversity hotspot characterised by tropical ecosystems including coral reefs, mangroves, seagrass, sandy beaches and rocky shorelines[63]. Due to its limited continental shelf area, which is narrow with a 50 m depth contour at a maximum of 2.8 km from the shore[64], much of its maritime jurisdiction comprises deep waters, home to marine biodiversity unique to the region. Dominica has approximately 72,000 inhabitants, which includes the Kalinago, an indigenous population, the last remaining among the islands of the Eastern Caribbean region[60]. Due to its topography, approximately 75% of Dominica's built development, including critical infrastructure, is located within a narrow coastal zone[29]. Tourism is the largest contributor to the economy, accounting for 12.2% of the GDP in 2019[65]. The fisheries sector is economically and socially important as well, contributing to the GDP, supporting socio-cultural practices and sustaining coastal communities[60], including indigenous populations[23].



Box Fig. 1 Map of Dominica. Location in the Caribbean Sea and Atlantic Ocean and the spatial extent of its Exclusive Economic Zone (maritime boundaries shown based on claims as not all boundaries have been formally delimited).

based on CC risk assessment levels as part of the EBM-DPSER model[27]. CC has the potential to impact all DPSER relationships[27].

The IPCC Special Report on the Ocean and Cryosphere in a Changing Climate[14] was used to assess the impacts of CC on coastal and marine ecosystems under the Representative Concentration Pathway (RCP) 8.5 scenario ("business as usual scenario") for greenhouse gas (GHG) emissions. The added risk to specific coastal and marine ecosystems was evaluated based on observed and projected climate impacts from multiple climatic hazards, including ocean warming, deoxygenation, acidification, nutrient changes, particulate organic carbon flux and sea-level rise. All CC risks for Dominica not explicitly addressed in the 2019 IPCC report were assessed by the CMSP project team, using scientific evidence and local and regional knowledge. These assessments applied risk levels developed by the IPCC (e.g. very high, high, moderate). For example, there is a high estimated CC impact on demersal and pelagic fish populations and a very high risk for the Caribbean spiny lobster due to ocean acidification[27].

Climate Change in Dominica's CC-Related Policies and the CMSP

Resilience, Adaptation, Mitigation, Sustainable Development, and Governance represent the main pillars of CC policy in Dominica (Table 1) and were guiding themes throughout the analysed policies (Table 2). The five themes described below (1) - (5) establish a connection between the CC elements of the national policies and how these elements are integrated into the CMSP.

Table 1 | Codebook of themes and codes derived from climate change-related policy analysis in Dominica

#	Theme	Code
1	**Resilience** *Resilience refers to "the ability of a system, community or society exposed to hazards to resist, absorb, adapt to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions"*[60].	1. Restore, conserve and sustainably manage the coastal and marine environment to enhance the resilience of ecosystems 2. Hazard preparedness: early warning systems 3. Emergency preparedness: training for vulnerable communities 4. Climate-resilient transportation
2	**Adaptation** *Adaptation refers to "all steps taken to cope with the adverse effects, including an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities"*[60].	1. Restoration of coastal and marine ecosystems 2. Climate resilient infrastructure 3. Decentralised infrastructure
3	**Mitigation** *Mitigation refers to "human interventions to reduce the sources or enhance the sinks of greenhouse gases, thereby slowing the rate of global warming"*[60].	1. Protect and enhance the coastal and marine environment to preserve carbon sinks 2. Offshore marine renewable energy 3. Low-carbon transportation system
4	**Sustainable Development** *Sustainable development refers to the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*[61].	1. Sustainability at the core of all CC responses 2. Blue economy 3. Sustainable economic development 4. Sustainable blue financing 5. Interlinkages among SDGs 6. Contributions to different SDGs 7. Social development 8. Protect cultural resources 9. Access and benefit sharing 10. Sustainable sectoral transformation (e.g. tourism, fisheries) 11. Intra- and inter-generational equity 12. Gender equity and inclusivity 13. Long-term development objectives
5	**Governance** *Governance refers to "the interactions among structures, processes and traditions that determine how power and responsibilities are exercised, how decisions are taken, and how citizens or other stakeholders have their say."*[62]	Management: 1. Risk-based management 2. Ecosystem-based approach 3. Environmental liability 4. Transboundary cooperation 5. Adaptive governance 6. Flexibility 7. Integrated management (e.g. ICZM, IOM) Precautionary measures: 8. Inter-sectoral and cross-sectoral collaboration 9. Stakeholder engagement and involvement 10. Enforcement Ocean literacy and awareness: 11. Ocean literacy and awareness raising 12. Environmental stewardship Monitoring and evidence-based decision making: 13. Sound science and best practice 14. Continuous monitoring, evaluation and research

They provide a framework for assessing the integration of climate change in Dominica's integrated coastal master and marine spatial plan (CMSP). Abbreviations used: climate change (CC), sustainable development goals (SDGs), integrated coastal zone management (ICZM) and integrated ocean management (IOM).

(1) The CMSP largely incorporates Resilience as a central theme by introducing measures to achieve the implementation of restoring, conserving and sustainably managing the coastal and marine environment, hazard and emergency preparedness and a climate-resilient transportation system (Table 1). It refers to the vision of the National Ocean Policy (NOP), which outlines a firm commitment to "ensure resilience to climate impacts"[27,28]. CC was streamlined into blue economy priority projects with climate resilience representing one out of five blue economy outcomes in the coastal master plan. The outcome refers to investments and actions focussed on climate mitigation and adaptation adding to greater resilience to natural disasters and CC impacts[27]. The CMSP also incorporates disaster and climate resilience considerations and recommendations in every project proposed based on the RAM undertaken[27]. Proposed projects for increased climate resilience include developing green energy infrastructure, replanting Dominica's littoral forest and creating resilient fisheries infrastructure, such as boat storage facilities in specific identified locations (CMSP: Figs. C3–1, *Proposed Priority Projects Focused on Climate Resilience*[27]).

(2) & (3) Adaptation and Mitigation measures are also reflected in the CMSP, particularly in the coastal master plan. The CMSP emphasises adaptation measures while focussing on restoring and protecting critical habitats as well as safeguarding coastal infrastructure[27]. Nevertheless, the country has set emission reduction targets to protect carbon sinks through, e.g., the creation of additional marine reserves, transition to a low-carbon transportation system, and the goal of using 100% renewable energy by 2030, mainly through exploiting its geothermal energy resources[29,30]. Although investments in offshore renewables are stated as an intervention towards achieving climate resilience in the 'Blue Economy Outcome' of the CMSP[27], it was not found to be part of sectoral policies.

(4) Sustainable Development is a common thread through the CMSP, linking actions with specific Sustainable Development Goals (SDGs) and achieving the 2030 Development Agenda[27]. The Eastern Caribbean Regional Ocean Policy (ECROP)[31] and NOP, in particular, highlight the role of Blue Economy Development in achieving the SDGs, including SDG 13 Climate Action, considering interlinkages among the goals[28,31]. Additionally, sustainable blue financing mechanisms have been recognised to play an important role, as well as partnerships and collaborations with the private sector and foreign donor agencies.

(5) Environmental management and governance principles associated with several agreements to which Dominica is a signatory, such as the 2018 National Resilience Development Strategy 2030 (NRDS) and the 2019 NOP, permeated the policies[20,28] and are central to the CMSP[27]. Approaches comprise the sustainable use of marine resources, collaborative

Table 2 | Dominica's climate-relevant legal instruments, policies and action plans at the national, regional and international levels until 2021

Governance Level	Climate-Relevant Policies and Action Plans
Global	1992 United Nations Framework Convention on Climate Change (UNFCCC)
	1992 Convention on Biological Diversity (CBD)
	2015 Sendai Framework for Disaster Risk Reduction 2015–2030 (non-binding)
Regional	2013 Eastern Caribbean Regional Ocean Policy (ECROP)
	2016 St George's Declaration of Principles for Environmental Sustainability in the OECS
	2018 Eastern Caribbean Regional Climate Change Implementation Plan
	2021 OCES Climate Change Adaptation Strategy and Action Plan (CCASAP)
National	Dominica Low-Carbon Climate Resilient Development Strategy 2012-2020ˣ
	National Climate Change Policy and Action Planˣ
	2012 National Fisheries Policy for the sustainable use of marine resources and aquaculture (Draft)*
	2013 National Biodiversity Strategy and Action Plan*
	2013 National Tourism Policy*
	2014 Dominica National Land Use Policy*
	2015 Intended Nationally Determined Contributions*
	2016 National Physical Development Plan*
	2018 National Resilience Development Strategy 2030*
	2019 National Ocean Policy (Draft)*
	2020 Dominica Climate Resilience and Recovery Plan*
	National Climate Change Policy and Action Planˣ

National policies and reports marked with a star (*) were analysed in the qualitative document analysis, and national policies marked with an X (ˣ) were unavailable.

management, cumulative impact analysis, education and information enhancement and scientific and technological information sharing[27]. Additionally, the CMSP in Dominica was developed with a Blue Economy lens, aiming at achieving Dominica's vision of maximising the potential of its Blue Economy, applying an integrated, multiple-use ocean planning approach to managing coastal and marine resources. Various methodologies and tools that apply several conceptual frameworks, i.e., Island Systems Management (ISM), Ecosystem-based management and Integrated Coastal Zone Management (ICZM)[27,31], were incorporated. ISM is particularly relevant in the context of islands, as it takes a holistic, ridge-to-reef approach, where the interactions and interdependencies between the terrestrial and marine environments are considered in planning[27].

Barriers and Pathways

The CMSP widely considers CC by employing relevant tools and data[27] and incorporating measures for *Resilience, Adaptation, Mitigation, and Sustainable Development* based on CC-relevant principles and governance approaches (Table 1). However, despite these efforts, barriers persist and impede more effective integration of CC. Several barriers and potential pathways towards achieving climate-smart ocean planning in Dominica have been identified.

The CMSP was partially developed during the COVID-19 pandemic[27], which required adjustments to the work plan, specifically a move from in-person to virtual stakeholder engagement activities[27,32,33]. There was also a change in the timeframe for the delivery of the plans, from 48 months to 30 months, due to administrative delays at the project's inception, which presented an additional challenge to the process[32,33]. In 2021, the CMSP was completed for Dominica, but up until February 2025, it had not yet been formally adopted or implemented[32] due to several factors, including a lack of ownership and institutional arrangements discussed below.

Additional factors impeding progress towards implementation of the CMSP and CC-relevant policies are connected to policy-making processes. The CMSP notes that long-term sustainability is often hindered by a legislative and institutional environment that does not allow mainstreaming interventions beyond project-based actions, having implications for both the implementation and institutionalisation of plans[27,32]. Dominica's NOP directs that MSP should be established and implemented[28]. Several pieces of key legislation that address coastal and maritime areas and maritime activities in Dominica will guide the implementation of the CMSP, some of which are in draft for approval, such as the Climate Change, Environmental and Natural Resource Management Bill 2016 and the Fisheries and Aquaculture Policy for the Commonwealth of Dominica 2012 – 2037, developed in 2012. After a significant delay, fisheries regulations that seek to improve fisheries management and modernise approaches were passed in 2023. Generally, policy-making in Dominica is challenged as it operates within a governance system where a siloed approach to sectoral policy-making is an additional contributing factor to impeding progress. Review and evaluation processes easily drop down the state's list of priorities, particularly when the process is not institutionalised and/or the coordination mechanism has not been operationalised. Moreover, the system is hampered by resource and capacity challenges to enforce existing legislation effectively[32].

Limited technological infrastructure, capacity and resources impede access to relevant data crucial for advancing efforts on CC in ocean planning. Limited access to ocean monitoring infrastructure (e.g. buoys, vessels), funding, and human resource constraints hamper data collection and efforts to fill knowledge gaps. For example, the economic value of Dominica's biodiversity assets is largely unknown due to a lack of data[27]. Additionally, access to ocean data is restricted by proprietary rights, data exclusivity, and departmental or agency policy, making it difficult to obtain, use, share and build upon existing knowledge. This is compounded as there is variability in data quality and standards across different sources, which can impede effective knowledge integration[32,34,35]. Beyond these challenges, stakeholders call for more timely information sharing and transparency in how data is collected and used[32].

A critical need for the country is to advance a system to facilitate regular updating of data. As one interviewee noted "sharing data, build[ing] a platform for data sharing and housing data and updating data is probably one of the things that [..] is a limitation to being flexible[32]." The shared regional-level spatial data platform[36], for which the islands need to collaborate to populate and maintain[26], must be developed further. Additionally, the development of detailed zoning was challenged by the lack of offshore data at the time the CMSP was developed[27,32]. The offshore zoning framework (CMSP: Figure B3-8, *Offshore Marine Zoning Framework*[27]) is more conceptual in nature[27] and requires a higher level of detail to guide decision-making and implementation. Subsequent plans can benefit from additional data relevant to assessing CC impacts on biodiversity and resources, including how spatial locations of maritime activities (e.g. fishing, tourism) may change, particularly for the deeper, less explored offshore areas. The data required should have a high level of detail and be site-specific[32].

A great number and diversity of stakeholder groups were consulted throughout the CMSP planning process[27], including academia, community members, the Kalinago, non-governmental organisations, private sector entities, and the public sector. Emphasis was placed on prioritising vulnerable communities, especially those engaged in fisheries and tourism, and the Kalinago due to their important role in Blue Economy development[27], as well as their valuable local ecological knowledge[37]. An End-of-Project Review and Evaluation report of the CROP was conducted by two consultants contracted by the OECS commission to evaluate the CROP's effectiveness, impact, relevance, and sustainability for all five participating countries. The report stated that in the project, efforts were made to involve all relevant stakeholders, and the level of participation was reasonably high,

however, some sectors reported limited participation. Overall, stakeholders' participation, cooperation and equity was assessed as "moderately satisfactory"[33].

The present study revealed that stakeholders, particularly those in state agencies and involved in the planning process, already have a good level of awareness about CC, its impacts and why climate-smart MSP is required: "You cannot do good marine spatial planning without including climate change. To me, that is not scientifically sound, nor is it going to be effective in the future[32]." At the societal level, the CMSP recognised the need for widespread awareness-raising and proposed a national education campaign led by the state as one of the projects for implementation under the plan[27]. Promoting awareness can serve a dual purpose, not solely to promote understanding of the value of the CMSP for moving forward but, crucially, to foster a sense of ownership. Only if all stakeholders are aware of the importance of the CMSP can they operationalise and implement it on a local level[32]. However, factors such as understaffed agencies and departments[32] and "zoom fatigue"[33] contributed to the limited participation of certain stakeholder groups. Post-delivery of the CMSP, particular stakeholders have expressed concerns about the final output due to having expectations of a more readily implementable plan, contributing to a feeling of a lack of ownership with the CMSP. Also, although the Climate Resilience Execution Agency for Dominica (CREAD), the national coordinating body for implementing CC policies, was consulted during the planning process, our findings indicate that their role in the CMSP implementation was unclear[32].

Financial capital for implementing CC projects, including data collection, is limited, and allocating funds to climate action faces additional challenges from external factors. Dominica largely depends on external funding from organisations, development banks and governments of developed countries[32]. However, funding is often channelled into developing plans with considerably less budgeted for subsequent implementation. If a project runs out of funding, work is often halted and tends to regress to its earlier status before the financial investment[32]. Furthermore, government funding is usually allocated to more pressing needs. For example, in 2017, Hurricane Maria led to an immediate reordering of priorities at the national level[32].

Additionally, the analysis reveals that even if more financial resources were available, developments are expected to happen slowly due to limited human resource capacities. Critical departments in Dominica's state ministries and agencies are understaffed[32], and specific technical skills required for climate-smart ocean planning are limited in the island's workforce.

The National Ocean Governance Committee (NOGC), in its role in implementing the NOP, coordinates projects to deliver CMSP objectives. In 2023, two years after the completion of the CMSP, the NOGC was not yet established, stalling the progress of plan implementation and development towards climate-smart ocean planning[32]. Significant challenges face those responsible for MSP who seek to coordinate among the various stakeholders and interests in developing and implementing the plan. Differing sectoral interests and governance arrangements between agencies can make joint working challenging. This was highlighted by one interviewee: "We talk about mainstreaming, we talk about integration, but we don't really work together at that level all the time[32]." Difficulties in sharing information are other impediments identified by interviewed stakeholders. As the Dominica NOP outlines, the cross-sectoral NOGC must be convened with a mandate to implement the policy objectives, including the CMSP. This committee must be formalised and operationalised for work to commence. As one participant pointed out, "using a coordinated, integrated body like a NOGC would be a great starting point…[32]", particularly with regard to bridging the implementation gap, as the diverse perspectives can support a coordinated approach to implementation, as well as potential revisions to the plans. Furthermore, to increase the adaptability and flexibility necessary for addressing CC, the diversity of perspectives and stakeholders within the NOGC can better inform future planning initiatives and how the plan can integrate CC considerations holistically. However, simply having a cross-sectoral group like the NOGC does not automatically imply a more integrated approach, as it is difficult for state ministries and agencies to break out of the siloed approach to ocean management[32].

Discussion

This study does not critically evaluate the methodology of the RAM used in the CMSP, but it rather highlights a method used to integrate CC considerations. The authors would like to emphasise that a focus on the implementation and how climate-smart ocean planning can practically be achieved was intentionally chosen due to the special circumstances of SIDS. The qualitative data analysis employed inductive reasoning, and we acknowledge that this is open to limitations, including researcher bias. To mitigate this, analytical responsibilities were shared among two researchers. Results may lack generalisability to other geographical regions. Another limitation stems from the scarcity of studies about CC-integration in MSP conducted thus far. Also, the unavailability of two pertinent policies - the Dominica Low-Carbon Climate Resilient Development Strategy 2012-2020 and the National Climate Change Policy and Action Plan - posed a constraint to the policy analysis. Moreover, it is important to note that the number of interview participants was limited to ten. Considering Dominica's population of 72,000, the pool of professional-level staff in the various government ministries and agencies is small, often comprising core teams of one to three persons. Lastly, developing themes and codes proved challenging due to the cross-cutting nature of CC. It may be prudent to consider alternative categories and groupings.

CC is addressed in Dominica's climate-relevant national policies and action plans (Table 2), as evidenced by the resultant codes and associated themes outlined in the assessment framework (Table 1). These themes categorise the codes into five overarching groups: Resilience, Adaptation, Mitigation, Sustainable Development and Governance. However, alternative groupings can be considered for the sustainable development and governance themes, which currently encompass a broad selection of codes that could be further subdivided into more specific themes. For instance, 'Blue Economy' could be an additional theme, given its prominence in policy discussions post-Hurricane Maria and its focus on creating opportunities to enhance livelihoods for the people of Dominica[27,32]. The integration of CC aspects from the national policies in the CMSP has been explored, showing that resilience, adaptation, mitigation, sustainable development and governance measures from Dominica's CC-related national policies and action plans are reflected in its CMSP. Implementing adaptation measures over prioritising mitigation efforts stems from the fact that Dominica is not a net contributor to global GHG emissions[30]. Although Dominica explores renewables, the marine environment is deemed to have limited potential for them[21,30]. Hence, there has been little effort to explore this further.

Research connected to climate-smart ocean planning thus far has focused on the content of plans, but this study shows that it is worthwhile to consider this issue in a broader context. Additional critical factors that impact the development of climate-smart planning are governance, management, politics, geography and other contextual factors such as financial, human and technical resources. We argue that climate-smart ocean planning must not consider the CMSP in isolation but rather the whole process, including plan making, implementation and revision, as well as contextual factors, while critically reflecting possibilities to integrate adaptive, flexible, and long-term governance approaches. The zonal approach and the corresponding rights and obligations of States as established in the UN Convention of the Law of the Sea[38] may be accounted for in these contextual factors. However, exploring this connection further is outside of the remit and scope of this paper.

Scholars call for dynamic and flexible MSP for CC integration. Planning objectives must be adaptable based on changing climate conditions[7]. Yet, this is one of the greatest challenges Dominica faces. Given the financial, human and technical resource constraints, conditions limit the ability to plan flexibly and dynamically. One participant in the interview summarised the challenge inherent in the current situation: "We know what to do, but we can't get it done." The gap between what is in the CMSP and other associated

planning documents and what is practically implemented is characteristic of plans addressing changing conditions[7] and the SIDS context in general[11,34]. In Dominica, reasons for this include the lack of institutionalisation of ocean planning and the particularities of the context. Implementation of the CMSP requires approval and ratification by the cabinet. To achieve this, CMSP implementation must become a priority, both at the institutional level and on the political agenda.

Political cycles additionally impact the development and implementation of plans, with the political level being an important driver of issues. With 5-year political cycles, the timeframe is often limited to delivering short-term goals rather than pursuing longer-term development objectives, as CC requires. Generally, decision-making processes focus more on short-term wins for different stakeholder groups. However, in changing conditions, there is a greater need to plan for both short- *and* long-term[12]. The resource and capacity constraints further limit opportunities to plan ahead[32].

Data challenges hinder effective marine management strategies[39], including addressing CC. This is a challenge facing SIDS across the region[34]. The inherent framework nature of the CMSP provides stakeholders with some flexibility, presenting an opportunity for applying a phased approach to implementation when funding becomes available. However, this requires more detailed zoning, particularly for the offshore area. When required offshore data becomes available in the future, the implementation of detailed offshore marine zoning can improve the allocation of ocean uses, which may also benefit CC adaptation and mitigation. Importantly, ensuring the adaptability of established zones is crucial, given that CC may affect optimal locations for different uses. This necessitates the availability of sound climate projections. Therefore, climate-smart MSP in Dominica should consider developing these zones and specific mapping and modelling strategies that consider the temporal and spatial dynamics of marine ecosystems - as they are vital for each maritime sector.

Developing knowledge, skills and awareness of key stakeholders and those facilitating the process is crucial for better outcomes. Further engagement of a broad range of stakeholders may likely increase collective ownership of the CMSP[40,41]. Yet, training opportunities for upskilling are limited, resulting in a high migration rate of particularly young adults leaving to neighbouring islands or mainland U.S.A[42]. Dominica is among the top 20 countries in the world with the highest emigration rates of educated labour[43]. This 'Brain Drain'[42] intensifies difficulties of both planning and implementation, especially when specific technical skills are required. To tackle Dominica's limited human resources, training opportunities through long-term capacity-building programmes for CC and MSP led by the CREAD and/or the NOGC are required, along with incentives to encourage people to stay on the island and work in ocean planning and related fields.

To limit further losses caused by CC impacts, investments in adaptation and mitigation measures are required to increase Dominica's climate resilience. Improving institutional capacity and acknowledging the need for a national budgetary allocation for CMSP processes and implementation can promote progress. National funding towards achieving climate resilience and external donor support for research, planning and implementation are priority areas for action. However, prioritised nearshore and offshore areas for detailed local-level planning must be identified before seeking financial support. Greater investments now contribute to significant cost savings in the long run when considerably fewer financial resources have to be allocated for response and recovery after, e.g., extreme weather events[3]. Long-term investments are an important lever for Dominica's economic development and increasing climate resilience. Future financial assistance may be obtained from a loss and damage fund established at the Conference of the Parties (COP) 27 and operationalised at COP28[44].

Exploring synergies can be another way of dealing with Dominica's limited financial, technical and human resources. CC mitigation and adaptation measures, such as building climate-resilient infrastructure and restoring coastal and marine ecosystems (Table 1), must be further developed to increase the island's resilience. In the long-term, measures that support SIDS like Dominica in climate-smart ocean planning through, e.g., financial or human resources, are vital. However, since timely action is needed, we argue that it is crucial to harness the full potential of what is already available and to promote the multi-use of resources. This could be done through, e.g. implementing measures with synergistic effects, such as protecting or restoring seagrass meadows. They buffer wave energy, provide habitats for marine species and sequester carbon dioxide. This benefits the fisheries and tourism sectors, enhances coastal protection and contributes to CC mitigation. Also, the establishment of a new whale sanctuary for the island's substantial sperm whale population serves the dual purpose of protecting the whales while sequestering significant amounts of carbon dioxide[45]. Sectoral synergies, e.g., between fisheries and tourism, should also be explored.

Adapting the CMSP is another way to advance climate-smart ocean planning in Dominica, potentially leading to positive change if the contextual and implementation challenges are addressed. The current CMSP provides a zoning framework with scenarios. Developing more detailed zoning plans with CC-specific long-term priorities, deliverables and objectives, including concrete goals for implementation, review and evaluation processes, can present a pathway to improving the 'climate-readiness' of subsequent iterations of the plan. Having detailed and regimented evaluation and review processes for ocean planning can encourage greater adaptability in the future and is essential when dealing with uncertainties and changing conditions[46]. An approach to addressing this could include objectives based on SMART deliverables. These objectives are formulated to make it easier to reach the goals as they are specific, measurable, achievable, relevant and time-bound. Although literature stresses the importance of formulating SMART objectives[47], plans often include only vague objectives[46,48]. Including additional SMART deliverables in Dominica's plan in the next revision may help reach long-term goals consistent with Dominica's aspiration to become climate resilient.

Other tools and management strategies can be employed to consider CC in the CMSP even more. Firstly, management strategies may not only target areas especially vulnerable to CC, i.e. the hotspots, but also areas where new opportunities for different sectors may arise due to the change, i.e., bright spots[13]. CC leads to redistributing marine species[49] and adversely impacts marine ecosystems. This affects ecosystem services with consequences for all maritime sectors, the fisheries sector in particular[14]. For example, highly migratory open-water species, especially reef-associated species, are vulnerable to CC in Dominica[24]. Mapping out bright spots and exploring associated potentials of changes could benefit climate-smart ocean planning in Dominica. Secondly, using decision support tools that provide scenarios on how CC and human activities impact marine and coastal environments can assist planners. These tools consider spatial and temporal developments and help develop adaptation strategies[50]. Thirdly, scientists argue that dynamic ocean management approaches can provide flexibility and increase the sustainability of planning initiatives connected to marine resources as they take shifts and changes of ocean resources and uses through CC into account[7,51]. Since dynamic ocean management may increase the efficiency and efficacy of fisheries management[52], it may be worth considering this for Dominica's fisheries as soon as necessary data becomes available.

Overall, three ways forward outline the most critical aspects for implementing climate-smart ocean planning in Dominica. Firstly, prioritise the establishment of the NOGC - the coordinating body responsible for CMSP implementation and revision. Continuity of the planning cycle must commence now for a climate-resilient Dominica in the future. Additionally, policies in draft must be adopted and entered into force. Secondly, a solid baseline of data is central for advancing climate-smart ocean planning. Through the NOGC, a strategy and mechanism for improving coordinated data collection, sharing and access can be developed and implemented, as well as for populating the regional-level platform where geospatial data is kept and organised. Additional data on CC impacts is needed, especially for the offshore area, to explore dynamic zoning approaches and develop SMART objectives. Further research to inform climate-smart ocean planning is required. Particularly, quantitative studies about CC integration into

ocean planning and context- and region-specific studies should be performed. Although additional data would open opportunities for advancing climate-smart ocean planning, we argue that sufficient scientific evidence about CC and the barriers and challenges of Dominica exists to take action now. Thirdly, financial resources are critical for Dominica to take the next steps. Engaging in partnerships with external agencies and donors presents a significant opportunity as soon as priority areas for detailed planning are identified and prior investment commitments made during the plan development are confirmed. Once financial resources become available, the focus should be on long-term investments for CC mitigation and adaptation in Dominica's marine and coastal space. It should be noted that a complex donor system coupled with the limited capacity of SIDS, such as Dominica, which have small government structures and at times rely on external agencies to broker on their behalf, may influence the type of projects funded with potentially adverse impacts for climate resilience[53]. Specific projects funded, while well-intentioned, may not always result in positive change as the aid might be limited to a single intervention that does not address the underlying issue. Meaningful engagement with local stakeholders can be a way of preventing those effects[54].

To summarise, Dominica has ambitions of becoming the world's first climate-resilient nation. Mainstreaming CC into ocean planning presents an opportunity to advance efforts towards achieving this. Dominica is also among the few SIDS having a CMSP and considering CC in its planning initiatives. The analysis has revealed that Dominica's CC-relevant national policies and action plans included measures for adaptation, mitigation, resilience, sustainable development and governance. The results indicated that those measures were largely reflected in the CMSP and that, above all, greater consideration was given to adaptation measures, such as building of climate-resilient infrastructure, in contrast to mitigation measures. Dominica's CMSP incorporates CC through the application of a risk assessment and hotspot analysis, recognising CC impacts on ecosystems and species while following IPCC's 1.5 °C scenario. However, it must be acknowledged that to date, the CMSP has not been adopted or implemented and that there is no system for the plan's evaluation, revision and updating. Because Dominica's options are limited, it is particularly challenging to address the need for climate-smart ocean planning. Legislative gaps, limited data and challenges with data sharing and access, financial and human resource constraints and lack of a coordinating mechanism for implementation and revision of the CMSP have resulted in stalling the Dominica CMSP, compromising the realisation of long-term visions set out in the plan. In the event of extreme weather or other impacts, severe devastation requires immediate, short-term action to rebuild, resulting in a shift in priorities. This adversely impacts ocean planning and the ability to effectively plan for a changing climate: Human, financial and technical resources are limited, and long-term objectives are often a lower priority in the face of more pressing needs, including restoring public utilities, critical infrastructure, roads and homes. These barriers also challenge the need for flexible planning, leading to continued economic, social and environmental losses from CC, now and in the future, as CC impacts are expected to increase in severity and frequency in the coming years[1].

To move forward, it has been shown that advancing climate-smart ocean planning requires developing context-specific, feasible solutions. This study suggests that climate-smart planning in SIDS must consider broader contextual factors that impact the processes for plan-making, implementation, revision, and updating. Due consideration must be given to the bigger picture.

Methods

Case Study: The Commonwealth of Dominica

Dominica was selected as the case study for this research due to several reasons. Dominica is especially vulnerable to the impacts of CC and, at the same time, is particularly dependent on the ocean space and its resources due to its unique geography. It is categorised as SIDS and has developed a CMSP. Among SIDS, Dominica is one of the few countries with a marine spatial plan and stands out with the ambition to become the first climate-resilient nation in the world. These characteristics make Dominica an interesting and relevant case for studying climate-smart ocean planning in a SIDS, highlighting its particular need and ambitious goal towards climate resilience.

Dominica is subject to a multi-level governance landscape, including legal instruments, policies, and action plans addressing CC adaptation and mitigation measures at national, regional, and global levels, with the majority delivered within the last decade (Table 2). Dominica has ratified the United Nations Framework Convention on Climate Change (UNFCCC), under which nationally determined contributions (NDCs) have been formulated based on the Paris Agreement[29,30]. As a member of the Organisation of Eastern Caribbean States (OECS), an intergovernmental organisation formed in 1981[55], the St George's Declaration of Principles for Environmental Sustainability (2001, revised in 2006)[56] is the overarching policy for environmental management. Principle 8, 'Address the Causes and Impacts of Climate Change', contributes to the overarching goal of building the capacity of members to guide and support sustainable development processes. The OECS's regional ocean policy, the ECROP[31] (2013, revised in 2019), has the main goal of having all members manage CC through appropriate adaptation and resilience strategies. Both the St George's Declaration and the ECROP are guiding but not legally binding. Policies to further advance the regional response include the 2018 Eastern Caribbean Regional Climate Change Implementation Plan[57] and the OECS Climate Change Adaptation Strategy and Action Plan (CCASAP) 2021–2026[58]. Since the ratification of the UNFCCC, national-level CC policies have been formulated to address the increasing impacts. The NRDS aims to guide climate-resilient, sustainable development, which comprehensively responds to CC[20]. The subsequent formation of CREAD to lead and coordinate cross-sectoral initiatives to achieve the goal of increased climate resilience marks a period with CC having high priority on the political agenda[20].

Policy and CMSP Analysis

This study conducts a qualitative document analysis consisting of two parts. Since no framework currently exists to assess the climate-readiness of marine spatial plans, the first step was to develop a scheme to guide the analysis. For this, nine national policies and action plans were examined (Table 2) by two independent coders. These documents were identified through a search of policies and action plans explicitly addressing CC and/or approaching adaptation, mitigation or resilience measures in sectoral policies. Except for the 2015 Intended NDCs, which were only indirectly referred to through the UNFCCC, all national policies were directly cited in the CMSP. Initially, the authors independently read the documents to gain an overview of their contents. Subsequently, all CC-related information from the policies and action plans was gathered and thoroughly examined before an inductive analysis of the CC-related content of the policies and plans led to the identification of codes. These codes were then sorted, streamlined, restructured and ultimately combined into themes. A total of five themes comprising 37 codes were identified, forming an assessment framework applied in the second part of the analysis, the deductive analysis of the CMSP. For this second part, the authors read the CMSP and allocated its contents to the previously developed codes using the software Nvivo[59]. The associated codes provided more specific measures and actions. The aim was to determine which CC-related aspects of the national policies and action plans were considered in the CMSP.

Semi-Structured Interviews

Complementary to the policy and CMSP analysis, eight semi-structured interviews with ten participants were conducted to obtain further information and fill gaps identified, especially connected to plan development, revision and implementation processes. Interviewees had various backgrounds, working in agencies at national and regional levels: fisheries, tourism, maritime administration, project management and consultancies. All participants had a role in the development of Dominica's CMSP (Table 3). After contacting the participants via email, the interviews were

Table 3 | Interview Participant Grid, including the sector, number of people and their role in Dominica's CMSP development

	Interview Participants by Sector	Number	Role in Dominica's CMSP Development
Government	Fisheries	3	Attendance at workshops/consultations and lead agency for developing and implementing the CMSP in Dominica
	Tourism	1	Attendance at workshops/consultations
	Maritime Administration	1	Attendance at workshops/consultations and review of plans
Consulting	International and Regional Consultants	4	Leading the development of the CMSP, including its methodology, data collection and stakeholder engagement (international consultants) and review of the CMSP (regional consultants)
Project Management	Regional-Level Project Management	1	Project management and technical guidance for developing the CMSP in Dominica (and other OECS member states)

The information is derived from the interviews and the CMSP.

conducted between 6 and 29 November 2023 via online video communication and lasted between 40 to 60 mins. Interview questions were structured around topics of CC, the political level and the processes of the CMSP development in Dominica. The authors separately analysed the transcripts and compared the results. Two participants requested a return of the transcript for internal review, and three interviewees provided feedback on the findings (Supplementary Table 1). Given the small number of people involved in Dominica's CMSP development, data was anonymised. All participants signed a consent form stating that personal information will not be published.

Data availability

The datasets generated and analysed in the present study are not publicly available due to their sensitive nature but can be provided by the corresponding author, J.B., upon reasonable request. This protects the interviewees' anonymity. Informed consent was obtained from each participant based on the World Maritime University's requirements. A checklist for consolidated criteria for reporting qualitative studies (COREQ) is provided within the supplementary material.

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Author contributions

J.B. and S.M. conceptualised, conceived and designed the study, analysed and interpreted the data, wrote the manuscript text and edited and revised the work. Project administration was led by J.B. All authors read, edited and approved the final manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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