



Interacting adaptation constraints in the Caribbean highlight the importance of sustained adaptation finance

Emily Theokritoff^{a,b,*}, Adelle Thomas^{a,c}, Tabea Lissner^a,
Carl-Friedrich Schleussner^{a,b}

^a Climate Analytics, Germany

^b Geography Department & IRI THESys, Humboldt University of Berlin, Germany

^c University of the Bahamas, Bahamas

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ABSTRACT

Adaptation to ever intensifying climate change is of paramount importance to reduce its impacts, in particular for those at the frontlines of climate change such as the Caribbean Small Island Developing States (SIDS). However, a range of constraints make it harder to plan and implement adaptation and thus hinder adaptation progress. Here, we provide an assessment on regional perceptions of adaptation constraints and avenues to overcome them based on a mixed-method approach, combining an online survey and semi-structured interviews with adaptation experts from Caribbean SIDS. We find that finance is the largest constraint being faced which closely interacts with information, human capacity and governance constraints throughout the entire adaptation process. Such interacting constraints can lead to vicious cycles profoundly hindering adaptation and therefore need to be addressed in parallel. Our results highlight how adaptation actors at the national level, in particular national governments, have a key role to play when overcoming constraints for the implementation of adaptation projects at the local level, alongside regional and international organisations.

1. Introduction

Although adaptation efforts are increasing globally, there is limited evidence as to whether climate risks are being reduced (Berrang-Ford et al., 2021; UNEP, 2021) and with the escalating impacts described in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), current adaptation implementation rates may not keep pace with increasing levels of climate change (Schleussner et al., 2021; UNEP, 2021). This makes it urgent to gain increasing understanding of what makes adaptation challenging, in particular in regions at the forefront of climate change such as Caribbean Small Island Developing States (SIDS) (Fig. 1). Although Caribbean SIDS are diverse in terms of geography, population, culture and levels of economic and social development, they share inherent physical characteristics and challenges to sustainable development resulting in high levels of vulnerability to both climate and non-climate stressors (Nurse et al., 2014; Schleussner et al., 2018; UN General Assembly, 1994). Small islands are increasingly affected by changes in temperature, the growing impacts of tropical cyclones, storm surges, droughts, changing precipitation patterns, sea level rise, coral bleaching and invasive species (Mycoo et al., 2022). In addition, land erosion, flooding, droughts, storms and marine heatwaves and ocean acidification resulting in coral bleaching also affect the Caribbean region, in

* Corresponding author at: Climate Analytics, Ritterstraße 3, 10969 Berlin, Germany.

E-mail address: emily.theokritoff@climateanalytics.org (E. Theokritoff).

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particular the sectors of agriculture, fisheries, tourism and health (Hoegh-Guldberg et al., 2018; Thomas et al., 2020).

Adaptation has been described as a context-specific and often local process, however national as well as international frameworks play a key role in providing the boundary conditions for local to regional adaptation planning and implementation. One indicator of adaptation progress at the national level are sound policies and strategies, a fundamental requirement for adaptation (Filho et al., 2021; UNEP, 2021). In the last years, adaptation planning has increasingly been formalised by Caribbean SIDS, four countries have published their National Adaptation Plan (NAP) (Grenada (2019), Saint Lucia NAP (2018), Saint Vincent and the Grenadines (2019), Suriname (2020)) and numerous other sectoral policies and plans incorporating aspects of the climate change adaptation have been developed across the region (Thomas et al., 2019). Although these planning documents have some limitations (Thomas et al., 2019), they have resulted in the formulation of concrete adaptation options, such as climate resilient agriculture, ecosystem-based approaches and strengthened building codes (Robinson, 2018; Thomas et al., 2020).

Adaptation is a complex process during which a range of challenges can occur, that can be differentiated into constraints (or barriers) and limits (see Section 2.1). A recent literature review on the global evidence of constraints and limits to adaptation highlights that finance, governance, institutional and policy constraints are the most prevalent constraints globally and that compared to other regions, small islands report more challenges when adapting to climate change (Thomas et al., 2021). In the context of Caribbean SIDS, institutional governance, human and technical capacity, climate information and climate finance are the constraints most reported in literature (Klöck and Nunn, 2019; Mycoo, 2018; Robinson, 2018; Thomas et al., 2020). A review of National Communications submitted to the UNFCCC, which highlight adaptation progress and challenges, finds that finance is the most commonly reported constraint, accounting for 15 % of the reported constraints (Robinson, 2018). Governments of SIDS have expressed dissatisfaction with current levels of international adaptation finance and with their experience accessing it (Robinson and Gilfillan, 2016).

Several studies have already explored constraints arising amongst SIDS and more specifically Caribbean SIDS (Benjamin and Thomas, 2018; Filho et al., 2021; Klöck and Nunn, 2019; Mycoo, 2018; Robinson, 2018; Thomas et al., 2020). Klöck and Nunn (2019) review academic literature on adaptation in SIDS and report that overall limited human, technical and financial resources and significant knowledge and data gaps are being faced. Caribbean states suffer from research capacity constraints resulting in a lack of local data and systematic observations, in particular for slow onset events (Benjamin and Thomas, 2018). Filho et al. (2021) describe the governance and biological constraints occurring in Trinidad and Tobago as minimal institutional support to withstanding floodings is provided and land arability decreases. Governance constraints must be overcome if temperatures rise beyond 1.5 °C in order to conduct effective adaptation (Mycoo, 2018). Robinson (2018) investigates the National Communications submitted to the United Nations Framework Convention on Climate Change (UNFCCC) by in eight Caribbean countries and conducts interviews in Jamaica, St. Lucia

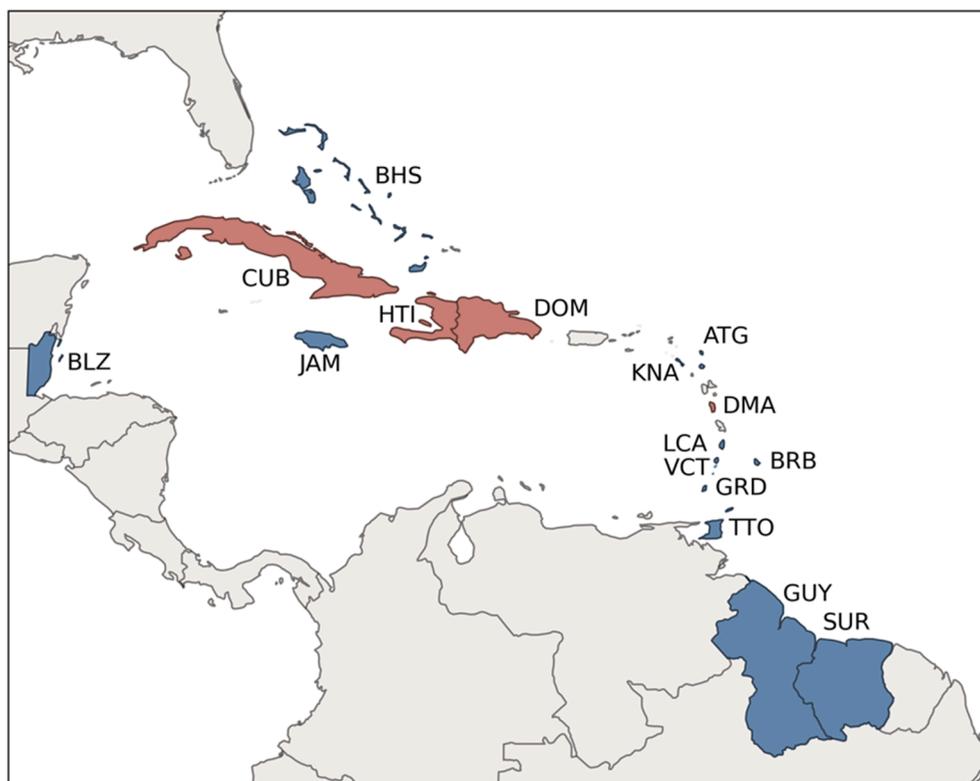


Fig. 1. Map of Caribbean SIDS (all coloured countries). The countries coloured in blue (12) were included in this study, countries coloured in red (4) were not taken into account. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

and regional Caribbean organisation. The study finds that finance is the most common constraint being faced, followed by human capacity and information constraints, although not all interviewees agree that finance is not constraint (Robinson, 2018). Thomas et al. (2020) provide a list of constraints and limits that can arise from a number of adaptation options relevant in SIDS. For example, with coral reef restoration, competing land issues can constrain adaptation and the increases in ocean acidification, temperature and sea-level rise could constitute biophysical limits for this adaptation option.

The existing literature therefore detects and analyses constraints in Caribbean SIDS but does not look into their dynamics and interlinkages, and rarely describes how they could be overcome. Filho et al. (2021) state that due to the high vulnerability of SIDS, more research on constraints and limits to adaptation is needed, to provide further knowledge on how their negative consequences can be reduced. The objective of this study is therefore to go beyond the identification of individual constraints by assessing regional perceptions on various constraint types to understand in more depth how they interact, what consequences they may have and how they could potentially be overcome. To do so, a mixed-methods approach is used to take stock of national, regional and scientific stakeholders' views on the most prominent adaptation constraints, to assess their interactions in detail and to identify ways in which they can be overcome.

2. Theory

2.1. Defining adaptation opportunities, constraints and limits

This study is based on the definitions of the Fifth and Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) of opportunities, constraints and limits to climate change adaptation (Klein et al., 2014; Mechler et al., 2020; Pörtner et al., 2022).

Opportunities to adaptation are defined as “factors that make it easier to plan and implement adaptation actions, that expand adaptation options, or that provide ancillary co-benefits” (Klein et al., 2014, p. 907). Increased awareness and the availability of additional resources for example can facilitate adaptation planning and implementation (Klein et al., 2014). The IPCC sets types of opportunities, used for classification purposes in this study, namely: awareness, capacity, tools, policy, learning and innovation.

Adaptation constraints are defined as “factors that make it harder to plan and implement adaptation actions” (Klein et al., 2014, p. 907). Lack of resources such as funding, technology or knowledge are common constraints which restrict the effectiveness and variety of adaptation options. The terms “barriers” and “obstacles” are considered synonyms of constraints (Klein et al., 2014). The IPCC also defines constraint types, namely: economic, social/cultural, human capacity, governance, institutions and policy, financial, information/awareness/technology, physical and biological (see Appendix A for more detailed information).

Limits to adaptation, “the points at which an actor’s objectives or system’s needs cannot be secured from intolerable risks through adaptive actions” (Klein et al., 2014, p. 907; Pörtner et al., 2022, p. 7), must also be acknowledged when looking at adaptation processes as they point out important thresholds that should not be surpassed. Single or multiple constraints can drive an actor or natural system to an adaptation limit (Klein et al., 2014). Recent literature has found that interacting constraints such as inadequate governance, insufficient financial resources and rigid cultural norms, can also result in limits being approached or reached (Thomas et al., 2021). With increasing climate change, more regions, sectors and communities will approach limits to adaptation (Dow et al., 2013) and in particular in the context of Caribbean SIDS, physical limits may be reached in a matter of decades due to the low-lying nature of islands and few economically feasible actions (Thomas et al., 2020).

However, in the field of climate change adaptation, researchers tend to use the terms of barriers, constraints and limits interchangeably, generally referring to factors that make adaptation more challenging (Dow et al., 2013; Eisenack et al., 2014; Moser and Ekstrom, 2010). In most cases, barriers and constraints are considered surmountable whereas limits are seen to be unsurpassable (Eisenack et al., 2014). Biesbroek et al. (2014) go one step further in distinguishing four analytical lenses which can be used to examine barriers: the optimist sees them as errors in the design of the adaptation process, the realist views them as inevitable temporary impedes and the pessimist categorises them as systemic errors in the system that are unmanageable. In past research, the dominating lens used has been the problem solving one, where barriers are analysed and ways to overcome them are proposed (Biesbroek et al., 2014), this is also the lens adopted here.

2.2. Diagnosing adaptation constraints

The framework to diagnose constraints to climate change adaptation outlined by Moser and Ekstrom (2010) is one of the leading tools used identify and analyse constraints (Biesbroek et al., 2013). The conceptualisation of the adaptation process presented in the framework provides the foundation for identifying and organising constraints. It was taken into account in this study to identify if constraints arise at specific stages of the adaptation cycle and if therefore constraints impede the progress from one phase to the other. Understanding, planning and managing are defined as the three main phases in the adaptation process. Each of these phases are broken down into three further stages. The understanding phase includes problem detection, gathering of information and (re)definition of the problem. Planning involves the development, assessment and planning of adaptation options. Managing focuses on the implementation of options, the monitoring of options and the environment and the evaluation of the latter. Although, these phases and stages are a simplification of reality and processes tend to be less linear, they prove to be a “useful ordering heuristic” (Moser and Ekstrom, 2010, p. 22027). This was confirmed during the interviews where the diagram of the adaptation cycle was shown and subsequently easily understood and applied by respondents.

3. Methods

A mixed methods approach focused on gaining the views of a broad range of stakeholders involved in adaptation in the region and allowed to collect both qualitative and quantitative information. The two-stage approach of conducting an online survey and then interviews provided an in-depth understanding of constraints experienced in the region. Inputs from adaptation experts working in Caribbean SIDS were sought, including those working at international and governmental organisations and in research. Adaptation experts were identified drawing from a broad network of contacts that were previously established through work of the authors in the region and was completed by online research and snowball sampling. The survey also allowed to identify potential interviewees. All Caribbean SIDS were originally included in the study. Based on the availability of the respondents, 12 out of the 16 Caribbean SIDS are represented in our sample (Fig. 1).

3.1. Online survey

The survey was designed and conducted to get an initial understanding of constraints being experienced on the national level in Caribbean SIDS and results were used to refine subsequent interview questions. The questions posed focused on adaptation opportunities and constraints and on overcoming adaptation constraints (the 25 questions of the survey can be found in Appendix B). The online survey was conducted between March and April 2020, using the Survey Monkey software. The survey was sent out to 82 adaptation experts from the Caribbean SIDS, namely people working for international and governmental organisations, the private sector, consultancies, non-for-profit/non-governmental organisations and researchers. 25 of 29 answers received were complete and from people who confirmed that they had worked on at least two or more adaptation projects, which was considered to be sufficient experience to answer the survey questions adequately. Appendix C gives an overview of the organisation types and sectors covered along with the geographical coverage of the respondents' work. The results of the survey were then analysed through Survey Monkey and Excel, comparing answers per organisation type represented, per country or per constraint depending on the question posed. In addition, the answers of some of the open-ended questions were coded.

3.2. Semi-structured interviews

Interviews were conducted to gain more detailed knowledge on the initial findings from the survey and a comprehensive picture of adaptation constraints in Caribbean SIDS. The survey findings allowed to fine-tune interview questions. The main topics covered were adaptation constraints experienced on an individual, national and at regional levels and finance and governance constraints. The potential 16 questions of the semi-structured interviews can be found in Appendix D. 23 adaptation experts were contacted, both survey respondents who had indicated their interest in taking part in a follow-up interview and additional experts identified through snowball sampling. Virtual semi-structured interviews were then carried out in November 2020 via Zoom, with key informants working in regional, governmental and research institutions in Caribbean SIDS (see Appendix E and F for more information). 11 interviews (with a total of 14 respondents) were conducted and lasted between 29 and 53 min. The screen share function was used to

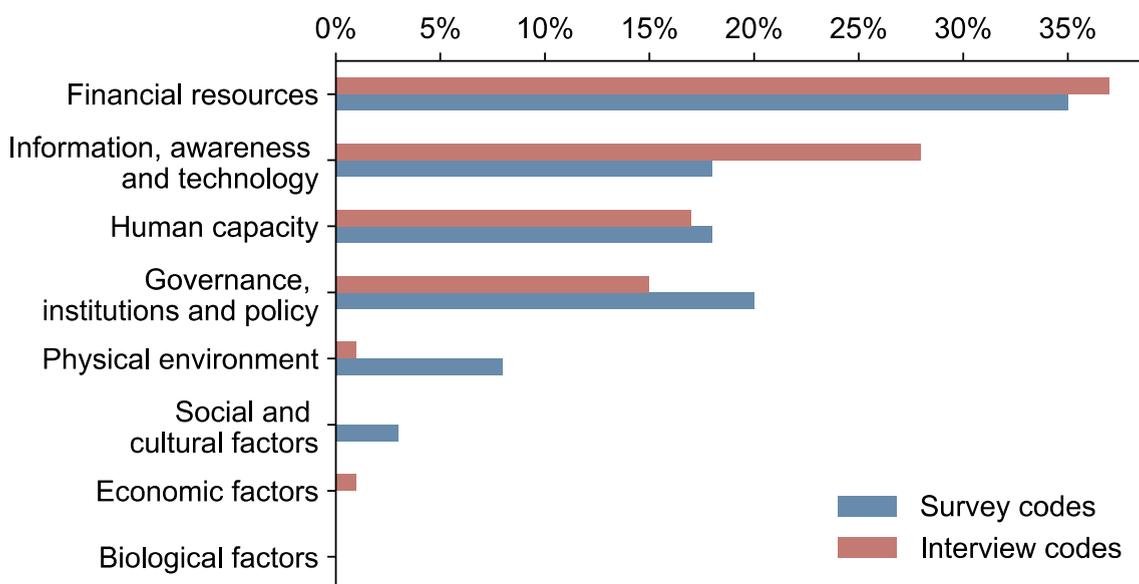


Fig. 2. Survey codes of the open-ended question on the most important constraint faced at the national level (52% of survey respondents described more than one constraint) (blue) and amount of interview codes of the main constraints based on IPCC categorisations (normalised results in %) (red). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

show the figure illustrating the adaptation process from Moser and Ekstrom (2010). 10 of the 14 interviewees had previously answered the survey. All interviews were conducted in English and 10 of the 11 interviews were recorded. Notes were also taken by hand during all interviews. The recorded interviews were fully transcribed with speechtext.ai, an automated speech to text software, and were subsequently all manually checked and corrected. For the interview that could not be recorded, an additional note-taker joined the interview to have a detailed record of the conversation. The interviews were then coded in MAXQDA, a software package for qualitative data analysis, and analysed per organisation type represented and country. Some of the categories coded were pre-defined, such as the different types of constraints, opportunities and limits, and adaptation phases. Other categories were added iteratively during the coding process as specific themes emerged, such as donor requirements and national economic situations. Summary tables for the various codes were created to have a clear overview of the main findings. A specific focus in the interviews was also put on assessing potential interactions between adaptation constraints. Any mention of such interactions was counted through the Code Relations Browser of MAXQDA, which visualizes relationships between codes and displays which codes co-occur. Results of this analysis are presented in Fig. 4.

4. Results

Based on the survey, 88 % of the respondents stress that climate change poses a high risk for Caribbean SIDS and that, “given the adaptation challenge ahead”, countries are somewhat prepared (confirmed by 80 % of the survey respondents). 64 % of the survey respondents think that there are just as many constraints as opportunities when it comes to climate change adaptation. Awareness raising, tools such as vulnerability and risk analysis and decision support, governance and planning processes and innovation and technology development were selected as the main measures making it easier to adapt, namely the largest opportunities. When asked to describe the most important constraint in an open-ended question of the survey, financial resources were mentioned most (35 %), followed by governance, institutions and policy (20 %), information, awareness and technology (18 %) and human capacity (18 %) (Fig. 2). Although the question asked for the single most important constraint, 52 % of respondents actually described several interacting constraints. Financial resources were also the most discussed constraint during the interviews (Fig. 2).

Based on the adaptation process conceptualised by Moser and Ekstrom (2010), the survey results show that adaptation constraints arise across multiple phases (Fig. 3). During the understanding phase, survey results show that all four main constraints evenly hinder the initial step of an adaptation process. The interview results further corroborate these results and highlight data availability and information gathering issues, arising due to the lack of equipment, human capacity and long-term finance. During the planning phase, responses from the survey show that finance (35 %) and governance (31 %) constraints are the most prominent. Interviewees highlighted the importance of stakeholder buy-in at this stage and mentioned policy blockages sometimes hindering processes. However, NAPs are seen as opportunities, namely as good support tools to guide planning, despite lack of information, technology and human capacity. During the managing phase, finance constraints (46 %) are most reported in the survey. Interviewees describe that although implementation usually runs smoothly, monitoring and maintenance are problematic, in particular when it comes to securing a budget for these activities. Overall, the survey results therefore show that the finance constraint is the largest one throughout all phases, which

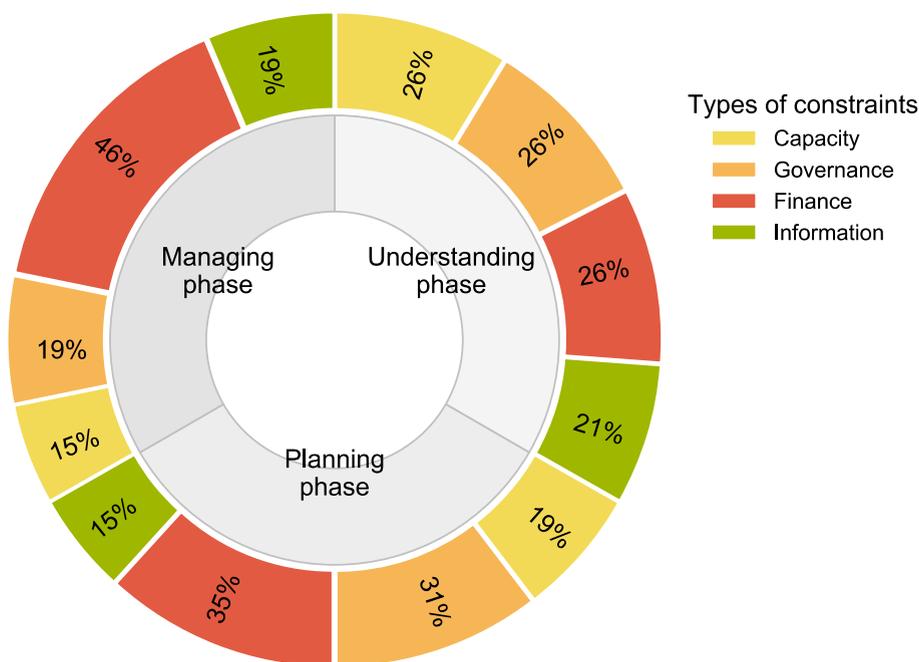


Fig. 3. Survey results on which types of constraints arise at which phase of the adaptation process.

was consequently discussed in depth during the interviews.

4.1. Financial constraints

4.1.1. National adaptation budgets

The lack of overall national funding dedicated to adaptation was mentioned by all interviewees. Countries are constrained by debt and limited fiscal spaces, with no financial reserves to draw from. An interviewee from a governmental organisation said: “you already have a constrained public service and the fiscal space does not allow you to expand that public service any further” (interview 1). A researcher also stated that: “Caribbean countries are already significantly indebted. They then incur more debt because of incidents of loss and damage and extreme events. And so other indebtedness increases over time” (interview 11). Indeed, interviewees highlighted that when Caribbean SIDS are hit by hurricanes or other extreme weather events, there are no means to predict these events which then take up all available resources, resulting in constant repair and recovery cycles. Due to COVID-19, adaptation funds have also been diverted: an example of World Bank funding initially dedicated for an on-going sea level rise project but being redirected due to COVID-19 was given. Several interviewees explained that it poses a political and moral question for governments to take out loans for climate action, as Caribbean SIDS are responsible for less than 1 % of global emissions.

4.1.2. International adaptation finance

The interviewees stated that the adaptation funding commitments made under the Paris Agreement were not being fulfilled and that there is a reluctance from countries in the global North to spend money on international adaptation finance.

Ten out of fourteen interviewees reported difficulties with donor requirements. To access international adaptation finance, the income status of Caribbean SIDS can be the first limiting factor. Countries such as The Bahamas and Saint Kitts and Nevis, classified as middle to high income countries, are in some cases not eligible to apply for finance, despite their high vulnerability to climate change. The process of writing up a proposal to access international adaptation finance was described as “complicated”, “daunting”, “timely” and “rigorous” (interviews 2, 6, 7 and 11). Interviewees testified that guidelines were not always clear and that there was too much paperwork, involving heavy reporting requirements. In addition, each funder has its own set of requirements, forcing applicants to adjust projects based on the funder. An interviewee from a regional organisation stated that the requirements from multilateral funders were onerous and that it had been easier for them to deal with bilateral funders in the past, with whom they also have been more successful with.

For the Green Climate Fund (GCF) specifically, the biggest dedicated multilateral climate fund, interviewees described the simplified approval process as more of a very long process of back-and-forth. Local and detailed information is required to justify projects, which is often unavailable due to the prevailing lack of long-term finance for data collection (see [Section 4.3](#)). The GCF requests vulnerability analyses and scientific papers/reports to build up the climate rationale and does not accept indigenous/local knowledge, although this would be valuable information to tap into. The overall length of the application process, usually between two to three years, was also criticised as funding cannot be synchronised with yearly national budgets and realities on the ground can change in the meantime.

An interviewee from a regional organisation explained that when evaluating funding proposals, funders tend to focus on how many people will be impacted by the suggested projects, disregarding the vulnerability of countries and putting the small populations of SIDS at a disadvantage. In addition, the more money is requested, the more the proposal is scrutinised: the focus is on the dollar value rather than the impact of the project. It was also stated that the GCF lacks understanding of local contexts when reviewing proposals, however, in the past, field visits from GCF staff have helped to grasp realities on the ground.

The funding ambiguity between adaptation, disaster risk reduction and development was also presented several times as a constraint. An interviewee working for a national government described that due to the size and vulnerability of Caribbean SIDS, development and adaptation were often synonymous.

Two out of the fourteen interviewees mentioned that from their experience, donor requirements were not an issue. A government official stated that there were no challenges encountered and a good amount of human capacity dedicated to this activity and a researcher confirmed that they were receiving sufficient support from the national government and regional organisations (the Caribbean Community (CARICOM) and the Caribbean Community Climate Change Centre (CCCCCs)).

4.2. Human capacity constraints

Human capacity was mentioned by twelve of the fourteen interviewees as a factor hindering adaptation in the region, both in terms of quantity and knowhow. The interlinkage to the finance constraint was made explicit as it was stated that ministries are reluctant to dedicate staff to proposal writing to access finance, since it does not always guarantee success and they prefer to see more tangible activities. It was also mentioned that funders are not willing to pay directly for additional staff, resulting in a vicious circle and highlighting the need for larger national adaptation budgets. The more donors exist with diverging requirements, the more the workload for applicants expands. Capacity is also lacking for project monitoring in the managing phase of the adaptation process.

More generally, few people have the level of expertise to undertake the full scope of the work required for adaptation and the people with the adequate skillset end-up taking on many different roles and have to work overtime, also a result of the limited budget available. Previous research shows that experts in SIDS are often extended with a range of responsibilities, from being UNFCCC negotiators to participating in international and domestic committees ([Benjamin and Thomas, 2018](#)). It was described that international consultants are repeatedly relied upon for projects or when writing up policy documents such as national communications, resulting in

large brain drains. In addition, it was also stated that the COVID-19 crisis highlighted the importance of having local expertise as travel was no longer possible.

4.3. Information, awareness and technology constraints

Information, awareness and technology were described as being adaptation constraints by all fourteen interviewees. Awareness around the importance of data collection is slowly rising amongst Caribbean SIDS but an overall lack of information still remains. There is very limited baseline data on temperature and rainfall, in some cases, with only one weather station for an entire island. This is partly due to the lack of national budget available and limited human capacity described in Sections 4.1 and 4.2. Lack of raw data results in difficulties to generate scientific assessments at the local levels at which adaptation projects are planned and implemented. An interviewee working for a national government stated that “no amount of external science or climate modelling or down-scaled models can actually substitute for on-the-ground evidence” (interview 5). Indeed, climate models are being downscaled by regional institutions but it remains difficult to see the impacts on an island level or at the local scale at which adaptation projects are implemented. In addition, adaptation projects that have already been implemented do not provide much data since there is a lack of monitoring and evaluation. In Jamaica, the MET service burnt down in 1992, resulting in the loss of a lot of historical data. Researchers at universities mainly have to concentrate on teaching and have little time left to conduct research. In addition, social scientists specifically struggle with funding since it is often seen as research that is “not scientific enough” (interview 10). A researcher also described that scientific research tends to be produced in the global North, for key topics such as loss and damage for example. It is often well-paid foreign consultants who conduct research and write up reports without sharing them in the public domain, resulting in a large ongoing brain drain, already mentioned in Section 4.2.

Technology also limits the quantity and quality of information available. It was described by interviewees that weather equipment gets damaged, stolen and although some networks of automatic weather stations are slowly expanding, there is no long-term understanding of the climate in many areas. There is a lack of land to install equipment, which then ends up being installed on both public and private property.

4.4. Governance constraints

Interviewees described the constant need for more political buy-in, which is heavily dependent on administration cycles. Changes in political priorities can make mainstreaming climate change into national budgets difficult, in addition to the fact that “the fiscal space does not allow you to expand the public service any further” (interview 1), highlighting persisting financial constraints. Currently, the prioritisation of adaptation is slowly improving at the national level but adaptation remains in competition with other sectors such as health and education due to limited national budget availability. Series of devastating hurricanes raised the issue of climate change on the political agenda but there are still insufficient policies in place, which is inter-alia hampered by the lack of data to base these policies on. An interviewee described that this lack of data sometimes influences the thematic of a specific policy, as the focus of the document is shifted to the sector with the most data available, based on which adaptation options can be developed. In addition, COVID-19 is currently being prioritised and is delaying policy processes. The fact that international adaptation finance has to be channelled through an already constrained government also poses some issues and there are ongoing efforts to facilitate the access to finance for civil society organisations.

4.5. Overcoming constraints

Survey results show that most constraints identified by the respondents arise at the national level (stated by 79 % of respondents), highlighting that they largely believe that adaptation is to be managed on a national country-level. 71 % of respondents answered that these constraints can also be overcome at the national level, although the regional and global levels also have a role to play. National governments were also found to be the stakeholders in the best position to address major constraints (83 %) and 77 % of national government stakeholders participating in the survey provided this answer. The strong focus on the national level in these results reflects the sample of this study: around 60 % of respondents are most active on the national level. However, these findings highlight that national government stakeholders feel able to tackle constraints if adequate resources are available and underline the importance of national level governance. The second type of organisation which can best tackle constraints, as adaptation can be tackled at multiple scales, are international/regional organisations (63 %), followed by private companies (54 %) and research agencies (54 %) (multiple answers were possible). Interviewees mentioned that regional organisations, such as the CCCCs, the CARICOM or the Organisation of Eastern Caribbean States (OECS), must support national governments in hurricane recovery, accessing international adaptation finance, developing projects and aligning programs across the region. As data collection challenges are being faced, universities in the region have the opportunity to produce science relevant for climate change adaptation.

All interviews ended on a question asking respondents to list their top three priorities for adaptation, if finance was endless, to ultimately overcome existing adaptation constraints. Capacity building came up most (mentioned by 40 % of interviewees), mainly government officials expressing the need for specialised staff in accessing climate finance, climate modelling, and adaptation methods and to raise general public awareness. More precisely, interviewees testified that the access to international adaptation finance would be facilitated if sector-specific experts supporting the development of project proposals were available, overcoming both the human capacity and finance constraints. The need for equipment to collect data and make assessments of climate change vulnerability was mentioned by 30 % of interviewees as being a high priority, such as hurricane proof real-time automated weather systems and early

warning systems. This would allow to collect data during extreme weather events such as floods for example, which would help in overcoming some of the information constraints. Thirdly, infrastructure also came up with 30 % of interviewees, describing the need for coastal protection measures and disaster shelters. In addition, it was mentioned throughout the interviews that increasing the involvement of the private sector and civil society organisations in adaptation processes are seen as opportunities for adaptation which would also decrease some of the governance constraints. Overall, 71 % of survey respondents estimate that most adaptation constraints could be overcome between 1 and 10 years, relatively short time spans stressing that great adaptation progress can potentially be made in the close future.

4.6. Interacting constraints

The analysis of constraints through the lens of the adaptation process shows that constraints arise simultaneously and across all stages. Understanding the interdependencies between constraints is key to explaining why constraints occur, how they persist and how they get resolved, as interlinked constraints might lead to vicious cycles, enforcing constraint clusters (Eisenack et al., 2014). When looking at the four main constraints faced in the Caribbean region, namely finance, human capacity, information and governance, the survey and interview results clearly highlight close interlinkages. They indicate that it is the financial constraint that is the most tightly linked to the other constraints (Fig. 4). Indeed, there is a dire need for financial resources to collect scientific information, additional human capacity is required and comes with additional costs and limited national adaptation budgets pose challenges for governance. The results also revealed vicious cycles, for example, insufficient availability of scientific information and lack of dedicated staff to write up funding proposals negatively impact the access to international adaptation finance, however, funding is required for the production of scientific information and additional human capacity. Prior studies in the Caribbean also shows that human capacity and financial constraints hamper further research (Benjamin and Thomas, 2018). Information constraints in turn also negatively affect governance as uncertainty in climate projections tend to delay adaptation policy processes, yet another call for the production of more scientific information (Robinson, 2020).

Interacting constraints can result in limits (O'Neill et al., 2022; Thomas et al., 2021), therefore, overcoming constraints is key and approaches should take interdependencies between constraints into account, addressing multiple constraints in parallel (Eisenack et al., 2014; Lee et al., 2022). As mentioned in Section 4.5, adaptation can take place at multiple scales and regional organisations play a key role in coordinating adaptation responses across SIDS (Robinson and Gilfillan, 2016) and have the potential to address several constraints simultaneously. With regards to the information constraint for example, more collaborations between regional organisations could lead to the production of both regional and national studies, allowing best practices to be identified and lessons learnt to be acknowledged (Benjamin and Thomas, 2018), thus facilitating the application process to international climate adaptation finance.

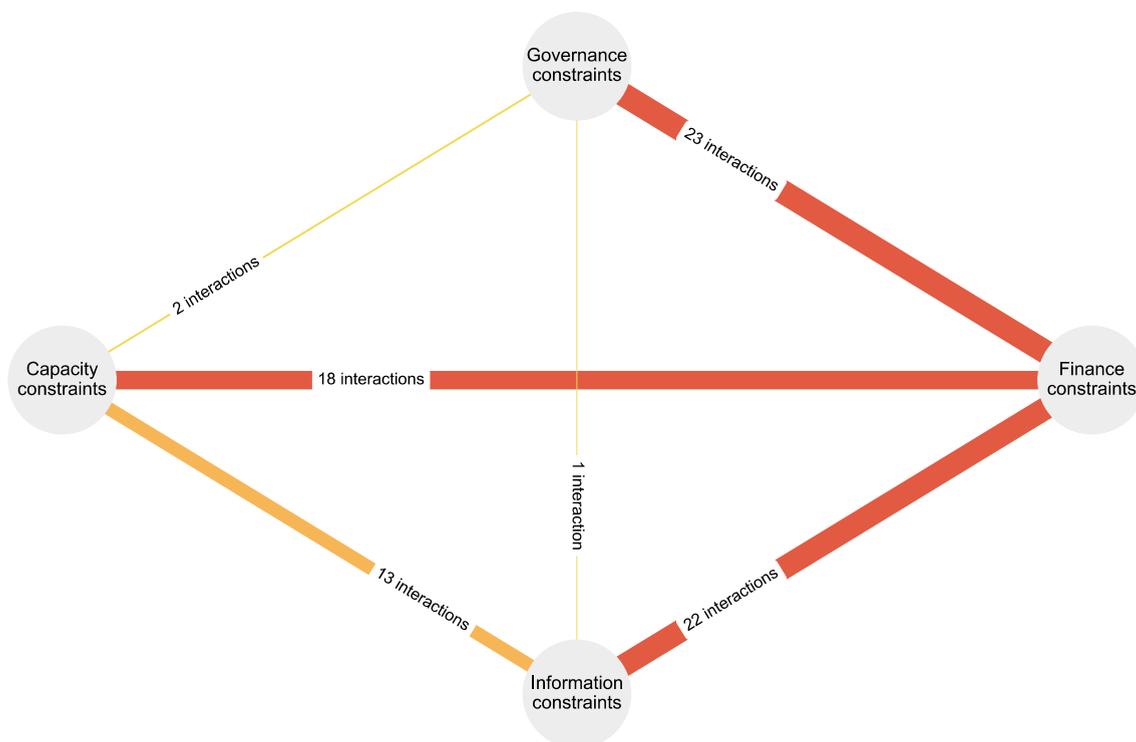


Fig. 4. Interactions between constraints (capacity, governance, finance and information) based on the number of times overlaps between types of constraints were mentioned during the interviews.

Robinson & Gilfillan (2016) also recommend regional organisations to focus on information, finance and capacity issues to enable adaptation. Improved governance structures allowing ample cross-coordination between sectors and stakeholders are needed to foster adaptation that is integrated into national development planning (Filho et al., 2021). Although survey respondents indicated relatively short time spans to overcome constraints, several key constraints such as data collection require long-term commitment and support to be effective and improving adaptive capacity in the long-term will likely take decades (Andrijevic et al., 2020).

4.7. Limits to adaptation

Although potential avenues for overcoming constraints were given, limits to climate change adaptation came up during the interview process and cannot be ignored. It was mentioned that mitigation is crucial, as in many cases adaptation will simply just not be sufficient: “SIDS will not be able to adapt if others don’t mitigate”. Limits were described in the context of sea level rise and increasing intensity of tropical cyclones in the Caribbean region. Due to the size and structure of the islands, costly coastal protection and relocation are sometimes the only options possible. Relocation is considered to be an option of last resort, which also generates high-costs. Inland retreat options are seldom economically viable in the region due to the tourist-based economies and the lack of land available. It was described that fishermen also face limits to adaptation as they are being forced to take on different activities for their livelihoods.

5. Discussion: The importance of adaptation finance to overcome constraints

The interlinkage of constraints highlights that, despite the need to address all constraints in parallel, improving availability of and access to adaptation finance adaptation could have positive repercussions on information, human capacity and governance constraints. This study shows that the national budget available for adaptation remains very limited in Caribbean SIDS and that a mismatch remains between the level of international climate finance mobilised and the scale of adaptation required in SIDS (Kalaidjian and Robinson, 2022). The way the funding applications are currently designed are clearly not suitable for Caribbean SIDS with low institutional capacities and limited historical data available. The results indicate that it is not only punctual international finance for adaptation projects that is needed but also sufficient national budgets dedicated to adaptation to fund additional human capacity and ensure the long-term collection of scientific data for example, reducing the dependence on consultants from the global North.

Caribbean SIDS are among the most heavily indebted per capita developing countries in the world (Fuller et al., 2018), constraining national adaptation budgets, as testified by the interviewees of the this study. COVID-19 is now having strong repercussions on their already vulnerable national economies as inter alia tourism contributes to a high share of their GDPs (Thomas and Theokritoff, 2021). COVID-19 is also expected to aggravate the existing adaptation finance gap both at national and international levels, as funds are being reallocated as described by an interviewee and political priorities are being shifted both in the short and the long-term (UNEP, 2020). With the prevailing debt situation, financial mechanisms such as debt cancellation, suspension, rescheduling or debt-for-climate swaps have the potential to improve the fiscal space and even create opportunities to reduce climate vulnerability (Thomas and Theokritoff, 2021). These measures would allow national governments to dedicate larger parts of the national budgets to adaptation. In addition, Caribbean policy-makers have expressed a strong preference for grant financing, as opposed to loans (Robinson, 2018), as they further increase debt levels. Between 2010 and 2015 in Caribbean SIDS, 62 % of climate finance has been provided as grants, with the other 38 % being loans (Atteridge et al., 2017). Due to their high vulnerability and exposure to challenging environmental conditions, Caribbean SIDS and SIDS in general have often been considered adaptation pioneers (Klöck and Nunn, 2019). Studying these sites can therefore provide valuable lessons for non-island contexts (Klöck and Nunn, 2019), in particular vulnerable Least Developed Countries (LDCs) with high levels of debt.

The global adaptation finance gap is widening due to higher adaptation costs (estimates indicate higher values than previously reported) and stable or decreasing finance flows (UNEP, 2021). As highlighted by the results of this study, international climate finance is a moral imperative and required to achieve climate justice as regions like the Caribbean SIDS are responsible for less than 1 % of global emissions but are facing many of the negative impacts caused by climate change. The current annual \$100 billion goal agreed during the Conference Of Parties (COP) 15 is not being met (Roberts et al., 2021), \$ 79.6 billion were disbursed in 2019, a 2 % increase from 2018 (OECD, 2021). Although adaptation finance grew by 20 % in 2019, mitigation still represents two-thirds of total climate finance provided by developed countries (OECD, 2021). \$ 1.5 billion climate finance were provided to SIDS globally in 2019, a 29 % decrease compared to 2018, however, adaptation finance represents more than 40 % on average over 2016–2019, which is significantly higher than the average for developing countries overall (OECD, 2021). Nevertheless, international climate funds should revise their eligibility criteria prioritising vulnerability to climate change rather than GDP (Thomas and Theokritoff, 2021) and should aim to simplify and harmonise application processes, as many hurdles are still being faced to access finance, as highlighted in the interviews. A 50:50 balance between adaptation and mitigation in the annual \$100 billion climate finance should also still be met.

6. Conclusion

Despite the diverse socio-economic contexts of Caribbean SIDS, the messaging from the survey and the interviews across the region are largely homogenous: adaptation remains insufficient and numerous constraints are being faced throughout the adaptation process. This study finds that amongst national, regional and scientific stakeholders, finance has been the largest constraint for adaptation, due to limited national adaptation budgets and difficult access and unavailable international adaptation finance. The findings also indicate that constraints are being faced in parallel and that they interact, resulting in vicious cycles. Insufficient availability of finance for

adaptation has repercussions on the production of scientific information, dedicated human capacity and political priorities on the national level, negatively affecting the implementation of adaptation on the local level. The consequences of the COVID-19 pandemic and the prevailing and deteriorating debt situation in Caribbean SIDS are further undermining finance for adaptation. This calls for synergistic approaches to address constraints, where national governmental stakeholders, regional organisations and the international level have key roles to play. The \$100 billion goal set for international climate finance needs to be met, application processes should be simplified and the eligibility criteria to funds has to be based on the vulnerability of countries to the impacts of climate change. In addition, national fiscal spaces can be improved through mechanisms such as debt cancellation and debt-for-climate swaps, potentially allowing larger long-term national adaptation budgets. Overcoming these interacting constraints is of utmost importance as they hinder adaptation progress and can result in limits to adaptation, where intolerable risks are faced.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.crm.2023.100483>.

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