CLIMATE RESILIENT COMMUNITIES:

A TRANSDISCIPLINARY STUDENT RESEARCH PROJECT ON MARINE PROTECTED AREAS IN THE LESSER ANTILLES

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ABBREVIATIONS

CBE	Community-Based Enterprise
CE	Community Entrepreneurship
GIZ	German Agency for International Development
MMA	Marine Managed Areas
MPA	Marine Protected Areas
SMF	Sustainable Marine Financing Programme
TD	Transdisciplinary

FOREWORD

VOLKER HAMANN & CAMILLE DAVID

Caribbean small island states face the brunt of the climate crisis with limited capacities to adapt. The ultimate impacts of climate change on these island systems depends on the intactness of their biophysical resources and their abilities to rebound after shocks, the adaptive capacity of the local communities and the abilities to transform challenges into economic opportunities to support livelihoods. Access to and support from government and non-governmental institutions is also critical to resilience building at all levels.

From a practical perspective, and our intimate knowledge working with MMA communities in the islands, we understand adaptive capacity to mean the abilities of communities to limit potential damage from disaster impacts, their abilities to take charge and transform challenges into new opportunities or to somehow simply cope with climate variabilities based on their indigenous knowledge pool. For MMA communities which are highly dependent on their coastal-marine resources, the stakes are even higher. Community entrepreneurship as a driver in harnessing local knowledge and leveraging opportunities in nature-based solutions holds promise for building strong resilient communities.

The GIZ Sustainable Marine Financing Program was designed to mobilize community action to support sustainable financial management of MPAs but weaknesses in governance, shortfalls in management capacity and limited access to long term secured financing remains a nagging challenge in several islands. As a result, MPAs have not been able to meaningfully contribute to development of new opportunities for the communities. There is a growing call amongst stakeholders for MPA management boards to do more in supporting their local communities. While SMF broad goals are to improve financial administration of MMAs, it also aims to work in parallel with other organizations and institutions to support community adaptation.

Our collaboration with Leuphana University in Germany is key to broadening the understanding how community entrepreneurship can enhance the adaptive capacity and resilience of disaster-prone MMA communities in the region. We are proud of this collaborative approach and what has been achieved during the first TD research project in Dominica. The achievement of the students this year again is exceptional in bringing into sharper focus the effectiveness of community entrepreneurship in enhancing resilience to climate change in our four focal countries.

INTRODUCTION

STEFFEN FARNY

Small island states in the Caribbean are among the most severely affected nations suffering from human-induced climate change, evidenced in the 6th assessment of the IPCC (Pörtner et al., 2022). The observed negative impacts range from sea-level rise, slow water scarcity and food production, the spread of diseases, mental health problems and displacement up to high exposure to extreme weather events. Caribbean island states are vulnerable to *disaster processes* – i.e., a rather slow erosion of human and natural ecosystems – as well as *disaster events*, such as floodings and storm-induced damages. Even if efforts to limit global warming are moderately successful, some climate change effects are already locked-in, and swathes of low-lying islands will be engulfed (Taylor, 2022). Therefore, local communities are in strong need of developing new approaches that recognize "*diverse forms of knowledge* [emphasis added] such as scientific, as well as Indigenous knowledge and local knowledge in understanding and evaluating climate adaptation processes and actions to reduce risks from human-induced climate change" (Pörtner et al., 2022, p. 9). In contrast to most research methodologies, transdisciplinary research explicitly combines knowledge from practice and knowledge from science in framing the research problem, co-creating and integrating new solution-oriented knowledge (Lang et al., 2012).

For a second time a group of Global Environmental Sustainability Science students at Leuphana University in Germany have partnered with the GIZ team St. Lucia to conduct a transdisciplinary (TD) research project. The first TD project on Dominica showed that community resilience is a complex concept that is not yet well understood. At the same time, it identified a resourceful deployment of material goods (e.g., adaptive capacity) and people's identity to the place and the community (e.g., community entrepreneurship) as cornerstones for resilient, demand-driven community responses to hurricanes (Farny, 2022). In line with the ongoing GIZ project on Sustainable Marine Financing, this TD project broadened the scope and focus in addressing the topic by studying Marine Protected Areas on Dominica, Grenada, St. Lucia, and St. Vincent & the Grenadines. This four islands design offers greater comparison to understand community approaches to solve a concrete sustainability problem: securing livelihoods while protecting natural and cultural resources. The joint problem framing led to the following research question: *How can community entrepreneurship support and enhance the adaptive capacity and resilience of disaster prone MPA communities?*

This report presents the results of a 14-week co-learning process, starting with joint-problem framing, concepts and literature, methodological approach and small island state context, before showing community resilience at the Soufriere Scott's Head MPA (Dominica), Sandy Island Oyster Bed MPA (Grenada), Soufriere MMA (St. Lucia), and Tobago Cays Marine Park MPA (St. Vincent & the Grenadines). In the end, the key learnings are summarized.

JOINT PROBLEM FRAMING

NIMISHA BARUAH EBBERS, ANNA HAUBRICH, KLARA KNOLLER, LYDIA SIMKO

The research project started with a joint problem framing session conducted with a local GIZ team, identifying the dependency on external finances and resources as a major factor in increasing the vulnerability of communities and inhibiting the development of sustainable long-term solutions. Essentially, the dependency on short-term foreign investments increases community vulnerability. One of GIZ's main ventures is improving the financing and management of Marine Protected Areas (MPAs) on different Caribbean Island states and encouraging a higher degree of self-sufficiency through sustainable income-generating activities and capacity building. Small island states such as the Caribbean islands are particularly vulnerable and exposed to risks such as rising sea levels, intense storms, and coastal erosion as these areas often lack the resources to maintain or restore the structures necessary to sustain basic functions after a disaster, making resilience a matter of survival (Jevrejeva et al., 2020). Thus, offering long-term perspectives that move beyond reactive disaster management strategies constitutes a fundamental aspect of this process.

Alongside the joint problem framing, this research project is informed by a research project previously conducted by a transdisciplinary team of students from Leuphana University, GIZ, and local stakeholders from Dominica. The findings of this study show that community resilience requires an adaptation of the material dimension (e.g., resources, social capital, emergency plans) to enhance the response to extreme weather events. Therefore, in addition to contingency planning, dimensions of identity such as social memory play an important role in enhancing community resilience: Memory processes and narratives of previous disasters can influence the way a community responds to disaster as well as the perceived urgency for disaster preparedness. In addition, fostering strong community ties and instilling a sense of ownership and belonging are fundamental parts in disaster preparedness and creating a people-centred response (Farny, 2022).

To align the scientific perspective with the practical relevance, the joint problem framing session was conducted following the ideal–typical transdisciplinary research process of Lang et al. (2012). With the input of the GIZ, three core problem areas were identified: Governance of MPAs, Sustainable Financing, and community entrepreneurship (CE) and Capacity Development in MPAs. Through joint prioritization, the problem area of CE and capacity development was decided upon as the focal point of the project.

CE is an alternative social enterprise model tailored towards "communities' economic and social goals" (Peredo and Chrisman, 2006, p. 310). Resilient responses should be demand-driven, people-centred, and adaptable (Farny, 2022). CE brings together these key aspects of

resilience by promoting the ownership of ideas and solutions, fostering a sense of innovation while also ensuring that climate adaptation measures and disaster preparedness are driven by communities themselves.

Moving forward in the problem framing process, key sustainability problems for CE and capacity building were brainstormed, leading to the identification of three main areas: community independence, local capacities, and knowledge sharing. After collecting potential research questions concerning these areas, a final question was drafted, mainly focusing on local capacities. Fundamentally, this project examines the extent to which entrepreneurship and the co-management of resources can increase climate resilience through livelihood preservation and agency building. The final research question - How can community entrepreneurship support and enhance the adaptive capacity and resilience of disaster prone MPA communities? - places an emphasis on a solution-driven approach, thereby developing adaptive strategies to eventually offer long-term solutions.

Reflecting on the problem framing process and outcome, two missing aspects were identified. Firstly, there was a lack of clearly defined boundaries, resulting in difficulties in setting concrete research objectives. Secondly, no precise “success criteria” were defined, which would have enabled the evaluation of the extent to which research objectives are met and therefore support the production of solution-oriented results.

CONCEPTS AND LITERATURE

VALENTIN LORENZ, MADAWI NANDAKUMAR, JANA SEIPELT, WANJA TOLKSDORF

As mentioned in the previous section of this report, our research focuses on communities living in selected MPA's of the Caribbean Islands. They are reliant on the health and functioning of their socio-economic system and must deal with the severe local impacts of hurricanes on a regular basis. The community's response to these unforeseeable situations determines **the well-being** and recovery of its people and its environment. One notion to adapt this response to be better prepared for the next natural disaster and to recover faster afterwards is the idea of building community resilience.

Drawing on community resilience and community entrepreneurship literature we developed a theoretical model (Figure 1) that shows how community entrepreneurship strengthens the four key attributes of the resources that are already present in the community. Hereby the inherent capacities are transformed into more adaptive capacities which increases the communities' ability to prepare for, respond to and recover from future disasters. Starting at this desired outcome (community resilience), this chapter breaks down the model in the context of MPA communities on the Caribbean Islands.

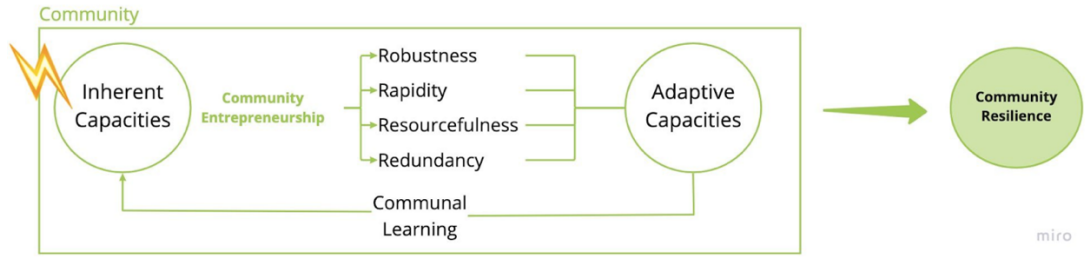

Figure 1: Conceptual Framework for TD research on Community Resilience

Community Resilience

Following Magis (2010), *community resilience* is defined as "*the existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise*" (p. 401). It can be seen as the state of a social-ecological system that changes and reorganizes in response to an event with the goal of retaining its core structures and functions (Berkes & Ross, 2013, p. 6). It increases the ability of a community to react to unforeseen circumstances in a more flexible way while making sure that all relevant stakeholders are included in the decision-making process (Norris et al., 2008, p. 127). One way to empirically investigate the current state of resilience of the MPA communities is to look at the structures that the communities are built upon. In our research the strategic approach is adjusted to the different MPA communities, however, some of the relevant questions to be considered could be as follows: How do the members of the community communicate with each other? Are they involved in decision-making processes and how? Is there anyone that is in contact with the authorities and the

local government to exchange knowledge and information? And what are the possible alternatives to resource supplies, shelter, and medical assistance in the case of a hurricane?

The following key processes which, in our understanding, support community resilience, are an important part of our investigation: emergency plans that can be adapted easily depending on the extent of a certain natural disaster, the provision of reliable information and knowledge including local-ecological and non-academic knowledge and the creation of better connections between stakeholders (infrastructure, communication channels, etc.). This last process is especially important in order to empower local people and other stakeholders and to encourage them to actively participate in the creation of response and recovery strategies to foster communal learning and more sustainable and resilient community structures.

Adaptive Capacities and Resource Attributes

Norris et al. (2008, p. 131) theorized that community resilience emerges from a network of adaptive capacities which they defined as "[r]esources with dynamic attributes, i.e., resources that are robust, redundant, or rapidly accessible". In other words, resilience is based on resources which can include material assets but also a sense of community, citizen participation, skills, infrastructure, and community action (Norris et al., 2008, p. 136).

Resources must be robust, redundant, or rapidly available in a sufficient quantity (resourcefulness) to retain the core functions of the system while adapting to the new conditions under stress. These adapted functions then translate into an increased resilience. According to Bruneau et al. (2003), *robustness* refers to the strength, or the ability of elements, systems, and other units of analysis to withstand a given level of stress or demand without suffering degradation or loss of function. *Rapidity* can be thought of as the capacity to meet priorities and achieve goals promptly. *Redundancy* refers to the availability of substitutable elements or systems that can be activated when disruptions occur, and *resourcefulness* is the capacity to mobilize and apply material and human resources to achieve goals in the event of disruptions.

Our research focuses on the assessment of the resources and their attributes such as the access to food, medical and social support right after a disaster.

Community Entrepreneurship

Natural disasters create significant challenges to the social and economic resilience of the community. According to research, responses of government agencies, emergency management and response organizations can help to strengthen community resilience. However, research has also highlighted how these organizations have failed to meet critical community needs by not addressing resource shortages created in the aftermath of a disaster (Linnenluecke and McKnight, 2017, p. 2). In the following, we draw attention to how various types of entrepreneurial disaster responses (community entrepreneurship) can help to enhance resource attributes and therefore build adaptive capacities.

Linnenluecke and McKnight (2017) describe how different entrepreneurial responses to disasters link to the resource attributes under the condition that the scope and scale of these disasters can be well anticipated. Continuing business despite a disaster is positively related

to the resource attributes of robustness and rapidity (Linnenluecke and McKnight, 2017). Firms drawing upon local knowledge, local relationships, and social networks within their community to re-establish their commercial activities, help to (re-)build commercial relationships and (re-)connect social networks which play a significant role in community recovery (Chamlee-Wright and Storr, 2014). Further, the scaling of organizational responses is positively related to the resource attributes of rapidity and redundancy. For example, when NGOs decide to expand their staff during a disaster event, these expansions across community boundaries allow organizations to access resources embedded in networks of weak ties.

Entrepreneurs also respond to natural disasters through improvisation and emergent behavior. Improvisation can provide necessary resources and services to the community and also help develop solutions based on the material and resources available at the given time and without prior preparation. Hence it is positively related to the resource attributes rapidity and resourcefulness (Linnenluecke and McKnight, 2017). Emergent behavior causes different stakeholders to engage in urgent disaster relief and recovery efforts which are not addressed by other means. If the response can help tackle an unanticipated lack of resources on large scales emergence is positively related to resourcefulness (Linnenluecke and McKnight, 2017, p. 13).

There are many possible relationships between the community and the enterprise. The community can for example be a passive beneficiary of an entrepreneur's actions or the active driver of entrepreneurship (*community-based enterprise (CBE)*). Well organized communities with strong capacities are more likely to be involved in active forms of community entrepreneurship than others, which creates more benefits for the community (Bacq et al., 2022).

This so-called CBE offers increased benefit in relation to disaster resilience. CBE describes the process of local venture creation that generates value for the community it is grounded in. This venture is not necessarily a business focusing on monetary profit, but can also describe non-profit organizations, individual or community projects, and community networks. The defining characteristics of CE and CBE are its locality as well as the creation of socioeconomic value (Pierre et al., 2014). In disaster recovery, it can create this value through providing goods and services, strengthening, and providing a space for social networks and exchange, and signaling that recovery is in process (Peek, 2017).

Inherent capacities and Learning

Through entrepreneurship, communities can gain the capacities to engage in more active forms of entrepreneurship. Entrepreneurship not only enhances the adaptive capacities that are relevant in immediate response to a disaster, but can also lead to community *morphing,* that is, a "change in the defining characteristics of existing communities" (Bacq et al., 2022, p. 36).

Communities can change defining aspects of their identity after shocking, life-changing realizations. These realizations are triggered by interactions with other stakeholders, experimentation, participation, and joint decision making, which are all aspects of community

entrepreneurship. Through making sense of these realizations, community entrepreneurs either shift in their identities or strengthen their existing identity. Both reactions lead to a restructuring of the community. This reorganization can entail a changed resource management, taking up new tasks, inspiring others, and understanding the complexity of organizing better (Dentoni et al., 2018).

The improved community organization then empowers the community to engage in more active forms of entrepreneurship like CBE (Bacq et al., 2022). Through these processes of communal learning, enabled by community entrepreneurship, the community's inherent features and thus capacities to actively participate in entrepreneurship are increased.

TRANSDISCIPLINARY PROJECT APPROACH

JOHANNA DIEDERICHS, LUCA HÖLBLING, DARIA SHEPELEVA, BENEDIKT VELTMANN

Key aspects of transdisciplinary research

As our research question addresses a complex and societally relevant sustainability problem, the provision of descriptive-analytical knowledge is not sufficient to develop solution options, but a more integrative and solution-oriented mode of research is required. Transdisciplinarity involves various types of knowledge from different scientific disciplines, but also from non-academic actors. This enables mutual learning processes through the interaction of scientists and stakeholders with different backgrounds. Furthermore, participation of parties affected by the problem increases the legitimacy of the output (Lang et al., 2012). In order to conduct transdisciplinary research and to combine societal and scientific practice for co-produced knowledge, the conceptual model of a transdisciplinary research process by Lang et al. (2012) was used as a reference.

In the first phase of problem framing and team building, a digital meeting between members of the GIZ working in the Caribbean and the course at Leuphana was organized, in which the problem area was defined by combining societal with ecological and economic problems present in the Caribbean. Although the members of the GIZ had an academic background, since they were integrated in the communities studied, they represented the societal sphere while the student group were representatives of science. The GIZ members also acted as agents for further, non-academic contacts and were thereby a central tool to enable our project to be transdisciplinary. Additionally, literature research on basic concepts, context and the present situation in the Caribbean islands complemented the joint problem framing to analyse the current state. The second phase followed, which targeted the co-creation of solution-oriented transferable knowledge. Here, the students contacted stakeholders in the MPAs and conducted semi-structured interviews to bring scientific and societal discourse together and co-produce the solution-oriented knowledge needed to answer the research question. A guideline was established containing the main questions, which covered the most important topics of our research question and were asked across all of the four islands to make an inter-island comparison possible. Depending on the context, further questions were added to get more in-depth information about certain areas (Young et al., 2018).

Due to time constraints, the third phase of reintegration and application of the co-created knowledge could not be concluded, though a joint reflection meeting with the partners in the Caribbean was scheduled at the end of the research process.

Challenges and Conflict Prevention

Following the definition of our project as a transdisciplinary (TD) research project, it is supposed to help solve real world problems whilst contributing to the field of sustainability

sciences (Lang et al., 2012). TD projects are mostly local and community based to ensure a thorough communication and cooperation. Even in these circumstances, an array of challenges can potentially arise. The remote research design of our project elevates these general challenges. Due to the international dimension of our research project, there are certain cultural differences, which need to be thought of. These include the site conditions such as infrastructure and the political environment as well as institutional structures (Löhr, 2018). In her dissertation "Conflict Prevention and Management (CPM) System in Transdisciplinary Research Collaborations: Potential and Constraints" (2018), Löhr presents a range of operational challenges like the general challenge of communication and coordination related to the reliance on digital communication and the time-limitation of a project. In our specific research project, we were confronted with discontinuous participation and long response periods for the same reasons. In general, the research teams can also face differences related to the communication style as well as other cultural differences, which are reflected in a variety of social, cultural, and moral expectations and norms that can affect project work. These expectations as well as diverging perceptions pose a potential point of conflict. In this specific research project, we experienced this in a lack of integration of communicative styles and knowledge types (Lang et al., 2012) because of the remote design and a lack of personal connection to the community. Another difficulty is an unbalanced problem of ownership (ibid). In our research project, the stakeholders were approached with the normative problem framing from a primarily white European researcher's perspective to a problem that is locally distanced. This also highlights the importance of the creation of a common understanding as there naturally is a high potential for misunderstandings or even the risk of a loss of methodological coherence if the common understanding is not created (Löhr, 2018). Another potential difficulty that could emerge is the transferability of the results (Lang et al., 2012). Results from one MPA do not guarantee transferability for an MPA on another island. Hence, the general problem posed in TD projects of limited case-specific solution options (ibid) could be a major challenge. Following Löhr (2018), another area for potential conflict in TD research projects is the leadership role of science. The use of scientific language can impose an effect on stakeholders that may seem exclusionary. It is important to involve stakeholders continually. If this is not given, it can cause conflict and further increase the already existing power differences.

In general, for transdisciplinary research projects, it is recommended to follow an approach, which is based on regular self-reflection and systemic adjustment of the research process for building value-consciousness as well as the enhancement of the mutual learning process (Hirsch Hadorn et al., 2008). Intensive communication should be actively managed and ongoing to enable the exchange or integration of different viewpoints and interests (ibid). Lastly, another possible future challenge concerns the tracking of scientific and societal impacts as the continuity of the project is not guaranteed and the future development of this TD project as well as the GIZ project is yet unclear.

EMPIRICAL CONTEXT

LUCA CALM, FAYE ENGELHARDT, LEA MÖLLER, CONRAD MOOSDORF

The four islands of Dominica, St. Lucia, Grenada, and St. Vincent and the Grenadines belong to the Lesser Antilles in the Southern Caribbean. The region is prone to the effects of climate change due to the local climate, their remoteness, increasing sea levels, and the lack of resources amongst other factors. The consequences of these circumstances not only have immediate effects during live-threatening events such as hurricanes but also long-term ramifications like the displacement of children (UNICEF, 2019). To contextualize the research, literature was reviewed regarding different context dimensions such as climate, the marine protected areas in general and the similarities between them.

Climatic information about the region

The islands are in the western tropical part of the Atlantic north of the equator. The temperatures on the Caribbean islands vary a lot during the day but not regarding the course of the whole year. The Caribbean islands usually have one dry and one wet season a year. The heat stress is much higher during the wet season when hurricanes are most likely to occur as well since the water surface temperatures reach a significant height during this period. Due to the inner-tropical convergence zone, which is located close to the Caribbean Islands at that time, the surface temperatures rise significantly as the sun almost has an angle of 90 degrees. Therefore, there is a lot of evaporation at that time which in return leads to high amounts of precipitation in these regions. Under these conditions, hurricanes become more probable. They can be predicted by satellites, which contribute enormously to saving lives. Nevertheless, they still hit the shores and destroy the infrastructure of entire regions which can go as far as roads being blocked by landslides, heavy flooding, or the destruction of coral reefs alongside the islands shores due to immense amounts of sediment being transported into the reefs by the increased precipitation (Harris et al., 2020).

MPAs and their Management in the Caribbean

All four islands accommodate marine protected areas or marine managed areas. They are geographically defined areas created to protect or conserve marine life and the ecological habitat in general. Controlling the extraction of marine life through different kinds of zones that are created in the area with various strict restrictions has the effect of improving the overall ocean health. This means a higher abundance and diversity of animals like fish or lobsters and an increased biomass and size of the individuals due to the possibility of growing older without getting caught (Belgrano et al., 2021).

Between 2013 and 2017 the MPAs of six eastern Caribbean states (Antigua and Barbuda, Dominica, Grenada, Saint Kitts and Nevis, St. Lucia and St. Vincent, and the Grenadines) were included in the CaMPAM-ECMMAN project (Caribbean Marine Protected Area Management Network and Forum together with the Climate Resilient Eastern Caribbean Marine Managed

Areas Network). The project was part of the International Climate Initiative (ICI) as well as the UN Environmental Program and had the goal of declaring new Marine Managed Areas (MMA) and strengthening the existing ones, building constituencies for sustainable livelihoods, and supporting the MMA network and its communication.

Similarities

Each of the four islands under study are threatened for the most part by disturbances caused by climate change for instance rising temperatures in and above the sea among other events. These effects of climate change cannot be mitigated by the islands alone as they only emit a proportionately diminutive amount of greenhouse gas emissions (Nurse et al., 2014). In addition to this, the Island states need to use their entire personal and material resources to cope with the effects of hurricanes, coral reef degradation, biodiversity loss on land and at sea as well as rising sea levels. After having a more in-depth conversation with local people it became clear that the communities have already established non-profit organizations, climate initiatives and other forms of community engagement where entrepreneurial activities take place as well. These institutions differ in their characteristics due to the diverse problems specific to the respective location such as social inequality, varying population sizes as well as different social structures and culture. Nevertheless, the communities creatively developed efforts to protect the reefs, conserve the ecosystem, and establish ecology-based tourism to secure financing which contributes to the regional resilience.

TD PROJECT DOMINICA: SOUFRIERE SCOTTS HEAD MARINE RESERVE

LUCA CALM, LYDIA SIMKO, WANJA TOLKSDORF & BENEDIKT VELTMANN

Soufriere Scotts Head Marine Reserve (SSMR) is a Marine Protected Area (MPA) in the Southwest of the Caribbean Island state Dominica that consists of a diverse and cohesive community. One of its main characteristics is its stunning nature, making tourism an integral part of the community. Also significant for Dominica and especially the SSMR is its elaborate structure, having different zones, e.g., for tourism, recreation, fishing, and nature protection as well as a comprehensive organizational structure.

Dominica has recently been dealing with multiple disaster events: In 2017 there was Hurricane Maria that hit Dominica, destroying the island physically as well as the tourism sector that had already been affected by previous Hurricane Erika. Still being in the recovery phase, the community then had to cope with the Covid-19 pandemic, once again bringing tourism to a stop. Additionally, the community has been fighting a coral disease that might destroy 80 percent of corals in the coming years. This complex problem situation leaves Dominica being in multiple phases of the disaster management cycle (Le Cozannet et al., 2020) at the same time, still recovering from Covid and Hurricane Maria, preparing for and working on preventing dire consequences of potential future natural disaster, and responding to the coral disease. Considering this complex situation, building resilience and adaptive capacities is one of Dominica's focal points.

To investigate how community entrepreneurship can enhance the adaptive capacities and resilience in Dominica, we conducted three interviews with key actors engaged in marine reserve management, disaster recovery and resilience building. The contacts were gathered through snowball sampling. We used adapted versions of the common interview guide that included questions about community entrepreneurship or community activities for disaster recovery and resilience building as well as questions about adaptive capacities and challenges.

When investigating the research question posed, several aspects were found to be dominant and of particular importance in the data collected from the interviews conducted. A general but clear and stringent insight mentioned throughout the interviews was that the clear structure of the MPA and the appealing natural environment in the area are the baseline for the entrepreneurial activities present in SSMR. This provides opportunities for the variety of organizations to take action in tourism or community focused projects. Those activities can in turn enhance adaptive capacities and foster resilience, as they close the loop by protecting the natural environment and strengthening the community. This revelation emphasizes the crucial role of a strong community and a well-managed, functioning environment.

To get a deeper insight into what influences the adaptive capacities in the MPA, the interviews provided a good overview about existing organizations and community activities in the SSMR. While the Fisheries Division is the lead governmental institution responsible for the marine

reserve, the Local Area Management Authority (LAMA) is its main managing body. Through coral restoration, that means the protection of the natural hurricane defence line, and outdoor education which creates awareness for resilience topics, this organization actively works on strengthen resilience. The same is true for Resilient Dominica, a privately funded community resilience NGO that engages in projects like the construction of a jetty, rebuilding the school and providing a disaster kitchen. Furthermore, there is the socio-economic group, a bigger group of people that facilitates networking or organizing beach clean-ups. After Hurricane Maria, a hurricane response team was established for disaster preparation and response. Finally, many small entrepreneurs are active in the area. Most of them are related to tourism like the dive shop, the bubble beach attraction or bars and restaurants. There is potential for them to contribute to resilience by meeting needs or educating about the natural environment.

We did not find a perfect example of community entrepreneurship in the SSMR. Instead, we perceive aforementioned organizations and activities on a scale of active to passive community involvement as proposed by Bacq et al. (2022) and on a scale of more to less entrepreneurial. The LAMA for example involves fishermen groups, village councils and tourism enterprises, that means the community is very involved, but it is less entrepreneurial. The small entrepreneurs lie on the other side of the spectrum since they are very innovative and entrepreneurial but more individualistic and do not necessarily directly benefit the community. After broadening our perspective through the process, valuable insights into the enhancement of capacities by these various community activities were gained.

Our further findings place a special focus on the adaptive capacities of the MPA community, which are influenced by community entrepreneurship and can in turn support community resilience in the MPA. During the process of investigating the community structures and dynamics, we distinguished between inherent and lacking capacities. Several inherent capacities were identified, which can be enhanced through community entrepreneurship. These included, firstly, community related capacities such as a strong sense of community and community engagement. The activities at place help the community feeling as one and binding together, while also more people are encouraged to take part in the projects present rather than having to overcome the barrier of initiating projects from scratch if those would be lacking. Additionally, the smaller organizations particularly constitute flexible and adaptive approaches of community entrepreneurship. Enhanced flexibility is another important factor fostering resilience in the community. The establishment of small organizations in SSMR has also shown to attract foreign investors providing financial support.

The earlier mentioned role of a functioning environment and the appreciation for this value, which were identified as a basis for activities in the first place, can also be regarded as capacities and resources, which are enhanced by community activities. Regular fish festivals, beach clean-ups or diving activities are able to improve the community's as well as tourist's perception of the natural surroundings, their value and the importance to preserve them, once again benefiting the resilience of SSMR. The adaptive capacities we found are also highlighted by community resilience literature. According to Norris et al. (2008), sense of

community, community action, flexibility, partnerships and attachment to place all help to increase community resilience.

Next to those positive relationships between community entrepreneurship and adaptive capacities, the interviews also revealed room for improvement regarding certain capacities. Though the organizational structure of the MPA and organizations is generally on a decent level with distributed zones in the MPA and division of areas of responsibility in the investigated organizations, organizational tools in between organizations and regarding the whole community are rather scarce. Not only organizational tools but also tools to assess the efficiency of the organizations at hand leave room for further work. The efficiency of community entrepreneurship in the area can currently neither be sufficiently assessed, nor enhanced. Next to that, transparency towards the community in the work of the organization is also lacking.

With regards to entrepreneurial potential, knowledge and experiences on entrepreneurial practices are another lacking capacity, which could help people to successfully start businesses in the community to foster resilience. Contrasting this, a potential threat of entrepreneurial activities on the strength of the community was mentioned. An increased number of entrepreneurs in the community could harm the closely knit community due to increased competition between entrepreneurs, and entrepreneurs could try to prevent others from being successful in fear of losing his or her own success. Another important aspect mentioned in the interviews was the lack of participation in the community organizations present. Most of the organizations are rather small regarding the people involved and incorporate only a small fraction of the community, such as a small number of local entrepreneurs or fishermen and women. The need for a much greater number of people forming diverse parts of the community to be involved in the community projects on resilience was demonstrated by the interviewees. This requires increased motivation of people to engage, constituting another fundamental capacity that is lacking. Recruiting this diverse group of motivated people to engage in resilience building activities was identified as the biggest challenge towards community resilience in SSMR.

Having in mind the lack of people participating in the resilience work of the community we came up with an artifact that can meet this very need of motivating people. We created a leaflet which summarizes the work of the different organizations, which can be folded into three parts and therefore be easily distributed. This leaflet could then be handed out to different parts of the community, like the diving shops, local bars or offices of the organizations, as well as at local events like the fish festival, where various people from all parts of the community come together. With a leaflet with a broad general overview like this, these distribution methods can then lead to reaching a broad target group and therefore hopefully recruiting a broad range of participants, an aspired aim formulated in one of our interviews.

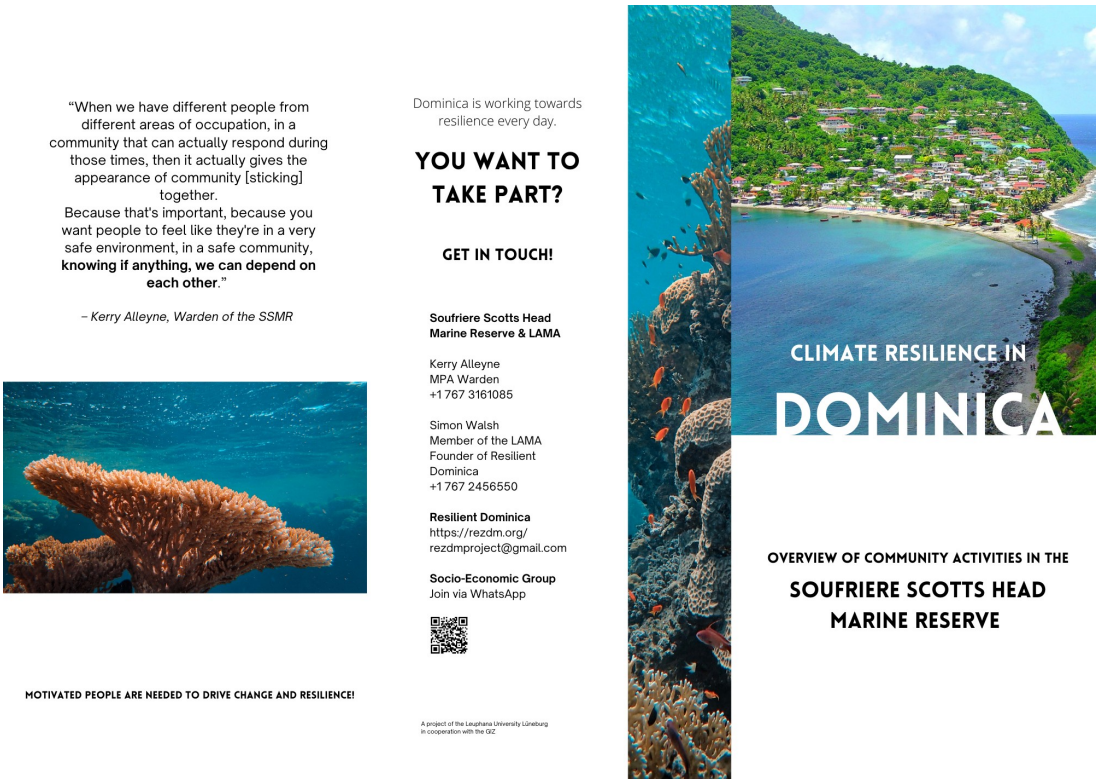

Figure 3: Leaflet "Climate Resilience in Dominica" (front and back)

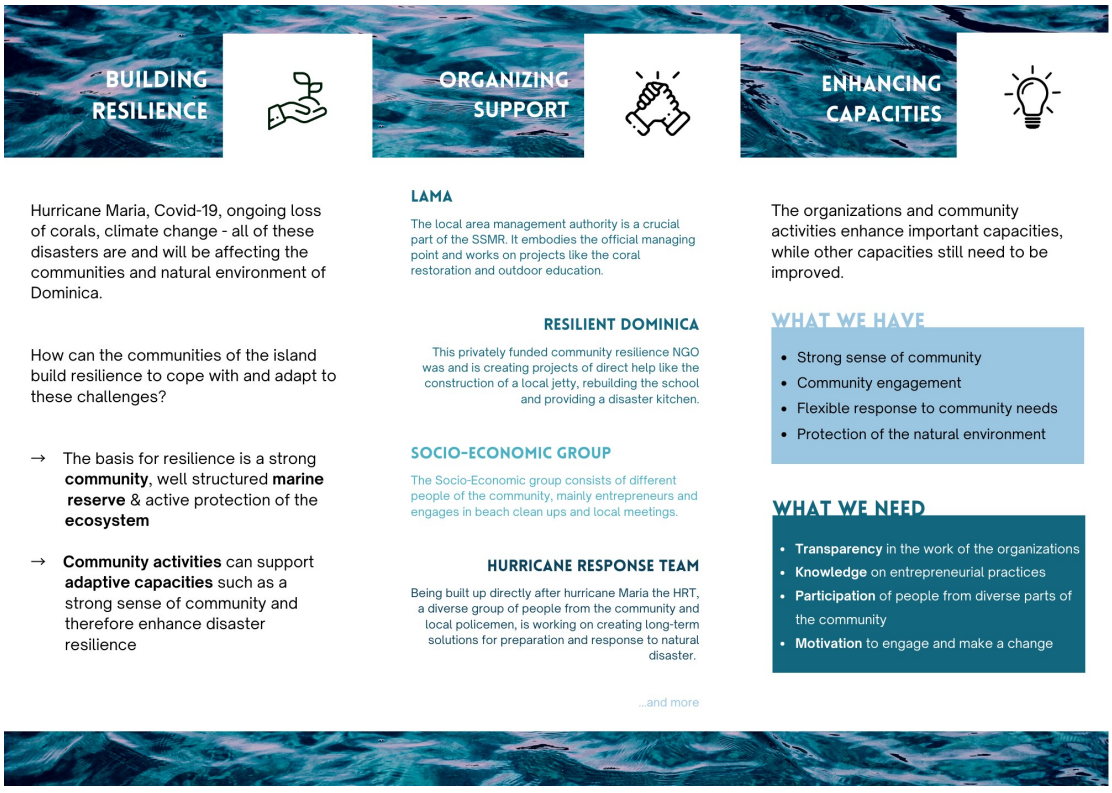

Figure 2: Leaflet "Climate Resilience in Dominica" (inside)

This method of distributing the results of our research back into the community is, in our opinion, the best way of opening an opportunity to solve the challenges that were formulated without imposing our limited information onto the local people. There might still be the problem that people are not interested to engage in the activities or are not motivated enough by the leaflet.

Although we gained a very good and broad insight into the community throughout the process, limiting factors can be identified. Firstly, we only had a limited amount of time for our project and therefore were not able to get some further and broader insights into the community and understandings about the direct impact of entrepreneurship. Secondly, we were facing the challenge of gathering data remotely, which also made us rely on the information of only three interview partners. The potential of contacting more and diverse members of the community, and therefore getting a larger and diverse sample group, would have been higher if we had investigated at the local level. Furthermore, it is questionable whether we fulfilled the requirement of participation in the process for higher legitimacy, ownership by and relevance to the practitioners adequately, or if there would have been a need for more integration of the local partners into the research process, for example through integrative workshops.

Despite the limits we identified, we believe that our research outcomes offer a good foundation for future research concerning the relationship between resilience and community entrepreneurship in disaster prone MPAs in the Caribbean.

TD PROJECT GRENADA: SANDY ISLAND OYSTER BED

JOHANNA DIEDERICHS, FAYE ENGELHARDT, KLARA KNOLLER & JANA SEIPELT

Grenada is an island group consisting of the three islands Grenada, Carricou and Petit Martinique. It has a total size of 348 square km and is known as the 'island of spice', being a world leading exporter of mace and nutmeg and growing various other spices like cinnamon, cloves, and ginger. In the past years it has become increasingly popular for eco-tourism due to its beautiful nature and wonderful beaches. However, the island still has high debts in connection with its postcolonial dependencies and therefore struggles with high unemployment and poverty rates. In our research we focused on the Sandy Island Oyster Bed (SIOB) MPA which is located on Carriacou and to this day is the only somewhat functioning MPA on Grenada. It has a very important ecosystem function with regard to disaster resilience and is a culturally significant area for the people of Carriacou. Although the island is not as frequently hit by devastating hurricanes, Hurricane Ivan in 2004 destroyed the majority of SIOBs coral reef and mangroves. Still today the MPA has not recovered, although it has one of the most important marine ecosystems in the region.

Due to the remote setting of the TD project, semi-structured interviews were chosen as the method. Our first interview was with Denzel Adams, the National Project Officer of the GIZ SMF project for Grenada. He gave us a thorough introduction to the GIZ project and introduced us to the Sandy Island Oyster Bed (SIOB) MPA, its current structures, characteristics, and difficulties. Thereafter, we had four other interviews, with the manager of the Coral Reef Foundation, a representative of the Grenada Red Cross Society, and two members of the Nature Conservancy (TNC). These interviews were essential for our understanding of the dynamics of the island, the current issues the MPA is facing, and possible solutions and future states.

Based on the conversations with our interview partners, we examined the current state of Grenada during our coding process under the aspects of conservation, collaboration, resilience, inherent and adaptive capacities, as well as disaster management and community-based entrepreneurship. Grenada has only been able to conserve 1.2% of Grenada's nearshore environments of the 20% targeted by the Caribbean Challenge Initiative by 2020. Out of several declared MPAs, SIOB is the only functioning MPA with an employed area manager and staff. A general lack of employment, technological capacities, and motivation within the government and responsible ministries can be identified as the main obstacle to a more functioning conservation system throughout the islands. The collaboration with international and local organizations such as the GIZ, the TNC, and the Coral Reef Foundation has so far been evident in the developments of the provision of human resources, projects,

plans, technologies and fundings. Projects such as the implementation of Biorock technologies, which support the rehabilitation of coral reefs are helpful and important for the involvement of the local communities. However, their efficacy often ends as soon as the project is finished. The same problem extends to funds, which are limited, inconsistent, but essential to conservation and restoration activities and the establishment of the MPAs. The only community-based entrepreneurship and self-generated income of the MPAs is from yacht mooring by tourists or from diving activities. The so-called mooring fees are collected by the government and reinvested in the employment of the MPA staff. The fees are currently insufficient to ensure financial independence of the MPA, and the government needs to make further investments to cover the costs of the MPA. These problems are replicated in the disaster management in Grenada, which relies heavily on volunteering and external funding.

According to our interviewees, it is especially important to have a more persistent workforce and also higher motivation to engage in the SIOB MPA through volunteering. Volunteering is crucial in crisis situations. However, the financing of the MPA also plays an essential role since there is often a lack of financial resources. A self-financing mechanism would allow the MPA to be independent of external sources as well as the government, which could lead to more extensive projects. Regarding the disaster situation, it was expressed that natural events and climate change impacts, are not socially induced disasters because the community can absorb and manage the consequences. In addition, the Biorock Project should be enlarged and there should be more community activities regarding coral restoration and mangrove planting to strengthen climate and community resilience. Lastly, incentives for community-based entrepreneurship in the MPA should be expanded to increase people's motivation to participate.

Based on our findings we developed a creative output that aims at increasing the financial flow into the SIOB MPA for financial independence. Furthermore, it aims at fostering an understanding, acceptance, and support of the taken conservation efforts within the local community and the tourists. The additional funds and business activities would allow for restoration and conservation projects. It would also cover the salary of the existing staff as well as allow further staff from the local community to be employed. All of this would help to strengthen the relationship of the local community within the MPA, which could increase their willingness to participate in protecting the MPA. The first part of our output entails increasing the mooring fees that are currently collected in the MPA. In exchange, the visitors will receive “The Coral Saviour Ticket” (see figure 4) which grants them access to the MPA. The positive connotation of the name of the ticket is supposed to foster a feeling of pride in the visitors making them feel welcome in the MPA but also introduces them to the topic of coral reef destruction threatening SIOB.

This topic is further discussed in the second part of the output, the digital brochure (see figures 5-8), which can be accessed by scanning a QR code on the back of the ticket. The

brochure contains information about SIOB, the current situation of its coral reefs and how the price of the fee is made up and redistributed. Thereby the tourists will know how their personal contribution through the collected funds is reinvested into MPA in a transparent matter. A personal thank-you-note written by the MPA manager, or a member of the community is supposed to further enhance the previously mentioned positive feelings of the visitors.

Lastly, the brochure entails discount vouchers of different locally owned businesses such as restaurants, diving schools or guided tours and some local recommendations of other activities that can be undertaken in the MPA. This can help to give visitors an idea of what they can do on their holiday and can also nudge them towards further financially supporting the local businesses and thereby the SIOB MPA through further fees.

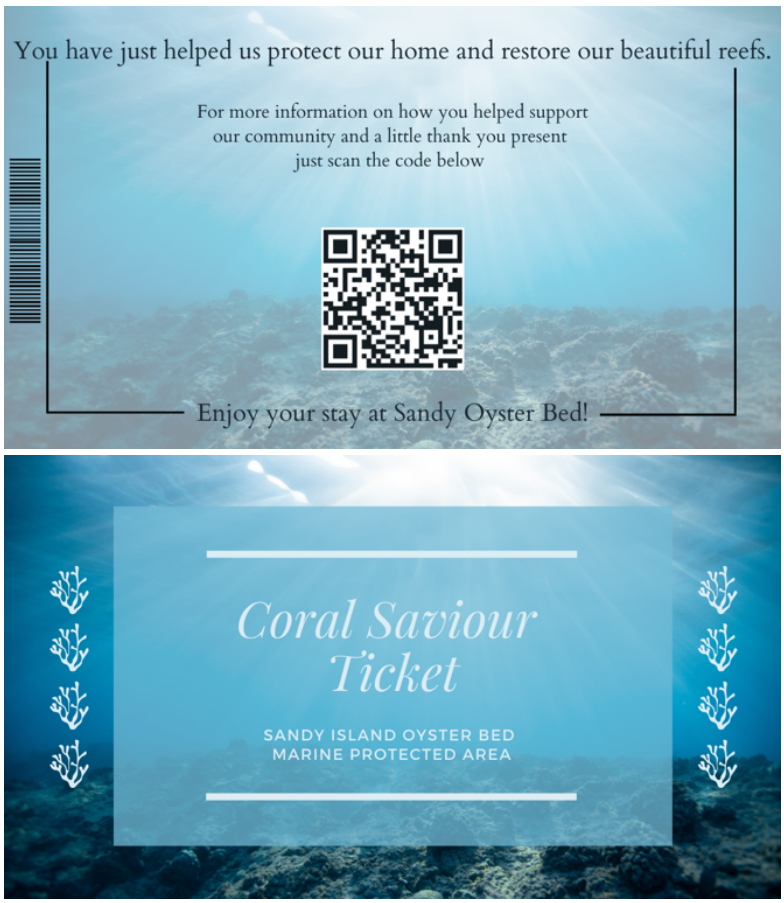

Figure 4: Part I: "The Coral Saviour Ticket"

Figure 5: Digital Brochure- Cover

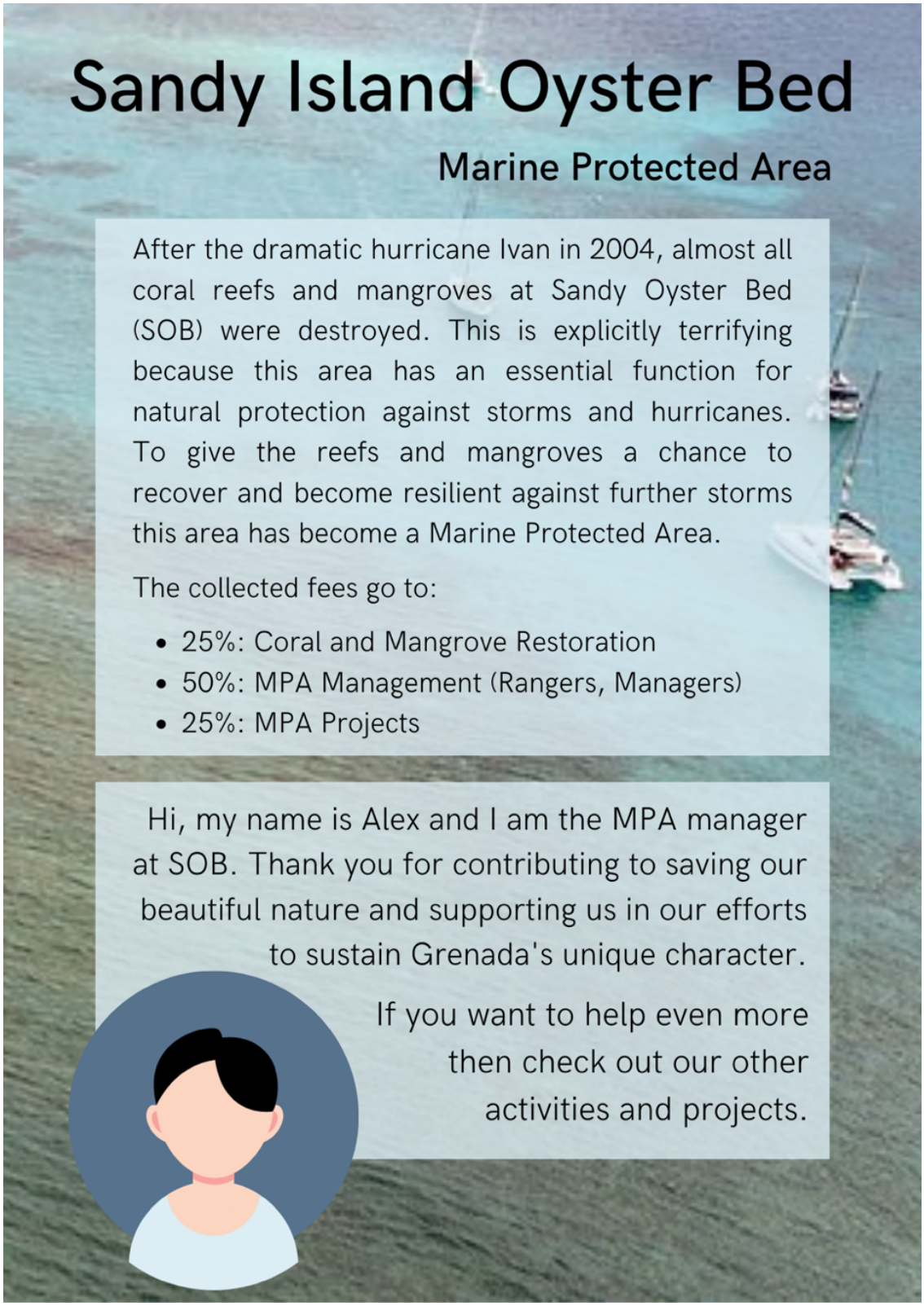

Figure 6: Digital Brochure- Page One

Figure 7: Digital Brochure- Page Two

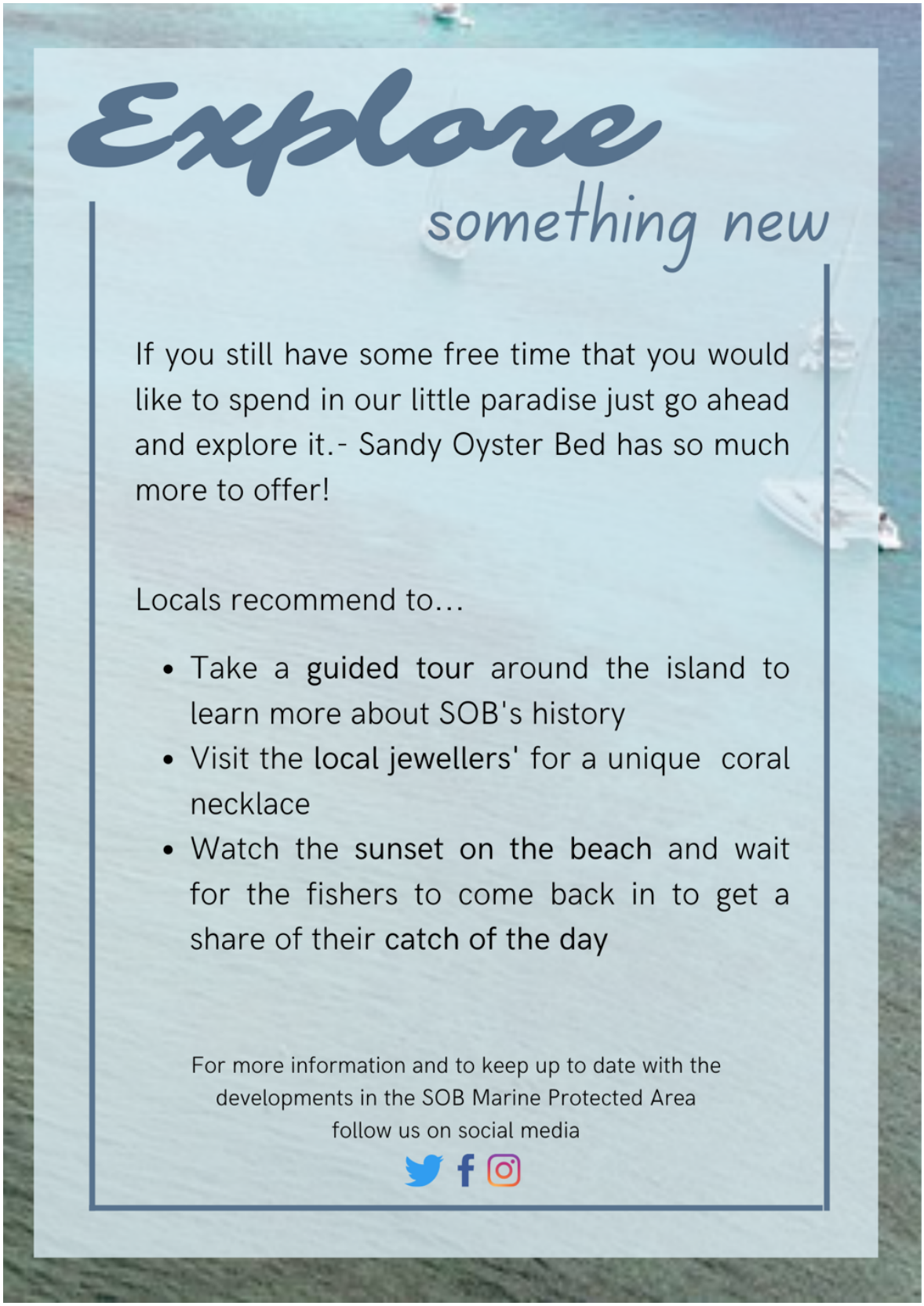

Figure 8: Digital Brochure- Page Three

TD PROJECT ST. LUCIA: SOUFRIERE MARINE MANAGED AREA

NIMISHA EBBERS, LUCA HÖLBLING, VALENTIN LORENZ, CONRAD MOOSDORF

Like other Caribbean islands, St. Lucia's economy is highly dependent on the tourism sector which in return depends on functioning infrastructure and institutions (Gov of St. Lucia, 2020). In the past decades, these structures are increasingly threatened by environmental damage in the context of the global climate crisis. However, instead of hurricanes or other singular event-based natural disasters, the environmental disasters facing St. Lucia are of a rather procedural nature, continuously degrading the environment through coastal erosion and reef destruction. The Soufriere Marine Managed Area (SMMA) is a 12-kilometre-long coastal segment in the South-West of St. Lucia which provides a significant contribution to the island's economy. At the same time, the area is one of the most impoverished areas, showing a disparity between capital generation and its distribution. Among the commercial activities in the area are projects of community-based entrepreneurship (CE) which, if given access to resources and support, can facilitate the regional resilience.

The research consisted of semi-structured interviews as well as parallel literature reviewing of topics, related to the basic research context, and arising topics from the interviews. The interviews were analysed and interpreted to discuss the potential of CE for the community to become more resilient towards natural disasters. To get into contact with potential interview partners, the research relied on a snowball system. Three professionals were interviewed who are working in the fields of marine financing, capacity building and conservation. Though the snowball method inhibited reaching stakeholders beyond the academic and professional realm, this lack was made up by adapting the research guide to not only reflect professional expertise but also personal perception. All interviewees were stakeholders and members of the SMMA community. The abstraction of the interview data during the analysis led to two main sets of findings, namely the deficiencies and the potential for the community of Soufriere. Both sets were linked to the initial overarching framework developed by the group responsible for the conceptualization of the research design.

Regarding the deficiencies, four main findings were identified in the interviews. Concerning the inherent capacities, there is a lack in social capacity, specifically transformative knowledge. This relates to the insufficient capacity of the community to implement ideas into action which was described by the interview partner Newton Eristhee as "implementation deficiency disease". In addition, the robustness of the community is threatened by environmental loss and internal conflicts. The environmental loss such as coral reefs dying through coastal degradation, sedimentation of the reefs in cases of storms and climate change effects overlap and strip the area of its natural barriers. This is related to hurricanes

as they contribute to phases of intense precipitation but is not exclusive to them and a rather continuous process. The internal conflicts pose a threat to the community's robustness as well. They take place between sub-groups like the fisheries and tourism officials about resource conflicts and using rights and between the private and public sector about financing and decision making. The third deficiency lies within the missing resourcefulness for autonomous action. The area is strongly dependent on external agencies such as foreign aid and support programs to the degree that there is a lack of self-maintenance once initiated projects run out of external funding. The last major deficiency is the underdeveloped communal learning which needs stronger community ties to unify the community members to gain critical momentum to set up, implement and maintain projects.

The potential which was revealed during the research was the essentiality of CE for the community as it is a constituting element in building it. Newton Eristhee described it in the following: "*It is not only about livelihoods. It's a sense of belonging. That sense of belonging and that sense of place is important to the people of Soufriere. And that entrepreneurial activity or this suite of activities is what keeps them in place*."

The interview findings overlapped and complimented the knowledge acquired by prior research. Previous studies have shown that the lack of Soufriere's adaptive capacities lies within insufficient cooperation and trust in the community as well as external dependencies which can be surmounted by maintaining environmental resources and fostering innovation (Hogarth and Wojeik, 2015). CE has additionally shown to be necessary to overcome the inequal distribution of wealth based on tourism on other similar island states (Giampiccol et al. 2020). Regarding the connection of economics and the environment it has also been found out that nature conservation positively effects economic activity and growth (Miranda et al. 2021).

In lieu of these findings, it was decided that a citizen science toolkit which includes a presentation and brochure would be developed as an output. Fundamentally, citizen science involves non-academic community members in the process of scientific research. Such investigations can be both local and global. Community members can contribute to scientific projects in several ways and there are various levels of engagement that range from projects designed by scientists where people help with data collection and monitoring, to assisting in analysis and interpretation of data and the co-creation of a project. Furthermore, citizen science allows for engagement of a diverse group of stakeholders in projects relevant to climate adaptation and resilience thus bringing various parts of the community together. Though citizen science was not explicitly mentioned by an interview partner, the interviews revealed that there are already projects involving the restoration of coral reefs which rely heavily on training local fishery and boat drivers to dive, restore, and monitor the reefs.

The main inspiration behind the citizen science output was the emphasis interviewees made about the dependence not only on foreign finances but also on foreign expertise. Apart from the concept, the medium of a presentation and a brochure was chosen based on the consideration of accessibility and flexibility, which are granted by a PDF presentation as well as a practical brochure to introduce the target group to the topic which can be provided online, embedded into a website, or used for in-person sessions.

TD PROJECT ST. VINCENT AND THE GRENADINES: TOBAGO CAYS MARINE PARK

ANNA HAUBRICH, LEA MÖLLER, MADAWI NANDAKUMAR, DARIA SHEPELEVA

Our group's research was conducted in the Tobago Cays Marine Park, which is located in the South Grenadines of St. Vincent and the Grenadines. We focused on Mayreau, the only inhabited island in the area. The size of Mayreau is about 4 square kilometers, the population of the island is around 300 people. Many people born in Mayreau leave the island at an early age of 10 years because they need to attend secondary school on the mainland. Most of them never return as they do not have many prospects of finding a job or even sustaining themselves on the small island as it is, like most of the Caribbean islands, threatened by climate change in a dramatic way. One of the most effective ways to protect the island and its inhabitants from the devastating consequences of a hurricane are coral reefs that protect the coasts from waves, storms, and floods. In addition, the reefs around Mayreau create a habitat for a great diversity of marine animals like fish which are essential for the coast's health and provide food for the local population. To protect their islands from these threats, an inhabitant's initiative called "We are Mayreau" was founded as a non-profit organization that received funding for two years. They are working on reef restoration around the island, which creates a lot of opportunities, but also requires creativity to secure funding as well as simultaneously foster resilience in multiple dimensions.

Like the other island groups, we conducted semi-structured interviews with representatives of the MPA. To get an overview of the Tobago Cays Marine Park, we contacted the national project officer (NPO) and conducted an interview. For deeper insights into the entrepreneurial activities on Mayreau, we first reached out to local people whose contact information we found on websites and Facebook pages and asked for their willingness to answer some questions in form of an interview or phone call. Further interview partners were recruited mainly through snowball sampling by asking interview participants whether they knew other relevant stakeholders for our research. The general question guide created in the seminar was used as a basis for the interview question. It was expanded by further questions emerging during the interview process.

A total of four interviews were included into the analysis of our main findings. The interviewees were the NPO of the Tobago Cays Marine Park, two members from the "We are Mayreau" initiative and one diver from the "Mayreau Explorers" sea moss farming initiative. The interviews were transcribed and summarized in a table that included the main concepts from the resilience framework. With the help of this baseline, we connected our main findings and applied the framework.

Two major adaptive capacities for the Mayreau community that we defined were food security, community leadership and self-organization. To increase the food security on the

island, hydroponic farming was implemented in the community. The advantages of hydroponic farming are that the plants are cultivated without soil which makes the farming more efficient in terms of land consumption. Most of the land on Mayreau is privatized, so that the limited space for agriculture challenges the food security for the population, especially in case of a disaster when the connection to the main island is cut for several days.

Another community-based entrepreneurship approach that is common on the island is sea moss farming (Figure 9). It offers two major benefits to the community: firstly, the farms are a habitat for different species that enhance food security for the inhabitants of Mayreau, secondly, the community profits from selling the sea moss globally.

Figure 9: Map of Sea Moss Farms on Mayreau (2018)

Among the problems identified in the analysis of the data collected, our creative output addresses the problem of the lack of human resources on the island. Our interview partners emphasized that the young Mayreau residents are not very keen on returning to the island after completing their studies. One of the recommendations to enhance the capacity of social capital was to create awareness to raise the felt responsibility. “[...] At the moment everybody works a little bit on everything which actually shows that we need more people and resources.” (a representative from “We are Mayreau"). The main goal of the creative output is to further enhance the social capital in the community of Mayreau by increasing the local youth's involvement in the entrepreneurial activities (Hydroponic crop cultivation, reef restoration and sea-moss farming) of "We are Mayreau" incorporation. We expect to reach our target group of local youth from the ages of 18- 30 through the communication channels of social media, posters, and handout advertisements. Our objective is to promote the orientation day at “We are Mayreau'', through which the young people would get the opportunity to witness the day-to-day work at “We are Mayreau" (sea-moss and hydroponic farms and reef nurseries). Mayreau as a community with various inherent capacities is a

beautiful island with rich nature. This attempt could be a starting point to inspire more youth to get involved in such entrepreneurial activities which could lead to more community action and enhance the social embeddedness and sense of community.

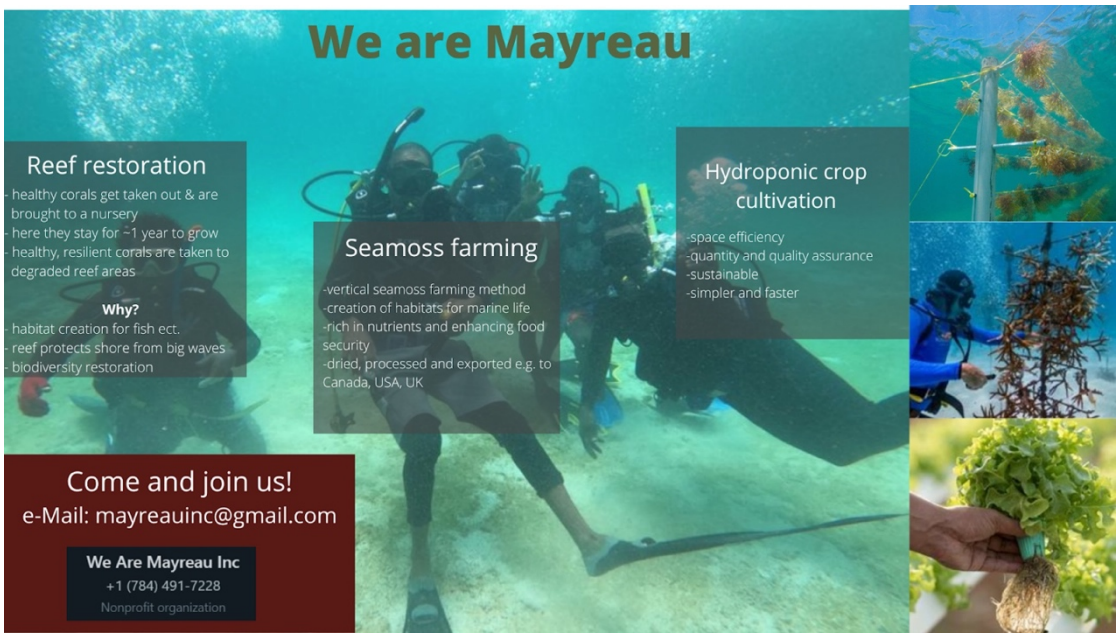

Figure 10: Youth For Mayreau Leaflet

LESSONS LEARNT: NATURE-BASED SOLUTIONS TO ENHANCE CLIMATE RESILIENCE OF CARIBBEAN MPA COMMUNITIES

STEFFEN FARNY

Climate change heavily disrupts and damages communities and biophysical systems on Caribbean islands. It is vital that communities are able to limit potential damage from disaster impacts, i.e., have a high adaptive capacity (see *Foreword*). On the one hand, this requires a legal set up that enables the protection of biophysical systems in coastal areas, which is the case in Marine Protected Areas (MPA). On the other hand, as outlined in the latest IPCC report, it also requires diverse forms of knowledge (e.g., local knowledge, technical knowledge, etc) to reduce the exposure and vulnerability of local community to human induced climate change (Pörtner et al., 2022). Therefore, this student research project on community resilience in MPAs conducted by students of the Global Environmental Sustainability Science students of Leuphana University in close collaboration with the GIZ Team on St. Lucia applied a transdisciplinary design sensitive to combining knowledge from practice and science (Lang et al., 2012). Building on results from last year's project on Dominica (see Farny, 2022), the focus of this year was to understand the effect of varying local conditions in disaster-prone regions in the Southern Caribbean on climate resilience (see *Introduction*). In particular, it asked: *How can community entrepreneurship support and enhance the adaptive capacity and resilience of disaster prone MPA communities?*

In an initial joint problem framing session with Camille David and Volker Hamann (GIZ), the students gained a mutual understanding of the core *societal problem* that is the need to enhance community resilience by finding nature-based solutions to protect valuable assets in order to meet the 30x30 targets – i.e., worldwide initiative to designate 30% of Earths land and ocean area as protected areas by 2030. This societal problem contains challenges for (1) governance, (2) financing, and (3) capacity development in managing the MPA (see *Joint Problem Framing*). Joint problem framing revealed that focusing on **community entrepreneurship and capacity development** offers great potential to address the current vulnerability in a sustainable use of environmental resources in a coastal area, which can be scientifically conceptualized as a sustainability problem that is simultaneously complex, contains nonlinear interaction effects and has both local and global implications (Wiek et al., 2011). A review of core concepts and the literature on community resilience exposed that local communities' inherent capacities are often insufficient to locally absorb and maintain basic functioning in response to climate change effects. Therefore, a student group developed a conceptual model (see Figure 1 on page) that displayed a number of factors that help

increase a community's adaptive capacity through community entrepreneurship and thus strengthen community resilience (see *Concepts and Literature*).

Thus, over 14 weeks the students worked together with national project officers (NPAs) of the GIZ team to engage with local stakeholders in four MPA communities and **co-create new solution oriented transferable knowledge**. Using a transdisciplinary project design, the student teams could build on the multi-year experience and close connection of the GIZ with local MPA communities on four small island states (see *Transdisciplinary Project Approach*). The four island states of Dominica, Grenada, St. Lucia, and St. Vincent proved to be an ideal context to implement a transdisciplinary research project on MPA communities and climate resilience, as they have declared several coastal regions as marine protected areas in order to manage the severe risks, frequent expose and projected effects of climate change in the Southern Caribbean (see *Empirical Context*). As such, four student teams separately focused on one MPA community, exposing the varying conditions, enabling and constraining factors, as well as ideas for increasing the adaptive capacity of the different MPA communities (see *TD Project Chapters*). In addition to the MPA specific results, a comparison of the four TD projects revealed four overarching lessons.

First, all countries see a **need for restoration and conservation projects**, thus nature-based solutions implemented and governed by the local community in the MPA! However, a number of inhibiting factors currently constrain and even undermine the implementation of these solutions: (1) limited sense of belonging and motivation of local community to increase (voluntary) engagement, (2) insufficient tools to implement an efficient governance model, (3) lack of financial resources to implement a self-funding model, (4) absence of long-term, fairly-paid employment to manage the MPA, (5) low priority of the central government to strengthen MPA and achieve the 30x30 conservation targets. As a result, the MPAs hardly exposed nature-based solutions that integrate the needs of natural ecosystems and people's economic needs in an environmentally-sensitive business idea. Despite its potential, community entrepreneurship is hardly practiced. Instead, we predominantly witnessed ideas relying on volunteers and external support which could be further developed into self-financing community entrepreneurship models. Developing hybrid business models in conjunction to local tourism seems to be a promising starting point.

Second, all four cases show **limited local participation** in governing and organizing the MPA as constraining factor for community resilience. This could be improved through more formal employment opportunities and support of the central government, which seems to be a necessary factor to increase the nature conservation objectives (cf. SIOB MPA Grenada). Also, greater access to technical solutions to develop nature-based solutions, for example for Coral Reef restoration, could mobilize community engagement. Oftentimes mooring fees are insufficient to cover the costs of MPAs creating a high dependence on volunteering and external funding which is not sustainable in the long run. Since a sense of community,

community action, flexibility, partnerships and attachment to place all help increase community resilience (cf Norris et al. 2008), local interventions likely increase people's motivation for participation in community organizing.

Third, this TD project highlights the importance to distinguish **climate change as an event or as a process**. When climate change occurs as a series of *disaster events* (e.g., hurricanes, floodings, and heatwaves) in combination to the gradual degradation of natural ecosystems (e.g., coral bleaching and ocean warming), people in MPA communities were more aware of and exposed a higher level of engagement in MPA activities (e.g. regular fish festivals, beach clean-ups or diving activities). On Dominica and Grenada informants showed highly adaptive and restorative behaviour in response to hurricanes, i.e., a greater adaptive capacity. These MPA communities exposed a higher awareness about the importance of community resilience. Therefore, both student groups suggest developing additional information material and develop mechanisms to include additional stakeholder groups and develop more efficient governance mechanisms. In contrast to that on St. Lucia and St. Vincent climate change occurred as a *continuously degrading process of the environment* through coastal erosion and reef destruction. These MPA communities expressed a greater lack of "transformative knowledge" and implementation deficiency of resourceful, adaptive and even corrective actions. In these cases, a first objective would be to minimize external dependency, activating the community, for example in form of a citizen science exercise, which at the same time would develop a basis for collective action and even community-based entrepreneurship. First and foremost, these MPAs are in need of developing greater awareness of the potential for nature-based solutions that also offer people a salary and stop inter-island migration of younger people away from the MPA to areas with healthier ecosystems and more economic opportunities.

Fourth, this project was an attempt to realize a cross-cultural **virtual transdisciplinary project**. It proved to be the biggest hurdle in entering the co-creating of solutions stage where physical proximity seems to be a major enabling factor. A major learning was that in virtual TD projects particular attention needs to be paid to setting clear boundaries and be explicit about success criteria. Due to time constraints during the joint problem framing exercise, we set neither of them. This created a state of limbo leaving both parties with considerable uncertainty about the scope and quality of the desired outcome. At the same time, even a deliberate search of the literature did not offer the needed clarity on how to effectively design a virtual TD project. Therefore, in the beginning, the virtual interaction was perceived as a constraint. However, over time the student groups changed their attitude and approached the purely virtual relationship also as an opportunity to access people in remote places. For example, one group called a local bar and the phone was passed from person to person quickly revealing the general sentiment of the community about the local MPA. Yet, new practices need to be developed and tested in order to virtually run a systematic co-creation workshop.

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