Fine-Tuning Climate Resilience in Marine Socio-Ecological Systems: The Need for Accurate Space-Time Representativeness to Identify Relevant Consequences and Responses

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Climate change triggers a wide mosaic of regional and local responses, often different to the large-scale variability in magnitude and direction. Because of the psychological connections (cognitive and emotional) with the frequency, intensity and age of a climatic event, people may have the capacity to recognize key variations at lower scales, especially those from which they perceive risk. Yet, the anticipatory actions and social engagement to respond or adapt to climate change are difficult to achieve, mostly when there exists a long psychological distance to climatic phenomena. Research about climate change communication provides clues about the relevance of place-based discussion to gauge risk perception and improve response protocols, their design and prioritization. It argues that strategies and actions required to face climate risks may widely differ depending on the scale and accuracy of the local representations displayed during discussions of climate impacts. This work examines how local attributes (from climate to social) operate and control place-specific risks and priorities, by comparing coastal communities in two locations, Cabo Pulmo, Mexico and Zanzibar, Tanzania, which are subject to different climate dynamics. This paper discusses the need to identify relevant climate risks/responses at the local level and how psycho-social factors (e.g., psychological distance, collective memory, and social engagement) may operate positively for building climate resilience. We also illustrate a workflow to increase and enhance collaboration between researchers and local people by promoting dialogue, participation and narratives that rigorously consider the local knowledge.

Keywords: socio-ecological resilience, risk perception, climate adaptation, climate risk, coastal communities, adaptive capacity, anticipatory governance

INTRODUCTION

Climate resilience is the multidimensional capacity of the system itself to absorb, adapt and respond to climate risks (Perry et al., 2010; Welle et al., 2014). Building climate resilience in marine social-ecological systems (MSES) is of general interest due to their global importance for food production, livelihoods, and future sustainability (Charles, 2012). The climate may alter the state of marine ecosystems and coastal communities in terms of physics, ecology, economy, security, people health, and wellbeing (Barange et al., 2010). To achieve global resilience depends on resilience at smaller scales, where climate consequences manifest, and also where responses and adaptations occur (IPCC, 2007; Perry et al., 2010). This paper discusses the need to identify relevant climate risks/responses at the local level and how psycho-social factors (e.g., psychological distance, collective memory, and social engagement) may operate positively for building climate resilience.

Representation of Climate Variability and Change

Climate change is not homogeneous on Earth; there is a wide variety of regional and local responses. In many instances, these responses do not follow large-scale trends (IPCC, 2007; Cooney, 2012; Saldívar-Lucio et al., 2015). Conclusions based on predictions from global models can generate inadequate representations of climatic variations for local actors (e.g., managers, coastal people, and fishers, etc.). These smaller scale representations are critical because they are the basis for the recognition and perception of risk for the local response to specific situations (Sheppard et al., 2011) and for taking adaptive action (Shackeley and Deanwood, 2002; Jones et al., 2017). Generally, this problem is exacerbated by incomplete knowledge about local consequences of climate variability together with complicating factors such as the dissemination of inaccurate data (e.g., media misinformation) (Furness et al., 1998; Sheppard, 2005).

Despite notable advances in the simulation of the climate system of our planet, including the possibility to assess multiple scenarios of change (Cooney, 2012), there are well documented difficulties in communicating the potential impacts of climate change. This might be due to the level of abstraction of scientific climate models. A consequence is that people distance themselves from model abstractions or scenarios: they do not mirror their own experiences and perceptions causing a so called "psychological distance." This term refers to things, persons or events that are not registered in the direct experience of reality (Liberman et al., 2007). The psychological distance may vary according to the intensity that any given climatic event impacts on cognitive and emotional components of human psychology (Spence et al., 2012; Trope and Liberman, 2012). When the psychological distance is short (psychologically close), the emotional and cognitive engagement increases, then people may recognize and feel connected to the event. However, if only a vague or long psychological distance (psychologically distant) is generated (e.g., a weak hurricane or a coarse model), people will find it difficult to establish cognitive and emotional connections (Lorenzoni et al., 2007; Steynor et al., 2020).

In this context, some researchers have warned about the possible need of new climate-driven calamities to change the collective perception of risk and induce people and governments to take action (Tickell, 2002). Sheppard (2005) demonstrates that realistic landscape visualizations (showing potential future scenarios) reduce the psychological distance by engaging emotions and may substantially enhance awareness-building about the consequences of climate change. This kind of visualizations may also help to motivate behavioral change at individual and societal levels. However, it has been suggested that climate change representations (e.g., animations or scenarios) should not be chaotic or threatening. Instead they should strengthen the link between people and everyday concerns and emotions (O'Neill and Nicholson-Cole, 2009). Kolb and Kolb (2009) discuss that an experiential learning may be better achieved by focusing on concrete, locally relevant impacts, and responses to climate change.

Risk Perception, Collective Memory, and Social Engagement

Another important consideration in risk perception is the connection between the collective memory and the frequency, magnitude and temporal length of climate events (Bellelli et al., 2007; Viglione et al., 2014). Perry et al. (2010), page 2-3 describe an example of such connection: "...*over a typical human life of 50 years in a fishery, a fisher in the Pacific can be expected to experience several ENSO (El Niño Sorthern-Oscillation) events, and at least one event occurring at interdecadal time-scales. Variability on multidecadal and longer time scales may not be experienced by individual fishers but is likely to have been encountered by family forebears and/or by the community, and so will be embedded in local and traditional local knowledge.*" Even when memories of climate impacts may be maintained in the traditional knowledge, the response capacity (if any) will fade out with the gradual increase of the temporal distance of the event (Trope and Liberman, 2012).

The temporal distance, spatial distance, and uncertainty about whether the climate event will happen or not, are key factors defining the perception of climate risks because they govern the psychological distance of individuals and communities with respect to the event. Therefore, psychological distance influences the collective memory and resilience: the more familiarity to particular climate events, the greater the tendency to generate adequate responses by individuals and communities. In contrast, a poor collective memory associated with infrequent events induces higher levels of vulnerability (Steynor et al., 2020).

The psychological distance is also influenced by aspects of communication strategies. For example, there are difficulties with respect to the effective communication of climate threats, partially because narratives are focused on globally catastrophic consequences, implying inadequate representations of local climate dynamics and the corresponding local consequences. Individuals play an important role in responding to climate change, whether they are common citizens, government

representatives, or leaders who can initiate climate action (Wolf and Moser, 2011). But the kind of delocalized communication strategies (inadequate representation of local climate) can seriously increase the psychological distance because of the difference in the communicated message with every day experienced climate conditions. Such difference eventually can induce perception of no climate risks, thus preventing engagement with related topics, policies or activities (Wibeck, 2014; Steynor et al., 2020). In the current context, "engagement" is the personal connection with climate change, comprising cognitive, emotional, and behavioral aspects (Lorenzoni et al., 2007).

In addition to the many factors modulating individual and collective willingness to get involved in climate action, such as collective memory, psychological distance, or social engagement, there is a general gap in knowledge regarding the set of procedures necessary to face particular climatic events (Asrar et al., 2013). This set of procedures or response protocols (defining specific responsive actions) needs to be designed and implemented to co-exist latently with daily life, in order to avoid new climatic tragedies. Developing a good response capacity demands understanding how local climate relates to everyday human perceptions and activities, which is a keystone for building the social engagement required to implement local responses and associated protocols. In this context, the next section shows how local attributes (from climate to social) operate and control place-specific risks and priorities, thus demanding tailored response protocols.

MODELING LOCAL CLIMATE RESPONSES FOR BUILDING RESILIENCE

The Climate Sets the Scene and the (Social) Actors Play Their Roles

We engaged with the questions above by illustrating with two case studies from one of our ongoing projects (The SEAgender project, PI Maricela de la Torre, Stockholm University, all co-authors are participants), both are coastal communities located in tropical seascapes and embedded in a marine protected area (MPA): Cabo Pulmo (México) and Unguja Ukuu (Zanzibar, Tazania; **Supplementary Figure 1**). These two sites were selected for having (to some extent) similarities, but different economic levels, institutional set-ups and donor history. Thus, selection of cases for comparison was done according to the most similar, ecological features, and the most different in terms of developmental levels and socioeconomic activities. We included this comparative exercise (between sites) to exemplify how local characteristics/circumstances determine the consequences of climate events, thus the kind of response and priority required (in all socio-ecological dimensions: form physics to social).

In addition to our previous knowledge on these coastal communities, having worked there for almost two decades, we used direct observations in the field, conversations with local people, group discussions and literature review, to disentangle

and conceptualize how local climate dynamics influence on ecological, social and psychological factors (e.g., economic activities and perceptions). Such climatic influences define not only the specific vulnerabilities to climate variability and change, but also provide the necessary clues for fine-tuning adequate responses, as part of local response protocols (a critical tool toward climate resilience).

First we schematized a conceptual model (workflow) to guide a hypothetical process of social-academic interactions (e.g., workshops) for building climate resilience in MSES, by promoting dialogue, meaningful participation and trust (**Figure 1**). All this with the aim of decreasing the psychological distance and ensuring the integration of local perceptions in the process. The proposed workflow in **Figure 1** manifests the need for accurate space-time representativeness for both climate events and local conditions, in order to identify relevant consequences and responses. This is the point at which it becomes relevant the use of place-based representations (e.g., photographs, maps, videos, and documentaries), in order to operate in a desired direction the aforementioned psycho-social factors: psychological distance, collective memory and social engagement.

Then, we simulated a process of identifying and prioritizing risks/responses (**Table 1**), by comparing Cabo Pulmo and Unguja Ukuu. We started aligning climate events to local impacts at multiple temporal scales. At each temporal scale, risks identification was based on the interactions of climate events (first column, **Table 1**) with every dimension of the social-ecological system where there was experience of past events (local knowledge), or documented impacts (literature review). Each climate impact was ranked in magnitude with a corresponding color code (green, yellow and red) and risk level (Low, Medium and High), accordingly to the experience of the locals and/or as a result of group discussions (based on scientific knowledge and experience at the sites). Specific circumstances of each social-ecological system were considered (**Table 1**).

From these exercises, we obtained a list of ranked climate risks, so specific responses may potentially be formulated according to the needs and priorities from each place. With **Table 1** we also exemplify how different a response protocol may be from one site to another -depending on the required set of responses and priorities-. The general idea of the simulation exercise is to illustrate that locally identified problems allow centering discussions around pertinent actions in the local context. The graphs, maps and photographs used as place-based representations are expected to substantially reinforce the effects of psychological and social factors described above.

This approach is in contrast to identifying solutions from a global problem (or global model): the global problem/priority may not apply at the site or the solution may not be suitable for every locality. For example, some communities may not be willing to adopt such a proposed solution because of environmental, cultural or socio-psychological reasons (Stoll-Kleemann et al., 2001). Therefore, appropriate response protocols are expected to emerge from the aggregation of tailored responses at each local context.

FIGURE 1 | Schematic workflow to support place-based climate resilience in MSES.
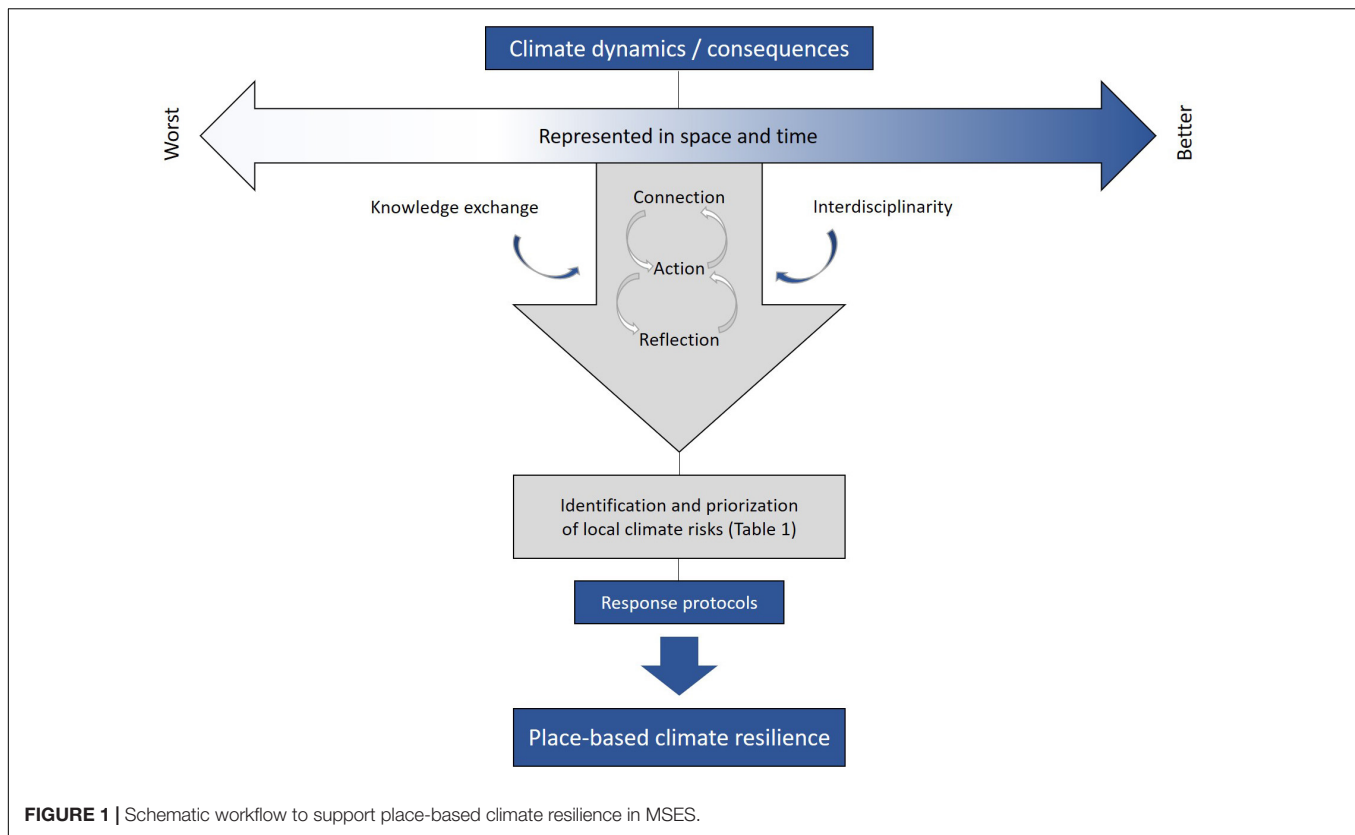
To exemplify how local climate dynamics and socio-ecological aspects are integrated and why they should be considered in a process of building climate resilience, we describe the physical and social characteristics of the two chosen cases: Unguja Ukuu and Cabo Pulmo.

Unguja Ukuu, Zanzibar, Tanzania

Unguja Ukuu is located at 6°S of latitude and 39°E of longitude, in the southwest of Unguja Island, the biggest one of the Zanzibar archipelago, on the Tanzanian coasts in East Africa. Average annual air temperature in the region is about 27°C, with minor seasonal variation (Rohli et al., 2019). In contrast, the wind shows clear seasonal shifts: the southeast monsoon (locally known as "*kusi*") usually occurs from April to October, while the northerly monsoon ("*kaskazi*") blows from November to March (Mahongo et al., 2011). The monsoons influence local wind direction and speed, air and sea temperature, rainfall and coastal hydrography (Newell, 1957). Sea surface temperature ranges from 25 to 30.5°C along the year, presenting significant decreases during intense rainfall (Nyandwi and Dubi, 2001). According to Rohli et al. (2019), the rainfall regime corresponds closely with the monsoonal circulation.

The mean seasonal patterns may significantly vary in response to larger scale forcing. However, the seasonal change domains over another patterns of climate variability (e.g., interannual or decadal). The multidecadal increase of sea level registered for all the East African coast seems to be ameliorated by the frontal reef barrier in the locality (**Supplementary Figure 1**). Unguja ukuu is influenced by the dynamics of the large-scale circulation of the Indian Ocean, particularly from the warm North Equatorial current. The region has a moderate exposure to variability associated to El Niño/La Niña. Tsunamis have been registered with minimum to moderate ecological and economic impacts, with loss of human lives (Jidawi, 2019 personal communication). The Zanzibar archipelago is near the path of hurricanes but has not been impacted by any such storm for the past 50 years National Oceanic and Atmospheric Administration (NOAA) (2020).

Artisanal fishing is the most important economic activity in the community. Women, children and men have long walks during low tide, fishing, and gathering at the intertidal zone or to reach fishing boats. These harvesting activities are possible because the tidal range is larger than 5 m and the intertidal is protected by the extensive barrier reef. The main fisheries resources are tropical seascape related fishes, mollusks, gastropods, lobsters, and octopus. Like most MPAs in Zanzibar, the MPA in Unguja Ukuu has social objectives beyond pure conservation because it provides fresh fish and other marine products to commercialize in local markets. The livelihoods of the Unguja Ukuu community are highly dependent on a healthy ocean but fshing activites are not well regulated, wtih a lack of, or inadequate, enforcement (Jiddawi and Öhman, 2002). There is an ongoing revision of marine and fisheries regulation in Zanzibar, especially since the early 2000

TABLE 1 | Comparing climate-social interactions/priorities to build response protocols based on local-climate consequences in two Marine Socio-ecological Systems (MSES).

Scale	Climate event	Socio-ecological component	Potential consequences	Priority of action	
				Unguja Ukuu	Cabo Pulmo
Multidecadal	Sea Level Rise	Physical	Beach loss	H	M
		Economical	Touristic infrastructure damage	H	M
			Community infrastructure damage	H	H
	Ocean warming/cooling	Ecological	Species distribution	L	H
			Coral bleaching	H	M
			Biodiversity change	H	M
		Economical	Touristic attractions damage	L	H
			Fisheries yield trends	H	L
Interannual	Hurricanes	Societal	Human lives	L	H
		Ecological	Seascape damage	L	H
		Economical	Infrastructure damage	L	H
	El Niño / La Niña	Ecological	Species distribution	M	H
			Biogeographic proportions	L	H
		Economical	Target species	L	H
			Fisheries yield	H	L
Seasonal	Wind	Physical	Mixing and turbidity	L	H
			Upwelling	L	H
		Ecological	Marine productivity	M	H
		Economical	Number of navigating days	M	H
	Sea surface temperature	Physical	Stratification	M	H
			Nutrients	M	H
		Ecological	Reproductive success	L	H
			Species composition	L	H
			Biogeographic proportions	L	H
		Economical	SCUBA divers satisfaction	L	H
	Rain	Physical	Turbidity	M	H
			Eutrophication	L	H
		Ecological	Marine productivity	L	H
			Species dominance	L	H
		Economical	Visitors satisfaction	L	H
			Fishing yields	H	L
Random	Tsunamies	Societal	Human lives	M	L
		Ecological	Transitory effects	L	L
		Economical	Infrastructure damage	M	L
			Boats loss	M	L
				⬇	⬇
				Response protocol	Response protocol

Color code shows priority: Red, high (H); Yellow, moderate (M); Green, low (L).

when the World Bank provided a large amount of financial resources for the formation of MPAs (Ruitenbeek et al., 2005; de la Torre-Castro, 2012). The region is growing at an accelerated pace due to tourism-related immigration as well as local demographic growth.

Cabo Pulmo, México
Cabo Pulmo is a National Marine Park located on the Mexican Pacific, at the west coast of the Gulf of California in the 23.5° N of latitude and 109° W of longitude. It is

the only extensive coral reef of the Gulf of California and the northernmost of the Eastern Pacific (Álvarez-Filip et al., 2006). The tidal range is about 2 m and wave activity are attenuated by a reef barrier located a few hundred meters from the coastline. Cabo Pulmo is part of a subtropical-temperate transition zone with two seasons contrasting in average sea surface temperatures, wind regimes, and circulation patterns. During the summer, prevailing southeastern winds promote upwelling activity and nutrient-rich surface waters (Álvarez-Borrego and Lara-Lara, 1991; Lavín and Marinone, 2003). There

is a large interannual variability, mainly produced by El Niño/La Niña oscillations that modulate ecological attributes (e.g., fish diversity and biogeographic composition) and influence hurricane activity and extreme rains/droughts over the entire region (Magaña et al., 2003; Álvarez-Filip et al., 2006). The influence of the California Current and atmospheric teleconnections imposes decadal to multidecadal climate patterns in the NE Pacific, but environmental variability in Cabo Pulmo is dominated by seasonal to interannual changes (Lavín et al., 2003; Lluch-Cota et al., 2010). The long-term sea-level trends in the region are positive but small (Climate Change Initiative (CCI), 2020). In recent years there are informal reports of coastal erosion and some damage to shoreline infrastructure, associated with seasonal variability, from the passage of hurricanes in the summer to the northwesterly winds in the winter.

Cabo Pulmo enjoys a worldwide reputation as a successful conservation site because of the recovery of fished species in the past and other ecological attributes (e.g., biodiversity), in combination with the beauty of seascapes and an unusual history of human/nature interactions (Cariño-Olvera et al., 2008; Langle-Flores et al., 2017; Anderson, 2019). This National Park has persisted as an effective no-fishing zone for 25 years, thanks to the active community engagement in protecting the environment, the relative isolation of the village, and the flourishing of local-owned business benefited from ecotourism (e.g., scuba diving, snorkeling, and whale watching). Unfortunately, all the positive social and ecological aspects relevant for the resilience of the community are being threatened by aggressive touristic developers and land speculation, thus compromising the community organization, local development, and environmental conservation (Cariño-Olvera et al., 2008).

From Climate Impact to Response Design

In comparing Unguja Ukuu and Cabo Pulmo, it is clear that climate variability interacts in different ways with the local ecological and social attributes. These interactions shape different climatic risks. For instance, hurricanes are not a problem in Zanzibar since none has landed in the last 50 years. Meanwhile, hurricanes approach every summer to Cabo Pulmo region, representing a very frequent, and high, risk because of their potential threat to human lives and to the integrity of the coral barrier and near-shore infrastructure. Cabo Pulmo is not impacted by another kind of interannual variability in social and economic terms since its economy depends on tourism, not fisheries. In contrast, Unguja Ukuu population depends highly on fisheries, reporting low fishing yields associated with interannual environmental changes (e.g., El Niño/La Niña). Hence, such a phenomenon may have a significant impact on local food security, livelihoods and adaptive capabilities (**Table 1**).

From the comparison exercise we can conclude that each local circumstance provides opportunities for a detailed analysis of the potential consequences driven by climate variability and change, in addition to helping with the prioritization of the required actions (**Table 1**). Better representations of

MSES attributes in space and time are expected to improve the identification of local climate risks and designing better response protocols. This is based on the highest chance to activate the collective memory, reduce the psychological distance and increase social engagement and willingness to operate response protocols. Therefore, in contrast to approaches based on digital media-visualizations or chaotic narratives inducing fear to reduce psychological distance, we posit that building response capacities would require bi-directional knowledge exchange (e.g., between civil society and academy), and engaging with the local realities. The knowledge-exchange exercises may include place-based representations of the climate dynamics and their potential impacts over appreciated elements at the target territory. The elements present in the territory may include biodiversity, landscape, infrastructure and economic activities, among others (Kolb and Kolb, 2009; O'Neill and Nicholson-Cole, 2009).

Documenting local conditions is an important first step to connect with the collective memory and people's interests, pointing to motivate participatory argumentations that look for solutions and adaptations to deal with change. An example of the power behind capturing local circumstances to induce social change is the documentary film by Julia Dahr: "Thank you for the Rain" released in 2017[1]. Unlike many climate change films, this is a personal story of a Kenyan farmer transitioning from the hardship to empowerment in climate-induced challenges. In addition to videography, many different tools may be used for documenting and displaying local attributes (whatever it maintains the focus of collective discussions on local climate consequences), for example, imagery from satellites (e.g., local physics), drones (e.g., spatial use of the ecosystem) or photography (e.g., local biodiversity and local activities). In consequence, an accurate and careful representation of local attributes in space and time may boost processes of knowledge exchange because it has the potential to reduce psychological distance and activate the collective memory; the raw materials to build not only engagement but also response capacities and resilience (Shaw et al., 2009; Sheppard et al., 2011).

Climate resilience cannot purely consider responses for the known threats, it needs to consider innovation, learning, and anticipation for the expected impacts of a changing climate (Welle et al., 2014). Many negative consequences of climate variability and change might be prevented in the presence of local capacities to anticipate and respond (Knopman and Berg, 2017; Marshall et al., 2019). Analyzing anticipatory governance, Croxatto et al. (2020), page 12 concluded that: *"preventive actions, together with transparent operational response frameworks, could significantly improve resilience and adaptability of local knowledge systems and institutions dealing with climate change adaptation."*

The achievement of global resilience is depends on resilience at lower scales because the local scale is where climate consequences are manifested, but also from where responses and adaptations

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[1]https://thankyoufortherain.com/

are born (IPCC, 2007; Perry et al., 2010). A global-scale climate resilience requires networks of local resilience builders, armed with tools that promote participatory argumentations by those social actors in the target territory. Strategies to build climate resilience are being tested and reproduced all around the world. In this context, the present paper calls attention about the importance of place-based spatial and temporal representativity of climate dynamics defining interactions with MSES. This work complements resilience-building approaches like those based on human-rights, livelihood, co-management, anticipatory governance, or social transformation.

Finally, we propose a conceptual model (workflow) expressing the role of place-based representativity applied in developing climate resilience at small scales. **Figure 1** emphasizes the importance of a better representation of local climate dynamics and consequences to establish connections with the memories, emotions, interests, and worries of individuals and communities. Such connections can determine how good the climatic risks are identified and prioritized, therefore rule on how pertinent a response protocol is for a particular MSES. The connection, action and reflection labels inside the vertical gray arrow, represent a strong dependence of the all process (from climate to resilience), on how finely are captured and displayed the local climate dynamics and consequences. **Figure 1** also suggests that all intervention process should be accompanied by interdisciplinary exchange of knowledge. The final output of the figure (bottom blue rectangle) represents how the integration of previous elements can be exploited in a process of building place-based climate resilience. In section "Suggested Steps to Apply the Conceptual Model (Workflow) in **Figure 1**," we detail some components for each stage embedded in the proposed workflow: (1) Connection, (2) Action, and (3) Reflection.

Suggested Steps to Apply the Conceptual Model (Workflow) in Figure 1

Stage 1: Connection (identifying and prioritizing risks).

  (i) Scrutiny of valued assets in the target territory (e.g., discussing the valued elements in the territory using imagery from satellites, video or photography of seascapes and landscapes).
  (ii) Compile the collective memory of historic climate events/impacts.
  (iii) Analyze specific cases (impacts/responses). Learn and enhance responses.

  Stage 2: Action (designing responses).

  (i) Prioritize responses according to risk level.
  (ii) Design specific protocols for each impact/response.
  (iii) Designate local committees/initial response (social engagement).

  Stage 3: Reflection (enhancing all process).

  (i) Understanding climate dynamics/impacts: local processes and manifestations in the territory + mechanisms connecting to large-scale dynamics.

  (ii) Integrate interactions of climate with other factors of physical and social change.
  (iii) Extend knowledge in space and time: encourage narratives and interpretative power of local dynamics/climate-forced changes/adequate responses.

CONCLUSION

Achieving sustainability in MSES demands improving multiple response capacities under contexts of uncertainty and change, with the additional complexity that the climate interacts with socio-ecological components (e.g., ecological function and structure, economic activities) at different temporal and spatial scales (Perry et al., 2010; Charles, 2012). Building place-based resilience requires tools to motivate participation and argumentation by those social actors at the target territory, generating the necessary social engagement (Wibeck, 2014). Here, "engagement" is the personal connection with climate change, comprising cognitive, emotional, and behavioral aspects (Lorenzoni et al., 2007). At social levels, engagement drives collective participation, which can be motivated by reducing the psychological distance (Kolb and Kolb, 2009) and stimulating the collective memory (Steynor et al., 2020), by using locally relevant components and dynamics captured in adequate narratives and visualizations (e.g., maps, graphs, video and photographs) (Sheppard et al., 2011; Jones et al., 2017; Marschütz et al., 2020). The better represented (in space and time) the local components and dynamics, the more empathy and connection with social actors, thus the better integrated and designed response protocols (e.g., Kolb and Kolb, 2009; Marshall et al., 2019). Thanks to the interconnections among the collective memory, psychological distance and social engagement – as key concepts to build local capacities and operate response protocols – the expansion of place-based strategies seems promising in the context of building response capacities, regardless if they are applied to climate resilience or beyond (Shaw et al., 2009; Charles, 2012; Marshall et al., 2019; Marschütz et al., 2020).

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

MT-C and LL led logistics and collective discussions. AT-C, NJ, MT-C, RC, LL, SJ, JF, and RS-L contributed to collective

discussions and further inputs for manuscript. MT-C, LL, RC, SJ, JF, and AT-C provided conceptual framework and feedback. NJ, MT-C, LL, and AT-C provided data and field observations. RS-L conceived the original idea, led writing, and version control. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2020.600403/full#supplementary-material

Supplementary Figure 1 | Key characteristics of the coastal MSES used to exemplify the analysis (in text: relevant physical characteristics, in photos: the seascapes, activities and key livelihoods). To the left, Unguja Ukuu, a coastal village situated in the south of Zanzibar, Tanzania. To the right, Cabo Plumo, México. This community is located in the southeast side of the Baja California Peninsula (west having Gulf of California as reference). Photographs by the authors.

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