

Climate Change Adaptation in Seychelles: Actors, Actions, Barriers and Strategies for Improvement

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1. Introduction

Small island developing states (SIDS) are particularly vulnerable to the impacts of climate change such as increased temperatures, sea level rise (SLR), and precipitation (Robinson, 2015). Chapter 29 of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (also called 'AR5') on SIDS reiterated that island vulnerability is often 'a function of four key stressors: physical, socio-economic, socioecological and climate-induced, whose reinforcing mechanisms are important in determining the magnitude of impacts' (Nurse et al., 2014, p1635). These vulnerabilities according to two previous studies include: rapidly increasing populations; weak governance structures; remoteness from world markets; sensitivity to external and global shocks; small size; and fragile ecosystems that are susceptible to natural hazards (Kelman, 2014; Guillotreau et al., 2012). Consequently, high priority is given to climate change adaptation compared to mitigation in SIDS. Seychelles reinforces this position in its National Communications and also in its Intended Nationally Determined Contributions (INDCs) submitted to the United Nations Framework Convention on Climate Change (UNFCCC).

Climate change adaptation according to AR5 (IPCC, 2014, p1758), is 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities'. The adaptation process can take place in natural or human systems and is either incremental or transformational (Moser and Ekstrom, 2010). It is germane to say that incremental adaptation aims to maintain the essence and integrity of a system or process at a given scale (IPCC, 2014). These are extensions of actions and behaviors that already exist in order to avoid the disruption of a system (Berrang-Ford et al., 2011) while transformational adaptation on the other hand, aims to change the fundamental attributes of a system in response to climate and its effects (IPCC, 2014). The latter is more radical, involving significant changes in, for example, how countries such as Seychelles organize, develop and manage their assets and resources (Khan and Amelie, 2014).

The academic literature on adaptation to current and projected impacts of climate change has expanded rapidly during the last two decades (Berrang-Ford et al., 2011). However,

identifying and implementing appropriate and/or effective adaptation actions in SIDS and Seychelles in particular is a complex issue. The short- and long-term impacts of climate change in Seychelles are not comprehensively understood. Concomitantly, scientific discussions have shifted from 'if there is a need to adapt' towards 'how to adapt' and 'what might constrain these adaptive efforts' (Kates et al., 2012; Berrang-Ford et al., 2011). In addition, the fourth IPCC assessment report (WG2, Ch.17) on the limits and constraints to climate change adaptation concluded that significant '... research challenges in understanding the processes by which adaptation is occurring and will occur in the future ...' still remain (Adger et al., 2007, p737). Several factors limit or facilitate adaptation and external shocks might trigger adaptation efforts thereby providing a 'window of opportunity' to implement adaptation options that have been developed but not yet implemented (Lesnikowski et al., 2015).

The adaptation landscape in Seychelles has evolved tremendously, ranging from actions rooted in local knowledge systems, to hard engineering options and, recently, the implementation of nature-based approach commonly known as ecosystem-based adaptation (EbA). In particular, EbA approaches have proved to provide flexible, cost effective and broadly applicable alternatives for reducing the impacts of climate change and as such are a critical tool at adaptation planners' disposal for tackling the threats that climate change poses to people's lives and livelihoods (Munang et al., 2013). Examples of EbA actions in Seychelles include mangrove restoration, rainwater harvesting, coral restoration, watershed management, etc. (Khan and Amelie, 2014). The effectiveness of these portfolios of adaptation actions in Seychelles have been put to the test by the recent variability and change in the climate. According to Seychelles' Meteorological Authority (SMA), new patterns of rainfall distribution have emerged compared to two decades ago resulting in flash floods (SMA, 2019). Other challenges include drought and water scarcity, projected sea level rise, ocean warming and acidification among others. Given these challenges, proactive measures/actions to reduce vulnerability and enhance human well-being of current and future populations, the security of assets and the maintenance of ecosystem goods, functions and services now and in the future is needed. The overall objective of this paper is to identify the actors and actions taken in the adaptation landscape in Seychelles, barriers encountered and to propose strategies for proactive adaptation within the context of Seychelles.

2. Seychelles' vulnerability – a review of literature

Seychelles, just as other SIDS, is currently facing unprecedented threats to its viability as a result of climate change. Development in Seychelles has occurred mostly in the coastal areas

that often suffer from constant flooding events that pose a risk to critical infrastructures (Rice et al., 2019). Seychelles is highly vulnerable and has suffered from several disasters in the last four decades, some of which are driven by climate change while others are non-climatic. This dates back to coastal erosion on Praslin in 1986, massive coral bleaching due to excessive warming of the ocean temperature in 1998, heavy rainfall and coastal flooding on Mahé in 2004, tropical cyclone in 2006, and tidal flooding on Mahé in 2007 and 2012 (Khan and Amelie, 2014; Payet and Agricole, 2006). Some of the non-climatic-induced vulnerabilities that are common across SIDS, especially in Seychelles, include size, location, insularity, human settlements and housing, waste and pollution, deforestation, etc. (Robinson, 2015).

The total land area of Seychelles is about 445 km² with an exclusive economic zone (EEZ) approximated at 1.3 million km² (Khan and Amelie, 2014). Limited land area due to its location exposes Seychelles to what is known as 'place vulnerability'. The most vulnerable marine ecosystems are coral reef biodiversity, which are essential for ecosystem resilience, fisheries productivity, and coastal tourism (Vousden et al., 2008; Payet and Agricole 2006). Fisheries and coastal tourism provide the majority of the export earnings and economic activities in the Seychelles. In addition to coastal threats, Seychelles has been experiencing prolonged droughts and water shortages that affect agricultural productivity and other domestic and industrial needs. However, new patterns of rainfall distribution are emerging in Seychelles amidst increasing coastal development compared to two decades ago (SMA, 2019), causing flash floods that last for several days, as seen in some neighborhood in Mahé during the month of May 2019 (Fig. 1). While it was not normal to experience two to three days of continuous rainfall two decades ago, the level of coastal development that has taken place with the potential of blocking drainage channels, and building on reclaimed lands, cannot be compared.



Figure 1. New patterns of rainfall distribution that have emerged in Seychelles compared to two decades ago as seen during the month of May 2019 in some neighborhoods in Mahé
(Photo Credit: Seychelles Meteorological Authority)

A historic account from the notable 1997 and 2013 flooding events provide some insight into what natural disaster induced damage to the country's infrastructure can entail. The entire airfield of Seychelles International Airport was flooded in September 1997, causing the asphalt to lift from the sub-base and the new surfaces to crack (Khan and Amelie, 2014). High tides combined with current sea level rise during the month of May 2007 resulting in flooding as far as 50 meters inland, in turn, causing damage to public infrastructure, including roads (Rice et al., 2019; Government of Seychelles, 2013). As a result, four main concerns have been raised regarding climate change impacts: sea level rise, changes in rainfall patterns, coastal flooding, and extreme weather events (Government of Seychelles, 2013). Given the country's vulnerability to climate change, it's important to assess the current landscape of climate-adaptation resources and services and to evaluate how well available resources align with the needs of actors in order to navigate existing and or potential barriers through the implementation of proactive adaptation measures and actions in the Seychelles.

3. Conceptual perspective

To improve our understanding on ‘how’ and ‘why’ barriers emerge within the context of Seychelles, a framework that identifies and organizes barriers to adaptation previously developed by Ekstrom et al. (2011), and Moser and Ekstrom (2010) is adopted to serve as a guide. This diagnostic framework first organizes barriers by relevant stages in the adaptation process (Fig. 2). Adaptation is relatively new to some actors in Seychelles and the adaptation decision-making process is likely to be hampered by issues related to understanding, planning and managing adaptation actions. In a second step, the framework helps identify the causes of each barrier in a given social-ecological system (Fig. 3), its structural component. Collaboration within and across institutions is of key importance to adaptation. The role of informal institutions, especially with customary practices or traditions that are often embedded in a culture, are likely to affect adaptation, such as the use of beaches and parking of cars in Seychelles vis-à-vis coastal resilience.

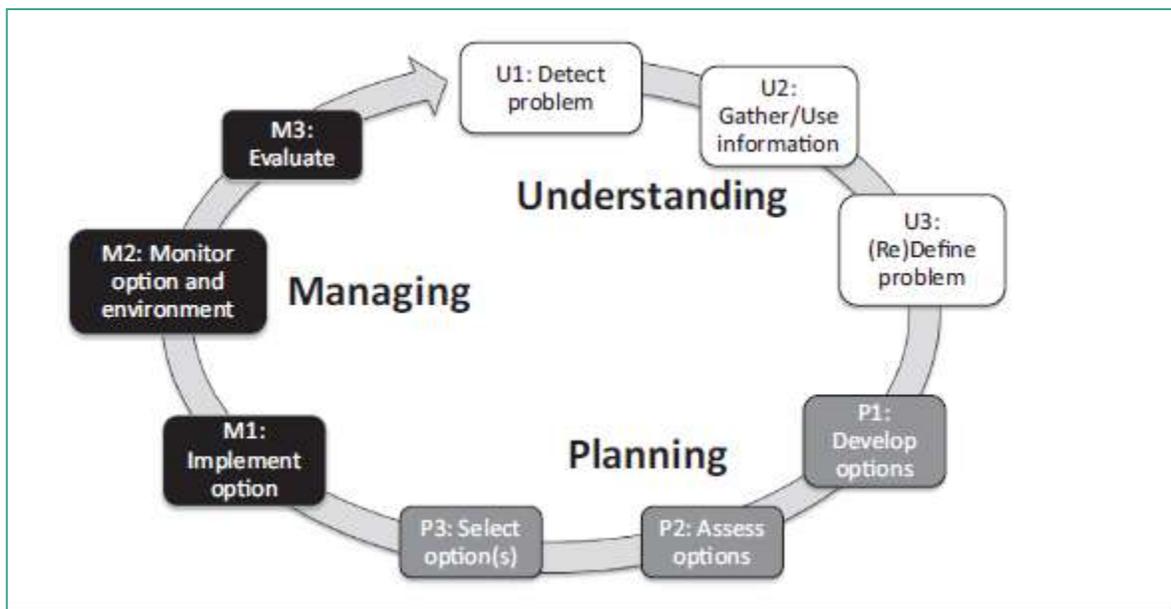


Figure 2. Framework illustrating the dynamic components of the adaptation decision-making process
(Source: Adapted from Ekstrom et al., 2011)

The three fundamental sources of the barriers as shown in figure 3 are (i) the actors involved in the adaptation process (which typically changes over time), (ii) the larger context in which they act (for example, the governance system and socio-economic conditions), and (iii) the object upon which they act (here called the system of concern, which is the system that is exposed to climate change impacts and needs to be managed).

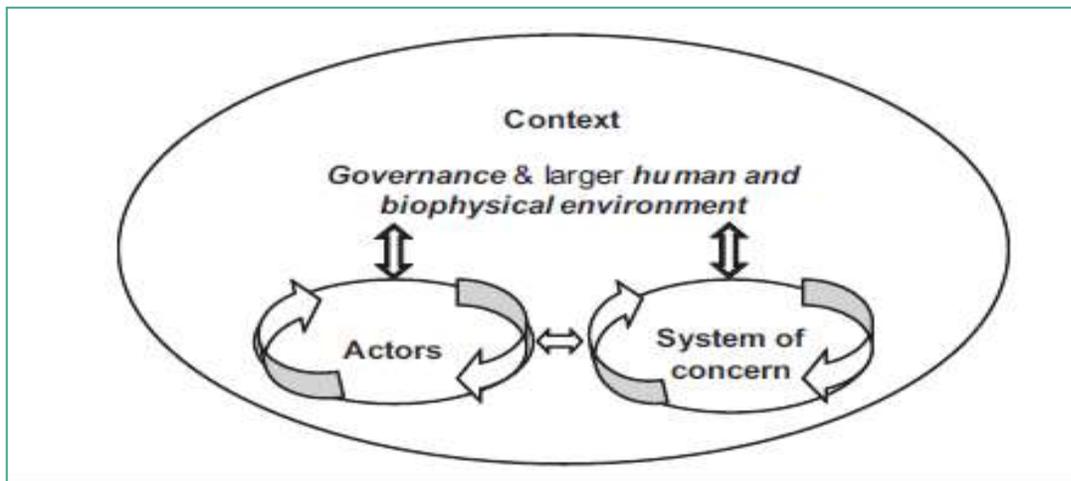


Figure 3. Fundamental sources for the existence of barriers
 (Source: Moser and Ekstrom, 2010, p16)

The first two components (process and structure) of the framework help answer two fundamental questions, namely: (i) What could or does thwart the adaptation process from moving forward? And (ii) how do the actors, context, and the system of concern contribute to the barrier in Seychelles?

4. Methodology

This paper builds primarily on secondary data and information from strategy and policy documents and literature supplemented by personal observations from climate change related workshops. Documents such as Seychelles' National Communications were invaluable to this study. These are national reports, submitted by the government of Seychelles to the United Nations Framework Convention on Climate Change (UNFCCC), which contain information on national situations, vulnerability assessments, education, technology transfer, financial resources and awareness on climate change. In accordance with Articles 4 and 12 of the Convention, State Parties are required to:

[[formulate, implement, publish and regularly update national and, where appropriate, regional programmes [sic] containing measures to [...] facilitate adequate adaptation to climate change' and to '[c]ommunicate ... information related to implementation [of the Convention through NCs]

(United Nations, 1992, p10-11)

National communications are intended to be the primary platform for sharing information, assessing implementation and monitoring progress with respect to the UNFCCC (Pauw et al., 2018). Non-Annex I countries such as SIDS are encouraged to include in their NCs, among other things, information on uncertainties, their vulnerability to climate and climate-induced risks and impacts, and high-priority adaptation strategies and measures (Lesnikowski et al., 2015). Therefore, national communications within the framework of the UNFCCC are considered a consistent, standardized data source (Government of Seychelles, 2011) and were complemented by other strategy documents such as Seychelles Sustainable Development Strategy (2012-2020), Seychelles National Climate Change Strategy, National Biodiversity Strategy and Action Plan (2015-2020), among others.

4.1. Identification of actors, actions and barriers to adaptation

Building on case studies and storylines from these documents on adaptation, a content analysis was conducted. Additionally, insights garnered from participant observation from six climate change related workshops/meetings (see Appendix 1) attended by the author (January – May 2019) was used to reinforce the findings. Content analysis, as described by Elo and Kyngas (2008), was used to identify actions included in reports related to adaptation in Seychelles. This involved reading through adaptation-related chapters in depth and using manual open coding procedures to determine (i) who or what is adapting (actors and sectors), (ii) how adaptation is occurring, (iii) barriers/limits to adaptation. Investigating these three key framing questions, based on Eisenack and Stecker (2012) and McEvoy et al. (2013), allows for the ‘unpacking’ of the critical elements of adaptation framing in Seychelles (Mavrogenis et al., 2014) with proposed strategies to improve the adaptation landscape.

4.2. Data analysis

The complementary qualitative data from strategy and policy documents and literature supplemented by personal observations from climate change related workshops were analyzed using MAXQDA 2018 version. The pdf versions of strategy and policy documents considered in this study were uploaded in the MAXQDA interphase. This is a qualitative data analysis software program designed for computer-assisted qualitative and mixed methods. This software was used because of its ability to find themes or relationships in documents or other text sources. It involved four main steps (Adam et al., 2015) that were adopted in the current study as follows: (i) identification of the main themes; (ii) attributing codes to the main themes; (iii) classification of responses under the main themes; and (iv) integration of themes and responses into narratives.

5. Results and discussion

5.1. Status of adaptation in Seychelles

5.1.1. Actors/sectors

The government of Seychelles (GoS) especially through the Meteorological Division and the Ministry of Environment was the only actor engaged in climate change adaptation until the end of 1990. This doesn't mean that environmental actions that were undertaken by community members based on their local knowledge are not important. The leading role played by the GoS led to the creation of Seychelles National Climate Change Committee (NCCC) in 1992 while the engagement of NGOs focused on climate related activities could be traced to the year 2008. The current adaptation landscape in Seychelles is diverse and includes the GoS, NGOs, community-based organizations (CBOs), and the private sector including hotels and the tourism industry amongst others (Rice et al., 2019:26). Examples of some NGOs are Sustainability for Seychelles (S4S), Wildlife Clubs of Seychelles (WCS), Green Island Foundation (GIF), etc. The hospitality industry has recorded some progress through the introduction of the Seychelles Sustainable Tourism Label (SSTL). The SSTL is a sustainable tourism management and certification programme designed specifically for use in Seychelles. Rainwater harvesting, tree planting and forest ecosystem restoration/rehabilitation are just some of the activities that are ongoing amongst hotels of different sizes in Seychelles.

Although NGOs specifically focused on climate change issues only began operating in Seychelles in 2008, their numbers have since witnessed an increase. Adaptation activities implemented by these NGOs, and even the private sector, include EbA projects, research, capacity building, education and outreach. Even churches in Seychelles are beginning to discuss issues related to climate change with members of their congregations. An important actor that came onboard to support climate change adaptation is the Seychelles Conservation and Climate Adaptation Trust (SeyCCAT). This is an independent, nationally based, public-private trust fund that was established in 2015. SeyCCAT provides financing for small and medium/large-scale projects that are capable of reducing Seychelles' vulnerability while concomitantly improving natural resource use efficiency and sustainability.

Despite the dominant role played by the government, which is consistent across SIDS (Robinson, 2015), climate change weighting by state entities in Seychelles confirms that agriculture (100%) and environment (83%) are far ahead of other sectors in terms of how both entities have incorporated climate change into their activities and programs (Fig. 4). Such findings could partly be explained by the fact

that the system of concern affects actors differently. On the other hand, it could also mean that adaptation could result as a side-effect of another action that actors are not able to capture due to difficulties in understanding the adaptation decision-making process. The government of Seychelles has also set up a unit, the GoS/UNDP/GEF coordination unit, commonly called the Program Coordination Unit (PCU) – an important actor in the adaptation landscape. This unit is dedicated to mobilizing climate change funding and implementing donor projects. The PCU had completed eight projects since its inception while four projects are ongoing inclusive of the EbA project that started in 2011 and financed by The Adaptation Fund.

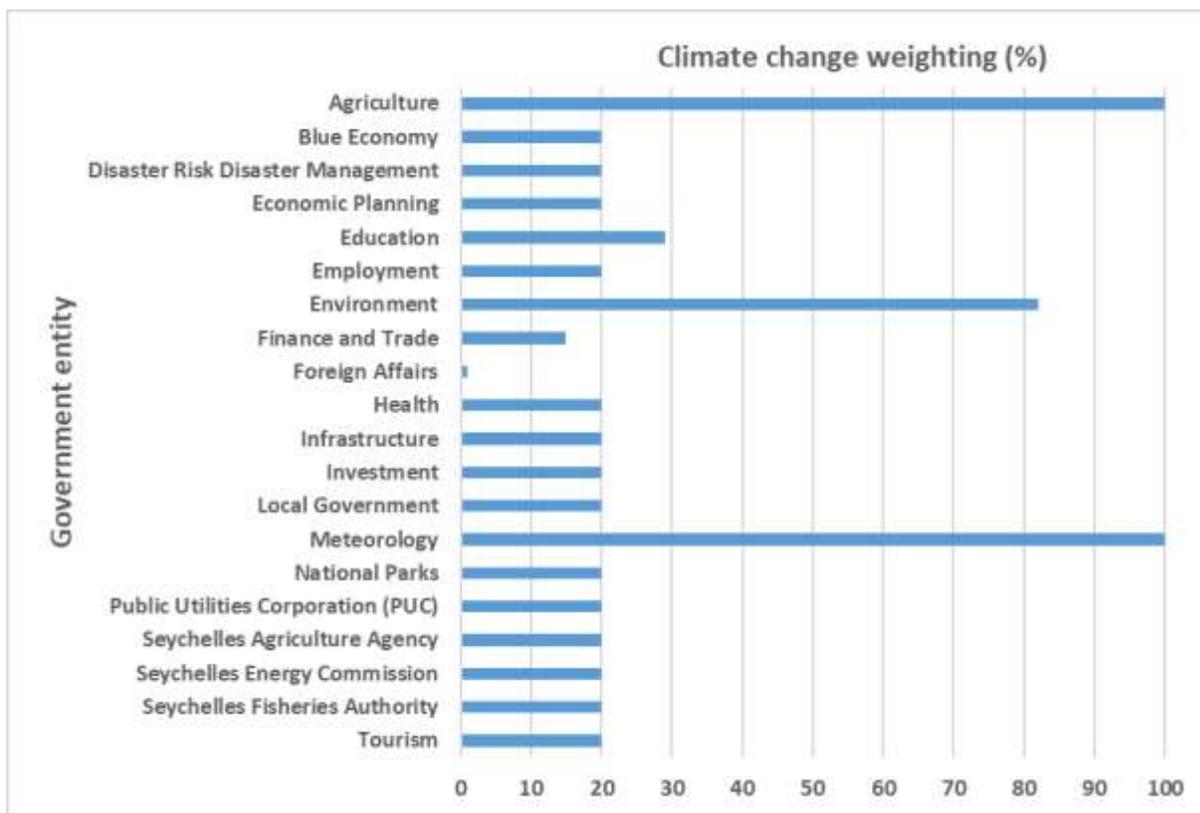


Figure 4. Weighting of climate change across government entities in Seychelles. Expenditures categorised as 100% relevant were those whose activities focused on climate change objectives and explicitly flagged this in the relevant programme documents, while those that helped meet climate change objectives and mentioned it in their documentation were weighted at 50%. Expenditures that helped meet climate change objectives but didn't mention it in their documentation were weighted at 20% and finally, expenditures that do not currently meet these climate change objectives (or only do so peripherally) were weighted at 0%.

(Source: Inspired by CPEIR, 2019a, p12-13)

5.1.2. Actions

A portfolio of approaches/interventions has been implemented in Seychelles in order to adapt to the impacts of climate change. These interventions include hard and soft

engineering adaptation actions, education and outreach, resource mobilization and policy development. It is therefore germane to say that climate change adaptation in Seychelles, just like in other SIDS, is a learning-by-doing process without a ‘silver bullet’ approach. However, existing services and resources are meeting the early phases of local adaptation efforts such as conducting vulnerability assessments and creating adaptation plans in Seychelles, but are failing to meet the needs associated with implementing, monitoring, and evaluating adaptation activities – a position supported by Nordgren et al. (2016). Although some initiatives can potentially foster adaptation in the short term, there is a risk that they affect the environments’, sectors’, and people’s long-term capacity and opportunities to cope with and manage the impacts of climate change – a view supported by Magnan et al. (2016). Such a situation is considered as maladaptation. Climate change requires people to adjust (‘adapt’), and the inability of persons and communities to adjust to environmental or economic instability is a part of maladaptation. Furthermore, people must be able to adapt to not only new hazards and changing resources, but also to new development initiatives, and to changes in access to and control over resources (Eriksen et al., 2015).

Some of the hard engineering adaptation actions implemented in the Seychelles include man-made structures such as rock walls, retaining walls, and groynes. Seychelles’ sea walls have been constructed of stone, timber piling, and rock armoring (Rice et al., 2019). Sea walls made of stone were mostly constructed during the colonial era, are low in height, and are currently compromised by wave action and, therefore, rarely used today. Timber piling has been a more recently utilized strategy, and it incorporates EbA approaches in view of dune restoration and replanting of native coastal vegetation. The success rate for this type of strategy is inconsistent. Most of the recent reclamation work on Mahé has been equipped with rock armoring and sea walls. Although these methods have proved to prevent coastal erosion, however, it is frequently considered an eyesore (Government of Seychelles, 2017a).

Soft engineering approaches mostly dominated by EbA approaches have gained importance in Seychelles during the last decade with projects supported by several international organizations. EbA is a set of adaptation policies or measures that consider the role of ecosystem services to respond to the adverse impacts of climate change and can be used on multiple scales and in different sectors (Munang et al., 2013). EbA initiatives just like the one that started in Seychelles in 2011, supported development aspirations and adaptation objectives through the sustainable management of biodiversity and ecosystems (Khan and Amelie, 2014). Currently, an ongoing EbA project on Mahé Island uses nature-based methods through the

application of technical solutions (Government of Seychelles, 2018a) at specific watershed and coastal sites (Figure 5). Examples of other soft engineering adaptation interventions include timber piling and beach nourishment. Both approaches are utilized in Mahé with the intent to protect the coast by buffering waves and offering protection to the coastline.



Figure 5. Reinforcing access to water (Fig. 5A and 5B), reprofiling of wetland (Fig. 5C) and mangrove restoration (Fig. 5D) through the Ecosystem-based adaptation project at Val D' Endor-Baie Lazare, Mahé Island
(Photo Credit: Terence Vel)

The EbA project is considered a win-win for climate change and livelihoods because the forests and wetlands of Seychelles' granitic islands play an important role in regulating stream flows and water quality. Forested land binds the soil, thereby decreasing soil erosion and increasing the capacity of soils to absorb and retain water. This allows water to penetrate deeper into the soil, allowing for less runoff and slower release. Wetlands and riparian vegetation also assist in reducing erosion while slowing water discharge over a longer period of time. The benefits include ameliorating the effects of climate change on water supplies by providing more regular stream flow during the lengthier dry season, and secondly, buffering against flooding following intense rainfall events. Similarly, mangroves and fringing coral

reefs protect coastal land against coastal erosion, while coastal sand dunes and wetlands play an important role in controlling coastal flooding (UNEP, 2017).

Coral reef restoration is another example of an EbA project that often entails the utilization of species resistant to bleaching and is considered a promising technology in Seychelles. There has also been wetland restoration work around Port Launay, Roche Caiman, and the freshwater marsh at North East Point. This work often entails the cleaning and replanting of mangrove areas. Dune restoration is another EbA strategy implemented on Mahé which has been done through replanting of natural vegetation and restricting vehicle access on the dune area (Government of Seychelles, 2017a). Other actions include education and research undertaken by several institutions. Example of such education programs is the development of home gardening to enhance food security. Some farmers in Seychelles are beginning to use drip water irrigation systems to address the reduction of available water in the agricultural sector. Water security in the agricultural sector was also addressed by the implementation and distribution of water tanks by NGOs. Another step adopted by the government to improve drainage and the down-flow of water is the constant supervision of drainage to prevent clogging (Mekenkamp, 2017).

5.2. Barriers to adaptation

Chief among the barriers to adaptation identified in Seychelles include (i) institutional/governance issues, (ii) scientific knowledge and understanding, (iii) financial, and (iv) human resource capacity (Fig. 6). As reiterated by Khan and Amelie (2014), a major institutional challenge to adaptation is its effective integration into development planning especially by Seychelles Ministry of Finance, Trade Investment and Economic Planning (MFTIEP). Each year, Ministries, Departments and other Agencies (MDAs) submit requests to the MFTIEP for the following year's annual budget. After receiving these submissions, MFTIEP determines the total funding allocated to each government entity based on the overall funding envelope available. It also selects which items from each proposed budget to fund. Typically, those expenditures prioritized by applicants in their proposed budget are likely to be prioritized by MFTIEP, but the final decision on which items to fund is at the discretion of MFTIEP taking into account the country's overarching national development plan (CPEIR, 2019b). Despite climate change being a development problem, most institutions in the Seychelles still lack the expertise and knowledge to differentiate between climate and non-climatic factors of vulnerability that are both important for adaptation planning.

Another barrier that also relates to institutions is that of financial support for adaptation actions – a view supported by an earlier study conducted in Seychelles (Mekenkamp, 2017). Seychelles' transition from a low to middle income country has reduced her chances of

securing international funding for adaptation. The need to focus on increasing both private and public funding for adaptation is increasingly acknowledged in Seychelles as a crucial step to strengthening resilience against climate change. The NCCC aims to engage all sectors in climate change discussions, but input from the private sector remains weak and this widens the adaptation gap. UNEP (2016) argued that the adaptation gap referred to the difference within institutions between the money needed for adapting to climate change and the amount of money available.

Furthermore, the role of informal institutions as barriers to adaptation in Seychelles is often ignored. Informal institutions are typically seen as the ‘invisible’ norms that govern behavior, like customary practices or traditions, and are often embedded in a culture (Hodgson, 2006). Parking of cars in the dune area especially in the Au Cap, Anse Royale and other hotspot areas in Seychelles is a common cultural practice that could limit the effectiveness of coastal resilience. Institutional capacity, in particular measures of good governance, are the strongest predictors of national adaptation policy in Seychelles and elsewhere. Adaptation actions are likely to be hindered by poor governance and, in the absence of good governance, other presumed determinants of adaptive capacity will show limited effect on adaptation (Berrang-Ford et al., 2014).

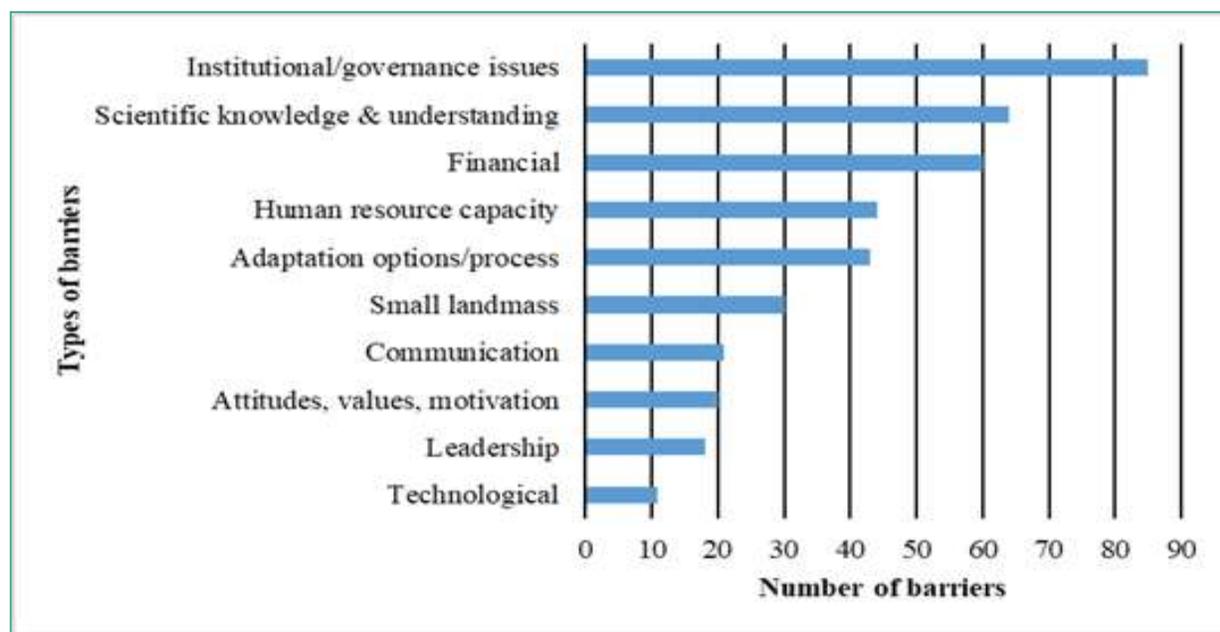


Figure 6. Different types of barriers encountered in Seychelles

(Source: Inspired by Rice et al., 2019)

Scientific knowledge and understanding of climate change adaptation in Seychelles is another barrier partly due to fragmented knowledge on adaptation and also due to little investment in research related to adaptation (Fig. 6). Climate change is relatively new to

several actors in Seychelles and understanding the different components in the adaptation decision-making process is likely to reduce the chances of maladaptive actions. As stated by UNEP, the knowledge gap relates to the difference between knowledge currently available and knowledge that is needed to adapt to climate change (UNEP, 2016). Institutions must be able to understand, plan and manage adaptation actions (Ekstrom et al., 2011).

A lack of appropriate knowledge and quality data seriously reduces the stakeholder's ability to adapt to climate change. This knowledge gap could be linked to the intensity of impacts that are usually beyond our range of understanding, as was the case of heavy rainfall leading to flash floods that lasted for several days during the last two weeks of May 2019 on Mahé Island (Fig. 1 and 7). Such occurrences reaffirm the findings of a climate change scenario conducted by the local Meteorological Services with predictions that the rainfall pattern will be shorter and more intense during the next two decades (Government of Seychelles, 2009). Therefore, there is a growing need to improve on the early warning systems and strengthen information and decision support systems for the population in general for climate proofing amidst legacy barriers such as poor land use planning in Seychelles (Fig. 7).



Figure 7. A road in the Au Cap neighborhood covered with water after the monsoon rain during the last week of May 2019 (Figure 7A) and the same road three days later with no visible drainage system (Figure 7B).

(Photo Credit: Daniel Etongo)

Although different national strategies have been put in place to address adaptation (Khan and Amelie, 2014), the lack of a national climate change policy implies adaptation has been guided by different national strategies that might not address specific needs. Beside financial

support from international agencies, national funding on adaptation seems to be very limited. A recent report on climate change expenditures across government entities in Seychelles for 2018 stood at 597,953 SCR of which 20% of this figure came from adaptation and mitigation actions implemented by the Public Utilities Corporation (CPEIR, 2019b, p 12-13). The private sector plays a vital role in catalyzing adaptation actions in the country, and their poor engagement in the NCCC and related outcomes impacts the effectiveness of adaptation actions in the hotel and tourism industry. Additionally, human resource capacity and adaptation option/process were two barriers cited by more than 40% of stakeholders (see Fig. 6). Initially, the adaptation gap was poorly communicated to mean a lack of financial resources for climate change adaptation actions. According to Fankhauser and McDermott (2014), adaptation deficit may be due to two factors: a demand effect, whereby the demand for the good 'climate security' increases with income; and an efficiency effect, which works as a spill-over externality on the supply-side. Adaptation productivity in high-income countries is enhanced because of factors like better public services and stronger institutions, which is not the case in Seychelles.

5.3. Strategies for improvement

Given that adaptation is a continuous process and interventions must be responsive to new information or challenges, there is always a need for improvement. Proposed strategies to improve the adaptation landscape in Seychelles include the following: promoting synergies between adaptation and mitigation into development planning, catalyzing adaptation finance, adaptive management, local action and knowledge sharing, synergies and trade-off between adaptation and development, monitoring, evaluation, and learning.

Climate change adaptation is not a stand-alone. Therefore, promoting synergies between adaptation and mitigation especially within the framework of EbA projects in Seychelles, has the potential of delivering a win-win solution for livelihoods and the environment. For example, zonation as a best practice for EbA projects for mangrove restoration is important to allow different species where is suitable, especially in relation to salinity requirements. Such actions will ensure a relatively better survival rate of planted species. Aside from zonation, the eradication of invasive species from some EbA project sites (see Fig. 8) while developing a business model supported by EbA actions can all ensure the sustainability of adaptation actions when projects phase-off.



Figure 8. Biomass removed from an EbA site beside the Anse Royale Campus of Unisey with visible signs of invasive species (Fig. 8A).

(Photo Credit: Daniel Etongo)

Cross sectoral and institutional collaboration is another option in overcoming most of the adaptation barriers that are institutionally driven. Collaboration across sectors will avoid the duplication of projects and improve on the efficient use of the limited financial resources nationally available for adaptation. It was identified during the NCCC meeting in May 2019 that mainstreaming adaptation into national development programs in practice across different institutions is not that easy. One of the reason for this difficulty might be related to the fact that our understanding of what constitutes real adaptation is not coherent. The resultant effect is that it becomes difficult to characterize, monitor, and compare general trends in climate change adaptation over time, across projects, sectors and institutions in Seychelles. Ford and Berrang-Ford (2014) are of the opinion that overcoming such barriers would require consistency, comparability, comprehensiveness and coherency which they described as the 4Cs of adaptation tracking. The University of Seychelles has put together a three-day short course that addresses the topic mainstreaming climate change adaptation into development planning. This course will offer a platform for different stakeholders to gain knowledge on mainstreaming adaptation into policy, across sectors and within projects.

The very first climate change policy for Seychelles and the Third National Communication to the UNFCCC offers another opportunity to improve climate change adaptation in the

country. A proactive climate policy should be coherent with other national development strategies. Some of these strategies are: Seychelles Sustainable Development Strategy, National Communications, in addition to Seychelles National Disaster Management Policy and various legal mandates on environmental protection such as the Environmental Management Plan amongst others. Informal institutions that are rooted in culture or 'way of life' might require new ways of doing things or a change in behavior in order to improve the adaptive capacity of Seychelles. A very good example in Seychelles is the parking of cars in the dune area. Creating car parks in specific areas where land is available and convenient could partly address this problem. On the other hand, a wheel clamp policy could be implemented for those parking their cars in the dune area across different hotspots in the Seychelles.

The role of local knowledge in adaptation to climate change is invaluable in reducing the vulnerabilities of communities to the impacts of climate change. However, there are concerns over its relevance for future adaptation amidst other challenges. Evidence from a study conducted in Tanzania suggests that local knowledge may contribute to adaptation to climate change in a number of ways especially when integrated with scientific knowledge (Naess, 2013). An overlap between local observations of climate patterns and meteorological observations was found in a study conducted in the Central Plateau of Burkina Faso (West et al., 2008). Local knowledge especially amongst the fishing community in Seychelles is an important knowledge system that could be documented. Local indicators of climate change impacts based on local knowledge has the potential to improve our understanding of how climate change affects physical, biological, and socioeconomic systems. The fishermen interact with the ocean space frequently and have accumulated local knowledge that could feed into early warning systems. Also, upon request from the Seychelles Meteorological Authority (SMA), the Seychelles Global Climate Change Alliance (GCCA+) has provided financial support for an eight-day early warning training during the month of August 2019, which is considered a step in the right direction.

Overcoming barriers such as insufficient climate knowledge and the absence of climate change risk assessments amongst other things could improve investment in climate change adaptation by the private sector. Quality research doesn't depend solely on technical capacity but also on available resources and equipment. There is need to increase Seychelles' research and development expenditure (% of GDP). Furthermore, information on climate risks and uncertainties is sometimes unavailable or inaccessible for medium and small enterprises (MSEs), making it difficult for these businesses to incorporate climate risks into their planning and decision-making processes. Moreover, a lack of information also limits the viability of weather-index based insurance products, which are potentially

effective risk management solutions. Without violating their data policy, the SMA should provide the public with greater access to climate-related information.

Finally, remote/legacy barriers are those barriers that are the most difficult to address in the 'here and now', as the locus of control is elsewhere and the origin of the barrier is in the past. The three dominant types of such barriers include institutional ones, such as the existing or missing governance structure and laws, economic and funding issues (such as the global economic crisis or state budget cuts), and attitudinal issues (the public's attitude, awareness and understanding of climate change, or longstanding personality conflicts). Intervention in this case is remedial and compensatory by local actors: those who can and those who take it upon themselves 'to break eggs' in order to make 'omelette' – a view supported by Ekstrom and Moser (2014).

6. Conclusions

The current adaptation landscape in the Seychelles is much more diverse compared to the year 2008 when the very first climate-related NGOs were established. The government of Seychelles has continued to play a leading role on climate change and is currently leading the process for the Third National Communication to the UNFCCC. Approximately twenty-four government entities are engaged in climate change actions of which most of the issues are relatively new to them except for agriculture and environment. The adaptation landscape reveals the following actors/sectors: the government through several ministries and departments, NGOs, private-sector and community-based organizations. Several actions have been taken to improve climate change adaptation in Seychelles given that it is considered a priority. These actions include policy development and revision, institutional set-up, hard and soft adaptation approaches, human resource capacity development, research, education and outreach. EbA approaches have attracted funding and some of the activities that have been implemented in Seychelles include coral and mangrove restoration, rainwater harvesting, tree planting activities and environmental conservation, etc.

Despite such efforts to reduce the vulnerability of the Seychellois population to the impacts of climate change, several barriers hamper the adaptation process. Chief among these barriers include institutional and governance issues, scientific knowledge and understanding, financial issues, and human resource capacity. Institutional capacity, in particular measures of good governance such as voice and accountability, government effectiveness, regulatory burden, rule of law and control of corruption, are the strongest predictors of national adaptation policy in Seychelles and elsewhere. Adaptation actions are likely to be hindered by poor governance which in some cases is not limited to formal but

also to informal institutions that are linked to cultural belief systems or a way of life. Parking of cars in the dune areas are 'invisible' norms that govern behavior like customary practices or traditions often embedded in a culture.

Some proposed strategies for improving climate change adaptation in Seychelles include promoting synergies between adaptation and mitigation into sectorial policies and national development. Climate change is a development challenge and engaging all sectors involved to effectively mainstream adaptation into their development programs will go a long way to ensure climate proofing. A major step in policy development is the very first climate change policy in Seychelles that will be available by the end of 2019. The preparation of this policy involves consultation across a wide range of stakeholders guided by other national strategic plans with the aim of achieving policy coherence rather than reinventing the wheel. Collaboration across institutions should be enhance and to avoid duplication of projects and also to share resources and expertise. The role of technology transfer could solve some of the legacy problems and lessons could be learnt from the Netherlands with most parts of this country below sea level. The eradication of invasive alien species from EbA project sites could improve the effectiveness of this approach. Further research is needed in the following areas: (i) A baseline study for a feasible business model in Seychelles that is capable of catalyzing adaptation finance using nature-based approaches such as EbA; (ii) how the national adaptation is implemented across sectors; (iii) to evaluate the effectiveness of EbA interventions; and (iv) climate change adaptation and cross-sectoral policy coherence in Seychelles.

Appendix 1.

Climate change-related workshops/meetings attended between the months of January to May 2019

Workshop/Meeting	Date	Venue
<i>National Climate Change Committee and Seychelles Global Climate Change Alliance +, A Steering Committee Meeting</i>	5 January 2019	Le Chantier Mall, Victoria
<i>National Development Strategy</i>	14 January 2019	Liberty House, Victoria
<i>National climate change committee and Seychelles Global Climate Change Alliance</i>	5 February 2019	Le Chantier Mall, Victoria
<i>Climate change policy workshop</i>	12 February 2019	International Conference Center, Seychelles
<i>Seychelles' Third National Communication (TNC) Inception Workshop</i>	28 March 2019	Savoy Hotel and Resort, Beau Vallon
<i>National Climate Change Committee/GCCA+, A Steering Committee Meeting</i>	16 May 2019	Le Chantier Mall, Victoria

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