ADAPTATION FUND

REGIONAL PROJECT/PROGRAMME PROPOSAL

PART I: PROJECT/PROGRAMME INFORMATION

Title of Project/Programme:	Restoring marine ecosystem services by rehabilitating coral reefs to meet a changing climate future
Countries:	Republic of Mauritius, Republic of Seychelles
Thematic Focal Area[1]:	Food Security, Disaster Risk Reduction
Type of Implementing Entity:	MIE
Implementing Entity:	UNDP
Executing Entities:	Seychelles: Ministry of Environment, Climate Change and Energy; Nature Seychelles; Seychelles National Parks Authority. Mauritius: Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping & Outer Islands (specifically Mauritius Oceanography Institute and Albion Fisheries Research Centre)
Amount of Financing Requested:	4,900,000 (in U.S Dollars Equivalent)

Project Background and Context:

Problem to be addressed

Mauritius and Seychelles are highly vulnerable to climate change in several ways, none more so than the impact that elevated sea temperature is having on their coral reefs. Coral reefs provide a wealth of ecosystem services including food, coastal protection, recreational use, biodiversity benefits, and regulating services, all of which are vital to the local economies and food security of human populations living in vulnerable Small Island Developing States (SIDS) such as these two countries. Healthy and robust coral reefs, through the provision of these ecosystem services, ensure that coastal populations of tropical countries have increased resilience to the adverse impacts of climate change.

However, in both Mauritius and Seychelles, corals have suffered heavy mortalities from bleaching events, caused by climate-change induced sea warming, over recent decades. Following a bleaching event, and depending on its intensity, coral colonies die rapidly and become algal covered, with the reef's structure, topography and productivity declining and even disappearing. The long-term impact of bleaching events and the extent of recovery of corals also depend on local pressures that negatively affect coral reefs such as over-fishing, nutrient enrichment, increased turbidity and sedimentation, and damage from boats and visitors. The global bleaching event of 2015/2016 has been the largest ever recorded, caused extensive bleaching of corals, and has contributed to scientific consensus that climate change is now the pre-eminent threat to the future survival of coral reefs, and the ecosystem services that they

[1] Thematic areas are: Food security; Disaster risk reduction and early warning systems; Transboundary water management; Innovation in adaptation finance.

provide. Without taking targeted actions to protect and restore coral reefs, the adaptation capacity of communities in tropical countries will be weakened through the degradation of reefs.

Coral reefs are the foundation of food security and coastal livelihoods in both Mauritius and Seychelles. They are the basis of artisanal fisheries and the tourism industry. The artisanal fishery of each country relies primarily on catches of reef associated species and, although not necessarily of high monetary value, these fisheries are a key to the health, and food and income security of coastal communities. The total abundance of demersal fish (and hence potential fisheries productivity) is strongly associated with the amount of live hard coral cover.[2] Similarly, the tourism industry in each country has developed primarily on account of the reefs, which not only provide the snorkeling and diving experiences that visitors specifically seek out, but also the white sandy beaches that in many parts of these islands are formed from the natural erosion of coral colonies. In both countries, the overwhelming majority of capital investments in the tourism sector are located on the coast for this reason; for example in Mauritius, of the total 115 hotels in 2015, over 90% were on the coast[3].

Coral reefs, through the protection they give the shoreline, also provide a key disaster risk reduction measure for some of the most damaging consequences of climate change: rising sea levels and increased frequency and intensity of storms. An estimated 100 million or more people globally benefit from the risk reduction that reefs provide. If reefs are degraded, the costs of hazard mitigation and adaptation would significantly increase. Healthy reefs play a major role in coastal protection by serving as natural breakwaters that shield coastlines, coastal populations, properties and infrastructure against storms, flooding and erosion. The live hard coral structures on fore reef slopes and shallow reef crests dampen oncoming waves, thus sheltering the lagoons and permitting the growth of other critical habitats, including seagrass beds and mangroves. These sheltered habitats further reduce the risk of coastal erosion, through stabilizing sediments, while also providing nursery habitats for the juveniles of economically important fish and invertebrate species.

The value of coastal protection provided by coral reef ecosystems is difficult to measure but is considered significant. The value has been estimated at US$1.2 million per year in the Virgin Islands[4] and even US$265.9 million a year in Bermuda[5]. Compared with other coastal habitats such as mangroves and salt marshes, reefs have been found to have the greatest potential for coastal protection[6]. Coral reefs reduce wave energy impacting shorelines by an average of 97%, with reef crests dissipating most (86%) of this energy[7] and reef flats dissipating approximately half of the remaining wave energy. This means that even narrow reef flats

[2] e.g. Komyakova V, Munday PL, Jones GP (2013) Relative importance of coral cover, habitat complexity and diversity in determining the structure of reef fish communities. *PLoS ONE* 8(12): e83178. doi:10.1371/journal.pone.0083178

[3] Ministry of Tourism and External Communications

[4] BT. van Zanten, PJH. van Beukering, AJ. Wagtendonk 2014. Coastal protection by coral reefs: A framework for spatial assessment and economic valuation. *Ocean and Coastal Management* 96: 94-103

[5] Sarkis, S., van Beukering, PJH, McKenzie, E. (eds.), 2010. Total Economic Value of Bermuda's Coral Reefs: Valuation of Ecosystem Services. Technical Report, Department of Conservation Services, Government of Bermuda, Bermuda. 199 p.

[6] Narayan S, Beck MW, Reguero BG, Losada IJ, van Wesenbeeck B, Pontee N, et al. 2016. The Effectiveness, Costs and Coastal Protection Benefits of Natural and Nature-Based Defences. *PLoS ONE* 11(5): e0154735. doi:10.1371/journal.pone.0154735

[7] Ferrario F, Beck MW, Storlazzi CD, Micheli F, Shepard CC, Airoldi L. 2014. The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. Nature Communications 5.

effectively contribute to wave attenuation[7]. They have also been estimated to reduce wave height by on average 70%[5].

Furthermore, research[4,6] has shown that reefs are critical not just for low-frequency, high-energy events such as storms and cyclones, but also for reducing coastal erosion from high-frequency, daily small wave events. Another key factor in wave attenuation is bottom friction, which is a function of bottom "roughness" and which is being reduced worldwide by coral reef degradation. For example, the loss of branching corals in the Caribbean has significantly reduced both the height and roughness of reefs, particularly the reef crests[8]. Thus a reduction in the amount of live hard coral cover and the loss of reef framework that occurs when a reef is degraded by anthropogenic or climate change related impacts, directly threatens the food security and livelihoods of communities, dependent on reef fisheries, and puts these same people and property at further risk from climate related coastal hazards. As vulnerable SIDS, both Mauritius and Seychelles must explore all possibilities to protect food security and reduce disaster risk from climate change induced events.

An important and innovative option available for both countries to recover reef health is to use active coral restoration in order to regenerate the associated structure and productivity of these ecosystems. Natural recovery processes on reefs often fail after large scale disturbances, such as bleaching caused by climate-change induced sea water warming. The loss and degradation of coral colonies leads to a reduced supply of coral larvae and often results in the substrate becoming unsuitable for settlement and/or survival of coral spat. The positive impact on coral reefs of commonly used conservation interventions, such as the establishment of marine protected areas (MPAs), generally do not occur fast enough to allow recovery before a further damaging event occurs; thus climate-induced bleaching events now tend to occur at a frequency and intensity that preclude natural recovery between each event. This results in increasingly poor health of the reef and reduced resilience to both further climate-induced events and to local anthropogenic impacts. In such situations, "active" restoration becomes the only option to initiate the rehabilitation of degraded reefs and protection of their ecosystem services (see Annex 1). Reef restoration, once considered a somewhat controversial intervention, is now recognized by the scientific community as an important complementary activity to more passive conservation measures, in order to both promote reef recovery and improve reef resilience.[9] Research is indicating that some coral types (certain species, or colonies with clades of resilient zooxanthellae – see below) are resilient or resistant to bleaching and if these are used for restoration there is strong potential for restoring some of the key functions of reef ecosystems.

Within the Western Indian Ocean (WIO), coral bleaching has undermined existing conservation reef efforts and many countries have been unable to respond using conventional practices. The SIDS in particular urgently need to develop new capacities to restore the ecosystem services lost after coral bleaching and build resilience. Both Mauritius and Seychelles have a number of measures underway that will indirectly or passively improve coral reef health, including the establishment of networks of MPAs, pollution mitigation projects, fisheries management, introduction of ICZM and coastal development regulation activities. Despite these passive measures, however, coral reefs continue to be degraded, through the increasing frequency of climate change-induced events. Without introducing active measures to restore coral reefs now,

[8] Alvarez-Filip, L., Dulvy, N. K., Gill, J. A., Cote, IM. & Watkinson, AR. 2009. Flattening of Caribbean coral reefs: region-wide declines in architectural complexity. Proc. Biol. Sci. 276, 3019–3025.

[9] Gomez ED, Cabaitan PC, Yap HT, Dizon RM (2014) Can coral cover be restored in the absence of natural recruitment and reef recovery? Restoration Ecology 22 (2): 142–150. doi:10.1111/rec.12041.

coral reefs will continue to degrade beyond their natural ability to recover, and before passive measures are able to create a conducive environment for this to occur. It has become clear that if reefs are to be able to continue providing the key ecosystem services of fisheries, tourism and coastal protection, a more active form of reef restoration should be attempted.

A regional approach will be essential, given the comparatively recent development of reef restoration technologies (see Annex 1 for terminology and a summary of progress to date globally and within each country). Sharing experiences and expertise between the two countries will help to accelerate progress. However, it will be important to take account of national differences. Research indicates that reefs in the two countries have different susceptibilities to bleaching[10]. Those in the Seychelles have amongst the highest susceptibilities to bleaching, out of five WIO countries that have been assessed: over 70% of the Seychelles reefs lie in moderate to highly susceptible geographical areas and are exposed to high currents and solar radiation, which makes them more prone to thermal stress. In contrast, susceptibility estimates for reefs in Mauritius are low compared to the rest of the region, attributed to the comparatively high temperature fluctuations and wind velocities experienced in this country, with cool periods caused by storms and cloudy periods, a consequence of the country's more southern geographical location.

A regional project thus provides an opportunity to test out different responses to the adaptation measure of reef restoration. Country-specific responses will need to be integrated into the regional approach and the socioeconomic and ecological conditions as well as long-term climate prediction in each country must be well understood as these will dictate the range of interventions that are feasible. Measures such as MPAs may be more appropriate where adaptive capacity (i.e. the ability of households to anticipate and respond to changes in coral reef ecosystems and fisheries, and to minimize, cope with, and recover from the consequences) is high, and local communities are able to respect restrictions and take advantage of new opportunities, such as increased tourism. Where adaptive capacity is low, for example if communities are poorly equipped to cope with even short-term restrictions on resource use and are unwilling or unable to comply with restrictions, the priority may be for investments in poverty alleviation, infrastructure, social capital, and alternative income generating activities to develop adaptive capacity.

Research suggests that although overall the Seychelles has high adaptive capacity[11], the high susceptibility of its reefs to bleaching means that passive conservation measures may be too slow for reefs to recover before a further damaging event, and so piloting an active and innovative technologically advanced restoration programme to rehabilitate the ecosystem and provide adaptation to climate change may be appropriate here. Mauritius has moderate adaptive capacity which, combined with its low environmental susceptibility to bleaching, means that protectionist conservation policies, such as MPAs, should be feasible adaptation measures and greater effort should be made to ensure these are put in place. Nevertheless, the current situation is such that more active measures such as coral restoration are needed as well, oriented also to helping to improve livelihoods.

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[10] Maina J, Venus V, McClanahan TR, Ateweberhan M. 2008. Modeling ecological susceptibility of coral reefs to environmental stress using remote sensing, GIS and in situ observations: a case study in the Western Indian Ocean. *Ecol Mod* **212**, 180–199,

[11] McClanahan TR, Cinner JE, Maina J, Graham NAJ, Daw TM, Stead SM, Wamukota A, Brown K, Ateweberhan M, Venus V, & Polunin NVC. 2008. Conservation action in a changing climate. *Conservation Letters* 1: 53–59.

The project will take account of such insights and ensure that the two countries learn from each other's strengths and weaknesses. The proposal is that Mauritius should develop a more community based management and low tech reef restoration approach while Seychelles should build on its field experience to date and undertake wider scale, tech-based reef restoration that could potentially be mainstreamed into productive sectors, such as tourism, on an innovative commercial basis.

In both countries, resilient corals will be propagated in nurseries in various partnership arrangements to supply a cost effective and continuous stock of corals for transplantation into areas degraded by climate change with the long-term aim of restoring the ecosystem services that healthy coral reefs normally deliver. The restoration efforts will provide alternative employment for local fishers, thus reducing current fishing pressure on the reefs, and for others providing improved livelihoods. The project will capture lessons from these activities and disseminate them to the wider region and will provide the opportunity to upscale and mainstream the experiences to date.

Inevitably initially, the restored areas will have a lower coral diversity than prior to bleaching events, and it will take a number of years for a comprehensive reef community to develop. However, research is showing that some species, particularly fish, return quickly to restored reefs. It must also be understood that coral reefs have changed, are changing and will continue to change. Scientific consensus is that it is unlikely that future reefs will return to historical conditions[12] and it is becoming clear that the "restored 'reefs of tomorrow' will be different from reefs of the recent and more distant past[13]. However, as was agreed by the 2500 scientists attending ICRS13, restoring reefs with resilient corals is a better strategy than leaving them to virtual extinction. The analogy is with forest and wetland restoration, which are now well established interventions bringing a range of conservation and socio-economic benefits and the restoration of essential ecosystem services.

Barriers to ensuring that coral reefs provide an effective ecosystem based adaptation measure

Both countries have developed national frameworks for climate change mitigation and adaptation responses (Part II, section D) and have paid increasing attention to the role that coastal ecosystems play in determining the vulnerability of communities to climate change and mitigating the adverse impacts this. Nevertheless, unless further action is taken, barriers remain that will prevent degraded reefs recovering sufficiently to ensure food security and shoreline protection for coastal communities. The speed with which climate change is resulting in negative impacts means that additional interventions are required to ensure sufficient adaptive capacity. Despite the current major investments in protecting coral reefs, including the creation and improved management of MPAs and the improved regulation of coastal development, this is still insufficient to maintain the role of coral reefs in food and income security and disaster risk mitigation. For example, in Mauritius, in 2009 only 14% of coral reefs fell within Fishery Reserves and 2% within Marine Parks, leaving over 83% with no protective designation[14].

[12] Rinkevich B (2015) Climate Change and Active Reef Restoration—Ways of Constructing the "Reefs of Tomorrow." J. Mar. Sci. Eng. 3:111–127

[13] Rinkevich B (2014) Rebuilding coral reefs: Does active reef restoration lead to sustainable reefs? Curr. Opin. Environ. Sustain. 7:28–36

[14] NWFS Consultancy 2009. Environmentally Sensitive Areas Classification Report, Republic of Mauritius. Final Report.

The limited experience in and the lack of knowledge on coastal ecosystem restoration both in these countries and more widely hinders the application of ecosystem based climate change adaptation measures. The weak institutional capacity of government and communities to address restoration needs and manage ecosystems to ensure their resilience is a critical barrier in advancing ecosystem based approaches to climate change risk management. Lack of knowledge and insufficient awareness of climate change impacts and the urgency of addressing ecosystem restoration and resilience as an adaptation measure are further barriers.

Economic and development context

Mauritius has a population of just under 1.26 million, of which around 97% live on the main island and the rest on Rodrigues[15]. Population density on Mauritius island is high (641 inhabitants per km^2), and even higher when tourist arrivals are included: the country had over a million visitors in 2014. Rodrigues has a much lower density of 399/km^2, although this is still high in global terms. Cumulative economic growth over recent decades has meant that Mauritius has moved from classification as a Low Income to an Upper Middle Income country with a gross national income per capita of USD 9,500[16]; it is aiming to achieve High-Income status by 2020. The Mauritian economy has been increasingly diversifying since the mid-1990s, when the sugar and textile sectors were dominant and, although both these sectors are still important, the offshore financial sector, a rapidly growing information, communication and technology (ICT) industry and the expanding ports sector are now key to the national economy.

The Seychelles has a population of just over 91,400 (of which about 12% are migrant workers)[17], most of whom live on the narrow coastal plains of the three granitic islands of Mahé (79% of the population), Praslin and La Digue, where economic activities are also concentrated. Seychelles has a high Human Development Index (HDI) value of 0.836 (the highest in Africa) and a GDP per capita of US$ 9,028[18]; it ranks high on human development indicators such as life expectancy, primary school enrolment (100%), and adult literacy rate (over 90%). Once a largely agricultural economy (cinnamon and coconut), the Seychelles is now a dual economy heavily dependent on tourism and fishing which are the main production sectors and, like Mauritius, it has a growing offshore financial sector. However, since the beginning of the 1990s, Official Development Assistance flows have fallen by over 90%. This, with the increased need to borrow from commercial institutions, has led to a slowdown of the economy.

The fisheries in both countries are key to the national economy. Although this sector is dominated by high-seas and export oriented tuna fishing, the artisanal fisheries which are largely reef-based, are also vital for the local generation of income and employment, and for the local availability of protein. In 2011, Seychelles was the 3rd largest consumer of fish per capita (59.3 kg) and the percentage of fish as a contribution to animal protein is 47.6%. A significant proportion of this is sourced from reef and coral associated areas (2011).[19] The submarine banks of the Seychelles, particularly the Mahé plateau where some 100 species of demersal fish are commonly caught, form the basis of the artisanal fishery providing vital food security, employment and high value trade commodities. Also important are the reef-based sea cucumber, lobster and octopus fisheries. Artisanal fishery catches peaked in 1991 and have declined steadily since, providing a very strong indication that the demersal stocks have been

[15] Mauritius in Figures 2015. Statistics Mauritius
[16] http://data.worldbank.org/about/country-and-lending-groups#Sub_Saharan_Africa, accessed 2 May 2015
[17] Seychelles in Figures 2015. National Bureau of Statistics.
[18] Indicative Estimate for 2009
[19] http://www.globefish.org/total-fish-consumption-per-capita-kg-and-fish-contribution-to-total-proteins-percent.html

heavily overfished[20]. In Mauritius, although high-seas fishing has seen a steady decline since the mid-1990s, lagoon and off lagoon fishing, a large proportion of which is reef-based, has recently increased and contributes some US$4.75 million annually to GDP, representing 40% of all fisheries[21].

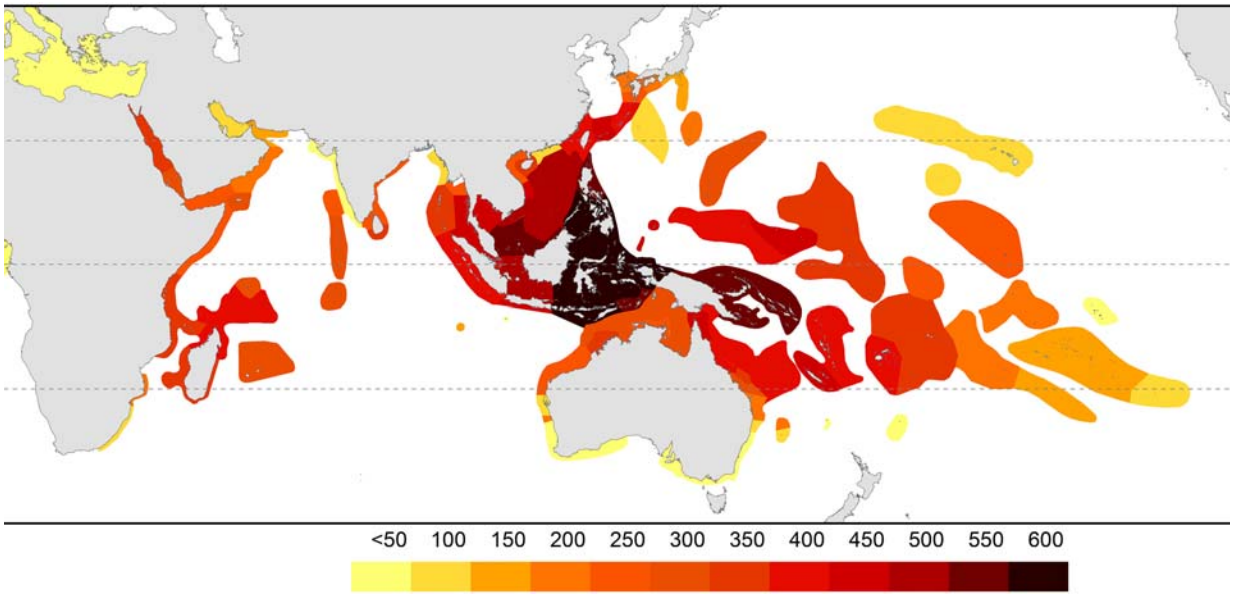
Tourism has followed a similar pattern in both countries. In Mauritius, this sector contributes around 11% of total GDP (total revenue from the sector represents more than 30% of foreign earnings[12]), and tourist arrivals have doubled since the mid-1990s. The Seychelles tourism industry expanded greatly after the opening of the airport in 1971, and in 2010 stood at 174,529 visitors a year, contributing 46.1% of the country's GDP, providing 56.4% of national employment and generating 33.2% (US$ 382.5 million) of the country's foreign exchange earnings. In both countries, the contribution of tourism to the national economy is even greater than these figures indicate if one takes into account the economic multiplier effect created by the industry and the value added in other sectors.

Environmental context

The Seychelles and Mauritius lie within the Indian Ocean centre of diversity for corals. The most recent analysis[22], incorporating earlier studies e.g.[23], indicates that the reefs of the two countries fall into three ecoregions on account of their different coral faunas: the Mascarene Islands, the northern Seychelles (predominantly the granitic islands surrounded by nearshore fringing reefs) and the southern Seychelles (predominantly the outer islands, which are largely atolls). The northern Seychelles and the Mascarenes have a slightly lower diversity than the southern Seychelles, but nevertheless, have over 350 species (Fig 1). Further work is required to fully understand the coral diversity and taxonomy of these countries.

Figure 1: Global diversity indicated by all records of occurrences. Colours indicate no. of coral species that occur in an area (see bar below map)[8]

[20] GoS (2014). Seychelles Biodiversity Strategy and Action Plan 2015-2020.
[21] World Bank.
[22] JVeron, M Stafford-Smith, Lyndon DeVantier1 and Turak, E. 2015. Over view of distribution patterns of zooxanthellate Scleractinia *Frontiers in Marine Science* 1(81).
[23] Obura D (2012) The Diversity and Biogeography of Western Indian Ocean Reef-Building Corals. *PLoS ONE* 7(9): e45013. doi: 10.1371/journal.pone.0045013



Reefs in the WIO, as elsewhere in the world, have suffered from a range of negative human-induced impacts but climate-change associated bleaching has caused particularly serious degradation, notably in the islands. The WIO was severely affected by the first major global bleaching episode caused by the 1997/1998 El-Nino/Indian Ocean Dipole event which resulted in high sea water temperatures. Coral mortality ranged from 10% in Mauritius to 80-95% on the worst affected reefs in the Seychelles[24], with live coral cover reduced to less than 3% in some areas[25]. While some reefs recovered naturally within 5-10 years, others remained as rubble strewn wastelands even within well-established MPAs, often impacted by other local factors. Further outbreaks of coral bleaching occurred in 2004 and 2009 and although in many sites bleached corals recovered, many others have died[26].

Figure 2 shows the trends in live coral cover since 1997, up to 2007[27]. Mauritius showed a major reduction (up to 70%) in live coral cover between 1997 and 2007, with a slightly smaller decline for Rodrigues. Coral cover at monitoring sites on Rodrigues in 2008 averaged just under 40%, and on Mauritius in 2009, between 10-20%[28], with a range of local impacts impeding recovery[29]. Although not shown on this graph, there was also a major decline in Seychelles, particularly in the inner granitic islands[30]. Coral cover declined by 50–90% after 1998, such that

[24] Obura D (2005) Resilience and climate change: lessons from coral reefs and bleaching in Western Indian Ocean. Estuarine, Coastal and Shelf Science 63: 353–601 372.

[25] Graham NAJ, Wilson SK, Jennings S, Polunin NVC, Bijoux JP, Robinson J (2006) Dynamic fragility of oceanic coral reef ecosystems. Proc. Nat. Acad. Sci. USA 103 (22): 8425–8429. doi:10.1073/pnas.0600693103.

[26] Moothien-Pillay, S., Bacha Gian, S., Bhoyroo, V. and Curpen, S. 2012. Adapting coral culture to climate change: the Mauritian experience. *Western Indian Ocean J. Mar. Sci*. 10(2): 155-167.

[27] Hamada, S.; Bijoux, J.; Cauvin, B.; Hagan, A.; Harris, A.; Koonjul, M.; Mercier, S.; Quod, J. P. 2008. Status of coral reefs of the South-West Indian Ocean Island States: Comoros, Madagascar, Mauritius, Reunion, Seychelles. In: *Status of Coral Reefs of the World*. p 105-118.

[28] Cauvin et al, 2010. Synthèse régionale 2010. Suivi de l'état de santé des récifs coralliens des Îles du Sud Ouest de l'Océan Indien. COI/ReCoMap.

[29] Moothien-Pillay, S., Bacha Gian, S., Bhoyroo, V. and Curpen, S. 2012. Adapting coral culture to climate change: the Mauritian experience. *Western Indian Ocean J. Mar. Sci*. 10(2): 155-167

[30] Chong-Seng KM, Graham NAJ, Pratchett MS (2014) Bottlenecks to coral recovery in the Seychelles. Coral Reefs 33 (2): 449–461. doi:10.1007/s00338-014-1137-2.

many reefs had cover of less than 10% while others had moderate recovery but experienced further coral mortality after bleaching in 2002–2003. The loss of live coral was so extensive and widespread that sources of coral larval influx for recruitment were greatly reduced and the spread of algae coverage limited coral recruitment and development. The increase in coral cover shown in Figure 2 for Seychelles is largely due to the recovery of reefs in the outer islands, which are subject to fewer local impacts.

Fig. 2 Trends in live coral cover in the COI countries, 1997-2007. Red line= Mauritius; yellow line = Rodrigues; brown line – Seychelles

Most recently, in 2015-2016, the largest bleaching event that reefs have seen worldwide since recording started has taken place[31]. Coral monitoring of the extent of the bleaching, the mortality that has ensued and the potential for recovery is currently underway, but preliminary information from Seychelles and Mauritius indicate that reefs in both countries were badly affected, and that the recovery that had started to be seen has been reversed in many locations. At two monitored sites in Mauritius (Ile aux Benitiers and Flic en Flac) live coral cover was about 70% in 2012 but dropped to 32-38% in 2015[32]. In Seychelles, on the inner granitic island reefs, which by 2012 were in many places dominated by macroalgae, coral recovery has been shown to be constrained by unsuccessful settlement or poor post-settlement survivorship; and equally on rubble dominated reefs high densities of juvenile corals failed to translate into high cover of adult corals because of the lack of a conducive environment[33]. By 2014, the inner Seychelles hard coral communities were assessed as having lower generic diversity and lower abundance of adult hard corals than other coral reef regions of the Indian Ocean for which comparable data were available[34].

Coral bleaching is now recognized as one of the major threats to coral reefs and their associated communities. The frequency of such events is predicted to increase in coming decades as seawater temperatures continue to rise. It has been estimated that, by 2100, live

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Harris A, Wilson S, Graham NAJ, Sheppard C (2014) Scleractinian coral communities of the inner Seychelles 10 Years after the 1998 Mortality Event. Aquatic Conservation 24 (5): 667–679. doi:10.1002/aqc.2464.

[31] Eakin, CM et al., 2016. Global coral bleaching 2014-2017 – status and appeal for observations. *Reef Encounter* 31(1): 20-26.

[32] MOI 2016. Presentation by MOI during consultant's mission.

[33] Chong-Seng KM, Graham NAJ, Pratchett MS (2014) Bottlenecks to coral recovery in the Seychelles. Coral Reefs 33 (2): 449–461. doi:10.1007/s00338-014-1137-2

[34] Harris A, Wilson S, Graham NAJ, Sheppard C (2014) Scleractinian coral communities of the inner Seychelles 10 Years after the 1998 Mortality Event. Aquatic Conservation 24 (5): 667–679. doi:10.1002/aqc.2464.

coral cover globally could reduce by 30-88% through impacts such as bleaching and reduced calcification in the event of 1.1°C to 2.6°C rise in temperature (RPC4.5 scenario)[35]. In both countries, over-fishing, land-based sources of sediments from erosion of agricultural land and deforested slopes, nutrients from sewage and fertilisers, and tourism based activities and anchor damage have been also been preventing recovery. Natural threats include cyclones and tropical storms and sporadic outbreaks of the coral predator, the Crown of Thorns Starfish, *Acanthaster planci,* which feeds on corals. The combination of these threats is resulting, as on reefs globally, in progressive replacement of reef building corals with soft corals and algae that have less ecological and socio-economic value[36].

Project Objectives:

The project responds to two of the three thematic focal areas: food security and disaster risk reduction, which are addressed jointly through the same objectives for each country:

1. To improve food security and livelihoods and mitigate disaster risk through active restoration of coral reefs degraded by coral bleaching as a result of climate change in Mauritius, in order to restore their essential ecosystem services.

2. To improve food security and livelihoods and mitigate disaster risk through active restoration of coral reefs degraded by coral bleaching as a result of climate change in Seychelles, in order to restore their essential ecosystem services

Food security: the restoration of degraded reefs will increase coral cover and thus restore fish habitats and spawning/nursery sites, thereby encouraging the recovery of reef associated fish communities important as food to the local communities in Mauritius and, in Seychelles, to the national economy as a whole. In addition, the restored reefs will benefit the tourism industry, through greater aesthetic value and consequently higher visitation by snorkelers and divers. This will create more opportunities for employment in the tourism industry and thus an increased source of livelihoods and greater food security. The coral nurseries and transplantation sites themselves are likely to play a role in aggregating fish and thus will contribute to the protection of fish populations which, through over-spill, can contribute to the local fishery. For example, research in Seychelles has shown that density of blue-yellow damselfish *Pomacentrus caeruleus* was 12–16 times higher when corals were present at a coral nursery than in nurseries with no corals; furthermore fish assemblages recruited into the nurseries were diverse in that they included three trophic levels, from herbivores to omnivores, in six families[37].

Disaster risk reduction: the restoration of degraded reefs will stabilise the reef substrate and increase coral cover and thus restore the protective barrier function provided by coral reefs. In the long-term this project will contribute to demonstrating where, when and how healthy or

[35] IPCC 2014: Arent et al. 2014: Cross-chapter box on the water–energy–food/feed/fiber nexus as linked to climate change. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*

[36] Thomassin A. 2011. No 5. Recommandations finales. Etude de faisabilité pour la mise en place d'une ou plusieurs AMP sur la côte sud-ouest de Maurice. MMCS/ProGeCo.54p

[37] Frias-Torres S, Goehlich H, Reveret C, Montoya-Maya PH. 2015. Mid-water coral nurseries recruit reef fish assemblages in Seychelles, Indian Ocean. *African Journal of Marine Science* 2338:1–6. doi: 10.2989/1814232X.2015.1078259.

restored coastal ecosystems can contribute to cost-effective solutions that address current and growing risk from natural hazards and climate change.

The third objective is regional and is:

3. To generate knowledge and understanding about the use of coral restoration as an adaptation measure for dissemination to other SIDS and countries within the wider region, and to build capacity for this intervention in the WIO. By adopting a regional approach, it is expected that the stakeholders involved will develop technical and scientific partnerships as well as a common understanding that will enable them to promote the use of effective natural solutions in adaptation and disaster risk reduction.

The project will enhance regional coordination, scientific exchange and learning across the WIO, identified as one of the regions that will be most negatively impacted by climate change. This regional scaling-up and learning would not occur if two separate national projects were to be funded. In particular the Seychelles will benefit from the established scientific capacity and facilities in Mauritius; and Mauritius will benefit from the recent experience gathered in Seychelles in undertaking large scale reef restoration.

The project will also contribute to the cross-cutting fourth theme of regional projects supported by the Adaptation Fund in that it will support activities that can be considered as an "innovation in adaptation finance[38] towards transformational impact", through the work that will done to identify mechanisms for ensuring sustainable financing of coral restoration.

Project Components and Financing

The table below describes indicative outputs and outcomes, and these are explained in more detail in Part II, Section A. During the project formulation phase, a thorough baseline study will be conducted which will enable more precise activities and outputs to be defined. The baseline study will involve collation of more detailed information on coral reef restoration, the ecosystem services that restored reefs can provide in terms of food security and disaster risk reduction, and the identification of knowledge gaps.

Project Components	Expected Outcomes	Expected Outputs	Countries	Amount (US$)
1: Enhancement of food security and reduction of risks from natural disasters through the restoration of degraded reefs in Mauritius[39]				
Development of a sustainable partnership and community based approach to reef restoration	Coastal communities benefit from improved livelihoods through: • employment establishing and maintaining coral nurseries and transplantation sites;	• Stakeholder analysis completed and partnership agreements drawn up with private sector and community groups; • Business plans in place for sustainable financing and maintenance of restoration initiatives	Mauritius	130,000

[38] "Adaptation finance" is taken here to mean "the finance for activities that address current and expected effects of climate change" http://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Common_Principles_for_Climate_Change_Adaptation_Finance_Tracking_-_Version_1__02_July__2015.pdf

[39] The target area of reef to be restored in each country will be estimated when the full proposal is prepared, and will depend on a better understanding of costs, potential suitable sites, capacity available and methods to be used.

	• improved fish catches as reef health improves; • increased revenue from tourism (glass bottom boat tours, snorkeling and diving trips)	• Fisher/women/youth community groups trained in establishment and maintenance of coral nurseries • Coastal communities and public aware of the need for reef restoration and the potential of coral farming as an alternative livelihood		
Establishment of coral farming and nursery facilities	Coral colonies of appropriate species (resilient, maintaining genetic diversity) available at sufficient scale (quantity, time intervals etc) for transplanting onto degraded reefs	• Reports on coral reef status, water quality, and other key environmental and social parameters for potential nursery sites • A land-based nursery and 2 or more ocean nurseries established and maintained on a regular basis • Stock of farmed corals available for transplantation	Mauritius	800,000
Active restoration of degraded reefs, with maintenance and monitoring of survival and growth rates of transplanted corals	• Rugosity and structure of reefs restored, leading ultimately to greater protection of shore from flooding and storm damage • Recovery of fish populations and other reef associated fauna and flora, leading ultimately to improved food security and livelihoods.	• Reports on reef health and diversity, water quality, species diversity and key parameters for all transplantation and control sites • Identified sites restored using farmed corals of resilient species, with good survivorship and growth rates of the colonies • Long-term maintenance and monitoring programmes in place, recording survival and growth rates of transplanted corals, and abundance and diversity of other reef-associated species	Mauritius	700,000
2. Enhancement of food security and reduction of risks from natural disasters through the restoration of degraded reefs in Seychelles[1]				
Development of a sustainable partnership and business approach to reef restoration	Stakeholders benefit from improved livelihoods through: • employment establishing and maintaining coral nurseries and transplantation sites; • improved fish catches as reef health improves, and spawning/nursey areas are protected or created; • increased revenue from tourism (glass bottom boat tours, snorkeling and diving trips)	• Stakeholder analysis completed and partnership agreements drawn up with private sector and other participants; • Business plans in place for sustainable financing and maintenance of restoration initiatives • Participating groups trained in establishment and maintenance of coral nurseries • Coastal communities and public aware of the need for reef restoration and the potential of coral farming as an alternative livelihood	Seychelles	130,000
Establishment of coral farming and nursery facilities	Coral colonies of appropriate species (resilient, maintaining genetic diversity) available at sufficient scale (quantity, time intervals etc) for transplanting onto degraded reefs	• Reports on coral reef status, water quality, species diversity and other key environmental and social parameters for potential nursery sites • Ocean nurseries established and maintained on a regular basis	Seychelles	800,000

		• Stock of farmed corals available for transplantation		
Active restoration of degraded reefs, with maintenance and monitoring of survival and growth rates of transplanted corals	• Rugosity and structure of reefs restored, leading ultimately to greater protection of shore from flooding and storm damage • Recovery of fish populations and other reef associated fauna and flora, leading ultimately to improved food security and livelihoods	• Reports on reef health and diversity, water quality, and key parameters for all transplantation and control sites • Identified sites restored using farmed corals, with good survivorship and growth rates of the colonies • Long-term maintenance and monitoring programmes in place, recording survival and growth rates of transplanted corals, and abundance and diversity of other reef-associated species	Seychelles	700,000
3. Knowledge management and sharing, training and sensitization to build regional capacity for sustainable reef restoration				
Improved understanding and knowledge management of use of reef restoration as an adaptation measure	Coral restoration efforts undertaken by the project and within the region are based on best available science (e.g. factors determining success in coral restoration are known; cost-effective approaches, constraints and challenges identified and lessons learned documented)	• Comparative review and analysis of coral restoration initiatives in the region and globally, with gaps in knowledge identified • Selection criteria developed for (1) location of nursery and transplantation sites, and (2) corals to be propagated. • Research undertaken to provide information to guide restoration and enhance reef resilience were required (e.g. genetic connectivity of coral species, spawning seasons and coral recruitment patterns, resistant/ resilient species and clades)	Mauritius & Seychelles	300,000
Lessons learned regionally and globally on methods and approaches to sustainable reef restoration are disseminated	Improved understanding within the WIO and globally of successful approaches to reef restoration, the constraints and challenges, with lessons learned incorporated into new initiatives	• Lessons learnt in reef restoration documented and shared • Reef Restoration tool kit and manual for use in the WIO published and disseminated	Mauritius & Seychelles	89,671
Training to build capacity for sustainable coral reef restoration	Regional capacity developed for coral restoration	• Regional training programme on reef restoration in place, possibly with an associated Certificate of Competence • Regional training workshops undertaken on monitoring, DNA-based approach for the identification of resilient corals, and other topics as appropriate • Sustainable long-term monitoring programme developed and underway for restored reefs, based on international/regional protocols and best practice	Mauritius & Seychelles	400,000
6. Project/Programme Execution cost				**425,215**
7. Total Project/Programme Cost				**4,474,886**
8. Project/Programme Cycle Management Fee charged by the Implementing Entity (if applicable)				**425,114**

Amount of Financing Requested		**4,900,000**

Projected Calendar:

Milestones	Expected Dates
Start of Project/Programme Implementation	Oct/Nov 2018
Mid-term Review (if planned)	Mid-2020
Project/Programme Closing	Oct/Nov 2023
Terminal Evaluation	April 2024

PART II: PROJECT JUSTIFICATION

A. *Describe the project components, particularly focusing on the concrete adaptation activities, how these activities would contribute to climate resilience, and how they would build added value through the regional approach, compared to implementing similar activities in each country individually.*

The project will use the approach of ecosystem-based adaptation, which involves the management and restoration of ecosystems in such a way that the services provided by these ecosystems reduce the vulnerability of communities and also increase the resilience of ecosystems to human induced climate change. Addressing coral reefs, the project will support the "up-scaling" of coral propagation and transplantation of coral colonies onto degraded reefs, using best available science and knowledge gained in both countries from pilot initiatives and from research undertaken globally. The focus will be on coral colonies that have survived coral bleaching and that are therefore either resistant (i.e. do not bleach as a result of elevated temperatures), or resilient (i.e. despite bleaching, the colony recovers).

Although country-specific responses are needed to facilitate adaption to climate change, capacities to address these challenges in the SIDS are limited. Mauritius and Seychelles, two of four SIDS in the WIO region (the others are Comoros and Maldives), both share the geographically common challenges and climate-induced threats of rising seawater temperatures, sea level rise, and ocean acidification. The focus of the project will thus be on consolidating and sharing best practices and expertise in coral restoration and the most cost-effective measures for this, between the two countries and more widely across the WIO region. Mauritius and Seychelles recently negotiated a joint extension to their Exclusive Economic Zone (EEZ) which increases both the means and motivation for sharing knowledge and expertise.

Existing international and regional platforms will be used, including those established specifically for ensuring the future survival of reefs (e.g. WIO Coral Reef Monitoring Network, International Coral Reef Initiative) and those established to ensure that information and knowledge related to climate change adaptation is widely available and shared. An important aspect of the project is that it will demonstrate south-south co-operation. Reef restoration has been trialled in a number of other countries in the WIO, notably in the Maldives. Presentations at the 13th International Coral Reef Symposium (ICRS) in June 2016 indicated that great strides

have been taken around in the world in the development of reef restoration techniques and in understanding the obstacles, constraints and factors in success, particularly in developing countries which now have greater experience. Although a few developed countries are advanced in coral restoration (e.g. USA) this is not usually undertaken with the primary purpose of rehabilitating reefs as an adaptation measure, and so this project will be innovative at the global, as well as regional level.

The three project components will run in parallel and are closely interlinked. Components 1 and 2 address Mauritius and Seychelles respectively and concern the establishment of new, or expansion of existing, coral farming facilities and nurseries, and the restoration of selected degraded reefs. This measure (restoration of degraded reefs), if successfully implemented, will ultimately lead to both an increase in food security and in disaster risk reduction. The project has therefore been designed with a reef restoration component for each country. The activities will be broadly similar in each country but adapted to the different national environmental and socio-economic characteristics, and to the previous experiences in restoration and development of adaptation measures of each country. However, throughout implementation, there will need to be extensive regional networking and exchange, in order to use the knowledge generated in Component 3 which is entirely regional in nature and which will ensure sharing of knowledge, resources and the joint development of capacity. It will be important to allow for flexibility in planning and implementation so that the project can make full use of the rapidly accumulating new research on the most appropriate way to undertake reef restoration.

Component 1. Enhancement of food security and reduction of risks from natural disasters through the restoration of degraded reefs in Mauritius

Component 2. Enhancement of food security and reduction of risks from natural disasters through the restoration of degraded reefs in Seychelles

Components 1 and 2 are described together because of the similarity of activities as well as the co-ordination and networking that will be involved. Throughout the planning and implementation of activities, there will be regular sharing of information and experiences with the project partner organisations in the two countries, to ensure that lessons are learned as the project proceeds and that each country builds of the experiences and knowledge of each other.

The project will start with a full stakeholder analysis in each country and the drawing up of agreements with the organisations and communities that are to be involved in coral restoration.

In Mauritius and Rodrigues, the approach will be to work with small coastal communities and local NGOs, with the involvement of tourism enterprises (hotels, dive centres, boat operators etc) where appropriate. The technical work will be led by MOI and AFRC (MOEMRFSOI), with the support of the University of Mauritius (UoM). The community/NGO aspect of the work will be managed through a UNDP-SGP call for proposals, with the selection of organizations and communities to take part based on a careful assessment. The interest of coastal communities in coral farming in Mauritius was assessed in 2014[40], and many would be willing to participate. There are also a number of NGOs with relevant experience including Reef Conservation, the Mauritius Marine Conservation Society (MMCS), Eco-Mode, Eco-Sud and, on Rodrigues, possibly TerMer Rodriguez and the Shoals Rodrigues Association.

[40] Nazurally, N. and Rinkevich, B. 2014. A Questionnaire-based Consideration of Coral Farming for Coastal Socio-economic Development in Mauritius. *Western Indian Ocean J. Mar. Sci.* 12 (1): 47-56.

In Seychelles, there are few local coastal communities and the focus here will be on NGOs, SNPA and the tourism industry. Nature Seychelles will have a lead role in implementation of project activities, but other NGOs, such as the Marine Conservation Society Seychelles and the Green Island Foundation, will also be involved, according to their interest, capacity and skills. Consideration will be given to involving the University of Seychelles, notably the Blue Economy Research Institute (BERI) which was established in 2015 to provide the knowledge and technical input for the development of the Seychelles Blue Economy. The National Institute of Science, Technology and Innovation (NISTI) might also play a role by contributing to the innovative approaches that will be needed to develop coral restoration as a sustainable enterprise.

Coral restoration is labour intensive, and the stakeholder analysis will include an assessment of sources for the work force. Community members, including fishers, women, youth and boat operators are likely to be willing to take part. University students in both countries are likely to want to be involved, both for work experience and also to undertake dissertations and master's theses. It may also be possible to involve MPA, fisheries and NGO staff. The source of labour will require particular attention in Seychelles, as this has already been found to be a limiting factor. Nature Seychelles resolved this by recruiting volunteers from overseas.

In both countries hotels have expressed interest in participating. Many hotels globally are taking an interest in creating coral "gardens" for the enjoyment of their guests, given that good snorkelling and diving opportunities on their reefs are declining as a result of bleaching and reef degradation. In 2016, there were anecdotal reports that hotels are increasingly developing non-reef related attractions (other water-sports, honey-moon activities) for this reason. Diving will however continue to be an important activity and dive centres might be willing to take part, providing labour and equipment. The involvement of tourism enterprises may be attractive to their clients (it may be possible to involve tourists directly in the work involved), as well as beneficial to their long-term business through the improved health and scenic value of the reefs.

This component requires the development of business plans for the sustainable financing and maintenance of both the nurseries and the transplantation sites. These plans will consider the potential sources of funding and what remuneration is needed for labour, as well as the costs of maintenance and monitoring programmes and equipment purchase. The project provides an opportunity to develop partnerships with the diving and hotel industries and to take advantage of CSR opportunities to leverage funding. In several countries (such as Maldives and Malaysia) hotels have "adopt-a-reef" programmes through which they involve their clients in reef conservation activities and also generate funds that can be used for reef conservation activities; these might provide models for the project. The two countries will develop a harmonized approach to preparing business plans, to ensure the key principles are incorporated, whilst recognising these will need to be adapted to local conditions. In both countries the environmental impact of the revenue generation activities identified will be carefully assessed; for example it will be important not to promote or encourage collection and sale of wild grown corals.

In each country, participants will be trained in handling corals and in maintenance and monitoring at the nurseries and transplantation sites. At nurseries and initially on rehabilitated reefs, rigorous maintenance programmes are required to remove predators and algae. Growth rates of coral colonies, as well as abundance and diversity of associated reef species including fish and key invertebrates, will be monitored. Participants with previous experience of reef restoration will lead the training, with regional and international expertise brought in as required. A "training-of-trainers" approach will be taken, with suitable leaders identified in the communities

and partner organisations who will be taught the protocols and procedures and will be able to train others. An awareness and communication programme will be undertaken as well in each country, to ensure that the public and all stakeholders are aware of the project and why it is being undertaken and to sensitise people to the opportunities for employment and improved livelihoods.

Scoping studies and technical assessments will be undertaken to identify nursery and restoration sites, species for propagation and appropriate approaches and methodologies. In each country, these activities will be closely co-ordinated and dependent on the work undertaken in Component 3 (see below). Studies will be undertaken at potential restoration sites to determine their suitability in terms of water quality, health of existing reefs etc.

An important component of the project is construction of coral nurseries in each country where the colonies will be farmed. A land-based coral nursery is envisaged for Mauritius, building on previous experience at MOI, with small-scale ocean-based community coral farms at suitable locations in both Mauritius and Rodrigues, also building on previous work and taking into account the interest of adjacent hotels. A large ocean-based coral nursery has been proposed for the Seychelles, possibly based at the existing facility at Cousin Island managed by Nature Seychelles. However, in order to spread risk (e.g. loss of all corals at one site only), it will be necessary to have one or more back-up facilities and these might be established at locations where work is underway in the marine parks through SNPA, and/or at hotels with NGO-based projects. Experiences in each country are described in Appendix 1.

Once the colonies in the nurseries have reached a sufficient size and quantity, they will be planted out onto the selected reef sites, which have been appropriately prepared. For example, where the Nature Seychelles model is used for reefs that are essential devoid of living corals, the substrate is “cleaned” before transplantation. Methods for attaching the colonies (e.g. directly to the substrate, or on frames) will be selected as part of work under Component 3. Monitoring and maintenance activities will be undertaken according to the programmes developed in Component 3.

An estimation of the number of coral colonies to be transplanted and the area of degraded reef that could be restored in each country will be made during the preparation of the Full Proposal for the Adaptation Fund. Given that the work involved will vary according to the characteristics of the sites selected for restoration, it will be difficult to estimate in advance what can be achieved. Given the innovative nature of this project in terms of up-scaling restoration efforts, there are few if any examples from other parts of the world that could be used as a basis. The Reef Rescuers Project undertaken by Nature Seychelles transplanted a total of 24,431 corals over an area of 0.52 ha (4-5 colonies per m^2) of degraded reef over a period of about 18 months, resulting in a 700% increase in coral cover by the end of the project, from 2% in 2012 to 14% in 2014. This project estimated that for a completely degraded reef, some 400-500 corals are needed to restore 100 m^2. In the small-scale pilots undertaken in Mauritius, 10-12 colonies were planted per m^2 (equivalent to 1000-1200 per 100m^2). However, at some locations it may be equally important to provide corals for “in-filling” small degraded areas, for example to restore the topography of the reef, which might require less effort and fewer corals. Knowledge on successful approaches is accruing rapidly however, and the review to be undertaken in Component 3 of the project will enable targets to be set.

Component 3. Knowledge management, training and sensitization to build regional capacity for sustainable reef restoration

This component focuses around the need to ensure that experiences built up through Components 1 (Mauritius) and 2 (Seychelles) contribute to the development of a solid base of knowledge on best practices in the use of coral restoration as an adaptation measure at both international and regional levels, with particular emphasis on the SIDS.

A review of coral restoration initiatives in the region and globally to identify factors determining success, constraints and obstacles, lessons learned, and cost/benefits of different approaches will be undertaken at the start of the project, with the emphasis on assessing applicable methods and experiences in scaling up successful approaches as adaptation measures. Understanding of restoration as a coral reef conservation intervention, and increasingly as an adaptation measure, is evolving rapidly, and during the inception phase of the project it will be important to take stock of progress made in order to learn the most recent lessons and adapt the planning for project activities accordingly. Discussions with stakeholders during the June 2016 mission to Mauritius and Seychelles indicated a need for a better understanding of work undertaken to date in each country, particularly relative strengths and weaknesses of different approaches and their application in different marine environments.

Selection criteria for species to be propagated and planted will be identified based on best available knowledge about bleaching resistant and resilient species. Research undertaken in Seychelles, Mauritius and globally provides some strong indications already. The corals will be sourced from adjacent reef areas (i.e. no alien species will be used) and will be those that have demonstrated (by their survival from previous events) either resistance or resilience to bleaching. Research on Mauritius has shown that although *Acropora* species generally suffer high mortalities following bleaching events, at least three species (*Galaxea fascicularis, Pavona decussata* and *Pocillopora damicornis*) have survival rates of over 65% in nurseries[41]. Several species of *Pocillopora* in particular seem to be resilient and have been successful propagated in nurseries[42].

In addition to using species already shown to be resilient, further studies will be undertaken (e.g. identification of bleaching-resistant clades of zooxanthellae) to identify other suitable species and strains. This will also enable information on the coral fauna of both countries to be updated and coral distributions mapped; a regional WIO field guide would be a useful output and could contribute to the development of coral restoration in other parts of the region.

Selection criteria for sites in which to locate for nurseries and for appropriate degraded reefs for transplantation, as well as possible control sites, will be developed, bearing in mind the key principle that the restoration efforts have the objective of helping to increase food security and/or shoreline protection. Coral reef status and water quality will be assessed at potential sites for nurseries and transplantation and GIS mapping will be used to help identify suitable sites, as well as locations for obtaining donor coral colonies. Some mapping of reefs has been initiated in Seychelles e.g. an atlas of shallow marine habitats around Praslin Island is being prepared by SNPA, and post-2016 bleaching assessments are underway around both Praslin and Mahe to identify areas of resilient reefs that could potentially provide coral fragments for

[41] Moothien Pillay R., Bacha Gian S., Bhoyroo V., Curpen S. (2012). Adapting coral culture climate change: the Mauritian experience. Western Indian Ocean J. Mar. Sci.10 (2): 155-167.

[42] Bacha Gian S., Moothien Pillay R., Nicolas A., Bapoo-Dundoo P., Seeam V., Nazurally N. (2015). Small Scale Reef Rehabilitation in Mauritius. 9th WIOMSA Scientific Symposium 26–31 October 2015 Book of Abstracts; Oral presentation.

restoration work. Previous work in Mauritius (e.g. at the Mahebourg Fish Farm and Blue Bay[43]) has started to provide an understanding of the critical factors for nurseries (e.g. bathymetry, distance from shore, currents, existence of predators, human threats etc). For transplantation sites, an important consideration is the extent to which the area is protected and free from human interference: best practice guidance is that transplant sites should be within an MPA and ideally within a no-take zone. However, the involvement of communities and NGOs, rather than relying solely on MPA staff who may have other duties, may be equally important. These studies should also include research on how farmed corals are best transported to the transplant sites.

Knowledge gaps in the taxonomy and ecology of corals will be identified and research undertaken to fill these, where this is necessary for successful reef restoration (e.g. identification of coral species that are resistant or resilient to bleaching; genetic connectivity of species; spatial and temporal variations in coral spawning and recruitment). It will be useful to develop a better understanding of why adjacent sites may have widely different coral cover, and be affected in very different ways by bleaching events. If some coral species are found to be genetically identical, the propagation and maintenance of common coral stocks in both countries could spread the risk during future disturbance events. The detailed planning for this part of Component 3 will be undertaken during the development of the full proposal, and will be based on a good understanding of current global progress in research and knowledge of these topics as this field of research is evolving very rapidly. Mauritius has the technical and institutional capacity to undertake this research while currently Seychelles does not – hence the advantage of a regional approach. The Seychelles however will be involved in this component, providing assistance and building research capacity through knowledge exchange with MOI. The proposed Regional Scientific Advisory Committee (see implementation arrangements) would play an important role in the planning of any research.

The lessons learned in each country will be compiled, documented and shared and made available widely, both in the region and globally, and will contribute to the existing documentation on reef restoration (e.g. Caribbean restoration manual[44], World Bank guidance[45]; papers presented at ICRS13 in 2016). Nature Seychelles has produced a Reef Restoration Manual for the methodology that it is currently using at Cousin Island and this will used as a basis for developing a tool kit and guidance for wider applicability in the WIO, with a broader discussion of approaches and methodologies.

Regional technical training workshops, involving individuals from other countries in the Indian Ocean (particularly the SIDs) will be held on a range of relevant topics as determined during the project. Priority will be given to training on methods of coral farming and transplantation, using the experiences and lessons learned gathered in Mauritius and Seychelles. If appropriate, the training programme could be developed in such a way that a Certificate of Competence could be awarded to participants. The research work undertaken during the project might also lead to a regional training course, for example, on using DNA-based approaches for the identification of resilient corals. In both countries, the maintenance of coral nurseries will be critical to success and this component will also address the need for rigorous maintenance programmes at each nursery. Coral nurseries attract biofouling which is a major impediment to the growth of the

[43] Nazurally, N. and Rinkevich, B. 2014. A Questionnaire-based Consideration of Coral Farming for Coastal Socio-economic Development in Mauritius. *Western Indian Ocean J. Mar. Sci.* 12 (1): 47-56,

[44] Bowden-Kerby, A. 2014. Best Practices Manual for Caribbean Acropora Restoration. Punta Cana Ecological Foundation, 40pp.

[45] Edwards AJ (2010) Reef rehabilitation manual. Coral Reef Targeted Research and 530 Capacity Building for Management Program. St Lucia, Australia. ii + 166 pp.

corals but research undertaken through the Nature Seychelles project has shown that increased presence of fish, attracted by the nursery, helps to control this and thus can reduce the person-hours needed for nursery cleaning. Higher abundance of large fish (total number of individuals) resulted in 2.75 times less person-hours spent in nursery cleaning[46].

Comparative monitoring across both countries will increase knowledge about the effectiveness of the propagation and restoration methods and will assist in the evaluation of the project. Appropriate indicators must be selected, building on global experience and ensuring that socio-cultural, economic, and governance considerations are included so that the efficacy of coral restoration as a tool to promote reef resilience and ensure the sustainable delivery of reef ecosystem services is assessed.[47]

B. *Describe how the project would promote new and innovative solutions to climate change adaptation, such as new approaches, technologies and mechanisms.*

Reef restoration is a comparatively new measure for ecosystem-based adaptation, and has yet to be proved on a regional basis in the WIO as a solution to increasing food security and reducing risks from natural disaster. The scaling up of this potential adaptation measure to the regional level and the focus on ensuring financial and ecological sustainability is not only a new approach but will involve the development of new methods and ways of working. The technology has largely been developed but methodologies for undertaking it on a larger scale, comparable to the restoration initiatives now underway to build resilience and adaptation to climate change on land (e.g. forest and wetland restoration), are yet to be tested.

Involving communities fully in reef restoration programmes is a key recommendation of the global community and has been attempted on a small scale in many countries, particularly in South-East Asia, but often without long-term success. The work in Mauritius will be innovative in that it will demonstrate how this relatively new adaptation measure could be rolled out in a larger number of communities on a sustainable basis.

C. *Describe how the project would provide economic, social and environmental benefits, with particular reference to the most vulnerable communities, and vulnerable groups within communities, including gender considerations. Describe how the project would avoid or mitigate negative impacts, in compliance with the Environmental and Social Policy of the Adaptation Fund.*

Economic benefits

The introduction of an ecosystem based adaptation measure in the form of coral restoration will have a range of long-term economic benefits. It will ensure that the aesthetic value of coral reefs, which are an important component of the tourist industry in both countries is retained. For example, in Seychelles, the contribution of travel and tourism to GDP is expected to increase from 46.1% (US$ 480.0 million) in 2010 to 48.6% (US$ 916.8 million) by 2020, its contribution to

[46] Frias-Torres S, Goehlich H, Reveret C, Montoya-Maya PH. 2015. Mid-water coral nurseries recruit reef fish assemblages in Seychelles, Indian Ocean. *African Journal of Marine Science* 2338:1–6. doi: 10.2989/1814232X.2015.1078259.

[47] Hein, M. Y., Willis, B. L., Birtles, R. A., Beeden, R., 2016. Characterising coral restoration effectiveness: a review of current limitations and challenges at a socio-ecological scale. Paper presented at Int Coral Reef Symp, Hawaii.

employment from 22,000 jobs in 2010 (56.4% of total employment) to 28,000 jobs (61.3% of total employment) by 2020. Export earnings from international visitors and tourism goods in Seychelles are expected to increase from 33.2% of total exports (US$ 382.5 million) in 2010 to US$ 748.3 million (28.2% total) in 2020. For Mauritius, similar increases in tourism earnings and employment are anticipated: as an example, in 2014, travel and tourism directly supported 60,000 jobs (10.9% of total employment) and this figure is expected to rise to 74,000 jobs in 2025. In both countries, direct beneficiaries will include not only those employed directly in the tourism industry, but also their dependents (as a result of job security and the maintenance of current quality of life).

The anticipated long-term improvement in reef-based fisheries as a result of coral restoration will also have economic benefits. And there will also be indirect economic benefits for the citizens of each country. For example, in the absence of measures to improve food security and protect coastal areas from flooding, essential sectors will not be able to expand and these countries will not be able to harness their full economic potential either domestically or in the global economy.

Social benefits

The project will respond to the needs of the more vulnerable groups in each country. In Seychelles, the poorer groups within the community comprise some 25,000 people (30% of the population lives under the Basic Needs Poverty Line)[48]. In Mauritius 8.5% of the population is below the national poverty line[49].

Many of these groups are the most vulnerable to coastal flooding either because they live on the shoreline or in reclaimed areas of wetlands at risk of flooding or because the structures they live in are not robust enough to withstand flooding. Infrastructure that is immediately adjacent to the beach is at risk, and there is clear evidence of this in some areas, with seawalls collapsing and erosion of roadbeds, especially after storms. Beaches are critically important as a first line of defence for coastal infrastructure, and the restoration of coral reefs will help to maintain these through the provision of coral sand.

Coastal communities will benefit from improved shoreline protection and from the growth of the economy through receiving benefits through remuneration for work done, including tourism and direct employment on restoration initiatives. Small businesses (+/-200 businesses in Seychelles) especially tourism enterprises which tend to be near the beach/waterfront investment will be at risk from flooding resulting from sea level rise and increased storm surges and will similarly benefit, as will urban dwellers (+/- 40,000 people in the Seychelles) that are at risk of losses of life and property from increased flooding.

Mauritius will benefit from Seychelles experiences in the professional training in reef restoration techniques. Seychelles will benefit from Mauritius experiences in setting up a land-based nursery and community ventures, and laboratory facilities (e.g. coral genetics, identification of resistant clades and larval propagation). The advantage of the regional approach will thus reside principally in the development of real cooperation within a sector where long term success and capacity building requirement need to be ensured.

[48] www.nsb.gov.sc
[49] https://www.undp-aap.org/countries/mauritius

In Seychelles and Mauritius, the extensive progress in improving human development conditions risk being rolled back by climate change. With the proposed project, reef restoration will in the long-term build the adaptive capacity of coastal communities to climate change (reducing the need for investment in costly structural solutions, such as coastal sea walls). As a result of this approach, finance can be diverted to increase social welfare e.g. education and health. In the absence of this project, the country would have been forced to make continuous reactive and ad-hoc expenditures to address the loss and damage to infrastructure.

Environmental benefits

Environmental benefits are inherent in the ecosystem based adaptation approach proposed in the project, as it will result in increased resilience of coral reefs, protection of reef biodiversity and maintenance and restoration of essential ecosystem provisioning and regulating services.

The project is compliant with the Environmental and Social Policy of the Adaptation Fund. As described in Section L, it will avoid negative impacts relating to the environmental and social principles identified by the Fund.

D. *Describe or provide an analysis of the cost-effectiveness of the proposed project programme and explain how the regional approach would support cost-effectiveness*.

The project is designed to up-scale coral reef restoration using best practices and to build national and regional capacity for using this adaptation measure more widely to reverse the trend of rapid decline in reef health and thus ultimately improve shore protection and food security ecosystem services that reefs provide. Ecosystem restoration is increasingly recognised as being a more cost-effective approach to building long-term adaptation to climate change impacts, than developing hard engineering and expensive technological solutions, and the proposed project is considered as a key catalytic investment to develop this.

The cost of coral reef restoration varies significantly according to method, objective and location, as does the cost effectiveness of the methods used, but as the number of initiatives increase and further research is undertaken, costs are reducing as greater experience is gathered. Preliminary costs of restoration have been assessed in Mauritius (US$100/m^2 rehabilitated reef; US$565/nursery unit)[50] and Seychelles (approx. US$153/ m^2)[51] based on work to date, but these figures are not directly comparable as they have been estimated in different ways. Nevertheless, they are broadly comparable with estimates obtained from meta-analyses of studies which have resulted in costs of about US$115/m^2 according to one study of 52 restoration efforts[52]. A more detailed study of 71 coral reef restoration efforts[53] is also available which provides a range of estimates for different situations; this will be used, along with any further work on this topic, in the preparation of the full proposal.

[50] MOI 2016. Pers.com. Presentation
[51] Montoya-Mya, P. 2016. Pers.com (webinar)
[52] Narayan S, Beck MW, Reguero BG, Losada IJ, van Wesenbeeck B, Pontee N, et al. (2016) The Effectiveness, Costs and Coastal Protection Benefits of Natural and Nature-Based Defences. PLoS ONE 11(5): e0154735. doi:10.1371/ journal.pone.0154735
[53] Bayraktarov E, Saunders MI, Abdullah S, Mills M, Beher J, Possingham HP, Mumby PJ & Lovelock CE 2016 The cost and feasibility of marine coastal restoration. *Ecological Applications*, 26(4): 1055–1074

Alternative approaches are, in the long-run, more costly, requiring the installation of shoreline defences, and the development of more costly alternative food sources for coastal communities, such as offshore fisheries or mariculture. A meta-analysis[54] of the costs of coral reef restoration versus construction of artificial defences found that the former were significantly less than the costs of building breakwaters, and that if the maintenance costs for breakwaters and the benefits of reefs in terms of fisheries and recreation were also considered, cost-effectiveness of coral reefs for coastal defence purposes is high. In addressing coastal erosion and flooding, structural engineering options include artificial barriers constructed to diminish wave action out at sea, barriers on the beach and groynes out to sea. However these measures are costly – for a 500 m stretch of coast the cost of seawall construction can be US$40,000 – 80,000, plus annual maintenance costs. Further, tourism is dependent on natural beauty and aesthetic values, which such artificial barriers will affect adversely, whereas careful reef restoration can be an added attraction for divers and snorkelers.

The project is also cost effective in that through the component on knowledge distillation and dissemination, and capacity building there will be multiple add-on impacts for the WIO region as a whole. A manual on reef restoration has already been produced by Nature Seychelles; and as part of the scaling up of activities this will be revised through the project to provide a resource for the region. The regional approach is a major aspect of ensuring the cost-effectiveness of the project, through the sharing of experience, knowledge, research facilities, and of other resources.

During further formulation of the project document, a more detailed cost effectiveness analysis will be undertaken, comparing the proposed resource allocation with measurable outcomes to other options, in order to validate costs, benefits and effectiveness.

E. *Describe how the project is consistent with national or sub-national sustainable development strategies, including, where appropriate, national or sub-national development plans, poverty reduction strategies, national communications, or national adaptation programs of action, or other relevant instruments, where they exist. If applicable, please refer to relevant regional plans and strategies where they exist.*

The proposed project is fully consistent with the national development policies and associated strategies, programmes of action and other instruments of each country, and well as to relevant regional strategies and agreeements.

It will support implementation of the National Climate Change Action Plans of both countries and, in particular, efforts to prepare for adaptation in line with the recommendations of the UNFCCC and the Kyoto Protocol. The INDC's for each country indicate priority adaptation actions to be undertaken and the project will support and respond to many of these; coral reef restoration/farming is specifically mentioned as an adaptation measure in the INDC for Mauritius[55]. Beach erosion is a significant problem in both countries, and the project is consistent with initiatives identified to address this.

[54] Ferrario F, Beck MW, Storlazzi CD, Micheli F, Shepard CC, Airoldi L. 2014. The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. Nature Communications 5.

[55] Government of Mauritius 2015. Intended Nationally Determined Contribution for the Republic of Mauritius

As is the case with other SIDS, both countries are placing emphasis on the development of an "Ocean" or "Blue" economy which will depend on the sustainable exploitation of coastal and marine resources; coral restoration is consistent with this in that in addition to ensuring future survival of coral reefs and the ecosystem services that they provide, it has the potential to provide livelihoods and income. Both countries have produced or are producing "Road Maps" for the development of their "ocean" and "blue" economies, and in both countries, mariculture is a key element.

The project will also contribute to progress towards international commitments under the Convention on Biological Diversity and achieving objectives and targets laid out under the National Biodiversity Strategies and Action Plans (NBSAPs) of each country, and in achieving the Sustainable Development Goals.

Additionally, the project will contribute to the implementation of the following national and regional policies, strategies and programmes:

Seychelles:

- Seychelles National Climate Change Strategy, 2009: the project is consistent with:
    - Objective 1 - to advance understanding of climate change, its impacts and appropriate responses;
    - Objective 2 - to put in place measures to adapt, build resilience and minimize vulnerability to the impacts of climate change, including: developing and implementing pilot scale effective adaptation measures and tools at community level, including coastal ecosystem restoration approaches; demonstrating of adaptation technology implementation, with focus on nature-based methods; enhancing the management of coral refugia and resilient areas; and exploring and developing micro-insurance, risk reduction and financing mechanism and private sector financing options for adaptation;
    - Objective 5 - to build capacity and social empowerment at all levels to adequately respond to climate change; promote ongoing stakeholder/community involvement in decision making regarding climate change education, awareness and training at national and district level; and develop communication and awareness strategies to engage the community in responding and adapting to climate change.
- Environment Management Plan of Seychelles (EMPS 2011-2020 particularly the thematic areas on biodiversity, fisheries and marine Resources processes, and tourism and aesthetics
- Seychelles Mariculture Master Plan; although focusing primarily on fish and sea cucumbers, the principles and approaches identified through this are likely to be applicable to coral farming as well.
- UN Country Programme Document for Seychelles 2007 - 2010

Mauritius

- Climate Change Information, Education and Communication Strategy and Action Plan 2014, and National Climate Change Adaptation Policy Framework 2013
- National Environmental Policy 2007, which defines the overarching environmental objectives and strategies for the country,
- National Tourism Policy (2005/6),
- ICZM Framework (2010)

- Reef Environment Conservation Plan (2015), which calls for active reef restoration given the declining health of coral reefs and recommends that further work builds on the experiences gained to date, that local communities and other stakeholders are involved, and that collaboration and co-operation between the various organisations are essential if measures are to be effective. The Japan International Cooperation Agency (JICA) project *Capacity Development on Coastal Protection and Rehabilitation in the Republic of Mauritius*[56] this project undertook an analysis of coastal erosion in the RM and developed coastal management plans for 14 sites in Mauritius, with guidelines for reef conservation and coral farming as one option for erosion control.

Regional

- As SIDS, the Seychelles and Mauritius are committed to meeting the sustainable development goals and priorities of the Barbados Programme of Action and the Mauritius Strategy for Implementation (MSI)[57]; the project will contribute to meeting the goals of these programmes.
- The project will contribute to meeting the commitments of both countries under the Nairobi Convention, particularly the recommendations relating to marine and coastal biodiversity developed at the 8th Conference of the Parties held in June 2015[58].
- The project will support the Western Indian Ocean Coastal Challenge (WIOCC)[59], which is a Global Island Partnership (GLISPA) initiative led by Seychelles and launched in 2012 that promotes actions for climate resilient development that achieves effective conservation of biodiversity, enhanced livelihood and economies for greater social security among coastal communities.
- The project will also complement and assist in meeting the goals of a number of regional projects and programmes as described in Section G.

F. Describe how the project meets relevant national technical standards, where applicable, such as standards for environmental assessment, building codes, etc., and complies with the Environmental and Social Policy of the Adaptation Fund.

All UNDP supported donor funded projects are required to follow the mandatory requirements outlined in the UNDP Programme and Operational Policies and Procedures (UNDP POPP). This includes the requirement that all UNDP development solutions must always reflect local circumstances and aspirations and draw upon national actors and capabilities. The project will comply with the Environmental and Social Policy of the Adaptation Fund as described in Section L. During preparation of the full proposal, the individual interventions will be assessed and adapted where necessary to ensure full compliance.

In addition, all UNDP supported donor funded projects are appraised before approval. During appraisal, appropriate UNDP representatives and stakeholders ensure that the project has been designed with a clear focus on agreed results. The appraisal is conducted through the formal meeting of the Project Appraisal Committee (PAC) established by the UNDP Resident

[56] JICA 2015. Reef Environment Conservation Plan. Chap. 6. Final Report. The Project for Capacity Development on Coastal Protection and Rehabilitation in the Republic of Mauritius

[57] National Report of the Republic of Mauritius; Third International Congress on Small Island Developing States, September 2014, Western Samoa. UNDP/UNDESA

[58] http://www.unep.org/NairobiConvention/Meetings/COP8/index.asp

[59] http://glispa.org/11-commitments/32-western-indian-ocean-coastal-challenge-wio-cc
https://sustainabledevelopment.un.org/partnership/?p=8020

Representative. The PAC representatives are independent in that they should not have participated in the formulation of the project and should have no vested interest in the approval of the project. Appraisal is based on a detailed quality programming checklist which ensures, amongst other issues, that necessary safeguards have been addressed and incorporated into the project design.

In addition, regional technical standards will be developed for the establishment of coral propagation nurseries and transplantation activities, and the selection of the locations of these activities will be guided by criteria developed through the project which will take account of zoning, MSP and MPA regulations and other relevant requirements in each country. Where required, EIAs will be conducted prior to implementation of activities.

For the implementation of the project, the following legislation in each country has relevance:

Seychelles

- The Environmental Protection Act 1994 provides for the protection, preservation and improvement of the environment and for the control of hazards to human beings, other living creatures, plants and property.
- Environmental Impact Assessment (EIA) is dealt with under the Environmental Protection (Impact Assessment) Regulations [EP (EIA) Regulations]. The legislation requires that an EIA study be carried out and that an environmental authorisation is obtained if any person commences, proceeds with, carries out, executes or conducts construction/ development. This legislation is being strengthened under the Adaptation Fund, *Ecosystem Based Adaptation to Climate Change* project with a view to improving climate change risk management and strengthening the public consultation process.
- Relevant guidelines and policies in the Mariculture Master Plan would be adhered to.

Mauritius

- The Environment Protection Act (EPA) 2002 (amended 2008) covers pollution prevention measures, EIA and development of environmental standards and guidelines.
- The Fisheries and Marine Resources Act 2007 (amended 2008) provides for: the management, conservation, protection of fisheries and marine resources and protection of marine ecosystems, and covers the establishment of aquaculture enterprises and MPAs. The Fisheries Division is the responsible authority for placement of structures at sea and would ensure compliance with its regulations.
- The 2009 draft proposed bill on Environmentally Sensitive Areas (ESAs) Conservation and Management and the associated ESA study, the recommendations of which address the conservation and sustainable use of biodiversity and ecosystem services in the coastal zone, with particular reference to coral reefs and other threatened habitats, will be assessed as part of the forthcoming UNDP/GEF project *Mainstreaming biodiversity into the management of the coastal zone in the Republic of Mauritius,* which could result in relevant amendments to legislative approaches.
- Relevant guidelines and policies in the Aquaculture Master Plan would be adhered to.

G. *Describe if there is duplication of the project with other funding sources, if any.*

There is no duplication of the proposed project with other initiatives or funding sources. However, the project will complement a number of on-going and planned initiatives which will result in added value and complementarity. Note that there is no overlap with projects

underway or planned for the Seychelles Outer Islands, as the focus of the coral restoration is the granitic inner islands, where reef restoration is most feasible and cost effective.

Relevant on-going and upcoming initiatives are described in the following table:

Project & Funding Institution	Objective	Potential Synergies
Seychelles - Ongoing Projects		
GOS/UNDP/GEF Seychelles *Protected Areas Finance Project* 2016-2020	To improve the financial sustainability and strategic cohesion of Seychelles protected area system, while addressing emerging threats to biodiversity	This will have close synergy with the proposed project, in relation to find ways to make interventions financially sustainable. In Seychelles, many of the restoration sites are likely to be within protected areas and will benefit from work undertaken through this finance projects. Both projects will be working with the tourism industry and will be able to build on shared lessons learned and activities.
GOS/Adaptation Fund, *Ecosystem Based Adaptation to Climate Change* 2012-2018	To incorporate ecosystem based adaptation into the country's climate change risk management system to safeguard water supplies, threatened by climate change induced perturbations in rainfall and to buffer expected enhanced erosion and coastal flooding risks arising as a result of higher sea levels and increased storm surge.	This project takes a broader approach than the restoration project to restoring ecosystem functionality and enhancing ecosystem resilience, addressing watershed and coastal processes in order to secure critical water provisioning and flood attenuation ecosystem services from watersheds and coastal areas. One of the activities has direct relevance to the new project: a reef restoration activity involving a soft-engineering approach at North-East Point, Mahe; this will provide experience relevant to the design of the new project.
UNEP-EU *Building capacity for coastal ecosystem-based adaptation in SIDS*	To strengthen the climate change resilience and adaptive capacity of SIDS, which have high dependence on coastal ecosystems	Includes site projects in Seychelles and Grenada; the Seychelles component involves the SNPA and coral farming activities in the Curieuse Marine Park, Praslin
GEF SGP – Anba Lao (NGO); Testing methods of human induced resilience of socio-economically important coral reef sites within the Seychelles Marine National Parks 2016 -18	To promote recovery of coral reefs that are presently classed as non-resilient.	This project is looking at differential survival of coral recruits at different locations which is directly relevant to proposed project activities in Seychelles and will provide important knowledge that can be used when considering survival of transplanted corals.
UNDP-EU GCCA+ project	To ensure that the people, economy and environment of Seychelles are able to adapt to and develop resilience to climate change and its effects, thereby safeguarding the sustainable development of Seychelles	Project activities focus on La Digue island. Integrated shoreline management will result in enhanced shoreline protection and potentially contribute to stabilization of offshore reefs. There are no coral restoration activities under the project.
TNC *SeyCCAT Seychelles Conservation and*	To provide a sustainable flow of funds - which supplements existing and future funds from any	SeyCCAT will be used for activities to work towards the expansion of the MPA network (planned addition of 400,000 km2 new MPAs).

Project & Funding Institution	Objective	Potential Synergies
*Climate Adaptation Trus*t 2016 onwards	sources - to support the long-term management and expansion of the Seychelles system of protected areas and other activities which contribute substantially to the conservation, protection and maintenance of biodiversity and the adaptation to climate change	Coral restoration is one of 8 identified priorities for SeyCCAT funding but the SeyCCAT Board expects that any funded projects will add incremental value, be synergistic and not duplicate any existing initiatives.
GOS/GEF/TNC Seychelles Marine Spatial Planning (MSP) initiative 2014-2020	To develop and implement an integrated marine plan to optimise the sustainable use and effective management of the Seychelles marine environment while ensuring and improving the social, cultural and economic wellbeing of its people.	The MSP Initiative is an integrated, multi-sector approach to address climate change adaptation, marine protection and support the Blue Economy and other national strategies. It will demarcate areas designated for fishing, tourism and recreation, biodiversity conservation and cultural heritage, and a range of industries, taking into account the need for MPAs; it will be particularly relevant to the coral restoration project in relation to the selection of sites for nurseries and transplantation
Seychelles - Upcoming projects		
UNDP/GEF PIF – to be prepared for a Reef to Ridge project	To address the 'whole island' priorities of improved management and conservation of upland forest and agricultural ecosystems as well as coastal and marine ecosystems in the Seychelles to produce global benefits in terms of conservation of globally significant biodiversity and the effective management of the large marine ecosystems (including coastal and near-shore marine ecosystems), and to arrest and reverse ecosystem degradation	The project has a focus on addressing land-based threats to coastal and near-shore marine ecosystems, including particularly reducing land-based threats to offshore coral reefs. The project will aim to enhance protection of selected resilient reef areas from further threats, subsequent to assessment of target reef areas that remain viable following the 2016 coral bleaching event.
USAID/Nature Seychelles	Potential development of a coral reef research centre	Potential 3rd phase of Reef Rescuers Project – this would be directly relevant to the proposed project in that it would provide a much needed research base in the Seychelles
Mauritius – on-going		
GOM/UNDP/AFB *Climate Change Adaptation Programme in the Coastal Zone of Mauritius*: 2012-2018. Implemented by MOESDDBM.	To increase climate resilience of communities and livelihoods in coastal areas of Mauritius.	This project is aimed at combating beach erosion and flood risk at selected sites with different forms of hard infrastructure and natural protection mechanisms, and helping to ensure that all policies, strategies, plans, and regulations recognize climate change impacts in the coastal zone over the next 50 years. It will directly complement the coral restoration project in that it will provide an enabling environment for the work to be undertaken in terms of policy and will sensitize the public to the urgency of climate change. The project has a component on reef and seagrass

Project & Funding Institution	Objective	Potential Synergies
		restoration at Mont Choisy, the results of which will provide useful experience to feed into the new project.
Mauritius - upcoming		
UNDP/GEF FSP *Mainstreaming biodiversity into the management of the coastal zone in the Republic of Mauritius*. Approved; anticipated to start 2017	To mainstream the conservation and sustainable use of biodiversity and ecosystem services into coastal zone management and into the operations and policies of the tourism and physical development sectors in the Republic of Mauritius through a 'land- and seascape wide' integrated management approach based on the Environmental Sensitive Areas' (ESAs) inventory and assessment.	This project directly complements the new project in that it will include activities that will contribute directly to the passive conservation of coral reefs (e.g. improved management of marine protected areas; a "reef-to-ridge" approach to coastal planning; sustainable management of tourism activities) and will also help to create the environmental conditions (good water quality, reduced sediment run-off, reduced damage from boats and tourism) that will facilitate the survivorship of transplanted corals.
Smart Agriculture Project. Mauritius Chamber of Commerce funded by Agence Francaise de Developpement	To reduce the use of pesticides at national level.	The project aims at controlling the use of pesticide, sensitise agriculturalists about the impact of the use of pesticide; this will reduce land-based pollution and ultimately improve lagoon water quality.
EU/Global Climate Change Alliance (GCCA) + Initiative supporting climate smart agriculture for small holders in Mauritius	To increase the resilience of non-sugar small holders to climate change by building their capacity to develop and sustain climate smart agriculture practices and techniques in Mauritius.	The project will build institutional capacity to promote the adoption of climate smart agricultural practices that make minimal use of agrochemicals (fertilisers and pesticides) in crop production, and will thus complement this project as it will help address one of the key causes of coral reef degradation. In reducing the amount of agrochemicals being washed into the sea this project will create the required enabling lagoonal environment for coral restoration, and will thus increase likelihood of success of the restoration project.
Regional - ongoing		
COI – EU *The coastal, marine and island specific biodiversity management in East African and Indian Ocean states*:. 2014-2018	Strengthening national and regional capacities, at all levels, in managing coastal, marine and island-specific biodiversity resources and ecosystems.	This project has components on (1) improving and harmonising policies and institutional framework; (2) education, awareness-raising and communications particularly aimed at decision makers; (3) improving mechanisms for sharing data relating to biodiversity; (4) establishment of regional biodiversity thematic centres; and (5) a small grants programme for projects relating to biodiversity and sustainable livelihoods. Many aspects of the work undertaken through this will be of value to and support the coral restoration project. In particular the WIO Coral Reef Monitoring Network which is being established through this project, will provide a regional framework

Project & Funding Institution	Objective	Potential Synergies
		and long-term monitoring of the restored reef
COI/FFEM - *Projet de Gestion Durable des Zones Côtières des pays de la COI – Indian Ocean Commission* (GDZCOI). 2014-201&	Gathering and disseminating experiences and progress in ICZM and protection of marine and coastal biodiversity in Mauritius (Rodrigues), Madagascar and Comores	Lesson learned and knowledge gathered through the GDZCOI project, with respect to coral reefs, will potentially be of value to the new project
UNDP/GEF *Western Indian Ocean Large Marine Ecosystems Strategic Action Programme Policy Harmonisation and Institutional Reform* (WIO LME SAPPHIRE): 2015-2020	To support and assist government institutions and intergovernmental bodies in the region to implement the activities required to deliver the Stragetic Action Programme and to ensure sustainability of efforts and actions toward long-term management of activities within the LMEs and the sustainability of associated institutional arrangements and partnerships.	This large regional project includes components on policy harmonisation and management reforms, capacity building, integrating the ecosystem-based management approach into Local Economic Development Plans at selected pilot sites; ecosystem-based practices among artisanal fisheries. It will contribute to providing an appropriate policy and governance context for coral restoration in the region
WIOMSA/MASMA– *Emerging Knowledge for Local Adaptation - Modifying the Symbiosis of Knowledge and Governance for the Adaptation of Western Indian Ocean Coastal Communities at Risk from Global Change.* 2014-2017.	Assess emerging knowledge on coastal vulnerability to inform and guide climate change adaptation at local government level; Evaluate the capacity of local government to build resilience; Devise strategies and make recommendations to strengthen knowledge management systems relating to vulnerability to climate change; Build capability of local government to implement this emerging knowledge; Test the applicability of improved knowledge systems to improve local government ability to use emerging knowledge and monitor their uptake	This project involves Kenya, Mauritius, Mozambique, and South Africa, and will contribute to work underway in the region to build capacity for adaptation with a focus on local government; the involvement of MOI in this project will mean that knowledge and lessons learned from this project can be fed into the coral restoration project at the design stage
Regional- upcoming		
WIO-SAP *Partnerships for the Implementation of the Strategic Action Programme for the Protection of the Western Indian Ocean from Land Based Sources and Activities*. 2nd Phase of WIO-LAB programme	To reduce impacts from land-based sources and activities and sustainably manage critical coastal-riverine ecosystems through the implementation of the WIO-SAP priorities.	This project will address water pollution and degradation of critical habitats from land-based impacts and will therefore be critically important to the new coral restoration project, given that water quality will be a key issue to address. The WIOSAP project will have excellent synergies with the coral restoration project as it aims to calculate environmental flows and address compliance with effluent standards which ultimately will result in better lagoon water quality.

H. *If applicable, describe the learning and knowledge management component to capture and disseminate lessons learned.*

The proposed project has a comprehensive specific learning and knowledge management component (Component 3). This is described fully in Section A above.

I. *Describe the consultative process, including the list of stakeholders consulted, undertaken during project preparation, with particular reference to vulnerable groups, including gender considerations, in compliance with the Environmental and Social Policy of the Adaptation Fund.*

In the course of preparing the Concept, discussions and meetings were held with the following organisations, and there was extensive consultation by e-mail with key individuals:

Mauritius: MOI, AFRC, University of Mauritius, Eco-Mode, MOEMRFSOI, MOESDDBM, Ministry of Finance, WiseOceans

Seychelles: Nature Seychelles, Ministry of Finance, MECCE, SNPA, MCSS,

A meeting of the Regional Steering Committee was held in Seychelles, July 2016, to review the draft concept, the notes of which are included at Annex 2. Discussions were also held with the regional organisations COI and CORDIO, and the consultant participated in the reef restoration sessions at the 13th International Coral Reef Symposium and was thus able to benefit from meetings with scientific experts on this topic to gain an understanding of the current global scientific perspective on coral restoration.

A full stakeholder analysis will be undertaken during preparation of the full Project Proposal to be submitted to the Adaptation Fund, to ensure that vulnerable groups are addressed. The full range of stakeholders will ultimately be involved, including in particular coastal communities, who in Mauritius have already expressed an interest in taking part in coral restoration activities[60], and the tourism sector. In Mauritius, the involvement of hotels is likely to be co-ordinated by the hotel association, AHRIM.

A full gender analysis will also be undertaken. Both countries are taking significant steps to improve gender equality; for example, in Mauritius the Local Government Act of 2011 stipulates that at least one third of candidates for the municipal council and village council elections must be of either gender. As a result the share of women on municipal councils rose from 13.5% in 2001 to 36.7% in 2012, and on Village Council elections, from 2.8% in 1998 to 25.4% in 2012.

J. *Provide justification for funding requested, focusing on the full cost of adaptation reasoning.*

This section summarizes the baseline and additionality reasoning for the project. This will be further expanded and articulated for each project component in the full project proposal submitted for final approval by the Adaptation Fund Board. The full proposal will outline baseline development activities that are currently financed out of government funds, traditional ODA and

[60] Nazurally, N. and Rinkevich, B. 2014. A Questionnaire-based Consideration of Coral Farming for Coastal Socio-economic Development in Mauritius. *Western Indian Ocean J. Mar. Sci.* 12 (1): 47-56.

the private sector and further explain the value added of outcomes financed with resources from the Adaptation Fund.

Components 1 and 2. Enhancement of food security and reduction of risks from natural disasters through the restoration of degraded reefs in Mauritius and Seychelles

Baseline (without AF Resources)

In both countries, as in all SIDS, the main climate change threats, confirmed in many cases by meteorological observations, are changes in rainfall patterns leading to flooding and landslides, extended periods of drought, increases in sea temperature, changes in acidity which weakens the carbonate structure of reefs, and increases in storms, storm surges and sea level rise. Escalating coastal erosion and flooding events are already being felt in both countries. Between 1998 and 2007, mean sea level rose by 2.1mm per year in Mauritius and since then has been rising by around 3.8 mm/year; average temperature has risen by 0.74^{o}C when compared to the 1961-90 mean; flash floods in 2008 and 2013 resulted in loss of lives; and there has been an increase in the frequency of extreme weather events, heavy rains and storms[61]. It is predicted that half of the beaches on Mauritius could disappear by the middle of the century, which would be disastrous for the tourism industry[62]. Rates of sea level rise around Mahe in Seychelles have been put at 1.46 mm a year[63]. It has been estimated[64] that globally, without adaptation, a 1 m rise in sea level will produce a 14-fold increase in flooding compared to the situation without sea-level rise. Even under a lower sea-level rise scenario of 38 cm by the 2080s, the global increase in flooding will be seven-fold compared with the situation without sea-level rise. Shore wave heights are limited by water depths, so with the increase in sea level, the height of waves will also increase.

Flooding in the coastal areas of both countries is already increasing, affecting many of the most populated locations given that these are concentrated on the low-elevation coastal areas, and there are predicted to be large relative increases in flooding in the small island region of the Indian Ocean[65]. In both countries, the impacts of cyclones and tropical storms have intensified[66] and this trend is projected to continue: Mauritius lies in the South Western Indian Ocean cyclone basin and, although lying just to the north of this, the granitic islands of the Seychelles are affected by the associated extreme rainfall and wave swells[67]. There is also evidence that wave action in coastal areas has increased as a result of climate change, with sea level rise exacerbating coastal erosion as the waves reach further inland at high tide.

[61] http://environment.govmu.org/English/Climate_Change/Pages/Climate-Change.aspx
[62] Mauritius TNA
[63] Chang-Seng, D. 2007. Climate Change Scenario Assessment for the Seychelles, Second National Communication (SNC) under the United Nations Framework Convention on Climate Change (UNFCCC), National Climate Change Committee, Seychelles.
[64] Nicholls, R.J. & Hoozemans, F.M.J. 2002. *Global Vulnerability Analysis*. In Schwartz, M. (Ed). Encyclopedia of Coastal Science, Kluwer Academic Publishers.
[65] Nicholls, R.J. & Hoozemans, F.M.J. 2002. *Global Vulnerability Analysis*. In Schwartz, M. (Ed). Encyclopedia of Coastal Science, Kluwer Academic Publishers.
[66] Chang-Seng, D. 2007. Climate Variability and Climate Change assessment for the Seychelles, Second National Communication (SNC) under the United Nations Framework Convention on Climate Change (UNFCCC), National Climate Change Committee, Seychelles.
[67] The Seychelles National Climate Change Committee, 2009. Seychelles National Climate Change Strategy.

Mauritius is particularly vulnerable. It is ranked 13th in terms of overall disaster risk (measured according to the extent that natural hazards - floods, droughts, storms, earthquakes and sea level rise - coincide with a vulnerable society) on the World Risk Index[68] (on this set of parameters it is at highest risk of all the African nations) and 7th on the list of countries most exposed to natural hazards. Seychelles is considered less at risk during to its favourable socio economic status (it ranks 153rd) but lacks the ability to reduce overall risk: since the beginning of the 1990's, Official Development Assistance (ODA) flows have fallen by over 90% and this has placed a financial burden on the Government's budget. Furthermore, of the 86% of the Seychelles population living on Mahe, around 60% live in coastal areas; the remaining 14% of the population live mostly on Praslin and La Digue and almost all live in the narrow coastal plains. Thus around 75% of the population may be considered vulnerable to climate change risks and in need of adaptation measures.

In 2011, insured losses from natural disasters, especially coastal (and riverine) hazards, reached globally US$105 billion, an all-time high. The Indian Ocean, one of the most disaster-prone regions, is particularly vulnerable to storms and wave surge, coastal flooding and sea-level rise.

Both countries have developed comprehensive action plans and strategies to adapt to the negative environment and socio-economic impacts of climate change, and also to protected and sustainably manage those ecosystems, such as coral reefs, that provide services that will provide concrete adaptation measures for climate change.

Mauritius has a Climate Change Action Plan in place and has invested significant resources in starting to develop appropriate adaptation and mitigation measures, and planning is in place for the introduction of a Climate Change Bill. A National Climate Change Adaptation Policy Framework and a Technology Needs Assessment (TNA) identifying and prioritizing relevant technologies for adaptation to and mitigation of climate change impacts has been prepared that highlights the importance of adaptation to Mauritius. A Climate Change Information Centre has been set up, with the support of UNDP, the Inter-Regional Technical Support Component of the Africa Adaptation Programme and Japan International Cooperation Agency (JICA) funded by the Government of Japan[69].

In both countries, work is underway to strengthen the management of and expand the network of MPAs, with the support of the forthcoming GEF project, and this will help protect coral reefs *in situ*. The recently completed GOS-UNDP-GEF project 'Strengthening Seychelles' Protected Area System through NGO management modalities'

In Seychelles, progress will be made toward adaption as a result of the Seychelles MSP Initiative which will produce a national multi-use marine spatial plan that guide the strategies and interventions to be undertaken through the Seychelles Conservation & Climate Adaptation Trust (SeyCCAT). SeyCCAT will ultimately lead to designation for some 30% of the EEZ as protected areas, half of which is planned to be strict no take zones.

However, the costs of implementing all the adaptation measures are extremely high and for both countries, further active measures and financial and technical support are required to ensure

[68] 2015 World Risk Index, UNU-EHS and the Alliance Development Works/Bündnis Entwicklung Hilft (BEH) http://www.worldriskreport.org/

[69] http://environment.govmu.org/English/Climate_Change/Pages/CCIC.aspx

that life and property are protected from disaster and that food security and livelihoods are assured.

Although coastal erosion is being addressed in both countries this tends to be through the continual upgrading of infrastructure (e.g rock armouring, sea-walls, break-water/piers, groynes) and through reclamation, particularly in Seychelles. This results in a fragmented approach, with the tourist industry covering costs to protect beaches, government financing the protection of public infrastructure, and private owners safeguarding their own investments. In extreme cases, infrastructure such as roads has to be moved away from the shoreline. Under the business as usual scenario, coastal erosion is thus likely to continue, affecting public and private/hotel beaches and impacting on the recreational enjoyment of the public and the willingness of tourists to both countries. The potential impact of coastal erosion on tourism in Mauritius is already of concern to the government and efforts are underway to reduce this but these are costly and not necessarily effective.

As reefs decline, fewer tourists will come for the purpose of diving and snorkeling, and already the government is promoting a strategy of greater diversification of attractions.

Flooding of coastal communities will continue, artisanal fish catches will continue to decline and food security will be jeopardized. Reefs will be protected within the MPAs for their biodiversity values and for tourism and fisheries purposes, but MPAs are not always in locations where the reefs can provide buffering services to protect coastal infrastructure and communities, and the management of the MPAs rarely takes adaptation to climate change and food security into account.

Both countries have undertaken pilot activities in coral restoration, but these have been uncoordinated and have often lacked sustainability and adequate resources for maintenance and monitoring. Existing adaptation efforts have not adequately incorporated EbA approaches; in the Seychelles, the Government has recognized that this is a shortcoming and has identified EbA it as its priority for adaptation fund financing—seeking to put in place the requisite management systems.

Additionality (with AF Resources)

With AF financing, activities under the proposed project will result in restored degraded reefs in key locations in Mauritius and Seychelles that ultimately will have the outcomes of:

- More effective shore protection and a buffering service against erosion and floods
- Enhanced economic activities, leading to improved livelihoods and greater food security as a result of increased fish catches for coastal communities, and increased enjoyment of reefs for tourists, leading to greater employment for local people through the tourism industry

The additional resourcing will provide an opportunity to upscale initiatives significantly to restore degraded reefs, and to ensure that they provide improved livelihoods for local communities and in the long-term benefit the national economies of both countries.

The sites where reefs have been restored may well become visitor destinations in their own right, attracting scientists, tourists and the general public. These efforts are expected to increase public awareness of the coastal adaptation issues in Seychelles and an understanding of cost-effective solutions to climate change impacts.

Component 3. Knowledge management, training and sensitization to build regional capacity for sustainable reef restoration

Baseline (without AF Resources)

Institutional capacity for coral reef restoration will remain insufficient, with limited technical knowledge. There will continue to be predominantly small scale restoration efforts will continue, wasting financial and human resources on initiatives that are not based on best available science and sustainable approaches - efforts will remain fragmented and uncoordinated. No systematic knowledge management system with adequate ecosystem based adaptation elements will be developed and instituted. Up-scaling of best practices will therefore be unlikely to happen.

Additionality (with AF Resources)

With the financing rendered through the Adaptation Fund, decision makers, local communities and the general public will have a good understanding of the coral reef restoration and how it will contribute to comprehensive adaptation measures, which will increase the likelihood that both countries will succeed in their adaptation efforts. Institutions will be strengthened in skills and capacity for reef restoration, and knowledge generated and shared.

K. *Describe how the sustainability of the project outcomes has been taken into account when designing the project.*

The development of a business plan for each reef restoration initiative is a key element in ensuring sustainability. In particular, the project will look at opportunities to use Corporate Social Responsibility (CSR) funding. In Mauritius, under the Finance Act 2015, all companies must put 2% of their chargeable income of the preceding year towards a CSR Programme, which must have objectives of benefiting Mauritian communities. Similarly, in Seychelles, there is a CSR contribution of 0.5% of the monthly turnover, of which half can go to an approved NGO. This means that in both countries there are opportunities to develop small scale reef restoration activities with the tourism industry using the CSR approach, although other industry partnerships might also be possible. Although there has been reluctance in the past for hotels to contribute to conservation initiatives, the growing number of hotels already involved suggests that this is changing, perhaps as recognition grows that many tourists are disappointed by the diving and snorkelling experiences now available in these countries.

Development of linkages with related projects will help to further develop and ensure sustainability. For example, the COI ISLANDS project currently in its second phase but due to complete in 2017, includes a number of activities related to coral reef monitoring including the establishment of a regional coral reef facility and development of the Coral Reef Information System (CRIS).

The long-term sustainability of active reef restoration efforts can only be ensured if coral recruitment is enhanced, either by the transplants becoming an additional source of recruits or by the attraction of recruits from elsewhere due to the settlement cues associated with the

presence of corals[70]. This indicates the importance of establishing a permanent monitoring programme at each restoration site to develop a full understanding of the evolution of the reef.

L. *Provide an overview of the environmental and social impacts and risks identified as being relevant to the project.*

Environmental impacts and risks

Coral reefs are recognised for their high conservation value, and although this project involves manipulation of corals, this is for the direct purpose of improving their health and future survival.

Reef restoration is however, at a comparatively early stage of research and development, and the project thus is at some risk of failure on account of the vulnerability of corals to factors beyond the control of the project managers and stakeholders. Nevertheless, an understanding is developing of appropriate mitigation approaches and these will be used. A significant risk is coral mortality at nurseries and transplant sites as a result of future bleaching events, predator outbreaks and other major negative impacts. Mitigation will include:

- Selection of species that are proving to be more resilient/resistant to such events (e.g. species that have survived previous bleaching events).
- Development of rigorous long-term maintenance and cleaning programmes to remove predators and fouling organisms
- Careful selection of sites that are protected from human disturbance, and less vulnerable to land-based sources of pollution
- Selection of a number of transplant and nursery sites, thus providing greater insurance (if one site fails, others may survive)

Social impacts and risks

Coral restoration is, by its nature, a labour-intensive and costly activity and requires specific skills. There is a risk that skills and capacity will be inadequate to sustainable manage the nurseries and transplantation sites. Mitigation will include:

- Intensive training courses for all those involved in establishing and maintaining nursery and transplants sites
- Use of locally sourced and recycled materials and equipment for nurseries and transplanting activities
- Rigorously planned and executed maintenance and monitoring schedules
- Sensitisation and awareness-raising of adjacent communities and their involvement in the planning and implementation of the project, to ensure public understanding of the challenges of coral restoration
- Development of business plans for restoration work in each country, to ensure a full understanding of the costs involved

[70] Montoya-Maya1 PH, Smit KP, Burt AJ, Frias-Torres S. (2016). Large-scale coral reef restoration could assist natural recovery: a case study in Seychelles, Indian Ocean. *Nature Conservation*

Checklist of environmental and social principles	No further assessment required for compliance	Potential impacts and risks – further assessment and management required for compliance
Compliance with the Law	Project will be undertaken in compliance with domestic law of Mauritius and Seychelles and with all international law	
Access and Equity	Project will provide fair and equitable access to benefits in a manner that is inclusive and does not impede access to basic health services, clean water and sanitation, energy, education, housing, safe and decent working conditions, and land rights. It will not exacerbate existing inequities, particularly with respect to marginalized or vulnerable groups.	
Marginalized and Vulnerable Groups	Project will avoid imposing any disproportionate adverse impacts on marginalized and vulnerable groups including children, women and girls, the elderly, displaced people, refugees, people living with disabilities, and people living with HIV/AIDS.	
Human Rights	Project will respect international human rights.	
Gender Equity and Women's Empowerment	Project will be designed and implemented so that women and men (a) are able to participate fully and equitably; (b) receive comparable social and economic benefits; and (c) do not suffer disproportionate adverse effects.	
Core Labour Rights	Project will meet the core labour standards as identified by the International Labor Organization.	
Indigenous Peoples	N/A – no indigenous peoples in the countries concerned	
Involuntary Resettlement	Project will not cause any involuntary resettlement	
Protection of Natural Habitats	The project will not involve unjustified conversion or degradation of critical natural habitats, including those that are (a) legally protected; (b) officially proposed for protection; (c) recognized by authoritative sources for their high conservation value, including as critical habitat	Potential risks and impacts are discussed in the text above this table
Conservation of Biological Diversity	Project will be designed and implemented in a way that avoids any significant or unjustified reduction or loss of biological diversity or the introduction of known invasive species.	Potential risks and impacts are discussed in the text above this table
Climate Change	Project will not result in any significant or unjustified increase in greenhouse gas	

	emissions or other drivers of climate change.	
Pollution Prevention and Resource Efficiency	Project will be designed and implemented in a way that meets applicable international standards for maximizing energy efficiency and minimizing material resource use, the production of wastes, and the release of pollutants.	Potential risks and impacts are discussed in the text above this table
Public Health	Project will be designed and implemented in a way that avoids potentially significant negative impacts on public health.	
Physical and Cultural Heritage	Project will be designed and implemented in a way that avoids the alteration, damage, or removal of any physical cultural resources, cultural sites, and sites with unique natural values recognized as such at the community, national or international level; it will also not permanently interfere with existing access and use of such physical and cultural resources.	
Lands and Soil Conservation	N/A - project does not involve productive lands or land that provides valuable ecosystem services.	

PART III: IMPLEMENTATION ARRANGEMENTS

A. *Describe the arrangements for project management at the regional and national level, including coordination arrangements within countries and among them. Describe how the potential to partner with national institutions, and when possible, national implementing entities (NIEs), has been considered, and included in the management arrangements*.

The project will be coordinated through the **UNDP Country Office in Mauritius**, which provides UNDP representation for both countries under a single UN leadership with shared programme support services.

A **Regional Steering Committee** (RSC) will be established composed of representatives of the National Steering Committees. The RSC met once during the concept stage, and will meet at least twice during the preparation phase to ensure regional aspects are taken on board and to achieve consensus, and at least annually during implementation at side events to the planned regional workshops.

A **Regional Scientific Advisory Committee** will be established composed of relevant scientists from each country, and including recognised international and regional coral reef restoration experts.

Existing regional bodies and platforms will be used where appropriate to ensure that activities undertaken through the project are appropriately co-ordinated and communicated at the regional level. These will include the Indian Ocean Commission, WIOMSA, the proposed WIO

coral reef network, and the various committees and co-ordinating bodies under the Nairobi Convention.

The **National Steering Committees** will be composed of the principal stakeholders for each country, as well as other private sector, civil society and government organisations. These Committees will meet quarterly.

In **Seychelles, t**he project will be implemented by the **Ministry of Environment, Climate Change and Energy (MECCE)** which has the mandate for environmental, climate change and energy policy and management. Other key NIE will include

- **Nature Seychelles (NS)**, an NGO that has pioneered terrestrial restoration of islands, been the recipient of GEF-funds and other large donor funded projects. NS manages the Cousin Island Special Reserve, the site of a 5,500 m^2 restored reef, and is registered as a Private Educational and Training Institute (under the Education Act);
- **Seychelles National Parks Authority (SNPA)**, which is responsible for the management of all state owned terrestrial and marine protected areas. SNPA will build on its existing coral reef restoration work and benefit from opportunities for further training for its staff.

Consideration could be given in the Seychelles to setting up a Call for Proposals to involve other NGOs and civil society groups. There is also a need for a national co-ordination mechanism so that project partners in the Seychelles can share their experiences and lessons learned as the project progresses.

In **Mauritius** the main NIE will be the **Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island (MOEMRFSOI),** which has the mandate to provide an enabling environment for the promotion of sustainable development of the fisheries sector and is responsible for the management of coastal waters and any related activities being carried out within these, and specifically the following bodies under this Ministry:

- **Mauritius Oceanography Institute (MOI)** established in 2000 to develop and strengthen oceanographic research, within the maritime zone of the Republic of Mauritius, with technical expertise and institutional capacity for both coral farming, species identification and coral genetics. MOI will lead on research activities in the project, and the development of a land-based coral nursery.
- **Albion Fisheries Research Centre (AFRC)** established in 1982 under the MOEMRFSOI, and responsible for stock assessment of marine resources, MPA management, ocean-based coral farming/restoration and long term coral reef monitoring. AFRC will lead on the development of ocean-based coral nurseries, with support from MOI.

The **UNDP Mauritius GEF Small Grants Programme (SGP)** will be tasked with working with community groups to implement local based coral restoration initiatives, under the direction of AFRC. **The Rodrigues Regional Assembly (RRA),** which established the South East Marine Protected Area (SEMPA) on Rodrigues, will coordinate efforts in Rodrigues. The **ICZM Sub Committee on Coral Reefs,** chaired by MOEMRFSOI and with representatives from AFRC, MOESDDBM, MOI, University of Mauritius, National Coast Guard, Beach Authority, Wastewater Management Authority, Tourism Authority, NGOs and Indian Ocean Commission (IOC), will play a key oversight role and provide a mechanism for sharing experiences and lessons learned among the project participants.

Project assurance - UNDP Mauritius/Seychelles will support project implementation by assisting in monitoring project budgets and expenditures, recruiting and contracting project personnel and consultant services, subcontracting and procuring equipment through Direct Project Costs being recovered. A Letter of Agreement will be signed with the Designated Authorities at project document preparation stage. UNDP Mauritius/Seychelles will also monitor project implementation and achievement of the project outcomes/outputs and ensure the efficient use of donor funds through an assigned Programme Manager.

Project Manager – (PM). He/she will be a national professional designated for the duration of the project. The PM's prime responsibility will be to ensure that the project produces the results specified in the project document to the required standard of quality and within the specified constraints of time and cost.

The PM will be supported by a core technical and support staff located at the AFRC in Mauritius and at MECCE in Seychelles, and by other supporting organizations to execute the project activities, including day-to-day operations of the project, and the overall operational and financial management and reporting.

B. *Describe the measures for financial and project / programme risk management.*

During the development of the project document, the risks will be further analysed and elaborated in a risk log. A summary of potential risks and their anticipated management is given in the following table.

No	Type	Description	Comments	Rating
1	Institutional	Policy makers prioritize economic benefits over sustainable and resilient ecosystems	Project will build capacity of the relevant national stakeholders at central and local levels. Awareness raising activities will be undertaken to ensure clear understanding of the importance of ecosystem based adapation measures.	Medium
2	Environmental	Extreme natural disasters affect confidence of local community and policy makers to adaptation measures	Further bleaching events that impact on the restoration efforts could have a negative impact on the partners. Local level implementation will provide incentives for the local communities and businesses involved to cooperate towards developing long-term resilience.	Medium
3	Environmental/ Social	Adaptation measures increase inequity	The project will ensure that the adaptation measures are gender sensitive and that at the local level that they do not limit the participation of women and the disabled as beneficiaries. As climate change will impact the livelihoods of the moist vulnerable, the project will address the needs and adaptive capacity of the groups that are most affected.	Low

C. *Describe the measures for environmental and social risk management, in line with the Environmental and Social Policy of the Adaptation Fund*.

During the preparation of the Full Project Proposal, all relevant issues related to environmental and social risks will be identified; the UNDP SESP checklist will be completed along with all related requirements under the Adaptation Fund and recommendations made for appropriate action at the project implementation stage.

D. *Describe the monitoring and evaluation arrangements and provide a budgeted M&E plan.*

The monitoring and evaluation (M&E) scheme will be applied in accordance with the established UNDP procedures throughout the project lifetime. The implementing partners, together with the UNDP Mauritius/Seychelles will ensure the timeliness and quality of the project implementation. The M&E plan will be implemented as proposed in the table below. Technical guidance and oversight will be also provided from the UNDP's Regional Service Centre in Addis Ababa as well as the RSC. Audits on the project will follow UNDP finance regulations and rules and applicable audit policies.

Project start: A *Project Inception Workshop* (IW) will be held within the first 3 months of project start with those with assigned roles in the project management, AF, UNDP CO and where appropriate/feasible, regional technical advisors as well as other stakeholders. The IW is crucial to building ownership for the project results and to plan the first year annual work plan.

Annual Progress Report. An Annual Progress Report (APR) shall be prepared by the Project Manager, shared with the RSC and submitted to the Donor. The APR will be prepared with progresses against set goals, objectives and targets, lessons learned, risk management and detailed financial disbursements.

Mid-term of the project cycle: The project will undergo an independent Mid-Term Evaluation (MTE) at the mid-point of project implementation (mid-2021). The MTE will determine progress being made toward the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation; will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation and management. The findings of this review will be incorporated as recommendations for enhanced implementation during the final half of the project's term.

Periodic Monitoring through site visits: UNDP Mauritius/Seychelles will conduct visits to project sites based on the agreed schedule in the project's Annual Work Plan to assess, at first hand, project progress. Other members of the RSC may also join these visits.

Project Closure: An independent Final Evaluation will be undertaken 3 months prior to the final RSC meeting. The final evaluation will focus on the delivery of the project's results as initially planned and as corrected after the mid-term evaluation, if any such correction takes place. The final evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefits/goals.

Type of M&E activity	Responsible Parties	Budget US$	Time frame
Inception Workshop and Report	▪ Project Manager ▪ UNDP CO, RBAP, AF	10,000	Within first two months of

			project start up
Measurement of Means of Verification for Project Progress on output and implementation	▪ Oversight by Project Manager ▪ Project team	n.a	Annually prior to APR/PIR and to the definition of annual work plans
ARR/PIR	▪ Project manager and team ▪ UNDP CO	0	Annually
Periodic status/ progress reports	▪ Project manager and team	0	Quarterly/ Annually
Mid-term Evaluation	▪ Project manager and team ▪ UNDP CO ▪ UNDP RBAP ▪ External Consultants (i.e. evaluation team)	25,000	2014
Final Evaluation	▪ Project team, ▪ UNDP CO ▪ External Consultants (i.e. evaluation team)	25,000	2021, at least three months before the end of project implementation
NEX Audit	▪ UNDP CO ▪ Project manager and team	8,000	As per UNDP regulations
Visits to field sites	▪ UNDP CO ▪ Government representatives ▪ Project Unit ▪ UNDP RSC	20,000	Yearly
TOTAL indicative COST		**US$ 85,000**	

Note: The costs indicated here do not include the costs associated with UNDP staff. Those UNDP related costs are covered by the MIE fee.

E. *Include a results framework for the project proposal, including milestones, targets and indicators.*

The results framework, with SMART indicators, their baseline and targets, will be prepared during the preparation of the Full Project Document to be submitted to the Adaption Fund for approval.

F. *Demonstrate how the project aligns with the Results Framework of the Adaptation Fund*

Project Objective(s)[71]	**Project Objective Indicator(s)**	**Fund Outcome**	**Fund Outcome Indicator**	**Grant Amount (USD)**

[71] The AF utilized OECD/DAC terminology for its results framework. Project proponents may use different terminology but the overall principle should still apply

To generate knowledge about effective restoration techniques for dissemination to other SIDS and countries within the wider region.	*(to be developed during preparation of the full project proposal)*	**5**: Increased ecosystem resilience in response to climate change and variability-induced stress	5. Ecosystem services and natural resource assets maintained or improved under climate change and variability-induced stress	789.671
To improve food security and livelihoods and mitigate disaster risk through active restoration of coral reefs degraded by coral bleaching as a result of climate change in Mauritius and Seychelles, in order to restore their essential ecosystem services.	*(to be developed during preparation of the full project proposal)*	**6:** Diversified and strengthened livelihoods and sources of income for vulnerable people in targeted areas	6.1 Percentage of households and communities having more secure access to livelihood assets	3,260.000
Project Outcome(s)	**Project Outcome Indicator(s)**	**Fund Output**	**Fund Output Indicator**	**Grant Amount (USD)**
Ecosystem services and assets provided by reefs in the form of shoreline protection, fisheries and tourism strengthened	*(to be developed during preparation of the full project proposal)*	***5:*** Vulnerable ecosystem services and natural resource assets strengthened in response to climate change impacts, including variability	5.1. No. of natural resource assets created, maintained or improved to withstand conditions resulting from climate variability and change (by type and scale)	1,630,000
Stakeholders benefiting from improved livelihoods and greater food security as a result of employment in coral restoration initiatives, improved fish catches as reefs recover; potential sale and/or export of corals from nurseries for souvenir and the aquarium trade;	*(to be developed during preparation of the full project proposal)*	**6:** Targeted individual and community livelihood strategies strengthened in relation to climate change impacts, including variability	6.2.1. Type of income sources for households generated under climate change scenario	1,630,000

greater revenue from tourism				

G. *Include a detailed budget with budget notes, broken down by country as applicable, a budget on the Implementing Entity management fee use, and an explanation and a breakdown of the execution costs.*

A broad outline of the proposed financing for the project is given in Part I. A detailed budget will be developed during the preparation of the full proposal.

H. *Include a disbursement schedule with time-bound milestones.*

The disbursement schedule will be developed in the course of preparation of the full proposal for submission to the Adaptation Fund.

PART IV: ENDORSEMENT BY GOVERNMENTS AND CERTIFICATION BY THE IMPLEMENTING ENTITY

A. Record of endorsement on behalf of the government[72] The letters of endorsement are as follows:

Mr D D Manraj, Financial Secretary, Alternate Designated Authority, Ministry of Finance and Economic Development	15 July 2016
Mr Didier Dogley, Minister, Designated Authority, Ministry of Environment, Energy and Climate Change	8 October 2015
Mr Wills Agricole Permanent Secretary Ministry of Environment, Energy and Climate Change	31 July 2015

The letters are included at Annex 3.

B. **Implementing Entity certification**

I certify that this proposal has been prepared in accordance with guidelines provided by the Adaptation Fund Board, and prevailing National Development and Adaptation Plans (Seychelles: National Climate Change Strategy, 2009 and Mauritius: Climate Change Information, Education and Communication Strategy and Action Plan 2014, National Climate Change Adaptation Framework 2013, INDC report 2015) and subject to the approval by the Adaptation Fund Board, commit to implementing the project/programme in compliance with the Environmental and Social Policy of the Adaptation Fund and on the understanding that the Implementing Entity will be fully (legally and financially) responsible for the implementation of this project/programme.	
 **Adriana Dinu,** Executive Coordinator, UNDP-GEF Implementing Entity Coordinator	
Date: *8/1/2016*	Tel. and email:+1 (212) 906-5143 adriana.dinu@undp.org
Project Contact Person: Dr Akiko Yamamoto, Regional Technical Adviser	
Tel. And Email: +251 91 250 3316, akiko.yamamoto@undp.org	

6. Each Party shall designate and communicate to the secretariat the authority that will endorse on behalf of the national government the projects and programmes proposed by the implementing entities.

ANNEX 1. Background information on reef restoration

Current global understanding of reef restoration and terminology

Ecological restoration[73] is defined[74] as the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. Two types of restoration[75] can be distinguished:

- ***passive*** restoration – management actions that remove the impact of environmental stressors that prevent the natural recovery of an ecosystem, such as establishing MPAs, reducing overfishing and pollution, etc
- ***active*** restoration which involves direct interventions such as (in the case of coral reefs) coral transplantation, removal of macroalgae (seaweeds), substrate consolidation and construction of artificial habitats.

Passive restoration is generally a less expensive option than active restoration. Even where active restoration is undertaken, passive methods are essential to remove threats and stressors that will otherwise prevent the growth and maintenance of the restored reefs, and create a high risk of failure and potential waste of resources.

Active restoration of terrestrial ecosystems is now a well-established and scientifically accepted discipline (for example for forests[76], but restoration of marine and coastal ecosystems is newer and until recently has been subject to scepticism on the part of some scientists. However, reef restoration initiatives have increased rapidly in recent years as demonstrated by the work presented at the 13th ICRS (a total of 49 papers and 23 posters).

One of the obstacles for scaling-up of reef restoration is that there has been comparatively little critical evaluation of their success, with most projects evaluated over only a short time. A review of 74 scientific papers using coral transplantation for reef restoration, found that only 4% of reefs were monitored for more than the recommended five years' post-transplantation, and over 50% were monitored for only one year or less. Furthermore, the most widely used indicators were growth and survival of the coral fragments (51% of studies used these only) and other ecological factors are rarely addressed. Evaluation of the effectiveness of coral restoration programs should integrate ecological characteristics with socio-cultural, economic, and

[73] The terms "restoration" and "rehabilitation" are often used interchangeably. However, rehabilitation is normally used for the full replacement of structural or functional characteristics of an ecosystem that have been diminished or lost. The term restoration is used in preference in the concept, as there remains some question as to whether it will be feasible ultimately to fully rehabilitate coral reefs using active restoration techniques, although some scientists believe it may be possible

[74] Society for Ecological Restoration International Science & Policy Working Group. (2004) *The SER International Primer on Ecological Restoration.* www.ser.org & Tucson: Society for Ecological Restoration International. 13 pp. www.ser.org/content/ecological_restoration_primer.asp

[75] Perrow, M. R., and A. J. Davy. 2002. Handbook of ecological restoration. Cambridge University Press, Cambridge, UK

[76] David Lamb and Don Gilmour. (2003). Rehabilitation and Restoration of Degraded Forests. IUCN, Gland, Switzerland and Cambridge, UK and WWF, Gland, Switzerland. x +110 pp.

governance considerations to assess the efficacy of coral restoration as a tool to promote reef resilience and ensure the sustainable delivery of reef ecosystem services.[77].

Restoration of damaged reefs by transplantation of whole coral colonies or coral fragments is being increasingly shown to increase coral cover, species diversity, coral reproduction capacity and local recruitment[78]. Coral transplantation can be used to "spread" bleaching-resistant genotypes by using survivors of previous bleaching events as donor colonies[79].

Several active reef restoration methods are now available and have been tested widely[80],[81],[82]. The selection of which method, or combination of methods, is the most appropriate requires careful consideration as the appropriate choice is generally site-specific. Most efforts have been based on the use of asexually produced coral fragments, sourced from healthy coral colonies that are still present either on the disturbed reefs or on less damaged nearby reefs, or that represent "corals of opportunity": i.e., colonies dislodged through natural processes or coral fragments produced through natural processes and collected from the substratum[83]. A two-step protocol in which fragments are grown in *in situ* or *ex situ* nurseries ("gardening"), followed by planting them out onto selected sites is proving to be most successful, in particular when floating *in situ* nurseries are used. Midwater floating nurseries have been used with nearly 90 coral species successfully propagated in nurseries around the world[84]. Nurseries using coated metal frames of various designs (e.g. tree frames, spider frames) on which the coral fragments are attached have also been successful in many locations.

The main purpose of the nurseries is to grow coral colonies to a size that reduces mortality after transplantation onto damaged or degraded reefs. Coral transplants have a greater chance of survival the larger they are[85]. The nurseries offer the advantage of decreased competition for resources (space, light), decreased predation, and suspension above sea-floor sediments. Coral nurseries can also be used to capture and harvest coral larvae, as genetic repositories[86] ,

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[77] Hein, M. Y., Willis, B. L., Birtles, R. A., Beeden, R., 2016. Characterising coral restoration effectiveness: a review of current limitations and challenges at a socio-ecological scale. Paper presented at Int Coral Reef Symp, Hawaii.

[78] Horoszowski-Fridman YB, Izhaki I, Rinkevich B (2011) Engineering of coral reef 572 larval supply through transplantation of nursery-farmed gravid colonies. J. Exp. Mar. Biol. Ecol. 399 (2): 162–166. doi:10.1016/j.jembe.2011.01.005.

[79] Mascarelli A (2014) Climate-change adaptation: designer reefs. *Nature*: … doi:10.1038/508444a.

[80] Edwards, AJ, Gomez, ED (2007). Reef Restoration Concepts and Guidelines: making sensible management choices in the face of uncertainty. Coral Reef Targeted Research & Capacity Building for Management Programme: St Lucia, Australia. iv + 38 pp.

[81] Edwards, AJ (ed.) (2010). Reef Rehabilitation Manual. Coral Reef Targeted Research & Capacity Building for Management Program: St Lucia, Australia. ii + 166 pp.

[82] Young CN, Schopmeyer SA, Lirman D (2012) A review of reef restoration and coral propagation using the threatened genus Acropora in the Caribbean and Western Altlantic. Bull Mar Sci 88(4): 1075–1098

[83] Ng CSL, Chou LM (2014) Rearing juvenile 'corals of opportunity' in in situ nurseries: A reef rehabilitation approach for sediment impacted environments. Mar Biol Res 10(8):833–838.

[84] Rinkevich, B., 2014. Rebuilding coral reefs: does active reef restoration lead to sustainable reefs? Curr. Opin. Environ. Sustain. 7, 28e36.
Rinkevich, B., 2015. Climate change and active reef restoration - ways of constructing the 'reefs of tomorrow'. J. Mar. Sci. Eng. 3, 111e127

[85] Guest JR, Baria MV, Gomez ED, Heyward AJ, Edwards AJ (2014). Closing the circle: Is it feasible to rehabilitate reefs with sexually propagated corals? Coral Reefs 33(1):45–55.

[86] Schopmeyer SA, et al. (2012) In situ coral nurseries serve as genetic repositories for coral reef restoration after an extreme coldwater event. Restor Ecol 20(6):696–703.

or to grow mature breeding corals for larval production and seeding of surrounding reefs[87]. In the Caribbean, where there has been a massive reduction in live coral cover, such techniques are being widely used. Active restoration is especially important for reef-building corals that provide the bulk of the three-dimensional complexity on reefs and support critical ecological functions for many other reef-associated species[88].

The following conclusions were reached and recommendations were made at a round-table on restoration, following the formal sessions, at 13th ICRS:

- Standard operating procedures (SOPs) are needed and best management practices must be collated and disseminated
- Individual initiatives should be tailored to local situations
- Use best available science
- Capacity building and training of local communities and others, is needed, making full use of local communities where appropriate, given the labour-intensiveness of the work
- A better understanding of successes and failures to date is needed
- Biosecurity issues must be addressed – including diseases of corals, introduction of alien species, potential future introduction of modified corals
- Funding is urgently needed, recognising the current high costs involvement although these are already decreasing.

Experience of reef restoration in Seychelles and Mauritius

Seychelles

Active reef restoration activities in the Seychelles are underway through Nature Seychelles, SNPA and some of the hotels and NGOs.

With funding from the USAID Development Grant Program (DGP) and the GEF, Nature Seychelles established the four-year Reef Rescuers project which started in 2011. 13 midwater rope nurseries were constructed, using locally available and re-cycled materials, and filled with some 40,000 coral fragments, taken from donor corals and corals of opportunity in adjacent areas, of 10 species (branching, massive and encrusting). These were grown on until they reached transplantation size (10-20 cm diameter), which took about one year. Between November 2011 and June 2014, almost 25,000 nursery-grown coral colonies from 10 different coral species were transplanted to a 5,225 m^2 area of degraded reef in the no take zone of Cousin Island Special Reserve[89]. The species were selected based on their survival rates during the 2007 bleaching event. The colonies were cemented to the natural substrate which had been cleaned of algae and sediment. Coral survival during the nursery stage was 75.2%, with losses largely due to a hurricane and an invasive sponge. The labour force for the work was provided by the "reef rescuers" who were volunteers who came for up to three months at a time, supported by eight experts. All participants were trained through a full-time six-week classroom and field based training program. A manual on the method used has been produced.

[87] Amar KO, Rinkevich B (2007) A floating mid-water coral nursery as larval dispersion hub: Testing an idea. Mar Biol 151(2):713–718.

[88] Drury et al. 2016. Genomic variation among populations of threatened coral: *Acropora cervicornis.* BMC Genomics: 17:286

[89] Montoya-Maya1 PH, Smit KP, Burt AJ, Frias-Torres S. (2016). Large-scale coral reef restoration could assist natural recovery: a case study in Seychelles, Indian Ocean. *Nature Conservation*

Standardized protocols are being used to monitor the survival, reproduction, recruitment and bleaching response of donor and transplanted colonies, at the transplantation site and two control sites, one of which is a healthy and the other a degraded coral reef.

By 2014, there had been a 700% increase in coral cover, from about 2% in 2012 to 16%, and a five-fold increase in fish species richness, a three-fold increase in fish density, and a two-fold increase in coral settlement and recruitment at the transplanted site. The coral transplants also responded better to stressful conditions resulting from increased sea temperatures and a harmful algal bloom than corals that had remained in situ. The transplanted corals appear to recover faster and better than corals at other sites. However, the global bleaching event that started in 2014 and continued through to April 2016, has caused significant bleaching but is providing an invaluable opportunity to determine the effectiveness of the choice of coral reef species and the methods used.

The SNPA initiative, supported by the UNEP project *Building capacity for coastal ecosystem-based adaptation in SIDS*, has involved the establishment of a nursery with capacity to produce about 9,000 coral colonies every 6 months in Curieuse Marine National Park. Following the 2015-2016 bleaching event, over 8% of corals in the nursery bleached and died, but this provides an opportunity to identify the more resilient corals and to use these for future propagation. A survey will be undertaken in to document the impact of the bleaching event and to identify pockets of resistant corals. Ultimately corals will be transplanted to 3 coral reef sites around Praslin Island (two within Curieuse Marine National Park and one outside, and through an extension to the project, the capacity of the nursery will be increased by about 50%.

The NGO Anba Lao and SNPA and will be using the Curieuse Marine National Parks, Ile Cocos Marine National Parks and Port Launay Marine National Parks as pilot sites to test 2 methods to promote survival of coral recruits once they have settled on rubble and macro-algae dominated reefs, classified as non-resilient reefs, by stabilising rubble and removing macro-algae. The partnership with SNPA ensures that the work is of benefit to socio-economically important reef sites upon which many people are dependent for their livelihoods; and boat charter operators will be involved.

Several hotels have initiated small projects to restore reef habitat for the benefit of tourists. A coral garden was created at the Hotel Lemuria on Praslin, with the technical support of Nature Seychelles. Nature Seychelles is developing a similar initiative with the resort on Cousine Island. The Marine Conservation Society of Seychelles is undertaking a coral restoration project with a PhD student, in partnership with the Cerf Island Resort and the Cerf Island community. Fragments and “corals of opportunity” are collected and attached to frames in a nursery and survival rates are being compared; as elsewhere, these have been affected by bleaching but the monitoring will continue.

At the Four Seasons Resort Seychelles, at Petite Anse on Mahe, a project to restore 10,000 m^2 of degraded reef is underway with the technical assistance of the NGO WiseOceans and support of MECCE. The aim is to grow 16,000 coral fragments (the majority coral of opportunity) in an in-situ nursery of rebar arches that has been constructed. Awareness raising is a central component of the project, and the reef restoration project is used in marine education programmes for guests and the wider community

Under the Adaptation Fund project, *Ecosystem Based Adaptation to Climate Change* the coastal protection ability of the degraded fringing coral reef at North East Point on Mahe is being

enhanced by clearing rubble and building a submerged breakwater in the reef crest surf zone to protect the reef and to provide a substrate for coral colonization.

Mauritius

In Mauritius, coral restoration work has been undertaken by MOI, AFRC, MOESDDBM, and several NGOs in collaboration with hotels.

The MOI has undertaken research on coral farming projects since 2008, investigating the survival and growth of ten coral species in land- and ocean-based nurseries[90]. A pilot project was initiated to determine the feasibility of land-based coral culture using a variety of local coral taxa. A land-based nursery and an ocean-based nursery were established at Albion.

In 2012, with funding from the UNDP-GEF-SGP, MOI initiated a small scale reef restoration project with the NGO ELI Africa[91]. During the implementation phase (2013-2014), the MOI jointly with ELI-Africa cultured up to 3000 selected coral fragments at Trou aux Biches, which were later transplanted to recipient reef sites. After providing suitable training in coral farming, MOI handed this over to ELI-Africa. The NGO Eco-Mode is also undertaking related activities.

Multi-layered rope nurseries were established at Albion and Flic en Flac in 2012 and at Trou aux Biches in 2013 using nine coral species. After 8-14 months, the nursery grown corals were transplanted to artificial reef restoration modules (ARRMs). Highest survivorship was recorded for the Pocilloporidae family. Growth rates did not differ significantly between nursery grown corals and transplanted corals. Predation by fish and *Drupella* snails and algal overgrowth were the main causes of coral mortality at the nurseries and ARRMs; although volunteers and other partners were trained to inspect, clean and regularly remove parasites, at Trou aux Biches which was the main community site this was not undertaken regularly.

According to surveys carried out in 2014, the survival rates of planted corals were over 75% at Albion (3 years after plantation), over 65 % at Flic en Flac (2 years after plantation) and over 35% at Trou aux Biches (1 year after plantation)[92].

A joint MOI and University of Mauritius (UoM) study looked at the effects of artificial feeding and environmental conditions on the *in situ* growth of cultured coral fragments in 2010 and involved the fish farm at Point-aux-Feuilles where nutrient levels are high. Notwithstanding their slow growth, corals may exhibit high calcification rates in such nutrient-rich environments (Shafir & Rinkevich, 2008, 2010) and the best results were obtained at the fish farm nursery (Nazurally, unpubl. data).

AFRC set up a pilot coral nursery at Albion in 2008, and following successful coral growth, colonies were attached to small basal tables made of PVC and placed on reefs at Albion, Pointe aux Sables and Trou aux Biches in 2011. According to an AFRC report, the survival rate of planted corals was ca. 50 % after 2 years[73] In 2013, AFRC placed large galvanised iron basal tables, holding up to 96 coral fragments each, at Balaclava Marine Park, Trou aux Biches and

[90] R. Moothien Pillay, S. Bacha Gian, V. Bhoyroo and S. Curpen 2012. Adapting Coral Culture to Climate Change: The Mauritian Experience. *Western Indian Ocean J. Mar. Sci. Vol. 10,* No. 2, pp. 155-167,

[91] Moothien-Pillay, R., BachaGian S and Nicolas, A.2014. Community-based Rehabilitation Project, Trou-aux Biches. Final report to UNDP-SGP

[92] JICA 2015. Reef Environment Conservation Plan. Chap. 6. Final Report. The Project for Capacity Development on Coastal Protection and Rehabilitation in the Republic of Mauritius

Blue Bay Marine Park (600 coral fragments). In future plans, the same type of large basal tables will be set at Ile aux Benitiers, Pointe aux Sables, Albion, Bel Ombre and Mon Choisy.

Under the *UNDP/AFB Climate Change Adaptation Programme in the Coastal Zone of Mauritius*, which is aimed at combating beach erosion and flood risk in three coastal sites, there is a pilot project on coral farming at Mon Choisy, underway through MOEMRFSOI.

The JICA supported project on *Capacity Development in Coastal Protection and Rehabilitation in the Republic of Mauritius* (2012-2015) developed coastal conservation plans for 14 sites where there is significant coastal erosion, and recommended reef restoration for five of these sites. In addition, a Reef Environment Conservation Plan was prepared which is being implemented by the Fisheries Division, coordinated by the MOESDDBM with stakeholders including Fisheries Division, MOI, and NGO's.

Following the Study on Coastal erosion in the Republic of Mauritius (2003), 7 concrete block modules were placed in the Flic en Flac lagoon by the Beach Authority, MOESDDBM, Fisheries Division, NCG and NGO on a pilot basis, to provide a substratum for coral larvae to settle and grow. Monitoring of the modules was undertaken by the Fisheries Division and successful coral larvae settlement was recorded. A full scale project was initiated by the MOESDDBM in 2010, involving the placement of 60 concrete modules in the lagoon of Flic en Flac under the supervision of the Fisheries Division. Follow up monitoring showed that coral larvae successfully settled on the concrete blocks.

There are several NGO initiatives. WiseOceans is working with the Four Seasons Anahita Hotel to initiate a coral garden project that will use tree frames[93]. Under the Australian Aid Blue Economy Challenge, a potential project is being developed with the private sector to develop a coral farming facility in collaboration with the hotel sector. Reef Conservation is monitoring the trial sites that have been established at Balaclava as well as trial cement blocks with corals attached that have been put in at Albion by AFRC. Reef Conservation is also planning a reef restoration initiative in one of the Voluntary Marine Conservation Areas. Eco-Sud has submitted a proposal to the UNDP-SGP for coral farming in Blue Bay.

On Rodrigues, the NGO Shoals Rodrigues has undertaken some small scale restoration work on a reef that had suffered anchor damage Jean Tac in Anse Aux Anglais Marine Reserve. Some other initiatives were undertaken under a project led by Ministry of Fisheries with the support of the RRA for the planting of coral using metal tables whereby some coral settlement trials have been undertaken in SEMPA. The RRA has also undertaken some restoration work in the eastern lagoon at Anse Ally with the support of the fisher community.

[93] http://fourseasonsreefaction.com/about/

Annex 2

Minutes of the Regional Steering Committee, held on 6 July 2016 at the Seychelles Fisheries Authority.

Project: Restoring marine ecosystem services by rehabilitating coral reefs to meet a changing climate future

In Attendance: As Attached

1. Opening

The meeting was officially opened at 0930 hrs. by the UNDP Resident Representative, Mr Simon Springett, who also acted as chairperson for the first Regional Project Steering committee. The PS of Environment Mr Decomarmond also welcomed the colleagues from Mauritius and shared the importance of joint regional cooperation through this project and others.

The representative from the Mauritius Ministry of Finance and Economic Development, Mrs Ramsurn reiterated PS Decomarmond's sentiment and recalled how the idea and enthusiasm for this project was borne and the rapid collaboration between Mauritius and Seychelles.

Dr. Shah also commented on the collaborations and felt that the original concept of the Adaptive nature of the Coral Restoration focusing on Food Security and Disaster Risk Reduction must be kept.

The Agenda adopted was as follows:

09 30 to 11 00: Presentation and Discussion of Concept note by Ms Sue Wells, Consultant on Skype.
11 15 to 11 45: Presentation of UNDP – Project Board and Quality Assurance
Mr Satyajeet Ramchurn, UNDP Environment Programme Officer
11 45 to 12 30 Presentation of MOI Coral Restoration Projects – Dr D Dumur, MOI

2. Presentation of Concept Note

The Concept Note Preparation consultant, Ms. Sue Wells, presented the concept note via Skype. There are 3 components; the first two are the country specific actions, are identically worded and the 3rd component will look at a regional experience. The committee agreed with the proposed structure.

Key points of the proposal to focus on

- Scientific Data to support increase in fish catch (at full proposal stage)
- Linking Food Security in relation to Tourism
- Linking Tourism and Restoration
- Documentation and Lessons learnt from both countries
- Development of Business Plans for Sustainable Management &Financing of Reef Restoration efforts
- Rehabilitation of Coral sites in Marine Protected Areas

- International Coral Reef Symposium June 2016 – Demonstrated worldwide interest in restoration of reefs

3.0 Discussion points:

The discussion points are not individualized. However, the points below emanate from representatives from both Seychelles and Mauritius counterparts attending the meeting.

General

- Important to identify gaps and support livelihoods and DRR links
- Benefits of research must be clear such as development of a Regional Research Platform to extend beyond lifetime of a project
- Build on comparative advantages of the two countries for Upscaling
- Capacity is an issue in Seychelles; AFB may not be willing to fund International Volunteers
- SNPA Structure and capacity also limited- could expand with financial support
- Tourism could play an increasingly critical role in training and mobilizing private sector resources.

Adaptation Aspects to be emphasized

- List Concrete Adaptation Activities
- Importance of such activities to build Climate Resilience
- Vulnerable Groups and benefits from the project – how to ensure
- Level of urgency – corals are degrading rapidly especially in Mauritius
- Emphasize cross/multi-sectoral approach

Timeline for submission

- 15 July for Concept Note (Review between 07-13 by partners/Regional SC)
- 18 July Submission to UNDP HQ
- National Office Endorsement by 18 July
- Submission to AFB is partners in agreement 1 August.

Project Board Guideline/Membership

- Possibly request Nairobi Convention/UNEP to be part of SC through SAPPHIRE regional project which will be implemented in Seychelles.
- Will need more thought at full proposal stage given costs to be incurred

Site Selection: Justification

- Genetic Research
- Site selection and science
- Linkages important with community support
- Coastal mapping and zoning already advanced in Seychelles
- Site selection may serve one purpose not both but there is a need to review sites that may have more relevance in terms of Disaster Risk Reduction and Food Security
- Will need to examine Linkages between GEF6/AFB and other projects

Meeting Closure
The meeting closed at 12 30 pm with a vote of thanks to all those present despite the short notice. The help and collaboration of all stakeholders was sought in order to meet the 1 August Deadline.

ATTENDANCE LIST

SNO	NAME	DESIGNATION	ORGANIZATION	Contact
1	Mr. Alain Decommarmond	Principal Secretary	Ministry of Environment, Energy and Climate Change	adecommarmond@gov.sc
2	Dr. Andrew Greiser-Johns	Chief Technical Advisor and Programme Coordinator	UNDP-GOS-GEF Programme Coordinating Unit	a.grieserjohns@pcusey.sc
3	Mr. Flavien Joubert	Chief Executive Officer	Seychelles National Parks Authority	f.joubert@env.gov.sc
4	Mr. Denis Matatiken	Special Advisor to te Minister of Environment, Energy and Climate Change	Ministry of Environment, Energy and Climate Change	boga@seychelles.net
5	Mr. Savinien Leblond	Programme Officer	Marine Conservation Society of Seychelles	savi72011@gmail.com
6	Mrs. Meggy Tirant	Programme Assistant, Global Climate Change Alliance Project	United Nations Development Programme	meggy.tirant@undp.org
7	Mr. Jude Bijoux	Consultant	UNEP-Ecosystem Based Adaptation Project.	judebijoux@gmail.com
8	Mr. Rodney Quatre	Programme Manager, Global Climate Change Alliance Project	United Nations Development Programme	rodney.quatre@undp.org
9	Dr. Danishta Dumur-Neelayya	Associate Research Scientist	Mauritius Oceanography Institute, Mauritius	ddumur@intnet.mu
10	Mrs Rachna Ramsurn	Analyst/Senior Analyst	MOF, Mauritius	rramsurn@govmu.org

SNO	NAME	DESIGNATION	ORGANIZATION	Contact
11	Mr. Simon Springett **(Chair of the Regional Steering Committee)**	UNDP Resident Representative/UN Resident Coordinator	United Nations Development Programme	simon.springett@one.un.org
12	Dr. Akiko Yamamoto	UNDP-GEF Regional Technical Advisor - International Waters	UNDP-GEF, Regional Service Centre, Addis Ababa	akiko.yamamoto@undp.org
13	Dr. Nirmal Shah	Chief Executive Officer	Nature Seychelles	nirmalshah@natureseychelles.org
14	Mr. Andy Rylance	Technical Advisor Protected Area Finance Project	UNDP-GOS-GEF Programme Coordinating Unit	a.rylance@pcusey.sc
15	Mr. Peter Purvis	Legal Officer	Ministry of Finance, Trade and Blue Economy	ppurvis@finance.gov.sc
16	Ms. Helena Sims	Project Manager	The Nature Conservancy - Seychelles	h.sims@pcusey.sc
17	Mr. Roland Alcindor	Programme Manager	United Nations Development Programme	roland.alcindor@undp.org
18	Mr. Marille Benoit	Programme Assistant	United Nations Development Programme	marille.benoit@undp.org
19	Mrs. Preethi Nair	Project Officer	United Nations Development Programme	preethi.sushil@undp.org
20	Mr. Satyajeet Ramchurn	Environment Programme Officer	United Nations Development Programme	satyajeet.ramchurn@undp.org

Annex 3: Letters of Endorsement
Letter of Endorsement Mauritius

Ministry of Finance & Economic Development
Government Centre, Port Louis, Republic of Mauritius

In your reply, please quote:

CF/50/100/40/38 **15 July 2016**

Endorsement Letter

The Manager
Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: afbsec@adaptation-fund.org

Dear Madam,

Restoring Marine Ecosystem Services by Rehabilitating Coral Reefs To Meet a Changing Climate Future

As designated Government authority for endorsing projects under the Adaptation Fund, this Ministry confirms that the concept note for the above regional project proposal is in accordance with the priorities of Government in implementing climate adaptation activities. This project will help to reduce the adverse impacts of, and the risks, posed by climate change. It will also enhance collaboration and synergies not only between Mauritius and Seychelles but in the region as a whole.

2. Accordingly, we are pleased to endorse the above project concept with full support from the Adaptation Fund. If approved, the project will be implemented by the United Nations Development Programme (UNDP) and the lead executing entity in Mauritius will be the Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Islands.

Yours Sincerely,

D.D. Munraj, G.O.S.K
Financial Secretary
Designated Authority

Letter of Endorsement Seychelles

Republic of Seychelles
Minister of Environment, Energy & Climate Change

The Minister

10th August 2015

The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

SUBJECT: ENDORSEMENT FOR "RESTORING MARINE ECOSYSTEM SERVICES BY REHABILITATING CORAL REEFS TO MEET A CHANGING CLIMATE FUTURE"

Dear Sir/Madam,

In the capacity as the designated government authority for endorsing projects under the Adaptation Fund, this Ministry confirms that the above national project proposal is in accordance with government's national priorities in implementing adaptation activities to reduce the adverse impacts of and risks posed by climate changes in the Republic of Seychelles.

Accordingly we are pleased to endorse the above regional project proposal with full support from the Adaptation Fund. If approved, the project will be implemented by the United Nations Development Programme (UNDP) and executed in the Seychelles by the Ministry of Environment, Energy and Climate Change in collaboration with the Seychelles National Parks Authority and the Nature Seychelles.

Yours Sincerely,

Didier Dogley (Mr.)
MINISTER

2nd Floor - Le Chantier Mall - P. O. Box 445 - Victoria - Mahe - Seychelles Tel: 4610740 Fax: 4610558

Republic of Seychelles
Ministry of Environment, Energy & Climate Change

Office of the Principal Secretary
Energy & Climate Change

DATE: - 31st July 2015

The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

SUBJECT: ENDORSEMENT FOR "RESTORING MARINE ECOSYSTEM SERVICES BY REHABILITATING CORAL REEFS TO MEET A CHANGING CLIMATE FUTURE"

Dear Sir/Madam,

In the capacity as the designated government authority for endorsing projects under the Adaptation Fund, this Ministry confirms that the above national project proposal is in accordance with government's national priorities in implementing adaptation activities to reduce the adverse impacts of and risks posed by climate changes in the Republic of Seychelles.

Accordingly, we are pleased to endorse the above regional project proposal with full support from the Adaptation Fund. If approved, the project will be implemented by the United Nations Development Programme (UNDP) and executed in the Seychelles by the Ministry of Environment, Energy and Climate Change in collaboration with the Seychelles National Parks Authority and the Nature Seychelles.

Yours Sincerely,

Wills Agricole (Mr.)
PRINCIPAL SECRETARY

I Love Seychelles
Mon Kontan Sesel
J'aime les Seychelles

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