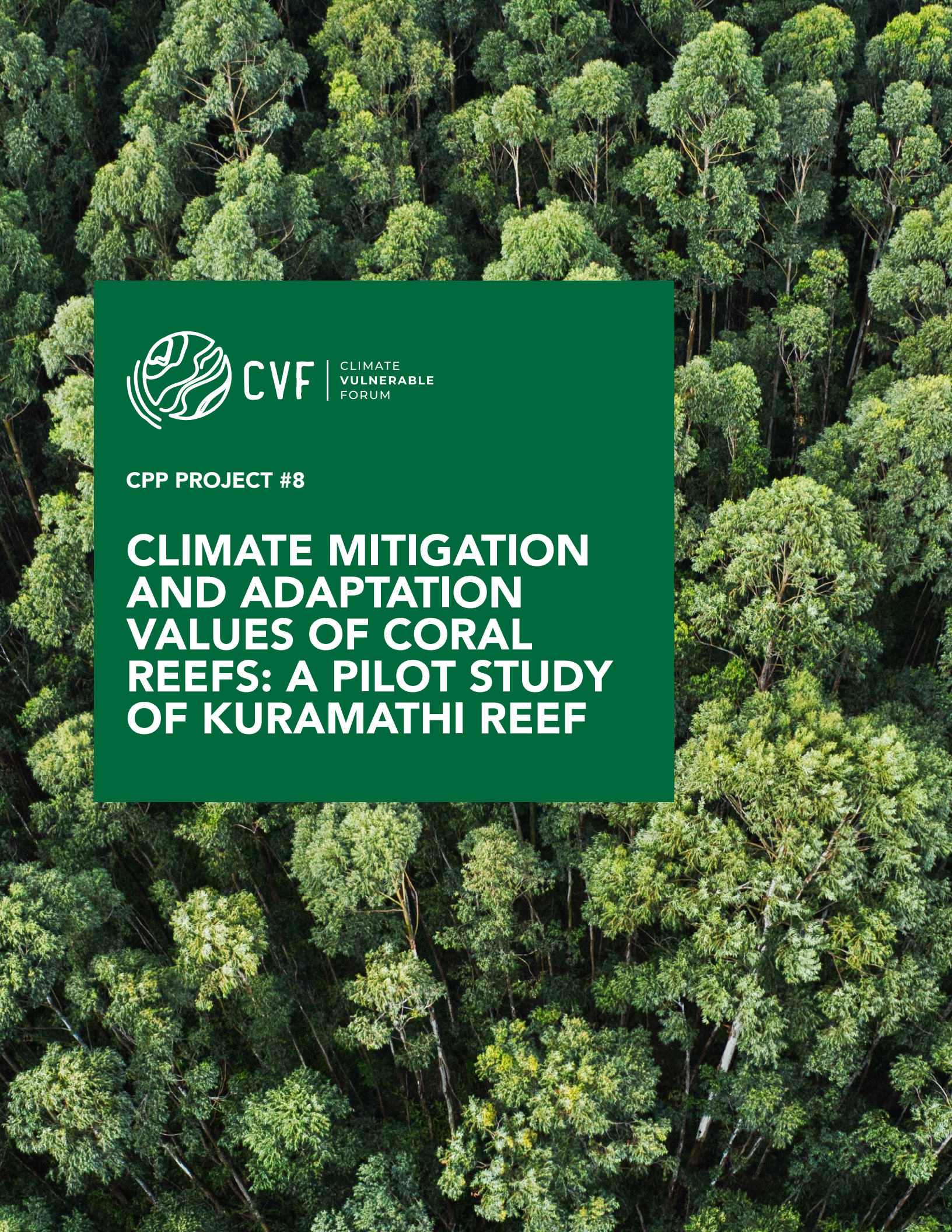

CVF | CLIMATE VULNERABLE FORUM

CPP PROJECT #8

CLIMATE MITIGATION AND ADAPTATION VALUES OF CORAL REEFS: A PILOT STUDY OF KURAMATHI REEF

PROJECT SNAPSHOT

INTRODUCTION

Coral reefs cover an area of 350,000 km2 of the world's ocean surface and they are among the most diverse ecosystems, hosting thousands of species of organisms. Reefs offer coastal protection, while supporting economic activities of human communities both directly and indirectly. Coral reefs are the reason for the existence of many low-lying atoll nations, such as Maldives, but they render them among the most climate vulnerable of all countries due to the extreme sensitivity of corals to ocean warming, acidification and local human pressures.

The coral reef system of the Maldives is one of the largest in the world, covering an area of approximately 8,900 square kilometers, and still among the most intact, despite significant damage from three global coral mass bleaching events. It consists of 26 atolls, with over 1100 islands of which more than 200 are inhabited. As none of the natural islands rise more than two metres above sea level, the Maldivian population, currently numbering around 530,000, are highly exposed to climate related impacts from rising sea levels, increased wave energy and storminess. They urgently need to find viable pathways to climate adaptation.

This Climate Vulnerable Forum (CVF) and Kuramathi Resort/Maldives collaboration pilot project will measure the generic ecosystem service values of Kuramathi Reef, understand ways to increase its value to local people, Maldivians in general and the international community. The project seeks:

1. to understand the value and functioning of reef systems in the global carbon cycle,
2. to explore the role of a critical but overlooked component of reefs – coralline algae – in reef growth and island protection from wave action, now and into the future,
3. to determine whether good reef management, particularly protection from extractive and harmful human uses, can increase reef resilience and ecosystem services, and
4. explore the use of coralline algae in reef restoration, especially the creation of hybrid

natural-engineered coastal defences.

THE COLLABORATION:

The Climate Vulnerable Forum, with its Secretariat in Accra, Ghana was established in 2009 in Male, Maldives as a forum of heads of state and government of countries highly vulnerable to a warming planet. The Forum serves as a South-South cooperation platform for participating governments to act together to deal with global climate change. Climate Prosperity Plans (CPPs) are the overall anchor of CVF strategy. They are national, strategic plans combining the transition to clean energy, clean technologies, and climate adaptation, with economic growth, prosperity and improved livelihoods in climate vulnerable developing countries.

Kuramathi Reef is a reef system that stretches north from the Island of Kuramathi in Rasdhoo Atoll, Maldives and the Island hosts the 400-bed luxury Kuramathi Resort. The Resort has taken several steps to ensure that the coral reefs are well taken care of. To minimise the use of plastic, in 2011, the Resort installed a bottling plant and started producing potable water that is served to the guests and staff. In addition, Kuramathi now serves paper straws in all bars as part of its sustainability program and all the Resorts plastic waste is collected and sent to for recycling. Measures have also been put in place to ensure recycling of grey water. The water is treated and purified and reused in the gardens and for flush tanks.

ETHICAL PRACTICES AND UN SUSTAINABLE DEVELOPMENT GOALS

Supplier Ethical Data Exchange- Sedex Members Ethical Trade Audit (SMETA) is one the most widely used social audit programs, providing a compilation of the best ethical audit techniques. It provides a globally recognized way to assess responsible supply chain activities, including labour standards, health and safety, the environment and business ethics.

This project will be audited by Société General de Surveillance (SGS) in accordance with SMETA Best Practice Guidance and SMETA Measurement Criteria, covering four pillar audit requirements which included Labour standards, Health & Safety, the Environment and Business ethics.

The scope of this ethical audit will be against the Ethical Trade Initiative (ETI) Base Code,

Universal rights covering United Nations Guiding Principles on Business and Human Rights (UNGP), Management systems & code implementation, Responsible recruitment, Entitlement to work & immigration, sub-contracting, the Environment and Business Ethics.

THE PROJECT

Achieving the Paris Agreement target of limiting temperature rise to 1.5oC will require rapid reduction emissions coupled with carbon uptake by natural ecosystems and carbon capture and storage. Marine wetland habitats, including mangroves, seagrasses and saltmarshes have been identified as important 'blue carbon' sinks whose conservation will assist with carbon drawdown from the atmosphere. However, a majority of scientists have dismissed tropical coral reefs as viable blue carbon habitats that actively remove CO2 from the atmosphere. The main argument against their being active carbon stores that can help mitigate greenhouse gas emissions is that in the process of depositing carbonate rock in their skeletons, CO2 is released. Based simply on the chemistry of the process, one mole of CO2 is released for every mole of carbonate that corals or other calcifying animals and plants deposit. This basic assumption has been received wisdom for half a century, but the time is ripe for a thorough re-evaluation.

There are several emerging reasons to suspect that the carbon budget of reef systems is more complex, and from a climate perspective, more promising than this:

1. Reef systems consist of far more than just corals. They comprise a matrix of interconnected habitats. Corals only dominate in a relatively small fraction of reef complexes, estimated at around 23%. Other components of the matrix include classic blue carbon habitats such as mangroves and seagrasses. In addition, large areas are covered in green seaweeds that actively take up CO2 in photosynthesis. While much of the carbon they capture is recycled through reef food webs, a substantial but unquantified fraction may be trapped and stored in sedimentary habitats associated with reefs, particularly the deep reef lagoons that are prevalent in coral atolls.
2. Recent research on coralline algae, which are an important and often neglected component of coral reef ecosystems, suggests that CO2 released during calcification is taken up in photosynthesis. In some recent well-studied cases, these algae acted as net carbon sinks. This is important because coralline algae cover significant areas of the reef platform, in some places occupying as much space as coral.
3. Stony corals themselves deserve a more in-depth assessment of their carbon budgets. Their internal photosynthesising zooxanthellae could, like the coralline algae, also be taking up CO2 released by calcium carbonate deposition.

Beyond their potential for carbon capture, there are several further reasons for this project's strong focus on coralline algae. These algae appear to be relatively unaffected by marine heatwaves, surviving well through events that cause mass mortality of reef corals. They play a crucial role in reef building, cementing and binding together the raw materials of reef construction, i.e. corals, rubble and sand. They dominate the seabed in areas of high wave action at the edges of atolls, performing a major role in reef and island protection. They grow upwards rapidly towards sea level at rates that could potentially keep up with predicted future sea level rise, and therefore could perform a vital service in the survival of reefs, atolls and islands as the world warms. In Maldives, coralline algae have maintained net carbonate accretion even after mass coral mortality. They also act as a beneficial substrate for natural coral settlement and survival. On reefs where coralline algae predominate, they could promote natural reef regeneration to the extent that this remains possible in the face of repeated coral bleaching episodes from warming seas.

Coralline algae are susceptible to overfishing, however, which could undermine these important roles. In places where intense fishing removes seaweed-eating fish, like parrotfish and surgeonfish, they may be outcompeted for space by more rapidly growing fleshy and filamentous seaweeds, which in turn prevent corals settling and increase their mortality when they do. There are many overfished reefs worldwide now smothered by green seaweeds that instead of growing are actively eroding, exposing coasts and their human populations to greater wave action and jeopardy. Protection from overfishing could therefore be critical to the health survival, functioning and ecosystem services coral reefs provide.

Questions the project will investigate:

Are coral reef systems sources or sinks of carbon dioxide?

a. Using radioactively labelled carbon tracers, the project will undertake detailed experimental, lab-based measurements of the carbon budgets of different species of corals, coralline algae, and different components of the reef matrix, such as filamentous and fleshy algal mats.

b. The project will measure the concentrations and rates of uptake and storage of organic carbon in reef and lagoon sediments using analyses of carbon in dated sediment cores. It will identify the sources of organic carbon in cores using environmental DNA.

c. The project will map the reef habitat complex surrounding Kuramathi and a series of comparator sites (see below). Using project generated measures of carbon uptake, release and sediment storage, it will calculate the net carbon budget of the whole reef system.

What is the role of coralline algae in reef and island protection now and in the future?

a. The project will map the distribution and extent of coralline algal dominated habitats, and will measure their vertical growth rates in different reef zones to determine their current role in reef and island protection, and assess whether growth rates are sufficient to keep pace with predicted sea level rises.

b. Three major mass bleaching events have affected Maldives, in 1998, 2016 and 2024. The project will examine – based on historical and new surveys – how coralline algae have responded to coral losses.

Can good management enhance reef functioning and resilience?

A key question in coral reef science and conservation is whether good management will improve the outlook for reefs and people as the world warms. Parrotfish are already protected by law in Maldives because of their keystone ecological role in controlling the growth of green seaweeds and promoting that of coralline algae. Reef fishing is on the increase in Maldives, however, and there may be other important consequences of exploitation for reef functioning. In Maldives, resort reefs are protected from fishing enabling comparisons to be made with reefs that are open to exploitation.

a. A key question the project seeks to answers is does protection favour carbon uptake over carbon release? The project will map habitat distribution and coverage on multiple cross-sections (x5) of unprotected control reefs in Rasdhoo and nearby Ari Atolls, paired with protected sites at Kuramathi and four other comparable protected reefs in Ari Atoll. At each site the project will undertake whole community fish censuses to determine differences in herbivory and grazing controls over green seaweed growth and relate them to habitat composition. Habitat maps at these sites will be used to estimate differences in carbon budgets between protected and control reefs.

b. Do protected reefs support more coralline algae and higher coral cover? Both corals and coralline algae are integral to reef resilience and functioning, and to positive responses to climate change and rising sea levels. To find out whether protection benefits these components of the reef community, we will compare coral and coralline algal cover between protected and paired unprotected sites.

Can coralline algae improve reef restoration practice?

Present practice in coral restoration is centred around growing corals to replace and augment those lost to bleaching events or more local human pressures, such as coastal development. While these efforts are often successful in the short-term, producing high cover of coral and abundant associated fish, they are limited by being highly vulnerable to coral mortality during warming events. They also fail to reproduce natural reef building processes that can sustain reef growth without continued human intervention. Coralline algae, because of their key role in promoting coral settlement, survival and growth, and

their importance for reef accretion, represent a promising addition to restoration practice. Furthermore, they could prove the missing element needed to marry coral restoration with concrete coastal defences to create hybrid living/non-living structures that have the advantages of both, creating durable and effective island protection. Do date there is little practical experience with incorporating coralline algae into restoration.

a. The project will investigate ways to attach and culture coralline algae to artificial substrates, including materials used to build hard coastal defences.

b. Once culture and attachment methods have been developed, the project will experiment with combining transplanted and fragmented coral colonies with coralline algae to develop more functional and resilient structures.

c. The project will experiment with designs for hybrid natural-engineered island defences to promote joint delivery of natural ecosystem services with durable coastal protection.

EXPECTED OUTCOME

Carbon Credits

The Republic of the Maldives is a party to the international treaty on climate change adopted by 196 parties of the Conference of the Parties 21 in Paris on 12th December 2015 and entered into force on 4th November 2016. The Maldives has shown its intention to participate in cooperative approaches under Article 6.2 of the Paris Agreement to cooperate in the implementation of its nationally determined contributions (NDC) to allow for higher ambition in mitigation and adaptation actions, promote sustainable development and environmental integrity. The Maldives also allows mitigation outcomes to be authorized for international mitigation purposes other than the achievement of an NDC.

One of the goals of this project is to assess the feasibility of incorporation of coral reefs in NDCs. This depends on whether reef systems prove to be net carbon sinks in Maldives, and whether good management can enhance the rate of uptake of carbon. The project will ascertain the potential of management activities for reefs to create an authorized Mitigation Outcome (MO) that can be transferred to an acquiring participating Party as an Internationally Transferred Mitigation Outcome (ITMO). The revenue from such carbon credit could provide for the return on investment and to support the management and protection of the Kuramathi Reef, or other reefs to which management is applied.

Viable climate adaptation pathways for vulnerable reef-dependent communities

Coral reef dependent communities inhabiting low lying atolls face a very uncertain future based on predicted climate trajectories and their consequences for coral loss and sea level rise. This project will assess the role and potential of coralline algae, which are known to be resilient to marine heatwaves, in sustaining reef upward growth and coastal protection into the future. The project will develop management options to promote coralline algal growth and will establish principles for their use in hybrid artificial-natural coastal defences. The aim is to combine the strength and durability of concrete and rock with the ecological and aesthetic benefits of living reefs.

Guidance on coral reef protection to support and enhance ecosystem services

This project will provide critical information as to how to implement a Reef Resource Management Plan to support and increase delivery of ecosystem services, particularly reef growth and coastal defence. The plan will demonstrate whether it is possible, by establishing regulations on the use, upkeep and conservation of the reef, the catchment islands as well as all others who may use the resources of the reef, to enhance reef resilience and provide an improved climate adaptation pathway for island communities who depend on the reef for their livelihoods.

PARTNER

Project partners include Kuramathi Resort, Maldives, Climate Vulnerable Forum, Maldives Coral Institute, University of Exeter, Rasdhoo Atoll Council, Ukulhas Island Council, Maldives Ministry of Finance and Treasury, Maldives Ministry of Environment, Maldives Ministry of Tourism, Maldives Ministry of Fisheries and Agriculture and Maldives Ministry of Local Government.

DETAILED BUDGET

		No	Rate/year ($)	Total
1	**Staff**			
1.1	Maldives Coral Institute central staff and office costs	1	100,000	500,000
1.2	Full time Maldives Coral Institute project manager and assistant	1	50,000	250,000
1.3	Full time Maldives Coral Institute project technical experts	2	30,000	300,000
				1,050,000
2	**Training and research support**			
2.1	Maldivian internship programme for Maldives National University students	4	2,500	50,000
2.2	Masters' scholarships for Maldivian students to participate in training and research in Exeter	2	65,000	390,000
2.3	PhD scholarships to be hosted by Exeter University/MCI	2	260,000	520,000
2.4	Postdoctoral research fellows to be hosted by Exeter University/MCI for 5 years	2	390,000	780,000
2.5	International staff costs/university overhead	1	65,000	325,000
				2,065,000
3	**Lab, accomodation, boat and field research costs**			
3.1	Capital costs	1	300,000	300,000
3.2	Recurrent annual running costs Maldives	1	100,000	500,000
3.3	Annual consumable costs Maldives	1	20,000	100,000
3.4	Annual lab consumable costs overseas partners	1	130,000	650,000
				1,550,000
4	**Travel and subsistence**			
4.1	International travel	12	2,600	156,000
4.2	Domestic travel, accommodation and subsistence Maldives	1	120,000	600,000
				756,000
				5,421,000