



Australian Government



Australian Government assistance to the Seychelles tsunami relief effort

PREPARED BY AN AUSTRALIAN GOVERNMENT MISSION IN COLLABORATION
WITH THE SEYCHELLES MINISTRY OF ENVIRONMENT AND NATURAL
RESOURCES AND THE SEYCHELLES FISHING AUTHORITY



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AUSAID MISSION, 15–30 APRIL 2005

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Australian Government
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Marine Park Authority**



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COVER PHOTOS

MAIN: *Fishing boats at the tsunami-damaged wharf at Victoria.* PHOTO: *Martin Russell*

TOP LEFT: *Women with children walking on the road outside the Anchor Café during the peak of the tsunami flood waters.* PHOTO: *Keith Berke*

BOTTOM LEFT: *Staghorn coral at Anse Petit Cour Reef.* PHOTO: *Udo Engelhardt*

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Summary

ON 26 DECEMBER 2004 AN EARTHQUAKE OCCURRED OFF THE WEST COAST OF NORTHERN SUMATRA, WHICH TRIGGERED A TSUNAMI. THE WAVES GENERATED BY THIS EARTHQUAKE SPREAD AWAY FROM THE SOURCE AND AFFECTED SEVERAL INDIAN OCEAN COUNTRIES, INCLUDING SEYCHELLES.

The Australian Government received a request from the Government of Seychelles in late January 2005 for Australian technical and financial support to assess tsunami-caused damage to the coral reefs around three main islands (Mahé, Praslin and La Digue) and to traditional fisheries and fish stocks based on coral reefs.

In response to the request AusAID sent a small team to work with the Government of Seychelles on:

- 1 building an overall reef monitoring strategy
- 2 coral reef damage mitigation and rehabilitation, and
- 3 assessing impacts on near-shore fisheries.

The assessment of the impacts on near-shore fisheries did not detect any decrease in fishery abundance for any species or species group in the artisanal inshore and shallow benthic fisheries in the three months after the tsunami compared with recent baseline data. In fact, the density of sea cucumbers increased by 38 per cent and the rabbitfish (*Siganus* spp.) catch per unit of effort increased by 68 per cent following the tsunami. Some changes to shallow near-shore habitats were detected using repeated benthic surveys. However, these appear to be relatively minor at this stage and should be reversed by the natural movement of soft sediments by ambient currents. This result is consistent with information provided by several post-tsunami assessments by other international and

local agencies, and through site assessments and interviews with local reef users.

Further research is required to determine changes over the longer term to near-shore shallow fisheries, such as recruitment-related impacts that may cause fluctuations in the densities and abundance of future fishery species.

The tsunami has highlighted the need for the Government of Seychelles to progress initiatives to monitor, assess and mitigate impacts on coral reefs and associated fish stocks. Those coral reef areas damaged by the tsunami will recover naturally provided local impacts are adequately addressed.

The AusAID team recommends the following actions.

- > The Seychelles Government should compile and prioritise all recommendations from assessments of the tsunami impact to date. This should be done as soon as possible to facilitate long-term proactive management of the Seychelles marine ecosystem.
- > The Seychelles National Coral Reef Network needs to be revitalised or redeveloped to provide relevant information directly to management and to create greater awareness of reef issues by reef users in Seychelles. The network needs to involve a wider part of the community in addressing coral reef issues.

- > The artisanal fisheries Catch Assessment Survey undertaken by the Seychelles Fishing Authority proved to be useful for monitoring the effects of environmental changes on fishery populations. However, it requires renewed effort to maintain the survey and to upgrade it to fulfil its potential. Some smaller scale sampling of catch composition and population parameters is recommended. Similarly, the benthic survey sites from the broad-scale sea cucumber survey carried out in 2004 proved to be a useful baseline for detecting changes in invertebrate populations and their habitats. This network of sites throughout the Mahé Plateau and the Amirantes could be included in a longer term monitoring strategy.

1 Introduction and background

THE REPUBLIC OF SEYCHELLES, AN ARCHIPELAGO, COMPRISES SOME 155 ISLANDS IN THE WESTERN INDIAN OCEAN, NORTH-NORTH-EAST OF MADAGASCAR OFF THE EAST AFRICAN COAST.

The inner islands are predominantly composed of Precambrian granitic rock, and the outer islands are predominantly coral atolls and carbonate-based islands. These islands are on a broad (300 kilometres by 150 kilometres) continental shelf with water depths of less than 200 metres.

The magnitude 9.0 earthquake that occurred off the west coast of northern Sumatra on 26 December 2004 triggered a tsunami that killed more than 200 000 people. The waves generated by this earthquake spread away from the source. Those that travelled westward crossed the Indian Ocean, with the wave train experiencing refraction when it encountered the Maldives, the Chagos Islands, Mauritius, La Réunion, Seychelles and finally eastern Africa. As the wave train approached Seychelles, the sea-floor plateau surrounding the granitic islands refracted it.¹

The overall tsunami damage in Seychelles was estimated by the Seychelles Government as relatively moderate (three dead and an estimated US\$30 million of damage). Damage assessments carried out by various international and domestic agencies show that there was some localised physical damage to coral reefs, especially around the north-eastern islands, and impacts to near-shore fisheries and fisheries infrastructure.

To April 2005 six post-tsunami assessments of coral reefs and coastal areas had been carried out (table 1).

The AusAID mission was designed to complement these assessments and focus on helping the Seychelles Government to answer the question: ‘Where to from here with coral and fish monitoring and management?’

TABLE 1 POST-TSUNAMI ASSESSMENTS OF SEYCHELLES CORAL REEFS AND COASTAL AREAS

Agency	Report
Seychelles Centre for Marine Research and Technology – Marine Parks Authority (SCMRT–MPA)	Preliminary report on the state of coral reefs around Mahé after the December 26 th tsunami event.
World Conservation Union/United Nations Environment Programme (IUCN/UNEP)	Assessment of tsunami impacts on the marine environment of the Seychelles.
Food and Agriculture Organization (FAO)	Project for ecosystem rehabilitation after tsunami and torrential rainfall.
United Nations Environment Programme (UNEP)	Republic of Seychelles, From the mountains to the reefs, Mission report of the UNEP Asian Tsunami Disaster Task Force.
Canada–UNESCO Indian Ocean Tsunami Expedition	Effects of the 26 December 2004 Indian Ocean tsunami in the Republic of Seychelles.
Marine Conservation Society Seychelles (MCSS)	No report.

1 LE Jackson, Jr, JV Barrie, DL Forbes, J Shaw, GK Manson and M Schmidt, *Effects of the 26 December 2004 Indian Ocean tsunami in the Republic of Seychelles, Report of the Canada–UNESCO Indian Ocean Tsunami Expedition, 19 January – 5 February 2005*, Geological Survey of Canada, Open File 4539, 2005.

2 Australian mission to assist the Seychelles tsunami relief effort

THE AUSTRALIAN GOVERNMENT RECEIVED A REQUEST FROM THE GOVERNMENT OF SEYCHELLES IN LATE JANUARY 2005 FOR AUSTRALIAN TECHNICAL AND FINANCIAL SUPPORT TO ASSESS TSUNAMI-CAUSED DAMAGE TO THE CORAL REEFS AROUND THREE MAIN ISLANDS (MAHÉ, PRASLIN AND LA DIGUE) AND TO TRADITIONAL FISHERIES AND FISH STOCKS BASED ON CORAL REEFS.

A rapid assessment of the damage caused by the tsunami in Seychelles was conducted by the United Nations Environment Programme (UNEP) in February 2005. The UNEP mission found that the tsunami itself had compounded damage from the 1998 bleaching event specifically on the most vulnerable reefs on the granitic islands and those most valuable for tourism – the loosely consolidated carbonate framework reefs. This represents <1% of the total area of reef. UNEP's report recommended that the Government of Seychelles undertake further monitoring, protection and rehabilitation of its coral reefs to reduce further vulnerability to damage and to assist recovery.

To progress the request from the Government of Seychelles, and taking into consideration the conclusions from the UNEP mission, AusAID organised a team of three coral reef and fisheries experts from the Great Barrier Reef Marine Park Authority, CSIRO and Reefcare International P/L to lead a mission. The team was scheduled to be in Seychelles in mid-April 2005 to assist the Government of Seychelles to commence the process of developing a comprehensive coral reef monitoring plan and develop strategies for protecting and rehabilitating coral reefs and assessing the fisheries impacts. The Government of Seychelles agreed to provide the necessary counterpart personnel to facilitate this mission. The terms of reference for the AusAID team are in appendix A.

3 Consultation and mission objectives

CONSULTATION

Before commencing fieldwork in Seychelles the mission team consulted the following agencies.

SEYCHELLES MINISTRY OF ENVIRONMENT AND NATURAL RESOURCES (MENR)

The Seychelles Centre for Marine Research and Technology – Marine Parks Authority (SCMRT-MPA) (Jude Bijoux) sent a submission outlining the priorities for coral reefs. The authority considered it had a comprehensive picture of the physical state of the Seychelles coral reefs after the tsunami, and identified two priority tasks for assistance:

- > developing a nationally coordinated long-term coral reef monitoring program, and
- > rehabilitating coral reefs, ‘especially those that are used commercially for glass bottom boat, snorkelling and diving, with special emphasis on the marine protected areas’.

The authority also noted the need to fill the important information gap on the tsunami impacts on fisheries, particularly the near-shore finfish (trap) fishery and the deep-water finfish fishery.

SEYCHELLES FISHING AUTHORITY (SFA)

The Seychelles Fishing Authority submitted a detailed list of research priorities to assess tsunami damage to fisheries, principally the artisanal near-shore benthic and pelagic fisheries. There had been very little damage assessment of these fisheries. Most of the focus had been on the heavily impacted fishing capacity, with the artisanal sector estimated to take a further six to nine months to become fully operational. The mission provided an opportunity to assess the status of these fisheries and recommend both short-term and long-term strategies for monitoring and sustainably managing the fisheries. The SFA proposed an approach that focused on assessing the short-term impacts of the tsunami on these fisheries and designing long-term monitoring programs that would be carried out by the SFA.

UNITED NATIONS ENVIRONMENTAL PROGRAMME (UNEP)

UNEP, with the assistance of the World Conservation Union (IUCN) and Coral Reef Degradation in the Indian Ocean (CORDIO), carried out a rapid environmental assessment of the marine and terrestrial environment of Seychelles after the tsunami and produced recommendations and priorities for the coral reefs of Seychelles. The UNEP recommendations do not contain any more 'damage assessment' type surveys. The UNEP is now in the process of trying to implement a wide-ranging program starting with the short-term priorities.

THE WORLD CONSERVATION UNION/CORAL REEF DEGRADATION IN THE INDIAN OCEAN (IUCN/CORDIO)

IUCN/CORDIO undertook a follow-up assessment as part of the UNEP rapid assessment, doing some additional coral reef surveys to augment that assessment. IUCN/CORDIO also made a list of recommendations that mostly mirrored the UNEP document (see table 1), but with a little more detail in some cases.² They listed as the priorities the development of a long-term monitoring program for coral reefs and the production of baseline data of habitat and reef status. However, the latter appears to have been achieved largely for the pre-tsunami coral reefs by recent coral reef projects, including the SEYMEMP project.³

OBJECTIVES

Given the range of priorities and recommendations provided by the various agencies consulted, three subprojects were developed for the AusAID mission prior to the team going to Seychelles. Meetings in country with SFA and MENR staff refined these to:

- > building an overall reef monitoring strategy
- > coral reef damage mitigation and rehabilitation, and
- > assessing impacts to near-shore fisheries (appendix B).

Because of the importance of coral reefs to the Seychelles economy they were the primary focus of the Australian mission. Coral reefs are one of the main attractions for a large tourism industry and they support locally important artisanal fisheries. They also provide an important buffer to the coastline from storm wave damage.

² D Obura and A Abdulla, *Assessment of tsunami impacts on the marine environment of the Seychelles*, IUCN/UNEP Report, 2005.

³ U Engelhardt, *The status of scleractinian coral and reef-associated fish communities 6 years after the 1998 mass coral-bleaching event*, Final report to the Global Environmental Facility (GEF) and the Government of Seychelles (GOS), Reefcare International Technical Report, Townsville, Australia, 2004.

4 Building an overall reef monitoring strategy

BUILDING A REEF MONITORING STRATEGY WAS A PRIMARY OBJECTIVE OF THE MISSION. A KEY AIM WAS TO REVITALISE OR EXPAND THE SEYCHELLES NATIONAL CORAL REEF NETWORK (SNCRN). THE NETWORK WAS ESTABLISHED IN 1997 IN RESPONSE TO A NATIONAL OBLIGATION UNDER THE NAIROBI CONVENTION.

Summaries of meetings and interviews held as part of this subproject are provided in appendix C.

SNCRN GOALS AND OBJECTIVES

The terms of reference recently drafted by MENR represents the first real attempt to more clearly define the network's goals and objectives (appendix D). Previously, its operational framework was defined largely by a need to satisfy a number of contractual requirements under the Global Environment Facility (GEF) project Regional Coral Reef Monitoring Network in Member States of the Indian Ocean Commission (COI). It was also influenced by the broadly defined objectives of the national Coral Reef Task Force initiated in response to a decision by the Nairobi Convention. However, details of the network's origin and contractually stated focus were not widely appreciated by all SNCRN members.

The broad operational frameworks resulting from the GEF-COI project and the Nairobi Convention do not provide sufficiently detailed, country-specific operational guidelines for both the longer term strategic and the day-to-day dealings of such a network. A set of commonly accepted goals and objectives for the SNCRN needs to be developed as a matter of the highest priority. The draft terms of reference provide a useful framework for this process. However, the wide range of issues and potential activities identified in the current draft would need to be further prioritised and consolidated. Clearly defined and demarcated objectives would be desirable. Particular care

needs to be taken to match the identified goals and objectives with the available resources, both human and financial.

Recommendations

- > In close consultation with relevant stakeholders, develop an agreed set of three to four clearly defined priority goals and objectives for the SNCRN.
- > Draw up and finalise more detailed terms of reference after developing clearly defined goals and objectives.

'OWNERSHIP' OF THE SNCRN

It would be desirable to have the SNCRN function as a type of 'joint venture' between government agencies, non-government bodies and private business, with government agencies acting as SNCRN hosts but sharing responsibilities with the wider membership. There is a need to make membership of the SNCRN more attractive and allow institutional as well as individual members in order to retain and maximise input and expertise from local as well as international members.

There is a clear need to improve the commitment to ('ownership' of) the SNCRN through a range of membership initiatives. These measures could include:

- > assigning members clearly defined roles and responsibilities to monitor specific sites
- > implementing cost-sharing arrangements, particularly in relation to the supply of staff time, field equipment, boats and fuel
- > formally and publicly recognising all resources provided by members as 'in-kind' contributions, and
- > jointly publishing an annual report of the status of Seychelles coral reefs.

In-kind support provided by members – for example, free seats on boats and reduced rates on gear hire – should be logged and their value calculated and formally acknowledged at each meeting of the SNCRN as well as in SNCRN reports and publications.

Recommendations

- > Improve 'ownership' of the SNCRN by implementing a wide range of measures and incentives aimed at addressing the respective needs of members.
- > Set up an appropriate accounting scheme to record and track all contributions – both financial and 'in-kind' – made to the operations of the SNCRN.

SNCRN MEMBERSHIP

There is a desire to both consolidate and expand the membership of the SNCRN. There should be a concerted effort to push for the inclusion of new members, both institutional and individual. Furthermore, appropriate measures aimed at stimulating higher levels of active involvement and commitment are desirable (see 'Ownership' of the SNCRN).

In recent years, there have been relatively high levels of staff turnover, resulting in a significant loss of skills and expertise from the SNCRN. This problem could feasibly be resolved by allowing individual as well as institutional membership of the SNCRN and encouraging individuals to stay actively involved in the SNCRN even after a workplace change.

Recommendations

- > Embark on a targeted membership drive aimed at involving a wider and more representative cross-section of the Seychelles 'marine community'.
- > Allow both institutional and individual members and specifically target potential members with relevant skills and expertise.

STAFFING

The operations of the SNCRN are currently under the guidance of a Chair (based at MENR), a Focal Point (based at SCMRT-MPA) as well as a Secretariat (based at MENR). However, none of the identified personnel are formally assigned to the SNCRN and most are overcommitted with their regular duties. In view of the identified wide range of future tasks and activities of the SNCRN (appendix D) there is a clear need to appoint a dedicated SNCRN coordinator. A full-time position would be preferable – and in many ways essential – if the SNCRN is to achieve its emerging goals and objectives.

The SNCRN coordinator should maintain close contact with all members and encourage their active participation. Furthermore, the coordinator should actively pursue opportunities to use space (latent capacity) on local dive boats to regularly visit key local dive sites and conduct opportunistic spot checks and monitoring activities. These site visits would also assist in maintaining the required skill levels and would provide additional opportunities to provide some relevant training to the staff of these operations.

In view of recent developments in marine environmental activities at the government level in Seychelles, there may be an opportunity, even a real need, to share certain SNCRN duties and responsibilities between relevant organisations. For example, the Marine Unit located at the Conservation Section in MENR has been earmarked to play a greater role in developing and implementing marine environmental policies. In contrast, SCMRT-MPA is likely to be increasingly responsible for conducting and managing marine research, including reef-monitoring activities.

The future operations of the SNCRN may be more effective if responsibilities were shared by both MENR and SCMRT-MPA contributing, on a half-time basis, a staff member with skills that reflect their organisation's relevant areas of expertise. It would be highly desirable for the coordinator to have a tertiary degree in environmental sciences or management.

Recommendations

- > Appoint a dedicated, full-time SNCRN coordinator whose role and responsibilities should be defined in the network's terms of reference.
- > The SNCRN coordinator should be responsible for maintaining close links with all members of the SNCRN outside of the regular meeting schedule.

FUNDING

There needs to be recognition at a national level and across the community at large that regular monitoring of coral reefs in Seychelles is not a luxury, but rather a critically important activity that will assist in properly managing the reef resources in the future. A properly designed and conducted national coral reef monitoring program will benefit many in the local community. Consequently, both the operations and the funding of such a program should be viewed as a shared responsibility involving a wide range of stakeholders – government, non-government and individuals.

At the time of the mission, the day-to-day operations and activities of the SNCRN were funded largely as part of the GEF-COI regional coral reef monitoring project. However, future funding sources for the SNCRN following the completion of the GEF-COI project in late 2005 were somewhat uncertain.

While several potential donors had been identified (for example, CORDIO, COI and Nairobi Convention), at the time of the mission these bodies had made no firm commitment to provide the required funds. For the purposes of generating future funding support, it may be helpful to divide the overall operations of the SNCRN into a number of discrete activities that lend themselves to funding by specific sources.

For example, the basic administrative operations and reporting requirements of the SNCRN should be considered the responsibility of government and could feasibly be met by providing adequate staffing in identified government bodies and allocating appropriate basic operational funds. Funding for field-based reef monitoring activities, however, may be obtained more readily from regional and/or international donor organisations. Irrespective of the ultimate breakdown of funding responsibilities, there is an urgent need to develop a funding strategy.

Recommendations

- > Develop a medium-to-long-term financial plan for the SNCRN based on appropriate cost-sharing arrangements that will reduce any dependency on a single funding source.
- > The Government of Seychelles should consider covering the basic administrative and operational costs for the SNCRN as part of its core activities.
- > Funds for specific monitoring and related research activities should be obtained through external sources, such as international donor agencies.
- > The SNCRN should set up a small funding subcommittee to develop a short-term strategy for the period immediately after the completion of the GEF-funded regional reef monitoring project.

DATA AND INFORMATION

As many of the SNCRN's operations are carried out on a voluntary basis, there is a need to develop appropriate processes and standards for collecting, processing, sharing, storing, analysing and subsequently publishing data. Ownership issues will have to be considered in this context. The operational process used by the Seychelles National Turtle Database Project, a joint government and non-government initiative, may provide a useful model for developing data usage protocols and standards relating to coral reef monitoring. The agreed data-handling procedures and protocols should be formally adopted through an appropriately structured memorandum of understanding.

Recommendation

- > Develop appropriate processes and mechanisms for all aspects of processing data and sharing information, using database arrangements for the National Turtle Management Strategy as a model and adopting a formal memorandum of understanding.

DISSEMINATION OF INFORMATION

All data and information generated under the auspices of the SNCRN should be made available as part of a policy to publish and disseminate relevant information at national, regional and international levels.

Nationally, the SNCRN should be responsible for producing and disseminating an annual report on the status of the Seychelles coral reefs. This document should present the full range of data sources and monitoring techniques used and their associated strengths and weaknesses, thus highlighting the different 'resolution' and level of detail that each tool can feasibly provide. The status report should also include appropriate cautionary notes and explanations to facilitate a meaningful and correct interpretation of results, thereby providing a realistic and qualitatively sound account of the status of local reefs.

To give this report the status and recognition it deserves, it is imperative that it is widely distributed within the public arena and throughout government, including the National Assembly. Such an annual report would assist the SNCRN to play a more active role in improving public awareness and understanding of important coral reef issues.

Regionally and internationally, relevant sections of the annual report should be distributed to satisfy any existing contractual obligations (as in the GEF-COI project) or assist international bodies on a voluntary basis (the Global Coral Reef Monitoring Network of the International Coral Reef Initiative).

Recommendations

- > The SNCRN should be responsible for publishing an annual report on the status of the Seychelles coral reefs, drawing together all available information from a variety of sources.
- > The status report should identify any gaps in knowledge and make recommendations to address any reef-related issues identified, thereby providing a key tool for generating external funding support from potential donors.
- > The SNCRN should try to maximise the outputs from any reef-related activities conducted by members by developing a targeted media and publicity strategy.

FIELD OPERATIONS AND CORAL REEF MONITORING TECHNIQUES

Currently, coral reef monitoring activities under the SNCRN have a long-term focus but are based largely on the use of simple baseline survey techniques. Further expansion of the scope and extent of coral reef monitoring coordinated by the SNCRN depends on its capacity and resources.

In the development of future reef monitoring priorities, there is a clear need to weigh up the costs and benefits of further standardising the monitoring program against the need to provide event-specific, high-resolution data and information. There is a risk that greater methodological standardisation will result in only one or two monitoring methods being applied. The SNCRN should play an active role in

promoting appropriate reef monitoring techniques that can provide both the quality and the quantity of data required to address the wide range of potential impacts on the Seychelles reefs.

It is important to realise that there is no single coral reef monitoring technique available to date that can produce the wide range of information and data required for proper management of coral reefs. The challenge is to make qualified, smart choices and decisions on the best available monitoring techniques that can provide relevant environmental data for addressing the stated information needs and objectives.

A simple, non-weighted overview of some of the available coral reef monitoring methods and techniques is provided in appendix E. This tabular overview also identifies some of their respective field applications. However, it is by no means intended to be a comprehensive overview of the full range of reef monitoring techniques available. Additional tools and techniques available for both environmental and socioeconomic monitoring in relation to coral reefs can be found in the relevant publications of the Global Coral Reef Monitoring Network.⁴

The targeted use of different reef monitoring techniques should assist the drive to include a wider and more active membership by providing a greater range of options and levels at which valuable observational data can be contributed to the SNCRN. Different coral reef monitoring techniques that reflect differences in the locally available skills can provide important qualitative 'stepping stones' to promote more active participation and involvement of a wider membership. For example, the 'reef check' methodology is particularly suitable for use by relative novices in the field of marine environmental monitoring, whereas intensive transect-based surveys of the abundance, distribution and diversity of reef coral biota clearly require much greater skill levels and, consequently, the use more formally qualified field personnel.

The SNCRN must be proactive in describing and helping to apply the different types of monitoring technique. Irrespective of the methods used, there will always be a need for ongoing training and retraining of field staff, preferably just prior to any scheduled monitoring activities. Depending on the monitoring methods advocated, an appropriately qualified trainer should be used to ensure high and consistent levels of standardisation throughout the data-handling process.

Recommendations

- > The SNCRN should encourage the use of an appropriate range of reef monitoring methods and techniques, thereby recognising the importance of using the best available tools to address the wide-ranging issues affecting coral reefs.
- > The SNCRN should be responsible for providing documentation and field datasheets for a range of suitable monitoring techniques, and regular, dedicated training programs (i.e. 6-monthly) for field personnel involved in on-site reef monitoring activities.

⁴ These are available at the website of Global Coral Reef Monitoring <<http://www.gcrmn.org/>>.

5 Coral reef damage mitigation and rehabilitation

DEVELOPING STRATEGIES FOR PROTECTING AND REHABILITATING CORAL REEFS WAS A KEY OBJECTIVE OF THE MISSION.

Summaries of meetings and interviews held as part of this subproject are provided in appendix C.

Ten coral reef sites were assessed for tsunami-related impacts and the observations are provided in appendix F. Although the impact of the 2004 tsunami appears to have been relatively small, the incident has highlighted the need for the Government of Seychelles to expand work being done to mitigate all impacts on coral reefs to ensure a more resilient ecosystem. Like coral reefs worldwide, the Seychelles coral reefs and fisheries have been under pressure from events such as the coral bleaching event in 1998 and from fishing, land use practices and coastal processes.

Innovative impact mitigation projects, such as substrate stabilisation pilot projects by SCMRT-MPA, are already under way. There is also an investigation of the effects of grazing activities on rates of coral recruitment and survivorship. These projects adequately address a large part of this mission subproject.

Recommendations

- > Additional work needs to be done to manage perceived and actual impacts on reef-based tourism. The development of a questionnaire-based survey of visitor perceptions and responses in relation to the tsunami and the general status of the reefs would serve as a basis for targeted promotional activities through the Ministry of Tourism.
- > Assessing and mitigating impacts from and to the coastal zone should be prioritised. Priority issues to monitor include run-off and coastline modification (including possible changes to drainage patterns). Specifically, three priority impact sites were identified by SCMRT-MPA in the coastal zone for assessment and mitigation options: Anse Royale, Anse La Mouche and Anse Petit Cour (Praslin).

6 Assessing impacts to near-shore fisheries

ASSESSING THE IMPACTS OF THE TSUNAMI ON THE INSHORE AND SHALLOW COASTAL REEF FISHERIES WAS IDENTIFIED AS AN IMPORTANT ACTIVITY TO FILL THE SEYCHELLES GOVERNMENT'S INFORMATION GAP. IT WAS LISTED AS A TOP PRIORITY BY THE SFA AND THE INFORMATION GAP WAS IDENTIFIED AS SIGNIFICANT BY MENR AND UNEP.

On advice from the SFA, we focused our efforts on assessing the tsunami impacts on two important sectors of the artisanal inshore fishery – the inshore finfish fisheries, which include the artisanal trap fishery, and the shallow (mostly reef associated) benthic fisheries, which include sea cucumbers. For details on these fisheries, see the mission report prepared by CSIRO Marine and Atmospheric Research.⁵

INSHORE FINFISH FISHERIES

The study of the inshore finfish fisheries focused on several important fisheries and used fishery-dependent data collected by the artisanal fisheries Catch Assessment Survey. The survey, which was established in 1985, is a system for collecting stratified data on catch, effort and species composition. The survey is stratified geographically and by boat and gear type. Overall there are records from 26 122 sampling days at various landing sites throughout the Seychelles main islands and the database contains 57 807 individual records of catch, effort and species composition.

The inshore trap fisheries were identified as those most at risk from tsunami impacts and there were reports of localised juvenile and adult mortality of the target species rabbitfish (*Siganus* spp.) due to stranding by the tsunami (Jude Bijoux, pers. comm.).⁶ Species categories used for the small boat survey for the artisanal fisheries catch assessment can be found in the report by CSIRO Marine and Atmospheric Research.⁷

CHANGES IN CATCH PER UNIT OF EFFORT

The Seychelles small boat fishery survey employs four types of fishing boat and eight types of fishing gear and captures 18 fish species or species groups.⁸ Many of the boat and gear combinations and species did not have a satisfactory time series of data as most gear types catch only one or two main species. Therefore we selected boat, gear and species combinations for analysis based on their contributions to the total catch. For species, those accounting for more than 5 per cent to the total catch were selected.

⁵ TD Skewes, Y Ye and C Burridge, *Australian Government assistance to the Seychelles tsunami relief effort: assessing impacts to near-shore fisheries*, CSIRO Marine and Atmospheric Research Final Report to AusAID, October 2005.

⁶ The offshore fisheries mostly target deeper demersal (red snappers, e.g. *Lutjanus sebae*, groupers, e.g. *Epinephalus chlorostigma*; jobfish, e.g. *Aprion virescens*) and semipelagic (trevally, barracuda) species.

⁷ Skewes, Ye and Burridge, 2005.

⁸ Skewes, Ye and Burridge, 2005.

We then calculated the monthly mean catch per unit of effort for each species or species group for the period from April 1985 to March 2005 and plotted the data against time to assess trends. For all species the catches per unit of effort in January, February and March in 2005 were within the normal range of variation and did not show any clear declines when compared with those in 2004.

CHANGES IN MONTHLY FISHING EFFORT

We calculated the monthly total fishing effort for the seven selected species. Generally the monthly fishing effort expended on each of these species did not demonstrate any unusual changes following the 2004 tsunami. This may suggest that, while some damage to vessels and gear loss were reported, fishing activity in the inshore, small vessel, artisanal fishery in Seychelles was not significantly decreased by the tsunami.

STATISTICAL ANALYSIS

To investigate any changes in catch per unit of effort associated with the tsunami, a general linear model was used to compare before and after data together with any other factors or covariates such as year and month. For the month factor we chose to include only the three months of January, February and March, because these are the months for which we had data after the tsunami.

The above model was applied separately to each of the seven selected fish species or species groups and to the five years 2001–05 to decrease the influence of long-term trends in the data. The month factor was not significant for any species, and the tsunami factor was significant only for rabbitfish. A check on the coefficient estimate shows that the catch of rabbitfish per unit of effort was 1.68 kg/trap (68 per cent) higher in the three months after the tsunami than in the corresponding months of the previous four years.⁹

Discussion of findings

The general linear modelling based on catch per unit of effort data for the seven selected fish species or species groups did not detect any negative changes after the 2004 tsunami. However, the potential environmental damage caused by the tsunami is more likely to have been translated into fish habitat loss or an increase in the natural mortality of fish at early life stages. This kind of impact may manifest itself over a longer period.

No clear reduction in monthly total fishing effort could be found following the tsunami. This suggests the small boat fisheries were not greatly hindered by tsunami impacts. Most vessel damage and losses occurred in the whaler and schooner fleets, which were moored in the inner harbour of Port Victoria, an area that suffered significant impact. Many small boats moored near district landing sites escaped damage, and outboard engines are usually removed when the boat is moored. In terms of gear, many static fish traps were deployed in deeper areas at the time of the tsunami, and spare fish traps kept by fishers may have compensated for any losses. SFA estimates indicate that overall fishing effort in most artisanal fisheries quickly returned to around 80–90 per cent of effort recorded in the corresponding period of the previous year, probably as a result of relatively rapid repairs to minor damages and due to the considerable latent effort in most fisheries.

Recommendation

- > A monitoring program should be implemented to detect possible long-term effects on fishery resources. For the fast-growing species such as rabbitfish, observations of year class strength over the next five years may reveal a signal related to the tsunami. The collection of ancillary information such as length frequency and age data from the examination of fish otoliths should complement the analysis of fishery data.

⁹ Skewes, Ye and Burridge, 2005.

SHALLOW REEF BENTHIC FISHERIES

In 2004 the SFA completed a project to determine the distribution and abundance of commercial sea cucumbers in Seychelles to form the basis for a sustainable management strategy for this fishery.¹⁰ As part of this project the SFA carried out a large-scale survey of the stock and fishery habitat that included the shallow fringing reefs of the main islands of the Mahé Plateau. As well as determining sea cucumber density, the survey counted benthic macro-invertebrates and semi-quantitatively estimated the percentage cover of important benthic components such as the substrate characteristics and the cover of macrobiotic fauna and flora. The project surveyed 38 sites on and adjacent to coral reefs around Mahé, Praslin and La Digue, and four sites at Ile Mamelles.

The data were used as a baseline for a repeated measures study to investigate changes in sea cucumber density and their related habitats caused by the tsunami. Twelve sites were resampled close to Mahé Island by the SFA and CSIRO scientists on 19 and 20 April 2005, six sites on the north-west side of Mahé Island adjacent to Beau Vallon Beach, and six sites on the north-eastern side adjacent to the Sainte Anne Marine Park. All sites were shallow (less than 20 metres) and part of the fringing reef system of Mahé Island. At each site, sea cucumbers and other benthic fauna of commercial or ecological interest were counted, and the substrate was described in terms of the percentage of sand (less than 2 cm diameter), rubble (2–30 cm), boulders (more than 30 cm), consolidated rubble, pavement and live hard and soft coral. The percentage cover of all other conspicuous biota such as seagrass and algae were also recorded. This is the same sampling protocol used during the full-scale sea cucumber survey carried out in 2004.¹¹

The density estimates for sea cucumbers and sea urchins for each site and year (2004 and 2005) were used to calculate overall and stratum averages and variance values for the 12 repeated sites for each sample year. Paired site density estimates were analysed to investigate the changes in average abundance before and after the tsunami using paired tests on raw and transformed (log and square root) data.

A mixed general linear model was used to analyse selected species counts and environmental variables. In addition to the 12 repeated sites, we included eight sites that were sampled only during 2004 to increase the level of statistical power in the between-stratum comparison and associated interaction terms.

The repeated measures comparison and the mixed model analysis showed that there was a marginally significant increase in density of sea cucumbers after the tsunami of 38 per cent. The increase in density was greater in the western stratum. However, there were no significant differences in the changes in each stratum between the sampling years. None of the change comparisons for individual species of sea cucumber were statistically significant. Population compositions for the two periods were reasonably similar, although there were more *Bohadschia argus*, *B. subrubra* and *Pearsonothuria graeffei* in the post-tsunami population and fewer *B. marmorata*.¹²

Substrate components showed considerable change between the pre-tsunami and post-tsunami sampling periods. Sand cover decreased by 38 per cent while cover of both rubble and consolidated rubble more than doubled. The changes were consistent over the two strata, although the eastern stratum did show a larger increase in loose rubble than the western stratum.

10 R Aumeeruddy, T Skewes, J Dorizo, F Carocci, F Coeur de Lion, A Harris, C Henriette and M Cedras, *Resource assessment and management of the Seychelles sea cucumber fishery*, FAO Project Number TCP/SEY/2902 (A), October 2005.

11 R Aumeeruddy, T Skewes, J Dorizo, F Carocci, F Coeur de Lion, A Harris, C Henriette and M Cedras, 2005.

12 Skewes, Ye and Burridge, 2005.

The average cover of live coral increased slightly between the two sampling periods, though the change was not statistically significant overall. Soft coral cover was consistent over the two years but also extremely spatially variable, resulting in large standard errors and non-significant results even for the large differences between the two strata, given that most of the soft coral was found in the western stratum.

Discussion of findings

The results of the benthic survey indicate that the tsunami did not have a large negative impact on an important shallow reef benthic resource (sea cucumbers) around the main island of Mahé. The tsunami was not expected to cause much direct damage to sea cucumbers, and the movement of sediment and the stirring of the environment may have promoted the bacteria and detritus that sea cucumbers depend on for food.

Live hard coral and soft coral cover did not change significantly at the repeated survey sites after the tsunami, and the increasing trend may indicate the continued recovery of live coral in Seychelles after the catastrophic mortality resulting from the 1998 coral bleaching event.¹³ These general observations showing a lack of direct tsunami-related damage to the fringing reef are similar to previous assessments of tsunami damage in the area carried out soon after the tsunami.¹⁴ However, the changes to sand and rubble cover observed at the repeated survey sites may be related to water movements associated with the tsunami. Loose sediments may have been moved during the tsunami event, with finer particles being moved to deeper water. This is not surprising given the scale of the water movements that occurred during the Seychelles tsunami event.

The IUCN/UNEP assessment¹⁵ identified tsunami-related damage to shallow coral reefs around the granitic islands in the north-east of the Mahé Plateau, such as Praslin and La Digue. However, this was not detected in interviews with dive operators in this area (appendix C) or in site assessments (appendix F). If there were damage, we would have expected it to be more prevalent in the north-eastern region, the area first impacted by the water movement. As there are suitable baseline sites around the north-eastern islands, sampling could be repeated in that area to quantify any changes.

The impact of the tsunami on the shallow reefs does not appear to be deleterious in the short term. There were no large decreases in sea cucumber density or live coral cover in the three months after the tsunami, and the environmental changes may be reversed over time by natural movement of soft sediments by ambient currents.

Recommendation

- > Because there may be changes in the shallow reef benthic fisheries in the longer term as a result of the tsunami, the suitable benthic sample sites on shallow reefs throughout the Seychelles Plateau and the Amirantes should be included in a monitoring strategy for the longer term.

13 U Engelhardt, M Russell and B Wendling, 'Coral communities around the Seychelles islands 1998–2002', in Olof Linden et al. (eds), *Coral reef degradation in the Indian Ocean: status report 2002*, CORDIO, Sweden, 2002, pp. 212–31.

14 PA Adam and U Engelhardt, 'Seychelles reefs post the tsunami', *Marine Conservation News*, vol. 3, no. 1, January 2005; D Obura and A Abdulla, *Assessment of tsunami impacts on the marine environment of the Seychelles*, IUCN/UNEP Report, 2005.

15 Obura and Abdulla, 2005.

7 Conclusions

THE AUSAID MISSION HAS DRAWN THE FOLLOWING CONCLUSIONS BASED ON PREVIOUS ASSESSMENTS BY EXTERNAL AND LOCAL ORGANISATIONS, IN-COUNTRY INTERVIEWS, SITE VISITS AND DISCUSSIONS WITH SEYCHELLES ORGANISATIONS.

Coral and fish seem to have been relatively unaffected by the tsunami. There was minimal impact on coral reefs and fisheries in Seychelles. However, environmental damage related to the tsunami may manifest itself in the longer term. Therefore, the existing monitoring program (Catch Assessment Survey) should be continued and enhanced to detect long-term effects on fishery resources. For the fast-growing species, such as rabbitfish, observations of year class strength over the next five years may reveal a signal related to the tsunami. The collection of ancillary information such as length frequency and age data from the examination of fish otoliths would compliment the analysis of fishery data. Some finer scale sampling of catch composition and population parameters is also recommended.

Similarly, the benthic survey sites from the broad-scale sea cucumber survey carried out in 2004 proved to be a useful baseline for detecting changes in invertebrate populations and their habitats. This network of sites throughout the Mahé Plateau and the Amirantes could be included in a longer term monitoring strategy.

It is recommended that the Seychelles Government consolidate all tsunami impact assessment reports conducted to date. This would provide a basis for prioritising resources for research, monitoring and management of the coral reef ecosystem. The SNCRN needs to be revitalised or expanded into a more output-driven program. Its primary role should be to provide information for management. The SNCRN should involve a wider part of the community in coral reef issues. Mitigation of other impacts to the marine ecosystem will help to make the system resilient. The reefs will recover naturally, provided other impacts are minimised. Mitigation measures should include greater coastal zone management, including minimising the pollution in run-off, preventing sediment drift from any land reclamation activities, and carefully assessing the locations of coastal development. Fishing pressure in coastal areas needs to be reduced by, for example, establishing an expanded network of marine protected areas based on protecting robust and representative examples of habitats.

Developing a national plan of action would provide support for ensuring an ecologically sustainable ecosystem in the long term.

The key reef management issues identified in this report are a sound basis for attracting future international assistance.

A Terms of reference for AusAID team

MISSION – TERMS OF REFERENCE

- 1 Undertake, and lead the implementation of the following sub-program components with the relevant Government of Seychelles ministries as defined in the approved mission proposal:
 - > Building an overall reef monitoring strategy,
 - > Coral reef damage mitigation and rehabilitation, and
 - > Assessing impacts to near-shore fisheries including
 - (a) assessment of impacts to shallow benthic communities
 - (b) assessment of impact to artisanal finfish fisheries.
- 2 Coordinate with the Australian and Seychelles team members to plan and facilitate the logistics of the work program as per the proposal.
- 3 Assist the team in preparing syntheses and summaries of data collected, and in writing a report detailing the team's activities, data and conclusions.

REPORTING – TERMS OF REFERENCE

- 1 Coordinate with the other Australian team members and the Seychelles team members of the Ministry of the Environment and Natural Resources' (MENR) and the Seychelles Fisheries Authority (SFA) to compile a final report for the Governments of Australia and the Seychelles.
- 2 Recognising that component one and two will initially be drafted with one Seychelles ministry (MENR) and component three with another Seychelles ministry (SFA):
 - > Ensure the reports for all three components of the mission are consistent and can be compiled in a similar or compatible format

for a combined report, recognising the Seychelles ministries may consider them to be separate reports for their own purposes.

- > Acknowledge (list) the Seychelles contributors of the two Seychelles ministries.
 - > Acknowledge (list) the Australian contributors of the two Australian departments (GBRMPA and CSIRO) and the Australian contracted company of Reefcare International.
- 3 Ensure that any recommendations made in the report are consistent with:
 - > the views of the Seychelles Government and the Australian experts undertaking the assistance mission
 - > Australian government tsunami aid policy with the Seychelles
 - > And within the capabilities of the Seychelles Government to carry forward without future requirement for Australian development assistance funds.
 - 4 Acknowledge any others, if relevant, who may have significantly contributed or been intellectually involved in the mission, e.g. IUCN, UNEP.
 - 5 Collect an electronic version of the logos of the Seychelles ministries, CSIRO and GBRMPA logos to supply to AusAID, for the purpose of the final publication of the report, which will be undertaken by AusAID in Canberra.
 - 6 Ensure that the relevant Seychelles Government authorities ratify the final draft of the report before its presentation to AusAID at the end of the mission.
 - 7 Drafts and final copies of the report should not be released publicly by any parties without the prior knowledge and consent of AusAID.

B AusAID mission subprojects

The mission subprojects were determined during discussions in Seychelles with the Government of Seychelles.

1 BUILDING AN OVERALL REEF MONITORING STRATEGY

There is a clear need to collect suitable data for determining long-term trends in the status of coral reefs for conservation planning. There is already considerable research effort on coral reefs by government agencies and non-government agencies but it is somewhat fragmented. Developing a system within which the non-government organisations can conduct complimentary monitoring surveys would be a major improvement to the coral reef monitoring capacity in Seychelles.

This subproject will include:

- > designing an efficient and targeted monitoring strategy suitable for guiding long-term reef monitoring activities, and
- > recommending options to implement the above strategy through a nationally coordinated local network of relevant stakeholders.

This subproject will be achieved by consulting and interviewing relevant stakeholders and subsequently preparing a long-term monitoring strategy that includes an overview of applicable monitoring tools and techniques. The identified activities will complement current initiatives aimed at revitalising a coordinated reef-monitoring network in Seychelles. To this end, the activities would include discussions with and contributions from participants to identify:

- > a hierarchy of information needed for assessing the condition of reefs
- > components of their monitoring programs that are directed towards common goals (a fishery agency and a marine parks agency may have different objectives)

- > ways to make data from different programs compatible (for instance, one can count coral reef fishes using different methods and a study using the different techniques on the same area would allow biases in the techniques to be estimated)
- > the components of a simple reporting system, preferably web-based
- > gaps in the available information, and
- > other resources that are relevant, for instance remote sensing of sea surface temperature (e.g. the National Oceanic and Atmospheric Administration Coral Bleaching Hotspots program and possibly ocean colour).

2 CORAL REEF DAMAGE MITIGATION AND REHABILITATION

The December 2004 tsunami is the latest of a series of impacts on the Seychelles coral reefs, including a large coral bleaching event in 1998, fishing and tourism impacts and coastal processes. This subproject is focused on developing strategies for protecting and rehabilitating coral reefs, particularly protecting or increasing the cover and diversity of live coral.

This subproject will include:

- > assessing and mitigating impacts from and to the coastal zone, e.g. run-off and coastline modification (including possible changes to drainage patterns), and
- > managing perceived and actual impacts on reef-based tourism.

This subproject will be done by compiling available site-specific information on tsunami impacts, including formal assessments by MENR's Environmental Impact Assessment Unit as well as other observations.

Three priority impact sites were identified in the coastal zone for assessment and mitigation options:

- 1 Anse Royale
- 2 Anse La Mouche
- 3 Anse Petit Cour (Praslin).

3 ASSESSING IMPACTS TO NEAR-SHORE FISHERIES

Inshore fisheries are an important source of income and protein for the Seychelles people. The per capita consumption of fish in Seychelles is one of the highest in the world and the artisanal fisheries contribute significantly to the protein requirements of the population.

There are likely to be direct and indirect impacts of the tsunami on the fish stocks that support these fisheries. For example, sea cucumber populations could be affected by damage to coral reefs, and the Seychelles Fishing Authority has reported that finfish populations suffered high mortality due to stranding. CSIRO was recently involved in an FAO-funded project to assess the status of the sea cucumber fishery in Seychelles.

This subproject will assess the impact of the tsunami on two important sectors of the artisanal inshore fishery, as outlined in the SFA submission:

- > the shallow (mostly reef associated) benthic communities, including sea cucumber, and
- > the inshore finfish fisheries, which include the artisanal trap fishery.

C Meeting and interview summaries

18 APRIL 2005

Meeting at SFA attended by Riaz Aumeeruddy, Jan Robinson, Tim Skewes, Martin Russell and Udo Engelhardt

- > Meeting was to include other MENR staff. However, participants postponed to a later date.
- > Informal discussions were held on the information available from other international teams.
- > The SNCRN is not fully functioning at this stage. It will need funding and resources.

18 APRIL 2005

Phone interview between Martin Russell and George and Margaret Norah, Managers, Bird Island Resort, Bird Island

- > At 11.30 there were extreme low and high water levels, but not to the highest water level.
- > There was no real beach damage to the island.
- > Dr Thales, Austrian University of Innsbruck, assessed the tsunami impact on coral and fish. Her conclusion is that there is little to no impact damage.
- > Denise Island did get some water movement over the island, and seven guests had to be redirected to Bird Island because of accommodation damage.
- > The damage to Seychelles is not as bad as first thought. It is very localised and only some people and areas have been affected.
- > Not sure why Seychelles is not helping other countries.
- > Praslin has had some impacts. Platte Island (Island Development Commission managed) in the south was impacted because it is a low island.
- > Margaret Norah supplied several photos and video footage of the movements of water at Bird Island. The following photos show the extreme low tide at Bird Island resort and the extreme high tide at Bird Island Resort, within about one hour.

TOP PHOTO: *Extreme low tide at Bird Island Resort, looking north*

BOTTOM PHOTO: *Extreme low tide at Bird Island Resort, looking south*



TOP PHOTO: *Extreme high tide at Bird Island Resort within 1 hour, looking north*

BOTTOM PHOTO: *Extreme high tide at Bird Island Resort within 1 hour, looking south*



Interview with Keith Berke, owner–operator, Anchor Café, Anse La Mouche, Mahé Island

- > There were more than nine movements of the water.
- > Keith Berke lost most of his shop and house contents.
- > Water moved more than 250 metres inland.
- > A Canadian geological shoreline study was done just after the tsunami. The report recommended the Seychelles Government no longer approve land development practices so close to the beachfront.
- > Keith Berke received about 10 per cent compensation, and there are rumours of inconsistent compensation.
- > The Government declared a national holiday the day after the tsunami, but this had the effect of hindering any clean-up work. People wanted to come and have a look at the damage, rather than help. Couldn't buy equipment, etc.
- > There is no shortage of fish in Seychelles as a result of the tsunami. There is no change because of the loss of boats. Some smaller boats were affected, but most boats are OK.
- > The coral and fish life in Anse La Mouche are OK and there is no sign of any damage, except for some minor disturbance of seagrass beds.
- > Keith Berke supplied many photos and video footage of the movements of water at Anse La Mouche. The following photos show the extreme low tide at Anse La Mouche, the extreme high tide at Anse La Mouche, within about one hour, and incoming water at Anse La Mouche.

19 APRIL 2005

Meeting at SCMRT-MPA attended by Jude Bijoux, Rodney Quatre, Jan Robinson, Udo Engelhardt and Martin Russell

- > The meeting discussed the project, Australian Government Assistance to the Seychelles Tsunami Relief Effort, and what needs to be modified considering the resources, staff and time available.
- > It was agreed that:
 - 1 the proposal dated 6 April 2005 will need modification as detailed below.
 - 2 Jude, Rodney, Pierre, MCSS staff and other SNCRN members will be contacted by the AusAID team to discuss the needs in relation to subproject 1.
 - 3 The AusAID team will meet with Jude, Rodney and Kate at SCMRT-MPA on Wednesday 20 April at 08.00 to discuss aspects of subproject 1.
 - 4 The AusAID team will conduct a workshop/ briefing session with identified stakeholders on the initial findings in relation to both subprojects 1 and 2 on Friday 22 April at 13:30 to 15:30 at SFA meeting room.
 - 5 Jude will provide first-hand accounts of tsunami progression and impacts as observed by rangers in the Curieuse Marine National Park, as well as any other relevant background information on observed tsunami impacts.
 - 6 Jude will provide a one-page summary overview on the substrate stabilisation pilot project for inclusion in the report.

TOP PHOTO: *Extreme low tide at Anse la Mouche*

BOTTOM PHOTO: *Extreme low tide at Anse la Mouche*



TOP PHOTO: *Extreme high tide at Anse La Mouche within 1 hour*

BOTTOM PHOTO: *Extreme high tide at Anse la Mouche within 1 hour*



PHOTO: *Incoming water at Anse La Mouche*



The following paragraphs represent the modified work program as agreed.

1. Building an overall reef monitoring strategy

This project will:

- > Design efficient and targeted monitoring strategy suitable for guiding long-term reef monitoring activities.
- > Recommend implementation options for the above strategy through a nationally coordinated local network of relevant stakeholders.

This sub-project will be achieved through targeted consultation using interviews and subsequent preparation of a targeted long-term monitoring strategy including an overview of applicable monitoring tools and techniques. The identified activities will complement current initiatives aimed at revitalizing a coordinated reef-monitoring network in Seychelles. A draft document will be provided to the SNCRN in time for their next scheduled meeting in early May 2005.

2. Coral reef damage mitigation and rehabilitation

This project will include:

- > Assessing and mitigating impacts from and to the coastal zone, e.g. runoff, coastline modification (including possible changes to drainage patterns).
- > Managing perceived and actual impacts on reef based tourism.

This sub-project will be done through a compilation of available site-specific information on tsunami impacts, including formal assessments by MENR's EIA unit as well as other observations.

Jude identified three priority impact sites in the coastal zone for assessment and mitigation options. These are:

1. Anse Royale
2. Anse La Mouche
3. Anse Petit Cour (Praslin)

3. Assessing impacts to the near shore and shallow reef fisheries.

This project will remain as detailed in the original proposal (Appendix X).

Sub-project activities agreed to be beyond the scope of a short-term mission, or duplicating existing activities are as follows:

Sub-point one, Substrate stabilization pilot projects.

Jude advised that the SCMRT-MPA is already conducting a funded pilot study looking at a range of substrate stabilization methods near Beacon Island. Furthermore, this project is also investigating the effects of grazing activities on rates of coral recruitment and survivorship, which relates to **sub-point four, Enhancing the natural recruitment/survival of coral recruits.**

Sub-point three, Managing fishing impacts and tourism/general use impacts.

It was agreed that this sub-point is being covered in sub-project three (being conducted by Tim Skewes and SFA). However, the tourism aspect of perceived/actual impacts should be considered further, and recommendations for further action should be provided.

- > Key sites for looking at impacts are:
 - Anse Petit Cour
 - Anse Royale
 - Anse La Mouche.
- > An awareness-raising component was proposed for the tourism industry to bring perception back to the real issue.
- > AusAID team agreed to meet again on Wednesday 20 April 2005 at 08.00 with Jude, Rodney and Kate.
- > A workshop and briefing session should be held on Friday 22 April at SFA to discuss project with all relevant stakeholders.

- > Staff availability is very limited next week, and so meetings etc will not be possible. Need to make the most of this week.
- > Udo and Martin reworded the project proposal because of the above discussions. This document was given to Jude at 13.00 on 19 April 2005.
- > Jude phoned at 17.00 to advise that the meeting scheduled for 08.00 on 20 April 2005 would need to be postponed because he was in a meeting all day and could not discuss the amended project with his manager.

19 APRIL 2005

Meeting at MENR Marine Unit attended by Selby Remie, Pierre-Andre Adam, Udo Engelhardt and Martin Russell

- > There is an SNCRN meeting proposed for 2 or 3 May 2005. Therefore, the draft AusAID tsunami report should be ready for tabling at this meeting.
- > The SNCRN terms of reference have been drafted.
- > The minutes of previous SNCRN meetings will be made available.

20 APRIL 2005

Interview with Achim Leiss and Kolja Uhlig, Managing Directors, Angel Fish Dive Centre and Yacht Charter, Mahé Island

- > Private marina was washed away.
- > The channel was deepened because of the water movement. However, this is a good thing.
- > A large coral rock cracked apart on Moyenne Island. However, this coral area has been modified from the land reclamation and was fragile anyway.
- > There was no damage to the underwater environment. There were very strong currents (14 knots), but this caused damage to above water areas only.

- > The tsunami has affected the tourism industry, because there have been cancellations. The dive centre has mostly European clients, and they have cancelled flights and bookings.
- > The Seychelles Tourism Marketers Association has sent emails to tour offices saying that Seychelles is not affected by the tsunami. However, Achim and Kolja are not sure that this is effective.
- > The Seychelles Government gave no warning of the tsunami to businesses. The staff at the dive centre noticed water started to rise, and attempted to move boats to safety. They had a boat on a dive site, with divers in the water, and they radioed them to say 'something strange is happening'.
- > They have not been approached to be part of the SNCRN, but would like to be part of it.
- > Achim Leiss supplied several photos of the movements of water at the Angel Fish Dive Centre marina. The following photos show the extreme low tide at the Angel Fish Dive Centre marina and the airport highway bridge being washed out by the receding tide.

21 APRIL 2005

Meeting at SFA attended by Jan Robinson, Udo Engelhardt and Martin Russell

- > The two UNEP reports and the Canadian report will be made available.
- > Jan is to organise a meeting with Rolph Payet.
- > The AusAID report should be channelled through the Department of Foreign Affairs to help ensure it gets the necessary response.
- > The SFA's Geographic Information Systems section is to provide inundation maps.

21 APRIL 2005

Meeting at SCMRT-MPA attended by Jude Bijoux, Udo Engelhardt and Martin Russell

- > Problems with the SNCRN were discussed.
- > There needs to be more involvement of operators, and this needs coordination.
- > There is a need to assign specific areas of responsibility to organisations.
- > SNCRN participants are not really aware of what needs to be done. There is a lack of focus and objectives.
- > Outputs from the SNCRN should be used in management decision-making, but there is no clear process for this.
- > The outputs should feed into national and international status reporting on an annual basis. This could be done at a ministerial level. This information needs to feed back to tourism promotion activities.
- > The SNCRN Coordinator should be a government staff member.
- > The SNCRN needs to be more proactive to notice local issues such as changes to fishing (live fish trade, aquarium fish, etc.) and the introduction of pests.
- > Non-government organisations, dive facilities and resorts should be part of the SNCRN.
- > There is a lack of awareness of the marine ecosystem issues and initiatives in the community.
- > There is a need for newsletters, meetings and schools field trips (e.g. Reef Guardian Schools).
- > The non-government organisation, Reef Check, could become involved in some future monitoring.

TOP PHOTO: *Extreme low tide at the Angel Fish Dive Centre marina*
BOTTOM PHOTO: *Airport highway bridge washed out by receding tide*



21 APRIL 2005

Meeting at MENR attended by Selby Remie, Pierre-Andre Adam, Udo Engelhardt and Martin Russell

- > The SNCRN should be run by government.
- > Monitoring should be done by both government and other stakeholders.
- > Problems have occurred with getting people on board the SNCRN. More non-government organisations need to be involved. All stakeholders need to be involved in monitoring (i.e. tourism and fishing).
- > There is unlikely to be any patch conflict or problems with people not supplying data.
- > Financing will need to be explored by the SNCRN. In the interim, funding could come from the Nairobi Convention.
- > Selby is Chair; Jude is the contact/central point.
- > It was proposed that Pierre become the coordinator for putting together the status report, relying on contributions from all SNCRN participants.
- > There is a need for an international linkage. This is already in the terms of reference, but there is no linkage working yet. Formal links have already been made with the Global Coral Reef Monitoring Network to report on the status of Seychelles reefs.

24 APRIL 2005

ICRI discussions

Jude Bijoux of SCMRT-MPA advised the International Coral Reef Initiative (ICRI) that most of the impact to coral reefs in Seychelles from the tsunami is on unconsolidated rubble areas, not on the granitic areas. Some channels and passes have been affected, especially from the backwash with debris.

Clive Wilkinson of the Global Coral Reef Monitoring Network advised ICRI that there is a need to remove other impacts to coral reefs to help ensure minimal impacts from events such as a tsunami. There is a need for more marine protected areas and better coastal management. The coral reefs will recover naturally provided other impacts are minimised or mitigated. There are many offers of assistance from organisations and countries to help rehabilitate damaged reefs in Seychelles, but this would seem to be a misdirected use of resources.

26 APRIL 2005

Interview with Sabrina Dobin, dive instructor, Underwater Centre, Mahé Island

- > Sabrina was diving with a group of eight people at Baie Ternay Reef Marine Park in 16 metres of water when the tsunami arrived in Seychelles.
- > The current started to move strongly in different directions, and the visibility dropped dramatically to near zero.
- > The coral and fish at dive sites have been unaffected by the tsunami. Sabrina mentioned that more damage occurs from boats anchoring on coral reefs than by the tsunami.

26 APRIL 2005

Interview with Glynis Sanders, owner-operator, Underwater Centre, Mahé Island

- > There is minimal to no damage from the tsunami to corals and fish at dive sites around Mahé.
- > Some fishers could not catch fish for a few days after the tsunami because of the after currents.

26 APRIL 2005

Interview with David Rowat, Chair, Marine Conservation Society Seychelles

- > There is minimal to no damage from the tsunami to corals and fish at dive sites around Mahé.

26 APRIL 2005

Interview with Gillie Fideria, owner–operator, Big Blue Divers, Mahé Island

Tsunami issue

- > There is minimal to no damage from the tsunami to corals and fish at dive sites around Mahé.

SNCRN issue

- > Local dive operations should be offered more incentives to become involved in coral reef monitoring activities such as concessional rates on certain taxes.
- > Expenditure recovery is seen as a major issue in trying to get monitoring activities on a long-term sustainable basis.
- > The SNCRN should be engaging in a lot more on-the-ground actions and activities involving local children and the media.
- > SNCRN participants should be allowed to gain valuable publicity in return for their efforts as a promotional tool.
- > There is a need for more creative ideas to generate a higher level of public interest and participation.
- > The SNCRN should embark on a targeted membership drive, using posters, stickers and reward certificates.
- > Given the international nature of the Seychelles dive tourism industry, the SNCRN's activities should focus on providing information to international visitors and agencies.
- > The important role of the private sector in supporting SNCRN activities should be acknowledged with more regular feedback provided by the coordinating bodies within government.

27 APRIL 2005

Interview with Seedy, dive instructor, Azzurra Pro-Dive Centre, La Digue Island

- > The tsunami caused some rubble movement, but in areas where the rubble is loose anyway.
- > There is no recognisable damage to coral reefs around La Digue. Seedy regularly dives 25 different sites and has seen no damage to coral or fish that could be attributed to the impact of the tsunami.
- > Most impact occurred in the harbour, where boats were tied to the wharf.
- > There was about a 10-knot current near the harbour.
- > The dive centre has not been approached to be part of the SNCRN, but would like to be part of it.
- > Seedy suggested that it would be good for the SNCRN to provide knowledge to dive operators. This could be passed onto tourists to give an environmental image. There are often questions from divers about the condition of the reefs in Seychelles. It would be a major drawcard and opportunity to demonstrate awareness of the health of the coral reefs in Seychelles if the information from the SNCRN were made available.
- > Seedy suggested having an information package on laminated paper about what the SNCRN is and its activities, including pictures.

27 APRIL 2005

Interview with Veronique Vanacore, owner–operator,
Octopus Dive Centre and White Tip Divers,
Praslin Island

- > Some rubble and live shells have been washed up onto some beaches.
- > Many clients with booking emailed her to see whether it was still OK to come for a diving holiday. No cancellations have occurred to date.
- > There has been no recognisable damage to dive sites around Praslin Island.
- > The dive centre has not been approached to be part of the SNCRN, but would like to be part of it.
- > There needs to be a more consistent approach to coral reef conservation, with a balance between land reclamation and coral reef protection.

Draft terms of reference for the Seychelles National Coral Reef Network

(Draft provided by MENR, 21 April 2005)

SEYCHELLES NATIONAL CORAL REEF NETWORK TERMS OF REFERENCE

Background

The Coral reefs of Seychelles and in the region are under considerable human pressures, with increasing human populations and coastal development. These stresses have been intensified by natural factors such as more frequent coral-bleaching events and coral grazing organisms (e.g. Crown of Thorns Starfish). In response to these ever increasing stresses a National Coral Reef Monitoring Network known as the Seychelles National Coral Reef Network was set up under the auspices of the Indian Ocean Commission in 1997.

Furthermore, a Regional Coral Reef Task Force (CRTF) was established by the Third meeting of the Conference of Parties of the Nairobi Convention as per decision CP.3/2 Protection of coral reefs and associated ecosystems. The decision also recommended the establishment of national bodies to co-ordinate coral reef activities within each country and to develop national coral reef action plans or strategies where appropriate. The network should support the development of local capacity in research, management and government, co-ordinate communication at the national level, and serve as a platform to share information on regional initiatives. It should influence the review of legislation and policy change at national level as appropriate. It should also encourage monitoring programs within the country and recommend better coordination within and between countries in the region in designing and implementing monitoring programmes.

Bearing the factors mentioned above in mind, the Ministry of Environment and Natural Resources has found it necessary to expand the membership of the network for it to be more representative, in order to discuss coral reef issues in a more coordinated, transparent and coherent manner.

The New Terms of Reference for the Coral Reef Network is as follows:

Membership

Current active members: Ministry of Environment and Natural Resources, SCMRT-MPA, Maritime Training Centre, Seychelles Coast Guard, Apostolat de la mer, Big Blue Divers and Seychelles Island Foundation.

Meetings

The Network will meet at least on a quarterly basis.

The Network shall:

- 1 Assist with the development of local capacity in research, management of coral reefs and associated ecosystems.
- 2 Assist in the preparation and review of coral reef action strategies both nationally and internationally.
- 3 Examine the need for appropriate mechanisms to design suitable national action plans or equivalent strategies, under the umbrella of the regional action plans and sub-regional frameworks.
- 4 Facilitate communication with other organisations working coral reefs and associated ecosystems.
- 5 Review of legislations and policies at national, regional and international level as appropriate.

- 6 Improve reporting mechanisms nationally and within the region on coral reef work.
- 7 Conduct education and sensitisation programs in order to raise the profile of coral reef issues in the country.
- 8 Facilitate and encourage communication and the dissemination of information nationally and within the region using the most appropriate mechanisms.
- 9 Encourage the development of capacity building and training opportunities.
- 10 Ensure coordinated coral reef monitoring programs within the country that is efficient, and avoids duplication and wastage of resources.
- 11 Assist with ongoing work with regards to marine invasive species.
- 12 Promote both biophysical and socio-economic monitoring.
- 13 Promote more effective co-ordination with regional and international monitoring programmes.
- 14 Promote exchanges of information between different scientific bodies working in Seychelles.
- 15 Assist with approval of research applications related to coral reef ecosystems.
- 16 Promote activities that will attract funding for coral reef work in the Seychelles.

Reporting

The Network shall after the period of each working year, provide a status report about its activities.

Recommendations shall be made as to the running of the Network itself and with regards to specific activities undertaken by the Network.

Overview of coral reef monitoring methods and techniques recently used in Seychelles

Table E1 presents a simple, non-weighted overview of coral reef monitoring methods and techniques used in Seychelles since the 1998 mass coral-bleaching event. All of the listed methods and techniques have their distinct applications, strengths and weaknesses that would need to be considered prior to selecting any one of these techniques for a particular monitoring purpose.

Potential users should be made aware that the ultimate choice of monitoring method depends entirely on the objectives of the study. The level of detail (data resolution) required and the level of certainty needed for management responses to be initiated are two possible selection criteria.

TABLE E1 CORAL REEF MONITORING TECHNIQUES AND METHODS USED IN SEYCHELLES SINCE 1998

Method/technique (in alphabetical order)	Project	Biota	Skills	Contact
Benthic quadrates – randomised	GEF SEYMEMP	Coral recruits	Medium	MENR
Benthic transects – permanent	GEF-COI	Coral cover & fish abundance	Medium	SCMRT-MPA
Benthic transects – randomised	GEF SEYMEMP	Coral cover	Medium	MENR
Benthic transects – randomised	GEF SEYMEMP	Coral diversity	High	MENR
Reef check survey	MENR	Reef benthos & fish	Low	SCMRT-MPA
Stationary point counts	GEF SEYMEMP	Reef fish	High	MENR
Stationary point counts	University of Newcastle	Reef fish	High	SCMRT-MPA
Transect swim counts	GEF-COI	Reef fish	Medium	SCMRT-MPA
Transect swim counts	GEF SEYMEMP	Reef fish	High	MENR

Note: GEF-COI = Global Environment Fund Seychelles reef monitoring project.
 GEF SEYMEMP = Global Environment Fund Seychelles marine ecosystem management project.
 MENR = Ministry of Environment and Natural Resources.
 SCMRT-MPA = Seychelles Centre for Marine Research and Technology – Marine Parks Authority.

Rapid assessments of coral reef sites likely F to have been affected by the tsunami

Ten coral reef sites were surveyed for tsunami-related damage using a simple rapid assessment protocol – two observers using scuba and/or snorkels visually assessing possible impacts on reef habitats and associated benthic biota. Observations were recorded by Udo Engelhardt, Martin Russell and David Rowat of the Marine Conservation Society Seychelles.

TABLE F1 OBSERVED TSUNAMI-RELATED IMPACTS AT 10 CORAL REEF SITES

Date	Location	Survey	Tsunami impact	Recovery since 1998 bleaching event
27 January 2005	Baie Ternay Reef	Scuba	<1% of area	Good coral recovery
27 January 2005	Corsaire Reef	Scuba	<1% of area	Low coral recovery
28 January 2005	Aquarium Reef	Scuba	None	Good coral recovery
28 January 2005	L'ilot Rocks	Scuba	<1% of area	–
27 April 2005	Cousine Is Reef	Snorkel	None	Low coral recovery
27 April 2005	Anse Petit Cour Reef / Praslin	Scuba	<1% of area	Good coral recovery
27 April 2005	Petite Soeur Is Reef	Snorkel	<1% of area	Low coral recovery
27 April 2005	Ilê Cocos Reef	Snorkel	<1% of area	Moderate coral recovery
27 April 2005	Marianne Is Reef	Scuba	<1% of area	Good coral recovery
27 April 2005	La Digue Reef	Scuba	<1% of area	Low coral recovery

