South Pacific Regional Environment Programme

SPREP Report and Studies Series no. 100

Environmental Impact Assessment (EIA) Report

Atmospheric Radiation and Cloud Station in Nauru

SPREP Library Cataloguing-in-Publication Data

Onorio, Komeri

Environmental impact assessment report : Atmospheric Radiation and Cloud Station in Nauru / by Komeri Onorio. - Apia, Samoa : SPREP, 1997.

18 p. : maps, photos ; 29 cm. - (SPREP Reports and Studies series ; no.100).

"Prepared for the United States ARM Program's Tropical Western Pacific Program Office and the Ministry of Island Development and Industries, Republic of Nauru".

ISBN: 982-04-0175-5

1. Environmental impact analysis - Atmospheric Radiation and Cloud Station - Nauru. 2. Environmental monitoring - Atmospheric Radiation and Cloud Station - Nauru. I. Atmospheric Radiation Measurement (ARM) Program. II. South Pacific Regional Environment Programme. III. Title. IV. Series.

333.7109685

Published in November 1997 by the
South Pacific Regional Environment Programme
PO Box 240
Apia, Samoa

Typeset in 11/13 Garamond
Printed on recycled paper 90gsm Savannah Mat Art (60%) by
Commercial Printers Ltd
Apia, Samoa

Cover photo: The island of Nauru (courtesy of the *Tropical Western Program Office*)

Original Text: English

South Pacific Regional Environment Programme

Environmental Impact Assessment Report

Atmospheric Radiation and Cloud Station in Nauru

Prepared for the United States ARM Program's
Tropical Western Pacific Program Office
and
Ministry of Island Development and Industries
Republic of Nauru

by Komeri Onorio
Environmental Impact Assessment Officer
South Pacific Regional Environment Programme

Contents

List of Figures

1 INTRODUCTION

The Atmospheric Radiation Measurement Program (ARM) contracted with SPREP's Climate Change Programme to act as an independent regional consultant to determine likely environmental impacts of locating and operating an Atmospheric Radiation and Cloud Station (ARCS) in the Republic of Nauru. In particular, ARM is concerned with the appropriate improvement of the seawall at the proposed ARCS site.

This report incorporates comments raised by the ARM Program on the draft report. Comments from the Nauru Government were not available at the time of publication.

1.1 The Atmospheric Radiation Measurement Program (ARM)

The US Department of Energy (DOE) initiated the Carbon Dioxide Research Program in 1978 to address the effects of increased concentrations of carbon dioxide in the atmosphere. Recently, DOE developed programmes that are an integral part of the extensive national and international effort to understand global climate change.

Large-scale numerical models are key elements of modern climate research and the effort to accurately predict future climate scenarios. The models of the global climate system have advanced to include realistic geography, the annual cycle of the seasons and varying cloud cover. However, research has also revealed that important uncertainties remain in these computer models.

DOE's Atmospheric Radiation Measurement Program was therefore created in 1989 to address the impact of clouds (one of the most important of these uncertainties) on the atmospheric energy balance and to improve climate change predictions. This programme now forms part of the ongoing effort to resolve scientific uncertainties about global climate change that may result from the addition of carbon dioxide and other so-called greenhouse gases to the atmosphere.

Modelling the impacts of clouds are difficult due to their complex and differing effects on both weather and climate. Clouds can reflect incoming sunlight and therefore contribute to cooling, but they also absorb infra-red radiation leaving the earth and thereby contribute to warming. High cirrus clouds for example, may have the impact of warming the atmosphere while low lying stratus clouds, which are frequently found over oceans can contribute to cooling. In order to successfully model and predict climate, it will be necessary to have the ability to both describe the effect of clouds in the current climate but also predict the complex chain of events which might modify the distribution and properties of clouds in an altered climate.

The specific goals of ARM, therefore, are to:

- improve General Circulation Models (GCMs) as tools for predicting global and regional climate change;
- improve the treatment of radiative transfer in GCMs under all conditions i.e. clear sky, general overcast and broken cloud conditions; and
- improve the parameterisation of cloud properties and formation of clouds in GCMs.

1.2 The ARM Experimental Program

Improving the treatment in General Circulation Models of clouds and their interaction with solar and terrestrial radiation requires a new experimental approach to the study of climate models. ARM has chosen to create an experimental framework in which large arrays of instruments can be used over extended periods of time to understand not only the processes associated with clouds and radiation, but also the way in which these processes are captured in climate models. These instruments will collect data for analyses that will help determine the effects and interactions of sunlight, radiant energy and clouds on temperatures as well as weather and climate. Knowledge gained from these measurements will contribute to a better understanding of potential climate changes by improving the accuracy of the computer models used to predict these changes.

Three primary and six supplementary locales, also referred to as Cloud and Radiation Testbed (CART) field measurement sites, were identified as representing the range of climatically significant regimes in which observational programmes should be conducted. The selection of the primary and supplementary locales involved an extensive evaluation based on the cloud and radiation processes to be studied and modelled in order to achieve the objectives of the ARM Program. The primary locales selected include the Southern US Great Plains, the Tropical Western Pacific Ocean and the North Slope of Alaska. The first primary locale, in the Southern Great Plains, was dedicated in 1992. The second to be established by the ARM Program is in the Tropical Western Pacific (TWP). The TWP locale covers the area between approximately 10°N to 10°S of the Equator from Indonesia to near Christmas Island, locally known as Kiritimati (see figure 1.1).

The ARM Program has commenced deploying to the TWP locale by establishing the first of several Atmospheric Radiation and Cloud Stations (ARCS) in Manus, Papua New Guinea, in September 1996. This will be followed by the founding of an ARC Station in Nauru during 1998. The establishment of Kanton and Kiritimati ARCS will commence following the completion of the Nauru station. In each primary locale, a "site" related to the size of a typical general circulation grid cell will be equipped with an array of instruments for long-term (seven to ten years) observations, to support the evaluation and improvement of cloud and radiation process models. The current ARCS design consists of five to six containers, and will include meteorological instruments, computer systems for data collection and storage, a satellite communications system and support equipment (see figure 1.2 for an artist's impression of a typical ARCS).

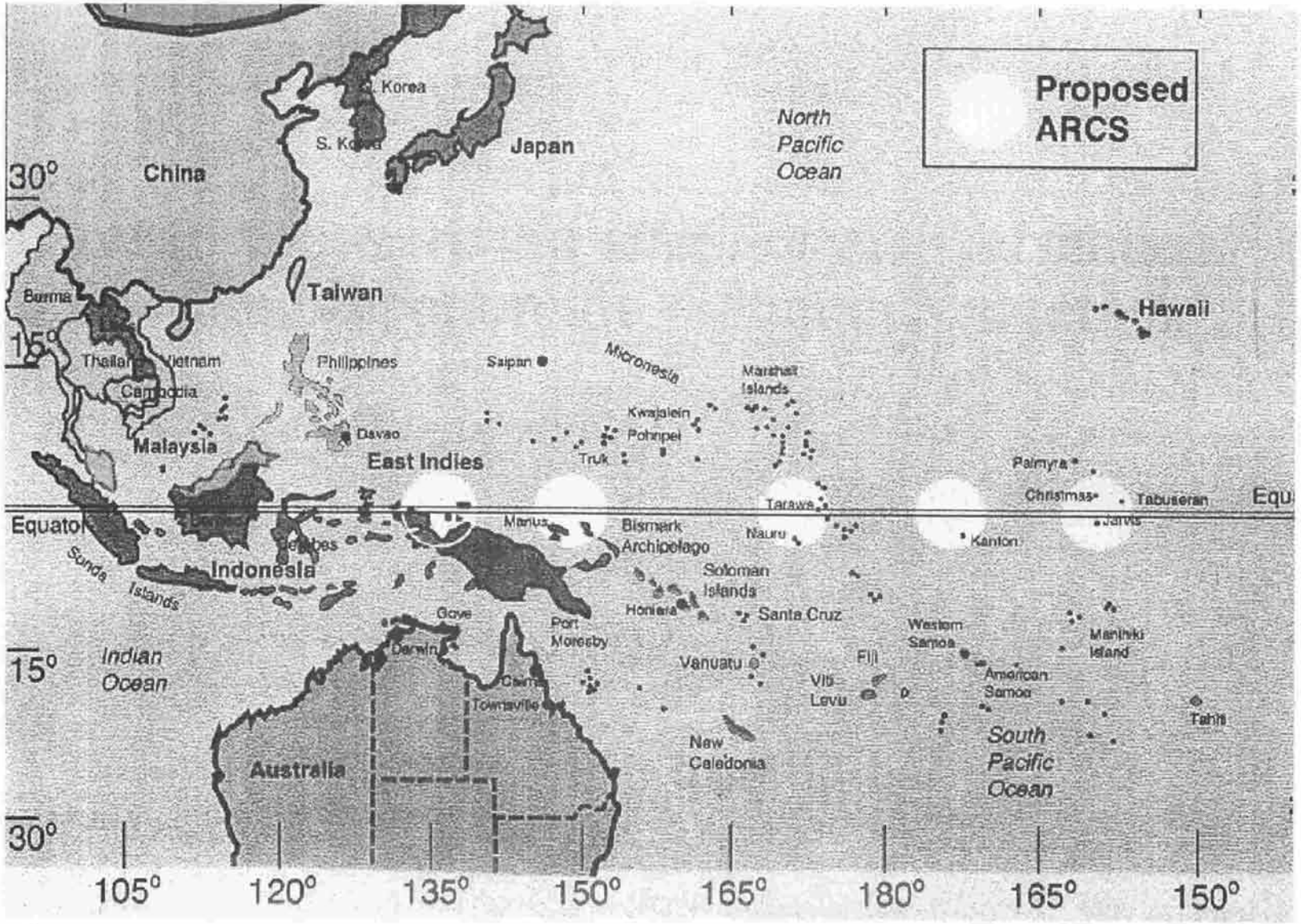


Figure 1.1: Proposed Atmospheric Radiation and Cloud Station (ARCS)

Source: Tropical Western Pacific Program Office

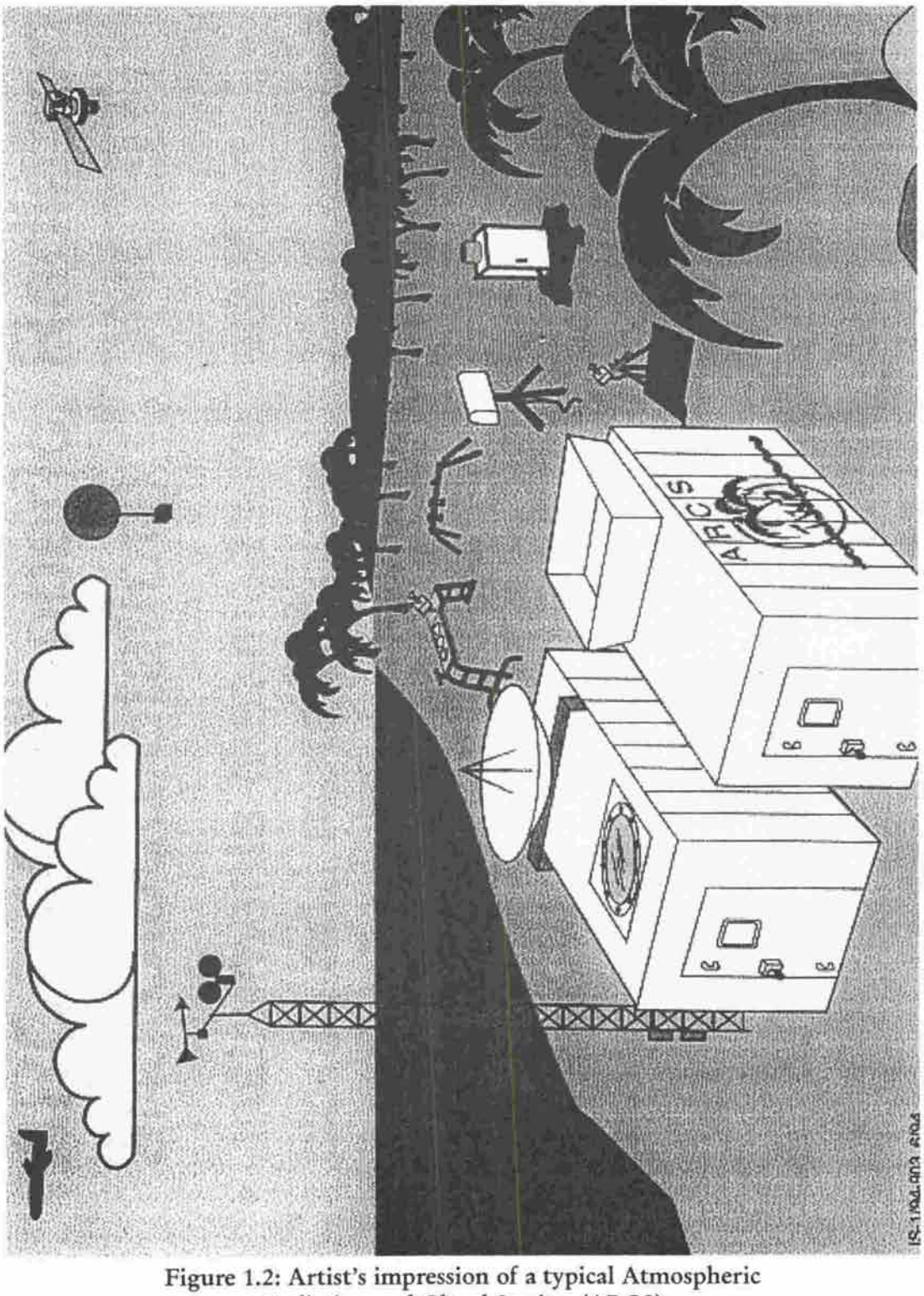


Figure 1.2: Artist's impression of a typical Atmospheric Radiation and Cloud Station (ARCS)

2 PROJECT DESCRIPTION

The US Department of Energy's ARM Program, in collaboration with the South Pacific Regional Environment Programme (SPREP), proposes to operate its second Atmospheric Radiation and Cloud Station (ARCS) on the island of Nauru in cooperation with the Nauru Department of Island Development and Industries (DIDI). The Government of Nauru has decided to locate the ARCS at Ella Park, an area of land on the south-western side of the Nauru airfield, approximately 50 metres east of the last domestic household along the coast of Yarren District. DIDI will provide any necessary permits for the operation of the ARCS at Nauru for the anticipated period of operation of ten years (see the map of Nauru in figure 2.1).

2.1 The site

The ARCS site is at an area in the Yarren District Portion No. 90, locally known as "Atomo", a government-leased land under the Aerodrome (Acquisition of Land) Ordinance 1952. The required land surface area for the ARCS site is approximately 70 metres long by 14 metres wide. The allocated land area is very narrow therefore, much of the required space will have to be reclaimed from from an area 10 metres south of the seawall.

2.1.1 Site construction

The proposal is to construct an extended seawall from the eastern bend of the old seawall (adjacent to the last household), to join the new airstrip seawall past the pill box. The reclaimed area would be landfilled and refurbished for the establishment of the ARCS site which will be fenced in (see figures 2.2a and b).

All backfill material will be coral pinnacle limestone which are in abundant supply at the used phosphate mine site, "Topside". Initially, boulders up to 1100 kilograms will be used, gradually moving to smaller sized rocks and finally to crushed chips and gravel for the surface. Boulders will be cemented together and anchored down to the base reef rock by steel pins to ensure the weather side of the seawall will withstand the strong wave action normally experienced in this particular area.

Heavy equipment, skilled and casual labour needed for the construction of the site is available on the island.

2.1.2 The ARCS equipment

2.1.2.1 Instrumentation and equipment

A complete ARCS facility will be installed on Nauru. This consists of five to six specially equipped 20-foot sea containers and associated instrumentation, including a 50 kilowatt backup generator set. The typical instruments that will be operated at the site include:

- Vaisala Ceilometer (VCEIL25K)
- Micropulse Lidar (MPL)
- Downwelling Radiation (SKYRAD) Instrumentation
- Multifilter Rotating Shadowband Radiometer (MFRSR)
- Caterpillar Diesel Generator and Electrical Control System
- ARCS Enclosures (Vans)
- Monitor and Control System (MACS) and Communications System (COMS)
- Microwave Radiometer (MWR)

- MET Tower-Wind Speed/ Wind Direction/ Relative Humidity (SMET) ARCS Data Loggers
- Upwelling (GNDRAD) Instrumentation
- Whole Sky Imager (WSI)
- Atmospheric Emitted Radiance Interferometer (AERI)
- Millimeter Wave Cloud Radar (MMCR)

Should the Governmnent Nauru decide to use the ARCS as a basis of establishing a Meteorological Service, additional instrumentation may be located on the site.

2.1.2.2 Data and operators

The ARM Program will make available as required all ARCS data with calibration information based on ARM operational research requirements. ARCS operators (local staff trained by the ARM Program) will be responsible for the daily operations of ARCS instruments and associated systems. A Regional Service Team (RESET) from the US will make periodic and emergency visits to service, repair, and calibrate instruments and systems and will provide continued training for personnel.

Should the ARCS be used as a basis for a Meteorological Service some additional instrumentation and operators will be required. This will be the responsibility of the Nauru Government. The ARM Program will assist in this effort and a cost efficient collaboration will be worked out. Any requirements of the ARCS instruments or requirements and use of the ARCS data outside ARM operational research requirements will be the responsibility of the Meteorological Service. ARM will collaborate within its charter to assist in these areas as well. Basically the ARM and Meteorological Service working together can serve both functions in a cost effective manner.

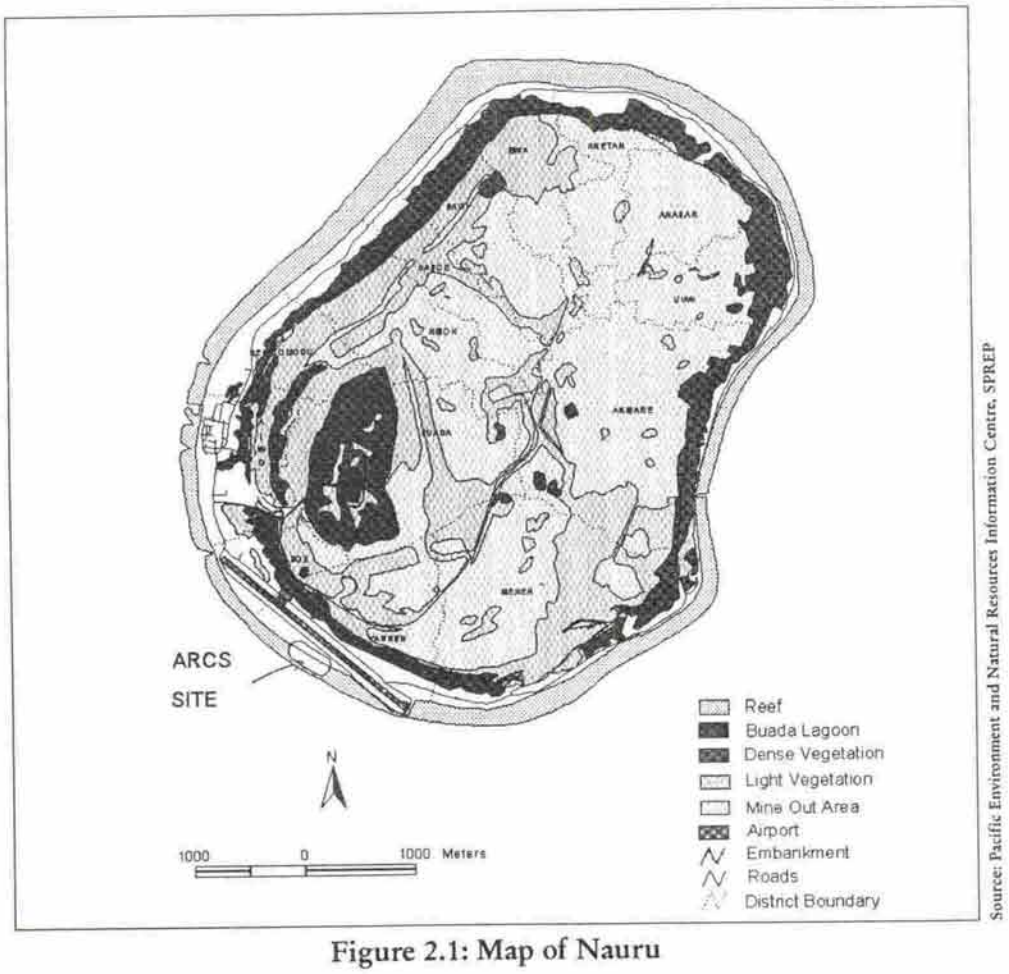
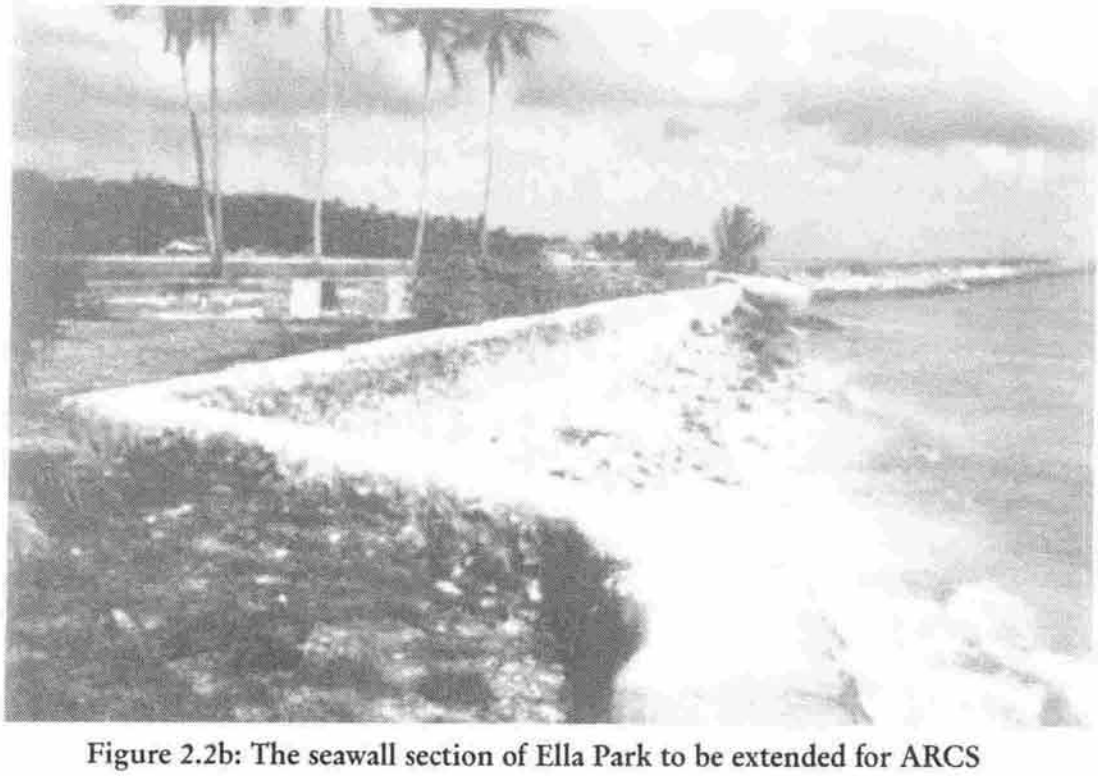


Figure 2.1: Map of Nauru

Source: Tropical Western Program Office

Figure 2.2a: Ella Park



Source: Tropical Western Program Office

Figure 2.2b: The seawall section of Ella Park to be extended for ARCS

Source: Bogden and Associates (1992)

Figure 2.3: Bald Plateau

3 EXISTING ENVIRONMENT

The Republic of Nauru is located at 0°30'S latitude and 166°55'E longitude. Thus it is in the TWP locale (between 10°N and 10°S of the Equator) in which the ARM Program wishes to deploy its ARCS. Nauru is a single raised limestone island with a circumference of 19.3 kilometres (12 miles) and a total land area of 21 square kilometres (8.2 square miles). The island consists mainly of a flat plateau, at about 90 metres above sea level, that descends to a narrow coastal fringe where most of the population live. The plateau interior contains extensive phosphate deposits which have been mined since 1902. The over-mining of the island has resulted in an eerie, barren and inhospitable plateau suggesting a science fiction creation, as seen in figure 2.3. Further, as observed by Helen Bogdan and Associates in 1990, "the removal of vegetation to facilitate mining has left the plateau with a bald top". This has caused an "oven" effect which is so hot that the updraft of air disperses the cloud formation resulting in less than 1.5 metres of annual rainfall being recorded. These draughts have retarded much of the normal vegetation growth, restricted habitats for local birds and further accentuated the problem of water shortage.

3.1 Ella Park

The ARCS site will occupy Ella Park and the reclaimed land. The tiny park, which currently provides two picnic tables with seating under the shade of two coconut trees, is in an area of compacted coral sand and rubbles devoid of vegetation except for stunted grass growth in patches, low growth salt bushes *Scaevola sericea* and ground cover *Ipomoea sp.* The site is approximately 50 metres east of the nearest residential household alongside the main road, and about 50 metres away from the side of the airstrip.

A seawall was built on the sea side of the park due to heavy coastal erosion from pounding waves during high tides, enforced by the prevailing strong south-easterly wind. This seawall extends to the new eastward extension of the airstrip, completed in 1993, close to the outer edge of the reef.

3.2 The reclaimed reef

The reef area under study is typical of a coral island coastal area. The inundated area under the reclamation will extend from the beach side of the existing seawall to about 8 metres into the reef flat covering about 70 metres of the coastline of Yarren District.

The narrow strip of sand that has formed over beach rock are moderately sloped areas of clean coarse sand and coral rubble with little biota outside of the ghost crab, *Ocypoda sp.* found in abundance inside the holes along the seawall. This strip of sand, like the reef platform, is submerged only at high tide.

The reef platform in general varies slightly with depth. Close to the study site, the reef flat has numerous shallow reef pools (with a depth of less than 0.2 metres) which are surprisingly devoid of living organisms except for hermit crabs. This is compared to the pools further out to sea which are inhabited by small fish, gobies, juvenile surgeon fishes and the odd sea cucumbers, mainly the surf redfish *Actinopyga*

mauritiana and lollyfish *Holothuria (Halodeima) atra* variety. This particular area of the coast has been heavily disturbed through seawall construction and coastal erosion. Thus the reef flat close to the seawall is also devoid of biota cover, while further to the middle and lower areas of the reef there is an abundant cover of green and red coralline algae.

The reef surrounding Nauru has the potential to become toxic. Ciguatera fish poisoning was not known in Nauru until its outbreak in 1990. Research work by Tebano in 1991 confirmed only 5 cases out of 39 reported as caused by ciguatera fish poisoning. The research work relates the outbreak of ciguatera fish poisoning as a reult of reef blasting of the Anibare passage where the poisoning began, subsequently spreading to Anabar and Anetan reefs. Yarren reef has been heavily disturbed by the airport extension and will be further impacted by the reef reclamation for.the ARCS site. Therefore the potential exists that the reef in Nauru may become toxic once again.

3.3 Socio-economics

Nauruans have a very strong affinity for their village life and community. Their deep attachment to the tiny country has much relevance to the important question of rehabilitation and development of infrastructures that will provide security and sustainability of livelihood to the island people.

Phosphate mining is now almost exhausted and Nauruans are finding that fisheries may become the only important socio-economic activity and future for the average citizen. In fact, most Nauruans are relying more and more on traditional full time fishing for their recreation and livelihood.

The deployment of ARCS to Nauru would not appear to have economic importance to the average Nauruan since neither creates a social amenity nor a highly visible economic development opportunity. However, the expansion of the ARCS into a meteorological service for Nauru would result in long-term economic benefit to the fishing and tourist industries as local weather forecasting abilities came on-line and Nauru entered into the international weather forecasting network. In addition, the enrichment of Nauru science education as a result of the ARM education programme could have far-reaching effects for Nauru. Children will have the chance to visit a state-of-the-art research outpost, and will also have in-class enrichment materials and visits from ARCS scientists and technicians.

On the negative side, the ARCS will be installed on one of the few picnic areas in the tiny island country. However, the ARM Program has agreed to move the trees or plant others in another location and contribute to the enhancement of another picnic area. If the Nauru Government decide to choose the enhancement to take place at a more central location, the net gain may well be a positive one for Nauru.

In addition, it is possible that significant environmental impacts could result from the ARCS installation, mainly from the construction impacts of the seawall improvement. The Nauru Government should determine if this seawall improvement is in the best interests of Nauru, in the long-term, given the following considerations, and if the resulting impacts can be monitored in enough detail to mitigate the effects as they happen.

The coastline likely to have immediate construction impact is about 300 metres, approximately 1.3 percent of the overall

Nauru coast. This section of seawall is already in disrepair and needs reconstruction to prevent further erosion due to wave action. Although potential reef impacts (outlined in section 4.1) are all predicted following the disturbance of a pristine reef, this section of the reef is already heavily disturbed. The course of recovery of a reef from successive disturbance is not well understood.

The Government of Nauru has approved the ARCS installation for the following reasons:

1. Nauru's interest in global climate changes that might affect sea-level rise which could, in the long term, adversely affect their coastal environment;
2. the long-term advantages of having a Meteorology Service on Nauru;
3. needed improvements to the seawall; and
4. long-term benefits of an education enrichment programme.

4 ENVIRONMENTAL IMPACTS AND MITIGATION

This section discusses the possible impacts the establishment of the ARCS site on reef reclaimed land will have on the Nauru environment. The primary impacts of the proposal are likely to be derived from the construction phase associated with excavation and gathering of fill, and those associated with consolidation and placement of fill for the seawall.

4.1 Expected effects of reef reclamation

4.1.1 Short-term effects

The destruction of coral reef is likely to have similar effects to severe storm damage. The result of drilling, filling and consolidation of coral reef provide new substrata for colonisation of marine organisms, produce coral fragments and erode corals to provide a source of rubble and finer sediments.

New surfaces for colonisation often undergo a succession of dominance by different algae. Walsh (1983) reported a succession from green to red to brown algae, which after nine months resulted in exposed substrata that resembled pre-storm or pre-disturbed conditions. Explanation of this algae succession is usually attributed to nutrient enrichment of waters from surface run-off or from disturbed sediments. Such a succession of algae as a result of reef reclamation could temporarily attract and concentrate large numbers of exploitable herbivorous reef fish (Acanthurids: surgeonfish, Scarids: parrotfish) from surrounding areas to feed. A succession of algae, particularly red algae, could lead to an outbreak of ciguatera.

The production of coral fragments could result in a shift in coral community structure by providing a new habitat for organisms not normally found in the area.

4.1.2 Long-term and/or permanent effects

4.1.2.1 Alternative community structures

One of the more obvious biological effects that could occur as a result of reef disturbance would be for communities not to return to their original conditions after the impact has passed. The present or existing community structure is a result of "who got there first" rather than the results of biological interactions, or real differences in requirements of communities. Shifts in community structure are expected to occur if a temporary disturbance allows one of a number of "stable states" to take over.

Human impacts as well as natural disturbances are potentially important sources of the kinds of disruptions that might shift the structure of coral communities to alternative forms. There is some evidence that large-scale shifts in community structure can occur as a result of natural disturbance. However, the implication is that some forms of pollution and/or disturbance on coral reefs which may apparently have insignificant immediate effects, may also have significant long-term effects on community structure by precipitating a shift between alternative stable states.

This kind of shift could arise in the new seawall construction. The provision of newly exposed surfaces as a direct result of construction could become colonised

by algae, corals or invertebrates not presently dominant, resulting in changes in associated fauna such as fish. Similar effects could occur if the reef slope habitat were affected by short-term sedimentation as a result of the seawall construction. Such shifts in habitat structure could have a great impact on the associated fisheries.

Kaly and Jones (1990), in their review of literature on long term and/or permanent effects of blasting channels, reported several studies have concluded that structural complexity of the habitat as well as proportion of live coral cover were important determinants of the diversity and numbers of fish present. The studies also concluded that the death of corals is likely to cause a significant decrease in the number of species of fish and individuals associated with a reef. A good indication of the "health" of coral reefs is the richness of (butterfly fish) Chaetodontid. Other indicators include Pomacentrids, Scarids and Acanthurids (damsels, parrot fish, surgeon fish), or the abundance of the entire fish community in general.

The seawall itself may provide a new kind of habitat, thus increasing the local diversity of fish and invertebrates. This new habitat then would be acceptable for reef organisms to colonise.

4.1.2.2 Ciguatera

An increase in fish poisoning, such as ciguatera, has been linked with human activities and other forms of disturbance on coral reefs. The consumption of fish containing ciguatoxin results in acute digestive, neurological and cardiovascular responses in humans, and sometimes death. It is therefore of great importance to include a consideration of ciguatera in this assessment of human impact on the coral reef systems under study.

Reef becomes toxic in a pattern, spreading out from the centre of disturbance, first appearing in herbivorous fish and later the carnivores. Toxicity of fish is not entirely dependent on species, but on the association of particular individuals of fish with toxic areas of reef. Larger fish of a species, particularly higher carnivores, are more likely to be toxic and have higher concentrations of the toxin. Studies have reported that toxic areas may be able to "recover" and become non-toxic with time, i.e. years.

It was first suggested that the toxicity in fish was caused by an algae which was the first to grow on new substrata. Later, poisoning is attributed to a dinoflagellate *Gambierdiscus toxicus* which lived under the surface mucous layer of algae and was eaten by fish. The "host" algae carrying the toxic dinoflagellate included red, green or brown forms with the finely branching types harbouring the greatest number of *G. toxicus* cells.

A particular study on colonisation of *G.toxicus* on new substrata, noted in Kaly and Jones (1990), indicated that colonisation by the dinoflagellates may take up to eight to nine months. However, another complicating factor regarding the problem of ciguatera on reefs is that not all populations of *G. toxicus* are toxic according to laboratory cultures.

4.1.2.3 Alteration of sedimentary regimes and current flow

The potential for permanently altering the flow of water across the reef and hence sedimentation requires consideration in relation to new seawall construction. The presence of the seawall closer to the mid-tide area of the reef might act to facilitate the movements of important food fish over the reef crest. It may also improve the supply of fresh nutrients to organisms within some area around the seawall.

Negative effects of the seawall could also be expected. The new seawall could alter

present patterns of deposition and erosion to unconsolidated areas of reef, as well as to the coral cays that support the village communities of Yarren. Changes in water flow could influence the types of corals that would survive in the altered habitat. Permanent changes in the movement and deposition of sediments could affect coral growth.

4.2 Expected effects of ARCS site construction

While the most important environmental effects of most water-related development projects are in the long term, the short-term effects during the construction phase must also be carefully considered.

Since the Nauru Government has control over approving an appropriate design for the seawall improvement and the oversight of the construction techniques, the following points should be considered by DIDI in guiding the seawall improvement process.

4.2.1 Construction work

Construction work on both the reclamation area and the seawall will result in the formation of plumes of suspended sediment around the adjacent reef area during high tide. The coastal waters at Yarren at present are apparently clear of siltation and/or suspended sedimentation.

The vicinity of the constructed seawall will be affected sufficiently by increased turbidity and deposited sediments to in turn affect marine biota and productivity, in most cases causing total loss of photosynthetic activity. This will have further implications for the coastal environment food chain. The impact in the context of biotic and fishery resources in this part of the reef is not considered significant, although local fishermen will be forced to fish elsewhere during the construction. However, there is currently very little reef fishing activity in this area compared with other areas along the coast. The coastal waters around the project site are not considered to be a significant spawning or nursery area.

Disturbed sediments will have a more significant impact on recreational resources in areas west of the project site (normal current movement assisted by the south-easterly winds are towards the west), reducing the quality of nearshore waters for contact and non-contact recreation during the construction period.

All seawall construction works should be carried out during low tides to help restrict the spreading of sedimentation plumes at the project site.

4.2.2 Water pollution

This project has the potential to cause water pollution through several sources including:

- run-off during construction and quarrying for fill material;
- sanitary wastewater during construction and operation of the ARCS site, including oil spills from the operation of the diesel generator; and
- wastewater from instrumentation cleanings and so forth.

The impacts from run-off, sanitary, oily and other wastewater can be avoided by providing appropriate measures for collecting and disposal of wastewater.

Quarrying at "Topside" and transport of quarried materials also have the potential for water pollution by dust, but this is not expected to be significant at the proposed construction sites.

4.2.3 Air pollution

The likely sources of air emissions during construction will include:

- dust from traffic, site clearing and construction activity;
- emissions from vehicles bringing materials to the site and from construction equipment;
- emissions from the burning of waste materials; and
- dust from quarrying.

These emissions are expected to result in degradation of air quality primarily in the working environment, affecting construction employees and nearby households. Dust and other emissions from the quarry and aggregate at "Topside" are unlikely to spread sufficiently to affect homes and other properties around the project sites. Dust will be generated within the quarry working areas and measures will need to be taken to protect workers.

Dust and emissions from trucks carrying materials between the site and "Topside", particularly quarried rock and aggregate, are expected to generate dust nuisance to communities along their routes. In particular, if the road via the government quarters at Menen is used, the residents along that road will be highly inconvenienced by noise and dust during the entire construction period due to their close proximity to the road.

4.3 Expected effects of operation of the ARCS site

4.3.1 Atmospheric radiation and cloud study

The ARCS will be operating a variety of scientific instruments to record and document atmospheric radiation and cloud data for approximately 10 years. As the site is within the aerodrome boundary, some activities (such as setting off weather balloons) may have to be scheduled so that they do not cause disruption to airline flights.

The instruments employed on site have the potential for occupational hazards and therefore training and education of local employees is vital. In particular, employees should be well cautioned on the use of Micro-pulse LIDARs (MPLs). The MPL is an eye-safe radar system during normal operation but the MPL Daily Operating Procedure cautioned to avoid directly viewing the transmitter beam for an extended period of time (more than several seconds). If the side panels are removed from the MPL Transmitter/Receiver module, or if the fibre optic cable is disconnected from the laser head, the system is no longer eye-safe.

The following warning should be clearly displayed next to the MPL instrument:

> *The Spectra-Physics Model 7300 laser diode module employed in the MPL is a Class 1V High Power Laser. The laser radiation is in the near-infrared spectral range (800nm) and is not visible to the human eye. Do not look into the end of the fibre optic cable when the diode module is "On". The Model 7960 laser head and the Model 7965 frequency doubler employed in the MPL Transmitter/Receiver head are classified as Class 111-b High Power Lasers. The output beam from each is, by definition, a safety hazard. Avoid direct viewing of the beam or its specular reflection.*

The back-up generator may be operated from time to time. The electrical power grid in Nauru uses 240 volts so proper converters should be employed. The noise from the generator will be minimal to the nearest household as compared to the noise from aeroplanes landing and taking-off at the airstrip close by. Nevertheless, since the generator will be located at the boundary of an adjacent

household, it is recommended that noise at the face of the power container does not exceed 60dBA. This is a commonly accepted standard in New Zealand for industrial concerns adjacent to residential property. For continuous noise, production of 45dBA is the accepted standard at the boundary for noise produced at night.

4.3.2 Focus of human activities

It is inevitable that once the ARCS site is completed, human activities will become more focused in the area, that is outside the fenced ARCS area. There is likely to be a localised increase in foot and vehicular traffic to the area by employees, recreationers and fishermen. There is also likely to be the additional effects of vehicle traffic, of noise and solid waste from users of the area.

The seawall will see more recreational use by the general public and by fishermen encouraged by the "deeper" seawall offering excellent vantage fishing points for recreational line casting.

5 SUMMARY OF FINDINGS AND RECOMMENDATIONS

One of the initial objectives of this study was to determine the likely impacts the site construction and operation of the Atmospheric Radiation and Cloud Station would have on the Nauru environment. This report finds that the operation of ARCS will require safety precautions on the use of some equipment and therefore a properly scheduled education and training programme for the operators should precede the actual operation of the ARCS. The ARM Program has an established training and safety programme for all operators that was developed for and is being used at the first ARCS site in PNG. These programmes will be tailored for the Nauru ARCS and implemented prior to operations.

The most important environmental effect of the construction of the site, as discussed in the earlier section, is the long-term effects it may cause to the marine environment. Therefore, the following considerations are offered:

(a) It is recommended that the seawall construction starts from and includes the western end of the poorly constructed seawall behind the last house to the pill box area. This will provide proper shoreline protection of the new seawall at its western end.

(b) Shoreline protection works should form a major component of this reclamation project.

(c) The seawall construction should be securely pinned to the reef and boulders cemented together to withstand the pounding waves.

Construction should be carried out during low tide to avoid the spreading of sedimentation. Sediment screens should be used whenever working during high tides.

(d) Landscaping will improve the visual impact of the fenced-in complex. Consideration should be given to planting tall trees (where they do not obstruct the ARCS activity) within and outside the fenced compound. The project also should replace the picnic tables by creating a recreation area on a new site to be designated by government.

(e) The unpaved road through Menen from "Topside", although providing shortcut access for transporting aggregate and construction material to the site, should not be used. The road is unsuitable for large haulage trucks and houses along this road are built too close to the road. The vibrations from the trucks together with the dust spills from their load will adversely affect the buildings and their occupants.

(f) The Fisheries Division should monitor the possible outbreak of ciguatera poisoning and advise the public of fish species that are affected.

(g) The whole of Nauru's 19-kilometre coastline has been heavily encroached upon by human activity. An important consideration was given (Onorio, 1996) to the setting aside of a permanent reserve to compensate for the loss of reef ecosystems due to seven reef-blastings that have taken place on Nauru's coastline. It is recommended that such a reserve be established as a matter of urgency.

(h) It will provide good public relations if the ARCS run guided tours of the site so the Nauru public will better understand and appreciate the relevance of the project.

6 REFERENCES

ARM 1995, *Tropical Western Pacific Locale: ARM/TWP/ARCS/Education,* Tropical Western Pacific Program Office, Los Alamos National Laboratory, New Mexico, USA.

ARM 1996, *ARCS Equipment Notebook,* ARCS Development Program, Sandia National Laboratory, New Mexico, USA.

Helen Bogdan and Associates 1990, *Nauru 1990: An Environmental Challenge for Australia and the Pacific,* Helen Bogdan and Associates, Melbourne, Australia.

Kaly, U. L. and Jones, G. P. 1990, *The Construction of Boat Channels across Coral Reefs: An Assessment of Ecological Impact,* Ministry of External Relations and Trade, New Zealand.

Onorio, K. 1996, *EIA of Development of Boat Harbours at Anibare and Gabab, Nauru,* South Pacific Regional Environment Programme, Apia, Samoa.

Tebano, T. 1991, *A Preliminary Survey on Ciguatera Fish Poisoning on Nauru Island,* Institute of Marine Resources, University of the South Pacific, Suva, Fiji.

US Department of Energy 1996, *Science Plan for the Atmospheric Radiation Measurement Program (ARM),* US Department of Commerce, Technology Administration, National Technical Information Service, Springfield, USA.

Walsh, W. J. 1983, "Stability of a coral reef fish community following a catastrophic storm", in *Coral Reefs,* 2:49–63.