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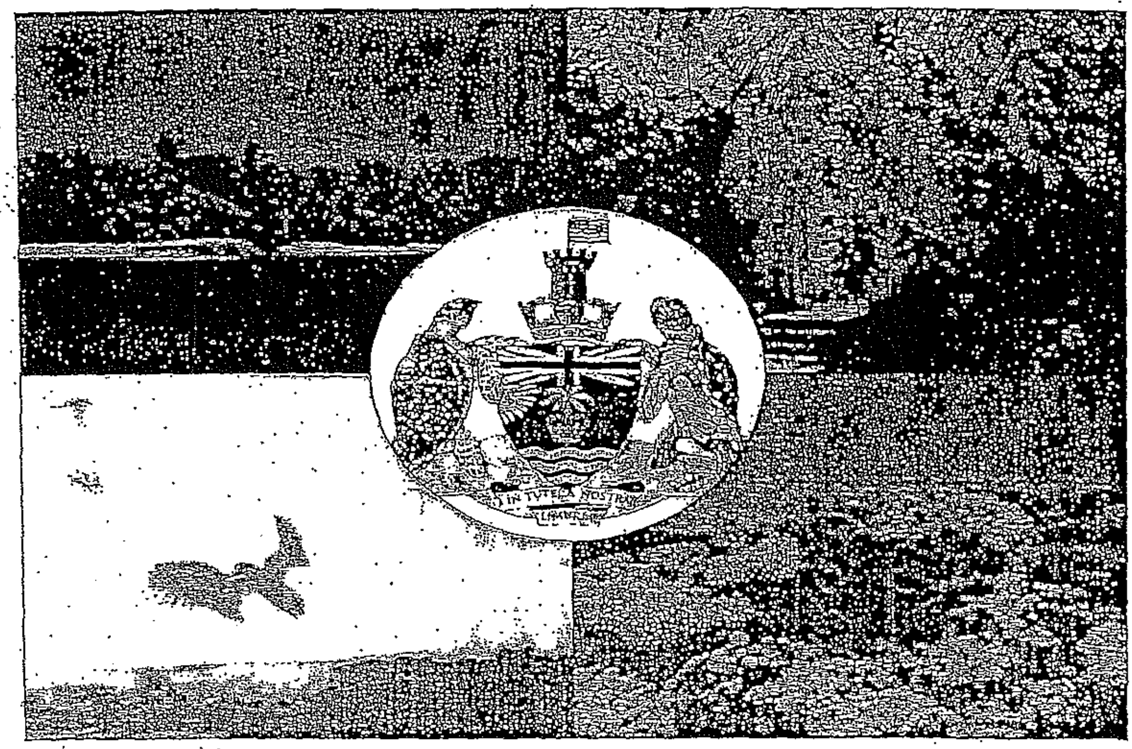
FEASIBILITY STUDY FOR THE RESETTLEMENT OF THE CHAGOS ARCHIPELAGO

Phase 2B

Volume I : Executive Summary



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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

This report, which is set out in five volumes, documents the findings of Phase 2B of a study investigating the feasibility of resettlement on the outer atolls of Peros Banhos and Salomon Atolls, Chagos Archipelago. The study was commissioned by the British Indian Ocean Territory Administration of the Foreign and Commonwealth Office in response to a request made by the Ilois (the former inhabitants of the Archipelago) to be permitted to return and live within the Archipelago.

The Chagos Archipelago, known as the British Indian Ocean Territory (BIOT), lies in the central part of the Indian Ocean (Figure 1.1). The Archipelago covers an area of some 60,000 km^2 and comprises a number of atolls, islands, and several submerged banks (Figure 1.2). It is noted for its high species biodiversity and rich marine and terrestrial habitats. For over 30 years, the islands of the Archipelago, except for Diego Garcia, have been devoid of human inhabitants.

The Ilois inhabited the islands of the Archipelago from the early nineteenth century up until 1973, having been brought to the islands to provide labour for the copra plantations, which were the principal economy of the islands throughout this time. In the early 1970s, the economic foundation of the islands collapsed with the falling price of copra and the plantations no longer remained viable. At this time, the British and US Governments entered into an agreement to reserve the use of the islands for defence purposes, which led to the subsequent establishment of a military base on Diego Garcia. This resulted in the depopulation of the territory and the relocation of the Ilois in Mauritius and, to a lesser extent, the Seychelles.

The presence of the military base and the strict conservation policy imposed by the BIOT Administration has, until recently, permitted only brief compassionate visits by the Ilois. The only regular visitors to the islands are yacht crews, who often spend several months each year within the outer atolls. There are also periodic military and fishery patrols. Commercial activity within BIOT is limited to the seasonal fisheries operating within the Archipelago, namely an offshore tuna fishery, largely exploited by European purse seine and long-line vessels, and an inshore demersal fishery, mainly exploited by visiting Mauritian vessels (often crewed by Ilois).

In early 2000, the Ilois sought, through the courts, the right to return and live within the Archipelago. In response to this, the BIOT Administration commissioned a study to explore the feasibility of resettlement on the outer atolls of Peros Banhos and Salomon. These atolls lie to the north of the Archipelago, some 300 miles from Diego Garcia, and comprise 35 small islands which have a total land area of 1200 hectares, the biggest island being just 140 hectares in size (Figure 1.3). The islands are low-lying and covered with dense vegetation.

The first phase of this study was tasked with briefly investigating possible development opportunities based upon the natural resources within these two atolls. Phase I was very much a theoretical exercise in that it did not involve meeting the potential settlers, and therefore did not take into account their aspirations or social capital, nor did it entail any detailed resource assessments. It concluded that whilst a number of livelihood opportunities might be available to a resettled population, there remained a large gap in our understanding of the quantity and quality of resources available to them. Further studies were recommended to investigate these resources more fully and to engage the Ilois in this process.

In November 2000, the court granted the Ilois the right to return and live on the outer atolls. Since this time, however, none of the Ilois have returned and are instead seeking support from the UK and US Governments to financially assist their return or alternatively to provide compensation. Concurrently, the BIOT Administration has further proceeded with the feasibility study. Phase 2A of the study, which took place in 2001, involved establishing equipment to generate long-term information on local climatic conditions and tides, and their influence on the freshwater lenses on two of the islands within the atolls.

Over the period November 2001 to March 2002, the BIOT Administration commissioned Posford Haskoning, together with MacAlister Elliott and Partners Ltd and Agrisystems Ltd, to undertake Phase 2B. This has entailed detailed assessments of groundwater, soils, fisheries resources, and the marine and terrestrial environment, and a further consideration of the livelihood opportunities put forward in Phase I. The core of this phase was a five-week field visit to Peros Banhos and Salomon Atolls, which mostly focused on the islands of Ile du Coin in Peros Banhos Atoll and Ile Boddam in Salomon Atoll. Based on the findings of the field studies, Phase 2B has also assessed the future vulnerability of a resettled population to possible climate change, and has outlined infrastructure needs and the environmental implications that would accompany resettlement.

This report has not been tasked with investigating the financial costs and benefits of resettlement, nor has it engaged the Ilois in a discussion on their ambitions and proposed livelihood strategies. It remains, therefore, a somewhat theoretical study. These are essential elements of the resettlement debate, and should become a priority for any further stages of the study.

Phase 2B is summarised in Volume I (this volume). Volume II details the findings of the resources assessments and the consideration of possible livelihood opportunities. Volume III explores resettlement issues, namely the future implications of climate change; infrastructure needs; an environmental appraisal of resettlement; and considerations for future environmental management. Recommendations for further investigations are also suggested where appropriate. Volume IV contains the appendices to Volumes II and III. A Geographical Information System (GIS) mapping selected elements of the fieldwork is provided in Volume V. In this volume, sections 1.2-1.7 are set out fully in Volume II, and sections 1.8-1.11 in Volume III. Certain laboratory testing cannot be completed until 31 April. The results will be incorporated into Volume II after that date.

Indian Ocean Area

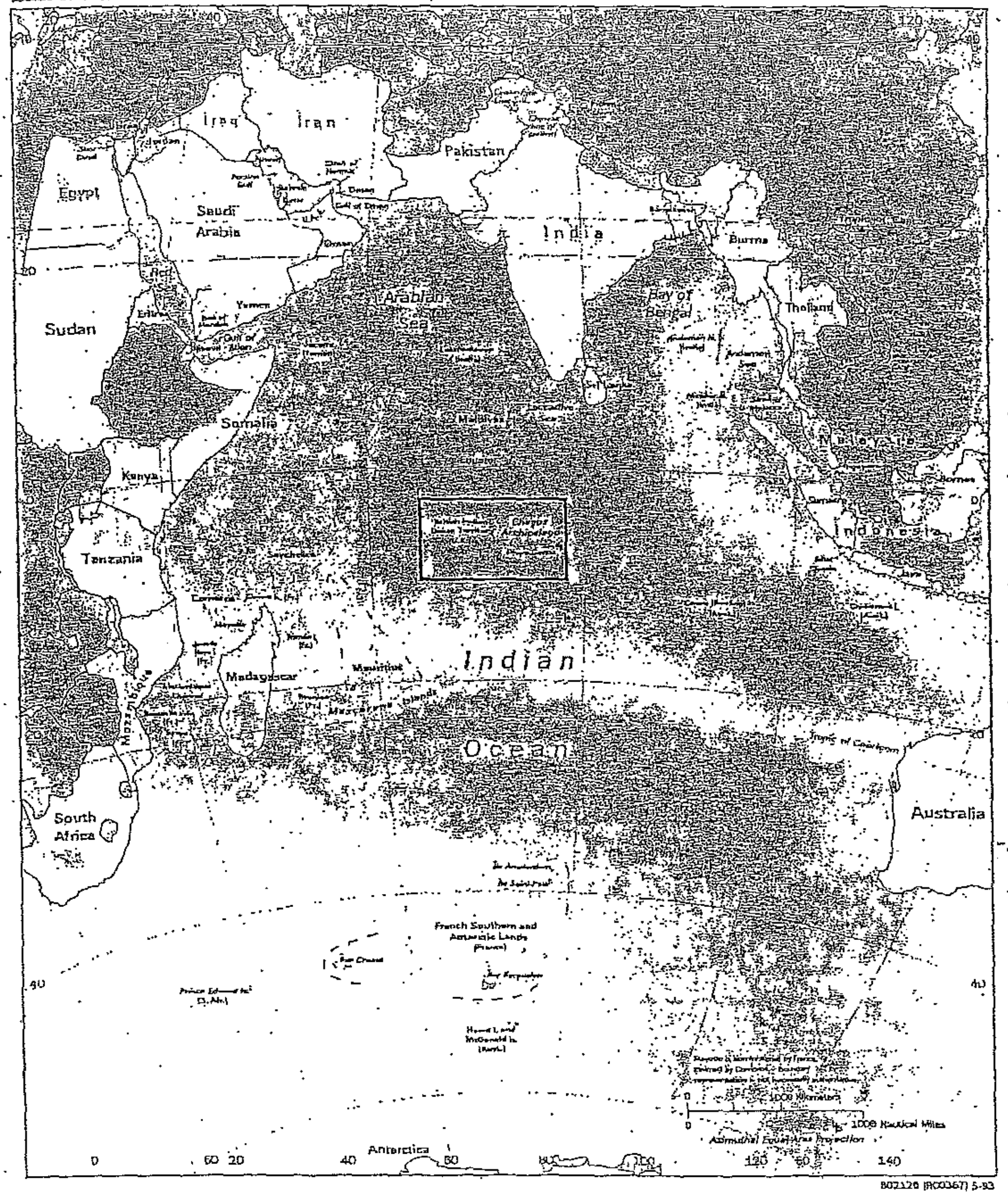

Figure 1.1

Location of the Chagos Archipelago within the Indian Ocean

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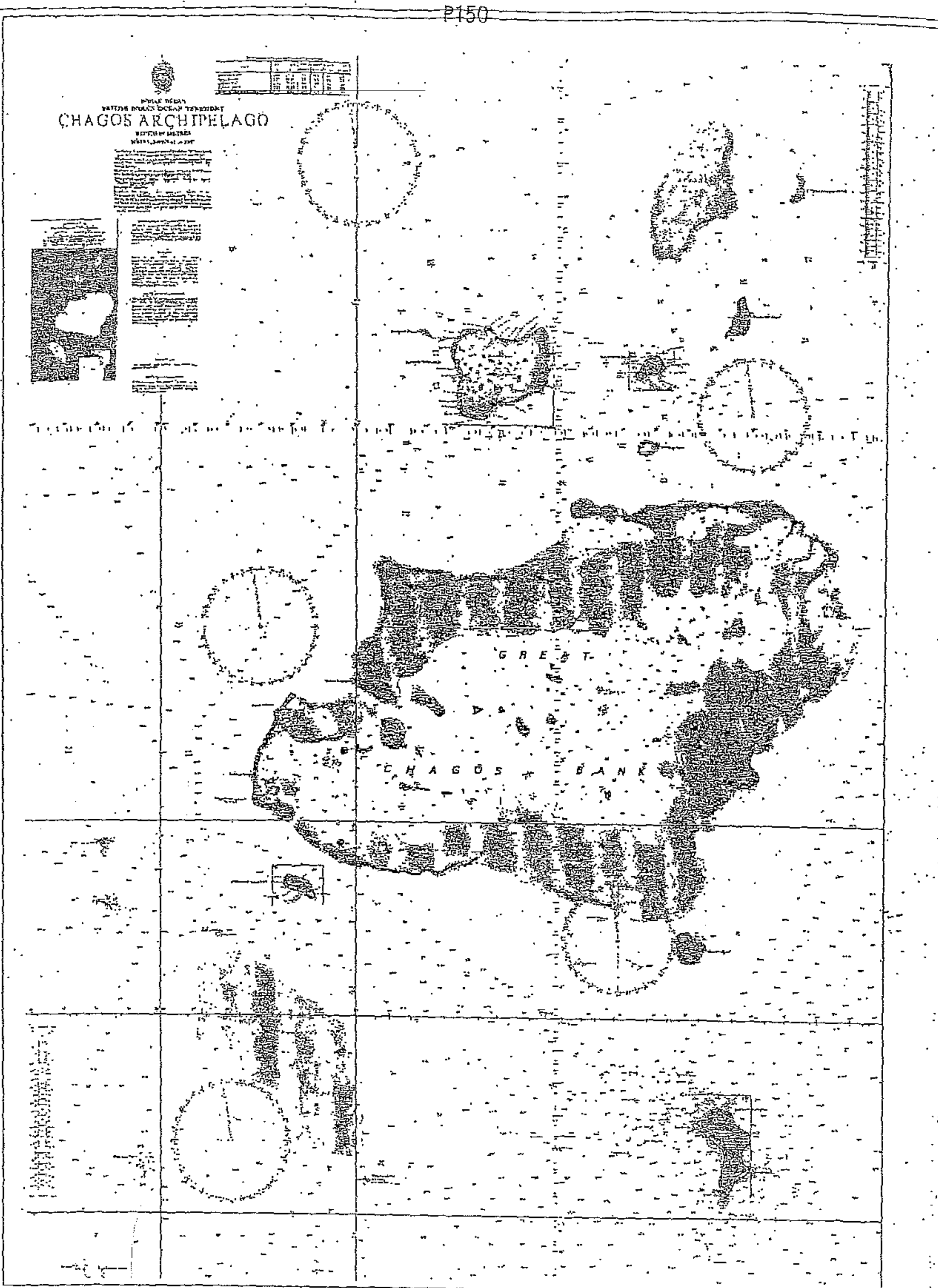

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CHAGOS ARCHIPELAGO

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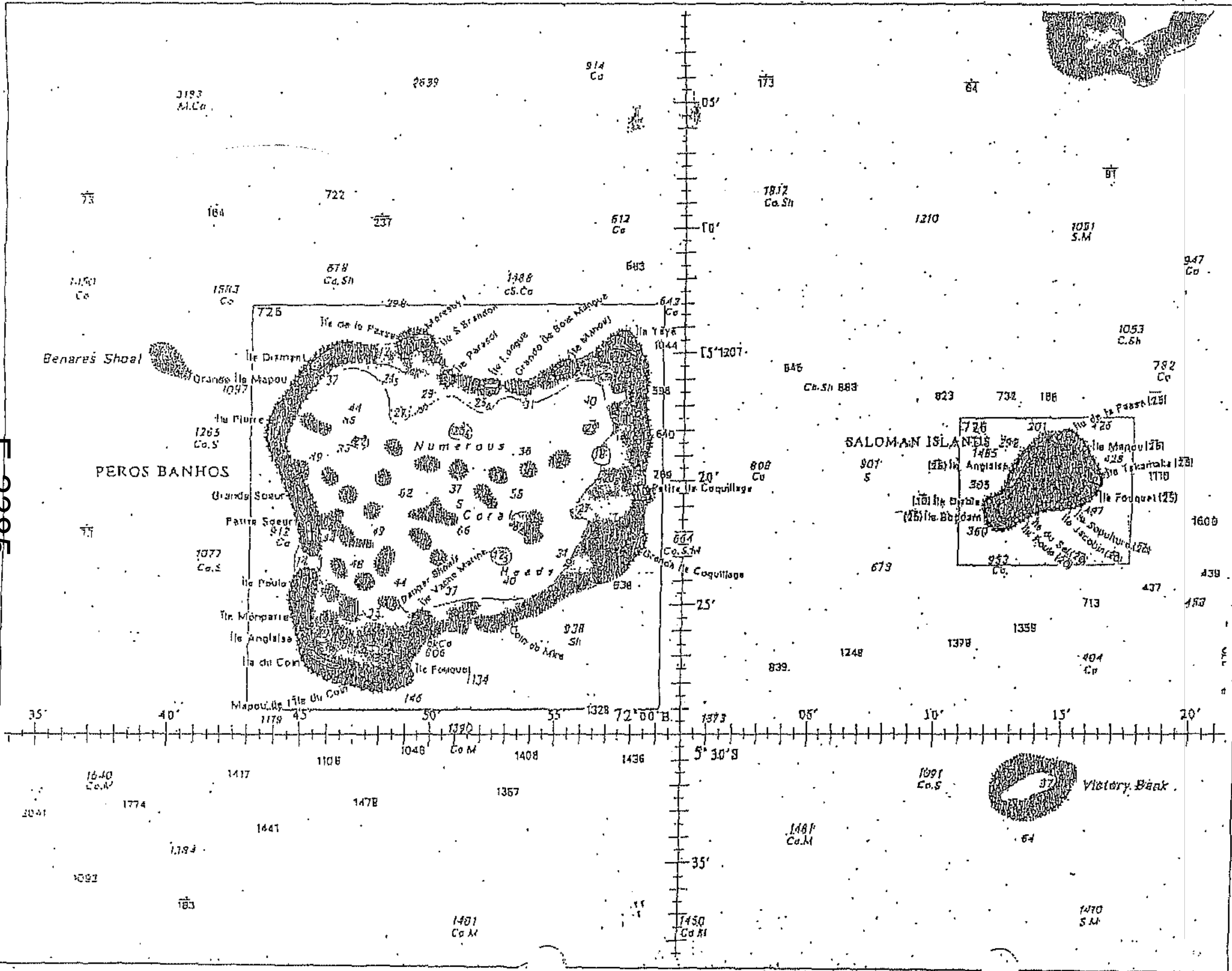

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PEROS BANHOS AND SALOMAN ATOLLS

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1.2. GROUNDWATER RESOURCE ASSESSMENTS

Groundwater investigations were completed on the islands of Ile du Coin and Ile Boddam, and identified that groundwater in the form of 'freshwater lenses' occurs on both islands. Each island has a single lens and not a series of separate lenses, as is found on some atoll islands. The lens on Ile du Coin is significantly larger in terms of area, thickness, and volume than that on Ile Boddam. At the time of the investigations, the freshwater lenses extended over approximately 66 hectares or 55% of the total area of Ile du Coin and 25.5 hectares or 24% of the total area of Ile Boddam.

The freshwater lenses on both islands are of moderate thickness in comparison with other atolls. The maximum thickness of the potable water component of the freshwater lenses was approximately 7.5m on Ile du Coin and 5.5m on Ile Boddam. The maximum thickness of the freshwater lenses to the specified non-potable salinity limit for freshwater was approximately 9.2m on Ile du Coin and 6.5m on Ile Boddam.

Photo 1: Drilling activities

On both islands, the freshwater lens is displaced towards the lagoon side, particularly on Ile Boddam. This is due primarily to differences in the permeability of the sediments across the island from lagoon to ocean side. On Ile Boddam, the across-island change in permeability appears to be related to the presence of a former and higher reef platform in the central, western and southern parts of the island.

The volumes of freshwater within the lenses were estimated to be 700 and 260 million litres (megalitres), respectively, for Ile du Coin and Ile Boddam. It is estimated that the potable water component of the freshwater lenses accounts for approximately 80% of the total volume. The freshwater lens characteristics and corresponding volumes will inevitably change with seasonal and inter-annual climatic conditions.

There is some evidence of a geological unconformity between the coral sediments and underlying limestone. This observation is consistent with findings on other atolls. Radio carbon dating of core samples taken from selected boreholes would assist in confirming the age of the sediments and underlying limestone rock.

1.2.1 Water quality

Overall, the water chemistry of the wells was good but many wells showed elevated levels of phosphate, which indicates faecal contamination from animal sources. Bacteriological tests carried out on both islands confirmed that faecal contamination is present in all but one of 17 wells. Pits and rainwater tanks also showed faecal contamination. The sources are likely to be rats and possibly crabs. Remedial action could be taken to ensure that all open wells and rainwater tanks are sealed, which is currently not the case.

1.2.2 Rainfall and recharge to groundwater

Mean annual and monthly rainfall for the two atolls based on summary data from the 1950s and early 1960s indicate that the rainfall for Peros Banhos and Salomon Atolls is quite high (approximately 4,000 and 3,750mm per year on average, respectively). However, long-term rainfall records at Diego Garcia indicate a lower mean annual rainfall of 2,700mm. Due to some uncertainty about the long-term rainfall for Peros Banhos and Salomon Atolls, upper and lower bound estimates were made from the summary data for these islands and the mean annual rainfall for Diego Garcia.

Recharge estimates were based on a relationship between average rainfall and average recharge. From this relationship, it was estimated that average recharge is approximately 40% of average rainfall. The upper and lower bound estimates of mean annual recharge were 1,080mm and 1,600mm for Ile du Coin and 1,080mm and 1,500mm for Ile Boddam. The lower bound estimate is similar to an independent recharge estimate for Diego Garcia.

From studies on other atolls, recharge to groundwater can increase by 20-25% if vegetation is selectively cleared in areas where the freshwater lens is known to occur. Water balance studies using daily rainfall data would need to be undertaken to confirm these estimates.

Estimated residence times of the freshwater are quite short, being, on average, 0.9 and 1.0 year for Ile du Coin and Ile Boddam, respectively. It is unlikely that a single drought year would impact significantly on the freshwater lenses. If there was a series of low rainfall years, the freshwater lenses could be depleted to a level where the salinity of water pumped from the thinnest parts of the lens may temporarily rise above the potable limit.

1.2.3 Sustainable yield estimates

The sustainable (safe) yield for the freshwater lenses on both islands has been estimated based on the freshwater lens boundaries and the estimated recharge from rainfall. These boundaries have been mapped into the GIS. Adopting a conservative approach, the sustainable yield was assumed to be equal to 30% of average recharge and to be applicable only to that part of the freshwater lens where the thickness was equal to or more than 3m.

The upper and lower bound estimates of sustainable yield of the freshwater lenses are:

- 290 and 430 kilolitres per day for Ile du Coin;
- 140 and 190 kilolitres per day for Ile Boddam.

Using the more conservative (lower bound) estimates, the 'population capacity' of each island would be approximately 3,000 for Ile du Coin and 1,500 for Ile Boddam for an average water demand of 100 litres per person per day. This water demand is sufficient for reasonable domestic water needs. The 'population capacity' does not take account of any non-residential water demands. If per capita water demands were higher, or if significant other groundwater demands were introduced (e.g. tourism, irrigation, fish processing), then the availability of water for human consumption would be proportionately reduced.

1.2.4 Recommendations

A number of recommendations concerning the short- and long-term use of water resources on the islands are put forward. These include monitoring activities and a longer-term investigation of recharge to the aquifer based on more robust rainfall data derived from the weather station on Ile du Coin. Further work is required to analyse the impacts of recharge variations on the freshwater lenses. In the event that resettlement of the islands proceeds, a number of recommendations are provided concerning infiltration galleries and land use planning to prevent contamination of the groundwater, and improved water management. The development of a groundwater model based on several years of climatic data is also recommended.

1.3 SOIL AND LAND RESOURCES

The soils of Peros Banhos and Salomon atolls are divided into 12 classes. The most extensive are the group of deep sandy soils developed in non-rubbly wash deposits in the centres and lagoon side of the islands. The other extensive soils are developed in rubbly wash on the ocean sides of the islands. There are also some shallow soils on the coral outcrops on Ile Boddam, which have dark humic topsoils over hard rock. The pockets of soil in the limestone grikes are humic or mucky and are among the few soils to have discernible contents of silt and clay. There are small areas of permanently or intermittently wet and patchily saline soils in lakes, ponds and former inter-reef channels that contain some silt and clay, although these are still predominantly sandy. Some soils appear to have been enriched, especially in phosphates, by guano beneath roosting sites. This effect seems to be patchy and is not as intense as reported on atolls elsewhere. Soil maps are provided in Volume V.

Ex-plantation coconuts are the dominant vegetation on the majority of islands and occur on most soils. The persistence of the high coconut canopy appears to be positively related to the fertility of the soil. Stands of semi-mature probable native tree species (including *Barringtonia asiatica, Calophyllum inophyllum* (Takamaka), *Pisonia grandis* and *Intsia bijuga*) demonstrate that these soils can support broadleaf forest where land management allows. A band of *Scaevola taccada* on the ocean and lagoon shores of most islands is important in erosion control. Open areas, colonised by *Gramineae* and *Cyperaceae* spp., occur in patches on most islands and are associated with the fine sand phases of soils in which topsoil moisture availability is low. In these areas, rain splash erosion of the (fine) sand of the surface horizon occurs.

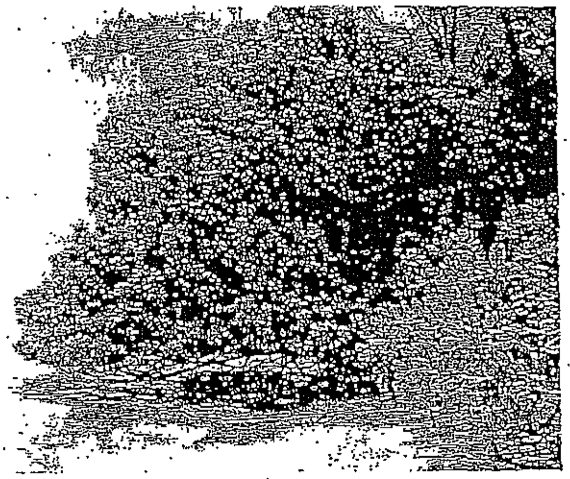

Photo 2: Takamaka (rear) and *Scaevola* (fore)

Coral atoll soils are generally regarded as marginal, with low fertility and limited and specialised agricultural potential. Although the soils of the Peros Banhos and Salomon atolls are typical of coral atolls in many ways, they have unusually high soil organic matter contents in the surface horizons and lack cemented compact subsoil pans. These differences mean that most Peros Banhos and Salomon soils have somewhat higher, if ephemeral, soil fertility and soil water availability in comparison with other similar atolls. The fertility resides almost entirely in the organic matter and the predominantly sandy mineral fraction is virtually inert. The most important factor determining this fertility is the past 30 years of coconut growth without habitation or plantation management.

This fertility will be rapidly and easily lost unless the soils are sustainably managed. This is fundamental to the feasibility of the agroforestal[1] aspects of resettlement. Any resettlement on these soils will require an agroforestal system that combines 'atoll agriculture' with agroforestry to achieve sustainable fertility management. Although coconut production will continue to be an important component it will not become a viable export enterprise and no alternative export crops are identified. Production will concentrate on local consumption.

Agricultural practices for the production of food crops have been developed and adapted to the physical and social environments on atolls and provide a basis for sustainable agricultural production. There appear to be few agronomic obstacles in Peros Banhos and Salomon to

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[1] Agroforestal is a blanket term for all agricultural, horticultural, livestock and forestry enterprises.

food crop production for local consumption using traditional atoll-adapted crops and technologies. There is an adequate information base on atoll agriculture, which can be adapted to provide agroforestal research and extension support to settlers in Peros Banhos and Salomon.

Atoll agricultural systems are knowledge- and labour-intensive. Thus the settlers' agricultural knowledge and, in particular, willingness and/or ability to commit the labour required are identified as major potential obstacles to food crop production in any resettlement programme. They need to be assessed, in conjunction with the settlers' general aspirations, capabilities, and resources, through participatory assessments and decision-making.

The major element of sustainable soil management and agroforestal production on the islands will be agroforestry. There are a number of positive features of agroforestry, which include the protection of the soil surface and soil fertility; little need for the introduction of exotic species into the atolls due to the presence of a number of suitable indigenous species; and buffering against severe disease outbreaks or pest infestations. This latter point is particularly important, as the use of agrochemicals should be prevented to protect both the groundwater and environment. There will be a need for strict quarantine and assessment of potential exotic species. The negative side of agroforestry on the outer atolls is that the tree canopy will use groundwater resources through evapotranspiration. For Peros Banhos and Salomon it is estimated that this will not exceed half of the annual rainfall, and this is justified by the benefits of agroforestal systems. The siting of agroforestal activities away from settlement areas will reduce conflict over water resource use.

A suitable agroforestal system will combine species and technologies for agroforestry agriculture, horticulture, livestock and forest production. A range of available candidate species and technologies are identified. Combining these in a locally adapted and effective system will require institutional support for adaptive research and extension. As the system will take time to become effective, settlers may require subsistence or other forms of support during establishment.

1.3.1 Recommendations

Sufficient data have been provided to furnish the agroforestal aspects of land use planning on the main islands, but these will need to be supported by the characteristics of the settlers and the locations for infrastructure and other development. Sustainable resettlement will probably involve agroforestal activities on several islands in each atoll, and the soils of the other islands will need to be surveyed at a semi-detailed level. Attention will need to be given to the economics of sustainable types of soil fertility management, especially towards establishing secure land tenure systems and stakeholder participation in the design of the resettlement.

1.4 FISHERIES RESOURCES ASSESSMENTS

The fisheries resources of the Chagos Archipelago are some of the least exploited and best managed in the Indian Ocean. Previous studies[2] indicate that the inshore finfish fishery (i.e. that in less than 150 metres water depth) is producing around only one-third of the precautionary maximum sustainable yield of 1,102 tonnes.

From these figures, it is suggested that exploitation of the finfish fisheries resource could be at least doubled yet remain within safe biological limits. Based upon experience in other parts of the Indian Ocean region, a fisheries development strategy for adoption by a resettled population has been suggested, which provides a realistic yet conservative scenario for providing both subsistence and income. The main elements of this strategy are outline in the following sub-sections.

[2] Largely undertaken by the Marine Resources Assessment Group on behalf of BIOT Administration.

1.4.1 Subsistence fishing

Inhabitants would be permitted to conduct subsistence fishing in the atolls within a single day reach (i.e. 12 nm) from the outer atolls. This includes Blenheim Reef and Victory Bank but essentially rules out Speakers Bank to the north as well as most of the Great Chagos Bank. This activity would be restricted to hand-line only and all the catch would be either eaten directly or marketed fresh within the atoll population centres. Based on regional consumption statistics, this activity could support the fish protein nutritional needs for between approximately 500 and 1,000 persons.

1.4.2 Outer reef and banks commercial fin-fish fishery

Relocation of the dory fishermen to the atolls - the current licensing of Mauritius-based freezer ships could continue based on its present form, with the atoll residents returning to their homes during the closed season (November – March) to rejoin the subsistence fishery. As in the past, this would produce around 300 metric tonnes (mt) of frozen fish worth around US$ 600,000.

Development of an atoll-based fresh fish fleet - an alternative scenario, which would provide a similar level of employment (approx 60 person years per annum) would be the use of up to ten multi-purpose fishing vessels that would produce high quality fresh fish for the international market. The fishery could be operated year round and a conservative estimation of potential yield suggests production rates of up 880 mt would be possible, with a market value of approximately US$ 4.75 million. This scenario would only be viable if an airlink was developed, providing both a distribution route to the main markets as well as an outlet through local tourist operations. Whilst this may appear to be a promising option for the long-term sustainable development of the Chagos fisheries resources, there are a number of significant logistical constraints. Apart from the substantial infrastructure and skills development required, the communication and management needed to develop a fresh fish export business should not be underestimated, along with the problems associated with isolation from potential markets. It could in the right circumstances, however, present a controllable high value, low biomass yield that, if coupled with the simultaneous development of carefully planned tourism, has potential to become an economic mainstay for a small population.

1.4.3 Inshore invertebrate fishery

Holothurians (sea cucumber), *Trochus* (top shell) and *Tridacna* (giant clams) are important elements of atoll fisheries throughout the world. Both women and men are typically engaged in invertebrate fisheries, and their exploitation can be an important component of household income. Holothurians and *Trochus* exploitation are suited to remote atoll environments as the product can be processed with low technology and stored without refrigeration for several weeks, even months, prior to marketing. Conversely, the commercial exploitation of *Tridacna* would require rapid access to markets, either as frozen or live commodities for the food and/or aquarium industries. The resource might also provide an important subsistence food.

From a precautionary fisheries development perspective, it is important to note that these invertebrates are highly susceptible to exploitation pressure. Based on field observations, with extremely strict management it would be possible to establish a sustainable holothurian fishery. Average densities of holothurians within the two atolls indicate that a holothurian fishery would yield a value of between £10 - 880 per hectare, with the variability in value depending on the species targeted. Due to the patchy distribution of holothurians, it is not desirable to place an overall potential value based on an estimate of suitable habitat area over the two atolls. The economic viability of exploiting these resources in a highly controlled manner would need to be investigated.

It is not recommended that a *Trochus* fishery be developed unless accompanied by a controlled and appropriate re-seeding programme. This would rely on the establishment of hatchery facilities within the atolls, which would require significant investment, skilled human resources, and a research and environmental monitoring programme.

The commercial exploitation of *Tridacna* would probably be uneconomical unless a reliable and rapid link to markets was developed (i.e. an air link). Otherwise, exploitation would be limited to dried or frozen products, which have a much lower market value than live products. Based on *Tridacna* densities in the field, the potential value (extrapolated from current Singapore market prices) for dried product is only £32 per hectare, whereas similar calculations for the export of live clams (for the aquarium industry) reveals a potential fisheries value in the range £2,400 – 12,500 per hectare. This is of course a crude calculation but it serves to demonstrate the difference in value between dried and live product.

In addition to the question of economic viability is the issue of sustainability. As *Tridacna* species are protected by international law (CITES) any exploitation of this resource would have to demonstrate that it was sustainable before export would be permitted. An assessment of sustainable limits of exploitation would need to be the subject of long-term research. As with *Trochus*, *Tridacna* are frequently exploited through reef re-seeding programmes, and this would be the recommended approach in any fisheries development strategy. Whilst this might generate a sustainable fishery, the same development constraints would apply and would probably only be economically viable for the export of live product.

1.4.4 Small-scale Inshore Fisheries Aggregating Devices

The promotion of Fisheries Aggregating Devices (FADs) to target epi-pelagic or large pelagic fish has been ruled out on a number of technical and environmental grounds over the medium term. Essentially, FADs do not increase productivity but simply aggregate fish that may lead to over-fishing (juvenile fish are particularly vulnerable). In addition, inshore FADs are mostly employed to gather baitfish for 'pole and line' tuna fishing, an activity that is not considered appropriate for the Chagos Archipelago within the near future.

1.4.5 Mariculture

Intensive mariculture, such as for shrimp and finfish, has been immediately ruled out on technical, economic and environmental grounds. More extensive forms of aquaculture, especially those that produce products with minimal processing, storage or specialised distribution needs have been considered, especially if their technologies have been demonstrated to be easily transferable to skilled but non-specialist personnel.

Seaweed culture may be appropriate for the outer atolls but an initial examination of the hydrological and environmental characteristics indicate that growth may be marginal and crops vulnerable to high seawater temperatures. On the basis of some fairly coarse estimates derived from the GIS, it may be possible to produce up to 3,000 mt of seaweed from around 300 hectares of seabed, mainly on the western islands of Peros Banhos. However, it must be emphasised that the marginal growing conditions require that more detailed site selection and pilot-scale trials be conducted before serious investment is considered.

Pearl oyster culture for 'mother of pearl' shells may be possible since the most commonly cultivated species *Pinctada margaritifera*, and the increasingly more popular *Pteria penguin*, are both present in the outer atolls. However, like seaweed, site selection in the nutrient-poor waters of the atolls will be essential and the level of natural spat fall will need to be determined. Depending on the results of these further studies, it cannot be definitely stated that pearl oyster culture is a viable livelihood option for potential settlers.

1.4.6 Conclusions and Recommendations

The findings have concluded that there are a number of opportunities that would provide both subsistence and an economic return from fisheries and mariculture activities around the atolls and the outer banks. They are considered realistic on the basis of the existing resource information and from previous fisheries development experience in the region. However, the two main elements missing from both this phase and Phase 1 are (i) an economic justification of the proposed activities and (ii) consultation with the Ilois.

The next stage is therefore the preparation of an integrated fisheries sector development strategy, based upon the options provided in this study and linking these with other suggested livelihood opportunities. In some areas these are straightforward, such as the development of the subsistence fishery. However others, especially when they involve the associated development of infrastructure and skills, will require considerable further study and detailed assessment.

The need for further investigations will be defined in response to any specific proposals made by the Ilois for the development of fisheries or mariculture enterprises. These would cover social and cultural issues such as the interests and skills of Ilois relevant to fishing and their perceptions of the constraints on the development of such enterprises in the atolls. The availability of marketing channels, both traditional and new, and any changes that would be needed to the current management system to ensure adequate enforcement of the fishery and the possibility of self-regulation by the fishing community should also be assessed.

1.5 NATURAL ENVIRONMENT

Information on the biological, ecological, geological and physical processes of the environment are an essential component for planning for its conservation and sustainable use. It is also valuable for determining the range of future development opportunities such as fisheries, tourism, and agroforestry development.

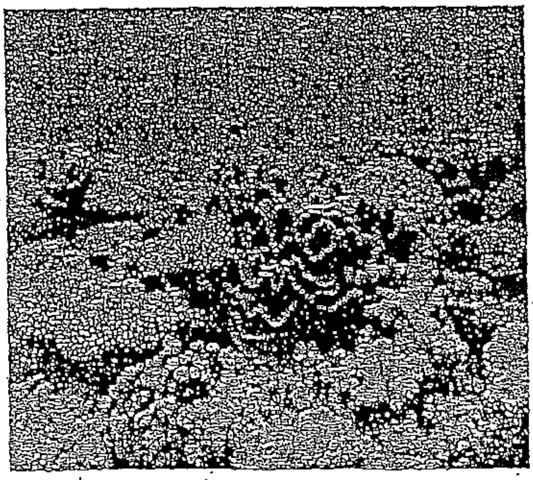

Photo 3: Typical coral-reef assemblage

The Chagos Archipelago has a rich diversity of marine and terrestrial habitats, which have been well documented by numerous scientific expeditions that have taken place over the past 30 years. The Archipelago has the greatest diversity of corals in the central Indian Ocean. Coral reefs support a large number of fish species, many of which have economic as well as recreational importance. It is likely that many more species are yet to be found. The terrestrial environment offers rich habitats for a large number of bird species, and some of the beaches are used as turtle nesting sites. The islands are also home to the protected coconut crab.

This section describes the status of the largely undocumented lagoon reefs together with a brief description of the coastal terrestrial environment, to provide an environmental baseline for the evaluation of anticipated environmental threats associated with resettlement. Environmental impacts resulting from resettlement activities are likely to have a greater impact on the lagoon environment, and this information is therefore essential to inform sustainable planning and management decisions.

1.5.1 Lagoon reef systems

Corals diversity and abundance

Coral cover varied little within island reef tracts but showed higher variability between islands and also between atolls. Mean coral cover was significantly higher in Salomon Atoll (45%), especially around Ile Boddam, than in Peros Banhos Atoll (26%). The diversity of scleractinian (stony) corals was also greater within Salomon atoll; a total of 16 genera were recorded from Peros Banhos, whereas 27 genera were recorded from Salomon. The most abundant genera within Peros Banhos were branching growth forms, of which *Acropora* was the most abundant followed by *Stylophora* and *Pocillopora*. In Salomon, the most abundant genera were

Acropora, Favites, Favia, and *Cyphastrea.* Massive growth forms were not as well represented in Peros Banhos as in Salomon.

Coral topographical complexity

The measurement of topographical complexity is an indication of habitat (i.e. shelter and refuge) provided by the reef structure. Complexity was highest at sites in Peros Banhos atoll, particularly close to the jetty at Ile du Coin. Sites that had high complexity were dominated by large stands of the branching coral *Acropora* and had high levels of coral cover (30-40%). Although coral cover was higher in Salomon atoll, the reefs were dominated by large massive corals, which do not provide the same level of structural complexity as the branching corals. Preliminary findings indicate that the topographical complexity of lagoon reef habitats in both atolls offers a wide variety of shelter and refuge to a range of reef fauna and flora.

Reef fish abundance and diversity

A total of 171 reef fish species were observed within the lagoons of the two atolls: 91 in Peros Banhos and 135 in Salomon, indicating that fish diversity is higher in the latter. There were no significant differences in the mean counts of fish abundance or species richness between the two atolls (based on fish census results); however, greater fish numbers were observed in Peros Banhos. There was considerable variability in abundance and species richness of fish between sites within both atolls but this was not correlated with coral cover. Fish communities in Peros Banhos atoll were dominated by herbivores followed by invertebrate feeders, and in Salomon the dominant groups were plankton feeders followed by herbivores. Although the percentage of coral-feeding fish was low overall it was twice as high in Salomon Atoll, and possibly correlated with the higher coral cover in this atoll. Whilst reef fish communities within the two atolls have similar diversities and densities of fish, analyses showed their community structure to be different.

The lagoon reefs within the atolls were not only found to be biologically diverse but they were also in a relatively pristine condition. Given the poor condition of the seaward reefs, the lagoon reefs may have an important role in re-seeding the degraded outer reefs, and the maintenance of their health will be an important consideration for future planning and management.

1.5.2 Terrestrial environment

Broadscale terrestrial surveys were undertaken around the perimeters of several islands, during which features such as beach gradient and composition, dominant vegetation, key fauna, levels of flotsam, and critical species habitats, such as turtle nesting sites, were noted. These findings are presented in the GIS (Volume V). The islands surveyed lie on the outer perimeters of the atolls, and therefore have different characteristics on their lagoon and outer coasts. Beaches on the lagoon sides of the islands are generally gently sloping and comprised mainly of sand, whilst those on the outer side are often characterised by rocks and boulders, and in places exposed reef conglomerate and fossilised reefs.

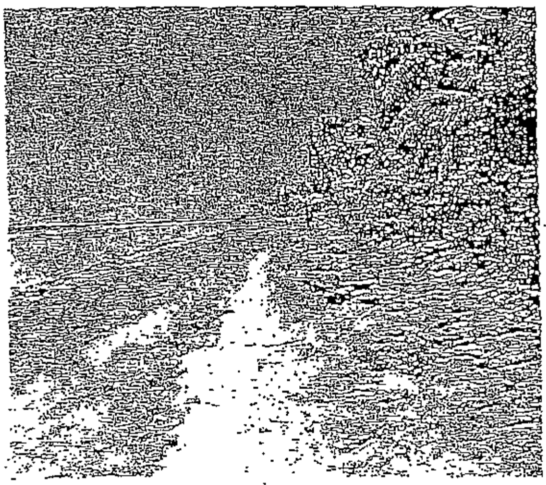

Photo 4: Exposed reef conglomerate

The vegetation on the islands was typical of coral atolls elsewhere. Coconut palms were dominant, and along many areas of the coastal fringe the beach scrub *Scaevola taccada* was common, which is important in preventing beach erosion. The coastal scrub *Pemphis acidula* was only noted on Ile Anglaise, associated with the saline / brackish lakes on the island. On some islands, broadleaf trees were often seen at the coastal edge, which included *Pisonia grandis* (Lettuce tree); *Hibiscus tiliaceus* (Sea hibiscus); *Calophyllum inophyllum* (Takamaka); *Barringtonia asiatica* (Sea putat); *Guettarda speciosa* (Nit pitcha) and *Argusia (Tournefortia) argentea*.

The pine *Casuarina equisetifolia* occurred in places, and is an important roost for the white tern, greater frigatebird and white-tailed tropicbird. Other species of birds that were observed in high numbers were the common noddy and lesser noddy, which were seen mostly on the outer exposed sides of the islands, and the roseate tern and black-naped tern, which were seen nesting on the spits. Old nesting sites of green and hawksbill turtles were noted on Ile du Coin.

Levels of flotsam were higher on the outer beaches of the islands, and were more densely concentrated in areas of high wave energy. Typical components of flotsam included plastic and glass bottles, flip-flops, fishing nets, buoys, and crates. The incidence of oil and other pollutants was very low.

1.6 COASTAL AND OCEANIC PROCESSES

The outer atolls are situated within a large expanse of ocean and the islands are low-lying and narrow; their maximum elevation being on average less than two metres and widths generally no greater than 500m. These characteristics, together with the steep slopes at their outer edges, render the islands highly vulnerable to oceanic and climatic processes. Investigations of these coastal processes, particularly around the islands of Ile du Coin and Ile Boddam, were undertaken to inform an appraisal of the current and future vulnerability of a resettled population and its infrastructure to climatic conditions. These investigations will also serve to guide the most suitable and reduced-risk siting of any infrastructure on the islands, and determine the need for coastal defence. The investigations were divided into four main topics: 1) meteorological and oceanic information from the Indian Ocean region; 2) the physical development of the coastline; 3) overtopping events; and 4) current patterns within the atolls.

1.6.1 Meteorological and oceanic information

A search of literature and meteorological records was undertaken to assess the risks of cyclones, earthquakes and associated tsunamis, and other events that pose a severe threat to the coastlines and islands as a whole. The investigations revealed that a number of events, such as cyclones, earthquakes, and tsunami, have occurred within the region, and future events would have the potential to cause severe flooding on the islands with possibly loss of life. The Chagos Archipelago is on the northern edge of the cyclone belt and, hence, is not subjected to frequent cyclones. However, there is the potential for cyclone attack even though (and partly because of their infrequency) there is little historic evidence.

1.6.2 Physical development of the coastline

The physical development of the coastline was investigated using a combination of field measurements, visual observations and numerical modelling. The investigations conclude that the oceanic sides of the islands are eroding, but that the lagoon sides of the islands are generally stable. The oceanic beaches and reef edges are sources of sediment for the spits that have developed at the ends of most islands, and may also nourish the beaches of the lagoon. The removal of this sediment source or the interruption of its long-shore drift, through the construction of coastal structures for example, would intensify erosion in downdrift areas. Should there be a need to construct on the oceanic coastlines (e.g. outfalls) then the impact on erosion would need to be quantified, together with other physical effects (e.g. accretion on the updrift side), so that suitable mitigation can be incorporated and/or better sites identified.

From the evidence gathered to date over this short study period, it has not been possible to quantify the rates of erosion, but it will be important to establish these rates prior to advancing any plans for future development on the islands. Failure to do so could result in development in inappropriate areas, and the subsequent need for coastal defence which may subsequent prove costly and possibly impractical to sustain.

The background rates of erosion will need to be determined through comparison of aerial photographs (which were not made available at the time of this study) and through other anecdotal evidence, such as might be gathered from the Ilois. This kind of historic information will provide essential input for the calibration of numerical models, which can then be used to evaluate the impacts of specific coastal structures. Monitoring programmes will be put into place to guide future evaluations.

1.6.3 Overtopping events

As part of an assessment of the vulnerability of a future population to climatic conditions, the likelihood of overtopping of the natural defences of the islands by waves was investigated using numerical modelling, and supported by visual observations made during the site visit.

The results indicate that the islands are likely to experience overtopping on a regular basis, e.g. annually. However, the extent to which this overtopping leads to inundation depends, of course, on the severity of waves and the sea level. The studies and historic data (e.g. Maldives 1987) suggest that during a severe storm, "wave set-up" is a principal element of the sea level, and hence a major contributor to potential flooding. Wave set-up is the rise in water level caused by the "piling-up" of breaking waves on the reef flat. Simple modelling, such as was undertaken for the present study, shows that this could be of the order of 2m in extreme cases, thus resulting in serious overtopping as waves at this level then simply weir over the beach crest and onto the island. However, this analysis is likely to be pessimistic, as it does not take into account the alleviation of wave set-up resulting from flow along the coast and around each island. In this respect, the studies have been invaluable in identifying the dominant processes responsible for potential flooding, but do not facilitate any precise estimates of the return periods of flooding events. For the present study, therefore, we must also draw on visual evidence and the limited historic data.

The fact that the Ilois survived this environment for some eight generations, and that copra was cultivated on a commercial basis during this time, suggests that the islands have not, historically, been subject to frequent inundation by seawater. Alongside this, there is a record of severe cyclonic damage in 1891, together with more recent events such as the flooding event that occurred in the Maldives in April 1987. In the future we can expect flooding to be more frequent as sea level rises, thus lowering the threshold event that can result in overtopping of the ocean coastal edge.

Summing up, it is likely that overtopping caused by wave action on the ocean side occurs regularly (e.g. more frequently than annually), but this does not necessarily lead to inland flooding. From time to time, when the sea is elevated, principally through wave set-up, severe flooding over a significant proportion of the island area can be expected to occur. The return period for such an event is not known, however, from available (very limited) evidence this might be expected to be in the order of tens of years.

Ground levels taken from transects across both Ile du Coin and Ile Boddam show that the land levels vary by typically 1.5 metres (excluding the beach ridge). Thus, in the event of severe inundation, we could expect flood depths of the same magnitude. Raised areas, such as identified towards the lagoon side of Ile du Coin, would therefore provide greater security for infrastructure. In areas which are more vulnerable to deep flooding, where it might be necessary to site infrastructure, any construction would have to be designed accordingly, using suitable fabrics in foundations and the ground floor, and appropriate ground floor usage.

The issue of potential inundation of the islands due to overtopping is a very important one. Further work would be needed in the next stage of the studies to quantify the risks and map out the risk areas. This further work must include, as a minimum: consultation with the Ilois to determine whether historically they had experienced flooding on the islands; 2-d modelling of wave set-up and overtopping; and topographic mapping of the islands.

1.6.4 Currents

Currents within and around the atolls were investigated using a combination of field measurements, previous data from the atolls, and analytical techniques. The investigations concluded that the currents existing within the atolls are generally very weak particularly within the lagoons, and are formed from a combination of tidal, oceanic and wave and wind influences. There may be some seasonal influence of waves and wind speeds on current characteristics. Current patterns have been used in models of possible effluent disposal and have facilitated the appraisal of certain mariculture development opportunities.

1.7 WATER QUALITY

To be completed when information arrives.

1.8 CLIMATE CHANGE

The reports of the International Panel on Climate Change were evaluated to determine the latest projections on climate change. Global sea levels are expected to rise by about 38cm between 1990 and the 2080s. Indian and Pacific Ocean islands face the largest relative increase in flood risk. Although there will be regional variation, it is projected that sea level will rise by as much as 5mm per year, with a range of 2-9mm per year, over the next 100 years. With a rise of 0.5 metres in sea level, the implications of climate change on the Chagos Archipelago are considerable, given that mean maximum elevation of the islands is only two metres; the diversity of livelihoods available is limited; and the relative isolation and exposure of the islands to oceanic influences and climatic events. These implications are discussed in the light of biodiversity and resettlement.

1.8.1 Implications for Biodiversity

The impacts of climate change on highly diverse and productive coastal ecosystems such as coral reefs and atoll islands will depend upon the rate of sea-level rise relative to growth rates and sediment supply. In addition, space for and obstacles to horizontal migration, changes in the climate-ocean environment such as sea surface temperatures and storminess as well as human pressures will influence the capacity of ecosystems to adapt to the impacts of climate change.

Several episodes of coral bleaching over the last 20 years have been associated with increased ocean temperatures. In 1998, a major coral bleaching episode in the Chagos Archipelago was found to be associated with periods when ocean temperatures were about 1°C higher than the seasonal maximum for periods greater than one month. Sea surface temperature projections suggest that the thermal tolerance of corals could be exceeded within the next two decades. Future sea surface warming would increase stress on coral reefs and result in an increased frequency of marine diseases and mass coral mortality.

In addition, it has been suggested that the ability of the corals and coralline algae to build reefs is being reduced by rising atmospheric carbon dioxide. Based on projected carbon dioxide concentrations in the atmosphere, it is predicted that there will be an approximate 14-30% decline in the calcification rate of corals by 2050. The earlier prognosis that healthy reefs would be able to keep pace with sea level rise is now far less certain for many reef systems in the Indian Ocean, where reef structures have already been weakened by a variety of climatic and human stresses.

Species that occupy terrestrial habitats for all or part of their life-cycle, such as birds, turtles and coconut crabs, will also be adversely affected by sea level rise. There is considerable uncertainty about how climate change will affect the natural environment in the Chagos Archipelago, but that the outcome is likely to be an unfavourable shift in biodiversity.

1.8.2 Implications for Resettlement

The most significant and immediate consequences of climate change on a resettled population within the Chagos Archipelago are likely to be related to changes in sea levels, rainfall regimes, fresh water resources, soil moisture budgets, prevailing winds (direction and speed) and short term variation in regional and local patterns of wave action. At present, the Chagos Archipelago lies just north of an active cyclone belt, however, a small northward shift of this belt could lead to frequent cyclones in the area. This would lead to more frequent flooding of the islands, with corresponding risk to life and any infrastructure. It would also reduce agricultural potential and the freshwater contained within the island aquifers would experience higher levels of salinity.

Irrespective of whether the Chagos Archipelago becomes subjected to regular cyclones, the general increase in storminess that may accompany climate change would result in increased wave energies and an increasing frequency of over-topping events. Based on a 0.5m rise in sea level scenario, models of overtopping events demonstrate an increase of between 20-50% of the frequency of severe events. Of further significance is the probability that sea level rise and overtopping events would threaten the characteristics and sustainability of the fresh groundwater lens.

The rate of erosion of the ocean coasts are likely to increase with sea level rise and increased storminess, and would be accompanied by an increase in sediment transport, which would have implications for shoreline infrastructure. On islands where physical space is limited, as in Chagos, coastal defences are likely to be low key and would need to be developed with a view to sustainability.

It is advised that future settlers on the outer atolls should be made aware of the risks of climate change in terms of their own safety and that of any physical investment. Should people wish to return, it would be prudent to provide specialist assistance in the preparation of appropriate and sustainable land use and coastal defence policies, which would ensure that the vulnerability of the resettled population was minimised as far as possible.

1.9 INFRASTRUCTURE CONSIDERATIONS

Information has been provided on a number of generic infrastructure items that would be required by a resettled population, namely sea defence structures; jetties; effluent disposal; dispersal of sediments arising from dredging; residential development; solid waste disposal; energy; and an airport. Costs have been provided where appropriate (or possible).

Sea defences: Development should be planned to avoid coastal areas subject to erosion, particularly along the ocean coast. With appropriate planning and enforcement procedures the need for sea defences can be minimised. The widespread flooding caused by overtopping of the ocean side defences is probably best dealt with by managing the flow of water on the islands. Defences to prevent overtopping would probably be impractical.

Jetties: Considerations are provided on the design structure and location for jetties, but these are kept generic considering the lack of information on the usage of such a structure.

Effluent Disposal: The establishment of an outfall is considered the most appropriate and safe means for effluent disposal. Consideration has been given to its appropriate location on the outer side of the islands. A model was employed to determine the fate of untreated effluent plumes from the outfall and demonstrated that concentrations around the outfall would exceed recommended limits for a coral reef environment, and would only dissipate to acceptable limits within 1.5km from the outfall. Primary and secondary treatment is therefore recommended. Once more information has been provided on the numbers of people likely to return, the preparation of a detailed effluent management plan is recommended.

Sediment dispersal: Activities such as dredging and marine construction will give rise to suspended sediments, which will have an impact on the relatively pristine marine environment (see next section). Particle size analysis and current measurements have been used to calculate the likely fate of these sediments. It is concluded that sediments originating from construction activities within the lagoons will be re-deposited on the seabed at between 63m for Salomon Atoll and 315m for Peros Banhos Atoll from the source. The zone of settlement will be increased if there is significant wave energy within the atolls. This will have implications for the health of the marine environment.

Disposal of dredged material: Dredging will generate quantities of material that will need to be disposed of in an environmentally responsible manner. Options for this disposal will need to be considered, and will include disposal in deep waters or on-land (e.g. for the provision of foundations for housing). The fate of disposed sediments will need to be assessed, together with a consideration of any environmental impact they may incur.

Considerations for residential development (e.g. design and construction), solid waste disposal, energy, and an airport are very briefly described. More information on these would be required at a later stage, particularly when more is known on the numbers and livelihood strategies of the proposed settlers.

1.10 ENVIRONMENTAL APPRAISAL OF RESETTLEMENT

1.10.1 Appraisal of environmental impacts

The characterisation of the nature of potential environmental impacts associated with resettlement has been carried out. This will be expanded when resettlement demography, livelihood strategies, and socio-cultural characteristics are available. The appraisal is necessarily generic and the scale and intensity of potential environmental impacts are not discussed in detail. Environmental impacts can be broadly divided into two categories: those associated with the construction and operational development of physical infrastructure; and those related to livelihood strategies.

Development of physical infrastructure

One of the major environmental concerns relating to resettlement is the potential loss of marine and terrestrial biodiversity and habitats. Impacts are likely to occur as a result of the construction of jetties, harbours, coastal defence works, effluent discharge, waste disposal, and if relevant, the establishment of an airport. The major threats to the environment from these activities would include:

- Sedimentation arising from dredging activities, landfill and sewage disposal may have an adverse impact on the marine environment, particularly coral reefs, if activities are not conducted in an environmentally responsible manner. Minimising the loss of corals is pertinent to the maintenance of biodiversity, the future stability of the coastline and beaches, the productivity of fisheries, and tourism interests. It is interesting to note, however, that an evaluation of the impacts of dredging in Diego Garcia found no evidence for any significant change to reef communities after the completion of works;
- Coastal erosion might arise through the disruption of shoreline processes, due to the construction of shoreline infrastructure. This may have a subsequent adverse impact on turtle and bird nesting sites, and might lead to the loss of beaches and protective coastal vegetation;
- Loss of soil fertility and some soil erosion as a result of vegetation clearance for the establishment of infrastructure. These resources are very fragile and ephemeral, and their loss will have an impact on agricultural productivity and possible recharge to the groundwater.

It is possible to minimise these potential impacts through sound land use planning and good environmental management practices.

Livelihood strategies

The environmental issues relating to livelihood strategies concern a number of factors, which include economic activities and waste disposal. The scale of the impacts will depend largely on the nature and magnitude of the activities.

Income generating activities

- Fisheries: the major environmental concerns associated with fishing include the potential for over-exploitation; habitat disturbance; and changes in reef community structures. The implementation of an integrated fisheries sector strategy and management plan would be essential to reduce any adverse impacts of human intervention.
- Mariculture of seaweed and pearl culture in open coastal systems may incur significant environmental problems if poorly managed. These concerns relate to land-based infrastructure; processing; effluent and waste control; and the introduction of exotic species. Potential negative impacts include the degradation of natural habitats and alterations in the ecosystem balance. An important consideration for the atoll environment is the potential conflict over the use of limited groundwater resources. With careful siting and management, a number of these issues can be avoided.
- Agriculture: Without careful management, agricultural practices could lead to a rapid reduction in soil fertility and some erosion of soils. In line with the recommendations of the main report, it is suggested that the adoption of suitable agroforestry techniques will be the most appropriate and sustainable form of agricultural development.
- Tourism has not been a key subject for this phase, but as an obvious choice for income generation it has been considered as part of the environmental appraisal. Environmental damage from tourism could arise through poor design and siting of tourism residences; inadequate waste disposal; over-use of the groundwater aquifer; excessive pressure on coastal resources; and reef damage through ill-managed diving and boat anchorage. As with other development activities, tourism can be a highly sustainable industry if appropriate management measures are adopted.

Waste disposal

- Effluent disposal: The safe disposal of effluents should be a major consideration in resettlement planning. Sewage is very rich in biodegradable organic matter and unless appropriately treated and discharged can cause nutrient enrichment, algal blooms, a decrease in marine biodiversity, contamination of groundwater, and human health problems. These in turn can adversely affect income-generating activities such as fisheries, mariculture and tourism. The treating of effluent, and the appropriate siting and length of effluent outfalls will be an important component of an environmental management programme.
- Solid waste management will be a significant problem to settlers owing to the limited availability of land and the need to avoid contamination of the groundwater aquifer. Wastes that will require disposal will include non-biodegradable products such as plastics; and hazardous substances such as paint, waste oil, batteries and medical waste. Options for waste disposal include landfill, disposal at sea, incineration and export. Landfill and dumping at sea would have severe environmental effects and are not recommended. Incineration and export may be possible but have costs and environmental implications elsewhere.

1.10.2 Environmental management considerations

In order to ensure the sustainable development of the outer atolls, it will be important to ensure that development activities take place within an integrated planning and management framework, which is adapted to the Archipelago's unique political, cultural and institutional condition. The core elements of an integrated framework for environmental management should encompass:

- Participation: The involvement of those involved in resettlement in the development and implementation of land use plans and resource development strategies;
- Land use planning: Wise land use planning and zoning of development activities will be required, possibly including the establishment of protected areas. This should take into account the vulnerability of populations and infrastructure to climatic and coastal processes;
- Coherent resource use: Integrated resource development strategies, taking into account optimal exploitation limits and island carrying capacities, will be required to ensure that resources are used in a sustainable manner;
- Legislation and regulation: A robust and effective regulatory framework will be required, which will need to incorporate, and expand if necessary, existing legislation governing resource use and the environment in the Archipelago;
- Environmental monitoring: An environmental monitoring programme based on accurate information on local biophysical, ecological, oceanographic and meteorological characteristics is recommended. The monitoring programme will need to be carried out by appropriate specialists on a regular basis, and should seek to involve the island community wherever possible. Monitoring should incorporate international best practice employed within the region, such as the Intergovernmental Oceanographic Commission's Global Coral Reef Monitoring Network.

1.11 OVERALL CONCLUSIONS

Through a combination of field- and desk-based studies, laboratory analysis, and modelling, this phase has generated important information on the availability of natural resources within the outer atolls, and has further developed a number of livelihood strategies and income-generating opportunities that might be available to a resettled population. It has also developed our understanding of the implications of resettlement in terms of the vulnerability of people and infrastructure to current and future climatic conditions, and has outlined the possible environmental issues that would accompany permanent resettlement of the islands.

Water

The groundwater investigations revealed that there is a substantial body of water available on both Ile Boddam and Ile du Coin to support populations of between 1,500 and 3,000 people, respectively, assuming water utilisation requirements of 100 litres per person per day. This utilisation rate accounts only for modest domestic uses and would not be sufficient to enable additional development activities such as ice making requirements for the fisheries industry; irrigation support for agricultural production; or tourism needs. The apportionment of groundwater water to these other activities would result in the proportional reduction of water available for other uses, including human consumption, and may limit the numbers of people that the groundwater would be able to support. This assumes that the population would be dependent upon groundwater alone, and not on other forms of water supply, such as rainwater collection or freshwater-generating systems such as de-ionisation and desalination. The water resources themselves are largely contaminated with faecal bacteria and would need to be treated prior to consumption.

Soils and Agroforestry

The soils investigations concluded that the soils within the atolls were atypically fertile, due to the lack of habitation or plantation management for 30 years. This fertility is fragile and would be readily lost without the application of sustainable agroforestry techniques. It would be possible to develop a sustainable agroforestry system that would combine species and technologies for agroforestry agriculture, horticulture, livestock and forest production to provide for the subsistence needs of the population. The limitations in soil fertility, land area, and potentially labour, however, would mean that agroforestry production would be unsuitable for commercial ventures, except perhaps limited retail to the seasonal yacht trade. Whilst production from agroforestry should be able to meet some of the nutritional requirements of a resettled population, it would not be able to support their carbohydrate needs, which would need to be met through imported goods such as rice and cereals.

Fisheries and Mariculture

Conversely, the fisheries resources of the Archipelago are substantial and under-exploited. A number of fisheries and mariculture development opportunities have been explored, and based on principles of sustainable development some have been recommended as suitable options for income-generation and subsistence. The investment required to support these options vary from modest to considerable, and some will not be possible unless an air link is established. Bearing in mind that the Ilois already fish within BIOT waters, and that fish would probably be a resettled population's main source of animal protein, it is likely that fisheries and possibly mariculture would become an important provider of livelihoods and income.

Vulnerability

There appear to be sufficient groundwater, soils, fisheries, and environmental (e.g. limited tourism) resources to support a small population on a subsistence basis with some commercial opportunity, but there are some more fundamental issues surrounding the feasibility of resettlement. These relate to the vulnerability of a resettled population to current and predicted climatic conditions, and the fragility of the environment to human-induced disturbance.

Under the present climate, it is assumed, based on historic meteorological patterns and observations, that the islands are already subject to regular overtopping events, flooding, and erosion of the outer beaches. As global warming develops, these events are likely to increase in severity and regularity. In addition, the area is seismically active, and the possibility of a tsunami is a concern. These events would threaten both the lives and infrastructure of any people living on the islands. Whilst it might be possible to protect the islands to some extent in the short-term through coastal defence measures, it is likely to be cost-prohibitive and non-pragmatic to consider this form of defence in the long-term.

The environment of the Chagos Archipelago is highly diverse and yet very susceptible to human disturbance. Coral reefs, which are one of the most important ecosystems within the Archipelago, are already exhibiting signs of stress from increased sea surface temperatures and other climatic phenomenon. Predictions from climate change experts indicate that mass mortality of reef building corals in the Indian Ocean is likely to occur as global warming increases, may be as soon as within the next 20 years. This will not only have huge implications for the long-term coastal defence of the islands, and hence their very existence, but will also adversely affect livelihoods, particularly fisheries and tourism, which are likely to be the mainstay of any resettled population. Human interference within the atolls, however well managed, is likely to exacerbate stress on the marine and terrestrial environment and will accelerate the effects of global warming. Thus resettlement is likely to become less feasible over time.

General conclusions

To conclude, whilst it may be feasible to resettle the islands in the short-term, the costs of maintaining long-term inhabitation are likely to be prohibitive. Even in the short-term, natural events such as periodic flooding from storms and seismic activity are likely to make life difficult for a resettled population.

Recommendations

As a next stage in the feasibility study, an economic analysis of the development options put forward is required to determine their financial viability, together with an assessment of the costs of more generic resettlement needs. Careful consideration will also need to be given to appropriate land use planning and resource development. Most importantly, consultation with those wishing to resettle the islands is essential in order to incorporate their needs and aspirations into the resettlement debate.

Given that this study represented a snapshot in time, it is also recommended that a long-term monitoring programme be established to assess the seasonal and yearly trends of groundwater characteristics; examine rates of coastal erosion; monitor marine and coastal biodiversity; and examine the effects of climate change on the islands.

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Date	:	12 April 2002
Enclosure(s)	:	-
Re	:	**Feasibility Study for Resettlement of the Chagos Archipelago**

Dear Charles,

I have the pleasure in enclosing the first drafts of Volumes II, II, and IV of Phase 2B of the feasibility study for the resettlement of the Chagos Archipelago. Volumes II and III contain the complete findings and conclusions from this phase of the studies, and Volume IV contains the appendices. These volumes are complementary to the non-technical executive summary contained in Volume I, which you are already in receipt of.

We have decided not to include a Volume V containing the maps from the Geographical Information System; these have instead been inserted into the other volumes where appropriate. We will be forwarding a CD-ROM containing the GIS together with the final report.

We look forward to receiving your comments on the draft. As I indicated in an earlier communication, once we receive your comments we would be happy to provide a two-page summary of Phase 2B for ministerial briefing.

Yours sincerely,

Alex Holland
Senior Environmental Scientist