

# **An evaluation of ‘*Returning Home*’ – A Proposal for the Resettlement of the Chagos Islands (Howell Report)**

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## **ABSTRACT**

**The report, *Returning Home – A proposal for the Resettlement of the Chagos Islands* states that a concept is needed for the governance of the Chagos which ‘sets conservation at the heart’ in planning for sustainable and successful livelihoods for returning Chagossians. However, the report makes proposals for a non-Chagossian driven commercial and extractive development on a scale which seems incompatible with conservation and the globally important environment of Chagos. Of particular concern is the creep of harmful development and future expansion of activity. The locations of the proposed airport and tourist facility are inappropriate, and the airport design parameters, and thus costs, are incorrect. Proposals for income generation require greater consideration, being suggestions only at this stage. The report does contain some ideas which could contribute to a very different strategy for a much smaller scale Chagossian return within a positive conservation framework. However, the report fails to emphasise that any resettled community will be at risk in the short and medium term due to flooding and freshwater depletion, and development impacts are likely to exacerbate these effects of climate change. The report also seriously underestimates the costs of resettlement, both in terms of capital costs and operational cost.**

The evaluation is presented in a non-technical style. Section A, presents overall comments on issues of concern relating to the Howell Report ‘*Returning Home*’, and Section B addresses in greater detail the 5 areas on which the report is based: Settlement; Economy and infrastructure; Conservation; Governance; and Cost of resettlement.

The Report: *Returning Home A Proposal for the resettlement of the Chagos Islands* by Dr John Howell and the Chagos Refugees Group, published by the UK Chagos Support Association in March 2008, can be found at:

<http://www.letthemreturn.com/downloads/RETURNING%20HOME.pdf>.

## A. OVERVIEW

It is understood that the Howell Report is not a detailed feasibility study, but rather an attempt to assess the costs and benefits of resettlement by presenting a strategy for return. However the *'...proposal has ...been written to demonstrate the superficiality of the view that the resettlement of the northern atolls is impractical, unwise or inordinately costly.'* Whilst providing a useful broad outline, the report provides insufficient detail on practical, wise and economically viable settlement, because:

- (1) Quantification of demand for settlement remains uncertain, preventing sufficiently accurate predictions of facilities, and therefore costs and most importantly, impacts. As a result, a 'creeping' development is presented, which is problematic for planning and sustainability.
- (2) The size of the islands is unappreciated and the effects of island processes are not sufficiently understood, giving rise to false perceptions of how a modern settlement might operate in harmony with the environment.
- (3) The impacts of climate change on ecosystems, on human settlement, and on the ecosystems with human settlement need greater consideration and are currently underestimated, thereby potentially exposing returning Chagossians to significant risk

The report's main proposal for **initial** Chagossian resettlement involves three islands in Peros Banhos atoll: Ile de Coin island with housing (initially 150 houses); facilities for a non-Chagossian population and administration; an up-market resort for international clients with 50 chalets on adjacent Ile Anglais; and an international airport on Ile Pierre; each requiring necessary and substantial infrastructure, such as power, desalination plant, sewage, waste management and other services.

**The report then proposes a further phase of development.** *'On Ile de Coin, a further 100 families could be accommodated; on Salomon, 150 family houses could be built'. The potential number of settlers is therefore 400 families although initially the proposal is concerned with the settlement costs and income opportunities of 150 households'*. This means an additional expansion of over 150% and replication of facilities on another island on another atoll – Ile Boddam in Salomon. Costs will therefore increase substantially, as will the impacts of facilities and people. Of concern is that the proposal actually costs a settlement of 150 families on Peros Banhos, but also refers to possible larger future developments:

Howell on Settlement:

*'one island in Peros Banhos is proposed for the site of initial resettlement. In due course, another in Salomon could be settled.'*

*'...forms the principal initial focus of settlement planning, with Ile Boddam (in Salomon) in the next phase.'*

*'In making this proposal for limited settlement, the Chagossians are not giving up on their wish to return permanently to Diego Garcia, and they hope that acceptance of the*

*resettlement of the northern atolls will allow more regular access, and possibly employment opportunities, to the original home of most of the Chagossians.'*

*'This group includes those who regard Diego Garcia as their home and will only return to the outer islands if they feel this can be a stepping stone to an eventual return to Diego Garcia.'*

#### On Tourism:

*'A further island within Peros Banhos would be equipped with a small airport, and the success of resettlement would also initially require one island, but subsequently more, being developed for environmentally sensitive tourism.'*

*'The expectation is that other island resorts would be established later if there is commercial success for the first resort and if its environmental conservation ethos can be replicated.'*

*'the success of the first resort... would stimulate further investment on other islands suitable for 'niche' environmental tourism.'*

*'Such resort development, especially if replicated.'*

#### On Fishing:

*'This is based on the calculation that the volumes involved (possibly rising to 800 tonnes annually over ten years) ....'*

*'This suggests not only an unrealised production potential. It also indicates the potential for a significantly larger number of fisherman being engaged than there are at present.'*

*'...the development of an atoll based reef fishing industry requires a processing and marketing infrastructure.'*

*'Premium price for the more exotic whole fish'. '...link is the Maldives with connections to Dubai, including its fish restaurant trade'.*

*'Will allow at least half the catch to be exported to the higher value fresh fish market in Europe and the middle East.'*

These issues are examined in section B.

### **Other major areas of concern**

1. For there to be a just and wise outcome on the issue of the return of the Chagossians, an approach is needed which respects both the globally important Chagos environment and the interests of the Chagossians themselves (vs. outside commercial interests) in safe and successful livelihoods. The report states that *'conservation lies at the heart of resettlement planning'*. There needs to be a greater exploration of a solution lying

somewhere between permanent substantial resettlement, expensively supported by tourists and an airport, and briefer visits perhaps wanted by the many. A solution of simple facilities for essentially vessel-based visits (but well short of expensive hotels for wealthy, air-borne clientele) might offer an affordable and desired (by the majority) way forward. Greater exploration is required of the difference between provision of facilities for sympathetic, compassionate visits to northern Chagos by Chagossians, and permanent resettlement by numbers which require the large and significantly under costed (see later) infrastructure outlined. The former would need different and a much more achievable infrastructure. It is stated that of the Chagossian families in Mauritius, half do not want to resettle (but do want the right to return, perhaps occasionally for visits), most of the rest might after a few years if all went well, leaving about 20% (150 families) who want to return immediately. A much lower number of settlers is often suggested as being a more realistic number. A further approach might build on the admirable Chagossian attitudes cited in the report as: *'a keen appreciation of the need to preserve the marine and terrestrial environments of the Chagos Islands.'* A mix of factors mentioned, such as assistance with a research facility are clearly attractive, but do not go very far in addressing many of the issues raised in the proposal. Proper costing of all options should be an early, essential element to any development proposal for the northern Chagos islands.

2. At the heart of the problem concerning several aspects of development and environment is that the scales of the islands are not well appreciated. These are not simply 'small islands' for which numerous development models exist. Falkland (1992) for UNESCO: *'There is no firm number that automatically classifies an island as being large, small or very small in size. A recent UNESCO study of the hydrology and water resources of islands considered any island larger than 2000 square kilometres to be in the first category. Most 'small' islands, however, are less than 200 square kilometres in area, with those islands of less than 100 square kilometres falling into the 'very small' class. Categorizing islands by their size does make sense.'* All 35 islands combined of both Peros Banhos and Salomon total about 1200 hectares (12 km<sup>2</sup>), or 12% of the boundary for 'very small' islands given above. They could be termed 'minute islands'. Models do exist for development of some 'minute islands' such as in Seychelles atolls and in the Maldives, but for those there is already a much more substantial and developed national infrastructure into which they can integrate and by which they can be supported. Without Diego Garcia, this does not apply to the northern atolls of Chagos. There is evidently a need for careful exploration of social trends, exodus from, or immigration into other 'minute island' systems in the Indian Ocean.

3. Though the report often refers to the precious natural environment (*'the vast area of water around tiny specks of land contains a virtually pristine marine environment, unmatched elsewhere in the world'*), it does not assess potential environmental problems, e.g. of power generation, waste disposal, desalination effluent, agricultural runoff, shore protection. Clearly, relevant Environmental Impact Assessments will be required. The Chagos has become a critically important environmental 'oasis' for marine and island species in the Indian Ocean (which are nearly all in decline under pressure from the effects of recent human population increases in the wider region). Wild species globally have declined by 30% in the past 35 years, not least in fisheries, and the current extinction rate is up to 10000 times greater than in the past due to natural habitat destruction, overexploitation and other man-made causes. The Chagos environment

provides a rare and outstanding conservation opportunity that could be of lasting benefit for humanity. The report does recognize this point: *'The Chagos archipelago is unique: it includes the world's largest coral atoll....; it contains some of the most unpolluted ocean on the planet; it is a place of refuge for rare seabird colonies, turtles and diverse marine life.'* It even appreciates that the reason for this state is the absence of man. *'Because the Chagos islands have been largely untouched by human impact for over 30 years (and most never populated anyway), the vast area of shallow water around tiny specks of land contains a virtually pristine marine environment, unmatched elsewhere in the world.'* *'Coral reefs the world over are in a parlous state due to pollution, overfishing and shoreline development, but the Chagos Islands have largely escaped such threats.'* The report describes activities resulting from man's settlement, which may cause pollution, overfishing and shoreline development, unless substantial and costly mitigation measures are put in place. A thorough process of Environmental Impact Assessment will be essential.

4. The scale of progressive development on the islands that are currently proposed in the report may have environmental impacts which are damaging both for nature and for the returning Chagossians. The environmental impact of new human, extractive and other commercial activity and its related infrastructure may not be compatible with the necessary, and currently agreed, level of ecological protection. Examples are: *'a tourist industry and business ventures'*, requiring dedicated water supplies from a desalination plant, *'timber ventures for the production of timber, furniture and boats'*, a *'coconut industry'*, *'collaborative exploitation of the archipelago's underutilised fishing resources'* and airport facilities and other infrastructure sufficient to support such industries on these tiny islands. Suggestions have been made that there could be a viable timber industry using available imported and 'local' timber, including Takamaka. But only the islands of highest conservation importance have any of the rare original island trees and none should be raided for local construction.

5. The development model proposed requires a large number of non-Chagossians to be resident to construct facilities, support and complement original Chagossians for many years, with a disproportionate benefit to them. The report emphasizes the crucial role of outside commercial interests as the key to development of the tiny islands on the proposed scale and indicates that non-Chagossians would be responsible for most management and services and would have the better paid jobs. The report is generally less clear about the relative balance of benefits accruing to the Chagossians vs. the outside interests.

6. The report identifies Mauritius as a source of potential investment: *'... first priority in investigating transport alternatives for tourism would be a Mauritius link because of the wide range of other services that the Mauritian private sector could provide to resort operators.'* It is also noted that *'...proposed tourism and fishing industry initiatives are likely to elicit strong Mauritian industry interest...'* The substantial fishery would be a mainstay, and could develop with Chagossian equity in Asian and Mauritian companies, and *'Mauritius could become the hub of development in the Chagos islands.'* The change in preferential sugar price arrangements has initiated a restructuring of the Mauritius economy, and the Government has declared that it intends to increase tourism to 2 million visitors per year by 2015. Once more, the relative balance of benefits accruing to the Chagossians vs. Mauritian interests will need to be clarified.

7. Various aspects and issues raised in the report would benefit from further consultation with people familiar with the present state of the islands. For example, the locations suggested for the airport and the hotel are amongst the roughest lagoonal locations in the Indian Ocean. More advice might be sought from atoll nations in the Indian Ocean where issues of sustainability and its practice (including immigration into and emigration from) are currently uppermost (e.g. Cocos Keeling, Maldives, Seychelles atolls).

8. The risks for new inhabitants, connected with climate change including sea level rise and progressing reef mortality, are minimised in the report; yet they are likely to cause serious consequences to these islands in the lifetime of some of those who might intend to settle there. Indeed, flooding and erosion are already evident, and these aspects will require careful analysis.

9. Some key costs appear significantly under-estimated: the airport is a particular example (see later). Others are the extensive infrastructure, sea defences, transport links, and many other services. As the report says, '*most of the Chagossians will have known only modern amenities*', and they will presumably expect them. Moreover, very important costs would be the continuous operational costs, which cannot yet be addressed. Food supplies for inhabitants and visitors, including sources (and costs of importation) other than fish and coconuts, need greater consideration. Costs of renovating or converting the land for crops, and the environmental damage this could cause to bird nesting sites, lagoons and reefs will need to be considered.

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## B. MORE DETAILED CONSIDERATIONS

### 1. ON PEOPLE

The number of settlers is probably unknown, and a best upper estimate of 2500 is given in the report. The proposal however discusses feasibility and costings for less than 1000 people on Peros Banhos, but also refers to possible expansion in activities, which consequently will raise the level of impact. Good estimates of the upper and lower numbers of people are needed if facilities, costs and impacts are to be adequately assessed and planning achieved. Different levels of infrastructure are required for different levels of resettlement, but some of this infrastructure might not be extendable, and for economic reasons, may have to be put in at the beginning based on predicted future use, rather than be replaced by larger systems later.

Of the 800 Chagossian families (constituting about 5000 people), half (i.e. 400) want to return permanently with their families (average family size is 6.25), and so  $400 \times 6.25 = 2500$  people want to return to the islands. The other half wants the right to return temporarily for visits. *'Of those wanting to return, most intend to return only at some point in the few years after resettlement has commenced but there are 150 who want to return immediately, with their families and begin the process of re-building their community.'* This suggests  $150 \times 6.25 = 938$  people who may wish to return immediately, and therefore about 1562 additional people who may follow in the next few years. Visitors (even at 1% = 25 people), non-Chagossian administrators (16 based on bachelor quarter provision) and tourists (50 chalets  $\times$  2 persons  $\times$  0.65 occupancy = 65) will add at least another 100 or so people at any one time, suggesting around about 1050 people immediately and possibly within 5 years, over 2600 people. Because infrastructure must be concentrated for logistical reasons, this means an upper figure of 2600 people (and more if tourism replicates) in close proximity to one another, and because the islands are extremely small (e.g. Ile de Coin on Peros Banhos is 128 ha or 2000 m long by less than 500 m wide at longest and widest points, and Ile Boddam on Salomon is 108ha), impact will be highly concentrated wherever there is island usage. This means that sacrificial areas will be necessary, and therefore strict controls will be required to protect other areas and to prevent unplanned creeping expansion (assuming that conservation remains *'at heart'* as stated).

It is recognised that both the upper and lower estimates may be significantly more than the figure of a few 10s of persons often suggested as being genuinely keen to resettle, and in reality, a number somewhere between all of these estimates is probably closer to the likely figure. More accurate figures are needed for planning, but until then, lower and upper estimates must be used. A community of <100 people may be able to assist in environmental protection, but a community of 1000s can potentially have significant environmental impact. Clearly more detailed knowledge of numbers of persons wishing to return are needed before the economic activity and infrastructure can be planned, and impacts predicted and mitigated.

## **2. ON ECONOMIC ACTIVITY AND REQUIRED INFRASTRUCTURE**

### **2.1 Settlements**

Settlements on Chagos were probably fixed by trial and error by the earliest residents. On Peros Banhos it was Ile de Coin, an island aligned NW-SE with the village in the lee of both the Trades and NW winds. The island chosen on Salomon atoll was Ile Boddam, also aligned NW-SE, again with the village located in the lee of both the Trades and NW winds. When Egmont atoll was occupied, the island chosen was similarly aligned, with its village similarly located. On the Great Chagos Bank (Eagle Island) there are no suitably aligned islands, and in this case the village unusually faced seaward, but again in the lee of the SE Trades. Similar sites were chosen on Diego Garcia. This commonality of location is not coincidence. Ile de Coin is where the resettled village is planned in this report and the island is indeed the only island on this atoll suitable for settlement. Proposed housing design could be improved by putting houses on concrete stilts to give greater resilience to flooding, and by careful attention to good rainwater capture. Crushed coral rock and sand road and path surfaces should be acceptable allowing vertical flow of water (learning also from problems arising from impermeable surfaces seen in the Maldives). Aggregate should not be removed from the seabed or islands (because of the risk of causing more erosion and flooding) and hence materials must be brought to the islands. Coconut is really the only exploitable wood, and much of this is thick grained and hard to saw. Wood should be imported to prevent exploitation of the few indigenous trees.

### **2.2 Power, water and waste**

Power, water and waste provision will depend on the eventual scale of settlement. Power generation options are presented for the initial development, but will need to be expanded for further development and replicated for future developments on other islands. Safe transport, transfer and storage of diesel fuel oil must be considered to prevent marine spillages and groundwater contamination. Membrane liners and bunds will be required, or the groundwater will become easily contaminated. A hotel on Ile Anglais could be supplied from the village on adjacent Ile de Coin, reducing the need for two sources of power, but this must be balanced against impacts and costs of submerged trenching or aerial pylons across the gaps between islands, for water currents are significant through these gaps. Appropriately, solar panels were proposed for simple power requirements.

Fresh water is an important component of oceanic island environments, and the relationships between water resource development and sanitation, and the needs of vegetation, whether for conservation or agriculture, will be important. What is done will depend on the number of people returning, and consideration of this aspect will be important. Setting out of boundaries for groundwater catchment areas will be essential for any development, as would the locations of waste disposal or other polluting activities.

Desalination is proposed, and probably necessary if the higher numbers of settlers are likely, but there will need to be consideration of the impact of high salinity effluent (and possibly high temperature and even chlorinated effluent) into the natural environment. Discharges can be 1.8 times more saline than seawater. Distillation desalination systems

discharge heated water, while reverse osmosis systems often require chlorine biocides, with consequent damaging effects on marine life. A pipeline would almost certainly be required to take effluent beyond the reef on the ocean side where it could be disposed with little effect, but such pipelines are expensive and potentially damaging (both during construction and then by changing water currents around the structure).

Pumping from the aquifer near the saline interface may be possible at the lower end of settlement, but this poses a significant risk of ‘pulling up’ saline water. Because of this danger, especially when the lens is at its thinnest, due to drought, seasonal low rainfall periods, or overexploitation, groundwater abstraction would better be done using horizontal collector drains set at an average depth of about 1 m below minimum groundwater level. For a larger settlement, higher rates of pumping may require the effects of drawdown to be distributed. This will require a very sophisticated network of extractions points and control system. It can be successful, for example, in Diego Garcia, but at substantial cost. Even so, groundwater supply will be highly vulnerable to pollution because of the shallowness of the groundwater.

A piped waterborne waste water system with treatment plant is proposed, allowing for recycling of grey water for irrigation and solid waste for fertilisation. Again, such a system would be necessary for the upper settlement size, when it may be necessary to separate grey water from human waste prior to treatment, since grey water requires less treatment, and hence the treatment plant can concentrate on human waste. It is not clear whether secondary treatment to degrade biological content, and tertiary treatment, to remove nutrients is planned, or whether a hybrid system will be used. ‘Black box’ systems are now highly effective, producing irrigation water and solid waste which could be mixed with green waste to form a soil conditioner. Chlorinated effluent should be avoided if disinfection is required, for Ultra Violet treatment is safer and effective, but more costly. Membrane lined stabilisation ponds could also be used and crops irrigated, provided the water can then flow through the porous media to ensure any bacterial die-off, and abstraction is away from infiltration points. Waste water entry into, and contamination of the freshwater lens is a common problem in coral atolls. Faecal coliform contamination from rats is already a problem in the groundwater on these islands. Coliforms have been linked to coral disease elsewhere, as well as posing a significant risk to human health.

Solid waste treatment presents similar concerns especially in response to: *‘If landfill does become necessary, it will be important to keep such wastes to a minimum by ensuring, for example, that contractors and commercial operators (in tourism and fisheries) are responsible for disposal away from the islands’*. Dumping at sea is not acceptable or permitted under International Conventions, so some form of storage, transport and dock may be required for a substantial settlement; adding to costs.

### **2.3 Jetties**

The report proposes that boat transport and maintenance within the islands will be a licensed private sector activity, and small jetties will be sited to minimise environmental damage. However, air transport alone is unlikely to be sufficient to supply settlements and economic infrastructure with food, materials and fuels, and for a larger community

(2600 individuals), some sort of small dock will be required for larger vessels with hoists, transport and storage. Even small boats introduce impacts from noise, fuel, wash and anchoring, and strict controls would be required to prevent erosion, disturbing bird and turtle colonies and breaking corals.

## **2.4 Self Sufficiency – agriculture and fishing**

### **Agriculture**

Aspects of marine food other than fish protein were only briefly covered, and it was suggested that self sustainability will be important. The supply of basic terrestrial foodstuffs (e.g. rice, wheat) not grown in Chagos requires greater exploration. A supply chain of food products is almost certainly needed, requiring transport, docking and storage, because there is unlikely to be adequate soil for long-term agricultural self sufficiency for a population of 2600 people.

The land and soils needed for self-sustainability will need to be addressed. The report notes that *'The fertility of the soils and the moisture retention is well above the levels of coral islands elsewhere'* and accepts that the reason for this is *'...due to 30 years fallow under tree canopy'*. The Posford Haskoning feasibility study contains details of soil types on the main islands, but agricultural need was not considered against type of soil present at specific locations. Although coconut trees cover the islands, this does not mean that staple carbohydrate crops could too, for most coconut trees needed to be planted in individual pits dug into the shallow earth and coral rock. Constraints on agriculture are associated with soil type, depth and longevity, water retention and release by soil, and potential plant nutrient deficiencies arising from the poor solubility of certain essential elements under the prevailing calcium carbonate dominated alkaline soil conditions (for example, copper, zinc and iron). These problems could be overcome by the addition of mineral fertilisers but very careful management would be required to prevent nutrification of both groundwater, and reef and lagoon environments. The potential for soil erosion (which may result in reef damage and ecosystem collapse, with consequent impacts on fisheries and tourism), and also the long-term sustainability of the soil resources are important issues that need further study.

Several of the proposals for self-sustainability suggested as being worthy of pursuing in Posford Haskoning were not taken further or given any depth by the Howell Report, probably sensibly, because, while such enterprises occur in several countries, they are much less likely to yield much benefit in Chagos in the crucial early years. Examples mentioned are seaweed farming and supply to the aquarium fish trade (considered below). Such activities have recently been reviewed for the more developed Indian Ocean island of Rodrigues, with European Union funding and expertise, but abandoned due to logistical problems or economic reasons. These problems would be magnified in the Chagos because of its remoteness.

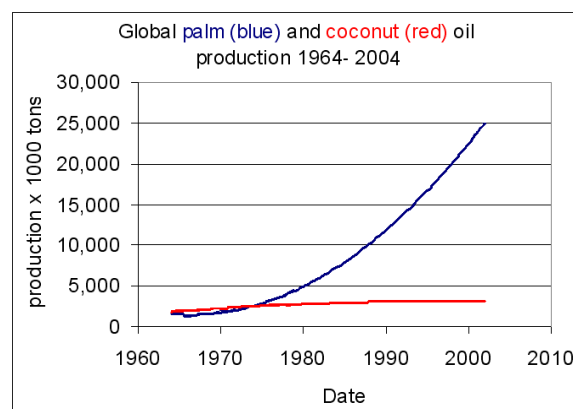
Longer term exploration of several other products were suggested, some in passing but then discounted as being less useful in Chagos. Several were noted to be sources of extra income, though not ones on which to base an economic case for resettlement. Coconut farming was assumed to be unrealistic, but the possibility of producing biofuel with suitable grants for clean energy was noted as a possibility. Although the report does

discount large scale coconut production in the manner of old, it does note many lesser uses for the fibres and other products from mattresses to hydroponic blocks. Yet all would require substantial restoration of some of the plantations at least –and it must be appreciated that the plantations are now very overgrown and virtually impenetrable (Figure 1). Without mechanical equipment, the effort required to clear or restore significant coconut plantations will require millions of person-hours. For example, it took 1000 person days to clear much less than 1% of understorey vegetation on Eagle Island in 2006 during the rat eradication project.



**Figure 1.** Overgrown palm plantation, typical of Ile de Coin on Peros Banhos , and Ile Boddam on Salomon

The suggestion that there is a ‘*culinary demand for fresh coconuts in the proposed resort; and fresh coconuts could even be air-freighted given imaginative marketing*’ is small in economic terms, while distances (and therefore costs) from Chagos need greater exploration. The trouble with many possibilities is that ready supplies of such produce already exist adjacent to airports in many countries around the Indian Ocean. Perhaps some could be developed in Chagos also ‘*with imaginative marketing*’, but it means that the possibility of doing so in any economically useful way cannot be assumed. Coconut for example, which was once the mainstay of these ‘Oil Islands’, has not seen a global rise in demand for decades (figure 2).



**Figure 2.** Global coconut production (red) and palm oil production (blue). (FAO and US Agriculture Department figures)

## Fishing

Fishing is presented as a key element in terms of local food supply and export, but greater attention needs to be given to the sustainability of fishing. Fishing intensity is low in these northern reefs, and equally, sustainable catches could perhaps be higher. However, fish are a key part of the 'working' of a reef, and many reefs have been destroyed by overfishing. What makes the reefs of the Chagos so different from most reefs worldwide is the fact that they have not been heavily fished, and reef food chains remain functional. Great care must be taken, or the reliance placed on fish and fishing will be a limitation, not an asset. Figures of 400 and 800 tons per year are suggested as being possible (the former being what might be needed for some aspects of commercial success). The problem is that environmental unpredictability makes it difficult to calculate sustainable yields, and extraction must therefore remain well below Maximum Sustainable Yields to allow for this. The reefs of the northern atolls are recovering from a bleaching event that destroyed much of the reef habitat on which the fish depend, but this recovery is highly vulnerable, and increasingly regular bleaching events are predicted in future years. The essential point is that it is very easy to over-exploit this resource for modern methods of fishing quickly deplete extensive reefs, especially when there are commercial incentives. The myth that restrictions can put 'environment' before people is common, but communities that have depleted their resources to their own detriment are numerous throughout the Indian Ocean.

The report states that *'among the fisherman, there are some who are impatient to return and become independent producers'*. Maybe there is scope for a locally managed fishery, but proper estimates are needed for sustainable catches, especially given the proposal to develop an atoll based reef fishery, with processing, refrigeration, and marketing infrastructure and desire to export. The report suggests: *'The scale of operations therefore requires small groups to be formed to procure 23 to 30 foot boats capable of remaining at sea for several days and containing ice making facilities'*. However, unlike the Mauritian Banks fishery which uses boats of this size operated from mother ships, the Chagossians will have no safe haven should they get into difficulties.

Great concern is expressed at the fact that the report highlights targeting large, high value fish: *'Premium price for the more exotic whole fish.'* *'Link is the Maldives with connections to Dubai, including its fish restaurant trade.'* *'... allow at least half the catch to be exported to the higher value fresh fish market in Europe and the middle East.'* Again, the Chagos reefs are unique because they still contain numerous larger individuals (grouper, shark) at the top of the food chain, so rare on reefs around the world (Figure 3). An economic survey would quickly reveal that such organisms have a far greater economic and biological service value as part of the reef system. For example, possible future boat-based tourism would depend on the presence of such fish, and it would be foolhardy to close such future options by fishing now. Non extractive values for turtles, sharks, and large fish such as grouper (which the report proposes for exploitation for the fish restaurant trade) have a value of 2-4 orders of magnitude more alive at a dive site than dead on a fishing boat. Many species are long lived, and hence their value is even greater over their lifetimes. Indeed, it will be restaurateurs in the middle and far east and Europe who will make significant profit out of their proposed extraction; not Chagossians.

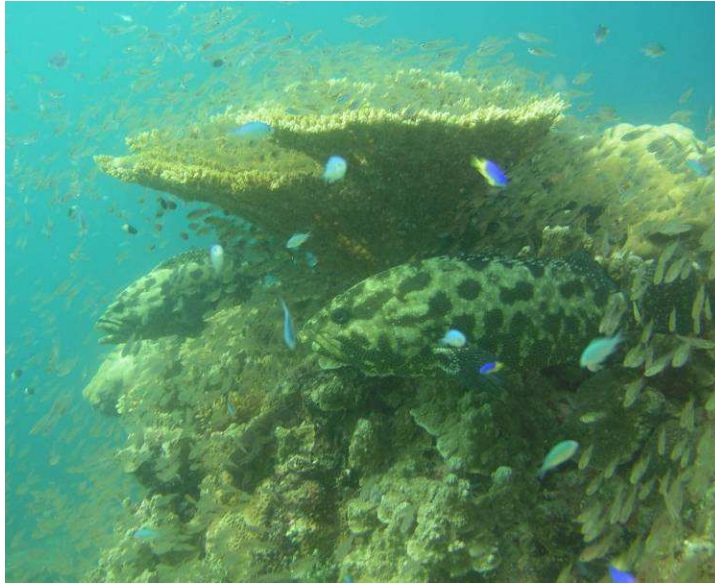


Figure 3. A pair of large grouper, in their territory on a coral head in one of the atoll lagoons. Such individuals must remain protected because of their role in reef ecology, and their potential value in tourism

It is suggested in the report that if the exported fish are badged with one of the sustainable or eco-friendly labels, then they will have added value and will command a higher price, but being able to do so will not necessarily be easy – if only because ‘food miles’ are increasingly considered too. The report suggests that: *‘In the case of Chagos, however, monitoring mechanisms need to be put in place and it should be possible to build on the scientific evidence to establish the data required to comply with MSC (Marine Stewardship Certification) certification requirements.’* MSC certification requires greater investigation, especially because monitoring expertise is required and this must be funded. The report rightfully identifies allowing *‘for effective fisheries management such as the notification of spawning aggregations and zoning of fishing operations. This is especially important in ensuring that over fishing of particular species does not take place’* and highlights *‘as experience of the extinction of grouper species in the Caribbean indicates, the short term exploitation of spawning aggregations leads inevitably to a major income loss long term’*.

Artisanal fishing is of concern and the report states *‘While recognizing the need for controls on lagoon fishing, including on artisanal fishing close to the shore line, the total prohibition is a matter Chagossians resident in Peros Banhos and Salomon would want to re-visit’*. It is just these near shore communities that are the all important nursery grounds for so many reef fish. Such fishing is hard to control especially if it is undertaken to supplement food due to low incomes. The report also states: *‘will require more self-discipline on the part of settlers. These include a prohibition on the killing of turtles and crabs; and a prohibition on the collection of eggs.’*

Live fish capture for the aquarium trade is also proposed, but again needs greater exploration. The ornamental fish and coral trade is large and growing and much higher value than food fish. However it relies totally on good access to international airports that can get animals to Europe and the US within one or two days, or to one of the

consolidators in Singapore or Hong Kong. There are already ornamental fish industries in the Maldives and Sri Lanka (the latter being particularly badly managed and damaging). There is a precedent for establishing this kind of industry sustainably on small remote islands, for example on Kiribati under the auspices of the Marine Aquarium Council. It requires infrastructure and technical expertise, and population sizes must be assessed to set extraction quotas accordingly.

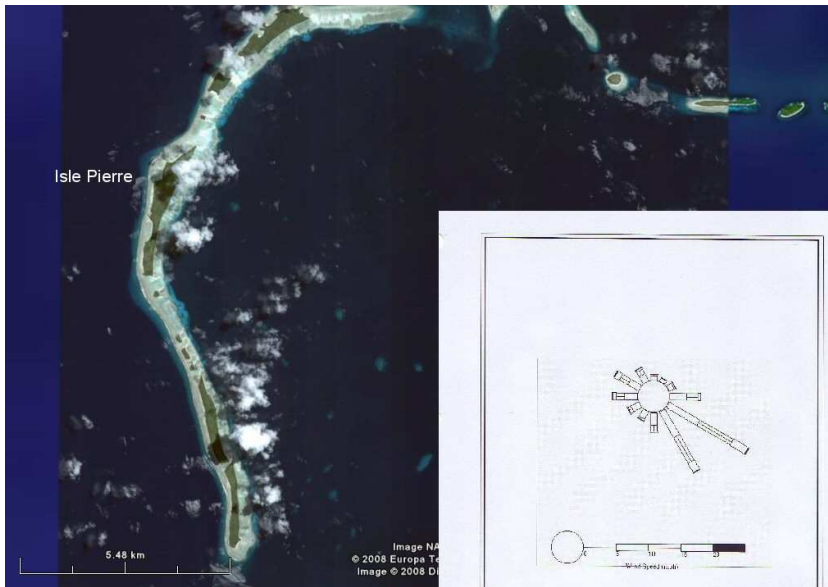
Fishing as a sustainable economic activity is highly vulnerable to environmental fluctuation and mismanagement, and would require extremely strict control. This raises the question of who will pay for monitoring and who will enforce the controls?

## **2.5 Airport**

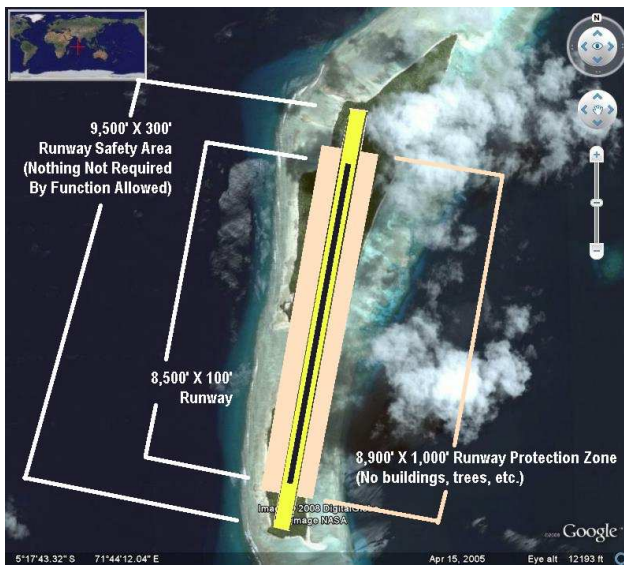
The report proposes an airport on Ile Pierre, Peros Banhos, suitable for flights to other countries such as Seychelles and Mauritius: *‘...the proposed airfield site served from either Mauritius or Seychelles’*; *‘These social and family links will mean that there are bound to be regular visits to and from Mauritius and both air and sea travel operators will want to service this demand’*; *‘For all these reasons Mauritius could become the hub of development in the Chagos islands.’*

Appendix 1 thoroughly reviews this most important aspect of development, and describes the aircraft type needed, and their requirements, which are substantially greater than those given in Howell’s report. The airport must cope with aircraft connecting to Mauritius. The type and range of aircraft proposed (ATR42) are inadequate, and alternatives are needed by a commercial operator (eg B737s or Airbus 320s). These require a substantially longer runway of at least 2590 m (8500 ft), rather than the 1615 m (5300 ft), based on the recalculated Howell Report figures for takeoff (for the 1100 m presented is incorrectly calculated, being based on landing).

Ile Pierre is suggested for the runway. Figure 4 shows the island with the annual wind rose for Diego Garcia. Ile Pierre lies almost exactly cross wind for much of the year, both during the Southeast Trades and the period of more erratic winds which are north westerly for much of the rest of the year. To make a runway into wind would require substantial landfill from several of these islands into the lagoon and cannot be done at all from Ile Pierre because of the depths of the water. Note that current shore protection costs alone (to protect existing land, not landfill created over water) on similar islands for just a few hundred metres of lagoonal coast, are currently estimated at about US\$20 million (£10 m). Note also that the size of clear areas beside the runway needed (see Figure 5, more explanation in Appendix 1).



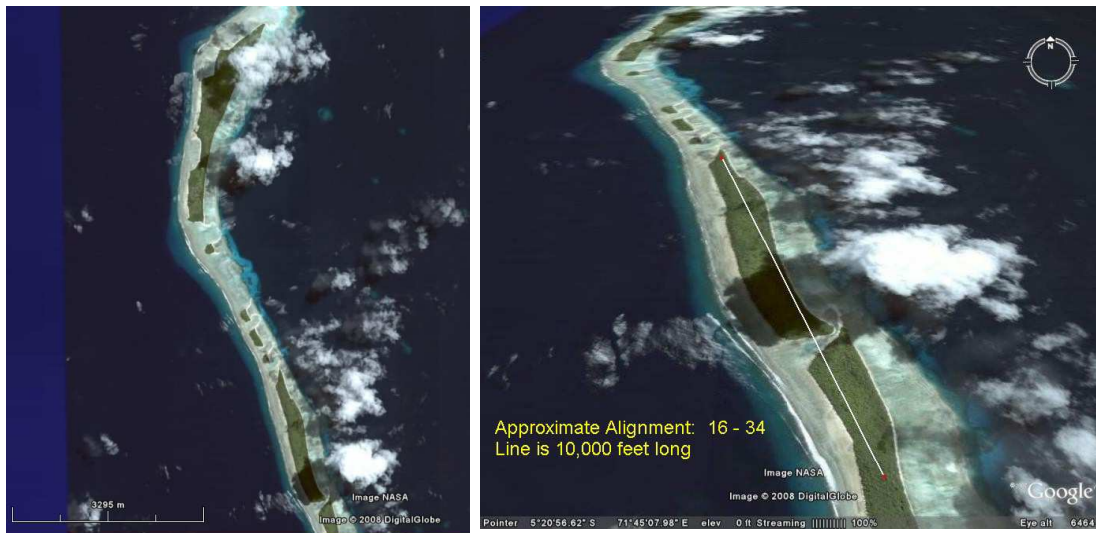
**Figure 4.** Ile Pierre showing alignment and the wind rose for annual wind. (Wind rose is an annual average, from Posford Haskoning report 2004, Images of islands from Google Earth.)



**Figure 5.** Runway on Ile Pierre (the proposed site in the Howell Report) with runway of the size required by aircraft capable of commercial travel to e.g. Mauritius.

There are several islands further south which are smaller but better aligned, but which require substantial landfill of reef between the islands to take a runway of suitable length (Figure 6). Note that landfill should not extend seaward of the islands onto seaward reef flat unless no alternative exists because of much higher exposure to waves, and note that landfill cannot in any case be used on either side beyond the visible reef flats because water depths plunge very steeply. Also, this would require substantial shoreline armoring, the high costs of which have been noted (observe also the lateral sand trails in the satellite images which show the strong currents which exist between islands). Further

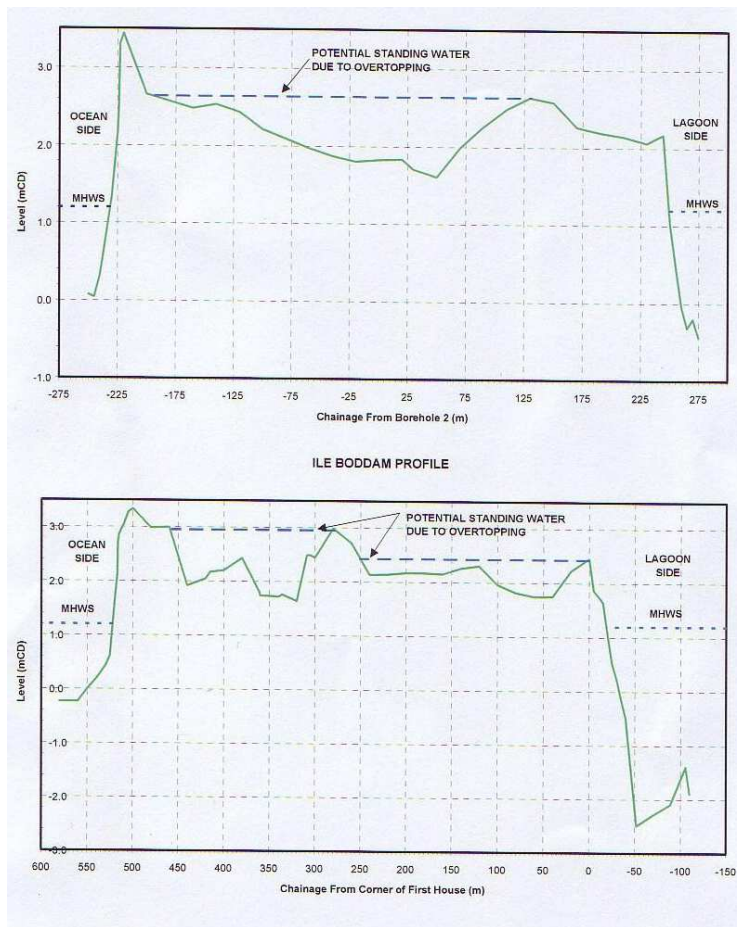
south still, the Soeurs have a size and alignment which would need much less between-island landfill.



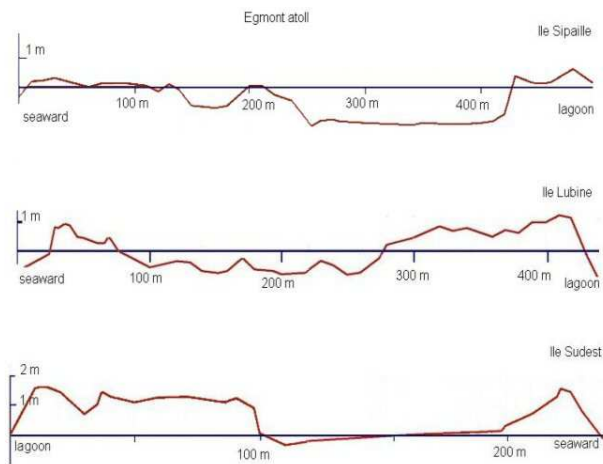
**Figure 6.** Islands south of Ile Pierre are better aligned. Landfill to join suitable islands would make a runway of sufficient length (left). The two larger (more southern) islands (right) are Grand and Petit Soeur. Note from the sand tails that the currents between all these islands are significant (Images Google Earth).

Importantly, the elevations of all these islands are known to be very low. As shown in figures 7 and 8, in other Chagos islands where land elevation has been measured, central parts of most are depressed below the level of the island rims, to levels which are near or even below present high tide level. Even on the Soeurs, substantial elevation and armouring are likely to be necessary before a runway could be constructed.

Even where the reef flats are not built upon, costs of landfill on islands themselves to fill in central depressions is likely to be high also due to lack of readily available local material. The only material which could be sacrificed for landfill without risking removal and erosion of island material, would be lagoon sand from depths of 20-30 metres, but then without damaging corals which occupy most of the lagoon beds even at this depth. The cross sectional profile with a dip is likely to apply to all of these limestone islands and includes all those mentioned above. Figure 8 shows cross-sectional profiles of another group of Chagos islands, in Egmont atoll, to make this point. It is seen that these dip below high tide level in several places.



**Figure 7** Levels across two transects of Ile de Coin and Ile Boddam, showing central depressions in the island (from Posford Haskoning report 2004).



**Figure 8.** Profiles across three islands of Chagos (Egmont atoll). The central dips are common to almost all islands to some degree.

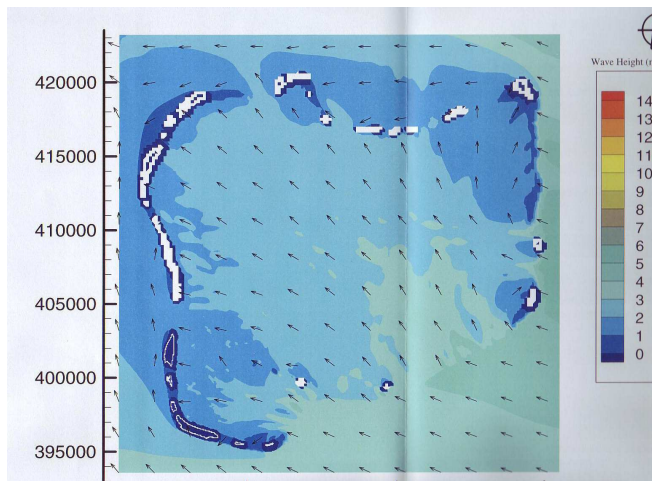
In their discussion of flooding in these islands, Posford Haskoning (2004) says: *'This analysis has highlighted that overtopping and the subsequent flooding is potentially a very serious problem for any resettlement scenario'*. They go on to suggest that further work would need to consider additional elements such as flow parallel to the beach which will have an effect on sediment erosion and deposition. Substantial landfill on reef flats, and probably on islands also, plus substantial armouring against wave erosion, will be needed for any airport, of any size.

In summary, the environmental impact of an airport will be highly significant, there being short term impacts during construction arising from noise, dredging for vessels to convey construction machinery, vegetation clearance, ground preparation and infill, sediment plumes and ancillary building construction. Further, operational impacts will include noise, fuel and water runoff from the airstrip, risks due to cross winds and the need for transport of people and cargo to other islands. The issue of bird strikes is also important: several of these islands are 'Important Bird Areas', which is not conducive to aviation. The source of materials for construction will need assessment.

## **2.6 Hotel and Tourism**

The report proposes a resort on Ile Anglais, adjacent to Ile de Coin in Peros Banhos and a 30 minute boat ride from the proposed airport at Ile Pierre. *'The expectation is that other island resorts would be established later if there is a commercial success for the first resort and if its environmental conservation ethos can be replicated.'* The report notes that *'international guests are prepared to pay high prices for exclusivity and pay additional premiums for unique access to pristine marine environments and rich sources of biodiversity'*, but does not appear to appreciate that development of a resort and transport infrastructure can quickly destroy the unique, pristine environment and degrades the rich source of biodiversity, thus reducing the value of all further tourism to that place. It is therefore doubtful that in the long term, *'Such resort development, especially if replicated, would be the mainstay of the economy'*. A better strategy from the environmental perspective might be to have little on land infrastructure, but to allow visiting ships and guided tours, but clearly such an approach has less to offer settled Chagossians (see later).

The proposed hotel site on Isle Anglais would be aligned more or less the same way as the proposed airport island (somewhat less exposed). Figure 9 shows the lagoonal wave energy pattern. This shows that the atoll is very open to the southeast trades, so that the lagoon-facing shores of the western side of the atoll (where the airport and hotel are proposed) receive relatively high wave energy.



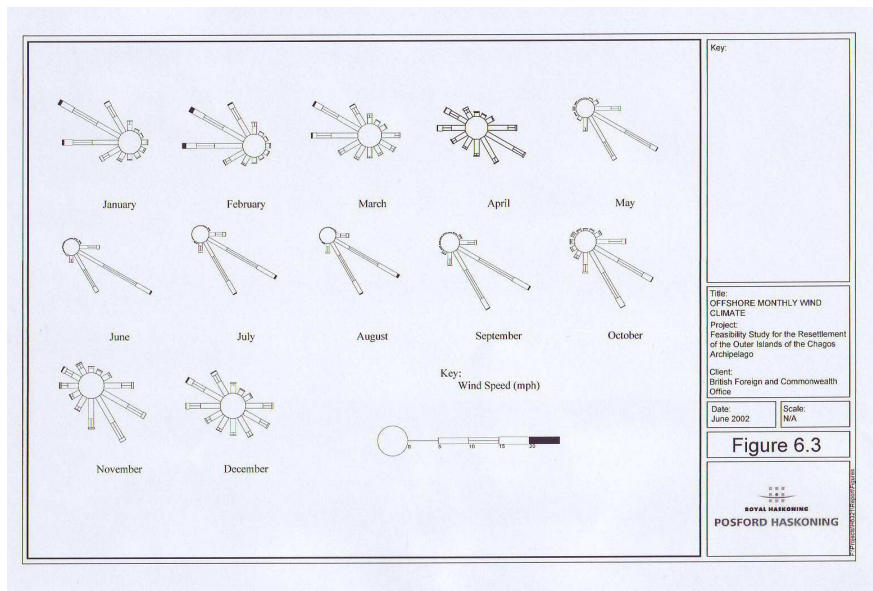
**Figure 9.** Wave height in Peros Banhos lagoon. (From Posford Haskoning 2004).

High energy exposure in this part of the lagoon is evidenced by the fact that this lagoon contains small algal spur and groove structures (figure 10). These are growths of stony algae which usually develop on ocean-facing reefs in response to high wave energy. There appear to be no other reports from any other atoll where these structures develop on lagoon shores too, as they do in this location, which suggests that this is a particularly exposed lagoonal shore.



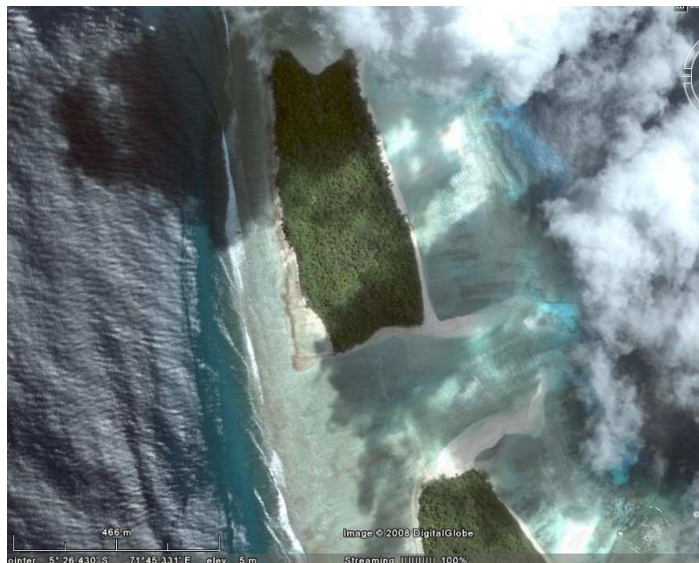
**Figure 10.** algal spur and groove structures inside the Peros Banhos lagoon off Isle Anglais. These are growths of stony algae which usually develop on ocean-facing reefs in response to high wave energy.

Monthly winds are shown in figure 11. Beach-based tourism will not be successful for the 5-6 months of the year when 10-20 knot winds constantly strike a hotel facing this beach. The lagoon side is benign for the rest of the year (November- April), but note the 65% occupancy rates required in the Howell proposal.



**Figure 11.** Monthly wind roses from Diego Garcia (from Posford Haskoning report 2004)

A hotel facing seaward might have a more benign atmospheric climate. There is a beach facing the ocean side which is sheltered from the SE Trades, but there would be no easy use of the sea for bathing and extremely limited or no water sports there at any time of the year (Figure 12).



**Figure 12.** Ile Anglais, with northern tip of Ile de Coin at bottom. Note the sandy trains extending lagoonwards (right side) from the tips of both islands, which reflects the strength of the currents between the islands.

If the ends of the island are contemplated, strong currents exist between the islands (note the sandy plumes in this and earlier figures), and sufficient data on current flow rates should be obtained at an early stage.

Other aspects of tourism are mentioned in terms of income generation: *'In addition, the resort itself could provide a range of services to 'yachties' that provided supplementary*

*paid work for its staff.* Peros Banhos is used by yachts very much less than Salomon atoll, mainly due to its uncomfortable exposure. The relatively few yachts which do visit Peros Banhos mainly stay in the far north, tucked behind Ile Diamante during the period when the wind is from the northwest. They do not generally stay at all during the southeast trades. Further, many of the 20-50 yachts which visit Chagos each year (many are frequent revisits) are proud to be extremely self-reliant and self-sufficient, as is common with those who spend many months of each year at sea. The visitors mainly come from places such as East Africa, Thailand and Malaysia, where labour costs are low and where owners generally fit out their boats during non-sailing periods. Accidents and emergency repairs which owners cannot fix themselves may indeed occur, but expenditure to provide a useful marina service should not be embarked on lightly - marina services might not generate much revenue.

In almost all respects, the much smaller and more sheltered Salomon atoll is really the only one which should be contemplated for tourism (though structures are similarly derelict there also) and there is even less space for an airport.

It is worth drawing attention to what is called the 'Aldabra Solution' as proposed by Prof. David Stoddart of Berkeley University. In this, tourism is boat based (as in Aldabra, Seychelles) where land support exists but where expensive island infrastructure is avoided. But even in Aldabra substantial support obtained from other Seychelles Protected Areas heavily subsidises Aldabra atoll.

Revenue from tourism is seen as essential to the success of settlement, and its integration with the settlement, its supply with energy and transport, is equally key. Any problems here may undermine the economic base of resettlement. The economics of tourism therefore requires thorough analysis. There is doubtless scope for some very high-end tourism, and this may be largely ship-based rather than airport supplied. In either case, consideration is required as to how much tourism will benefit Chagossian residents rather than tourism investors from overseas, for the balance between the two elements is crucial. Tourism developers would have to be invited to look at the feasibility in conjunction with issues of transport, climate and weather. The success of tourism as a viable economic activity is by no means a certainty, and much more investigation will be required.

### **3. On Conserving the environment**

#### **3.1 Conservation in the Chagos**

The BIOT Administration, is committed to conserving the environment of the Territory and has taken significant measures to put this into effect, within the framework of the UK's International Priorities and Sustainable Development Strategy and the Government's Environmental Charter for the Territory. The Chagos Conservation Management Plan (CCMP) seeks to maintain the resilience of the Chagos ecosystem through the establishment of protected areas representing all terrestrial and marine habitats.

The Chagos is one of Britain's largest and most important nature conservation areas. Its Environmental Protection Zone covers about half a million square kilometres. UK

legislation is also in place to protect natural resources, notably in the restricted and reserve areas, with controls on fishing, pollution and the killing, harming or collecting of animals.

A Ramsar (Wetlands Convention) site is designated on Diego Garcia, which includes all of the lagoon waters, the eastern side of the main island and the islands in the main channel as well as the marine waters to the limits of the territorial sea (3nm). There are agreements in principle on substantial further Ramsar designations and the whole area is managed 'as if' it were a natural World Heritage site (that is 'a site of outstanding universal value for the world's natural heritage'). 95% of BIOT's biodiversity is outside Diego Garcia. Existing terrestrial and marine protection is provided over wide areas of the Chagos Archipelago through national legislation. Protection for the northern atolls is provided in a number of Strict Nature Reserves, described in the CCMP.

The Chagos Archipelago is also subject to further levels of internationally binding legal protection. This includes, the Whaling Convention (including an Indian Ocean whale sanctuary), the Law of the Sea Convention (with provisions to protect fish stocks), the Indian Ocean Tuna Commission, the CITES Convention (Convention on International Trade in Endangered Species of Wild Fauna and Flora) (regulating trade in wildlife, including corals) and the Bonn Convention (with provisions to protect marine turtles and cetaceans).

### **3.2 The Chagos environment**

The features which make the Chagos an outstandingly important environmental site are:

- Probably the most pristine tropical marine environment surviving on the planet.
- The world's healthiest coral reefs and the world's largest coral atoll. Many reef scientists fear that half of the world's coral reefs could be lost by 2025. Hundreds of millions of people in the world depend on healthy reefs in one way or another. Living reefs provide food, protect beaches from erosion and form a rich resource of genetically diverse animals and plants, and a source of larvae and propagules for other reef and island systems.
- Wildlife biodiversity is very rich. It provides at least 220 coral species and over 780 species of fish with a stronghold which is vital. It is also a refuge and breeding ground for whales, sharks, dolphins, marine turtles, rare crabs and other threatened marine life. There are over 280 flowering plants and over 100 species of seaweed. 91 species of birds are known to visit or breed on the islands. In marine terms, BIOT is by far the most bio-diverse part of the UK and its Overseas Territories.
- The archipelago is isolated and at the centre of the Indian Ocean where it acts as an 'oasis' for marine and island species (many of which are in decline under pressure from the effects of human population growth in the region).
- Most of the Chagos is uninhabited. This is the main reason why the ecology of the Chagos is nearly pristine and diverse; a rare surviving example of nature in its original form, and where human pressures do not conflict with environmental needs and lead to degradation and impoverishment.
- Also, because of its mainly unspoilt and healthy environment, the Chagos provides a scientific benchmark for ecosystems in the absence of direct human impacts. This

is evidently important in helping us to understand such problems as pollution, loss of biodiversity and climate change.

### **3.3 Chagossians and conservation**

It is encouraging that Howell Reports that the Chagossians have: *'...a keen appreciation of the need to preserve the marine and terrestrial environments of the Chagos islands and, more importantly, a willingness to contribute to efforts, for example to protect the environment from illegal poaching and anchoring, to manage nature reserves and marine protected areas, to assist in monitoring spawning and breeding sites.'*

*'The Chagossians fully support these proposals (the CCMP) and the initial steps undertaken by BIOT to implement them.'*

*'...the Chagossians are fully prepared to accept regulations designed to preserve biodiversity and ensure sustainability in marine life. Furthermore there is an awareness of the damage to their own livelihoods of unchecked poaching and a readiness to contribute to efforts to identify suspected illegal operators.'*

*The Chagossians recognize the importance of their islands as bird sanctuaries..... There is readiness among Chagossians to assist in ensuring the enforcement of protected status for all the islands and in measures to maintain and improve the island habitats, including areas of native hardwood forest'.*

These are positive and laudable claims, and it is recognized by Howell that assistance and training will be required for Chagossians from organizations such as The Nature Conservancy, The Gerald Durrell Wildlife Conservation Trust, Mauritius Wildlife Foundation and the Marine Education Trust. Further expertise is also available through the Joint Nature Conservation Committee (JNCC), The Pew Foundation's Ocean Legacy, Chagos Conservation Trust and individual scientists and experts with specific knowledge of marine and terrestrial island ecosystems.

However, it must be appreciated that the skill and knowledge base will not be high, and great restraint will be required if settlers are not to exploit the surrounding environment to supplement food and other material requirements. This is recognized, and the report provides some cautions: *'..other measures which will require more self-discipline on the part of settlers.'*

*'These include prohibition on the killing of turtles and crabs; and a prohibition on the collection of eggs.'*

*'Given such external threats to both marine and terrestrial life, it is essential that the presence of settlers does not exacerbate the problem'.*

*'While recognizing the need for controls on lagoon fishing, including on artisanal fishing close to the shoreline, the total prohibition is a matter Chagossians resident in Peros Banhos and Salomon would want to revisit.'*

*'Thus the capacity to earn money, to pay for basic goods and services, is essential to the success of resettlement and critical if settlers are to be discouraged from those illegal 'survivalist' activities that could jeopardize the conservation efforts on which their long term future depends. Tourism and fisheries are the critical components of such an*

*income generation strategy.’ ‘Income opportunities are an important disincentive to illegal poaching to supplement food requirements.’*

These cautions raise the question of what would happen to the people and environment if economic activity, especially fishing and tourism, fail to provide income for the resettled Chagossians?

### **3.4 A new strategy**

The report also highlights, a different resettlement approach in which the Chagossians engage in active conservation through protection and also possibly rehabilitation of island ecosystems. This strategy is worthy of further exploration. Livelihoods could be available for a small scale community of Chagossians to act as guides, assist with research and enforce protection. The report recognizes that:

*Chagos ‘...provides an excellent research site to assess the impact of global warming on marine ecosystems, rates of erosion and recovery and the marine biodiversity. A resident population can be a considerable asset to such a research site.’*

*‘Chagossian contributions to efforts, for example, to protect the environment from illegal poaching and anchoring, to manage nature reserves and marine protected areas, to assist in monitoring spawning and breeding sites.’*

*‘...would require conservation guides, boatmen and auxillary helpers in permitting guests to enjoy the marine environment and islands’*

Better from several viewpoints of global conservation would be the development of something which would likely attract research and conservation funding. This would be to recreate some of the kinds of Indian Ocean hardwood forest and its attendant bird fauna that used to exist, as has been undertaken by the Mauritian Wildlife Foundation in Mauritius and on its shelf and lagoon islands. Several of the smaller Chagos islands have remnants of forest. In the 1970s some limited experimental replanting of seedlings in Peros Banhos to this end was a success. A larger project to obtain greater results is now being trialled in Diego Garcia too. The emerging world system of environmental offsetting must not be ignored, but the effort required and the benefits need to be explored. In the sea too, the importance of this large system of rich coral reefs to other parts of the Indian Ocean is slowly being more appreciated and understood.

A small community (10s to 100s) would stand a good prospect of success within such a framework of environmental protection for the precious and delicate islands, on which the community would depend for its survival. However, this approach would not support the upper settlement size of some 2600 individuals. Such a very different strategy might be further investigated, for it may represent a valuable solution and opportunity.

### 3.5 Risks to Settlers

The major problems facing even the smallest resettlement and minimal economic activity are the mid-term concerns that erosion of islands is increasing as warming, and ocean acidification, continues to stress and kill corals (corals form the material of which the islands are built), and sea level is rising. There have been predictions of changed intensities of storms, but in tropical locations such as this, uncertainty is too great to consider this aspect in depth. However, settlers, non-Chagossian support workers, or tourists should not be exposed to flood events resulting from high tides and storms, and threats to freshwater security are of particular concern. Substantial and costly mitigation measures will be required.

It is notable that the Dutch company Delft Hydraulics was commissioned to look at wave energy and overtopping for the Posford Haskoning feasibility study, and they sounded serious warnings. Their analysis highlighted *'that overtopping and the subsequent flooding is potentially a very serious problem for any resettlement scenario.'* Figures 7 and 8 previously showed that the cross sectional profile of the islands in which the centres dip below the level of high tide, demonstrates their vulnerability to flooding. Such flooding would not only endanger human life, but contaminate and destroy freshwater resources, remove soil, and damage agriculture and infrastructure. Given that this company is one of the leading groups engaged in flood control and hydrological work, caution might be wise before dismissing their warnings as the Howell Report does: *'Given the current incidence of overtopping and the limited nature of flooding caused, there does not appear to be any need for including sea defenses in the proposal.'*

Visiting yacht owners in Salomon in 2007 reported that on a calm day that year, high spring tides inundated the shoreline of Ile Boddam, up to some of the ruined buildings of the original settlement. It must be accepted that sea level and erosion are happening and increasing, and these factors must be taken into account. No reports exist of the situation during that high tide from Peros Banhos – that atoll is visited very much less for reasons noted earlier.

Erosion to date is patchy. Some atoll islands have marked erosion (Figure 13), some almost none, but most show some. The large, destructive tsunami in the last week of 2004 did cause erosion in a few areas, so there is potential to confuse tsunami effects with those of gradual attrition. However, all parts where tsunami damage was confirmed showed steep stepping of shorelines (even exposing turtle nests) and some stripping of vegetation. Other areas such as that in Figure 13 (no stepping on the beach) are likely to be the result of gradual attrition.



**Figure 13.** Some parts of islands in Peros Banhos and elsewhere are showing marked erosion. Other areas appear to show none, in unexplained patterns. Erosion patches such as this do not appear to be related to the tsunami and are more likely to be long term attrition, although no adequate research has yet been done on this. This is northern Ile Diamante, NW of the atoll in Feb 2006.

Substantial investigation of erosion and flooding is clearly required. Developments such as those outlined in the proposal are likely to exacerbate the situation due to shoreline modification, resulting impacts and reduced resilience of marine ecosystems. There is recognition of this in the report: *‘Nonetheless, the threats posed by climate change must be factored into resettlement even if the Chagos islands are deemed relatively benign in terms of natural threats. Clearly it is essential to preserve reef as a natural breakwater, to protect the vegetative cover on the shoreline, to ensure freshwater resources are not depleted, and to put in place a regulatory framework that ensures everything possible is done to mitigate any effects of climate change and global warming on the surrounding ocean.’* A pertinent reminder here is that protection of stretches of eroding shores in coral islands in many tropical areas costs tens of millions of dollars. **There is little doubt that people, freshwater, agriculture and infrastructure will increasingly be at risk from flood events.**

#### **4. On Governing and the management of resettlement**

The proposal for governance is rightfully inclusive: *‘The membership of the...(Chagos Development).. Trust, BIOT and Chagossian community representatives apart, should ensure that those with a significant interest in the future of the Chagos islands are included. This would mean the inclusion of environmental and social welfare organisations with a long engagement in the islands or exile community.’*

A local council is planned with agreed categories of expenditure. However, BIOT would remain the administering authority, although on matters of nature reserves, fishing permits and mooring sites, local consultation would be expected, and it is agreed that such engagement is desirable. It is proposed that on the 128 ha Ile de Coin, around 30 ha could be available for housing and 40 ha for further amenities. This scale of development is clearly incompatible with the existing conservation objectives. Protected areas such as nesting and breeding sites would require agreement and strict enforcement. Decisions should follow The Chagos Conservation Management Plan. The Report notes that: *'the CCMP was written in 2003, without reference to possible human habitation and that some components of the plan will require review in the detailed planning of resettlement.'* Parts of the plan were amended in 2007, and the plan would clearly need to remain flexible to ensure that conservation objectives and livelihoods can be met.

Island resources are extremely fragile. It will be essential for such resources as are found to be available, to be studied and developed with great care, and within an institutional context to permit proper management.

## **5. On costs of resettlement**

Because of the unknown scale of settlement, many costs remain vague. Some though are evidently seriously underestimated. **The costs are probably out by an order of magnitude or more, if shoreline protection, a properly costed appropriate airport facility, needed landfill for the latter, impact mitigation and other aspects noted below, are taken into account.**

The costs of the three electricity supplies needed (airport, hotel and village) may be underestimated and need to be referred to suitable engineers. Similarly, given the paucity in the report of mitigation measures to protect the environment, it is unlikely that these have been adequately costed in the modest sums for waste treatment plant, desalination, jetties, roads, boat repair yards, airport construction and so forth. No sums are included for a dock, shoreline protection, environmental monitoring, rehabilitation or necessary conservation measures arising from resettlement developments.

Operational costs are especially important, as Howell recognised: *'The important cost, however, is operational: not only power supply but also maintenance. Water charges would be prohibitive for low income users and, for this reason alone, grants for supplementary rainwater tanks for domestic users should be considered.'*

*'As with desalination, it is the operational costs that are the most challenging issue, indicating the importance of income flows to the settlers to ensure charges are met'.* It is hard to see how these operational costs can be met without a sufficient income stream, and income streams proposed are as yet inadequately developed, especially when the constraints to the airport, fishing and tourism aspects are realistically considered as discussed previously.

More information will be required from those who have recently visited the Chagos islands when considering the condition of existing facilities and costs of repair: *'This assumption [regarding costs being high] may not hold in all cases: the plantation manager's house, for example, appears to be relatively intact and some jetties remain*

*useable.*’ Figure 14 shows the actual condition of that house and jetty in 2006. Howell may have based his view of good condition on photos such as those on the CCT collection on cd, showing the house and jetty in the 1970s. The above is a trivial cost element, but the point made is not trivial because it does show the need to obtain the most recent sources of information. Other buildings are in no better, or are in worse condition.



Figure 14. Left side of Peros Banhos Managers house on Ile de Coin in 2006. Remaining timber is rotten and floors are missing, as is some of the roof. Right: Ile de Coin jetty in 2006. The block where the photographer is standing is fairly solid but the shoreward 75% is rubble.

The cost estimate of the airport in the Howell Report is especially modest: *‘The best current estimate (for airport construction) is £4 m although it may well be higher given uncertainties mentioned above as well as construction challenges. Nonetheless, a similar capacity airport receiving international visitors in southern Africa would cost in the region of £1.5 m (including power supply, telecommunications etc)’*. As can be seen from Appendix 1, the cost of the runway with turns at each end alone (without other airport facilities) is estimated at nearly US\$100 m (£50 m) because costs rise steeply with category of aircraft to be used. This sum does not include structures on the airport, nor substantial landfill, nor shoreline armouring, nor landing or port areas to get airport construction equipment ashore. A further US\$15 m (£7.5 m) is required for essential navigational equipment and taxiways, and more will be required for buildings, fuel storage, emergency vehicle and so forth. Operating costs will be over US\$8 m per year (£4 m). The airport design will need substantial modification and is currently very substantially under costed.

One of the highest groups of costs listed are those for management services for e.g. a Chagos Development Trust, Chagos Resettlement Commission (£0.7 m over 5 years) and ‘Professional fees’ at close to £1.5 m. But the overall cost is expected to be kept in check because such paid managers would keep down other labour costs: *‘several of the costs of technical assistance are likely to be met by volunteer organizations such as*

*Voluntary Service Overseas (VSO), by faith-based charities, by environmental NGOs, and by international agencies and foundations that regularly engage institutions to provide staff and training programmes....'* Further investigation is required to assess whether substantial support will be forthcoming. Doubtless some will, but gruelling and very unattractive tasks such as coconut plantation clearing for the required self-sustaining basic agriculture, may not be offered for free.

The proposal is as yet insufficiently developed to assert that the: *'Chagos can generate significant revenues from its economy once firmly established with private investment. It could well become the most self sufficient of those British overseas territories requiring DfiD financial support by combining the fishing and licensing revenues of, say the Falklands, and the tourism revenues of, say Anguilla'*. Mauritius does wish to expand its tourism industry and fishery, so indeed there will be industry interest, but this interest will need to be assessed. Fishing and tourism will most likely have significant impact if they go ahead as proposed, especially as both are unpredictable due to environmental change, and because both will inevitably creep to greater scale to support the economy of the upper limit of settlers. Realistic alternatives need to be presented, for in their absence, great concern must remain for protection of the environment, as is recognised by the report: *Thus the capacity to earn money, to pay for basic goods and services, is essential to the success of resettlement and critical if settlers are to be discouraged from those illegal 'survivalist' activities that could jeopardize the conservation efforts on which their long term future depends. Tourism and fisheries are the critical components of such an income generation strategy.'*

## **Conclusion**

It is understood that the report, *'Returning Home'* is not a detailed feasibility, but an overview of a strategy for return and resettlement. The report does recognise the outstanding environmental importance of the Chagos islands and their marine environment and acknowledges the need for man to live in harmony with this environment. Although the report presents proposals, some of which are worthy of further consideration, it does not present an effective blueprint for return because numbers, and hence infrastructure, costs and impacts on the environment are vaguely quantified. As a result, a creeping development is apparent. Options for different scales of return and hence development are required (it may be that simple facilities for visits by sea with much lesser development may be a way forward). Only then can impacts be accurately predicted, which means that the mitigation measures needed to protect the environment can be thoroughly explored. The likelihood of self sufficiency is questioned, suggesting the necessity to import food. The small size of the islands, poor condition of existing infrastructure, and overgrown nature of the plantations need to be recognised. Fishing requires much greater consideration if it is to be sustainable. Proposals for an airport are problematic because the suggested location has crosswinds and aircraft type and runway size are evidently insufficient. When these aspects are factored in, a much more expensive development is required for which there may be no appropriate location. Thus, the viability of economic activities dependent on air links must be carefully examined, and other activities more closely aligned to conservation might be explored. Proposals for tourism are problematic because of the need for air links, and because locations planned appear inappropriate, and because high end hotel-

based tourism may be short lived once development, environmental impact and loss of uniqueness follow. At present, options for income generation need much more exploration, because without any that are feasible, unsustainable use of natural resources will occur, especially in a creeping development. There is evidence to show that overtopping and subsequent flooding are likely to increase, and that erosion is already occurring, indicating a risk to settlement and the need for shoreline protection. Development and climate change are likely to exacerbate the situation. Protective measures are extremely expensive and are not included in the costs. The latter must be considered for any scale of return.

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## **Appendix 1. AIRPORT DESIGN**

Offered by Ted Morris on airfield construction following his read of the Howell Report. Major Morris was the US Air Force Military Airlift Command Commanding Officer on Diego Garcia, and is a retired USAF Lockheed C-141 and Boeing 737 pilot who has subsequently been involved in various aspects of aviation and airport management both in the United States and in South Asia and is the past-President of the New Mexico Airport Managers' Association.

### **Acceptable Design Standards for an International Airport**

The Howell proposal's airport section does not reference any established design standards. The proposed airport siting, size, design, and operation appear to be based solely on anecdotal stories of design and service elsewhere. Not examined are the isolation of the proposed airport, distances to other suitable airports, or how air service will be obtained. The standards to which the proposed airport must be designed, built and operated are substantially greater than stated in the report, and will also require substantially more money.

An airport is proposed, primarily for the tourist and export industries, with service primarily to Mauritius and possibly the Maldives. This will require the design, construction and operation of an airport able to accommodate properly certified air carriers capable of making the journey with a reasonable load of passengers and/or cargo using International Civil Aviation Organization (ICAO) established criteria.

As a British Territory, the UK Civil Aviation Authority (CAA) would regulate the design and operation of any civil airport in the BIOT. CAA criteria meet ICAO standards. However, as I am more familiar with the US Federal Aviation Administration (FAA) standards, (which also meet ICAO conventions, and therefore are nearly identical to those of the CAA) I'll refer to them for the comments that follow.

(If you would care to see the FAA Airport Design Specifications to which I'll refer in this appendix, and which are compatible with CAA and ICAO standards, they are posted on line at:[http://www.faa.gov/airports\\_airtraffic/airports/resources/advisory\\_circulars/index.cfm?template=homepage](http://www.faa.gov/airports_airtraffic/airports/resources/advisory_circulars/index.cfm?template=homepage). Once there, search for AC 150 5300-13.)

### **Determining Aircraft Requirements**

The basic question to be answered when designing a runway and the surrounding airport is 'What category of aircraft will the runway/airport be required to accommodate?'

Howell establishes several criteria for air service, including the following:

1. The desired destination for aircraft outbound from the proposed airport is Mauritius, and secondarily to the Seychelles for links to European tourism.
2. An alternative destination would be to the Maldives, for connections to Dubai for the fish trade.
3. He proposes using the Maldives as an alternate, if Diego Garcia is not made available.
4. Immigrations and Customs services would be required at the Chagos airport.
5. Suitable [electronic] navigation facilities would be required in the Chagos.

While these are important considerations, also needed are the distances to these airports and the proposed number of passengers and/or net cargo weight for each flight, These two factors will determine what types of aircraft will be required for the service proposed.

Any aircraft in service of the resettlement must be able to reach the proposed destinations, and with Howell's emphasis on links to Mauritius, specifically to that location. The approximate distances from Perhos Banos to the proposed destinations are:

Sir Seewoosagur Ramgoolam International Airport (Mauritius): 1,250 NM.  
Seychelles International Airport: 1,000 NM.  
Malé International Airport: 575 NM.  
Diego Garcia Airfield: 130 NM.

Although Howell's report does not state the requirements for payload, it proposes using ATR 42 aircraft. This implies it would be sufficient for expected passenger and cargo payload weight envisioned initially. The ATR 42-500 can accommodate up to 50 passengers, or a payload of approximately 6,000 kilos.

However, the ATR 42-500 (which is the 'long-range' version of the aircraft) has a range at maximum payload of only 870 NM, and is therefore unsuitable for the proposed air service to Mauritius or the Seychelles. It is also unable to carry sufficient fuel reserves for flights directly from the Chagos to Malé International Airport in the Maldives (approximately 575 NM distant) without first stopping at Gan Domestic Airport in the southern Maldives (300 NM from both Perhos Banos and Malé).

There are several aircraft capable of carrying 50 passengers or 6,000 kg of cargo, and fuel sufficient to reach Mauritius or the Seychelles. For example, the Bombardier CRJ100LR regional jet carries that payload and has a 2,000 NM range.

However, what of the future? It is evident that the proposed population will be at least 2,500 in the very near future, and with the inevitable increases from births and immigration, will potentially exceed that. In addition, the reliance on air shipment of food and the proposed fresh fish trade will require larger payloads that would be available using regional jets. Most probably the requirements for the foreseeable future will be aircraft of the size and payload of Boeing 737s and Airbus A320s.

Therefore, the airport infrastructure to accommodate those type aircraft should be designed and constructed from the beginning of the project, to avoid costly modifications at a later date.

### **General Runway Design Considerations.**

There are 6 basic considerations for runway design: Alignment, Length, Width, Load Bearing Capacity, Drainage, and cleared safety areas. Many factors influence the required calculation, but first and foremost are the wingspan and approach speed of the aircraft that will use the airport.

As we did in the section above, planners subjectively determine a set of aircraft types most likely to use the airport in the foreseeable future and from that, design the rest of the airport from the length of the runways required to the safety-setbacks on the airport using what is called the Airport Reference Code (ARC).

The ARC has two components - the approach speed and the wingspan of the aircraft anticipated to use the airport now or in the future. Combined, these are used to determine the runway width, weight-bearing capacity, and safety-setbacks for other pavements (such as taxiways), buildings, and residences.

An aircraft's approach speed is based upon 1.3 times its stall speed in the landing configuration at the particular aircraft's maximum certified weight. The five approach categories used in airport planning are as follows:

Category A	Speed less than 91 knots.
Category B	Speed 91 knots or more, but less than 121 knots.

Category C	Speed 121 knots or more, but less than 141 knots.
Category D	Speed 141 knots or more, but less than 166 knots.
Category E	Speed 166 knots or more.

The second basic design criteria relates is based upon wingspan. The six groups are as follows:

Group I:	Up to but not including 49 feet (15 m).
Group II:	49 feet up to but not including 79 feet (24 m).
Group III:	79 feet up to but not including 118 feet (36 m).
Group IV:	118 feet up to but not including 171 feet (52 m).
Group V:	171 feet up to but not including 214 feet (65 m).
Group VI:	214 feet up to but not including 262 feet (80 m).

As stated above, the aircraft most likely to service the Chagos in the foreseeable future are Boeing 737s, Airbus A320s or similar aircraft, meaning the ARC for the proposed airport should be C III.

### Using The ARC To Determine Runway Length

The determination of runway length requirements for an airport are based on five primary factors, two of which (Runway Gradient and Airport Elevation) will not be a consideration at the proposed airport site. The remaining factors are:

1. Mean maximum temperature of the hottest month. Using temperature data from Diego Garcia, one should figure about 90F/32C. The temperature varies little from month to month. The significance of the temperature is that the warmer the temperature, the less efficient the engines will be, and the longer it will take the aircraft to accelerate to takeoff speed. In turn this requires a longer runway than would be required, say, in the winter in Europe. Much longer.
2. Distance to the furthest destinations to be served non-stop. In this case, non-stop carries additional weight, as there are no en route airports between Perhos Banos and Mauritius or the Seychelles – only open ocean. The furthest destination is 1,250 NM away at Mauritius. Although this is not at the extreme range of the probable aircraft types, the destinations are remote without nearby alternate airports. From a practical standpoint, this means that the aircraft will carry a near-full fuel load on takeoff from the Chagos. If we consider that each flight will also carry near-full weights of passengers and/or cargo, we can then determine the gross weight of the aircraft that will use the airport, and the resulting required weight bearing capacity of the pavement.
3. The takeoff performance of the aircraft in the ARC most likely to use the airport, taking into account the elevation, temperature, and runway gradient. This is used to determine the length of the runway. At the proposed airport, runway gradient will be nil, and the airport elevation will be as good as it can get – sea level. The high temperature will significantly decrease engine performance, resulting in slower acceleration, and thus a longer runway length.

The FAA (and presumably the CAA) has a program that can be used to calculate the runway length required for specific aircraft types given the factors above. Airport Design Consultants also have similar programs. The most exact calculations can be made by checking aircraft performance manuals for selected aircraft in the ARC.

Without getting too technical, the amount of runway required for safe operations will allow a multi-engine aircraft (like those in our ARC) to accelerate to a given speed (called critical engine failure speed) loose an engine, and either take-off or stop in the remaining runway. The distance required for this is called Critical Field Length (CFL). An aircraft can never safely operate with a critical engine failure speed of less than 'refusal speed' – the distance to accelerate, loose an engine and stop in the remaining runway. Therefore, for safety reasons, it is CFL that determines

the minimum length of a runway, rather than the take-off ground run distance with both engines operating normally.

In an attempt to estimate the length of the runway required in the Chagos, I referred to flight manuals for Boeing 737-200 aircraft, operating at maximum gross weight (i.e., bound for Mauritius), at 32C, no wind, no slope, on a dry runway at sea-level, and determined the following:

Take-off Ground Run: 7,000 feet (2134 m)

CFL: 8,500 feet (2591 m)

Landing ground run (for an emergency return immediately after take-off): 4,000 feet (1219 m).

In Howell's report, it is noted that the ATR42 can land in 800 m (2,625 feet) and therefore that would be suitable for the runway. However, this is a completely irrelevant distance in designing airports, as we have seen. First, it must be remembered that runway required for take-off is the only criteria for runway length design. As can be seen above, it typically takes more than twice as much runway to safely take-off than it does to land at the same gross weight.

Ultimately, the minimum length required for the Chagos airport will be the CFL of the ARC group. Although other aircraft in the C III ARC may have better performance, a 737-200 is a typical aircraft in that part of the world, and therefore, I suggest that the minimum runway required for the proposed airport would be 8,500 feet (2591 m i.e. 2.591km).

### **Using The ARC To Determine Runway Alignment.**

The FAA Airport Design Standards considers cross wind to be excessive if it is exceeded 5% of the time or more for the ARC in question. A crosswind component is considered excessive at:

ARC A-I and B-I:	10.5 knots (12 mph)
ARC A-II and B-II:	13 knots (15 mph)
ARC C-1 through D-II:	16 knots (18 mph)

Since our ARC will be C III, the crosswind component to be considered is 16 kts. On Ile Pierre, the alignment of the runway will be determined by the alignment of the island itself - approximately 02 – 20. The SE trades would therefore be essentially direct cross-winds, as would the strongest winds in the December – March time-frame. Wind data from Diego Garcia shows these winds to often exceed 15 knots, and this would normally preclude designing a SW-NE aligned runway in that region.

Naturally, many airplanes are capable of that much x-wind, plus a lot more (a B-737-200 can handle 52 kts of x-wind). But for planning and design, the proposed airport should be built to limit crosswinds to 16 kts no more than 5% of the time. From the monthly wind data available, it appears that this 5% 'rule' may not kick in, but will certainly come close. Frankly, Ile Pierre would be the worst choice for runway location on the Perhos Banos atoll. However, if it is chosen there are ways to ameliorate the crosswind issue.

1. The timing of scheduled flights can be adjusted to arrive during the periods of least wind. Typically, wind dies down at night, for example. Drawback - The additional costs for lighting the runway (not just the lights, but the power to operate them), and providing a precision instrument approach, which is often required by the air carrier's operating certificate and insurance carrier. In this case this means the installation of an ILS (Instrument Landing System) as a Wide Area Augmentation System will not be available to permit precision GPS approaches for quite some time, if ever.
2. A valid forecast for surface winds at the proposed time of arrival will allow the flight to be delayed at their point of origin if winds are forecast to be 'out of limits.' Drawback – This would require maintaining a met office with a forecaster (not merely an observer or an automated weather station). Staffing may be very costly.

3. Diego Garcia can be used as an alternate – the US authorities probably cannot deny use of the airport as a weather alternate under ICAO rules. However Diego Garcia is 130 NM away, and that means the aircraft must arrive overhead Ile Pierre with enough fuel to get to Diego Garcia, shoot an instrument approach to landing, and have 45 minutes emergency fuel reserve. Generally, this added fuel means less payload can be carried.

Note: In the US, the FAA requires 10 years worth of wind data studies to determine the best alignment for a runway. Since few if any new airports are constructed each year, and since the locations of those few usually have no wind data, wind data from nearby airports is often used. When using wind data from Diego Garcia, it is important to note that Diego Garcia is 130 miles from Ile Pierre. It may be that the wind data from Diego Garcia is suitable, since there is no intervening land form to break the flow, but being so near the inter-tropical convergence zone, it may be that the wind data from Diego Garcia is significantly off. I'd recommend additional research on this point.

To positively resolve the crosswind issues, it would be best to choose an island that aligns more closely to the wind.

### **Using the ARC to Determine Runway Width**

Per FAA Design Standards, a C-III aircraft requires a runway 100 feet (30.5 m) wide (minimum).

### **Design of Safety Zones and Set-backs**

The amount of cleared land on either side and at each end of the runway to protect the aircraft and to protect the residents is determined by the ARC as well. For a C-III aircraft, the Runway Safety Area extends 150 feet (45.72 m) either side of centerline. Nothing may be placed in this area that is not required by function and required for aircraft safety (for example a wind-sock at the end of the runway, runway lights, ILS antennas, etc.). Various other clear zones extend up to 500 feet (152 m) on either side of the runway, and off the approach ends. It should be noted that Ile Pierre will be essentially stripped bare to accommodate these ICAO required cleared spaces (see Figure 5 in main text).

### **Determining the Weight-Bearing Capacity of the Required Runway**

The aircraft in our ARC typically weigh up to 150,000 pounds (68,000 kg). To support that weight, the design of the runway pavement is very specific. It should be noted that it is nothing like the design standards for a highway, and subsequently much more expensive.

It is acceptable to construct either a flexible pavement (i.e., asphalt) or inflexible pavement (i.e., concrete). Asphalt is much easier to construct than concrete, but requires a lot of routine and costly maintenance to maintain its integrity. In addition, some dislike the use of asphalt because of the oils involved in construction and maintenance which are reported to pollute groundwater. On the Chagos, with the water table just feet below the surface this could be a serious problem. Therefore, the runway should be constructed of concrete.

### **Costs**

Please note that ten years ago, asphalt cost one third as much as concrete to build, but maintenance costs were three times that of concrete. With the current price of oil, asphalt and concrete costs are now comparable, and concrete may actually soon be less costly than asphalt.

Here in the States, current prices for a 100 foot (30.5 m) wide runway for 150,000 pound (68,000 kg) aircraft, with the necessary clearing and grubbing of safety areas, installation of edge lights,

and the ICAO required paint job, we plan on US\$3 million per 1,000 feet (305 m). This does not count aprons, taxiways, or terminals. Please note that it also doesn't include the cost of the docks to get the machinery and construction materials ashore, fuel storage facilities & other infrastructure. Therefore, I would estimate that the cost to build a bare-bones, lighted ICAO compliant runway in such a remote location will be in the neighborhood of US\$10 million per 1,000 feet (305 m) by the time one factors in shipping costs, fuel, etc. So you're looking at something in the neighborhood of US\$80 – 100 million, plus the costs of the other airport infrastructure. For reference, here are some additional costs to bring the airport up to ICAO standards:

ILS (electronic instrument landing system): US\$2.5 million.

VOR/DME (area navigation system): US\$1.5 million.

Taxiways: For C III ARC, these must be built to the same weight-bearing standards, and must be at least 50 feet (15 m) wide. Therefore, these would cost about US\$1.5 million per 1,000 feet (305 m) here in the States, with a comparable increase in the Chagos to perhaps US\$5 million per 1,000 feet (305m).

### **Operational Considerations and Obtaining Air Service**

In the US, if the aircraft using the airfield are capable of carrying more than 30 passengers, the airport requires an Federally issued operating certificate showing the airport meets the requirements of the Code of Federal Regulations, specifically FAR Part 139. The standards are very strict and can be seen at:

[http://www.faa.gov/airports\\_airtraffic/airports/airport\\_safety/part139\\_cert/](http://www.faa.gov/airports_airtraffic/airports/airport_safety/part139_cert/). Without a certificate, one can operate an airport as long as no aircraft arrives capable of carrying more than 30 passengers. I assume the UK's CAA has a similar requirement. Conducting the inspections required by the certificate, as well as keeping the electronic navigation aids and lighting in good condition, and the aircraft operating pavements clear of foreign objects and in good repair proves to be a significant effort. For example, if the runway in the Chagos has a precision approach for incoming aircraft, the runway must remain painted in certain specific ways. Here in the USA, the paint alone for an 8,500 foot (2,500 m) runway would cost in excess of US\$75,000.

Such costs must be borne, if the airport hopes to attract air service. The airport must meet ICAO standards in design and operation or no certified air carrier will fly to it. Where the final rub comes is the air carrier's insurance. If the airport isn't to ICAO design standards - no insurance, and therefore no flights!

There is only one rule when it comes to obtaining airline service for an airport in a free market – the airline must make a profit. It does not appear that the proposed Chagos airport will ever generate sufficient commercial activity to attract any airline in a free market. That means some entity will have to contract and pay for the service. For that part of the world, figure around US\$10,000/hour for an airplane & crew plus fuel. It's a 5 hour round trip to Mauritius in a Boeing or Airbus, so one could figure US\$50,000.00 per flight + (at US\$4.00/gallon for Jet A1) US\$25,000 for the fuel. Assuming two flights per week, the recurring costs will be around US\$150,000 per week or US\$8million/year, at the very minimum.

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