

DEPARTMENT OF BIOLOGICAL SCIENCES

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Mr Charles Hamilton
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Please find enclosed my report on
the Posford documents.

Yours sincerely

Charles Sheppard

Review of Posford report on possible resettlement of BIOT

Dr Charles Sheppard

Summary

1. Three development scenarios are postulated which correspond broadly to artisanal, intermediate, and top-end commercial tourism.
2. Oceanographic, climate, groundwater and soils sections are scientifically sound (with some queries and revisions suggested). These broadly show that development in the islands is not sensible, long term nor sustainable (and may even become dangerous) for the first two development scenarios.
3. Most sections on natural resources are dismal. They are sampled and reviewed inappropriately and inadequately, and can support no conclusions of any kind. They did not and could not achieve the required information.
4. Such sections, and by implication conclusions and propositions generally, would be badly mauled if contested.
5. Several aspects of the ToR do not appear to have been addressed (even allowing for information still being processed). Some can be done from 'home', but some required proper initial field work.
6. Volume III on 'Resettlement issues' contains little of value. There is a huge amount of repetitive waffle and padding. Whole sections are very vague and banal. There is evidence of irrelevant 'cut-and-pasting' from other reports.
7. There is too little drawing together of separate sections, so conclusions written in isolation sometimes do not agree with each other; for example, suggested maximum populations vary widely depending on the basis of calculation. Resolution of this is one of the points of the exercise. Each section focuses on its own subject matter to the exclusion and compromise of others. Balancing such resource uses is what environmental management is all about, yet this is not addressed. A synthesis would be a useful part to BIOT Administration.
8. In many cases, text on one subject is scattered throughout the volumes instead of being concisely presented once, in one place. This would read much better, be clearer, be more internally coherent, and could say more, if it was one third the length.
9. The executive summary misses several important emphases made in the main text.
10. Reasons for not carrying out some of the work are stated often - no consultation with Ilois, aerial photos not supplied, diving was too dangerous, some snorkelling was too dangerous, etc. There are many suggestions for further work which should have been done by this project.
11. Major omissions include provision of the GIS (a 'proper' one - not just some island outlines and transect locations), remote sensing results such as ground-truthed island and shallow habitat maps, work on shoreline markers using differential GPS (for future erosion monitoring), marine resources assessments, and others.
12. If the gaps cannot now be filled, the issued report should include only the sound sections, whose general message is clear. Other ways of filling the gaps would need to be found for future management in BIOT.
13. Development scenario 3 (high end tourism development etc) becomes the obvious and only development possibility. This may create great interest in some quarters yet neither it nor its consequences are adequately discussed.

Volume I: Executive summary

This important section does not always reflect the content of the volumes very well. This is doubtless due to haste and short deadlines. Several key issues missed out are stated in the text and in the conclusions. I suggest that after a period of reflection this is revisited.

Several conclusions are apparently at odds either with each other or with other, known facts. During the rewrite, these apparent contradictions in the text can be resolved. They make parts of the report somewhat vulnerable. One example is the widely varying estimates of numbers of people that could be sustainably supported.

Volume II.

Section 2: Groundwater resources assessment

The section is generally comprehensive and sound. 'Groundwater has been recognised as a key constraint...' (p 15) and any errors here could be very important, so attention is drawn to some confusing items.

The section, like others, leads up to the numbers of people which can be supported, but this is based only on groundwater availability. It reaches figures of up to 3,000 in Ile du Coin based on an artisanal-level existence, assuming no water contamination, without irrigation or industrial use, and with no use for the islands other than being a source of water. Figures are of course much lower for 'better' development scenarios, or for alternative uses of some of the land.

However the postulated populations suppose that development and activities are focussed only around best use of water, and there is no discussion of the likelihood of this being realised, nor is there enough 'real case history' data from other atoll groups to show what really happens, nor are consequences shown of water actually being extracted to anywhere near this degree. Plenty of such data are available from the nearby Maldives, for example. The authors understand this. They make clear that these islands are vulnerable to faecal contamination because of the thin layer between surface and fresh water. They state that rat eradication may be needed to prevent faecal contamination, yet other sections point out that animal husbandry would be an obvious activity. It does not clearly state how such contamination could be prevented through the thin 'roof' of the aquifers. Where perfect conditions fail, the water lens runs into trouble quite easily. (NB rat extermination: on Ile du Coin it would also have to be done on all adjoining islands as they are connected by nearly dry reef at low spring tides.)

No direct measurements were made of specific water yield (p 37) and values from other atolls are used as surrogate. This may be reasonable, but if inaccurate it could greatly change the assumed maximum numbers.

The Electromagnetic survey provides a good preliminary guess of the extent of the lenses. But for Ile du Coin it may not have been enough to determine whether there is a single continuous lens as is assumed, or several separated by less permeable structures. This would greatly modify yield. That this is possible comes from the historical pattern of settlement: whereas in Ile Boddam settlement was where the consultant's chart says the lens is greatest, as would be expected, on Ile du Coin it was where the map says the lens is extremely thin. Island settlements were well aware of how and where to find fresh water. One reason why the settlement on Ile du Coin was where it was might be that the assumed central mass of the lens may be much smaller or fragmented. (Another reason is that there is so much more water than the map shows that settlement just about anywhere is possible.)

The authors recognise the limitations of the EM survey (p 56) and note that 'due to time constraints and difficulty of access in thickly vegetated areas...' there are major gaps. Clearly, with something as important as water supply, those gaps need to be filled. The 'time constraint' was presumably one imposed by the consultants, not by BIOT Administration? And difficulty of access is not really a valid constraint.

Nutrient contamination

Nitrogen nutrients are important indicators, but in this group only ammonium and nitrite were measured. The most important, nitrate, was not '...although these were requested, owing to the lack of appropriate reagents at the laboratory' (p 45). But ammonium and nitrite are transient, oxidising to nitrate in many conditions. In fact, based on the nitrite and ammonia, nitrate levels may be very high. If the samples were properly collected and fixed, nitrate analysis may still be possible. They are the most important, and should be done. (Nitrate analysis was done for seawater, section 7, so why they could not be done for drinking water is unclear.)

Rainfall and recharge of lenses

All measurements were conducted near the end of the 6 month 'rainy season'. Difficulties with availability of rainfall data including the important annual pattern were repeatedly claimed. However, www.ncdc.noaa.gov (type Diego Garcia for station name) offers met data, including rainfall from Jan 1971-Jan 2002 (cost \$70 so I didn't check further, though I have used this source previously). Other web sources also show Diego Garcia's annual pattern. There is a much drier spell during the trades from about May to September. Lens water residence time is less than one year. Given the seasonal drier spell, consequences to extraction and recharge should be explored better. The Hadley Centre's web site (www.met-office.gov.uk/research/hadleycentre/index.html) shows projected changes to rainfall in the future, using their HadCM2 models, and while these have admitted uncertainties these should be considered also: consequences to sustainable settlement numbers could be considerable.

The following should be more adequately addressed or resolved:

- Effects of sea level rise on the boundaries or depths of the lenses, especially in islands whose central parts are near sea level (two islands were levelled and this could be usefully incorporated).
- The very careful control and management needed of extraction from the lenses, (ref. Diego Garcia).
- Consideration of aquifer operating costs (e.g. trained personnel).

- The methods required to avoid sewage and ground waste contamination in the aquifer (e.g. from animal husbandry), especially with such a thin porous 'roof'.
- Possible effects of nutrients seeping in to the lenses from other land uses such as crop fertilisation.
- Effects on the vegetation under different extraction scenarios. Taking certain quantities may be possible, but may leave nothing for plants, leaving a fairly desolate landscape.
- Vegetation uses up probably about half of the input from rainfall. This is mentioned in the agroforestry sections but ignored here (other than by suggesting that cutting it down will enhance aquifer recharge). Yet adequate water extraction for human use would lead to reduced agricultural potential.
- Resolve contradiction: Water recharge of aquifers would increase by vegetation clearing (Groundwater resources section), but this would lead to quickly unacceptable soil degradation (Soil and land resources section). But: water recharge would decrease with clearance of plants and development (from Volume IV).

Section 3: Soil and land resources

Again, a good account of the soil and vegetation patterns.

Oddly, it starts: 'The Phase 2 ToR does not explicitly require evaluation of the soils.' But read the three paras of the ToR Section 2.5: 'Soils investigations'!

ToR 2.5.3. 'A base map at an appropriate scale should be derived from air photography or satellite imagery. The output should provide sufficient information, without need for further study, for the preparation of a land use development plan for the two main islands.' This has not been done.

The '...brief reconnaissance of the other principal islets... to determine the variability of soils there' has not been done adequately.

The consultants regretted the lack of aerial photography which would have assisted greatly. Yet details of old controlled aerials for all Peros Banhos, and countless oblique photographs (many nearly vertical) of all atolls, was given to a consultant in mid 2001 for this express purpose. Partly as a result, details of land / soil / vegetation categories on other islands is extremely sparse, making it difficult to judge soil suitability there. (It is known that historically such islands were used as an important food source, e.g. fruit from eastern Peros Banhos islands, rabbits on some northern islands.)

Other islands are generally smaller, though less able to produce as much food as Ile du Coin and /or Boddam. Yet the infrastructure required will need to be based mainly on these two, as would any air strips (air strips need to be aligned NW-SE and these are the only two candidate islands). The 'other islands' may be where all the food needs to be grown!

Half of the rainfall is 'used up' by having tree species in an agroforestry system viable on small coral islands. Tree growth is sensibly recommended, but consequences to other issues such as water extraction are not sufficiently addressed.

Several points are made about the social conditions, working skills and aspirations of settlers. Many important warnings are made (largely omitted in the executive summary) including current ability of settlers to carry out suitable agriculture, costs of education to enable them to carry it out, their motivation to do it when fishing would, on the face of it, yield much more money, demands on good soils as infrastructure grows, and even the possible need to import 'non-stakeholder' labour while the agroforestral system is being established (déjà vu 19th century!). All could be overcome by considerable investment, except perhaps the human population issue. But while these warnings are given: 'Realistic estimates... of risks involved are beyond the scope of this report.' Are they? That is surely a key point of the report. Some recommendations are made, and the authors doubtless do know the situations in many other coral atolls and similar small islands. I suggest that it is needed here.

The whole point is sustainable resettlement and numbers of people. The report recommends for the future (vol. 3, section 11.3) 'Reliable estimates of the sustainable human settlement carrying capacity of these atolls require synthesis of the completed soil survey with a potential agroforestral development plan.' Surely, this is a task for this report, at least to the degree possible with the soils, water and vegetation data now available?

Section 4: Fisheries

The text says in numerous places that this and that form of mariculture is unlikely to be viable, or even should not be tried, or that skilled practices are not likely to be available, that air transport, ice facilities, docks etc. are needed. All are very likely to be correct conclusions, based on other countries. Problems are:

- these conclusions are not well supported by the present study (thinking in terms of opposing interests picking holes in the report),
- the summaries, including the executive summary, occasionally imply contradictory conclusions (e.g. the fisheries can apparently be at least doubled in size).

Sampling adequacy.

Sea cucumbers, algae, oysters etc. This section fails due to inadequate sampling. From what can be deduced from various sections, sampling was in strips of 100 m to seaward from the shores in several places. It does not say whether this even reaches the edges of the reef flats (many are much wider than 100 m), nor what happens if water deepens to beyond that visible by snorkelling. It also seems to not include most seaward reef slopes, the large areas of coral knoll tops, the huge sandy areas from 4 - 20 m deep in the lagoons, etc.

Fish. No new survey work appears to have been done other than compilation of a very skimpy list of species and count of numbers spotted. Data from past reports were used instead to partly fill that gap. This may be valid where such data exist, but

past reports in this case do not contain very much on the commercial reef dwelling fish from those areas which are of great consequence to artisanal settlers.

The ToR required (3.2.2) '... carry out underwater surveys to appropriate depths within the lagoons and outer reefs of Peros-Banhos and Salomon... of holothurian and *Trochus* population...'

This was not done. The report says in many places that 'safety considerations' stopped any work everywhere other than some rather marginal areas, like reef flats and shallow lagoon sites. The consultants should explain why they did not use and support full survey in all areas, and why they did not support the only survey method (scuba) which could have filled the ToR. 'Safety' is claimed repeatedly, but numerous previous studies in these islands used it perfectly happily. Was inability to sample adequately made clear to BIOT Administration prior to the agreement? Did no other bidder offer to do it properly? The result was that several important requirements of the ToR could not be done. This means an important opportunity has been sadly missed. It also means that some conclusions remain guesses which 'opposing scientists' could easily pick holes in.

The report states that a (main?) reason for focussing on lagoons is that past work focussed on the other areas. But nearly as much work *has* been published on lagoon reefs: Salm PhD 1980, Salm 1984 *Environmental Conservation* 11: 209-215, Sheppard 1981 *Journal of Natural History* 15:607-621, Sheppard 1980, *Marine Ecology Progress Series* 2: 193-205, none of which appear to have been used. Added to that, two more recent papers in *Ambio* include lagoonal reefs, including knolls.

It should be remembered that Chagos reef flats are atypically shallow, and dry at low spring tides. They are not at all representative of even slightly deeper water, and are not even typical of reef flats in much of the Indian or Pacific Oceans. Limiting a survey to these sites is like examining a rainforest from the roadside.

The ToR requires (3.2.3) 'Using satellite imagery, bathymetric charts and ground truthing, determine...' several groups of things. Ground truthing (i.e. observing the habitat to validate maps) is key. Without it, all is guesswork. Habitat maps of shallow water are needed, based on satellite imagery (a dozen classes of habitat should easily be possible). These appear not to have been done. (Even BIOT postage stamps have shown 12-class unsupervised habitat maps of the marine areas, created from Landsat!)

Other points

The text says that the sites and findings are shown in Appendix E. There are no findings in Appendix E.

'Island atolls generally provide favourable environments for aquaculture. The surrounding oceanic waters are usually nutrient rich...' p 143. The point about Chagos is that it lies in the most nutrient poor part of the Indian Ocean.

The Chagos bank fishery potential is estimated to be half that of other banks (p 146). An important point. More attention should be drawn to the danger of extrapolating

fisheries potential catches from e.g. Seychelles to this region. The executive summary implies the reverse and says that the present fishery is yielding only about one third of what could be caught (vol 1 p 10). The idea of using 'precautionary target reference points' (p 171) of half the maximum sustainable yield (MSY) is sensibly mooted. Some rewriting to know what is actually being said and recommended is needed.

There is a general 'old fashioned' approach here, in that MSY is used as a benchmark, overlooking the point that it is probably the most discredited aspect of all fisheries, lying behind many fisheries collapses. This is not a criticism of this report – more a suggestion that these estimates of potential catches are not soundly based. It generally is only found out after it is too late.

Holothurians Distributions are said to be irregular. I suggest that this may be an artefact of much too little sampling. It is not fair to declare that a range of up to 0.975 sea cucumbers per square m can be viewed as 9750 / ha !

Tridacna 'It is not clear why *Tridacna* were so limited in number in Peros Banhos' (p 159). It is clear, and is due to the monthly desiccation on Chagos reef flats mentioned above. In fact *Tridacna* is not uncommon below snorkelling depths, another point missed by not doing scuba survey.

Seaweed Calculations suggesting x hectares of seaweed culture area are claimed. Maybe it is true. But based on what? Lines in green drawn on an outline map of the west of Peros Banhos suggest suitable sites, but it is not clear what are these based on: snorkelling, satellite imagery, or just where the chart said the depth was right?

Ground truthed, satellite-derived habitat classifications are the minimum upon which such assertions should be based, unless the surveyors looked at it all (and it seemed they did not). Page 174 says that this 'requires considerable ground truthing... for substantiation.' Indeed it does, which is why the ToR required it (3.2.3): 'Using satellite imagery, bathymetric charts and ground truthing, determine... the extent of suitable areas for seaweed mariculture.' Instead the report says 'The GIS was used to determine which areas might be suitable for seaweed culture.' What data went into that GIS in this respect? Does it really mean GIS? This requirement does not seem to have been done.

Several pages state why seaweed or oyster farming may not work well (probably correctly) but then (p 177): 'the extensive culture of seaweed or pearl is considered feasible'.

The report suggests that a more detailed survey including deeper water areas using scuba are needed. That is why it was requested.

'500-1150 persons could be supported by a subsistence fishery.' I suggest a table summarising all the different numbers of people who could live there sustainably, derived by the different sections, would be valuable in the summary.

It is concluded that the \$ valuable options (export of fresh produce etc) require an airstrip or two, and can only work alongside an industry such as tourism. Such

conclusions, while doubtless true, do require highlighting and not just burying in a thick volume. This is the sort of material that the executive summary needs.

It seems that the Diego Garcia recreational catch (113 t) is about 10% of what the archipelago can sustain. This may lie outside the ToR, but since Diego Garcia is much less than 10% of the archipelago does that suggest there is too much catch in Diego Garcia already?

These holes are major and need to be filled, or else these marine resources parts really need to be simply deleted from this report.

5: Natural Environment

The report says (5.2): 'The purpose of this study was to assess the current status of the lagoon reefs and their associated fauna and flora and to provide a baseline to evaluate the nature of the anticipated environmental impacts...'. It was not. The ToR (4.1-4.2) asked the consultants to (amongst other things):

- 'Design a protocol for a reef/benthic monitoring programme...';
- 'Evaluate potential environmental impacts...';
- 'To design a monitoring programme... to 40 m deep...';
- 'To design a management plan...';
- 'Generate data on baseline erosion patterns... The methods should include... beach and shoreline markers using differential GPS:...' (4.2.1).
- 'Assess the costs and benefits of mitigating adverse environmental impacts on the marine environment as a result of coastal construction works...'

Snorkelling methods could only look at the reef to ~3 m deep. Yet peak diversity and abundance occur in these lagoons deeper than that. An example of the error introduced by this survey is shown by the unfortunate statement (p 203) that Ile Diamante had '...the lowest coral cover of any sites...'. In fact, from 3 - 15 m deep its diversity and cover, even after the 1998 kill, was high at > 50%, with several species only ever found there. There is no reason why the authors should have known that, but it is mentioned to illustrate the inadequacy of snorkelling only.

The studies of the northern reefs were allocated half a day each. This cannot be expected to yield much.

'Health and safety' is mentioned again as being a reason why the main natural resource-bearing depths were not surveyed. However, having set a reliance on snorkelling, it then says (p 193) that weather prevented much snorkelling too! To replace it, some walking on reef flats was done instead. (Of all Indian Ocean reef flats, those of Chagos dry out the most and are least productive and typical anyway.)

Rapid broadscale assessments were then undertaken. They cite Price (1999, or maybe 1996?) as support. However his work in Chagos used plots of 500 x 500 m, assessing island and marine habitats, litter, oil... a total of 16 large scale gross events or habitats. The method is not very likely to yield much when focussed on just the two shallow habitats encountered in this survey (coral and sand, presumably).

The transects themselves were shorter than what effective, 'standard' sampling might require. Only 20 m lengths were used, and 'life form' under each 0.5 m length was recorded, a total of only 40 measurements per transect. This is skimpy, and an evaluation of its sufficiency appears to be missing. Reference is made (p 194) to a comparison with a more detailed approach, but these results seem to be missing too.

It is not surprising therefore that the numbers of corals seen were a small fraction of those known to exist in these general locations. Conclusions of richness are meaningless.

The data presented is unclear and in a form difficult for future comparison. Power analysis is referred to (this can help show sampling sufficiency, and is asked for in the ToR), but there is no indication that this was actually used. If it was, its results should be presented. Did it show that sampling was sufficient here?

Fish surveys were also done in the shallows, and so only found small numbers of low diversity. This also means that comparisons with earlier data (asked for in general terms in the ToR) cannot be made. The differences in patterns seen could be due to sample sizes (and see Spalding's paper on Chagos fishes in 'Ecology of the Chagos Archipelago')

Terrestrial Environment (5.3.2) should compare what was found with the data in Price 1999. Hopefully the method used was the same too, but this is unclear.

It is difficult to know what can be done to use the data collected to serve the ToR and the intent in this section. Clearly, too little time and resources were allocated by an order of magnitude. Nor does it provide '...an environmental baseline for evaluation of anticipated environmental threats associated with resettlement.' (Executive summary p 13).

6: Coastal and Oceanic Processes

This is a good account of the relevant marine and air climate. I am unqualified to judge on the different models used, but the results and arguments are convincing – and very important. It would be valuable if the results could be made available in an oceanographic journal. The figures are useful.

The island elevations (figure on p 259) correspond closely with others in Chagos which are 'in press'. Some description would be helpful (like a figure caption!). It is a pity they are drawn so small (especially when so many of the large maps which are presented contain almost no information). In Ile Boddam, high water level appears to differ by 0.4 m between seaward and lagoon sides – if true, this needs explaining.

Sediment transport sections well explain phenomena seen in these islands, namely seasonal appearance and removal of substantial sand banks and spits. The volumes computed are important. The most recent publication on reefs of Chagos (in Ambio) shows large quantities (unquantified) of dead and eroding coral rubble being transported into deep water in large scoured chutes, extending to at least 30 m deep. Given the recent coral death, a comment on different rates of sediment production

would help lead to views on mid- and long-term island erosion or deposition of beaches. End p 269, top page 270 touches on this, but this key aspect of erosion should be amplified.

The tidal current section p 270-277 does not seem to be quite right. The computation that 'it would be expected that surface currents would correspond to the elliptical motion associated with the passage of a "wave" with period 12 hours and a height of approximately 1 m' seems to ignore local waves. The equation ignores them. Thus the tide does not simply rise and fall smoothly in respect of water moving in and out of the lagoon. Instead, in Salomon atoll at least, waves pump water across the reef into the lagoon even on a falling tide. It has been observed that water (and sediment) can flow out of the main pass on both rising and falling tides. Therefore, is 'The principle ... that the water within the tidal prism of the lagoon must flow across the lagoon boundary over a period of six hours' (p 271) realistic? See also fig 6.32. With storms (ref. the wind driven currents on p 273) the situation is more marked. Would this make a difference to any conclusions?

It is a pity that all interpretations of the word 'Assess...' in the ToR 4.2.2 requiring oceanographic work, caused modelling only to be done. There seem to be no actual measurements at all! The above could have been picked up, for example.

7: Water quality

Nutrients in the sea were analysed, but it is not clear at what part of the tidal cycle. Nutrients can rise in a lagoon with water retention, and may rise near islands following rain, so tide can be very important in nutrient interpretation. This is important to possible nutrient loads following resettlement. Was at least one trace over a tidal cycle done to help determine this? This would be a very basic requirement, but it seems that locations were sampled only once. These are not an adequate 'baseline' for future reference! I could not even see at what state of tide the tiny amount of sampling was done.

The discussion states (p291) 'To resolve this issue, further studies are required with more extensive sampling.. High frequency of sampling is required...' to measure various aspects'. Indeed, which was the point of including this in the ToR. The ToR did not specify how much sampling was contractually required, leaving it to the consultant's scientific judgement to do sufficient to get answers to the obvious questions. The sub-minimalist approach used is well below acceptable scientific requirements and can not answer the question!

The same is needed for measures such as water clarity, TDS and others.

These sections do not strengthen the report, but would show inadequacies only. They should be removed unless more work is possible on retained samples.

Numerous particle size distributions are presented. They are left 'hanging' and an explanation is needed of what they mean in the present context.

Beach erosion

Shore erosion may be one of the key impediments to settlement, especially given the 'dish-shaped' profiles of many islands, including the two levelled here. The data for the levelling transects should be provided, to add to collections from other Chagos atolls.

Very importantly, the ToR 4.2.1 is concerned with the need to 'Generate data on baseline erosion patterns...' and the ToR requires that: 'The methods used to answer specific questions of erosion in the Chagos islands should include beach and shoreline markers using differential GPS...' though aerial photography should also be used if available. A series of differential GPS fixes (accuracy to a very few cm) were key to beginning investigations on island shoreline attrition. The erosion of the island rims is a key to flooding and breaching by waves, and so is key to decisions on some forms of shore protection, as well as other aspects of management.

I could see none of these crucial results.

Volume III.

Some parts suffer from a very great deal of waffle and trivial statements. It appears to be aimed at a very low level:

Section 8: Climate change

This is a simple review, based on general knowledge, much not specifically addressing Chagos. Key and correct statements include the last para on p 309, stating that sea level rise may intrude on the aquifers, increased storms may have marked effects, increased coastal erosion will occur and increased frequency of overtopping. Costs of defence against all these are rightly said to be 'prohibitive'.

A lesser known fact brought out here is that increased CO2 causes corals to calcify less (one third less in a few decades), which may exacerbate conditions. But most of this section, however, is trivial waffle: e.g. 'Avoid development in areas that are vulnerable to inundation.' 'Protect human lives...' 'Buildings will be required for habitation. ...', 'proper site selection is a crucial first requirement', and many pages more.

The conclusions (p 315) are that infrastructure and lives are threatened by climate changes likely in the next few decades, and this is, of course, the conclusion that matters most. But they are drowned amongst the morass of general essay.

To address better ToR 4.2.3: 'Quantify the risk associated with global climate change...', these conclusion should be tightened, and made as specific as possible to this archipelago.

Section 9: Environmental appraisal of resettlement.

The reasoning is made repeatedly that an environmental assessment is not made here because there is insufficient information on numbers, intentions and aspirations of Ilois. This is fair to a degree. But: 'This appraisal is, therefore, by default based on consideration of generic issues rather than specific information.' I think there is enough specific information to focus on BIOT rather more.

'Maps and geographical information systems, such as developed during this study, offer a valuable tool to assist with the assessment study.' But was a GIS developed? No useful GIS is presented, other than outline maps for most sections (excepting some climate modelling maps).

A proper set of habitat maps from the Landsat would help too, though this is likewise not given. It is not clear that they were in fact developed.

The report tends to state repeatedly how much work was done, but it shies away from presenting or synthesising it on the grounds that there isn't enough data, and then recommends that data should be obtained. (This does not apply to some sections.)

'Advance knowledge of currents in the area of construction would allow predictions of direction and persistence of turbidity plumes, thereby facilitating assessment of potential impacts of dredging...'. It is fair to say that the purpose of the project was to develop this knowledge, or, where it was tackled in Volume II, to use it more helpfully in a synthesis to aid interpretation here. ToR 4.2.2. in fact requires this. It is partly done in the previous volume, but a synthesis is needed here.

Some of the padding can only easily be explained if it was carelessly pasted from other reports. For example, a list of possible, future wastes includes: batteries, paint, pesticides, oil from engines, cars and motorbikes etc. Then: 'Observations at selected sites reveal that some of these items are being burnt or disposed of at sea' (p.324) ! Really? Where are these burn and dump sites ?!

'It will be essential to consider a strategy for the development of an integrated waste management plan...' (p 324). Indeed, this surely was an element of ToR section 4.1. It is crucial too to water resources use and contamination.

Development issues

Statements showing that resettlement would be expensive, hazardous and not viable are clear, and are valid where based on the water, oceanographic and climate sections. These are based on 'simple lifestyle' habitation (scenarios 1 or 2, near-subsistence, artisanal, or with a bit of industry). Nothing at all is said about scenario 3 (based partly around expensive tourism etc). Yet given the impossibility of scenarios 1 and 2, a tourism based option 3 becomes the only attractive development option for interested parties. This is ignored in the report. Another option, one of non-development, non-residential, but settled seasonally for some fishing, is likewise not really addressed (this has been how Mauritius manages fisheries in St Brandon and its banks).

The word 'ecotourism' is used but the word applies only when no significant additional facilities are needed, i.e. transport and accommodation are already in place, needing only 'soft' additional use. Since all facilities need to be built from scratch, no ecotourism is even possible in BIOT (but it could be in Diego Garcia!). This could usefully be mentioned, given the tendency of developers to call any and all tourism 'ecotourism'. Up-market tourism has not been explored in this report, though it could be viable and profitable even with a 30 year life expectancy (before being washed away).

10: Infrastructure needs

This provides a very truncated list of things which need to be done or built: housing, a jetty, dredging for a channel, food for residents...etc. It does not add much which is useful or Chagos-specific.

One startling suggestion is the use of wave protection using 'locally mined coral'. The authors should learn what happens when coral is locally mined to the extent needed, such as in the Maldives, Sri Lanka and elsewhere. And later, the possibility of constructing the jetty from coral rock is suggested. This indicates the lack of cross-communication between participants in this report – one member at least is very familiar with problems of coral mining at the scale suggested.

Page 337-8 provides some useful pollution dispersal values. But it uses values for west European countries, and values for 1500 metres from the outfall. This is not so useful for an Ile Boddam scenario. Why cannot tropical information be given? Coliforms survive for different lengths of time in different temperature water, for example. This section would be much more helpful if revised, including estimates concerning distance from outfalls.

Page 346: 'In Chagos there are no significant inputs of sediment into the system apart from recycling of bed material...' The meaning here is not clear (sediment production by e.g. bioerosion is vast). Does this refer just to turbidity plumes from outfalls, perhaps?

11: Recommendations

The inability to fulfil some elements is blamed on many things : not being able to discuss aspirations with the Ilois, lack of aerial photos (p 348), etc. This section is vague, urging much more work, filled with padding. It occasionally delves deeper (e.g. some fisheries options and warnings) but always seems to avoid getting its teeth into answering enough to be very useful. Only further work can, apparently, help here! The authors have a point in that they do not know the numbers of people and type of resettlement, but they could use more effectively one or all of the three scenarios they defined earlier. It contains mostly a long list of what future work should do, most of which is obvious already. Many of the suggestions, however, are perfectly valid and indeed will depend on the exact development adopted by settlers.

The same applies to the pages on seaweed and invertebrate culture. Some of them are repeats of what is recommended earlier. Some, e.g. a good survey, use of scuba to survey properly etc. seem to be what the present ToR called for in the first place.

Likewise, recommendations made on page 355 (part 11.5) are what the present ToR asked for: The establishment of an environmental monitoring programme, and the development of an integrated management plan.

One point is that several of the valid suggestions on cultivation do require 1-3 years of investigation prior to making a decision to resettle. This would be important if the result of that study was pivotal. But in fact, other elements strongly preclude resettlement at artisanal or near artisanal levels for other reasons.

The report can be strengthened by simply omitting much of it – enough will remain, whose conclusions are clear, especially with some reworking as noted.

Volume IV. Appendices

The inch thick pile of maps contain almost no information, many showing the lines of just one or two transects each. Much fewer figures could show it all. This sort of bulk detracts from a scientific report.

There is no 'GIS' other than using GIS to draw island outlines. This could still be done.

There is no remote sensing presented, i.e. habitat maps based on ground classifications, shallow water habitat maps etc. This could still be done.

It is difficult to see the purpose of including much of the field data pages. It does not show that lots of work was done, rather that work done has not been synthesised much in the main texts.

Appendix D5 could be worked to become crucial in the section on Agroforestral human carrying capacity. It should be 'up front', in the executive summary with other estimates of numbers of sustainably supportable populations. But why does it use numbers from Pacific atolls rather than e.g. Seychelles, Maldives, Lakshadweep?

The benthic data tables needs better keys of captions to understand them. Better would be more synthesis of the results.