THE LIKELY CONSEQUENCES OF PROJECTED CLIMATE CHANGE: WHAT ARE THE RISKS CONFRONTING THE CARIBBEAN ?

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Adapting to Climate Change in the Caribbean: Risk Management Workshop

Sherbourne Conference Centre, Barbados,

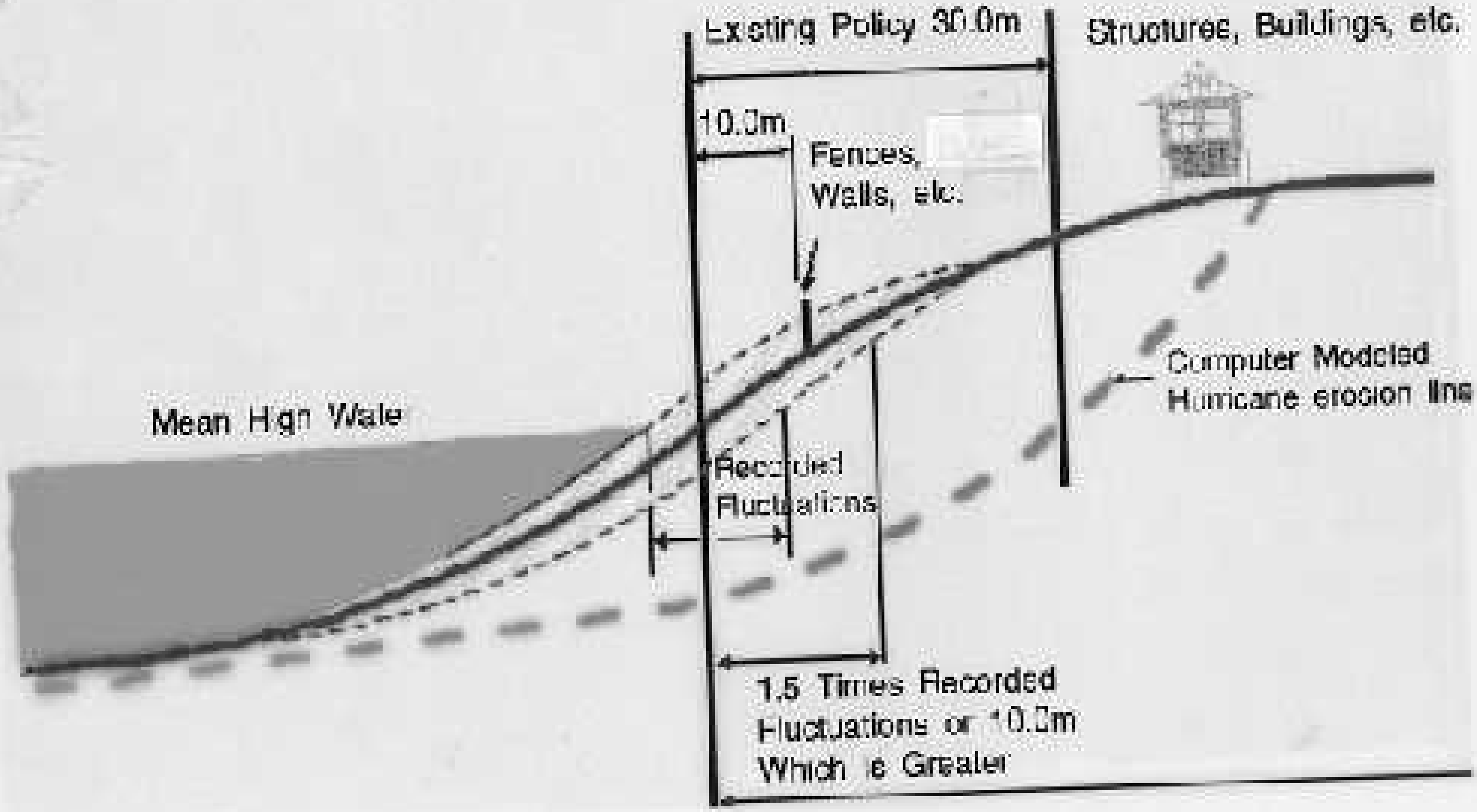
December 11 -13, 2001

LIKELY RISKS CONFRONTING CARIBBEAN

Sea-Level Rise:

- **Although there are variations in the signal, sea level in the regions of the Small Island States is expected to rise by as much as 5mm yr^{-1}, for next 100 yrs, as a result of GHG-induced global warming.**
- ***Coastal Land loss*, especially on atolls and low-lying coasts E.g. on the Georgetown and Onverwatt coasts there could be as much as 80 % shoreline retreat with a 0.5 rise in sea level. In the case of Grenada, 75% of Grand Anse Beach would disappear with a 0.5 rise in sea level. In extreme cases, abandonment of some atolls and small islands may be the only practical option, given (i) *elevation a.m.s.l.*, and (ii) *physical size*.**
- ***Loss of coastal infrastructure*. Practically all critical infrastructure is located at or near the coast on islands.**

Calculation of Setback Distance : BARBADOS



LIKELY RISKS CONFRONTING CARIBBEAN(cont'd)

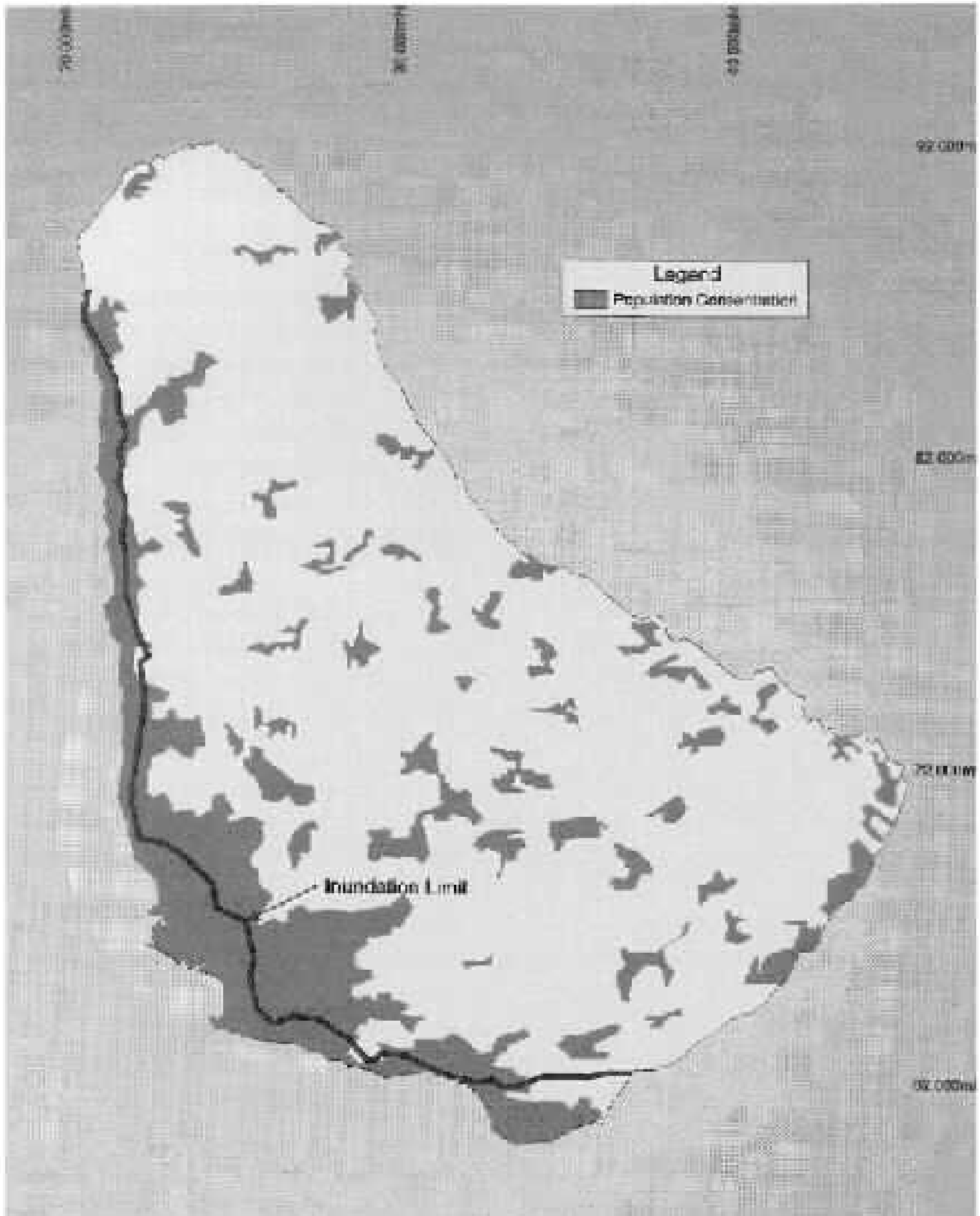
Beach Erosion

- **Model runs and observed data consistently project that a*ccelerated beach erosion* will be one of the inevitable threats facing small islands. While much present-day coastal erosion is man-induced (*sand mining, construction in active beach zone, infringement of building set-backs, etc.*), empirical studies show that SLR is a significant contributory factor.**
- **Higher Water Levels + Higher Wave Amplitude = Increased Wave Energy**
- **In Trinidad, some beaches are retreating by as much as 2.0 m yr^{-1}, where sea level has been rising at rate of 8-10 mm yr^{-1}, during the past 15 years.**

LIKELY RISKS CONFRONTING CARIBBEAN(cont'd)

Storm Surge, Flood Risks and Inundation:

- **Although there is uncertainty about the future behaviour of tropical cyclones (hurricanes), flood risks and inundation from storm surge will be more severe.**
  - **Even *quantitatively small increases in relative sea level* will have a *disproportionate effect on flood levels* (Non-linear relationship between SLR and inundation levels).**
  - **Flood risk modeling (HADCM2, HADCM3, UKMO, 1999) suggests that by 2080, numbers facing severe floods in the Caribbean, Indian and Pacific Ocean regions would be 200 times higher than if there were no SLR.**
  - **Recent studies in Cuba (Perez et al. 1999, based on HADCM2), identified 98 coastal settlements with a total population exceeding 50 000 persons, which would be completely inundated by a 1.0 m rise in sea-level.**



Barbados Inundation Zone

Assumptions

1: 100 Year Event

Coincident with astronomical high tide

LIKELY RISKS CONFRONTING CARIBBEAN(cont'd)

Coral reefs:

- **Observational evidence shows that periodic *warming of the ocean surface*, as occurs in El Ni⇧o years, leads to *coral bleaching*. The major events of the past 20 years occurred at times when ocean temperatures have been about *1^0 C higher than the summer maximum*.**
- **Most intense episode on record occurred during 1997-98 El Ni⇧o. On some islands >90% of live reefs affected.**
- **AOGCMs project that bleaching can be expected annually for the next 50 years or so.**
- **Increasing atmospheric CO_2 is being accompanied by similar increases in the oceans. This is expected to lead to a *reduction in the rate of calcification of reef -building corals by between 14-30% by 2050*.**

LIKELY RISKS CONFRONTING CARIBBEAN(cont'd)

Water Resources and Agriculture:

- **Water resources and agriculture are both *climate-dependent* and *climate-sensitive*.**
- **Many islands rely heavily on single sources, e.g. groundwater (Barbados, Antigua, Bahamas, Kiribati), harvesting of rainwater (Tuvalu, Cook Islands, Maldives), surface reservoirs and imports (Singapore) or rivers (Dominica, Singapore).**
- **Unfavourable shifts in precipitation (*quantity* or *distribution*), already predicted by some climate models, will worsen the situation in many states.**
- **Arable land for crop agriculture is also scarce, therefore the likely prospect of *land loss* and *soil salinization* due to SLR, will threaten the sustainability of both subsistence and commercial agriculture.**

TWO EXAMPLES OF ON-GOING CROP MODELING RESEARCH ON ISLANDS

- **<u>Trinidad</u> <u>and</u> <u>Tobago</u>: Singh and El Maayr (1998), using FAO crop model and CCCma to simulate crop yields), predict a *reduction of sugarcane yields by 20-40%*, under a *2XCO_2 scenario*.**

- **<u>Mauritius</u>: Cheeroo-Nayamuth and Nayamuth (1999), based on the Agricultural Production Systems Simulator Model, developed in Australia (APSIM-Sugarcane), project a decline in sucrose content by >50%, assuming *2XCO_2*.**

LIKELY RISKS CONFRONTING CARIBBEAN(cont'd)

Human Health:

- **Many countries, notably tropical islands, show a high incidence of vector-borne diseases, due to climate variability. In last 15 years in the Pacific, outbreaks of dengue strongly correlated with ENSO.**
- **With increase in ^{0}T and rainfall changes, some vectors will extend range, $\therefore$ wider transmission of diseases. E.g. malaria, - previously confined to the western and central Pacific, is now extending east to Fiji. Interior uplands (now virtually free of vectors, e.g. *Aedes aegypti*), are becoming more favourable breeding sites (McMichael, 1996; Epstein, 1999; Hales, 1999).**

- **Patz, J.A., P.R. Epstein, T.A. Burke & J.M. Balbus (1996) '*Global climate change and emerging infectious diseases*". *Jnl. American Medical Assoc.*, 275, 217-223.**

IMPACT OF CLIMATE CHANGE ON VECTOR-BORNE DISEASES: WHO PROJECTIONS

Disease	*Pop. at Risk*	*Projected Change in Distribution due to CC*
Malaria	**2,400**	**+++**
Schistosomiasis	**600**	**++**
Lymphatic filiarsis	**1,094**	**+**
Dengue	**2, 500**	**++**
Yellow fever	**450**	**++**

+ Possible

++ Likely

++ + Very Likely

Source: WHO, 1996: Climate Change and Human Health [McMichael, A.J., A. Haines, R. Sloof and S. Kovats (eds.)]. WHO, Geneva, 279 pp.

LIKELY RISKS CONFRONTING CARIBBEAN(cont'd)

Tourism: Major revenue earner and generates significant employment. In addition the the industry is almost entirely '*coastal*'. The impact of climate change on this sector will be both direct and indirect.

- **SLR will disrupt the sector through loss of beaches, the threat to physical plant and vital infrastructure.**
- **The industry is also sensitive to other climate-related impacts, e.g. the loss of corals and other marine flora and fauna, which support the scuba diving industry.**
- **The greatest temperature changes are projected for the higher latitudes. A large % of tourism is generated by the desire to '*escape*' the cold winters of the North. Milder winter temperatures in these markets could reduce the appeal of islands as tourist destinations.**

RISK MANAGEMENT AND CLIMATE CHANGE: SOME CAVEATS TO CONSIDER

There is little doubt that ‘*risk management*’ is a tool which can be usefully applied in the design and selection of strategies for coping with areas of uncertainty, e.g. climate change. Some of the strengths of the tool are:

- **Its capacity to integrate multiple factors;**
- **It possesses some level of predictive capability;**
- **If prudently applied, it can reduce the level of vulnerability of a given exposure unit.**

RISK ASSESSMENT AND MANAGEMENT

- ***Risk assessment*** **seeks to evaluate the *degree of exposure* (*vulnerability*) to an event, and offers a range of *options for risk reduction*. This is an objective, technical process.**
- ***Risk management*** **refers to the selection and implementation of an option or options. The process is informed largely by *human choice*. The strategy chosen depends on such factors as (a) the society's determination of what constitutes *acceptable risk* (b) how society values one set of resources versus another, and (c) how much the society is able, or is prepared to pay for coverage against the particular risk.**

Assumptions of Risk Management

Essentially, *risk management* methods are predicated on two primary assumptions:

1. **Events of a given *magnitude* and *intensity* are repetitive over time, hence their *recurrence interval* (or *frequency*) can be calculated with some level of confidence.**

- **Example: we can say that there is a *95 % probability* that wave heights > hs_x will be experienced along a given coast, *every 25 years*.**

2. ***Future events* will behave similarly to events of the past, i.e. the conditions giving rise to such events and the *amount of damage* (*impact*) can be *predicted based on past occurrences*.**

Limitations Arising From Imperfect Knowledge

- **The greatest impacts of climate change will be inflicted by *extreme events*, and our ability to predict the *onset*, *duration* and *magnitude* of these events remains relatively low.**
- **Even where we are able to predict the event with a fair degree of certainty (e.g. time of landfall of hurricane and associated storm surge; duration and intensity of a flood or drought), our ability to forecast and quantify the likely damage, hence the *costs*, is still poor.**

Limitations Arising From Imperfect Knowledge

- **There is still some uncertainty in our ability to clearly distinguish between *climate variability* and longer-term *climate change*. This limitation affects the extent to which a particular risk avoidance strategy will be efficacious or not.**
  - **For instance a farmer may switch backward and forward among *different cultivars* of the same crop, as a response to climate variability (e.g. during *ENSO* events).**
  - **This option may however be totally ineffective under climate change. The same farmer may have to change to a different crop altogether.**

Limitations Arising From Imperfect Knowledge

- **We lack the knowledge to determine with precision whether the range of climate change impacts will be *short-*, *medium-* or *long-term*. This is especially true of natural systems, e.g. beaches, which may recover *quickly*, *slowly* or *not at all*, depending on the *severity of the storm waves*, and the *resilience* of the system.**
  - **If beach recovery is rapid after storms, and the impact short-term, there may be no need to implement a costly risk management strategy (e.g beach nourishment, groynes, breakwaters). In fact, these strategies may be dysfunctional in the circumstances, and affect the system's capacity to recover from future events.**

Final Caveat

- **Most climate change model projections (*GCMs and RCMs*) are based on the assumption that there will be 2 x CO_2 by some pre-selected future date, e.g. 2050, 2080 or 21000.**
  - **This now appears to be an erroneous assumption, as the observed global emissions for CO_2 and other greenhouse gases suggest that there is likely to be at least 3 x CO_2 or greater by these dates. Thus, the risks for which we are planning a response, are expected to be far greater than currently projected.**