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# Issues in Information Poverty and Decision-Making in the Caribbean - A Way Forward

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*Several major external (global climate change, global economics and geopolitics) and internal (regional governments' national land policies, population growth and illegal settlements) factors are expected to significantly impact the Caribbean islands in the next few decades. If the Caribbean region is to manage the environmental, social and economic effects of these changes, it needs to develop appropriate mitigation strategies to address their likely consequences. However, planning and decision-making in this regard is seriously compromised due to the lack of data as well as the failure to understand the influencing factors and other processes on a regional basis. The lack of effective and reliable information base for decision-making is termed* ***information poverty****. This paper advances and evaluates the concept that a way forward to endure* ***information poverty*** *is to utilise available, and reliable cutting edge technology such as satellite remote sensing, global positioning systems and geographic information systems to originate, develop, supplement, manage and analyse the necessary data sets. Furthermore, this technology can be used to develop plausible scenarios, which does not require detailed data sets and extensive knowledge, to evaluate the necessary mitigation strategies for addressing possible impacts on the region.*

***Keywords:*** Information poverty, Decision-making, New technology, Caribbean

## 1. Introduction

In the coming decades, the Caribbean region is expected to witness significant changes in climate, weather patterns, sea level rise, land availability, food systems and the environment (**IPCC, 2001**). These changes arise from both external and internal factors. While some of these factors cannot be controlled, others may be radically adjusted to minimise their effects. External factors include global climate change and sea level rise. Internal factors include uncontrolled population growth, illegal settlement of prime lands and inappropriate national land policies.

If the Caribbean region is to minimise the environmental, social and economic effects of these changes, it needs to develop appropriate mitigation strategies to address their likely consequences. However, the lack of data as well as the failure to understand factors that control climatic and other processes on a regional basis is a problem (**Baban, 2003**). The lack of data and understanding may be termed 'information poverty'.

A way forward is to utilise new technologies such as remote sensing, global positioning systems (GPS) and geographic information systems (GIS) to collect and manage the necessary data sets and to generate plausible scenarios to evaluate possible mitigation strategies to sustain the Caribbean region. This paper reviews the major issues of information poverty and its effects on the decision-making process

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and proposes solutions to fill the information void. Section 2 evaluates the major factors that are likely to affect the region. The third section examines information poverty and critical information gaps in the Caribbean region. Section 4 proposes a way forward to address the lack of information that exists.

## 2. Change Factors

Two major sets of factors are expected to impact the Caribbean region. While some factors cannot be easily addressed, others may be significantly influenced at the national level.

### *2.1 External Factors*

The major external factors include global economics, geopolitics and global climate change. For example, international forces may influence national land policies and put pressure for land development to cater for the tourism market. In terms of climate change and sea level rise, the strong influence of the oceans surrounding the Caribbean islands on the climate of these islands is expected to generate changes in ocean circulation and temperatures. The generally accepted prediction is that sea levels will rise during the 21st Century by between 10cm and 1m, with a 'best guess' of about 50cm. This is particularly difficult for the Caribbean as the majority of the population and economic activities are concentrated in the coastal zone. Furthermore, natural systems such as mangroves that help protect marine and coastal resources are already being degraded by development and other human activities (**CPACC, 2000**).

Additionally, climate change may affect the character and pattern of tropical storms and hurricanes. These changes are expected to influence the global and regional hydrological cycle. This in turn will affect the distribution and availability of water resources in the Caribbean region (**IPCC, 2001**). The expected changes in climate could alter regional agricultural systems with substantial consequences for food production (**Fisher *et al*, 2001**). However, global climate change models (GCM) were used to generate the above estimates. These models generate very coarse outputs. The horizontal resolution of GCM grids normally ranges from 100 to 500 km. These outputs cannot be used to provide detailed climate change projections for spaces smaller than the horizontal resolution. This means that most islands in the Caribbean region are treated as if they were not there (**Trotman, 2002**). There is, therefore, a need to develop climate change models that are more sensitive to the geographical characteristics of the Caribbean. This will require spatial data as well as an understanding of the processes that affect the climate of the region. Estimates that are more representative of the effects of GCC can then be generated and used for mitigation purposes.

### *2.2 Internal Factors*

Internal factors include regional governments' national land policies, population growth and illegal settlements. For example, governments' land policies may cause the sterilisation of prime lands especially if relevant, up-to-date information is not available for decision support. Furthermore, the region is distressed by many problems that may be extenuated as a result of global climate change. At present, the arable land available is limited due to the physical nature for most of the islands both in terms of size, suitability and topography. Sea level rise and increased temperatures and rainfall are expected to reduce the land stock available for building and affect the suitability of land for agricultural purposes. However, the major problems facing the arable lands in the Caribbean are pressures brought about by population growth, tourism industry, illegal settlement and ineffective planning, development and environmental regulations (**Baban, 2004**).

Population growth in the Caribbean will continue to impose an additional burden on the resources of these islands. It becomes extremely important to continually increase the level of income earned from this industry because the economies of many islands are based on the tourism industry. This in turn puts pressure for further development of the coastal areas driving the price of land even further up. The local population is therefore forced more inland (**Baban, 2003**). However, the lands in these areas are normally very hilly and form part of the watersheds needed for ensuring a water supply. These areas are often protected through hillside development and other related planning regulations, such as the 100m contour line limit in Trinidad and Tobago (**Smart, 2003**). The lands available for housing in the formal sector are therefore quite limited. Unable to access these lands, many have resorted to squatting in protected and other valuable areas. Squatting has led to many problems including the breakdown of planning and development regulations, environmental degradation, the destruction of ecologically sensitive areas and the sterilisation of lands most suitable for agricultural purposes.

The long-term effects of national factors on the Caribbean need to be clearly understood if mitigation measures are to be implemented. This means not only understanding the effects of global climate change but the additional national factors that are likely to impinge on the adaptation strategies that are most appropriate for the region.

## 3. Information Poverty in the Region

Information is one of the most important strategic factors influencing development. Modern political and economic systems cannot function without a continuous interchange of reliable information. In fact, one of the barriers to sustainable development in developing countries is lack of information requisite to planning it (**Bernhardsen, 1992**).

There are critical information gaps and uncertainties regarding the understanding of vulnerability and adaptation potential of small island states to climate change (**IPCC, 2001**). Furthermore, there is little information regarding the potential impacts of climate change on essential resources such as the impact of the increase in sea surface temperature on loss of biodiversity, on ecosystem health and resilience, on the frequency of storms and hurricanes and damage to nursery areas, the specific geographical impact of sea level rise on coastal habitat loss, saltwater intrusion of coastal and estuarine wetlands, plants response to heat stress, variations in temperature and precipitation, day length and wind, the impact of climate change on plant growth and crop yield across the region and in specific locations, the impact of increases in soil temperature on soil water content, physical processes and biological activity, and the impacts of climate change on soil organisms (**Baban, 2003**).

Planning a sustainable future requires reliable information regarding the issues above among others. However, lack of understanding of the processes involved and the scarcity of information on the one hand and the lack of reliability of available data on the other make it difficult to assist with decision-making and to provide useful answers.

## 4. Living with Information Poverty

There is need to determine strategies to cope with the uncertainties of the effects of global climate change on natural resources, the environment, as well as goods and services, and to analyse the environmental and societal consequences of adaptation strategies (**Baban, 2003**). This process will require understanding the links between environmental change and societal well-being and promoting effective interventions. These can be realised by:

(i) Collecting and evaluating all relevant data sets.

(ii) Identifying areas of information poverty and possible information gaps.

(iii) Identifying the necessary tools for collecting, managing and analysing the necessary data sets. Additionally, examining the capacity of local expertise to use these tools to develop and manage the essential data sets.

(iv) Establishing a clear understanding of the processes involved on a regional scale in order to identify the variable impacts of global climate change on the region, the most vulnerable community groups, the process by which different parts of the region can adapt to manage both global climate change and changing demands, the environmental and societal consequences of adaptation to these changes.

(v) Developing plausible scenarios to account for the effects of climate change in the region. This step is necessary to cope with the inevitable information gap which will appear as a result of (i) - (iv) above.

(vi) Developing a Caribbean agenda to manage these issues by all stakeholders.

### 4.1 Information and Conceptual Issues

Seeking patterns and processes often fulfills the understanding component of scientific enquiry. This process starts with making observations and collecting the necessary data sets to capture the phenomenon of interest. Then, the data sets are examined to deduce the nature and the main characteristics of the phenomenon, the spatial distribution and time of occurrence. This information will lead to mapping the distribution of the phenomenon in space and in time. Then the question "Why?" is asked in order to understand the nature and cause of any significant spatial and temporal associations. Secondary data sets are often used during this stage to complement the primary data sets. Obtaining data sets and information during various relevant time frames will provide the monitoring required to reduce reality to manageable proportions, mimic the processes in the real world, as we best understand it and estimate the impact of various activities on specific natural resources through modelling (**Baban, 2001; 2003**).

The Caribbean region suffers from a scarcity of reliable and compatible data sets. For example, the soils maps for the region were constructed during the 1950s and 1960s and even some of the senior scientists in the region are finding these maps difficult to use (**Ahmad, 2002**). There is also a lack of suitable topographic maps, for example, the best topographic map of Trinidad and Tobago has a 5m interval which makes it unsuitable for predicting sea level change by 10cm, 50cm or even 1m. In addition, the processes involved at national and regional scales are not clearly understood. Obviously, this information poverty makes planning and decision-making for development planning and control, and managing agriculture and fisheries a difficult task. However, these obstacles may be mitigated using geoinformatics. This nascent discipline encompasses remote sensing, geographical information science (GIS) and global positioning systems (GPS). Geoinformatics contain the necessary tools to collect, handle and analyse spatial data sets as well as expand our knowledge of the processes involved at the appropriate scales.

#### 4.1.1 Remote Sensing

Remotely sensed data can provide vital information for managing natural resources and the environment particularly on a regional scale. There are several advantages in using remotely sensed data (**Baban, 1999a**). It provides an understanding of the physical phenomena associated with the interaction between radiation and matter based on the information contained in the various wavelengths. Using remote sensing, it is possible to map the factors influencing and contributing to environmental degradation such as vegetation cover, soil characteristics and human activities (**Barrett** and **Curtis, 1992**). Remotely sensed images provide information for monitoring change over appropriate time periods and conducting time-series studies.

One of the problems involved in studying the environment is the extreme variability of many phenomena over time. Geostationary satellites such as NOAA or Meteosat (Spatial resolution ranging from 1,000 - 2,500m) or the combination of geosynchronous satellites in the Landsat series or SPOT series (spatial resolution ranging from 30m to 80m), can provide the necessary information. The synoptic coverage provides information for vast areas. As certain phenomena are transient, it is very important to obtain information at regional basis at specific points in time. It may be used to conduct detailed analyses based on combinations of high and low-resolution data. Images with various resolutions are essential for examining regional and site-specific problems. Remote sensing also provides information on topography and relief. SPOT images for example, can be used to compile a topographical map with an elevation accuracy of 5 - 10m. Finally, remotely sensed imagery may be used to provide data for areas that have no ground measurements based on the interpolation of area-based information from sampled sites with similar attributes; subject only to the size of the area and the spatial resolution of the imagery.

The Caribbean islands cover a large geographic area. Remotely sensed data possess a great potential in a region like the Caribbean despite cloud cover problems over many of the islands. Industries are confined to specific locations, the agricultural systems are simple, pollution is confined and limited and regular ground referenced data can be gathered from various national and regional agencies. Remote sensing can be used effectively for surveying, conducting inventories, mapping and monitoring the environmental problems both on land and coastal marine domains in the Caribbean region. The increasing availability of sub-meter imagery will improve our understanding of the environment. Remotely sensed data have been used successfully to provide relevant information on catchments characteristics, for example, mapping and monitoring the spatial extent of various types of land use and land cover including changes in agricultural land (**Baban** and **Luke, 2000**), mapping parent material type, soils, vegetation type and canopy densities (**Lo, 1986; Barrett** and **Curtis, 1992**) as well as coastal and marine environments. Remotely sensed data can also be utilised to develop plausible scenarios used to simulate environmental response to different conditions/management scenarios (**Baban, 1999b; Baban** and **Wan-Yusof, 2001**).

#### *4.1.2 Global Positioning System*

Global Positioning Systems (GPS) are a military satellite-based navigational system developed by the Department of Defense in the United States. GPS provides 24-hour, three-dimensional position, velocity and time information. The satellites transmit timing information, satellite location information and satellite health information. The position is determined by using a small, portable receiver to receive and compare signals from three or more satellites. For each signal received, the interpretation of codes or measurement of phase permits computation of the satellite's position in space, and the distance between it and the receiver. The receiver's horizontal and vertical position is computed from cross-checking the signals from four or more satellites (**Bernhardsen, 1992**). The satellites are controlled and monitored from ground stations which monitor the satellites for accuracy (**Leick, 1995**).

#### *4.1.3 Geographical Information Science (GIS)*

The spatial nature of the data will allow GIS to be used firstly, to input, store, organise and analyse the ground survey data and the data derived from remote sensing. Secondly, the spatial analysis, visualisation and query capabilities of GIS can be employed to improve the outputs from the remote sensing stage (**Baban** and **Wan-Yusof, 2001**). The spatial nature of the examined phenomena will warrant the use of GIS to input, store, organise and analyse the ground survey data and the data derived from remote sensing. GIS also promotes spatial thinking, which is a method of assessing a situation based on perception of information that includes the location of features in space, and a structural approach to problem-solving (**Burrough** ***et al*****, 1998**). Therefore, based on the spatial nature of the acquired data, GIS capabilities in terms of spatial analysis, visualisation and query functions can be employed to provide information on the nature as well as the spatial and temporal distribution of the phenomenon of interest.

Additionally, GIS can be used to construct and simulate various management scenarios responding to various conditions of Global Climate Change and Sea level change at specific locations. Then, to establish which is the most suited scenario for a location under a given set of constraints (**Jones, 1997**). Finally, GIS is designed for assembling, integrating and analysing spatial data in a decision-making context (**Malczewski, 1999**).

### *4.2 Modelling based on Plausible Scenarios*

Modelling a phenomenon to mimic the real world and to develop management approaches based on expectations for the future requires relevant and detailed data sets collected over a number of years. Furthermore, models are often based on the deterministic mathematical approach, which is not flexible and cannot respond to novel situations, surprises and regime shifts.

Scenarios are probable alternative futures, each an example of what might happen under particular assumptions. A scenario may be defined as "a hypothetical sequence of events constructed for the purpose of focussing attention on causal processes and decision points" (**Kahn** and **Weiner, 1967**). Another definition is "archetypal descriptions of alternate images of the future, created from mental maps or models that reflect different perspectives on past, present and future developments" (**Rotmans** and **Van Asselt 1997**).

In the Caribbean, scenario planning is a must due to the lack of sufficient and accurate data sets to run 'hard' mathematical models. Therefore, scenario building is a practical approach to start now while data sets are being collected and compiled towards enhancing our understanding and ability to conduct more detailed studies in the future.

Scenarios provide an indication of what might happen, but not definitive probabilities and can be used as a systematic method for thinking creatively about complex, uncertain futures. For example, the concern might be with scenarios that forecast changes in Agriculture, Fisheries and Tourism due to global climate change and sea level change (**Figure 1**). Some scenarios are forward-looking "forecasts" that describe the emergence of future conditions from current conditions and driving forces. Others are "backcasts" that begin with an image of the future and seek to identify plausible development pathways for getting there.

Scenarios provide an important means of assessing a future that may or may not exist depending on certain conditions. They aid in the visualisation of the consequences of ignoring environmental problems before they occur. They help policy-makers in understanding the different aspects and connections within an environmental problem over a large period of time and scale. In this way, it is a valuable asset for helping us contend with increasingly complex problems (**Figure 1**).

A scenario consists of states, events, actions and consequences that are causally linked. They are more than just extrapolations of current trends as they include images of the future and likened to a logical sequence of images of the future. They include driving forces, events and actions that lead to the future conditions as visualised in the images of the future (**Figure 1**) (**Rotmans *et. al.*, 2000**). Ideally, scenarios should be internally consistent, plausible and recognisable stories exploring paths into the future (**Anastasi, 1997**).

A scenario portrays stepwise changes in the future state of the society/community and environment. These changes are expressed in the form of diagrams or tables or statements. Driving forces are the main

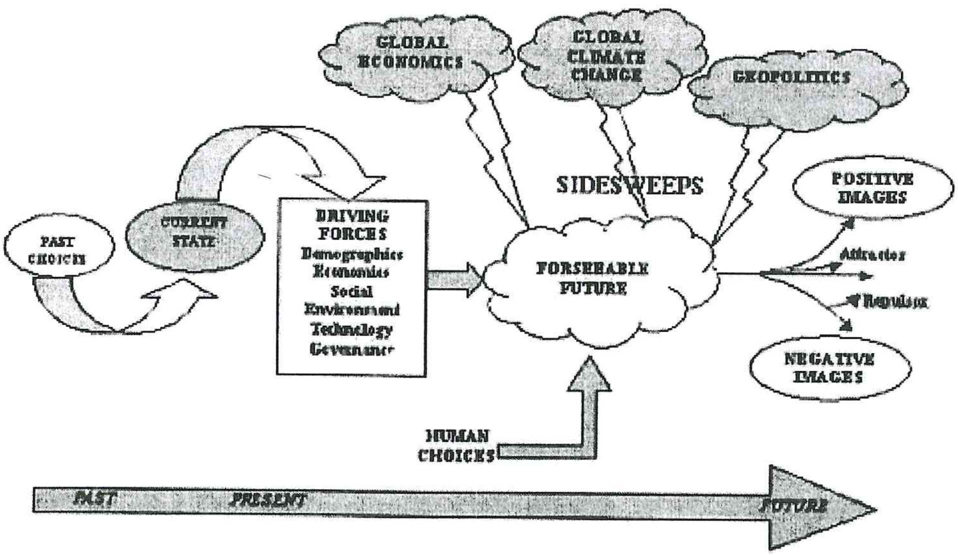


**FIGURE 1:** *Scenario Dynamics for Agriculture, Fisheries and Tourism in the Caribbean Region (Raskin (2002); Baban (2003))*

factor that determines or influences the step-wise changes. The values of driving forces in scenario building are either assumed or are taken from other studies (**Figure 1**). The starting point on the timeline over which the scenario is being developed is called the base year and is normally adopted as the year for which adequate data is available for starting the scenario. The period between the start point and the most distant year the scenario covers is called the 'time horizon' and is highly dependent upon the objectives of the scenario. The storyline is a narrative description of a scenario that highlights its main features and its relationship with the driving forces.

A plausible future is a statement about the condition of a social-ecological system, over a specified time horizon that is consistent with relevant scientific understanding. Plausible futures are usually considered in sets of three or four scenarios. Their purpose is to outline the diversity of possible outcomes, broaden discussion of what the future may bring, and provide a test bed for proposed policies or management actions. The decision-maker may prefer policies or actions, which are robust, that is, lead to acceptable outcomes under a wide range of plausible futures. The notion of plausible futures and their use in decision-making has been well-documented in the literature. For example, see **Cocks (1999), Sala *et al.* (2000)** and **Shell International (2002)**.

### 4.2.1 Selecting Scenario Numbers and Types

Modelling often depends on developing a number of scenarios for a particular type. These are largely dependent upon the goals of the scenario exercise. Scenario types may be singular or a combination of approaches as many scenarios have been developed that obscure the boundaries between scenario types. Hence, scenario developments are guided by the experiences of others but are flexible enough to be adapted to the specific requirement of the issues being addressed. Scenario types can be classified into:

(i) ***Qualitative Scenarios:***
These describe possible futures in the form of words or visual symbols rather than in strict numerical terms. They can be diagrams, phrases, or outlines, but more commonly they are in the form of a narrative text called a storyline. They have the advantages of being able to present the views of several different stakeholders and experts at the same time, and to be understandable to a varied audience. The disadvantage is that it does not satisfy an environmental assessments need for numerical information especially in the form of trend counts.

(ii) ***Quantitative Scenarios:***
These satisfy the environmental assessment's need for numerical data in the form of tables and graphs. Their disadvantage is that the numbers quoted are frequently taken as a sign of knowing more about the future than we actually do. They are based on the results of computer models, which only present one view of the future at a time, thus resulting in a narrow view of the future. Further, scientific modelling has the advantage of recording all of the assumptions used whereas the undocumented and unspoken assumptions in qualitative scenarios are frequently overlooked.

(iii) ***Exploratory Scenarios or Descriptive Scenarios:***
These begin in the present and explore trends into the future. This type of scenario is common in environmental studies because either they require less speculation about the future or researchers are more comfortable with a forward progression of time in the scenario.

(iv) ***Anticipatory Scenarios or Prescriptive scenarios:***
These start with a vision of the future and then work backward in time to visualise how this future could emerge. This type of scenario is also value dependent as it normally results in some desirable

or undesirable outcomes of the future being developed.

(v) ***Baseline Scenarios:***
These are known as reference or benchmark or non-intervention scenarios. They present the future state of the environment in which environmental policies either do not exist or do not have a significant influence. They are used to evaluate the consequences of current policies or lack thereof, to take into account the effects of the uncertainties in driving forces and uncertainties in environmental conditions. In this type of scenario, the impact of all policies directly related to the main theme of the scenario must be excluded.

(vi) ***Policy Scenarios:***
These include the effects of policies on the condition of the environment. They are used because in the real world, policies already exist and their effects would be difficult to remove from an assessment of the condition of the environment. These, therefore, portray the future effects of environmental policies. Some uses are to identify policies that achieve a specific goal(s), examine impacts from specific policies and account for uncertainties in future environmental conditions and societal driving forces.

Choosing the number of scenarios to develop is dependent upon the degree to which the scenarios diverge within the time horizon and the number of subjects covered by the scenario (larger number of subjects lead to a small number of baselines). In general, the greater the time horizon, the larger the number of scenarios are required because of the greater uncertainties in social and environmental systems. The number of scenarios comes down to a question of either an even number or an odd number. With an odd number, the middle scenario is frequently chosen for implementation by policy-makers as it threads the "middle path" and satisfies all stakeholders to some extent. This is undesirable, as each scenario should be evaluated on its own merits and demerits and not solely on its position in the hierarchy of scenarios. Two scenarios have the tendency to be seen as representing the two extremes of outcomes. Four scenarios may provide the two extremes but also present two intermediate scenarios.

### 4.2.2 Scenarios Uses

Scenarios are useful to crystallise a concept of the future, but they can also be a tool for assessing the future implications of current environmental problems and/or emergence of new problems. In general, their uses are summarised as follows (**Alcamo, 2000**):

1. Provision of a picture of alternative states of the environment in the absence of additional environmental policies (baseline scenarios). They may therefore be used to highlight the need for new environmental policies by illustrating the impacts of current practices on the environment.

2. Elevate the level of awareness of the future connections between biodiversity loss, climate change and environmental degradation.

3. Illustrate how alternate policy pathways can achieve an environmental target.

4. Combine qualitative and quantitative information to highlight a future environmental state.

5. Identify those environmental policies that are robust to changes in future conditions.

6. Help stakeholders, experts and policy-makers think about the "big picture" in respect of the environment by incorporating different scales and time horizons.

7. Help raise awareness about emerging environmental problems that may be insignificant now but of increasing significance in the future.

Although other methods are available to achieve these objectives, scenarios are the only approaches that can assimilate the enormous data required, incorporate both qualitative and quantitative data and communicate the results of an assessment to a large and varied audience in a transparent and understandable way.

## 5. Conclusions

There is a real need to understand the impacts of global climate change and associated sea level change with the view to design intervention strategies to ensure the integrity of agriculture, fisheries and tourism (see **Figure 1**). The first hurdle towards achieving this objective is to address the shortage of reliable and compatible data sets as well as minimise information poverty in the scientific knowledge regarding some of the processes involved on the national and regional scale. This hurdle can be managed by adopting Geoinformatics, which contain the necessary tools to collect, handle and analyse the necessary data sets as well as expanding our knowledge of the processes involved at the appropriate scales. Our knowledge and understanding can be further enhanced, under the circumstance, by using plausible scenarios to examine alternative futures based on different intervention strategies. This can be managed within a GIS framework. The outcomes can then be used to manage the impacts of global warming and sea level change in the region as a whole and in specific geographical locations.

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