

A Set of Prototype Caribbean Scenarios for Research on Global Environmental Change and Regional Food Systems

(Based on the Millennium Ecosystem Assessment Scenarios)

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1. Introduction & Background

Global Environmental Change and Food Systems (GECAFS) is a comprehensive programme of interdisciplinary research focused on understanding the links between food security and global environmental change (GEC). The programme's goal is to determine strategies to cope with the impacts of GEC on food systems and to assess the environmental and socioeconomic consequences of adaptation responses aimed at improving food security.

Part of the overall approach in this programme is the development of regional scenarios related to medium- and long-term prospects for food security. Starting from existing global scenarios that address global environment change in general terms (from the Millennium Ecosystem Assessment), regional GECAFS scenarios are developed to initially cover three regions: the Caribbean (CAR), the Indo-Gangetic Plain (IGP) and Southern Africa (SAF). With the lessons learned and understanding gained from the regional scenario exercises, the original global scenarios will then be revised to constitute a set of global scenarios for GEC research on food systems, see Figure 1.

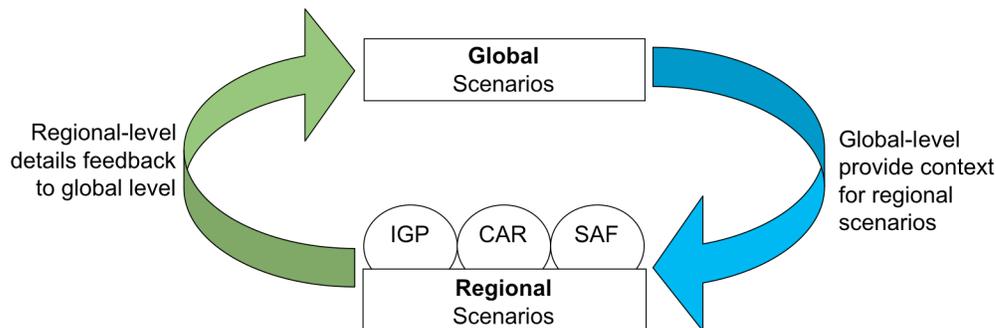


Figure 1 - GECAFS scenarios aim to link GEC and food systems at global and regional scales

This report presents a set of four prototype GECAFS Caribbean scenarios for GEC research on food systems - as developed and discussed at two regional workshops in Jamaica and Trinidad & Tobago in 2005. The scenario exercise summarised here, has two main objectives: (i) The development of a method to construct regional-scale scenarios suitable for use in GEC research on food systems, consistent with global-scale scenarios yet relevant for regional issues, and (ii) the development of a prototype regional scenario set as proof of concept.

These prototype scenarios should not be taken to be forecasts or predictions. Rather they should serve as a starting point for further discussions on plausible future developments in the region. On the one hand, they might provide an entry point to explore in more detail the

complex set of interactions between food systems and GEC, and thus understand better vulnerability to adverse developments. On the other hand, they can provide a general context for a political or societal debate on how best to avoid adverse future developments and how to adapt to changes that seem unavoidable.

One should note, however, that the four scenario storylines presented here do not aim to be complete, but highlight some consequences of different possible future developments related to Caribbean food systems - which may result either from GEC or be affected by the main driving forces behind GEC. With this they provide an entry point for further research and debate; for example to explore further decision support. The value of these scenarios is that they are based in a wide global context (of the Millennium Ecosystem Assessment), and yet have been discussed and agreed upon by a diverse group of regional stakeholders and experts.

The general approach and the objectives of the GECAFS Caribbean prototype scenarios exercise are described in more detail in Chapter 2. The global Millennium Ecosystem Assessment scenarios, which provide the global context and starting point for the Caribbean scenarios discussions, are introduced in Chapter 3. Chapter 4 then presents an overview of the assumed developments in the four Caribbean prototype scenarios with regard to how key socio-economic drivers, GEC and food system elements are expected to develop over the next 30 to 50 years within the four scenarios developed. In Chapter 5 a first indicative reflection on possible response options and adaptation strategies to strengthen food security in the scenarios is outlined. Finally, the four GECAFS Caribbean prototype scenarios are presented as detailed and drafted by a group of regional stakeholders and experts.

2. Approach

The development and analysis of scenarios provides a platform for thinking through plausible future developments and related uncertainties in a structured, yet creative manner. Scenario-based approaches have a long tradition in the realms of military, economics, and management, and have more recently also received much prominence within international environmental assessments (e.g. IPCC, 2000; UNEP, 2002; or MEA, 2006).

While no definitive definition exists, scenarios have been described as “*plausible and often simplified descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces and relationships*” (Millennium Ecosystem Assessment, 2006) or “*plausible descriptions of how the future may unfold based on ‘if-then’ propositions*” (European Environment Agency, 2005). Scenarios present, simply put, stories about the future, which can be told either as qualitative scenarios (words or pictures), quantitative scenarios (numerical estimates) or combinations of both - and are usually best used by making comparisons across a set of different scenarios.

Linking global and regional scenarios

Scenarios have in the recent past been successfully used at the global scale to help reveal and address knowledge gaps about plausible future interactions between GEC and a number of ecosystem goods and services, e.g. food or water availability or climate regulation. Examples of such global scenarios are the comprehensive greenhouse gas emission scenarios by the Intergovernmental Panel on Climate Change, scenarios focussing on ecosystem services developed in the Millennium Ecosystem Assessment, or the global environment scenarios of the United Nations Environment Programme – a range of further examples are listed in EEA (2005) and MEA (2006). However, scenarios specifically designed to investigate the wider issues that underpin food security are lacking.

Attempts to use global scenarios for analysing the food systems that underpin food security have proven to be difficult due to the relatively coarse scale of many global scenario exercises with respect to particular regions or specific driving forces important for such analyses. Therefore, the GECAFS project aims to further develop methods that can provide region-specific scenarios of future socio-economic, ecological and environmental conditions involving food systems - using the information available in existing global scenarios as appropriate, while ensuring relevance for regional food systems as well as comparability between different regions. Indeed, a long-term research question outlined in the GECAFS Science Plan (GECAFS, 2005) is: “*How best can global scenarios be linked to the regional scale so as to capture regional-level factors relevant to food systems?*” Different approaches to setting regional scenarios within the context of existing scenarios exist, and are summarised in Table 2.1.

Table 2.1 Different approaches for linking global scenarios to regional scenarios

'Congruent Scenarios' : Translate global scenarios in a direct and linear way into congruent regional scenarios – without regional deviations (yet flagging possible inconsistencies).
'Consistent Scenarios' : Detail regional scenarios within the context of global scenarios, aim for general consistency across scales – avoid regional deviation where possible.
'Coherent Scenarios' : Develop regional scenarios, based on broad rationale, assumptions and outcomes of global scenarios - allow regional deviation where needed.
'Complementary Scenarios' : Construct regional scenarios largely independently from global scenarios; add information from global scenarios only as may fit.

One should note that the input by regional experts and stakeholders, and with this the regional specificity of the scenarios at regional scale, increases from 'congruent' (which requires regional input for information only) to 'consistent' (which can be done involving a small group of regional experts) to 'coherent' (which requires a group of regional experts and stakeholders to discuss the global scenarios in considerable detail). Strictly speaking, the 'complementary scenarios' approach differs from the above three, as it does not require global scale information to frame regional discussions.

For the GECAFS Caribbean scenario development process, it was agreed at a GECAFS scenario research workshop (hosted by the FAO in Rome in April 2005) to apply a 'coherent scenarios approach', with the scenarios of the Millennium Ecosystem Assessment providing the global context (see chapter 3 for details). Within the global context and boundary conditions set by these scenarios, a set of corresponding coherent regional prototype scenarios were then developed together with a group of regional experts and stakeholders over the course of two Caribbean scenario workshops in September and November 2005.

First Caribbean scenario workshop

The first Caribbean scenario workshop was held in Kingston, Jamaica, 1st to 3rd September 2005; Annex I lists the workshop participants. The objectives of this workshop were:

- To update participants on the latest GECAFS developments;
- To familiarize participants with the concepts, purpose and methodology of scenarios/plausible futures development;
- To discuss and agree on the main uncertainties for the region with respect to food systems and GEC developments;
- To develop focal questions for the Caribbean GECAFS scenarios and begin the scenario development process.

The main outcome of this first Caribbean scenario workshop was the identification of a set of key driving forces that affect Caribbean food system in the context of GEC. These were

distinguished regarding whether their future development of is largely influenced by regional factors (i.e. endogenous) or by global factors (i.e. exogenous). Also, the interactions between driving forces and food systems in the region were conceptualized. This, together with the global scenario storylines (based on the Millennium Ecosystem Assessment scenarios, see chapter 3), was then brought together in a set of ‘zero-order’ descriptions of regional developments within four scenarios (of 1-2 pages each).

In the follow-up to this workshop, four participants took the lead in expanding these ‘zero-order’ regional scenario descriptions to ‘first draft’ regional scenarios. For each scenario, the first draft described the key assumptions with regard to the global context, socio-economic developments in the region, main GEC influences, as well as a first account of how these assumptions may play out with regard to Caribbean food systems. These ‘first draft’ regional scenarios comprised five to ten pages each, and provided the basis for discussions at the second workshop.

Second Caribbean scenario workshop

The Second Caribbean scenario workshop was held in Port of Spain, Trinidad & Tobago, 23rd to 25th November 2005; Annex I lists the workshop participants. The objectives of this workshop were:

- To arrive at an agreed Caribbean prototype scenario set of global environmental scenarios for food systems research, based on the work done in and since the first workshop;
- To discuss food system vulnerability to GEC, as well as adaptation options to reduce vulnerability, based on the Caribbean prototype scenario set;
- To discuss decision support approaches, and options for follow-up or out-reach activities.

In this second workshop, participants refined and detailed the assumptions of how the key endogenous driving forces identified in the first workshop would unfold in each of the four scenarios. Additionally, the assumptions on how GEC may affect the region were refined. Based on these assumptions, the vulnerability of food system in the Caribbean under each of the four scenarios was discussed, applying the conceptual GECAFS framework linking driving forces with food system activities and outcomes (see chapters 4 and 5).

Following these discussions, the ‘first draft’ regional scenarios were re-drafted by the participants, to include in a coherent manner the assumptions and the food system outcomes as discussed at the second workshop. These re-drafted and renamed ‘final draft’ regional scenarios comprise the prototype set of Caribbean scenarios for GEC research on food systems reported below.

3. The Global Scenarios (Millennium Ecosystem Assessment)

In the Millennium Ecosystem Assessment a large number of experts from across the world developed four scenarios to describe the consequences of different development pathways for ecosystem services and human well-being (Millennium Ecosystem Assessment, 2006). The scenarios were designed to explore contrasting transitions of society, as well as contrasting approaches to policies for managing ecosystem services. The four global scenarios are labelled: *Global Orchestration*, *Order from Strength*, *Techno Garden*, and *Adapting Mosaic*.

The logic differentiating these four scenarios can be described along two main axes, see Figure 2. On the one hand, the scenarios differ with regard to whether socio-economic conditions are governed largely by globalisation (i.e. *Global Orchestration*, *Techno Garden*), or whether fragmentation and regional blocs dominate (i.e. *Order from Strength*, *Adapting Mosaic*). On the other hand, the general approaches of how to deal with current and future environmental challenges differ: In *Global Orchestration* and *Order from Strength* the general philosophy is a largely reactive one, whereas both *Techno Garden* and *Adapting Mosaic* are based on the assumption of more proactive approaches.

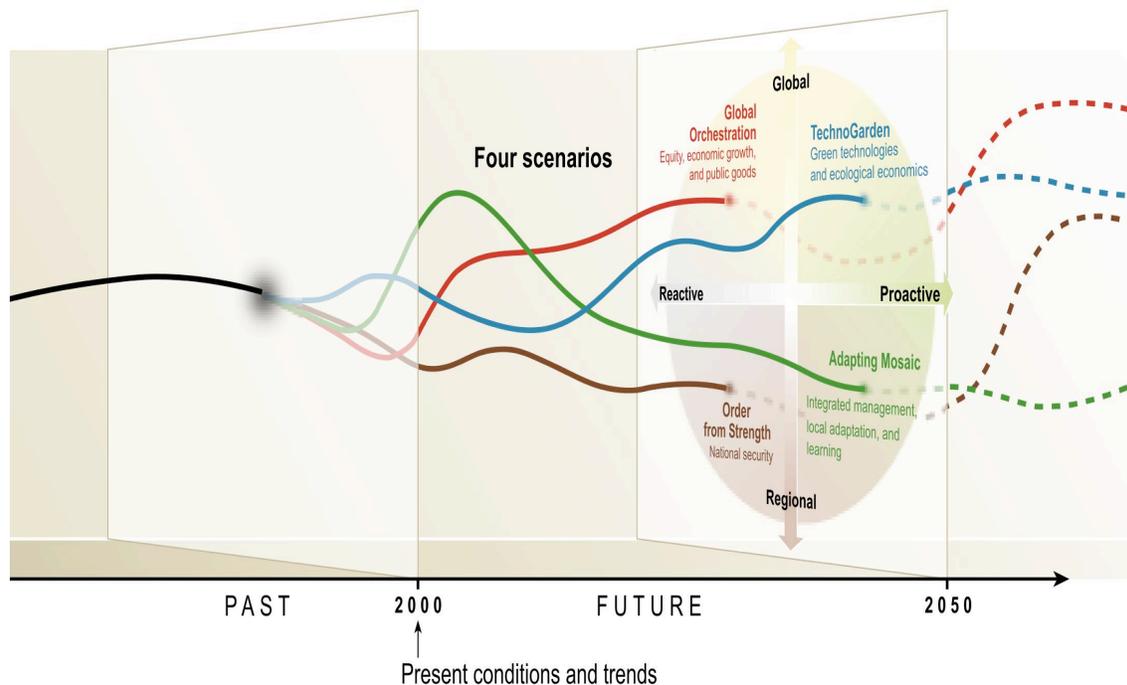


Figure 2 - Scenario logic of the Millennium Ecosystem Assessment scenarios
 Source: *Millennium Ecosystem Assessment (2006)*

Global Scenario 1: Global Orchestration¹

The *Global Orchestration* scenario depicts a globally-connected society in which policy reforms that focus on global trade and economic liberalization are used to reshape economies and governance, emphasizing the creation of markets that allow equitable participation and provide equitable access to goods and services. These policies, in combination with large investments in global public health and the improvement of education worldwide, generally succeed in promoting economic expansion and lift many people out of poverty into an expanding global middle class. Supra-national institutions in this globalised scenario are well placed to deal with global environmental problems such as climate change and fisheries. However, the reactive approach to ecosystem management favoured in this scenario makes people vulnerable to surprises arising from delayed action. While the focus is on improving human well-being of all people, environmental problems that threaten human well-being are only considered after they become apparent.

Growing economies, expansion of education, and growth of the middle class leads to demand for cleaner cities, less pollution, and a more beautiful environment. Rising income levels bring about changes in global consumption patterns, boosting demand for ecosystem services, including agricultural products such as meat, fish, and vegetables. Growing demand for these services leads to declines in other services, as forests are converted into cropped area and pasture, and the services formerly provided by forests decline. The problems related to increasing food production, such as loss of wildlands, are remote to most people because they live in urban areas. These problems therefore receive only limited attention. Global economic expansion expropriates or degrades many of the ecosystem services poor people once depended upon for their survival. While economic growth more than compensates for these losses in some regions by increasing our ability to find substitutes for particular ecosystem services, in many other places, it does not. An increasing number of people are impacted by the loss of basic ecosystem services essential for human life. While risks seem manageable in some places, in other places there are sudden, unexpected losses as ecosystems cross thresholds and degrade irreversibly. Loss of potable water supplies, crop failures, floods, species invasions, and outbreaks of environmental pathogens increase in frequency. The expansion of abrupt, unpredictable changes in ecosystems, many with harmful effects on increasingly large numbers of people, is the key challenge facing managers of ecosystem services.

¹ Please note that the short descriptions of the scenarios presented in section 3.1 stem from a GECAFS background paper by Monika Zurek for the Second Scenarios Research Workshop held at the FAO, Rome on 21 and 22 April, 2005. This information was made available to all participants of the two GECAFS Caribbean Scenarios Workshops, and provided a starting point for the regional scenario development (i.e. the down-scaling approach to arrive at ‘Coherent Scenarios’ – see section 2).

Global Scenario 2: Order from Strength

The *Order from Strength* scenario represents a regionalized and fragmented world, concerned with security and protection, emphasizing primarily regional markets, and paying little attention to common goods. Nations see looking after their own interests as the best defence against economic insecurity, and the movement of goods, people, and information is strongly regulated and policed. The role of government expands as oil companies, water systems, and other strategic businesses are either nationalized or subjected to more state oversight. Trade is restricted, large amounts of money are invested in security systems, and technological change slows due to restrictions on the flow of goods and information. Regionalization exacerbates global inequality. Agreements on global climate change, international fisheries, and the trade in endangered species are only weakly and haphazardly implemented, resulting in degradation of the global commons. Local problems often go unresolved, but major problems are sometimes handled by rapid disaster relief to at least temporarily resolve the immediate crisis. Many powerful countries cope with local problems by shifting burdens to other, less powerful countries, increasing the gap between rich and poor. In particular, natural resource-intensive industries are moved from wealthier nations to poorer and less powerful ones. Inequality increases considerably within countries as well.

Ecosystem services become more vulnerable, fragile, and variable in *Order from Strength*. For example, parks and reserves exist within fixed boundaries, but climate changes around them, leading to the unintended extirpation of many species. Conditions for crops are often suboptimal, and the ability of societies to import alternative foods is diminished by trade barriers. As a result, there are frequent shortages of food and water, particularly in poor regions. Low levels of trade tend to restrict the number of invasions by exotic species; however, ecosystems are less resilient and invaders are therefore more often successful when they arrive.

Global Scenario 3: Techno Garden

The *Techno Garden* scenario depicts a globally connected world relying strongly on technology and highly managed, often engineered ecosystems, to deliver ecosystem services. Overall efficiency of ecosystem service provision improves, but is shadowed by the risks inherent in large-scale human-made solutions and rigid control of ecosystems. Technology and market-oriented institutional reform are used to achieve solutions to environmental problems. These solutions are designed to benefit both the economy and the environment. These changes co-develop with the expansion of property rights to ecosystem services, requiring people to pay for pollution they create, and paying people for providing key ecosystem services through actions such as preservation of key watersheds. Interest in maintaining, and even increasing, the economic value of these property rights, combined with an interest in learning and information, leads to an increase in the use of ecological

engineering approaches for managing ecosystem services. Investment in green technology is accompanied by a significant focus on economic development and education, improving people's lives and helping them understand how ecosystems make their livelihoods possible. A variety of problems in global agriculture are addressed by focusing on the multifunctional aspects of agriculture and a global reduction of agricultural subsidies and trade barriers. Recognition of the role of agricultural diversification encourages farms to produce a variety of ecological services, rather than simply maximizing food production. The combination of these movements stimulates the growth of new markets for ecosystem services, such as trade in carbon storage, and the development of technology for increasingly sophisticated ecosystem management. Gradually, environmental entrepreneurship expands as new property rights and technologies co-evolve to stimulate the growth of companies and cooperatives providing reliable ecosystem services to cities, towns, and individual property owners.

Innovative capacity expands quickly in developing nations. The reliable provision of ecosystem services, as a component of economic growth, together with enhanced uptake of technology due to rising income levels, lifts many of the world's poor into a global middle class. While the provision of basic ecosystem services improves the well-being of the World's poor, the reliability of the services, especially in urban areas, is increasingly critical and increasingly difficult to ensure. Not every problem has succumbed to technological innovation. Reliance on technological solutions sometimes creates new problems and vulnerabilities. In some cases, we seem to be barely ahead of the next threat to ecosystem services. In such cases new problems often seem to emerge from the last solution, and the costs of managing the environment are continually rising. Environmental breakdowns that impact large numbers of people become more common. Sometimes new problems seem to emerge faster than solutions. The challenge for the future is to learn how to organize social-ecological systems so that ecosystem services are maintained without taxing society's ability to implement solutions to novel, emergent problems.

Global Scenario 4: Adapting Mosaic

In the *Adapting Mosaic* scenario, hundreds of regional ecosystems are the focus of political and economic activity. This scenario sees the rise of local ecosystem management strategies, and the strengthening of local institutions. Investments in human and social capital are geared towards improving knowledge about ecosystem functioning and management, which results in a better understanding of resilience, fragility, and local flexibility of ecosystems. There is optimism that we can learn, but humility about preparing for surprises and about our ability to know everything about managing ecosystems. There is also great variation among nations and regions in styles of governance, including management of ecosystem services. Many regions explore actively adaptive management, investigating alternatives through experimentation. Others employ bureaucratically rigid methods to optimize ecosystem performance. Great diversity exists in the outcome of these approaches: some areas thrive, while others develop

severe inequality or experience ecological degradation. Initially, trade barriers for goods and products are increased, but barriers for information nearly disappear (for those who are motivated to use them) due to improving communication technologies and rapidly decreasing costs of access to information.

Eventually, the focus on local governance leads to some failures in managing the global commons. Problems like climate change, marine fisheries, and pollution grow worse and global environmental problems intensify. Communities slowly realize that they cannot manage their local areas because global and regional problems are infringing, and they begin to develop networks among communities, regions, and even nations, to better manage the global commons. Solutions that were effective locally are adopted among networks. These networks of regional successes are especially common in situations where there are mutually beneficial opportunities for coordination, such as along river valleys. Sharing good solutions and discarding poor ones eventually improves approaches to a variety of social and environmental problems, ranging from urban poverty to agricultural water pollution. As more knowledge is collected from successes and failures, provision of many services improves.

4. Four Caribbean Prototype Scenarios

Based on the global scenarios and their underlying assumptions introduced above, a set of four Caribbean Prototype Scenarios focussing on food system development was detailed by a group of regional stakeholders and expert during the course of two workshops (see chapter 2). The four Caribbean scenarios are largely coherent with their respective global “parents” (see chapter 3), but may differ in aspects particularly relevant for Caribbean food systems:

Scenario 1: Global Caribbean (coherent with Global Orchestration);

Scenario 2: Caribbean Order From Strength (coherent with Order From Strength);

Scenario 3: Caribbean Techno Garden (coherent with Techno Garden);

Scenario 4: Caribbean Adapting Mosaic (coherent with Adapting Mosaic).

Figure 3 highlights that food systems encompass two main aspects: *Activities*, which relate to the production, processing and packaging, distribution and retail, and consumption of food (*cf.* p 20); and *outcomes of these activities*, which contribute to the three components of food security: availability of food, access to food, and utilisation of food. (The outcomes also contribute to environmental security and a host of other societal interests.) Interactions between and within biogeophysical and human environments influence both the activities and the outcomes.

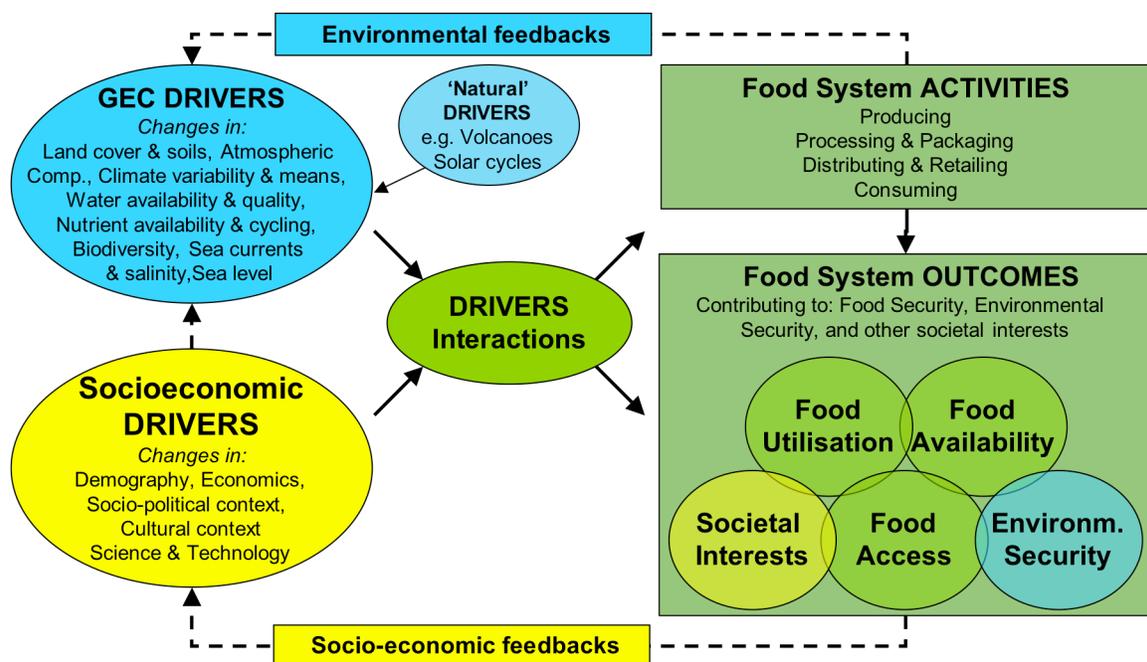


Figure 3 – Conceptual framework linking socio-economic drivers and GEC with food system activities and outcomes

This chapter gives an overview how key socio-economic drivers, GEC and food system activities and outcomes are assumed to unfold over the next 30 to 50 years in the four Caribbean prototype scenarios - as discussed during the Caribbean scenario workshops (see Tables 4.1 to 4.9). Based on these assumptions, more detailed storylines for the four scenarios, were developed and drafted by the group of regional stakeholders and experts during the workshops (see the scenario storylines presented below).

Key socio-economic drivers

Important demographic and economic developments that govern – directly or indirectly – the possible future developments in the Caribbean food system include:

- Population growth, migration, age structure
- Rural to urban drift
- Increased life expectancy
- Preferential trade changes
- Increase in tourism
- Remittances of agriculture in economy
- Changes in returns to land use
- Increased competition for land
- Female labour force participation
- Change in development paradigm
- Structural adjustments
- WTO (World Trade Organization)
- Change in relative price of food
- Niche-market production
- Diversification of export crops
- Non-tariff barriers for trade

Table 4.1 gives an indicative overview of how some of these driving forces compare under the four Caribbean prototype scenarios.

Table 4.1 Driving forces related to demographic and economic development

	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Population growth		Continues, lower rate		
Fertility rates	Low (due to high income)		Lower fertility & mortality	
Life expectancy	Increases		Increases	
Age structure	Stable (also in agriculture)	Stable / aging	Aging	
Migration	Decreasing	More selective, "brain-drain" within and also out of region	Selective, within region follows resource availability	Relatively low
Urban - rural	Low in small countries, due more rural development		Less people in agriculture	Less urban, less migration from rural; more small urban centres, rural settlement.
Economic Growth	Relatively high	Relatively low	Relatively high	Low, but steady (maybe initial drop), growth not in traditional economics
Transport Cost / Energy Systems		High		High

Tourism	Increased importance			
Equity	Increase in equity	More inequalities within region and countries, less 'middle class'	Greater economic divide, less access to food	More equitable wealth distribution, equity rather than growth
Financial flows	Intraregional increase in financial flows		Tech is concentrated in few companies -wealth follows	Less injection of money from outside Caribbean
New Green markets, Role of environmental economics		Green markets and environment economics play minor role only	New green markets emerge	New green markets emerge

Additionally, a number of developments related to international and regional socio-political as well as cultural developments, were identified as being relevant for the future of Caribbean food systems:

- Political independence
- Better agriculture and food policies
- Land tenure system changes
- Change in agric institutions
- Changes in regional policy cooperation
- Decline in role of agriculture in policy
- Dominant type of governance
- Improved food legislation/ regulation
- Gaps in legislation and enforcement
- Agriculture less important in education
- Life style more sedentary
- Impact of mass media
- Dietary changes
- More women in labour market
- Proliferation of fast food
- Changes in family structure
- Changing work arrangements
- Greater awareness health and food safety

Table 4.2 compares in an indicative manner how these driving forces are expected to play out under the four Caribbean prototype scenarios.

Table 4.2 Driving forces related to international, socio-political and cultural developments

	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Regional Cooperation	Increased cooperation in economic issues. Increased cooperation in some environmental issues only (reactive). Often market driven, policy follows Haiti issue resolved, fully integrated.	At first more regional coop (until 2015). More diverse global power situation: Caribbean countries as satellites, in struggle for international power spheres. Fragmentized world - leads to fragmented Caribbean. 'Neo-colonial mentality'	More regional cooperation. Countries specialize in key products and development of niche markets. National specialization, 'for the greater good'? CSME works!	CSM comes into play, effective by 2010. Allows for high labour movement, follows economic options. Disparities between countries drive mobility. Some regional cooperation, but sustainable developm addressed on national level only.
US - Cuba Situation	Embargo lifted	Remains		Embargo lifted
Emergence of new markets (India, China)		New markets emerge only for preferentials	New markets emerge	

Kind of Governance, Political Agenda		Driven by Multinational Organisation		Empowerment of local communities
Security situation, Crime	Enforced, Improves significantly			
Investments into human capital	Increase	Less domestic capacity building	High training levels, less 'unskilled' labour force	Increases 'big time'
Who invests in human capital?	Both public and private sector drive	Revenue driven, companies / private sector drive	Higher demand for ICT, more knowledge transfer	Local capacity building, intrinsic investment regime

In addition to the above socio-economic drivers, which impact the evolution of Caribbean food systems both directly and indirectly, a number of assumptions directly related to the type of agriculture in the region were discussed and detailed for the four Caribbean prototype scenarios. Table 4.3 presents some of these additional drivers and how they are assumed to play out in the four scenarios.

Table 4.3 Driving forces directly related to agricultural developments

	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Investments into agri knowledge, science & technology (AKST)	Big increase	Decrease overall	Investments increase	Major investments
Who invests in AKST?	Private sector drives primarily, but some public sector	Investments by profit, companies drive	Positive feedback result in more investments	
Investment to what end?		Specialised tech. & 'low-tech' invests		Particularly improving sustainability, env.
Dominant agricultural food policy	Market lead policy formulation, Trade friendly	Focus on 'food security', at the expense of other environment security	Policy governed by technological prospects	National and regional food security is emphasized
Subsidies	Removed, reacts to global trade liberalization	Protective	Focus on agri tech	Promote AKST, especially locally
Import / Export	High trade	First less import but with less regional coop: High imports		
Regulations / Focus	Regulation of quality assurance for exports (reactive), fish quotas			Niche products for exports (functional food, organic, specialties)
(Relative) Price of food	General decrease	Increase in price in local staple food, more import	Not likely to reduce significantly	Food price go up in the short-term, down in the longer run

Global environmental change in the Caribbean

Food systems are not only subject to socio-economic developments, but also to environmental conditions. Environmental conditions are subject to change either due to natural development (e.g. volcanic eruptions, solar activities) or due to global and regional environmental changes that result from anthropogenic activities. Some of the key aspects of GEC (identified at the first Caribbean scenario workshop) that are expected to shape Caribbean food systems are:

- Increase in frequency of extreme weather and changing weather patterns
- Deterioration of coral reefs and watersheds
- Over-exploitation of natural resources
- Pollution
- Sea level

GEC (and especially changes in mean temperature, changes in rainfall, changes in weather patterns and extreme events, and sea level rise) is expected to have a marked impact on the Caribbean. While the changes are assumed not to vary much between different scenarios over the next fifty years (see Table 4.4) it is important to note that the scenarios do differ markedly in how society reacts.

Table 4.4 Assumed developments related to GEC in the Caribbean

GEC DRIVERS (up to 2050)	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Climate Change: Temperature Mean	Global: Increase by 1.5 to 2.0 Degree Celsius Caribbean: Increase of 1.0 to 1.5 Degree Celsius			
Climate Change: Rainfall Mean / Var.	Global: Increase globally, but diverse spatial patterns Caribbean: Huge uncertainty, (potential: decrease in average, but increase in intensity)			
Extreme Weather: Tropical Depression, Storms, Hurricanes	Global: Increase with increase sea temperature (maybe) Caribbean: Uncertainty, (potential: increase in frequency) - no question that they continue,			
Sea level	Global: Increase by 25 to 30 cm Caribbean: Increase by 25 to 30 cm -> more storm surges, salt-water intrusion?			

Other aspects of GEC are expected to have differing developments and impacts in the four Caribbean prototype scenarios. Some examples discussed at the Caribbean scenario workshops are highlighted in Table 4.5.

Table 4.5 Assumed consequences related to GEC in the Caribbean

GEC DRIVERS (up to 2050)	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Flooding	Continues to be frequent initially. Then, with economic growth, better preparedness at national level. Individual risk remains. Some land zoning introduced	No flood planning	More engineering solutions and techno-fixes. Also better forecasting technology reduces flooding impacts. Choice to invest in proactive management	More management, situation not worse, maybe improved. More local incentive for flood planning, many more small-scale retention areas. More 'use' of floodwater
Land Use Patterns	High land use intensity plus abandoned marginal areas. Agriculture not for staple food, but niche markets. New urban areas on 'good' agricultural areas. Some 'land zoning'.	At first like Global Caribbean, then shift, leads to mix: - use of marginal land to provide basic food needs - use of good land for cash-crop areas, follow profits / export	Specialized agriculture for niche markets. Land use highly intensive, very productive agriculture. Proactive land management	More 'integrated' agriculture, more use of current marginal. Also more small-scale, yet intensive, production of niche products. Current marginal lands are brought into production
Water availability & use	Increasing water demand, competition between sectors increases, water pricing	Limiting factor for agriculture. Strong competition for water between water use sectors. More water shortages	Desalination and water treatment improves, also for use in agriculture. Less water needed in agriculture	Better water management and new green technologies
Fish stocks & Marine Resources	More collaboration in region, leads to tighter management. Fish quota introduced	'Fish as you can' policy, no regulation, more fierce competition, negative feedbacks. High risk: over-fishing and collapse. Some selective & aggressive management to secure markets	Enhanced stock rehabilitation tech, e.g. aquaculture. More cooperative management	Focus on local issues, not common goods. Initial risk of fish stock depletion, could lead to coop for recovery: 'can go either way'
Pollution (Air, Soil & Water)	Enough pollution management to (just) sustain the system	High pollution, largely unmanaged	'Can go either way', additional pollution potential due to new technology, but better societal pollution management, often supported by technology. Polluter pays principle! However - some problems technology cannot fix	Relatively low pollution, More local solutions, pollution prevention

Food Systems in the Caribbean

The analyses reported here are based on the concept that food systems include both a chain of connected activities and the outcomes to which these activities contribute (Ericksen, 2006). Future food system activities and outcomes depend on both socio-economic driving forces and GEC – see Figure 3.

Food system activities are grouped into four categories:

- **Producing food** (such as land preparation, input acquisition, planting, pest/weed control, harvesting, fishing, sale of primary product – *these activities are determined by, for example, prices, resource tenure, technology, climate, soil types, market access, etc.*)
- **Processing and packaging food** (such as acquisition of primary product, transformation into secondary product, packaging – *these activities are determined by, for example, prices, government regulations, infrastructure, technology, consumer demand, etc.*)
- **Distributing and retailing food** (such as transport, sale in market, advertising, delivery to consumer, pricing – *these activities are determined by, for example, government policies, trade patterns and regulations, population distribution, etc.*)
- **Consuming food** (such as purchase, preparation, eating, digestion – *these activities are determined by, for example, price, preferences, culture/ traditions, health status, source of food, etc.*)

Table 4.6 provides an indication of how food system activities are assumed to develop in Caribbean in the four scenarios.

Table 4.6 Resulting developments related to food system activities

	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Producing Food	(+) Rice, (-) banana, (+) sugar in few countries, (o) coffee stable for niche markets, (+) fruits for niche, (+) fish	(+) Increase in some areas (resource endowment); (-) Decrease in some areas (less efficient); (-) Climate variability; (-) Fisheries collapse	(+) Environmentally sound, but technology dependant, (+) National specialization, (+) Niche exports for external market, (-) import	(o) Small scale agriculture, but increase in productivity to combat rising food prices; (+) Less extra regional trade, more local-regional
Processing and Packaging Food	(+) More regional packaging and processing (demand driven) in CSME context; (+) fish	(+) likely increase in Caribb, due to competitive primary production sector; (+) more demand of convenience food	(+) Meet international quality and safety standards; (+) minimize waste or pollution	(+) Increased variety of secondary food product, processing of local food is key to sustaining local food production
Distributing and Retailing Food	(+) Trade, (+) import dependence, (+) income; (++) distribution through supermarkets; (+) no govt role in distribution or price	(-) Transport inadequate; (-) bioterrorism; (-) impact of GEC slows or destroys distribution; (-) some trade barriers	(+) Environmentally sound, but higher food miles, more regional sources; (o) Retail emphasis on env / nutritional benefits	(+) Increase in local distribution; (-) decrease in variety of food stuffs at local markets - less trade for certain commodities
Consuming Food	(o) Over time global patterns dominate, until health concerns kick in, a lot of advertising; (o) Health concerns may strengthen local markets	(-) Lower food quality (fats, salts, sugar - cheap sources of energy); (o) Quantity not quality; (-) Unhealthy diets, increase in NCDs	(+) Value on excess reduction, less quant, more quality; (+) balanced diets, regional products	(-) Less variety; (+/-) more use of local food; (-) higher prices

Legend: ++ or +: very positive or positive developments expected for the Caribbean; -- or -: very negative or negative developments expected for the Caribbean; o : no changes expected / current situation continues in the Caribbean

Tables 4.7, 4.8, 4.9 and Figure 4 then summarise how the assumed changes in the driving forces, and GEC, combined with the resulting future development with regard to food system activities, are expected to affect food system outcomes related to food security, i.e. food availability, food access, and food utilisation.

Food availability refers to the amount, type and quality of food a unit (household, community, region or nation) has at its disposal to consume. It may be produced locally, imported, or reflect a change in stocks. Availability may vary seasonally or by geographic location, as well as a host of other biogeophysical and socioeconomic factors. Three types of determinants contribute to food availability:

- **Production**, i.e. how much and which types of food consumed are available through local production – *determinants include climatic conditions, seed varieties, land holding sizes, tenancy arrangements, irrigation availability, cropping cycle, labour availability, human capital, energy sources, input and output prices, available and adopted technologies, etc.*
- **Distribution**, i.e. how food for consumption is made available (physically moved), in what form, when and to whom – *determinants include transportation and infrastructure, public safety nets, storage facilities, who has control over production, post-harvest processing, governance, security, enforcement of trade barriers and borders, etc.*
- **Exchange**, i.e. how much food is available through exchange mechanisms such as barter, trade, purchase, or loans – *determinants include income levels and purchasing power, informal social arrangements for barter, local customs for giving and receiving gifts, migration, gender and age structure, precipitation variability, markets, trade policy, etc.*

Table 4.7 Resulting outcomes related to food security (in the context of food availability)

Food Availability	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Production	+ / -	o / -	+ / ?	+
<i>Amount of food from regional production</i>	(-) Majority of food will be imported (except fresh fish, rice, bananas); (+) meat production; (-) fish stocks may deplete	(+) Increase in some areas (resource endowment); (-) Decrease in some areas (less efficient) (-) Fisheries collapse?	(+) Increase in yields (o) Prod segregated by nation and commodity (+) increase in regional production total	(+) Slow increase (+) Esp. Niche products (+) Variety of products
Distribution	++	-	++	+
	(++) Increased trade (o) Will take time	(-) Increase transport cost (-) bioterrorism (-) impact of GEC slows or destroys distribution (-) some trade barriers	(+) Improve infrastructure at all levels	(+/-) Initial inequity (+) Local market places (+) Decentralization (+/-) depend on transport; (+) proximity of prod/con
Exchange	++ & ++	+ & +	- & ++	-- & +
<i>Amount of food from extra-regional & intra-regional trade</i>	(+) open markets (+) quality assurance	(+) heavy food import (except Bel, Guy, Sur) (-) but sometimes demand cannot be met, due to high costs - food shortages result	(+) Interdependence at regional level. Less reliance on external food stuffs. And opportunity to export processed food.	(?) Depends on level of Caribbean cooperation (++) Intra-regional trade may be a must

Access to food refers to ability of households, communities or regions to obtain access to the type, quality, and quantity of food they require, over time. Three types of determinants contribute to accessibility of food:

- **Affordability**, i.e. the purchasing power of households or communities relative to the price of food – *determinants include pricing policies and mechanisms, seasonal and geographical variations in price, local prices relative to external prices, the form in which households are paid, income and wealth, etc.*
- **Allocation**, i.e. the mechanisms governing when, where and how food can be accessed by people – *markets are a key determinant of food allocation; government policies often are designed to correct market failures by allocating food to remote areas or at lower prices.*
- **Preference**, i.e. social or cultural norms and values that influence the demand for certain types of food – *determinants may be religion, season, advertising, preparation requirements, human capital, tastes, customs, politics, etc.*

Table 4.8 Resulting outcomes related to food security (in the context of food access)

Food Access	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Affordability	+	--	+	-
	(+) Food prices decrease (+) income increase (-) fish price goes up, due to limited availability	(--) Lower economic growth, less income (--) increase in food prices, also of staple food (-) GEC shocks	(+) Incomes increase (-) Different national situations as some countries are richer, dampened effect over time	(-) Moderate increase in wealth outweighs by food price increases What is the policy fix?
Allocation	+	-	+	o
	(+) Improvements	(-) Often mismatch where food is and is needed (-) Distribution (-) GEC hinders alloc. (-) 'rich served first'	(+) Present trends towards a balanced allocation system are expected to continue (+) Market driven: efficient	(o) Current marketing systems work well (both the formal and informal)
Preference	o	-	+	+ / -
	(o) Driven by global media and pricing, influence of media increases over time	(-) Often cheaper food, no focus on nutritional value; (-) due to low education and low affordability; (+) with money you can get what you want	(+) Wealth and choice allow preferences; (+) tourist sector enables authentic local foods	(+/-) Mixed outcomes: some preferring local foods over time; others continuing to prefer foreign foods. Based on price / convenience

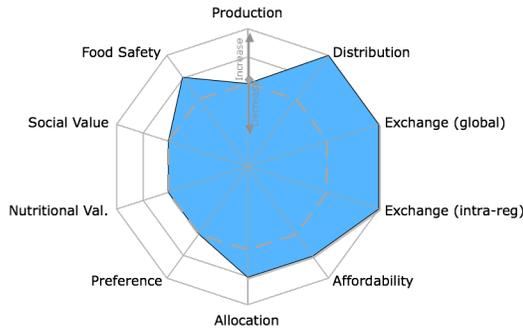
Food utilisation refers to household or community capacity (including strategies) to consume food. This includes how it is prepared (for consumption) and utilised by the body. The three elements of food utilisation are:

- **Nutritional value**, i.e. how much of the daily requirements of calories, vitamins, protein, and micronutrients are provided by the food people consume – *determinants include diversity of food consumed, type of primary protein (meat or legumes), disease incidence (which affects food absorption), human capital, etc.*
- **Social value**, i.e. all of the social and cultural aspects of consumption, for example, eating meals together may be an important part of kinship, or it may be very important to always have food for guests, or special foods may be an integral part of important holidays – *an understanding the determinants of social value requires insight into the community and household relations, as well as cultural customs.*
- **Food safety**, i.e. whether households can process and prepare their food without risk of contamination or decrease in the nutritional content of food – *determinants include facilities for cooking, access and availability of safe drinking water, hygiene practices, processing and packaging in factories prior to coming to households, etc.*

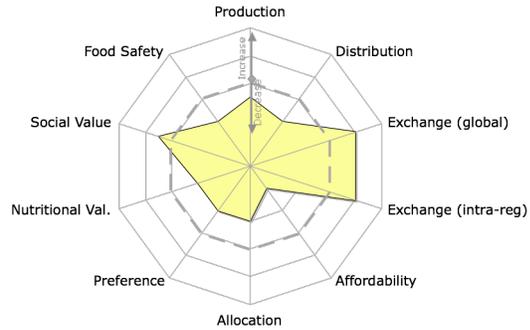
Table 4.9 Resulting outcomes related to food security (in the context of food utilisation)

Food Utilisation	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Nutritional Value	o	-	++	++
	(+) Higher awareness as global trend (-) convenience food counteract	(-) Affordability and preference do not favour balance diets (-) likely more diseases	(++) Gets better, also due to technological advance	(++) Increases in education about food (+) better quality, local control (+) more fresh food
Social Value	o	o / +	o/+	++
	(-) Influence decreases, also because of lifestyle changes	(+) Low info on nutritious value increases role of societal and religious settings (o) Likely: as currently	(+) Possible increase as reaction to technological environ (backlash), blending between technology and cultural values	(++) For local food (?) imported food less available
Food Safety	+	-	+	+ / -
	(+) Quality often improved because of competition (-) greater vulnerability to exotic diseases	(--) Increase in diseases due to diets (+) very basic dietary requirements usually met, but at low value	(+) Improved knowledge (+) better use of technology to ensure quality (+) active enforcement	(- to +) Initially no systems, regulation or enforcement in place, then social dimension kicks in

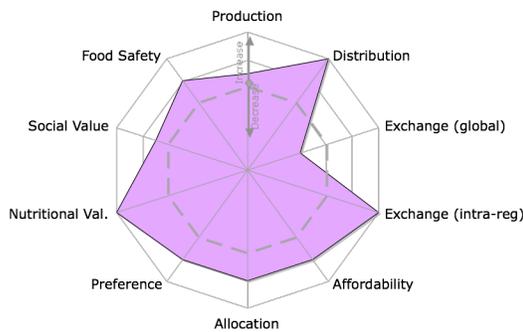
Global Caribbean



Caribbean Order From Strength



Caribbean Techno Garden



Caribbean Adapting Mosaic

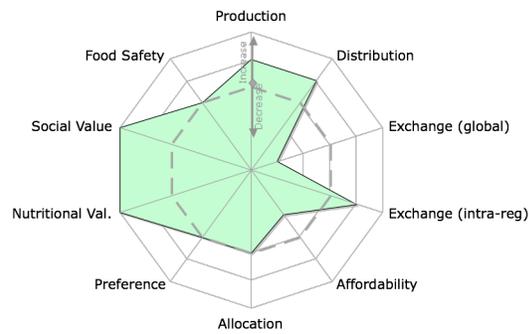


Figure 4 Indicative food security diagrammes for the four scenarios (derived from the food system outcomes presented in Tables 4.7 to 4.9).

Figure 4 provides an overview of food system outcomes in indicative food security diagrammes. These have been derived from the outcomes presented in Tables 4.7 to 4.9. Here a rating of (++) in the tables translates to high increase (i.e. outermost ring in the chart) and a rating of (+) to some increase (i.e. the second outermost ring in the chart). Conversely, a rating of (--) implies high decrease (i.e. the innermost ring of the chart) and a rating of (-) reads as some decrease (i.e. the second innermost ring of the chart). Finally, a rating of (o) translates to no changes versus the current situation and a rating of (+/-) shows mixed trends with some increase in some aspects alongside decreases in others (i.e. both are depicted by a value on the 'dashed line' centre ring).

Finally, a first (indicative only) comparison of how GEC may play out and place additional concern onto Caribbean food systems is depicted in Figure 5, based on the assumptions presented in Table 4.5 and 4.6. This serves to give a first impression of which aspects of GEC are assumed to be of high concern in all or most scenarios (e.g. climate change or fish stock depletion). Also this gives a rough indication where the eventual impact of unfolding environmental concerns depends much on the future socio-economic scenario and the possible response options or adaptation strategies to reduce food systems vulnerability.

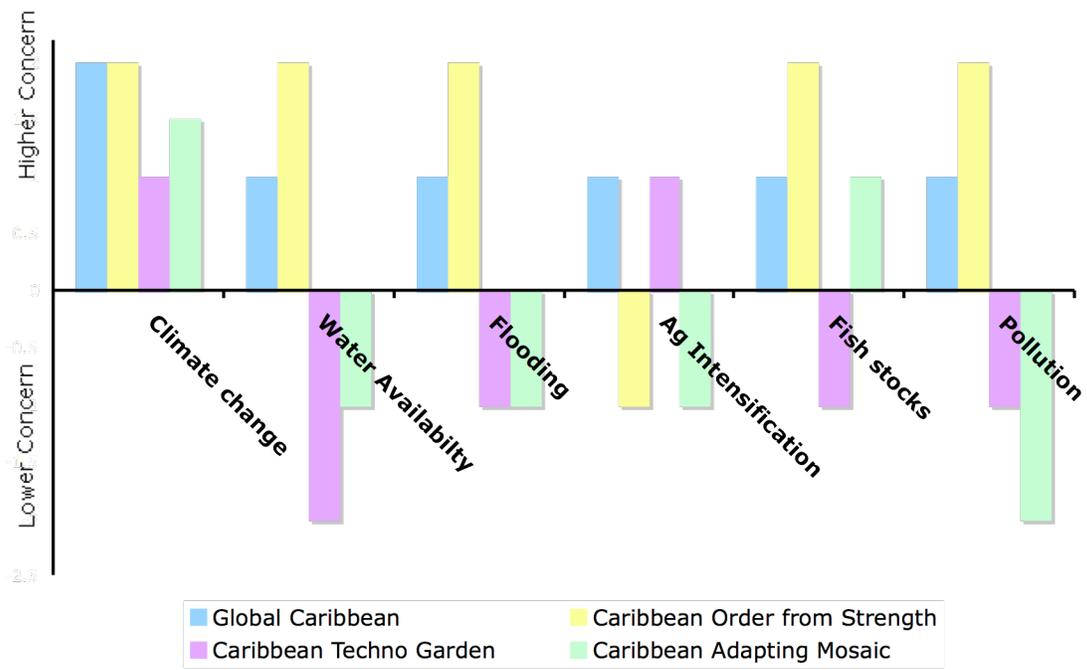


Figure 5 Indicative comparison of GEC concerns in the four scenarios (derived from the assumptions presented in Tables 4.5 to 4.6).

5. Response Options and Adaptation Strategies

The four Caribbean prototype scenarios developed and presented here provide a basis for discussing the viability of different response options and adaptation strategies to strengthen regional food systems. At the two regional workshops a range of options were identified (as listed below). As the scenarios themselves depict very differing views of plausible future developments, possible response options may play out very differently or may be even viable only in some of the scenarios. Experts and stakeholders mapped out a rough indication of which response options and strategies are conceivable in the four scenarios:

General strategies to improve adaptive capacity and decrease food system vulnerability:

	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Change in cropping systems (i.e. when we grow what, what we grow, where we grow)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Development of comprehensive disaster management system	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Implement integrated coastal zone management			<input checked="" type="checkbox"/> regional	<input checked="" type="checkbox"/> local only
Agricultural subsidies		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> pro environ	<input checked="" type="checkbox"/> local
Massive sectoral change in activities (e.g. abandon agriculture completely, or stop fishing, or increase tourism)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> (?)
Proactive safety nets: e.g. crop insurance, fishing gear insurance	<input checked="" type="checkbox"/> per market		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Reactive safety nets: e.g. compensation for flooded farmers; food aid (do nothing and let it increase)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> but limited		
Apply more mechanization and/or appropriate agricultural technology to improve productivity	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	

Responding to temperature changes, sea level rise and water availability stress:

	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Produce more food in greenhouses (very costly)			<input checked="" type="checkbox"/>	
Build sea walls (Belize, Guyana)	<input checked="" type="checkbox"/> after impact	<input checked="" type="checkbox"/> after impact	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Move agriculture out of the coastal areas xxx	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Implement better water management			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Introduce new laws for building w/ water harvesting			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Apply differential pricing policies for more efficient use (e.g. domestic vs industrial)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> (?)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Responding to increase in fish stock vulnerability:

	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
More aquaculture & mariculture	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Coordinated management strategies (incl fish quotas)			<input checked="" type="checkbox"/>	
Additional international conventions and improve enforcement	<input checked="" type="checkbox"/> after shock		<input checked="" type="checkbox"/>	

Responding to pollution:

	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
More advocacy to build public awareness			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Improving waste management, reducing land based sources of pollution	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
More advocacy internationally to keep ships with hazardous waste out/ regulate what they do	<input checked="" type="checkbox"/>			

General strategies to improve preparedness through research and knowledge transfer:

	Global Caribbean	Caribbean Order from Strength	Caribbean Techno Garden	Caribbean Adapting Mosaic
Better technology to forecast climate better, more early warning systems, international environmental assessments	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Change in research system to produce better technology to adapt to env change (incl. more south-south exchange)			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Research on and use of traditional or other knowledge				<input checked="" type="checkbox"/>
Additional research on role of environment on fisheries	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Additional research into varietal (incl species) adaptation			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

However, this overview does not aim to provide, nor should it be read as, a sound analysis of different response options and strategies - rather it gives an overview of some options. A fuller discussion on response options and adaptation strategies is much needed, if regional food systems are to be strengthened against likely adverse impacts of GEC.

The Caribbean prototype scenarios presented here provide a basis for a fuller discussion of plausible future developments and their impact on the food system, for an assessment of options to enhance future food security and the implications of these options, as well as for a more detailed reflection on how possible changes to the food system in turn affect the GEC driving forces.

Scenario 1: Global Caribbean (or Caribbean Libero)

A Caribbean Scenario coherent with the MA-Scenario: Global Orchestration

by Adrian Rodriguez, Ronald M Gordon, Terrence Phillips and Charles Carmichael

Global Context

The *Global Caribbean* Scenario assumes a future strongly influenced by widespread globalization involving major macro-scale policy reforms and heightened international cooperation. A strong focus on improving market performance and economic growth prevails. The role of public goods is redefined globally, resulting in general improvements in equity, health, education and social welfare. However, approaches to environmental management and responses to GEC continue to be reactive rather than proactive.

At the global level population is assumed to grow to the order of 8 billion by 2050 with characteristics of high migration and low fertility and mortality levels. The average income growth rate is high, with global GDP averaging 2.4% per year over the period 2006-2020 and 3.0% per year between 2020 and 2050. Increased equity is evident and the higher income levels are reflected in greater investments in new assets and human capital. This is accompanied by an upward trend in technological advances.

The energy-intensive lifestyles influenced by the higher incomes fuels energy demand. Energy supply requires the use of least-cost options and intensified technology use, and is fuelled by market liberalizations. A strong international cooperation network develops. However, a reactive attitude towards environmental policies prevails and no specific climate policy is pursued. There is a perception of sustainable development, mainly due to high economic growth. Least cost options and intensified technology use in relation to meeting energy demands also include the increased use of alternative energy sources (e.g. wind, hydropower, wave action, thermal, solar, etc.), and eventually there is a shift or reduced dependence on oil and gas.

Caribbean Context

Caribbean demography

Fertility rates and population growth: Fertility rates are already low in most Caribbean countries and are projected to remain low. As a consequence population growth also remains low.

Life expectancy: Life expectancy increases as a result of higher income and quality of life.

Age structure: The age structure becomes more skewed towards an aged population, a result of low fertility rates and increased life expectancy.

Migration (regional): Migration out of the region decreases because of improved income levels and quality of life. However, further intra-regional migration might be expected due to income disparities between countries and the implications for the labour market. There is also an increase of returning migrants from the diaspora as well as from non-diasporans.

Rural - urban migration (at the country level): In the long run, the rural - urban dichotomy becomes virtually non-existent in many of the smaller nations due to improved standard of living and increased attention to rural development. Therefore, rather than rural-urban migration there are two way flows, based on labour market dynamics and peoples' lifestyles preferences.

Economic development issues

Economic growth: Trade liberalization and improved governance contribute to increased economic gains, which in turn fuel economic growth. There is shift in the development paradigm from import substitution to one of export led growth, which results in higher intra-regional and extra-regional trade. This is supported by improvements in infrastructure, mechanisms and regulations that facilitate intra-regional trade (e.g. improved port facilities, removal of or reduction in non-tariff trade barriers, reduced transportation costs on account of more efficient systems). The relative contribution of agriculture to the economy decreases in favour of the tourism and services sectors. This results in increased competition for land and some shift in land use away from agriculture towards retirement and leisure utilization. Commodity agriculture is concentrated in some countries (e.g. Guyana, Belize and Suriname) and smaller islands specialize in production for the tourism market and other specialized niche markets only. The global and regional demand for fish products leads to increased pressure on fish stocks, which become fully exploited or even overexploited.

Equity: Equity improves because of economic growth and enhanced governance.

Financial flows: Financial flows increase because of trade, foreign direct investment in tourism and retirement activities and re-migration. Remittances continue to be important, but at a reduced level.

Labour markets: There is increased participation of women in the labour force. Increase in the importance of tourism and services lead to better employment opportunities. Increases in education and investments in human capital result in an overall better qualified labour force. Increased competition and the demand for skilled labour in the private sector result in reduced unemployment and improved quality of life.

Regional cooperation

Increased intra regional trade catalyzes more cooperation among the countries on political, economic and socioeconomic issues and responses to environmental concerns, within the context of CARICOM and the CARICOM Single Market (CSME). There is an increase in the harmonization of SPS regulations (i.e. the Sanitary and PhytoSanitary regulations of the World Trade Organization) and an improved capacity to overcome non-tariff trade barriers. There is also a market driven increase in cooperation and networking for managing natural resources (e.g. fisheries and energy sources) and enhancing the resource base for eco-tourism (see box on the Caribbean Regional Fisheries Mechanism).

Box: The Caribbean Regional Fisheries Mechanism (CRFM)

In March 2003 the Caribbean Regional Fisheries Mechanism (CRFM) was formally launched with the stated vision “*To promote sustainable use of fisheries and aquaculture resources in and among Member States, by development, management and conservation of these resources in collaboration with stakeholders to benefit the people of the Caribbean region*”. CRFM’s mission involves promoting and facilitating the responsible utilization of the region’s fisheries and other aquatic resources to the economic and social benefits of the current and future regional population. The institutional structure of the CRFM involves all the CARICOM countries and caters to the future inclusion of other Caribbean states as well as agencies that work in fisheries and with fisher folk.

The CRFM is supported by a Technical Secretariat that is charged with, *inter alia* :

- Collaborating with national fisheries authorities;
- Providing management and development advice and assistance, particularly in areas of coordination, communication and technical scientific operations; and
- Addressing urgent ad hoc requests falling outside of its agreed work programme.

The CRFM Secretariat delivers its functions through its headquarters in Belize and a second office located in St Vincent and the Grenadines.

Science & technology issues

There is a significant and more targeted increase in human capital and technological investments in response to the demands of the specialized agriculture, tourism and services sectors. This investment drive is led primarily by the private sector with support from the public sector.

Agricultural and food policies

Agricultural and food policies become more market led and trade friendly; hence, agricultural - and other - subsidies are faded out to comply with global trade liberalization rules. As a result, the relative price of food decreases. Cheaper food and higher incomes result in smaller food bills within household budgets. The focus of regulation, at the regional and national levels, is to assure quality and food safety, both for domestic and international markets. As a reaction to the initial

overexploitation of fish stocks, a Caribbean fisheries management strategy with restrictions on the fishing effort and fishing quotas is established in the later part of the scenario period.

Cultural developments

The impact of mass media, changes in family structures and more stringent work arrangements contribute to more sedentary lifestyles, changes in dietary patterns and a growing importance of fast food outlets. Eventually, this leads to a change in the pattern of diseases from infectious to Chronic Non Communicable Diseases (e.g. diabetes, cardiovascular illnesses, hypertension and obesity), which may or may not prompt greater awareness about healthy food habits and dietary and lifestyle practices.

Global and Caribbean Environmental Changes

Global trends

Predictions for GEC are here assumed to be roughly consistent with those from the IPCC. Up to 2050: a) global temperature increases by 1.5 to 2.0 degree Celsius; -- for the Caribbean this is expected to result in an increase of 1.0 to 1.5 degree Celsius; b) rainfall increases globally but with diverse spatial patterns -- for the Caribbean there is huge uncertainty (potential decrease in average, but increase in intensity); c) extreme weather events increase globally with increased sea temperature -- again, for the Caribbean there is uncertainty (potential increase in frequency), yet the trends evidenced by the current active weather cycle is expected to continue; d) sea level is predicted to increase by 25 to 30 cm -- in the Caribbean this impacts on the frequency of storm surges, increased salt water intrusion and deterioration of coral reefs, sea-grass and mangrove areas.

Flooding

Flooding events continue to be frequent, but the capacity to cope with it gradually increases with the growing national incomes. However, some risks remain at the community and household levels, especially in territories already currently affected by high incidence of poverty and natural resource degradation.

Land use pattern

Land use patterns are driven by a more diverse economy and the resulting competition from the service, tourism and other leisure related economic activities. This triggers a need for land zoning and a more structured utilization of marginal lands.

Water availability and use

The wider spread of economic activities, within the agriculture, fisheries, leisure and services increases the demand and competition for water. This increased competition triggers differential water pricing as a mechanism for water allocation.

Fish stocks and marine resources

Collaboration in fisheries management and enforcement of harvesting policies increase in response to the high exploitation levels of the fish stocks. The increased demand for fish and fish products, both regionally and globally, triggers the increased exploitation of under utilised and unutilised species. Only after a near collapse of Caribbean Sea fish stocks in the 2010s and 2020s, an improved management strategy is introduced to include licensing and the use of tradable quotas. There also is a growth in aquaculture and mariculture operations in response to the increased demand for fish and fish products.

Pollution (air, soil and water)

Increased economic activity is assumed to lead to an increased public demand for better control and disposal of agro-industrial, chemical and industrial waste as well as waste from tourism activities. This results in the design and implementation of private sector oriented waste disposal mechanisms, within the context of environmental policies under the ‘polluter-pays’ principle. Particular attention is given to the need to minimize any harmful effects on the tourism-related resources. This also has a positive effect on minimizing contamination of the water-table and supply. The increase in the consumption of fossil fuels and the consequential emissions harmful to the environment catalyzes a drive that harnesses wind and other environmentally friendly energy sources.

Caribbean Food Systems Issues

Beginning in the year 2006 through to year 2010 international agreements currently in the pipeline are assumed to be successfully implemented. These serve to fully liberalize trade by 2015 leading to a New Global Liberalized Economic order in the 2020s. Also, during the period 2006-2012, the CARICOM Single Market Economy (CSME) is implemented, with strong national policy support.

As a consequence to the unfolding market conditions there is increased private sector investment over the period 2012 to 2025, focussing on niche market agriculture from regional and global sources fuelled by low costs of labour and the attractive Caribbean lifestyle, among other things.

Food systems activities

Production: The liberalization of markets results in the reduction of tariffs, both globally as well as within CARICOM. The reduction of subsidies in developed countries leads to increased specialization of production by countries, according to natural resource endowment, agro-ecological factors or skills. Examples of specialization that may be observed in this scenario within the Caribbean include rice in Belize, Guyana and Surinam; sugar in Belize and Guyana and a little in Jamaica; coffee in Dominica, the Dominican Republic and Jamaica; cocoa in Grenada and Trinidad & Tobago; root crops, arrowroot starch and related products in St Vincent and the Grenadines; and exotic tropical fruits in Belize, the Dominican Republic, Guyana, Jamaica, the Windward Islands.

The following developments are here expected in production:

- *Rice:* Overall, production of rice increases, as well as processing of rice into specialty/ready to eat rice products. In addition there is further diversification of the rice industry providing by-products for export into other markets.
- *Coffee:* Coffee production remains stable, or decreases slightly and is increasingly focused towards niche markets.
- *Bananas:* Banana production decreases overall and the remaining production is targeted at niche markets (e.g. ethnic, organic).
- *Exotic tropical fruits:* Production of exotic tropical fruits increases, as well as the importance of niche markets for them.
- *Sugar.* Production of sugar increases in Guyana and Belize. The other countries that were former sugar producers diversify out of sugar; either by utilizing the land for other crops or by using the sugar cane for other products such as alcohol (*see Box on changes in the Sugar Industry in St Kitts and Nevis*).

Box: Recent Developments with the Sugar Industry in St Kitts and Nevis

Following recent years of economic downturn, the 350 year old sugar industry in St Kitts and Nevis was officially closed on July 30th 2005, following a debate in the parliament. In preparation for this historic and traumatic event the Government pursued policies and programmes that sought to provide alternative work options for the workers as well as to cater to their social needs. A special office has been established to offer advice on re-entry into the labour market as well as counsel on the stresses of the changes faced by the now displaced sugar workers.

Training and re-orientation will be provided together with a small stipend to assist in meeting some of their expenses.

As part of its efforts towards a smooth transition from a sugar to a non-sugar agriculture based economy the Government sought and received technical assistance from the International Centre for Cooperation on Agriculture (IICA) with the delivery of the training of youths focusing on entrepreneurship, agribusiness, agro-processing and agro-tourism linkages. There is also increased exploitation of forests and mineral resources in the resource endowed countries of the region.

Processing: There is an increase in packaging and processing of the agricultural products in which the regions specializes, in the context of the CSME. Some countries, especially Trinidad & Tobago and Barbados, enhance their processing capacities. For example, the majority of sugar produced in Guyana is refined in Trinidad & Tobago under a private sector joint-venture agreement, subsequent to the implementation of CSME.

Distribution: Food distribution mechanisms improve at national and regional levels. Exports increase in those products in which the region specializes. At the same time food imports increase. Food is distributed mainly by supermarkets owned by a few large corporations. The government plays no major role in setting prices or regulating distribution; however, it plays a role in precluding monopolistic practices.

Consumption: Consumption patterns are dominated by global trends and mass media advertising; however, the increase in chronic diseases (see above) associated with unhealthy dietary patterns eventually may lead to a surge in health concerns and a move to more healthy foods in the long run.

Food availability

Food production: Trade liberalization leads to specialization in a few agricultural products that are produced in a few countries; however, the majority of food is imported, except for fresh fish, rice and bananas. Increased demand for fish and fish products for export, the tourism industry and local consumption exerts significant pressure on fisheries.

Food distribution: Globally, food distribution mechanisms improve. This becomes evident in the Caribbean also on account of the infrastructural and other improvements in support of intra-regional trade.

Food exchange: Food imports significantly increase, both from within and outside the region, given the raise in incomes, demands from the tourist sector, and the specialization of agriculture. The role of the open market in food exchange increases, both globally and regionally. The main concern of governments in food exchange would be to assure quality and safety and compliance with SPS regulations in the context of WTO agreements.

Food access

Affordability: Food becomes more affordable, as the relative prices of food decrease and incomes increase. However, the price of fish and fish products increases in the longer term despite increased production of cultured fish products; at first due to increased demand from outside the region and then due the catch limits on the fish stocks introduced in the 2030s,

Allocation: Food is allocated more efficiently wherever it is needed. The main allocating mechanism here is a functioning market.

Food preferences: Food preferences are driven by global media advertising and pricing. The influence of mass media initially increases overtime. However, towards the end of the scenario period (2030s, 2040s) the mass media influence decreases, as people become more health conscious and aspire lifestyle changes.

Food utilization

Nutritional value: Two main forces drive the perception about the nutritional value of food. First, convenience, which leads to an increase in the consumption of packed and pre-prepared unhealthy food; second, a counterbalancing steady increase in awareness about the nutritional value of food in the longer run.

Social value of food: The social values attached to food in the Caribbean decrease; however, it remains important. The main force driving those values away are changes in lifestyles, family structures and working arrangements.

Food safety: Food safety increases because of competition. However, there is greater vulnerability to exotic diseases not currently covered by WTO's Sanitary and Phytosanitary regulations (SPS agreement).

Related Issues

Production diversification, trade and market expansion

The US Trade Embargo with Cuba is lifted in the 2010s. This leads to the expansion of cultural and commercial ties between Cuba and the English speaking Caribbean, initially informally and ultimately formally with Cuba as well as the Dominican Republic becoming members of CARICOM. The entry of Cuba into CARICOM leads to the further development of commercial activities based on sugar being used as raw material for the production of pharmaceuticals or other products.

Stronger ties with Central America are also established. (Note that the seeds for this development can already be seen today; examples include the current membership of Belize and observer status of the Dominican Republic in the Central American Integration System (SICA) and its bodies (e.g. Central American Commission on Environment and Development (SIECA)), Central American Economic Integration Secretariat, among others); and the emerging Free Trade Agreement between Costa Rica and CARICOM.)

Transportation costs

Transportation costs are high, and lack of adequate transportation limits intra-regional trade. This situation is gradually overcome by private led and government supported investment. Intra-regional air transportation improves and a major carrier dominates the market. Marine shipping capacity among the Islands and between them and mainland countries also increases.

Tourism linkages

Niche tourism expands, in particular eco-tourism, health tourism and marine tourism ventures. This growth in niche tourism is evident in countries such as Belize, Guyana, Dominica, St Lucia, Jamaica, Trinidad & Tobago and Suriname. This surge is influenced by Governments ensuring safety of the operations through an increased investment in public safety. Intra-regional tourism also expands. As additional support of the tourism thrust, visa requirements are dropped or waived for visitors from most countries. The promotion/marketing of the tourism product is industry led. Agro-tourism linkages increase with visitors having the opportunity and the wish to consume more locally produced foods. There are also stronger linkages between the agricultural and the tourist sectors, as hotel chains, with support from Governments, establish mechanisms to purchase fresh food locally. Some countries export human capital for working in the tourism industry. Jamaica and the Dominican Republic lead in this regard.

Special focus on Haiti

Subsequent to the lifting of the US embargo on Cuba there is even greater international pressure for a resolution to the ongoing instability in Haiti. Eventually, with considerable political leverage from CARICOM, which secures the active cooperation of the super powers and international agencies, internal security is established in Haiti and that country resumes an active role in CARICOM. A global donor conference on Haiti is convened in the 2010s, and by 2025 conditions in Haiti have finally stabilized. Agricultural production in Haiti increases but there is greater focus on and promotion of tourism and other leisure related ventures in order to further diversify the economy and secure sustained real growth.

Governance issues

Democratic governance has improved in all countries and the CARICOM institutional arrangements, as the regional structure for setting policy frameworks, is widely recognized by national governments and the private sector.

Petroleum Guyana - Suriname

The dispute between Guyana and Suriname over oil/gas reserves is settled, and the exploitation of oil and gas develops. There is a shift in labour towards the more lucrative oil/gas exploitation and

related industries that can lead to some disruption in the area of agriculture production (sugar and rice). The result is even more mechanization of agricultural production in order to maintain high output levels. This may also create job opportunities for persons involved in the marine capture fisheries, which are willing to live out at sea for long periods.

Overview

Five Key 'Global Orchestration' Certainties

- (1) The lifting of the trade embargo on Cuba imposed by the United States of America.
- (2) Increased frequency and intensity of severe weather systems, as a result of global warming and other factors.
- (3) The loss of traditional preferential markets for primary agricultural commodities.
- (4) Unrestricted flow of labour and capital within the CARICOM Single Market (CSME).
- (5) Increased aquaculture production of non-native food fish result in a challenge for the management and containment of these exotic species that ultimately escape into the wild. This could be mitigated by a focus on utilising technologies designed for farming indigenous species as practiced in Brazil.

Five Key 'Global Orchestration' Uncertainties

- (1) To what extent can food systems and social infrastructure survive severe weather systems?
- (2) What are the impacts of GEC on sea level rise, sea temperatures and marine life?
- (3) By how much will intra-Caribbean migration increase and what might be the resulting impacts on domestic food systems, following the removal on restrictions on movement?
- (4) To what degree can preferential based agriculture production be 're-tooled' into market led niche agricultural production without causing a big social problem with the displacement of several workers?
- (5) Can the trend of a declining age structure in the agricultural sector be successfully reversed?

Five Major 'Global Orchestration' Concerns

- (1) The ongoing threat of marine pollution from accidental spills related to the trans-shipment of hazardous cargo using the Caribbean Sea.
- (2) The potential damage to food systems and destruction of infrastructure following the advent of severe weather systems, threatening domestic food supplies as well as the ability to consistently serve the emerging niche markets.
- (3) The threat to traditional tourism from the increased frequency of hurricanes in the Caribbean, with direct impact on the domestic market for the hospitality industry as well as an indirect impact on the food security status of suppliers to that market.
- (4) The continuing impact of the fragile ecosystems in Haiti on the various food production systems in the country.
- (5) Securing the investment required for financing the commercial and social projects necessary for the strengthening/rehabilitation of the food systems and associated infrastructure.

Five Major 'Global Orchestration' Opportunities

- (1) Application of new technologies in agriculture and agro-processing towards the development of products demanded by the emerging niche markets.
- (2) Diversification of agricultural production, following the loss of preferential markets, in a manner that seeks to supply emerging niche markets while contributing to an improvement of the welfare of the displaced producers.
- (3) Development of strong linkages with the tourism sector in the provision of agro-tourism and eco-tourism market opportunities as well as in the enhancement of the supply of exotic foods to the tourism/ hospitality industry.
- (4) Strengthening of the food production systems in Haiti through a country-wide network of community designed projects, eventually leading to the gradual re-forestation of the hillsides of Haiti.
- (5) Develop a science-based system for the management and utilisation of the marine fisheries resources, with strong fishing community level support, to cater to the long term sustainable utilisation of the marine fisheries resources.

Depiction of Developments for Ecosystem Services and Human Well-being in 2050 compared with 2000 in the Caribbean Global Orchestration Scenario

	Global Development		Caribbean Development
	Industrial	Developing	Caribbean
ECOSYSTEM SERVICES			
Provisioning Services			
Sufficient access to food	↑	↑	↑
Fuel	↑	↑	↑
Genetic resources	↔	↔	↔
Biochemicals/Pharmaceuticals discoveries	↓	↑	↑
Ornamental resources	↔	↔	↔
Freshwater	↑	↑	↑
Regulating Services of Ecosystems			
Air quality regulation	↔	↔	↑
Climate regulation	↔	↔	↔
Water regulation	↔	↓	↑
Erosion control	↔	↓	
Water purification	↔	↓	↑
Disease control: Human	↔	↑	↑
Disease control: Pests	↔	↓	
Pollination	↓	↓	↓
Storm protection	↔	↓	↓
Cultural Services			
Spiritual /religious values	↔	↔	↔
Aesthetic values	↔	↔	↔
Recreation and ecotourism	↓	↑	↑
Cultural diversity	↓	↓	↓
Knowledge systems (diversity and memory)	↔	↓	↑
HUMAN WELL-BEING			
Material well-being	↑	↑	↑
Health	↑	↑	↑
Security	↑	↑	↑
Social Relations	↔	↑	↑
Freedom and Choice	↔	↑	↑
Key:	↑ = increase in ecosystems' ability to provide the service, ↔ = ability of ecosystem to provide the service remains the same as in 2000, ↓ = decrease in ecosystems' ability to provide the service.		

Source: Adapted from Millennium Ecosystem Assessment (2006)

Scenario 2: Caribbean Order from Strength

A Caribbean Scenario coherent with the MA-Scenario: Order from Strength

by Dr Ballayram, Christine Bocage and Adrian Trotman

Global Context

The *Caribbean Order from Strength* scenario begins from the observation that the struggle for global power is currently in a state of uncertainty as several countries seek to establish their respective spheres of influence. The basis of world political power also shifts. For example, power is no longer a function of military and natural resource endowments only, but relies increasingly on other factors, e.g. intellectual capacity and information technology in the case of India; cheap labour in the case of China; technology and resource endowment in the case of Brazil. At the same time energy scarcity increases transport costs, increasing the role of fuel and transport in bilateral relationships and trade.

The result of this is a marked increase in multilateralism, in which it is envisaged that eventually the modus operandi of global trade and politics is based largely on a range of ‘metropole-satellite’ relationships; for example, China may be a metropole with several Asian-Pacific countries being its satellites; or Brazil competes with the United States over being a metropole for many Caribbean and Latin American countries.

Meanwhile the gap between the rich and the poor widens both between and within countries. The scenario also assumes a global population of 9.6 billion by 2050, due to relatively high fertility rates and mortality levels and high population growth. Assuming increased threats of and the execution of coordinated terrorist attacks in the 2010s the USA and EU significantly reduce immigration and increase impediments and policing of travel. Exports thus become subject to increased regulations - thus resulting in higher transaction costs to trade. Consequently, intra-regional trade increases. Foreign direct investment decrease and come with strong corporate control of the means of production and profits, particularly in minerals, services and natural resources.

Oil and gas prices increase and the USA, as well as other metropole countries, attempt to set up unilateral trade agreements with individual nations to secure resource availability. With the advent of GMOs and its dominance by large multilaterals, agriculture in the rest of the world becomes more dependent on imported inputs (seeds, insecticides, weedicides), exposed to greater risks with respect to invasive species, gene pollution and leads to higher costs to food safety monitoring.

Caribbean Context

In this scenario, there is a high potential for the Caribbean Single Market and Economy (CSME) to disband in the longer run. Initially, however, global developments and high export tariffs might trigger Caribbean countries into stronger cooperation: The CSME is given a stronger hand and Caribbean nations move to strengthening its role in order to promote a stronger regional trade and cooperation and to mitigate future trade shocks. Between 2010 and 2015, even a new regional planning system helps to plan different country focuses (Guyana: food production, Jamaica: niche crops and others, Trinidad: oil). Individual country governments even may give up some of their sovereignty/power to allow more regional governance.

However, due to the global context, the CSME breaks down after only a few years. Because of pressures from consumers demanding cheaper food, export and imports from outside the region increase again in some countries that bypass the CSME system. Trinidad, for example, is targeted by the USA and begins bilateral negotiations. Other countries also develop preferential trade agreements with Brazil, disregarding CSME agreements. This results in CSME to break down in the late 2010s; and the Caribbean becomes highly fragmented leading to weakened food systems, greater inequalities, and increased poverty widening the gap between rich and poor.

Regionally, annual growth rates in Gross Domestic Product (GDP) are relatively low, with an average 1.4% up to 2020, and decreasing further following the CSME breakdown to 1.0% up to 2050. Average income growth is moderate to low and there is little investment in human capital. In the less competitive economies there are job losses (further fragmenting the region). Higher inequality, both within countries and intra-regionally result, and exacerbates poverty. Technological advancement is also some paces behind that at the global level because of a lack of investment in high-level technology. It is the private sector that invests in human capital, and it does so solely profit driven. There is instability with respect to state administrations leading to civil unrests and increased crime, which puts pressure on the regional tourist industry.

Global and Caribbean Environmental Changes

Global mean temperature is expected to increase in the range of 1.5 to 2.0 degrees Celsius by 2050, and mean temperatures in the Caribbean rise in the range of 1.0 to 1.5 degrees Celsius. With respect to average rainfall, there is an increase globally though this follows a diverse spatial pattern: For the Caribbean, future expected average annual rainfall is highly uncertain. Here, a general decrease is envisaged accompanied by an increase in high rainfall intensive events. The number of extreme weather events, including tropical depressions, storms and hurricanes, are also likely to increase with possible increase global sea temperatures. In the Caribbean there are some uncertainties, but potential increased frequency and consequent vulnerability to these weather patterns continue to be high.

A heightened irregularity in weather patterns unfolds over the next ten, twenty years. By 2020, additional flooding problems occur due to the increased frequency and severity of rainfall, storms and hurricanes. Farmers find it difficult to recover and the governments continue to pump relief into the sector. Additionally, there is an increased salinization in Guyana and Suriname with the reduction in freshwater fisheries.

Key Environmental Drivers (Up to 2050)	Scenario: Caribbean Order from Strength
Flooding	No flood planning
Land Use Patterns	Initially, there is more intense use of land, followed by use of marginal land to provide for basic food needs. Good land is captured by cash-crop export markets underlined by search for profits with scant regard for environmental considerations
Water Availability	Limiting factor for agriculture Strong competition for water between sectors that use water and this competition intensifies as water shortage becomes more pronounced
Fish Stocks and Marine Resources	Fishing follows individual capacity with keen competition for available resources - No fishing regulation hence potential for negative feedback on the resource, egg. over fishing and collapse of the resource - There is some potential for selective aggressive management to secure markets
Pollution (Air, Soil, & Water)	Potential for high pollution due largely to lack of environmental management practices and regulations

At the same time that oil prices are soaring, the ability of the ecosystem to enhance or support pharmaceuticals and biochemical discoveries is decreasing. There is also a reduced ability to support ornamental and freshwater resources development particularly in Guyana and Suriname. Air quality, climate regulations, water regulations, erosion control, pest and disease control in both plants and animals cannot be sustained in large parts of the region. Particular disaster events hit the regions hard (such as hurricanes, chemical spills, etc.) as effective Emergency Management Strategies are lacking in most countries.

Caribbean Food Systems

The table below summarises the situation envisaged for food system outcomes under the *Caribbean Order from Strength* scenario.

Food System Outcome	Scenario: Caribbean Order from Strength
Production (0 / -)	(+) Increase in some countries (depend on resource endowment) (-) Decrease in some areas (less efficient production systems) (-) Climate variation (increased natural disasters) (-) Fisheries collapse (?)
Distribution (-)	(-) Increased transport cost (-) bioterrorism (-) impact of GEC slows or destroys distribution (-) Some trade barriers
Exchange (+)	(+) Increased food imports (except for Belize, Guyana and Suriname) (-) Sometimes demand cannot be met due to high costs, resulting in food shortages
Nutritional Value (-)	(-) Affordability and preference do not favour balanced diets (-) likely more diseases
Social Value (0 / +)	(+) Low information on nutritious value increases role of traditional and religious settings (0) Current practices are likely
Food Safety (-)	(-) Increase in diseases due to diets (+) very basic dietary requirements are met but at low nutritional value
Affordability (--)	(-) lower economic growth, less income (-) increase in food prices, also of staple food (-) GEC shocks
Allocation (-)	(-) often mismatch where food is and is needed (-) distributional constraints (-) GEC hinders allocation. (-) rich served first
Preference (-)	(-) often cheaper food, no focus on nutritional value (-) due to low education and low affordability (+) with money you can get what you want

Legend: ++ or +: very positive or positive developments expected for the Caribbean; -- or -: very negative or negative developments expected for the Caribbean; o: no changes expected / current situation continues in the Caribbean; ?: very uncertain development

Food Availability, Distribution & Exchange

Food production increases in some countries depending upon resource endowment - while for others there is a reduction because of loss of preferential markets, increased competition and the imperative to achieve international competitiveness and as some countries reallocate resources to

activities other than agriculture. Environmental variability and lack of environmental management leads to the collapse of the fisheries industry. Food distribution is compromised due to increased transportation cost, bioterrorist activities and overall impact of GEC. Food imports for several countries increases (except Belize, Guyana and Suriname). However, for many countries, large proportions of the population lack access to this food - as income inequality increases, economic growth slows, and depletion of natural resources is accelerated by GEC.

Utilization

Lack of affordability and preference do not favour balanced diets, which in turn leads to increased prevalence of nutrition-related chronic diseases (NCDs). With respect to social value, there is an increased tendency to resort to traditional and cultural food consumption patterns due to low information on healthy food choices. Food safety is compromised, due largely to lack of human capital capacity to monitor and implement food safety regulations, in turn resulting in an increased burden on the health sector. Increased pressure on land and fisheries result in increased natural resources degradation. Increased agriculture leads to higher attention to proper cultivation practices in some places, but increased erosion and degradation of fisheries in most. The general trend is to resort to self-sufficiency—much like the current Cuban example.

Focus: Food Security and Food Safety

Key issues for concern:

In this scenario, the food-health link is of particular interest. Given the above-mentioned assumptions that underpin this scenario, several issues of concern emerge:

- Many countries still lack the legislation and ability to monitor food safety.
- Lack of trained staff to do normal food safety checks at the different ports of entry.
- Increasing prevalence of nutrition related chronic diseases and overweight/obesity as major risk factors.

Consequently, under-nutrition and nutrition-related diseases constitute the main causes of death and ill-health in the Caribbean Region. In turn, these are determined by factors that are (i) food-related (e.g. food availability, access and biological utilization); (ii) health-sector related (e.g. water and sanitation, food safety, health care services, including early childcare and development; and (iii) multi-sectoral (e.g. income distribution, accessibility to health care, poverty). However, while health and nutritional concerns become pressing, response is increasingly reactive and ineffective. (The Box below gives examples of how pressing health and nutritional concerns might be addressed, to ‘insure against’ the impacts of a *Caribbean Order From Strength* scenario unfolding unchecked.)

Box: Addressing Health and Nutrition Problems

To effectively address the health and nutrition problems in the region specific actions/interventions would be required. These actions cannot be posed as “quick-fix” solutions but as comprehensive and long-term in nature and involving the participation of all stakeholders, including the private sector and civil society and partnerships among regional and international agencies. Specific actions to counter some of the negative developments for health and nutrition issues expected in the *Caribbean Order From Strength* scenario may include:

National Food and Nutritional goals

Countries need to establish national food and nutritional goals so that their agriculture and food systems can deliver adequate and nutritionally appropriate quantities of food, especially to low-income and vulnerable groups

School Based Initiatives

Nutritional problems can be countered school based initiatives, such as school-based attendance programs (e.g., conditional cash transfers), school feeding programs fulfilling nutritional goals rather than ‘filling empty stomachs’, and healthy lifestyle programs that are aimed at engendering good eating habits and healthy lifestyles among school children.

Micronutrient Supplementation

In most countries anemia prevention and control programs do exist. These programs are in dire need for expansion to increase and sustain coverage of beneficiaries. Additionally, better targeting is required, especially among children who require complementary foods (e.g. provision of iron supplements).

Regional Approach

A regionally agreed approach to food production and trade is needed. What must be decided is which country grows what, and trades with whom, to provide the nutritional needs and at the same time reduce the imports into the region.

Overview

There are several key issues of concern and opportunities in the *Caribbean Order From Strength* scenario:

1. With stress on water availability the imperative is for better water management including differential pricing policies for more efficient use of the resource (e.g. domestic vs. industrial).
2. With rising sea levels and for countries below sea level (e.g. Guyana ,Belize) investments must be made in sea defences (e.g. planting mango forests on sea banks, sea wall construction).
3. Aquaculture and mariculture are appropriate responses to impending fish stock depletion.
4. Change in cropping systems (when we grow what, what we grow, where we grow).
5. Development of comprehensive disaster management system
6. Reactive safety nets: Compensation for flooded farmers; food aid (do nothing and let it increase).
7. Sectoral change in activities, i.e. a more concerted and judicious approach to diversifying production.

Scenario 3: Caribbean Techno Garden

A Caribbean Scenario coherent with the MA-Scenario: TechnoGarden

by Justin Ram, Donna McRae-Smith and Lauren Justice

The Global Context

In the early years of the 21st century, the world economy is at a crossroad, the Doha round of trade talks awaits completion, but there is mistrust among trading partners. The major international trade dispute is the farm subsidies paid to European and American farmers by their respective governments. Southern farmers want access to the European and American markets, and at the same time Southern governments do not want their markets flooded with cheap subsidised American and European produce. The price of energy is ever increasing as reflected by the price of oil and Southern societies need to earn foreign exchange to help offset their growing energy bill. Progress on trade talks followed US president George W. Bush meeting with his Brazilian counterpart, Lula De Silva and his commitment to lower American farm subsidies once the Europeans are prepared to do the same.

In the early 2010s, climate change issues and sustainable development are at the top of the agenda for all nations. A remarkable shift in trade negotiations follows as the US and Europeans reduce farm subsidies and allow farm products from the South to enter their markets. The US-backed regional Free Trade Area of the Americas (FTAA) is back on track despite some reservations from Venezuela and other countries in Latin America and the Caribbean. The FTAA, a free trade area that stretches from Alaska in the north to Chile in the south is rejuvenated because of American and European concessions on farm subsidy reforms. The FTAA is realised by the year 2030, and includes all American countries.

Meanwhile, fishing quotas and other market based natural resource management techniques are agreed upon and are being stringently enforced. New food production systems are developed based on innovative technology that are environmentally benign and able to take advantage of marginal land and marine conditions. Nevertheless, growing concern over the health and biodiversity risks of genetically modified foods leads to the abandonment of GMO technology.

The United Nations Development Programme (UNDP) brokers a deal between rich countries and southern nations that facilitates the transfer of technology and knowledge globally. Rising prices for hydrocarbon fuels leads to a shift in the use renewable sources of energy. Greater emphasis is now placed on sustainable forms of energy. The use of fuels that are net carbon dioxide emitters is regulated through market mechanisms including carbon trading and use of the Kyoto protocol's clean development mechanism.

Eco-tourism as a proportion of the total global tourism industry continues to expand. The Eco-tourism industry is therefore a thriving industry that is a leading innovator in global environmental solutions.

Caribbean Context

Successful completion of global trade negotiations that are deemed fair by all parties is an important conduit for political change within the Caribbean. Rising energy prices also mean that Caribbean economies struggle at first, but Caribbean populations demand economic and political reforms that would help them deal with the changed world order. Politicians rally behind the Caribbean people and call for greater Caribbean integration and state the importance of Caribbean agriculture, in line with CARICOM goals for food self sufficiency (i.e. reduced dependence on imported food). At the top of the agenda is deeper regional integration that includes the free movement of labour. The Caribbean Single Market and Economy (CSME) becomes operational well before the full FTAA implementation, and labour now moves freely within the Caribbean among centers of production based on skill value/needs – thus CARICOM's goal of sufficiency is realized.

At an aggregate level, the Caribbean population remains stable in absolute numbers but lower fertility and mortality rates lead to increased life expectancy resulting in an ageing population. Intra-regional migration is driven by the location of new industries including but not dominated by agro-industries. Agrarian/rural populations decrease. This leads to an increase of population in some and decrease others of the islands. For example, Trinidad and Tobago and Barbados see an initial rise in population numbers as labour from other parts of the region flock to these countries because of their booming economies, which are driven by energy, science and technology and cultural tourism. Other countries experience a decline in population as their skilled labour moves to other Caribbean countries where their marginal product of labour and hence wage is perceived to be higher.

This economic transformation of the Caribbean region, follows the Lewis model of “Industrialisation by Invitation” but it happens at a regional level, where there is a ‘transference wage’ in the more modern economies that helps attract labour from lower paying industries.² However, labour immigrates to higher paying jobs, and this allows the subsistence sectors (mainly agriculture and tourism, where the majority were employed in their home countries e.g. in Belize and Guyana) to become more productive as the marginal product of labour in these sectors increase. Over time the wages in these sectors improve as they provide food and

² Lewis, W.A., 1950, ‘ The Industrialization of the British West Indies. In Caribbean Economic Review, 2 (1) pp. 1-8.

recreation for the populations in the modern countries.³ A cadre of well-trained, local professionals are attracted to these sectors, as their productivity improves and profits are increased. Improved profitability allows new technology to be employed and once non-arable land like salt marshes, become “food baskets”. This change in the fortune of Caribbean societies is driven by the changes at the global economic level (of freer trade) and the call by Caribbean people for political, social and economic integration to help adjust to the new global reality. Generally, there is greater equity, even though the technology is concentrated in a few companies as wealth trickles down and unemployment reduces with rising investment in education.

Deeper political and economic integration becomes a lasting aspect of Caribbean integration. There are some social tensions, as native populations in some countries adjust to the new arriving immigrants and their culture. The West Indies cricket team and other catalysts of social integration help quell any social tensions.⁴ By 2050, cultures become merged, and the Caribbean becomes a melting pot of culture which helps propel cultural tourism as a major source of foreign exchange earnings for some countries.

Table TG-1 gives a brief overview of past GDP trends in selected countries. It shows that the economic performance of Caribbean countries vary significantly. For example the GDP of Trinidad & Tobago grew by 51% over the period 1995- 2003, while the GDP of Jamaica and St. Lucia grew by only 4% and 3% respectively. Differing economic prospects provide a conduit for the immigration of labour between Caribbean countries.

Table TG-1 Total GDP (US\$ million) at constant prices (Source: Justin Ram, pers comm)

	1990	1995	2000	2003
Antigua & Barbuda	377	415	524	550
Barbados	1646	1588	1845	1852
Belize	464	620	870	951
Dominica	198	218	234	226
Grenada	211	233	299	319
Guyana	317	477	561	558
Jamaica	4786	5240	5278	5449
Saint Kitts & Nevis	161	194	249	253
Saint Vincent & the Grena.	192	223	261	275
Saint Lucia	325	367	375	378
Suriname	535	519	561	588
Trinidad & Tobago	4871	5348	7506	8059

Overall economic growth is relatively high, but the economic equality decreases initially due to a few capitalizing on novel technology opportunities, but then increases as migration and access to economic opportunities across the region improve. Unemployment decreases as investment in

³ Lewis, W.A., 1958, “Economic Development with unlimited supplies of labour” In Agarwala, A.N. and S.P. Singh (eds.), The Economics of Underdevelopment, Delhi: Oxford University Press pp 431-435.

⁴ Beckles, Hilary (1999), The Development of West Indies Cricket: The Age of Nationalism. University of Michigan Press

education increases. This investment in human capital leads to a positive feedback in economic investment from outside the region, but regulated by regional goals. For example Brazilian firms begin to invest in alternative energy uses of sugar cane such as the production of ethanol (this is dealt with in more detail in section on ‘Adaptation and Response Options and Related Issues’).

Regional cooperation is strong, however, there is specialization by nation. The law of comparative advantage works for the benefit of all. Thus, for example, Guyana begins to grow more rice and staples for the region’s food demand. Through specialization, the region becomes food sufficient and the food import bill falls as a consequence.

Global and Caribbean Environmental Change to 2050

There are a number of factors that through their inter-relationships are resulting in a phenomenon, which is generally referred to as global environmental change (GEC). This includes temperature and rainfall changes that have hitherto not been experienced at the global scale, extreme weather events such as tropical depressions, storms and hurricanes, and greater fluctuations in sea levels.

At the global level GEC is often equated with “global warming,” but much more than warming is involved. The rising concentration of carbon dioxide and other greenhouse gases is leading to more extreme storms, higher-intensity hurricanes, rising ocean levels, melting glaciers and ice sheets, droughts, floods and other climate changes. Even the chemistry of the land and ocean is changing, with the ocean becoming more acidic – thus threatening coral reefs – as a result of higher carbon dioxide levels.

From the present time to 2050, Caribbean temperatures are expected to increase 1.0 to 1.5 degree Celsius, and there is a high level of uncertainty with respect to rainfall variation. A trend that points to a decrease in average rainfall, with an increase in the intensity of the showers seems to be emerging. With respect to tropical storms, depressions and hurricanes, it is believed that any rise in temperatures may lead to increases in the number and intensity of windstorm related natural hazard events, especially hurricanes, but there is no doubt that these continue and that the Caribbean Region continues to be highly vulnerable to these. The IPCC suggests there could be an increase of approximately 10-20% in intensity of tropical cyclones under enhanced CO₂ conditions caused by greenhouse gas emissions. Sea level is expected to increase by 25 to 30 cm and there is a very real possibility that this could lead to more storm surges, and to salt water intrusion into ground water systems.

With respect to agriculture and food security, an increase in windstorm related events could significantly affect food systems. In the aftermath of Hurricane Ivan, which affected Grenada in 2004, for example, it is estimated that 91% of the forest was destroyed leaving bare the watershed and an ecosystem that supported fauna and flora; 85% of nutmeg trees were destroyed; and 90%

of cash crops were also destroyed. From these estimates it may be concluded that food systems and food security could be severely undermined by future windstorm related events.

Related to the above, other general aspects of climate change such as temperature, rainfall, length of growing season and the timing of extreme events could decide the success and/or failure of agriculture policies in many countries. The direct impact of GEC arises from variations in the aforementioned climate conditions while the indirect impacts that GEC may have on agriculture could include unanticipated/undiagnosed pests and diseases that affect crops and which may not be easily quantifiable.

Caribbean Food Systems in the Scenario

Food policy

The main goal of Caribbean food policy is self-sufficiency. This, however, is predicated on the use of technology that allows for more efficient production and higher value added processes such as organic technologies to be employed. The focus is on production of green agriculture and fisheries technology. The relative price of staples goes down due to (i) economies of scale in centralized production areas, and (ii) intraregional shipping costs which are less than from the USA and other extra regional trading partners. However, increasing wealth and education leads to higher demand for higher quality, organic, which is more expensive.

At present, agriculture in terms of importance to GDP plays a role that varies heavily by country. However, at a regional level agricultural GDP contribution is high. In many islands, and in particular in mountainous regions, agricultural production takes place on small farms. Using the example of Dominica, most farmers currently have poor land tenure and use low technology systems. Small islands of the Caribbean also tend to equate to a lack of fertile land for cultivation; main crops are sugar cane, banana, rice and coconut. In terms of the food system, imports also play a significant role in nourishing the population. The recent trends for the main crops have not been encouraging, prices and exports have been falling mainly due to lost preferential access to markets and global over supply.

Given this background major changes that are likely in the *Caribbean Techno Garden* scenario in Caribbean food systems are discussed here in more detail:

Impact of new trade arrangements

The Caribbean is already losing access to its preferential markets. As a result there is a decline in production and profitability of these traditional crops. This is likely to continue as the US and Europe reduce their farm subsidies and open their markets to food produced from most countries. Caribbean low technology food production systems are unable to compete. This leads to an

increase in unemployment since farm workers are retrenched and small farmers no longer produce their traditional crops. Energy prices rise, the regions' import bill increases, and as mentioned before, reforms are called for, which refocuses the path of agriculture. Greater political and economic integration of the Caribbean, mainly through the CSME allows for labour to move to other islands where their skills are needed. The marginal product of agricultural labour therefore increases in countries that have a comparative advantage, namely Belize and Guyana and these two countries become the 'bread basket' of the Caribbean.

To compete with imported food, high technology is employed increasingly, which allows for example non-arable land to be cultivated. The technology for the new agricultural processes comes from other southern nations. Companies from these nations invest in the Caribbean since the Caribbean has access to the lucrative American market under the commissioned FTAA. The region's food systems are now characterised by large scale high-tech operations mainly in Belize and Guyana that sell to other Caribbean nations as well as export to North America. Agriculture in some of the other islands is also characterised by high technology for export to "new green markets" but mainly in high value added products such as horticulture and the development of processed indigenous products for niche markets.

Impact of GEC

Small farming in the Caribbean becomes particularly vulnerable to increases in number and intensity of storms. The poor land tenure means that small farmers are unable to insure against these events and are forced to leave agricultural production. The new high tech farms in Belize and Guyana have invested in storm resistant crops as well as buildings, which help protect against the adverse impacts of more extreme events. For example, salt marshes, which have increased due to hurricane activity, have been converted into arable land through the use of technology. Market policies, such as insurance and market based environmental policies such as ecosystem markets help protect the environment. The Caribbean however, still has a food import bill and GEC means that this is a source of vulnerability as storms interrupt the shipping and delivery of food both imported to the Caribbean as a whole and within the region from the new "Caribbean food baskets" of Belize and Guyana. This means that buffer stock arrangements are made and during the non-hurricane season, raw agricultural produce from Belize and Guyana are stored in some islands. Processing of food, a non-traditional form of agri-business, becomes an important industry for some islands as a further adaptation to GEC.

Food system activities

- Processing is characterized by waste and pollution minimization and meets international quality and safety standards.
- Distribution infrastructure is strong and environmentally sound.
- Higher food miles intra-regionally, but lower extra-regionally.
- Retail emphasis on environmental and nutritional benefits.

- Better education results in consumption of healthier and most expensive foods.
- Food consumption based on cultural preferences remains strong.
- Eco-tourism also drives regional food production.
- Social value of food remains high and the movement of skilled labour results in a deeper multicultural mix.

Adaptation and Response Options and Related Issues

Technological transformation

Technological transformation of the agricultural sector is likely with the use of technology transferred from southern nations, such as Mauritius and China. A present example is Brazilian investment in ethanol from cane in Jamaica and other countries. Brazil's president, Luiz Inacio Lula da Silva has pledged investment and export financing from his country's development bank, BNDES, for Jamaica's sugar sector if Brazilian firms go ahead with plans to invest heavily in Jamaica's sugar and ethanol industries (Jamaica Observer, 9 November 2005).

This type of technology transfer from other developing nations becomes more likely as the Caribbean becomes integrated into the FTAA in this scenario and there is a need for greater productivity in agriculture. Ethanol provides a good example of how new trading partners and markets can be nurtured in the face of changing WTO rules. The Jamaican sugar industry is reformed because of the intention by the Europeans to reduce the price by 39% that they pay for sugar from ACP countries like Jamaica. The Brazilians with better production techniques are able to help the Jamaicans transform their sugar industry into a modern sector that is able to compete. This scenario repeats itself in the Caribbean as new trade regimes are established and Caribbean agriculture needs to be reformed to compete in the future or over the next five decades.

Overview

Key Factors in the Caribbean Techno Garden Scenario

Farm subsidies in America and Europe are reduced
Farming becomes more competitive, with adverse impact on Caribbean food production
Caribbean integration increases and CSME is implemented and free movement of labour is allowed
Belize and Guyana become 'Caribbean Food Basket'
Technology from south is employed
Major GEC affecting region is CC with frequency and intensity of windstorms increasing
Delivery of intra regional and extra regional agricultural produce is vulnerable to storms

Scenario 4: Caribbean Adapting Mosaic

A Caribbean Scenario coherent with the MA-Scenario: Adapting Mosaic

by Sharon Hutchinson, Dunley Auguste and Joseph Lindsay

Global Context

In the *Caribbean Adapting Mosaic* scenario population continues to grow, peaking at to 9.5 billion in 2050. This is a result of high fertility rates up to 2010, which decline only slowly to a medium rate by 2050. Initially, in developed countries, medium rate of GDP growth continues; developing countries in general are worse off relative to developed countries, and have a low GDP growth rate. However, over time, these income growth rates increase, leading to a per capita growth rate of around 1.9 % by 2050 for all countries. International cooperation is weak, and with regard to environmental concerns there is a focus on the local level only. Over time, countries increase investments in human capital and new produced assets, even though these investments are initially medium and low for the developed and developing countries respectively.

Technology advances are medium-low across all countries. The absence of a climate policy globally, coupled with local-regional co-management, leads to mixed outcomes in specific environmental quality changes. Human well-being is generally expected to rise in the areas of: material well-being; health, security, social relations and freedom of choice for all countries.

Caribbean Context: Regional Interpretation of the Global Assumptions

This scenario assumes that for CARICOM countries, there is a focus on harnessing local skills, knowledge, expertise, and institutions in order to improve the quality of local ecosystems. It is also recognized that the local ecosystems are the bases for sustainability of these economies. The primary management approach is at the national, and not the regional level, and each country adopts its own, and varied style of management. Approaches range from rigid to flexible methods of assessing ecosystem performance.

There is a wide range in the economic status of Caribbean countries. However, all of the region's countries are viewed as developing. For this region, population growth rates are low, and may continue to fall as out-migration increases. Per capita income growth rates are low on average, but are expected to rise. Caribbean countries do not cooperate much with extra-regional countries or institutions on environmental policy issues, and the focus is conserving national or regional environments only.

An increased emphasis on tertiary education and training leads to increases in human capital, and investment in physical capital, though currently low, rises in the coming decades. Despite the rise in human capital, the continuation and possible increase in human capital migration result in medium-low technology advances by 2050. Until 2015 individual nations, or groups of nations, focus on their own environments using local-regional co-management.

It is expected that there is less concentration in mega urban centres. Instead there are more small urban centres around communities. As a result there is expected to be less rural-to-urban migration. Countries are expected to become more insular. This restricts trade flows and therefore there is less injection of investments of money from outside the Caribbean both in terms of aid and foreign exchange. Caribbean countries adapt to the new world order and therefore initially overall economic growth in the Caribbean declines but experiences low steady growth after 2015. As a result of the emphasis on community development, there is more equitable wealth distribution. In the transition period unemployment rises initially, and then falls steadily overtime.

The dominant policy is geared towards national and regional food security. To promote this, there is strong promotion of agricultural knowledge science and technology (AKST). This is applied towards the development of products for niche marketing, such as organic and functional foods (low volume/high quality/high price). As a result of restricted trade flows, local food prices are also expected to go up in the short term and down in the long term. There are higher investments in AKST funded by a mix of private and public sector partnership initiative and funding. This aims at improving sustainability and environmental resources. There also are higher investment in human capital, which boosts local capacity.

The CARICOM Single Market plays a more effective role by 2010 and thereafter. High labour movement occurs intra-regionally and labour follows emerging options. The economic disparities among countries drive the mobility of labour. There is some regional cooperation initially but this is limited, and sustainable development is addressed on a national level. The CARICOM single economy (CSME) is enacted by 2020.

Global and Caribbean Environmental Changes

Under the *Caribbean Adapting Mosaic* scenario, there is expected to be an increase in the ecosystem's ability to provide fuel, genetic resources and ornamental resources in industrial and developing countries in the long run. In all Caribbean countries, there is also expected to be an increase in water regulation, erosion control, water purification, storm protection and pest control. There is, however, not expected to be any change in air quality regulation, climate regulation and the rate of pharmaceutical discoveries.

Global mean temperature is expected to increase by 1.5 to 2.0 degrees Celsius by 2050, however, in the Caribbean, the change is expected to be less: 1.0 to 1.5 degrees Celsius rise. Global and

Caribbean sea levels are expected to rise 25-30 cm by 2050. This leads to a rise in salt-water intrusion. Rainfall mean and variability are expected to increase globally but with diverse spatial global patterns. In the Caribbean, there are huge uncertainties with a potential for decreases in mean and variability but increases in its intensity. Extreme weather may increase globally with increases in sea temperature. In the Caribbean there is uncertainty as to the frequency of extreme weather events but there is a potential or an increase in frequency of these events, which further increase the Caribbean's vulnerability.

Caribbean countries focus on the Caribbean Sea, forests, energy, freshwater and coastal zone management as key to their development. While each country recognizes its own autonomy, there continues to be the development of the CARICOM Single Market and Economy (CSME), which is expected to be fully implemented by 2020, with commitments by all governments and without any major barriers.

Community level activism increases, and is spurred by deteriorating local problems, such as flooding, unemployment and natural disasters. This is coupled by an increased demand for natural resources, and rising oil prices. There is also growing movement toward developing eco-tourism as a viable economic activity.

Fresh water quality and quantity are expected to decline under the *Caribbean Adapting Mosaic* Scenario. More integrated land management practices reduce the incidence of flooding. More small-scale agriculture is promoted, and more marginal lands are brought into production. This small-scale agriculture is intensive and focuses on niche products. In the Caribbean there is a better water management and the implementation of new green technology. As a result, the incidence of flooding is expected to further decline, and in the cases where flooding occurs, the water is retained and better utilized. In addition, better water management leads to increased availability of water, which in turn can be used to facilitate agricultural production on marginal lands. Pollution is relatively low as a result of proactive environmental planning and the implementation of more local solutions through community participation and empowerment.

The dominant role of community management leads to the better use of local fisheries. However, since fisheries resources are shared without regional supervision, national-level management of the fish stock of fisheries leads to sub-optimal decisions. This hastens the decline in regional seafood availability, and over time, may lead to the collapse of these fisheries.

Impact on Caribbean Food Systems

Food System Activities

Production in *Caribbean Adapting Mosaic* is based on small-scale agriculture. It is anticipated that food prices rise. To combat this rise in prices, initiatives are implemented aimed at increasing

productivity. The increased competition for land seen throughout the Caribbean, especially from tourism, housing and industry, boost the local price for land (which push food prices up). Local food production activities rise, as a result of the reduction in extra regional trade. However, there is more local-regional trade, to offset the declines in extra-regional trade.

The economies of the Caribbean focus on increasing the variety of secondary food product. In this light, processing of local food is key to sustaining local food production. With the development of more small urban centres, it is anticipated that there is an increase in local distribution of food. However, the variety of food stuff at local markets decreases, with less trade for certain commodities as a result of limited production capacities in the region. Consequently, there also is less variety in the consumption patterns. There is more use of local food, but local food prices are higher because of initial lower levels of overall food availability.

Food System Outcomes

The amount of food from regional production slowly increases, particularly in the area of niche products. There is greater distribution of products, since there is greater proximity of production and consumption centres (more decentralization), as a result of more local market places. The efficiency of food distribution depends on the intra-regional transport services. Initially, there is higher inequity as countries transition from current trade systems, but over time there is a more favourable distribution of food.

There is a slowing down with exchange extra-regionally, but an increase in intra-regional trade. Intra-regional trade is a must, but this depends on the level of Caribbean cooperation. There is a lower affordability of food, as the moderate increases in wealth are outweighed by food price increases. This outcome can be mitigated only if agricultural productivity increases. There is not expected to be any change in the allocation of food, as current formal and informal marketing systems work well. There are mixed effects on food preferences. Some persons prefer local foods over time; others continue to prefer foreign foods. These effects are based on food prices and the availability of convenience foods.

In this scenario, there is also much greater nutritional value food available. This occurs as a result of a significant rise in education about food, better food quality, more local control and the greater availability of fresh food. Social value of local food also greatly increases, as imported food is less available. Food safety outcomes are mixed. Initially there are no systems in place to ensure adequate food safety, regulation or enforcement. As planning and training increases, food safety increases over time.

Adaptation and Response

In order to adapt sufficiently to the emerging changes under the *Caribbean Adapting Mosaic* scenario, varied responses are implemented. As global temperature increases, the Caribbean economies are forced to engage in adaptation research, i.e. find new flora and fauna species to adapt to changing climatic conditions, find new food production systems, as well as engage in more mechanization, and appropriate agricultural technology to improve productivity. Overall more traditional or other local knowledge is applied.

To combat the water availability stress, new regulations are implemented for building the economy with water harvesting, and water saving techniques. This also includes the use of differential pricing policies for water use to encourage more efficient use of water by all users.

Sea walls are built in Belize and Guyana, to combat rising sea level. There is an increased use of aquaculture and mariculture, to supplement the availability of harvested wild fish. In order to maintain and/or increase wild fish stocks, stringent fishery management policies and strategies are implemented. This includes the use of environmental assessments, quotas, bans and community management. Supplementing this, there is more research on role of the environment on fisheries (for better understanding), and to improve the region's adaptive capacity.

To combat existing pollution, advocacy rises to build public awareness. Waste management systems are implemented to reduce land-based sources of pollution.

Since the emphasis is on managing local environments, there are more pro-active safety nets, such as crop insurance, not only for traditional crops, but also for a fairly wide range of crops to promote food security. Supporting this, also a comprehensive disaster management system is introduced in most regions, as well as strategies to reduce risk in fisheries and integrated coastal zone management.

References

European Environment Agency - EEA (2005). European Environment Outlook. European Environment Agency, Copenhagen, Denmark.

Global Environmental Change and Food Systems - GECAFS (2005). GECAFS Science Plan and Implementation Strategy, Earth System Science Partnership (IGBP, IHDP, WCRP, DIVERSITAS) Report No. 2, Wallingford, United Kingdom.

Ericksen, PJ (2006). Conceptualising Food Systems for Global Environmental Change Research (in prep).

Intergovernmental Panel on Climate Change - IPCC (2000). Special Report on Emission Scenarios (SRES), Intergovernmental Panel of Climate Change, Cambridge University Press, Cambridge, United Kingdom.

Millennium Ecosystem Assessment - MA (2006). Ecosystems and human well-being : Scenarios - Findings of the Scenarios Working Group, Millennium Ecosystem Assessment. Island Press.

United Nations Environment Programme - UNEP (2002). Global Environmental Outlook 3, Earthscan, London, United Kingdom.

Annex I – Participants

Workshop participants

Name	Affiliation	1st WS	2nd WS
John Agard	UNEP and University of West Indies Trinidad & Tobago		X
Dunley Auguste	Ministry of Agriculture, Forestry and Fisheries St Lucia	X	X
Dr Ballayram	Caribbean Food and Nutrition Institute (CFNI) Jamaica	X	X
Christine Bocage	Caribbean Food and Nutrition Institute (CFNI) Jamaica	X	X
Charles Carmichael	FAO Caricom/Cariforum Food Security Project Trinidad & Tobago		X
Anthony Clayton	University of the West Indies (SALISES) Jamaica	X	
Angela Cropper	The Cropper Foundation Trinidad & Tobago		X
Andrew Downes	University of West Indies Barbados	X	
Albert Faeron	University of West Indies Jamaica	X	
Ronald M Gordon	CARICOM Secretariat (Agriculture Development) Guyana	X	X
Michael Harvey	University of West Indies Jamaica	X	
Sharon Hutchinson	University of the West Indies (Agriculture Econ.) Trinidad & Tobago	X	X
Joseph Lindsay	Bodles Research Station – Ministry of Agriculture Jamaica	X	X
Regine Louis	Université Quisqueya Haiti	X	
Donna McRae-Smith	CARICOM Secretariat (Sustainable Development) Guyana	X	X
Elizabeth Migongo-Bake	United Nations Environment Programme Kenya	X	
Terrence Philips	Caribbean Regional Fisheries Mechanism St Vincent & Grenadines		X
Justin Ram	University of the West Indies (Economics) Trinidad & Tobago	X	X
Gregg Rawlins	FAO Caricom/Cariforum Food Security Project Trinidad & Tobago		X

Adrian Rodriguez	IICA Costa Rica	X	X
Godfrey St.Bernhard	University of the West Indies (SALISES) Trinidad & Tobago	X	
Ranjit Singh	University of the West Indies (Agriculture) Trinidad & Tobago		X
Andrian Trotman	Caribbean Institute for Meteorology and Hydrology Barbados	X	X
Neville Trotz	University of Belmopan (Climate Adaptation) Belize	X	

GECAFS Team (International Project Office, Scenarios and Decision Support System)

Name	Affiliation	Focus
Polly Ericksen	GECAFS International Project Office UK	Vulnerability
Thomas Henrichs	GECAFS International Project Office UK	Scenarios
John Ingram	GECAFS International Project Office UK	Executive Officer
Lauren Justice	University of Florida USA	Decision Support Sys
Greg Kiker	University of Florida USA	Decision Support Sys
Arvin Mosier	University of Florida & GECAFS Int Project Office USA	Decision Support Sys
Monika Zurek	FAO Italy	Scenarios

Annex II – Participants evaluation of workshops

At the end of the second workshop, participants were asked to evaluate the scenario exercise. The evaluation questionnaire was based on five questions. In total, twelve responses were received; this section reports these:

Question 1: From your perspective, was this workshop worth attending?

All responses were positive. Some additional comments were raised, such as:

- Discussion was interesting, but we also need to discuss how to incorporate findings into policymaking.
- Assisting in developing scenarios that can make our policy-makers think (about alternative) is worth it. It is also important in helping the GECAFS Caribbean programme to focus better.
- Yes, but I am concerned about the outcomes getting to the relevant policy makers to properly plan against these scenarios.
- Yes, very much so. It helped to share with other persons.
- It provided a different perspective regarding development planning.
- Very valuable – it would be helpful in the implementation of CARICOM/FAO food security project.
- The workshop was well planned and the objectives were met. It allowed me to think a bit more long-term and gave new meaning to the short-term planning that we do in the region.
- This was a worthwhile exercise. It raised very topical issues and proposed some really interesting solutions.
- Actually, I think this has been the best of the 4 workshops I have attended this year.

Question 2: Did you gain any new insights from this workshop and the scenario exercise?

Again, all responses were positive. Some additional comments were raised, such as:

- Absolutely!
- Gave me info on scenario building, especially on how to evaluate scenarios as a method of scientific research. Additionally I have gained a more structured way of looking at food systems in the Caribbean and the importance of GEC.
- A lot of new insights about the different ways the world may transform, and how it may affect the Caribbean.
- Different possible worlds help to think about policy solutions.
- Yes, all scenarios are important for decision-making. None is more likely.
- Yes, developed an appreciation for the scenario research from the presentations and participation in group discussions.
- Yes, but I still have a fundamental problem with the philosophical foundation and rationale of the TechnoGarden scenario (of the Millennium Ecosystem Assessment).
- Yes, I learnt a tremendous amount – particularly on how GEC impact on Caribbean food systems.
- The need for long-term planning and integration of different views and situations.
- Yes, it emphasised the need for long-term visioning in the face of uncertainty.
- Yes, I gained insight into the food system activities with which I was not familiar (not having participated in the Jamaica workshop)

Question 3: *Is there anything that could have been better during the workshop(s)?*

Overall participants were satisfied with the course of the workshop:

- No, not that I can think of.
- Not really. I believe we addressed any issues that would have affected the smooth running of the workshop.
- No. Guidance from resource persons (i.e. GECAFS Team) was excellent.
- The workshop was well organized and the facilitation has done exceeding well.

Nevertheless, some suggestions regarding logistics and agenda were made:

- I really cannot think about that at this time. Maybe a ‘little’ meeting with the people involved in the SANREM proposal, involving national and regional organisations.
- Yes: A bit more timely provision of hard copies of some of the intermediate outputs of our discussions.
- Perhaps start earlier and finish earlier. Otherwise it was very well executed. The final session in relation to concrete response in the Caribbean to the GEC situation could have been more in-depth.
- The Caribbean programme might be a bit different to the other two regions. I think therefore that an approach which separates national / local thinking (as in the general Caribbean plan) from regional (centre of analysis) from the beginning might have made thinking clearer. Some of this was later resolved. Also thinking about a rosy options in each of the four worlds helps policy-makers think more positively

Question 4: *Do you have any comments on and how would you rate:*

(a) Meeting organisation, logistics?	Excellent (2)	Very Good (6)	Good (2)
(b) Workshop agenda, facilitation?	Excellent (5)	Very Good (5)	Good (2)

Question 5: *Any other comments?*

- The workshop could benefit from more stable / consistent participant attendance.
- In a few instances some sessions dragged, causing my attention to wander. I’m unsure whether this was a perception of other participants. I welcomed the opportunities to contribute.
- One more day would have allowed for the full completion of the scenarios.
- Useful exercise – How can we get the messages across to society and policy-makers.
- There was a lot of hard work of the organisers, and I really appreciate it. It made things flow very well and they were able to clarify ideas.
- Looking forward to future collaboration.
- Keep developing the scenarios