European Commission

Strategic Environmental Assessment (SEA) of the implementation of the Accompanying Measures for Sugar Protocol Countries affected by the reform of the EU Sugar Regime in the Cooperative Republic of Guyana

SEA Study

Project No. 2013/319027

This project is funded by
The European Commission

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HTSPE Limited

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22 November, 2013

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ACRONYMS AND ABBREVIATIONS

“	Inches
°C	Degrees Celsius
µg	Micrograms
% pol	% polarisation
AAP	Annual Action Plan
ACP	Africa, Caribbean, Pacific
ADP	Agriculture Diversification Programme
ADRM	Agriculture Disaster Risk Management
AEP	Agro-Energy Policy
AMS	Accompanying Measures for Sugar
BCH	Burnt Cane Harvesting
bn	Billion
BOD	Biological Oxygen Demand
BP	Business Plan
CARDI	Caribbean Agricultural Research Institute
CARICOM	Caribbean Community
CBD	Convention on Biological Diversity
CCCCC	Caribbean Community Climate Change Centre
CDB	Caribbean Development Bank
CDC	Civil Defence Commission
CDM	Clean Development Mechanism
CER	Carbon Emissions Reduction
CHP	Combined Heat and Power
CIDA	Canadian International Development Agency
cm	Centimetre
CMS	Concentrated Molasses Solubles/Solids
CO	Carbon monoxide

CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
COLEACP	Europe-Africa-Caribbean-Pacific Liaison Committee
CPEIR	Climate Public Expenditure and Institutional Review
DAC	Development Assistance Committee
DDIA	Declared Drainage and Irrigation Area
DDL	Demerara Distillers Limited
D&I	Drainage and Irrigation
DNA	Designated National Authority
DRM	Disaster Risk Management
DSSAT	Decision Support System for Agrotechnology Transfer
E10	10% ethanol gasoline blend
E15	15% ethanol gasoline blend
EC	European Commission
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ENSO	El Niño – Southern Oscillation
EPA	Environmental Protection Agency
EPC	Engineering, Procurement and Construction
EPS	Environmental Permitting System
ET	Equatorial Trough
EU	European Union
EUD	European Union Delegation
FAO	Food and Agriculture Organisation of the United Nations
FLO	Fair Trade Labelling Organisations
g	Grams
G$	Guyana Dollars
GAWU	Guyana Agricultural & General Workers Union

GCCA	Global Climate Change Alliance
GEA	Guyana Energy Agency
GCH	Green Cane Harvesting
GCM	Global Circulation Model
GDP	Gross Domestic Product
GFC	Guyana Forestry Commission
GGB	Guyana Gold Board
GGMC	Guyana Geology and Mines Commission
GHG	Greenhouse Gases
GIS	Geographic Information System
GL&SC	Guyana Lands and Surveys Commission
GLDA	Guyana Livestock Development Authority
GNAP	Guyana National Action Plan
GoG	Government of Guyana
Go-Invest	Guyana Office for Investment
GPAS	Guyana Protected Areas System
GPL	Guyana Power and Light Inc.
GRDA	Guyana Rice Development Board
GRIF	Guyana REDD+ Investment Fund
GSA	Guyana School of Agriculture
GuySuCo	Guyana Sugar Corporation
GWh	Gigawatts hour
ha	Hectares
HCB	Hexachlorobenzene
HFA	Hyogo Framework for Action
ICZM	Integrated Coastal Zone Management
IDB	Inter-American Development Bank
IFOAM	International Federation of Organic Agriculture Movements

IICA	Inter-American Institute for Cooperation on Agriculture
IPCC	Inter-governmental Panel on Climate Change
IPM	Integrated Pest Management
IPP	Independent Power Producer
ISO	International Organisation for Standardisation
ITCZ	Inter-Tropical Convergence Zone
IWRM	Integrated Water Resources Management
km	Kilometre
km^2	Squared kilometres
kPa	Kilopascals
KTM	kill-to-mill
LCDS	Low-Carbon Development Strategy
m	Metre
m^3	Cubic metres
m^3/s	Cubic metres per second
m^3/s	Cubic metres per year
mg/l	Milligrams per litre
mm	Millimetres
mm/yr	Millimetres per year
MoA	Ministry of Agriculture
MoNRE	Ministry of Natural Resources and the Environment
MRV	Monitoring, Reporting and Verification
MTEF	Medium-Term Expenditure Framework
MW	Megawatts
N	Nitrogen
NAACIE	National Association of Agricultural, Commercial and Industrial Employees
NAREI	National Agriculture, Research and Extension Institute
NDIA	National Drainage & Irrigation Authority

NDS	National Development Strategy
NEAP	National Environmental Action Plan
NFPS	National Forest Policy Statement
NGMC	New Guyana Marketing Corporation
NH_3	Ammonia
NIP	National Implementation Plan
NGO	Non Governmental Organisation
NO_X	Nitrogen oxides
NLUP	National Land Use Plan
NPC	National Parks Commission
OCC	Office of Climate Change
OECD	Organisation for Economic Cooperation and Development
P	Phosphorous
PAC	Protected Areas Commission
PCB	Polychlorinated biphenyls
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PEER	Public Environmental Expenditure Review
PER	Public Expenditure Review
pH	Hydrogen potential
$PM_{2.5}$	Particulate matter under 2.5µ
PMO	Project Management Office
POP	Persistent Organic Pollutant
PPA	Power Purchase Agreement
PRS	Poverty Reduction Strategy
PRSP	Poverty Reduction Strategy Paper
RDB	Regional Democratic Board
REDD	Reduction of Emissions from Deforestation and Forest Degradation

SEA	Strategic Environmental Assessment
SLM	Sustainable Land Management
SO_2	Sulphur dioxide
SPS	Sanitary and Phytosanitary
SRDB	Sea and River Defence Board
SSMP	Skeldon Sugar Modernisation Project
ST	Short-term
SWAPS	Single Window Automated Processing System
t	Tonnes
t/ha	Tonnes per hectare
t/hr	Tonnes per hour
TC	Tonnes of cane
TERI	The Energy and Resources Institute
TEQ	Toxic equivalence
TSS	Total Suspended Solids
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US$	United States Dollars
USA	United States of America
VOC	Volatile Organic Compounds
VRA	Vulnerability and Risk Assessments
WICSCBS	West Indian Central Sugarcane Breeding Station
WMA	Wildlife Management Authority
wt%	Percentage by weight
yr	year

0. EXECUTIVE SUMMARY

Guyana is a country that has benefited from the provisions of the European Union (EU)/ACP Sugar Protocol, allowing it to export a quota of sugar to the EU market at a guaranteed price. In 2006, the EU Common Organisation of the markets in the sugar sector was reformed. The reform included a significant reduction in the price of sugar (36%) over four years beginning in 2006/07. The European Commission (EC) proposed an assistance scheme to help the Sugar Protocol countries that depend on the EU market to adapt to the new situation.

In the case of Guyana the adaptation strategy is reflected in the **National Action Plan on Accompanying Measures for Sugar Protocol Countries Affected by the Reform of the EU Sugar Regime** (GNAP) of 2006. The GNAP is being supported by the EU through its Multi-annual Indicative Programme for the Accompanying Measures for Sugar (AMS).

As the implementation of the GNAP may have impacts on the environment, the EC has foreseen to carry out a Strategic Environmental Assessment (SEA) to provide recommendations both to the EU and the Government of Guyana (GoG) to enhance the environmental and climate change (adaptation/mitigation) performance of the GNAP.

SEAs are ideally prepared during the planning process, as it is then that more opportunities are available to influence the shape and contents of the corresponding plan/strategy. In this particular case the GNAP has been long agreed (since 2006) and the AMS are phasing out. This situation necessarily limits the scope of influence that the SEA may have but, in the presence of political will to work towards sustainable development of the country, its findings should be useful to influence decisions in the GoG and the EU Delegation (EUD) towards the sector.

Due to the importance on the sugar sector to the country's economy, the sugar reform is not only affecting the sector but the national economy in general, putting at risk the livelihoods of a large percentage of the population. According to the GNAP (Government of Guyana, 2006a), the value of lost preferences was expected to be equivalent to 5.1% of GDP and 5.4% of merchandise exports annually. The economic impact would most immediately be felt in the balance of payments, putting at risk Guyana's reserves position, the exchange rate and capacity to service debt, as well as affecting investor confidence. Other impacts include: (a) a decline in the contribution from sugar to government revenues via income tax, corporation tax, property tax, land rent, import duty and national insurance, (b) reduced social service provision, (c) reduced income and employment amongst suppliers to the sugar industry and services used by sugar workers, and (d) increased social ills.

The main objective of the GNAP is to generate economic growth by bringing about sustainable improvements in the competitiveness of the sugarcane industry and the non-traditional agricultural sub-sector. It consists of three specific elements:

1. To promote the expansion and development and diversification of the sugar cane industry in Guyana;
2. To promote the growth and development of specific non-traditional agriculture sub-sectors; and
3. To provide infrastructural and human resource development support to achieve the points above.

The major thrust of is on the first of the above pillars, which is also the area of attention of EU support. The support to non-traditional agriculture has been provided mainly through the Inter-American Development Bank (IDB) Agriculture Diversification Programme (ADP).

Actions under the GNAP include the following.

Under the objective to support sustainable improvement in the competitiveness of the sugar sector: drive towards mechanised harvesting; upgrading and expansion of factories; installation of a packaging plant; construction of a raw sugar factory (Skeldon); construction of a refinery; construction of co-generation plants; support to private cane farmers; investment in the drainage system; construction of a deep water berth; ethanol production; and storage, shipping and logistics.

Under the objective to promote non-traditional agriculture: establishment of an Agricultural Business Development Unit; establishment of a Plant Health System; support to the beef sector; creation of a semi-autonomous fisheries authority; promotion of aquaculture and IPM; strengthening the land lease allocation system; and establishment of a credit facility for non-traditional agricultural exports.

Under the objective to promote economic regeneration through infrastructural and human resources development support: maintenance of drainage & irrigation structures; all weather farm access roads; training programme for career development; and a technical training programme.

The first part of the SEA was the Scoping Study, where key aspects were identified. These were subsequently validated and adapted accordingly through a stakeholders' workshop. Key aspects are categorised as Higher- and Lower-priority.

The SEA Study assessed the key aspects in further detail. Potential impacts were identified and assessed leading to recommendations to address key aspects and optimise environmental and climate change performance of the GNAP and the sugar sector. Positive impacts and practices in the sector are also identified and highlighted.

The performance indicators included in the Annual Action Plans (AAPs) are analysed to verify their implications for the environment and climate change adaptation/mitigation point of view.

The SEA was based primarily on: a comprehensive literature review; bi-lateral and multi-lateral semi-structured interviews with key actors; a stakeholders' workshop using the 'world café' format; use of Leopold-type matrices; site visits (Skeldon and Albion); and expert judgement. The Scoping and SEA Study reports were distributed to all key stakeholders for comments.

Key Issues

Key issues identified are outlined below, noting some of the basic underlying factors behind them.

Higher priority key issues

1. Drainage and irrigation capacities

    - Changes in weather regime demand higher drainage capacity, which is also compromised by increase in farming backlands, urban expansion, inadequate solid

waste management and encroachment into drainage canal banks not allowing proper maintenance.

- Under climate change more intense rainfall events are expected, but currently planning is not addressing longer-term climate change concerns.
- In addition, increased drought conditions are expected under climate change; the current irrigation system for sugar cane is based on inundation, which is the most water inefficient, and thus adds to climate change vulnerability in the sector. As well, irrigation by inundation puts extra pressure on the drainage system.
- There is a *de facto* overlap of institutional responsibilities for the management of the drainage system.

2. Integration of long-term climate change adaptation in the sugar industry and key government institutions
    - Despite the fact that the country is highly vulnerable to climate change, there is no known detailed climate change impact and vulnerability assessment, especially when it comes to non-traditional agriculture. Potential impacts are related mainly to increased rainfall intensity, a reduced rainfall season, increased temperatures, increased evaporation, sea level rise and salt water intrusion.
    - Institutional capacities within Hydromet are wanting and necessary tools (e.g. downscaled models) are not readily available.
    - Climate change adaptation is mainly responding to climate variability, but hardly looking at changes expected in the longer-term. This may be relevant to the sugar sector, particularly in relation to cane varieties, pest & disease dynamics, drainage capacities, and irrigation systems. In relation to non-traditional agriculture aspects such as salinity intrusion effects on aquaculture and grazing lands are to be considered.
3. Missed opportunities associated to non-traditional agriculture
    - Non-traditional agriculture is promoted by the LCDS as a low carbon sector. It is also promoted more generally by the Government in the context of poverty reduction and food security, and taken up by the GNAP (aquaculture, fruits & vegetables and livestock). Nevertheless progress has proved very limited.
    - Long-term climate change vulnerabilities for non-traditional agriculture are not well understood and deserve attention.
    - Non-traditional agriculture is being promoted in the intermediate savannahs, which are rich in biodiversity but don't enjoy any degree of protection under the Guyana Protected Areas System (GPAS), so any developments may entail a significant impact on biodiversity.

<u>Lower priority key issues</u>

4. Missed opportunities and potential impacts associated to fuel blending
    - Fuel blending is being promoted, although not yet supported by a national level energy policy.
    - Fuel blending has as its main advantage the reduction in fuel dependency and the reduction in the fuel imports bill. Environmental and climate change benefits may

also be obtained; although these require more attention to define, blended gasoline does not result in increased pollution.

- The production of ethanol has been promoted mainly targeting export-oriented foreign investment that has not materialised due to a number of reasons. However a distillery attached to a sugar factory would probably be a feasible alternative; it would have the environmental advantage of not requiring the take-up of additional lands and making use of molasses that are currently being produced.
- GuySuCo has an agreement with DDL to provide them 90,000 tonnes of molasses annually, which would only leave some 30,000 tonnes available for ethanol production, probably insufficient to achieve an E10 blend. This means that either the Government could start with a lower-grade blend, or renegotiate with DDL in order to reduce the supply of molasses for rum production.
- Production of ethanol generates vinasse, a highly polluting by-product that requires careful management. The capacities of the EPA are currently limited, and may need strengthening to adequately deal with enforcement of legislation to control potential pollution of water bodies by vinasse. The upcoming restructuring of the EPA should be a starting point to strengthen its capacities.

5. Missed opportunities associated to co-generation
    - Co-generation brings benefits through increasing energy efficiency in the sugar factories, valorising a by-product (bagasse), contributing to climate change mitigation, and potentially contributing to increase electricity supply in the region.
    - The GNAP promotes the construction of co-generation plants in the sugar factories, and so far only one has been built at Skeldon, which is also registered under the CDM. However it does not have a constant nor sufficient supply of bagasse and relies on the burning of heavy fuel oil to satisfy the electricity generation it has to supply to the regional grid as per its Power Purchase Agreement (PPA) with the electricity company.
    - The co-generation plant at Skeldon, as it relies on the burning of heavy fuel oil, has not generated any Carbon Emission Reductions, which is compromising its CDM register.
    - The increased mechanised harvesting at GuySuCo opens a potential to shift to green cane harvesting, which has various agronomic and environmental advantages, including, inter alia, the reduction in the generation of Persistent Organic Pollutants (POPs), health benefits, and a longer kill-to-mill time for the sugar cane.
    - Sugar cane trash (tops and leaves) can be either left on the ground for mulching, or used as fuel to complement bagasse in co-generation. The best option can only be determined through a careful cost-benefit analysis (including environmental and climate change mitigation/adaptation considerations).

Recommendations

Focused recommendations are put forward to address each of the Key Issues, which have implications for different institutions. Care has been taken to maintain recommendations at a strategic level, and taking into account the local context and feasibility considerations.

Recommendations are linked, where possible, to GuySuCo's Strategic Plan 2013-2017.

Recommendations are structured based on an objective to which they contribute, and the definition of specific activities.

Key recommendations are as follows (details are not reproduced and can be consulted in Sections 11 and 12 of this report).

1. **Drainage and irrigation capacities**
    - Objective 1: Upgrade the drainage capacities to take account of climate change
        - Define drainage capacity to cope with current climatic conditions and climate change in the medium- and long-term
        - Optimise exiting drainage capacities
    - Objective 2: Achieve an adequate institutional and regulatory framework conducive to efficient and effective management of the drainage and irrigation system
        - Review the legal mandates of all institutions involved or implicated in the management of the D&I system, their capacities and inter-institutional coordination mechanisms and prepare a firm proposal for any necessary institutional restructuring
        - Review the regulatory framework involved in the management of the D&I system and other activities that affect its efficiency, including its effectiveness and enforcement record
    - Objective 3: Increase drainage efficiency
        - Design and develop more appropriate field layout and drainage designs that are mechanised-harvesting friendly
    - Objective 4: Increase water-use efficiency in sugar cane cultivation as a climate change adaptation measure
        - Develop alternative irrigation systems to mitigate drought conditions predicted under climate change
        - Carry out applied research into changing crop scheduling, planting at different times and different systems of planting
2. **Integration of long-term climate change adaptation in the sugar industry and key government institutions**
    - Objective 5: Achieve a good understanding of climate change impacts and vulnerabilities in the agriculture sector
        - Carry out a detailed impact and vulnerability assessment for the agriculture sector
        - Identify and prioritise adaptation measures
        - Prepare a climate change adaptation strategy for the agriculture sector and GuySuCo
    - Objective 6: Achieve a more effective institutionality for climate change that would promote effective mainstreaming in key sectors

  - Review the role of the Office of Climate Change so it acts as a broker for attracting climate finance for the adaptation and mitigation measures that form part of the strategic development plans of the different ministries and agencies

- Objective 7: Achieve a more effective mainstreaming of climate change in the budgeting process
- Objective 8: Contribute to facilitate the access to international climate finance

3. Missed opportunities associated to non-traditional agriculture

- Objective 9: Adopt a more strategic approach towards selecting and developing land for agricultural diversification
  - Conduct an audit of all abandoned and unused agricultural land for consideration in the agricultural diversification process
  - The land administrative process should optimise the use of technical expertise to provide advice on in-depth environmental considerations of land use and development strategies
  - Expedite biodiversity mapping programme to determine biodiversity hotspots, especially within the intermediate savannah for preservation
- Objective 10: Promote integrated farm management practices that foster sustainable development
  - Revisit the results of the FAO IPM pilot project, where the integration of aquaculture with rice production showed promising results with a view to encourage commercialisation
  - Conduct research in the production of bioenergy from excrements and agricultural waste with a view to supply required in situ farm energy
  - Promote the production of organic farming systems
- Objective 11: To incentivise the initiatives of farmers to promote adaptation of new technology and advance development of the non-traditional sub-sectors
- Objective 12: Establish healthy agricultural value chains to strengthen the export potential of non-traditional agriculture

4. Missed opportunities and potential impacts associated to fuel blending

- Objective 13: Secure the availability of ethanol blended fuel in the Guyana market
  - Design and construct an ethanol distillery and blending facility attached to a sugar factory with capacity to satisfy the fuel blending market in Guyana
  - Develop the necessary policy and regulatory framework to guarantee a market for bioethanol in fuel blending
- Objective 14: Minimise the environmental risks associated to vinasse management in the production of ethanol
  - Proceed with the review and restructuring of the EPA
  - Ensure any bioethanol distillery integrates vinasse treatment to sufficient standard to comply with international effluent discharge standards

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5. Missed opportunities associated to co-generation

- Objective 15: Increase the share of renewable energy use in Guyana through the role of Independent Power Producers (IPPs)
- Objective 16: Maximise the environmental and economic opportunities opened up by mechanised harvesting through a shift to green cane harvesting

PART I INTRODUCTION AND BACKGROUND

1. BACKGROUND

Guyana is a country that has benefited from the provisions of the European Union (EU)/ACP Sugar Protocol, allowing it to export a quota of sugar to the EU market at a guaranteed price. In 2006, the EU Common Organisation of the markets in the sugar sector was reformed. The reform included a significant reduction in the price of sugar (36 %) over four years beginning in 2006/07. The European Commission proposed an assistance scheme to help the Sugar Protocol countries that depend on the EU market to adapt to the new situation.

In the case of Guyana the adaptation strategy is reflected in the **National Action Plan on Accompanying Measures for Sugar Protocol Countries Affected by the Reform of the EU Sugar Regime** (GNAP) of 2006. The GNAP is being supported by the EU through its Multi-annual Indicative Programme for the Accompanying Measures for Sugar (AMS).

As the implementation of the GNAP may have impacts on the environment, the EC has commissioned a Strategic Environmental Assessment (SEA) with the following objective:

> *"to (confirm and) complete the findings and recommendations of the GNAP pertaining to environmental issues. In addition, the SEA will provide decision-makers in the EU and other donors and in the partner country with relevant information to be integrated in the decision-making and implementation process".*

The SEA provides recommendations both to the EU and the Government of Guyana (GoG) on how to enhance the environmental and climate change (adaptation/mitigation) performance of the GNAP (including its component on agricultural diversification).

SEAs are ideally prepared during the planning process, as it is then that more opportunities are available to influence the shape and contents of the corresponding plan/strategy. In this particular case the GNAP has been long agreed (since 2006) and the AMS are phasing out. This situation necessarily limits the scope of influence that the SEA may have but, in the presence of political will to work towards sustainable development (mainly in the agriculture sector) of the country, its findings should be useful to influence decisions in the GoG and the EU Delegation (EUD) towards the sector.

2. THE SUGAR SECTOR IN GUYANA

2.1. INTRODUCTION

The Guyana Sugar Corporation (GuySuCo) is fully owned by the Government of Guyana (GoG). The company was formed in 1976, when the GoG nationalised and merged the sugar estates. The rapid nationalisation of the sugar industry, which led to severe management difficulties and an emigration of talent, initially lacked the needed experience and perhaps more importantly, did not have access to the reserves of foreign capital required to maintain sugar plantations and processing mills during economically difficult periods.

In 2004 it was announced that Guyana was moving to modernise its sugar industry to cushion the impact of the African, Caribbean and Pacific (ACP) countries on the world market. As part of a strategic plan to reduce costs and improve productivity a new factory was built at Skeldon, including a co-generation plant. A distillery and a refinery were to be constructed at a later stage.

The agreement was also made in compliance with the World Bank targets and obligations to contribute to an overall reduction of global greenhouse gases and to introduce modern technologies to the sugar industry, which would improve efficiency.

GuySuCo is the country's largest cultivator and producer of sugar, a commodity responsible for approximately 20% of Guyana's annual revenue and 40% of all agricultural production. Its brown sugar is exported internationally to the European Union, the USA and the Caribbean Community (CARICOM) countries.

In 2012 GuySuCo contributed 9.5% of the Guyana's total exports, bringing in approximately G$ 27bn[1]; an increase of nearly 50% in foreign exchange earnings from 2000, thereby proving that sugar is still a significant contribution to the country's economy and an undeniable influence on social life.

GuySuCo is the largest single employer in Guyana with a labour force of approximately sixteen thousand people[2], which can translate into between fifty to eighty thousand persons that depend on the sugar sector. This income distribution effect is multiplied towards other leading industries that depend on sugar related activities for their business such as the shipping, retail/supermarket chains and the agricultural and factory equipment and machinery suppliers.

Furthermore, it is through the sugar industry that rural development can take place and a population balance between town and country is maintained[3]. And finally, the sugar industry contributes to health and safety through providing primary health care and education to people in the vicinity of the sugar estates.

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[1] Approximately 13.5 M€.

[2] Exact numbers are difficult to determine. Based on World Bank (2006) about 82% of the workforce in the sector was permanent staff vs. approximately 18% seasonal workers. To these numbers we should add the workers of independent cane farms and cooperatives as well as all the people whose jobs revolve around the sugar sector.

[3] According to World Bank data for 2012 (http://data.worldbank.org/indicator/SP.RUR.TOTL), 71.5% of Guyana's population is rural.

The GuySuCo Estates are all situated along the coast and tidal affected rivers, as illustrated in Figure 1. Traditionally the Coastal region experiences two wet seasons from May to July and from November to January, with two dry seasons from February to April and August to October.

FIGURE 1 LOCATION OF GUYSUCO ESTATES IN GUYANA

KEY: U – UITVLUGT; W-WALES; E-ENMORE/LBI; B-BLAIMONT; A-ALBION; R-ROSE HALL; S-SKELDON

2.2. CURRENT SITUATION OF GUYANA'S SUGAR INDUSTRY

GuySuCo operates six ageing factories, a new plant at Skeldon and eight sugarcane estates.

The vast majority of agricultural activities take place in the coastal plains. For more than 8 km inland the land is below sea level at high tide. Drainage and water control are major activities and agricultural development has always been tied to the defence against water intrusion from the sea and from rainwater runoff.

To sustain a regular irrigation water supply, conservancies (i.e. large shallow dams that trap surface water runoff) and extraction pumps on rivers have been installed. The conservancy serves two purposes; first as a flood control structure which prevents water from the back lands invading the coast during the rainy season; and second as a source of irrigation for the agricultural lands during the dry season, although some deficit in water supply may occur under extreme events, such as during El Niño occurrences.

Sugarcane Production

Sugarcane and sugar production has fallen distinctly behind the GNAP and Business Plans (BP) for 2009-2013 and 2011-2020 projections, as shown in the Table below.

TABLE 1 SUGAR CANE AND SUGAR PRODUCTION 2006-2012 COMPARED TO GNAP AND GUYSUCO BP OBJECTIVES

	2006	2007	2008	2009	2010	2011	2012
CANE							
GNAP							
BP 2009-2013				2,887,230	3,608,789	3,857,316	4,157,641
BP 2011-2020						3,040,663	3,353,969
Cane produced	2,974,995	3,099,182	2,706,862	2,764,483	2,762,304	3,195,690	3,134,087
SUGAR							
GNAP	284,583	307,600	360,000	433,000	457,000	459,000	473,000
BP 2009-2013				249,522	321,210	350,043	382,306
BP 2011-2020						301,642	354,850
Sugar Produced	259,549	266,482	226,267	233,736	220,818	236,506	265,151

Cane yields have been declining in part due to non-achievement of the tillage and planting programmes in recent years due to unfavourable weather conditions, low labour turnout and limited cash for the procurement of tillage and planting machinery and equipment to maximise on opportunity days.

Soils

All of the sugar estates have heavy clay soils. East Demerara in particular has the heaviest soils, with virtually no water movement either horizontally or vertically and a principal rooting depth of only 30-45 cm. This restricts optimum cane growth, which is reflected in the yields obtained. Cane husbandry measures such as fertilising have to be geared to this limited rooting zone; multiple applications are thus recommended.

In the other areas (West Demerara and Berbice), the soils are slightly lighter, of clay to loamy clay, with better internal drainage characteristics. Rooting depths here are typically around 1 m and there is potential for cane to be produced to its full yield capacity.

With the introduction of mechanised operations, all of the above soils are prone to compaction. Timing of mechanised operations to avoid this is therefore crucial.

Furthermore, land preparation operations on these heavy soils should be executed only when conditions are suitable in order to avoid the forming of impermeable layers at the ploughing depth.

Varieties

Guyana has its own cane breeding and selection programme in collaboration with the West Indian Central Sugarcane Breeding Station (WICSCBS) based in St. George, Barbados. Since the restructuring of the sugar industries in the Caribbean, which saw the closure of a high number of industries, Guyana has become the biggest contributor to the WICSCBS.

Due to poor flowering conditions in Guyana, crosses are bred at the WICSCBS and the floss (pure seed) is returned, germinated and selected in Guyana. The length of the process from point of creation to the release of a new variety for commercial testing use is around 10 years.

The varieties created and in commercial use are of average sucrose and fibre content, at around 11% pol in cane and 17% fibre. In comparison, southern African commercial canes have around 16% pol in cane and 15% fibre.

All commercially grown varieties in Guyana are non- or shy-flowering. Because of this and the steady temperatures, the cane does not naturally mature, (i.e. sucrose does not increase in the cane stalk). Artificial maturing is therefore practised.

The average yield potential of the varieties is around 110 TC/ha in plant cane with a reduction of some 0-8% for each subsequent crop. The potential yields of the crop cycle would be:

- Plant: 110 TC/ha
- 1st Ratoon 99-101 TC/ha
- 2nd Ratoon 89-93 TC/ha
- 3rd Ratoon 80-86 TC/ha
- 4th Ratoon 72-77 TC/ha
- 5th Ratoon 65-71 TC/ha

Average potential yield for crop cycle of Plant + 4 Ratoons could be 90-93 TC/ha or for a crop cycle of Plant + 5 Ratoons, could be 86-90 TC/ha. This is of course a theoretical potential yield for the existing varieties. More realistic is an average yield for a crop cycle of Plant + 4 Ratoons of 80 TC/ha.

Field layout, land preparation and planting

Given the high levels of both groundwater and rainfall, fields are laid out as Dutch Beds, English Beds and Ridge/Furrow Beds. For irrigation purposes these fields are bunded, creating a plot that can be inundated for irrigation. As a method of land preparation these beds are ploughed with disc plough-harrows and are further tilted with disc harrows to produce a fine tilth. Cane is planted by sticking the cane stalk, at an angle, into the wet, tilted soil, and severing it at about 3 internodes. More recently, due to labour shortages, planting cane sticks in a furrow, severing them at about 3 internodes and than covered them mechanically, is practiced.

Husbandry

Due to the heavy clay type soils and high rainfall in the growth period, many operations have to be carried out by hand. Gapping/supplying, fertilizer applications and weed control are all manual operations.

GuySuCo has introduced motorised weed control equipment (boom sprayers) but there are only a limited number of fields suitable for its use. Therefore, a large area still needs manual application.

Fertiliser and herbicides are also applied by aircraft, but fly zones have to be strictly observed. The fly zones cover about half of the cultivated areas, leaving the other half to be treated using alternative means.

Cane diseases and pests

No major cane diseases have been encountered at the Guyana estates. Smut, brown rust and (suspected) orange rust are present but are not of economic importance.

Sugarcane stem borers are present, but a very successful biological control action, implemented on all estates, keeps damage well below threshold values.

Recently cane rats have started to cause damage to cane stalks, a problem largely attributable to the presence of rice cultivation within and around the sugar estates. A rodent control operation has therefore started and seems to be effective as, so far, damage levels have fallen below the set threshold levels at any of the estates.

Harvesting and cane transport

As previously indicated, cane does not mature naturally in Guyana. Therefore a "ripener" (Fusilage, Round-up) is sprayed on the cane by aircraft in order to enhance the artificial ripening of the cane. The highest rendement (increase of pol in cane) of the ripener is at 6 weeks after application. Delayed cutting of sprayed cane (over 8-10 weeks after application) will have detrimental effects on the following year's ratoon crop. Ripened sugarcane is burnt before cutting.

Traditionally the cane was cut by hand and loaded by hand into punts (flatbed barges for loads of over 7 tonnes), but in recent years GuySuCo has introduced Bell loaders which, particularly on the Dutch Beds, have taken over the loading of the cut cane into the punts.

Furthermore, cane harvesters have been introduced and are operating on converted English and Ridge/Furrow bed layout fields.

Loaded punts are pulled in convoys of up to 30 punts by a tractor through the navigation canals to the factory, where the punts are offloaded either by gantry crane or by "punt dumper", a device that turns the whole punt over, having lifted it out of the canal, and spills the cane onto the cane table.

The "kill to mill" period is crucial to the achievement of optimum factory performance. The factory requires cane that is both fresh (maximum 48 hours old for whole stalk cane, and maximum 8 hours old for billeted cane) and clean (limited trash, tops and mud) for its optimum efficiency. Records show that these critical levels are seldom reached and that deliveries of cane that is 60 to 72 hours old occur regularly. This has a critical effect on the total factory operation, reducing the overall recovery of sugar from the cane.

Observations

Over the last decade labour availability for cane harvesting and crop maintenance has become progressively more of a problem, mainly due to the reluctance of young people to carry out heavy agricultural work and to competition from more lucrative work opportunities in other industries, e.g. gold and construction.

In addition, changing weather patterns over the last few years have drastically reduced the number of opportunity days for operating in the fields, for both harvesting and production practices such as land preparation, land development and crop maintenance.

Replanting

Because of these changing conditions, GuySuCo has repeatedly fallen behind in its replanting since 2005 and yields have consequently suffered owing to the accumulation of older ratoons. The profile of harvested cane per cycle since 2006 is shown in the Table below.

TABLE 2 HECTARES HARVESTED PER CYCLE

	2006	2007	2008	2009	2010	2011	2012
Plants	6,954	8,280	7,145	6,861	5,640	9,831	7,257
1R	6,949	6,548	9,110	6,888	5,078	7,493	8,670
2R	9,027	6,742	7,166	8,926	5,841	5,966	6,987
3R	8,622	8,213	6,708	6,320	7,185	6,171	5,677
4R	6,692	5,312	6,975	5,607	4,517	7,200	4,650
5R+	4,169	4,663	7,158	8,953	8,108	8,755	10,375
Total estate	**42,412**	**39,758**	**44,262**	**43,556**	**36,510**	**45,416**	**43,616**

Source: GuySuCo Statistics Department

As the table shows, the proportion of cane beyond the fifth ratoon cycle has increased from 10% to approximately 25% since 2006 and the amount of cane being harvested beyond the fifth ratoon has also doubled.

The suppressing effect of this out-of-cycle trend on cane yields is illustrated in the Table below.

TABLE 3 YIELD (TC/HA) PER CYCLE

	2006	2007	2008	2009	2010	2011	2012
Plants	90.91	95.56	84.48	79.6	86.67	77.7	66.20
1R	72.99	78.46	65.31	64.1	72.24	66.9	60.77
2R	64.21	68.46	52.81	56.7	60.93	56.9	55.04
3R	55.06	63.54	49.07	49.2	59.84	56.1	50.96
4R	49.97	59.49	48.41	48.9	58.88	54.9	47.28
5R+	49.76	55.06	43.24	47.1	59.39	54.7	48.66
Total estate	**64.5**	**71.97**	**57.71**	**57.4**	**65.85**	**62.3**	**55.16**

Source: GuySuCo Statistics Department

The replanting programmes have fallen behind in their required continuous state (replacement) levels due to poor weather, which has limited the available opportunity days, and to growing labour shortages, especially on the Demerara estates. To solve this problem and to return to a normal crop cycle of 1 plant crop with 4 ratoon crops, replanting would need to be aggressively pursued and should ideally cover no less than 20% of the total annual area under cane. If this practice is rigorously maintained yields could be expected to increase to an average of 80 TC/ha under a normal crop cycle management from the low 60 TC/ha at present, distorted by the high acreage in older ratoons.

Furthermore we observe a decline in yields for the individual classes of cane. This can only be explained as an effect of climate change, as more rainfall intensity causes prolonged inundation of the fields with its negative effect on cane yields.

The practice of "supplying" or "gapping" of fields, in the case of both plant and ratoon cane, should not be considered equivalent to the replanting of a field. Normally the gaps are caused by water logging or damage to the cane stool by machines.

The supplying or gapping of Plant and first and second ratoon fields should be considered a standard field maintenance operation employed to produce a full cane line. Gapping cannot be used as a replacement of replanting as the majority of the cane in the field remains a third, fourth or older ratoon.

Mechanisation

The future viability of GuySuCo will be determined by the degree of mechanisation of its agricultural operations. Mechanisation will reduce harvesting costs and the level of dependency on labour turnout. However, this will also increase GuySuCo's capital costs as more machinery will be acquired.

It will take at least five years to return the current replanting and ratoon composition to a steady state/optimal condition. Nonetheless there will be positive benefits once the increased capital costs are netted against reduced harvesting and other related costs.

The acceleration of the conversion of lands to mechanisation-friendly field layouts will be influenced by weather conditions, capital for investment and the availability of human resources. While weather patterns are difficult to predict, GuySuCo cannot continue to plan for increased cane production and harvesting without increasing its equipment fleet to compensate for the significant reductions that have been occurring in Opportunity (planting and harvesting) Days.

However, GuySuCo has gained considerable experience in converting English beds to machine-friendly broad beds suitable for full mechanisation and there are therefore plans to convert all English beds and Ridge/Furrow beds (approx. 18,000 ha) to broad bed fields.

Following unpredicted labour shortages, artificially ripened cane might have been left for periods exceeding the "efficiency deadline," resulting in lower sucrose yields and even in damaged follow-on ratoon crops.

Independent Farmers (out-growers)

Six of the eight sugarcane estates have engaged in purchasing cane from independent cane farmers. For some of the factories, such as Wales (nearly 45%) and Skeldon (20%), out-growers' cane already accounts for a large portion of their cane supply.

Out-grower areas and production for the years 2009-2012 are shown in the Table below.

TABLE 4 OUT-GROWER AREAS AND PRODUCTION (2009-2012)

	2009		2010		2011		2012	
	Actual ha	**Actual TC**	**Actual ha**	**Actual TC**	**Actual ha**	**Actual TC**	**Actual ha**	**Actual TC**
Skeldon	690.2	56,556.0	1,438.2	136,669	2,119.6	150,732	2,416.7	140,781
Albion	585.20	25,349.0	392.9	20651	274.1	15,782	131	6,803
Rose-Hall	792.0	43,913.0	558.2	36,049	746.1	47,450	651.9	36,121
Blairmont								
BERBICE	2,067.40	125,818.0	2,389.3	193,369	3,139.8	213,964	3,199.6	183,705
Enmore	69.70	2,795.00	78.0	3,800	99.7	3,660	79	3,638
LBI	561.60	28,729.00	462.3	23,809	191.9	9,480	53.3	2,382.8
Wales	2,031.9	104,332.0	2,208.0	137,048	2,227.1	140,545	2,055	113,791
Uitvlugt								
DEMERARA	2,663.2	135,856.0	2,748.3	164,657	2,518.7	153,686	2,187.3	119,812
INDUSTRY	**4730.6**	**261,674.0**	**5,137.6**	**358,026**	**5,658.5**	**367,650**	**5,386.9**	**303,517.1**

Source: GuySuCo Statistics Department

In 2012 a total of 5,387 hectares or 10.99% of the total area under cane were owned by private cane farmers. It is projected that by the end of 2017, 16.41% of the harvested land will be owned by private farmers.

GuySuCo would continue to create incentives such as assisting farmers with Fair Trade Certification to earn premiums, leasing them land, providing agriculture services on credit, providing free agriculture consultancy services to retain and attract new private farmers to the industry and to develop models similar to the Wales estate, which had 45% of private cane farmers at the end of 2012.

It is also found that private cane farmers are able to attract labour more readily than GuySuCo (due to income not being taxable and almost immediate payment) and produce at a lesser cost than GuySuCo.

Cane farmers in Guyana receive a higher proportion of the returns that are obtained from the sale of sugar than in any other country in the Caribbean region.

TABLE 5 HECTARES PROJECTED TO BE HARVESTED BY PRIVATE CANE FARMERS

Estate	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Skeldon	2,417	2,578	2,600	3,800	4,250	4,250
Albion	131	100	300	300	300	300
Rose Hall	652	583	680	680	680	680
Blairmont	-	-	-	-	-	-
East Demerara	132	176	176	176	176	176
Wales	2,055	2,123	2,200	2,470	2,470	2,470
Uitvlugt	-	-	500	1,000	1,000	1,000
Industry	**5,387**	**5,559**	**6,456**	**8,426**	**8,876**	**8,876**

Source: GuySuCo Statistics Department

Drainage

In addition to the above, the Estates face severe drainage challenges due to ageing infrastructure, changes in land use, and restrictions on both operational and capital

spending, resulting in an overloaded drainage system. This has resulted in prolonged short-term flooding, which causes:

- Water logging in the cane root zone, reducing cane growth, thus resulting in lower cane yields;
- Reduced time periods within which to carry out agricultural husbandry and maintenance activities (fertilising, spraying, tillage, conversions, drain maintenance, etc.);
- Increased soil compaction and stool damage when working in wet fields, negatively affecting cane yields.

Sugar Processing

Most of the factories are ageing and their overall recoveries, especially at Skeldon and in the Demerara area, fall well below acceptable standards. At the same time, losses of % pol in by-products are well above acceptable standard levels. The following Table shows the overall recoveries and losses in by-products of the factories for the period 2002-2011 and for the individual factories for the year 2011.

TABLE 6 SUMMARY OF FACTORY PERFORMANCE (2002-2013)

	Overall recovery	Losses of % pol			
		Bagasse	Molasses	Filtercake	Undetermined
2002	81.32	7.68	9.25	0.41	0.81
2003	80.69	7.69	9.84	0.40	0.72
2004	80.98	7.90	9.70	0.42	0.96
2005	79.62	8.16	10.75	0.41	1.08
2006	80.41	7.91	9.93	0.47	1.27
2007	79.58	7.77	10.44	0.50	1.71
2008	79.13	8.21	10.20	0.55	1.92
2009	78.32	7.58	11.50	0.47	2.14
2010	77.19	7.48	13.05	0.46	1.84
2011	75.49	8.04	13.00	0.57	2.90
2012	77.98	7.67	11.44	0.63	2.28
2013 (1st crop)	76.53	8.75	13.12	0.53	1.06
2013 (2nd crop to Sept)	79.34	7.54	10.42	0.81	1.87

Source: GuySuCo Statistics Department

TABLE 7 SUMMARY OF INDIVIDUAL FACTORY PERFORMANCE (2011)

	Overall recovery	Losses of % pol			
		Bagasse	Molasses	Filtercake	Undetermined
Skeldon	58.62	8.27	23.66	0.73	8.72
Albion	80.79	6.36	10.28	0.57	2.00
Rose Hall	78.33	7.67	10.90	0.63	2.47
Blairmont	78.76	8.90	9.85	0.36	2.13
Enmore	77.92	9.30	12.52	0.70	-0.44
L.B.I.	71.77	7.33	14.03	0.66	6.21
Wales	78.47	10.17	10.08	0.52	0.76
Uitvlugt	76.35	7.71	13.54	0.43	1.97
Industry	**75.49**	**8.04**	**13.00**	**0.57**	**2.90**

Source: GuySuCo Statistics Department

In addition to the high maintenance, processing limitations and inefficient technology associated with the operation of six out-dated plants, the new Skeldon facility requires critical design changes without which the plant cannot optimise its capacity for co-generation.

Other specific problems arising at the new Skeldon factory owe mainly to the slow and stop/start crushing experienced due to irregular cane supply from field to factory and to the limited offloading capacity at the factory.

Cane quality

Various studies have indicated that the quality of the cane presented at the factories is not very high. For optimum efficiency in the factory, only cane that is both fresh (maximum 48 hours old for whole stalk cane, and maximum 8 hours old for billeted cane) and clean (limited trash, tops and mud) should be presented. Records show that these critical levels are seldom reached and that deliveries of cane that is 60 to 72 hours old occur regularly. This has a critical effect on the total factory operation, reducing the overall recovery of sugar from the cane.

2.3. THE GUYANA NATIONAL ACTION PLAN (GNAP)

As indicated above, the sugar industry is highly important for Guyana, both economically and socially. Even under the price cuts brought about by the EU Sugar Reform, it is considered that the sector can remain economically viable, as long as it is successful in implementing its business plan for the industry.

The GNAP was prepared as a national effort on the basis of a consultative process that included a broad range of stakeholders. Several bodies contributed to the formulation of the plan, including a specially appointed Cabinet Sub-Committee, a Steering Committee and an Inter-Agency Working Group. Inputs were also received through the national consultations.

Due to the importance on the sugar sector to the country's economy, the sugar reform is not only affecting the sector but the national economy in general and put at risk the livelihoods of a large percentage of the population. According to the GNAP (Government of Guyana, 2006a), the value of lost preferences was expected to be equivalent to 5.1% of GDP and 5.4% of merchandise exports annually. The economic impact would most immediately be felt in the balance of payments, putting at risk Guyana's reserves position, the exchange rate and capacity to service debt, as well as affecting investor confidence. Other impacts include: (a) a decline in the contribution from sugar to government revenues via income tax, corporation tax, property tax, land rent, import duty and national insurance, (b) reduced social service provision, (c) reduced income and employment amongst suppliers to the sugar industry and services used by sugar workers, and (d) increased social ills.

The GNAP is complementary to GuySuCo's Strategic Blueprint[4] and Business Plan for the industry, and its updated Strategic Plan 2013-2017[5].

The main objective of the GNAP is to generate economic growth by bringing about sustainable improvements in the competitiveness of the sugarcane industry and the non-traditional agricultural sub-sector. It consists of three specific elements:

1. To promote the expansion and development and diversification of the sugar cane industry in Guyana;
2. To promote the growth and development of specific non-traditional agriculture sub-sectors; and
3. To provide infrastructural and human resource development support to achieve the points above.

The major thrust is on the first of the above pillars, which is also the area of attention of EU support. The support to non-traditional agriculture has been provided mainly through the Inter-American Development Bank (IDB) Agriculture Diversification Programme (ADP).

The actions under the GNAP are indicated in the Table below.

[4] GuySuCo (2009a).
[5] GuySuCo (2013).

TABLE 8 KEY COMPONENTS OF THE GNAP

Actions
Objective 1: Supporting sustainable improvement in the competitiveness of the sugar sector
Conversion of fields to machine-friendly layout
Procurement of equipment for mechanical harvesting and husbandry
Semi-mechanised harvesting in Dutch Bed layouts
Upgrade of all factories to improve competitiveness
Installation of a packaging plant at Enmore
Construction of a raw sugar factory at Skeldon
Construction of a refinery
Construction of a co-generation plant at Skeldon
Construction of a co-generation plant at Albion
Construction of co-generation plant and expansion of Enmore
Blairmont expansion
Support to private cane farmers
West Demerara drainage
Construction of deep water berth
Ethanol production from cane
Storage, shipping and logistics
Objective 2: Promoting non-traditional agriculture
Establishment of an Agricultural Business Development Unit
Plant Health System
Support to the beef sector
Creation of a semi-autonomous fisheries authority
Aquaculture and IPM
Strengthening the land lease allocation system
Credit facility for non-traditional agricultural exports
Objective 3: Promoting economic regeneration through infrastructural and human resource development support
Maintenance or drainage & irrigation structures
All weather farm access roads
Training programme for career development
Technical training programme
Objective 4: Return to the GoG its contribution to the Skeldon project
Poverty Reduction Support Programme

2.4. KEY STAKEHOLDERS

Key stakeholders for the GNAP were identified during the scoping phase; these include primarily government institutional actors, industry, non-governmental organisations (NGOs) and labour unions. Table 9 below shows the main stakeholders, a description of which is found in Annex 2.

TABLE 9 KEY STAKEHOLDERS RELEVANT TO THE GNAP

Government • Ministry of Agriculture (MoA) • National Agriculture, Research and Extension Institute (NAREI) • Guyana Livestock Development Authority (GLDA) • National Drainage and Irrigation Authority (NDIA) • Pesticides and Toxic Chemicals Board • Sea and River Defence Board • Ministry of Natural Resources and the Environment (MoNRE) • Environmental Protection Agency (EPA) • Protected Areas Commission (PAC) • Office of Climate Change (OCC) • Guyana Hydrometeorological Service • Guyana Forestry Commission (GFC) • Guyana Energy Agency (GEA) • Guyana Lands and Surveys Commission (GL&SC) • Guyana Office for Investment (Go-Invest) • Ministry of Local Government and Regional Development • Guyana Rice Development Board (GRDB) • National Water Council • Civil Defence Commission (CDC)	**Industry** • Guyana Sugar Corporation (GuySuCo) • Demerara Distillers Limited (DDL) **International donors** • European Union (EU) • Inter-American Development Bank (IDB) • Caribbean Development Bank (CDB) • World Bank • United Nations Development Programme (UNDP) • FAO **NGOs** • Conservation International • WWF Guianas **Academia and technical training** • Guyana School of Agriculture (GSA) • University of Guyana **Labour Unions** • Guyana Agricultural & General Workers Union (GAWU) • National Association of Agricultural, Commercial and Industrial Employees (NAACIE) • Guyana Labour Union

2.5. RELEVANT POLICIES, PLANS AND PROGRAMMES

An identification of the key Guyana policies, plans and programmes relevant to the GNAP was done during the scoping phase

The Table below provides a synthesis of the relevant policy framework, a description of which is found in Annex 3.

TABLE 10 KEY STAKEHOLDERS RELEVANT TO THE GNAP

National • National Development Strategy (2000) • National Competitiveness Strategy (2006) • Poverty Reduction Strategy (2000, 2004, 2011) **Climate Change** • Guyana's Low Carbon Development Strategy (LCDS) • Guyana Climate Change Action Plan (2001) **Agriculture** • Guyana National Livestock Development Policy (2013) • National Policy on Inland Fisheries and Aquaculture (2012) • Disaster Risk Management Plan for the Agriculture Sector 2013-2018 • National Adaptation Strategy to address climate change in the agriculture sector in Guyana (2009) • Food and Nutrition Security Strategy (2011)	**Sugar sector** • GuySuCo Strategic Blueprint and Business Plan (2009) • GuySuCo Strategic Plan 2013-2017 **Environment** • National Environmental Action Plan • National Biodiversity Action Plan 1999-2004 • Mangrove Management Plan (2010) • National Forest Policy Statement (NFPS) (2011) • National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (2013) • National Water Policy **Energy** • Agro-energy Policy (AEP) (draft) (2013) **Land use planning** • Land Use Policy (draft) (2007) • National Land Use Plan (2013)

2.6. RELEVANT LEGISLATIVE FRAMEWORK

An identification of the key legislative framework relevant to the GNAP was done during the scoping phase. The Table below provides a synthesis of the relevant legislative framework, a description of which is found in Annex 4.

TABLE 11 KEY LEGISLATION RELEVANT TO THE GNAP

• Environmental Protection Act No. 11 of 1996 • Environmental Protection (Authorisations) Regulations (2000) • Environmental Protection (Air Quality) Regulations (2000) • Environmental Protection (Water Quality) Regulations (2000) • Environmental Protection (Noise Management) Regulations (2000) • Environmental Protection (Hazardous Wastes Management) Regulations (2000)	• Environmental Guidelines for Preparation of an Environmental Management Plan (2013) • Environmental Guidelines – Transportation, storage and occupational handling of chemical/industrial hazardous waste (2011) • Fisheries Act (2002) • Pesticides and Toxic Chemicals Control Act No. 13 of 2000 • Drainage and Irrigation Act (2004) • Water and Sewerage Act (2002)

2.7. METHODOLOGY AND TOOLS

This SEA makes use of a combination of tools. The Scoping phase was aimed at identifying the key environmental aspects relevant to the SEA, addressed in further detail in the SEA Study. Identification of key environmental aspects was based on:

1. Comprehensive literature review, including: relevant policies, plans, programmes, regulations, consultants' reports, and professional and academic publications;
2. Bilateral interviews with key stakeholders;
3. Site visits to the Skeldon sugar estate and factory (including the co-generation plant) and to the Albion demonstration bioethanol distillery; and
4. Expert judgement.

As for the SEA Study phase, the following mechanisms and tools were used for impact identification, impact evaluation and preparation of recommendations:

1. Literature review complementary to that carried out during scoping;
2. Bilateral interviews with key stakeholders;
3. Focused bilateral interviews to explore specific issues arising from the scoping phase;
4. Site visits to Skeldon and Albion estates and sugar factories;
5. Stakeholders' workshop to validate preliminary findings and explore potential ways to address the key aspects;
6. Use of Leopold-type matrices for identification and assessment of potential impacts;
7. Use of cause-effect diagrams for the identification and presentation of key environment-climate change-sector links; and
8. Expert judgement.

2.8. POSITIVE IMPACTS ASSOCIATED TO THE GNAP AND NON-ISSUES

The sugar industry in Guyana has developed over the years a number of good environmental practices, and the GNAP has also been promoting actions with positive impacts on the environment and climate change adaptation and mitigation. Some such positive aspects include the following.

Co-generation with cane bagasse in the sugar factories contributes to climate change mitigation by reducing the consumption of fossil fuels; it also reduces fuel dependency. Guyana has engaged in a shift to a low-carbon development and co-generation was identified as a potential to tap into international climate change finance (through the CDM) whilst contributing to low-carbon development.

The co-generation at the Skeldon factory is especially relevant as it is expected to generate excess electricity, to be sold to the national power grid under a Power Purchase Agreement (PPA). In addition, the Skeldon Sugar Modernisation Project (SSMP) is registered under the UNFCCC CDM, with the potential to bring additional benefits in the form of carbon credits. The World Bank played a key role in the design and finance of the SSMP. The GNAP also promotes the development of co-generation facilities at the Albion and Enmore factories, which is not yet happening.

In spite of the positive direction of developments at a policy level, the potential for co-generation is yet to be achieved, due mainly to the fact that sufficient amounts of sugar cane cannot be secured to run the co-generation facility at Skeldon, which means that it has to rely on the burning of heavy fuel oil in order to comply with its electricity supply commitments under its Power Purchase Agreement (PPA) with the electricity company. This is further explored under Key Issue 5 below.

GuySuCo has a full **ban on pesticides** in its sugar cane estates, which is part of its Integrated Pest Management (IPM) system; GuySuCo also works closely with the Environmental Protection Agency (EPA) and the Pesticides and Toxic Chemicals Board in the **design of flight routes for the aircraft spraying** of ripeners and herbicides in order to minimise spray drift. This corporate policy and related practices have a positive impact on water quality and working conditions, apart from contributing to food safety.

Other good practices at GuySuCo include the increased use of **flood fallowing**, which enhances weed suppression (reducing subsequent weed control and use of herbicides); soil structure rehabilitation by reduction and subsequent oxidation of iron within the soil; increases soil fertilisation (reducing subsequent fertiliser requirements) and allows a degree of flushing of salts from the fields. The EU is further promoting flood fallowing by including its extended use in the sugar accompanying measures budget support performance indicators.

Fair trade certification is being promoted by GuySuCo amongst farmers. There is a growing international demand for fair trade products, especially in the European Union, as consumers demand fairer payments for producers in developing countries as well as a larger degree of certainty that agricultural products are mindful of the environment.

In addition to the premiums, Fair Trade certification guarantees the adoption of good agricultural practices (including environmental). To date eight (8) fair trade certifications have been granted (there were nine, but one got suspended), covering 722 farmers. GuySuCo is also certified as a third-party miller/processor and as part of the supply chain for the small producers to market their product.

Fair Trade certification[6] implies compliance with a series of standards aimed at ensuring the implementation of good environmental and social practices, e.g. in relation to social and environmental policy and planning, child labour, remuneration of workers, use of agrochemical products, etc.

GuySuCo is also planning to promote fair trade certifications for hired labour[7].

In spite GuySuCo is not yet fully regulated by the EPA, regular **water quality monitoring** is carried out for its irrigation, drainage and process waters, and reported to the EPA. Recent monitoring carried out by GuySuCo show conformance with accepted standards, although it should be pointed out that water at the point of intake is not always of optimal quality (e.g. low levels of dissolved oxygen).

GuySuCo is seeking to move towards **ISO 14001 certification**, and has an Environmental Policy in place. It has developed some elements of environmental management, such as the establishment of a Safety Committee (and Agrochemical Safety & Agriculture Operations Safety Sub-Committee) and Guidelines for Safe Pesticide Use. GuySuCo currently has Environmental Management Plans for Skeldon, Clairmon and Enmore sugar estates and factories.

[6] FLO – Fairtrade Labelling Organizations International (2011) *Fairtrade Standards for Cane Sugar for Small Producers' Organizations*, version August, 2011.
[7] FLO – Fairtrade Labelling Organizations International (2011) *Fairtrade Standards for Hired Labour*, version May, 2011.

Developments promoted by the GoG towards **mangrove protection** (also supported by the EU under the Global Climate Change Alliance – GCCA) contribute to climate change adaptation in the agriculture sector, by strengthening sea defences and reducing risk of sea water overflows in the light of more extreme weather events and sea level rise.

Factory upgrades can lead to increased energy efficiency. Energy Audits are being carried out for all sugar factories by the Indian consulting company The Energy and Resources Institute (TERI), which should shed some light into opportunities for improved energy efficiency. This initiative is managed under the Office of Climate Change (OCC).

Non-traditional agriculture is promoted under the LCDS as low-carbon intensive sectors, and thus any progress in this area will be contributing to climate change mitigation. As well some positive environmental impacts can be obtained, more specifically through decreased use of pesticides in the rice industry by the introduction of aquaculture techniques, an area that has been explored in the sector. More insight into these opportunities is given under Key Issue 3 below.

GNAP components that address the upgrading and maintenance of the **drainage and irrigation** system will contribute to climate change adaptation in the agriculture sector in general, and the sugar sector in particular. More insight into these opportunities is provided under Key Issue 1 below.

Ethanol production can bring about environmental and climate change mitigation benefits, especially if linked to fuel blending. Potential positive impacts include reduced fuel dependency, degreased use of fossil fuels and decreased atmospheric pollution levels. The potential benefits are explored under Key Issue 4 below.

There are a number of environmental aspects that may sometimes give rise to concerns, but which in the context of this SEA have been identified as **non-key issues**, either because they are not relevant in the context of Guyana, or because the environmental issues are not significant. Some of the aspects indicated in the ToR to be explored fall under this category. These include:

- **Industrial waste management**. Hazardous wastes in GuySuCo are subject to strict management protocols in accordance with GuySuCos *Safe Use of Pesticides in the Sugar Industry* manual.
- **Atmospheric pollution**. Atmospheric emissions are not being monitored nor under an environmental permit and, with the exception of Skeldon, there are no emission control equipment in place. The Skeldon has installed Electrostatic Precipitators in the new factory, but these cannot yet be used as the factory still burns heavy fuel oil. In spite of these shortcomings, air pollution is not considered by stakeholders as a critical area of concern, especially in the light of more pressing needs and in a context of limited resources and also considering the degree of dispersion brought about by the location of the factories along the coast. Nevertheless this is an area that would require further attention in the future.
- **Process wastewater treatment**. Wastewaters from the factories are not treated and are discharged directly into the drainage canals, and into the sea. However, the monitoring carried out by GuySuCo at points of intake of water and discharge show acceptable water quality.

- **Soil management** was not identified as a key issue, as there are no major problems in relation to salinisation, which is restricted to a few pockets in the front lands. Compaction issues are not significant, but will be increasingly important due to the shift to mechanisation. Both salinisation and soil compaction may become more important under future climatic conditions.
- **Agrochemicals**. As indicated above, GuySuCo has a ban on the use of pesticides, and the use of herbicides and ripeners is subject to close scrutiny. The spraying of products by aircraft, which has been subject to concern, is closely coordinated with the Pesticides and Toxic Chemicals Board. GuySuCo also provides extension services to farmers on the correct use of agrochemical products.

Environmental impacts associated to the sugar industry and to GNAP actions are shown in the Leopold-type matrices presented in Annex 1 below.

2.9. KEY ENVIRONMENTAL ISSUES

The scoping study identified a number of Key Issues associated to the GNAP. The following criteria were used in identifying key issues:

- Environmental and/or climate change adaptation concerns in the sugar industry that are not adequately covered by the GNAP;
- Potential environmental impacts associated to GNAP implementation;
- Potential vulnerability to climate change increase associated to GNAP implementation;
- Opportunities to enhance environmental performance and contribute to climate change adaptation and/or mitigation not being addressed.

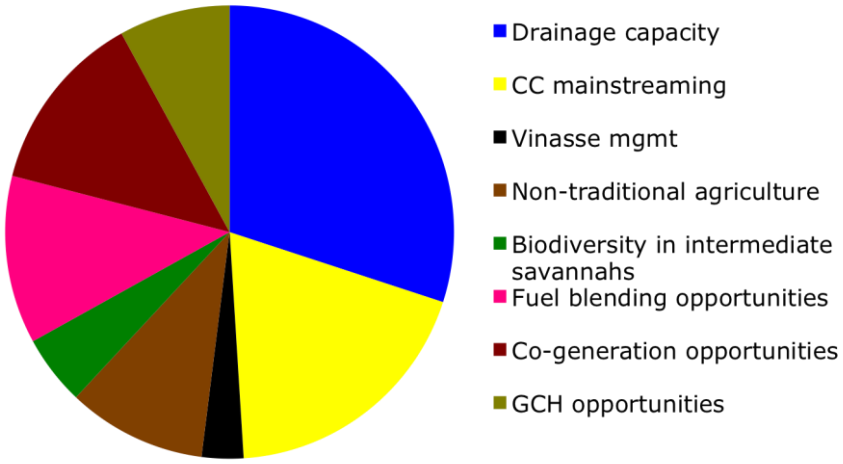
Key issues thus address not only potential environmental impacts of GNAP implementation, but also identify those environmental and climate change aspects that the sector is facing and which are not being adequately addressed, as well as missed opportunities to enhance environmental performance and/or climate change adaptation/mitigation.

The key issues preliminarily identified during scoping are as follows:

1. Upgrading and maintenance of drainage systems in the light of climate change and developments in the coastal plain;
2. Integration of long-term climate change adaptation considerations in the sugar industry and key government institutions;
3. Potential impacts of vinasse management in the ethanol industry;
4. Potential impacts on biodiversity associated to land use changes for bioenergy crops and agricultural diversification in the intermediate savannahs;
5. Missed opportunities for enhanced environmental and climate change mitigation in relation to fuel blending;
6. Missed opportunities for climate change mitigation in the sugar industry in relation to co-generation;
7. Missed opportunities for improved environmental performance in the sugar industry in relation to green cane harvesting;
8. Missed opportunities for enhanced environmental and climate change mitigation performance in relation to the promotion of non-traditional agriculture.

The preliminarily identified key issues were validated at a stakeholders' workshop - held on 8 October – and discussions held on options to address these key issues. As part of the workshop a prioritisation exercise was carried out, which shows a snapshot of the priority areas as perceived by the stakeholders. The results of this exercise are synthesised in the Figure below. We can appreciate that two issues (drainage capacity and climate change mainstreaming) capture almost half of the 'points' distributed, whereas impacts of vinasse management and impacts on biodiversity of intermediate savannahs received the lowest priorities.

FIGURE 2 RESULTS OF PRIORITISATION EXERCISE FROM STAKEHOLDERS' WORKSHOP



Based on the outcomes from the stakeholders' workshop, changes were made in the key issues. Some were validated, whilst the significance of others was decreased (e.g. impacts on biodiversity in intermediate savannah and impacts from vinasse management) and others expanded (e.g. attention to irrigation capacities and not only to drainage capacities). This led to a re-clustering of the key issues as shown in the Table below.

TABLE 12 KEY ENVIRONMENT AND CLIMATE CHANGE ISSUES ASSOCIATED TO THE GNAP

Higher priority key issues
1. Drainage and irrigation capacities in the light of climate change and developments in the coastal plain 2. Integration of long-term climate change adaptation in the sugar industry and key government institutions 3. Missed opportunities for enhanced environmental and climate change mitigation/adaptation performance in relation to the promotion of non-traditional agriculture
Lower priority key issues
4. Missed opportunities for enhanced environmental performance and climate change mitigation in relation to fuel blending and potential environmental impacts from ethanol production 5. Missed opportunities for environmental performance and climate change mitigation in the sugar industry in relation to co-generation

2.10. ASSUMPTIONS, UNCERTAINTIES AND CONSTRAINTS OF THE SEA

The consultants consider that this SEA captures the key environmental and climate change concerns in Guyana's sugar sector as well as in the GNAP, that sufficient information and data was available to undertake the corresponding analyses and that a good representation of key stakeholders were meaningfully consulted. Nevertheless, some factors have acted as constraints in the SEA process.

One important constraint has been the very low level of ownership of the SEA process by the Government. With the exception of close involvement of our focal point at GuySuCo, the SEA has been primarily an EU-driven exercise. This approach was probably inevitable in the context and timing of the sugar accompanying measures in Guyana. Nevertheless low degree of Government ownership can limit the SEA's effectiveness (its power to trigger change). This has probably been reflected in the difficulty to secure more and more extensive consultations as well as in the lack of representation of certain key stakeholders at the workshop (e.g. NDIA, NAREI). The overlap of the stakeholders' workshop with the Caribbean Week of Agriculture was one of the reasons why certain stakeholders did not attend.

Another important constraint for the effectiveness of this SEA is that it is taking place towards the end of the Sugar Accompanying Measures. To a very large extent this can limit the usefulness of the SEA findings, especially as it cannot be used to modify the original focus and contents of the GNAP. In response to this context the consultants have not pretended to influence the GNAP contents, as that document is already completed and coming to the end of its time-span. Recommendations are thus targeted to areas of attention that can be addressed by relevant actors (from Government, GuySuCo and the EU) to enhance the environmental and climate change adaptation/mitigation performance of the sector, looking beyond the GNAP.

The data accessed has been sufficient for the purposes of the strategic level analyses carried out as part of the SEA. However, project-level EIAs that may result from pursuing some of the policy directions indicated in the GNAP (e.g. bioethanol distilleries) may encounter data gaps and may thus need to integrate primary data generation as part of the process.

3. STATE OF THE ENVIRONMENT AND CLIMATE CHANGE PROJECTIONS[8]

3.1. STATE OF THE ENVIRONMENT

Guyana is located in the Northern part of South America and is also part of the Caribbean with approximately 214,970 km^2. It shares borders with Venezuela on the West, Brazil on the West and South, and Surinam on the East.

Guyana is divided into four main geographical areas: the coastal plain; hilly sand and clay regions; the interior savannahs; and the highland region.

The **low coastal plain** occupies about 4.3% of the country's area (GL&SC, 2013), but is the most populated region with more than 90% of Guyana's population and also where the immense majority of the economic activity takes place. The plain consists mainly of alluvial mud swept by the Amazon River, carried by ocean currents and deposited on Guyana's shores. As the coastal plain is below sea level at high tide, since colonial times efforts have been made to dam and drain this area.

Hilly, sand and clay region. The white sand belt lies south of the coastal zone and takes up about 13.7% of the country's area (GL&SC, 2013); it consists of low sandy hills interspersed with rocky outcroppings. The white sands support a dense hardwood forest, they cannot support crops and, if trees are removed, erosion is rapid and severe. This region is of high economic importance, as it is here were Guyana's reserves of bauxite, gold and diamonds are found.

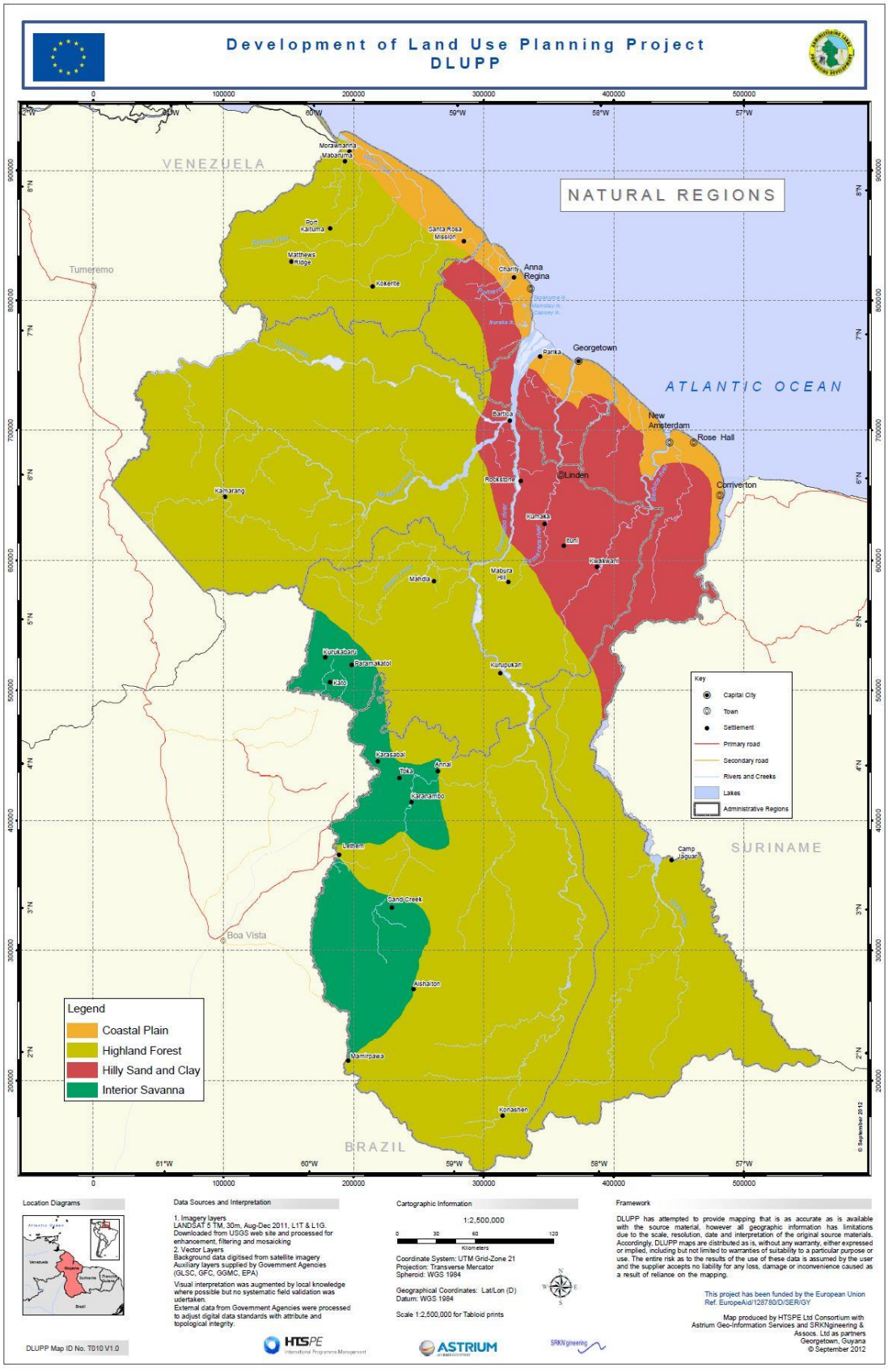
The **interior savannahs** account for 8% of the territory (GL&SC, 2013) and consist mainly of grasses, scrub and low trees. Human population is largely of the indigenous peoples living mostly in remote villages, with Lethem being the only town. The largest expanse of grassland, the Rupununi Savannah covers about 15,000 km^2 in the South. The grasslands in general only support grazing.

The **interior highlands** is the largest of the regions and consist of a series of plateaus, flat-topped mountains, and savannahs covering about 74% of the country's area (GL&SC, 2013). The Pakaraima Mountains dominate the western part of the interior highlands.

Administratively Guyana is divided into ten Administrative Regions, some divided into sub-regions whilst others are divided into Neighbourhood Democratic Councils.

[8] This section is based mainly on Pesticide and Toxic Chemicals Board (2013), Atkins (2005), UNEP (2010a), UNEP (2010b) and GL&SC (2013).

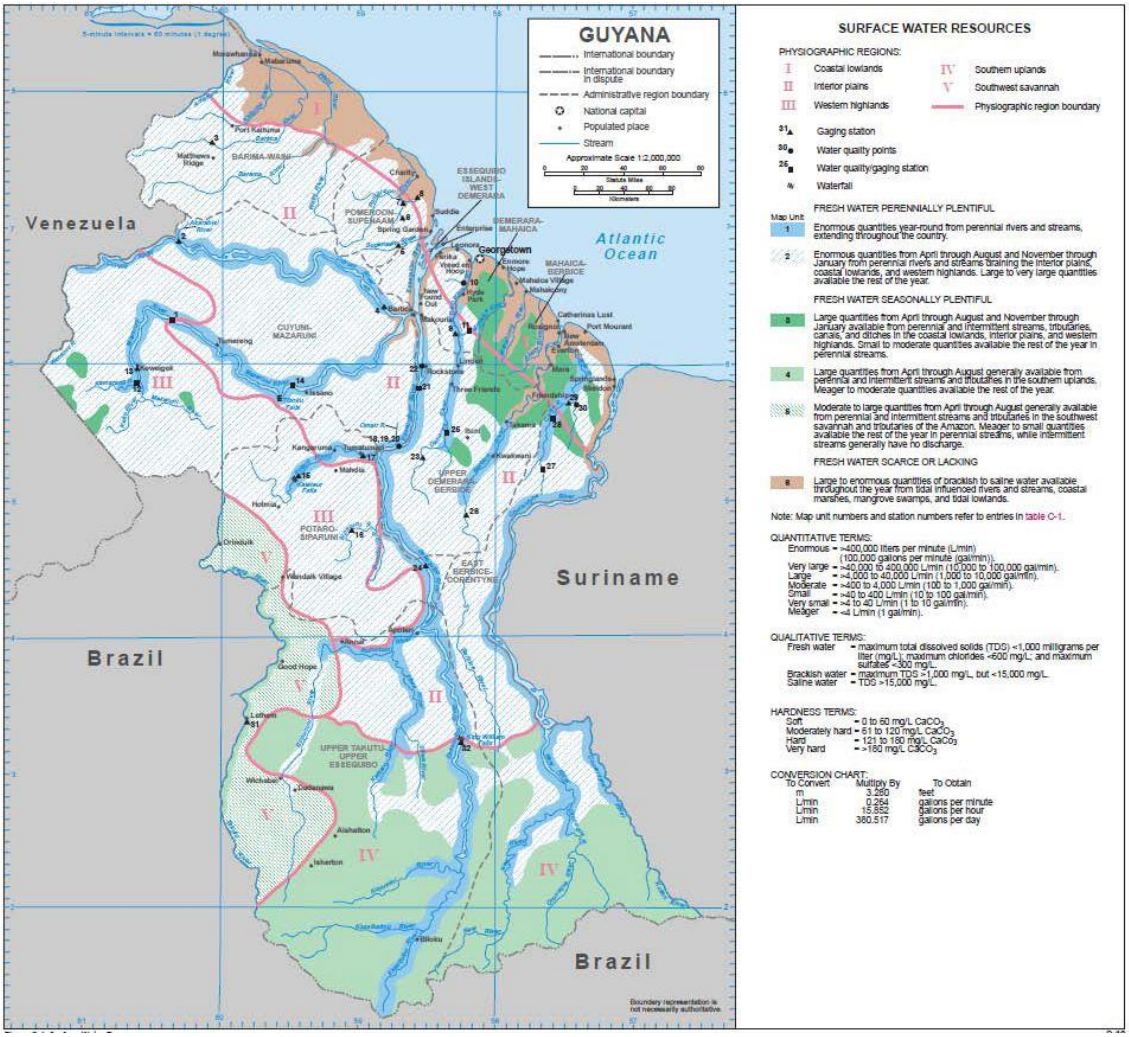
FIGURE 3 GEOGRAPHICAL REGIONS OF GUYANA



Source: GL&SC (2013)

Guyana is a water-rich country. Numerous rivers traverse the country on their way to the Atlantic Ocean, generally in a northward direction, although some rivers in the West flow eastwards into the Essequibo River. The most recent study of national water resources was undertaken by the United States Army Corps of Engineers in 1998; the results show that the majority of the country has perennially plentifully available fresh water with enormous quantities available for 8 months of the year (wet season) and large to very large quantities available for 4 months of the year. Exceptions include the coastal plain back-lands, Rupununi Savannahs and Pakaraima Mountains and the far south of the country where water is seasonally plentiful; only in the coastal front-lands is water scarce or lacking with large to enormous quantities of brackish to saline water available. (GL&SC, 2013). Fresh groundwater is plentiful in the coastal plain, white sands plateau and in the Takutu basin, with other inland areas only having pockets of fresh groundwater in largely unexplored aquifers (GL&SC, 2013).

FIGURE 4 GUYANA'S SURFACE WATER RESOURCES



Source: GL&SC (2013)

Forests cover some 88% of the territory and contain over 5 gigatonnes of CO_2 in above-ground biomass (MoNRE, 2012b cited in GL&SC, 2013), apart from being valuable reservoirs of biodiversity, provide numerous habitats for wildlife and are an integral component of the

country's freshwater ecosystems. Mining is the main driver of deforestation, although total deforestation rates are very low (around 0.053% in 2010-2011 period) (GL&SC, 2013).

The National Biodiversity Action Plan II points out that the coastal fringe and inland waters have relatively high biodiversity and that 'the rivers and wetlands of the Guianas hold some of the greatest concentrations of freshwater biodiversity in the world'. The freshwater ecosystems are in relatively good condition as their watersheds are still protected by large areas of pristine forests and their natural watercourses are mostly unaltered by dams and other water infrastructure (GL&SC, 2013).

The system of protected areas currently covers 10% of the territory and is managed by the Protected Areas Commission (PAC). According to the CBD (Convention on Biological Diversity) objectives, this should increase to 17%. Currently there are no protected areas covering the intermediate savannahs ecosystem, which is a concern with regards to the expansion of agricultural diversification of bioenergy crops; the PAC, together with key environmental NGOs, is working on identifying biodiversity hotspots.

Guyana enjoys abundant environmental resources. UNEP's National Environmental Summary[9] identified seven major environmental issues:

Natural disasters and effects of climate change, particularly floods due to the geographic vulnerability of the low lying coast (1.5 meters below mean sea level); changing weather/climate patterns, extreme weather events (associated to climate change and manifested as increased frequency and intensity of rainfall); inadequacy of and poor maintenance of existing infrastructure; capacity constraints of flood adaptation and mitigation; removal of mangrove vegetation for fuel wood and for use in construction and tanning. The consequences of climate change pose other challenges to Guyana: pollution of groundwater resources and domestic water supply; health problems due to emerging diseases; physical and social infrastructure damage; retarded economic growth and social development resulting in increased poverty.

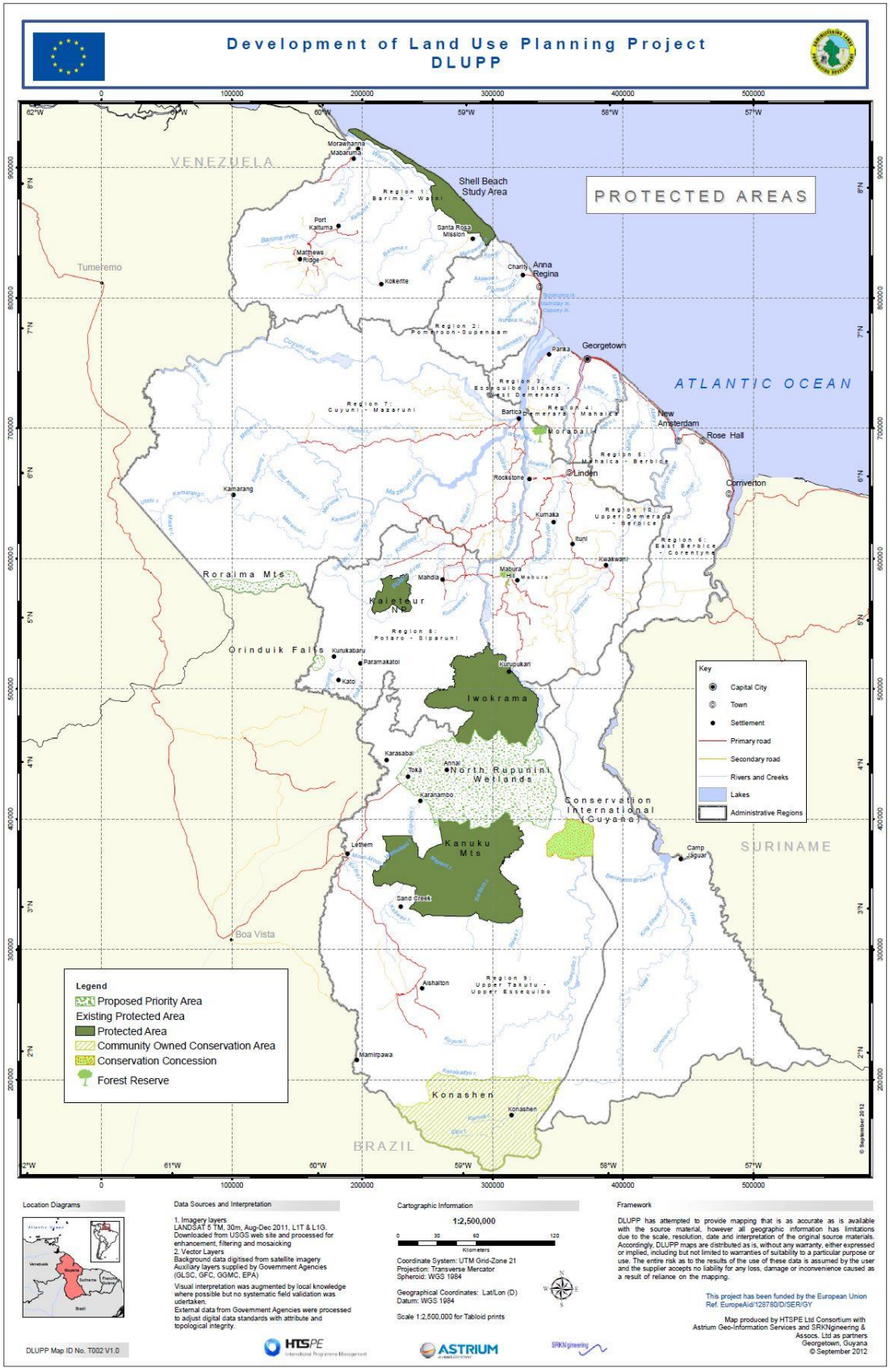
Land and water pollution: in Guyana there are no sanitary landfills that meet technical and environmental standards and solid waste disposal is especially critical in the Georgetown area. Although a large percentage of the population have disposal services, there are no central sewage treatment facilities; untreated sewage is discharged through an outfall into the mouth of the Demerara River. With regards to hazardous wastes, there are no significant companies or facilities in Georgetown to manage them, although a Hydroclave (for management of medical wastes) has been installed at the Georgetown Public Hospital.

The problem of land and water pollution is a consequence of various factors: inadequate infrastructure, limited monitoring and irregular enforcement of legislation, insufficient financial resources, poor governance and absence of organised solutions; unacceptable social and environmental behaviour (e.g. clogging of drains due to poor waste disposal practices), and lack of effective enforcement.

In the interior, mining activities lead to pollution of surface and groundwaters. Of especial concern is the release of mercury during the gold amalgamation process and the high turbidity of rivers and creeks due to land and river dredging operations.

[9] UNEP (2010a).

FIGURE 5 GUYANA'S PROTECTED AREAS



Source: GL&SC (2013)

Increased pressure on and threat to biodiversity due to illegal wildlife trade.

Air quality in Georgetown is a concern due to the burning of sugar cane fields south of the city, uncontrolled burning from the Mandela landfill site; burning of household wastes in yards; increase in waste generation; improper waste disposal; increase in the number of vehicles and traffic congestion in central Georgetown; and unauthorised small-scale industrial activities (e.g. paint shops). Another source is the combustion of fuels by Guyana Power and Light Inc. (GPL) for electricity generation.

Noise pollution is a growing concern.

Land use planning at the local/community level: inadequate policies to address land tenure and user rights issues, together with the incomplete processing of titles of new and extension of Amerindian rights (an issue to be addressed under the Low Carbon Development Strategy), have led to on-going conflicts between Amerindian communities, loggers and miners, whose activities continuously threaten surface water resources used by some households for domestic purposes.

Access to housing and basic social services (potable water supply, health care, electricity, rubbish and sewage disposal facilities) by vulnerable groups, including women, youth and Amerindians.

3.2. CLIMATE CHANGE[10]

Guyana lies within the Equatorial Trough (ET) Zone and its weather and climate are influenced primarily by the seasonal shifts of the ET and its associated Inter-Tropical Convergence Zone (ITCZ). Guyana enjoys a wet tropical climate with warm temperatures and abundant rainfall without either hot or cold extremes.

Guyana is highly vulnerable to natural disasters due particularly to extreme weather events. High intensity rainfall, wind or tidal/wave activity is the usual cause of floods, while sustained dry periods cause drought. However, flooding is also influenced by anthropogenic factors such as inadequate solid waste management (interfering with the drainage system) and the maintenance of physical infrastructure for drainage and irrigation, conservancies and sea defences.

Weather patterns have changed significantly in terms of both intensity and duration of periods of high and low rainfall, leading to an increase in the occurrence of both floods and droughts, and impacting particularly the agriculture sector. The Table below shows a synthesis of the global and national climate change scenarios.

[10] This section is based on Government of Guyana (2012), ECLAC (2011), Office of the President (2013) and Development Policy and Management Consultants (2009).

TABLE 13 GLOBAL AND LOCAL CLIMATE SCENARIOS

Global climate scenarios according to the IPCC 5th Assessment Report (2013)	**National climate scenarios**
Global-mean surface temperatures for 2081-2100 are estimated to increase by 0.3-4.8°C, depending on the models.	Minimum temperature has shown an increase of 1.2°C. A mean annual increase of 1.0°C over the same period.
Global sea level is expected to rise by 0.26-0.81m by 2081-2100.	Current sea level rise is at least several times the global average, in Guyana it is 10.2 mm/yr (Guyana's National Vulnerability Assessment to Sea Level Rise 2002).
For South America recent studies indicate heavy rain events are increasing in frequency and intensity over the continent. Impacts on rainfall: it is *virtually certain* that, in the long-term, global precipitation will increase with increased global mean surface temperature at rates between 0.5-4%/°C by 2100 (depending on the models). High latitudes are *very likely* to experience greater amounts of precipitation. Over wet tropical regions, extreme precipitation events will *very likely* be more intense and frequent.	Increasing rainfall intensities will contribute to higher runoff and increase flooding. The data supports the former; the latter is supported by the frequency of occurrences in floods.

Source for the right column: Development Policy and Management Consultants (2009)

Guyana's vulnerability to climate change is due to several factors. Its extensive low-lying coastal area where 90% of the population and most of the country's economic activity takes place is threatened by sea-level rise, increase in storm surges and changes in rainfall patterns. The levels of poverty[11] also result in low adaptive capacities.

With sea level rise, saline intrusion will extend up the three coastal rivers (Demerara, Essequibo and Mahaica), increasing the salinity content of between 10-33% of the soils on the coastal plain, reducing productivity and output and increasing costs of production. The sea defences are currently designed to accommodate sea level rise of 6 mm/yr, and the rip-rap design can facilitate raising of the crest level easily.

Climate related threats to the country are diverse; key ones in the agriculture sector include:

- Increase of heavy rainfalls (possibly leading to flooding);
- Sea level rise and storm surges (especially for the coastal zone), exacerbated by increased coastal erosion;
- Increase in temperature and decrease of main annual precipitation (possibly deriving from drought episodes);
- Increased pest & disease incidence;
- Greater plant stress (e.g. it has been suggested that with a temperature increase of 1°C, sugar cane production may decline by 5% - ECLAC, 2011);

[11] About 35% of the population live below the poverty line, with 19% living in extreme poverty according to 2001 figures indicated in the Poverty Reduction Strategy Paper (PRSP).

- Salinity intrusion;
- Increased plant transpiration rates and evaporation, leading to deficits in soil moisture supply.

An analysis of the economic impacts of climate change (ECLAC, 2011) examined economic implications for the sugar sector based on the IPCC A2[12] and B2[13] climate change scenarios and taking into consideration three distinct discount rates (1%, 2% and 4%). The results show potential benefits under the B2 scenario by the 2020's and 2030's, but otherwise cumulative costs amounting up to $US200 million by the 2050's.

TABLE 14 CUMULATIVE COSTS (2008 US$ MILLION) OF CLIMATE CHANGE FOR THE SUGAR SECTOR

year	1% discount rate		2% discount rate		4% discount rate	
	A2 scenario	B2 scenario	A2 scenario	B2 scenario	A2 scenario	B2 scenario
2020	-4.63	+48.03	-4.47	+46.35	-4.17	+43.28
2030	-65.05	+15.82	-57.05	+18.69	-44.27	+22.78
2040	-156.86	-57.81	-130.01	-39.78	-90.74	-14.42
2050	-300.13	-176.68	-232.72	-125.58	-144.20	-59.67

Adapted from: ECLAC (2011)

[12] The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing global population. Economic development is primarily regionally oriented and per capita economic growth and technological change are more fragmented and slower than in other storylines. (IPCC, 2000).

[13] The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels. (IPCC, 2000).

PART II ENVIRONMENTAL AND CLIMATE CHANGE ISSUES

4. INTRODUCTION

This section explores the key issues identified and that form the core substance of this SEA Study report. Each section consists of two parts: current state and trends; and options to address the key issue.

The first part establishes the baseline (current state), including the relevant policy, institutional and regulatory framework specific to the key issue, and indicates the main drivers and pressures (direct and indirect). It also examines the trends that can be reasonably expected for the particular key issue under implementation of the GNAP and other associated developments. It explores the potential implications on the environment and climate change vulnerability/emission of GHG associated to these trends. Such implications could include potential impacts (positive or negative) as well as missed opportunities to enhance environmental performance and climate change adaptation/mitigation.

The second section explores different options available to address the key issue under consideration, exploring advantages and disadvantages of different options. Different entry points are given consideration, as relevant, e.g. policy measures, institutional structures and capacities, regulatory instruments, technical measures, etc. Particular attention is given to feasible and realistic measures.

Specific recommendations are given in Part III below.

5. KEY ISSUE 1: DRAINAGE & IRRIGATION CAPACITIES (HIGHER PRIORITY)

5.1. CURRENT STATE AND TRENDS

Prior to development over a century ago, the present cane land areas were swamps fed by river runoff from the higher areas in the South West and some tidal inflows from the Atlantic Ocean. Agricultural development was possible by ring fencing the areas (Estates) with dykes to keep sea water out on the coastal edges and restricting incoming river runoff from inland, the south west side.

Water control in the form of effective drainage systems (to prevent flooding from the runoff of inland waters and rainfall) and sea defences (to prevent intrusion of sea water) are critical aspects for an agriculture sector that is concentrated in coastal plains located below the mean sea level, including all of the sugar cane lands.

Climate change, which has led to more intense rainfall events and sea level rise, is compromising Guyana's drainage system and sea defences. Moreover sea defences are being further compromised by the deforestation of mangrove (UNEP 2010a), although an important mangrove restoration project is seeking to reverse this trend.

Continuing climate change will very likely put further pressure on the drainage capacities and sea defences.

Drainage system

The National Drainage & Irrigation Authority (NDIA) and GuySuCo are the two main agencies within the Ministry of Agriculture that have responsibilities over drainage and irrigation.

The NDIA functions as the Nation's apex organisation dealing with all public matters pertaining to management, improvement, extension and provision of drainage, irrigation and flood control infrastructure and services in declared areas of the country. It is mandated to provide drainage and irrigation services in Declared Drainage and Irrigation Areas (DDIAs). All DDIAs are administered by the Regional Democratic Boards (RDB), which are responsible for maintenance of the conservancies, water allocation from the conservancies, operation of the reservoirs, and maintenance of the dams and head regulators. The RDBs do not themselves collect the water users' share of costs; this is the responsibility of the local authorities. Local authorities are required by the Drainage and Irrigation Act to assess the level of the drainage and irrigation rates on DDIAs and levy charges on landowners.

GuySuCo provides D&I not only for its own cultivation but also for the surrounding communities. Due to the unpredictable and unusual weather patterns for heavy rains and dry periods, proper drainage and irrigation is critical. The Corporation has budgeted to spend almost G$3.7bn to maintain and improve its drainage and irrigation across the industry in the next five years.

The distinction of responsibilities between NDIA and GuySuCo over the management of the D&I system is blurry at instances, with GuySuCo still carrying out services that are strictly speaking beyond its area of responsibility, but which they nevertheless undertake as they are fundamental to their own operations. In the areas where the sugar Estates are situated GuySuCo operates and maintains the full irrigation and drainage infrastructure, including the conservancy structures, and the outfall structures in the urban areas.

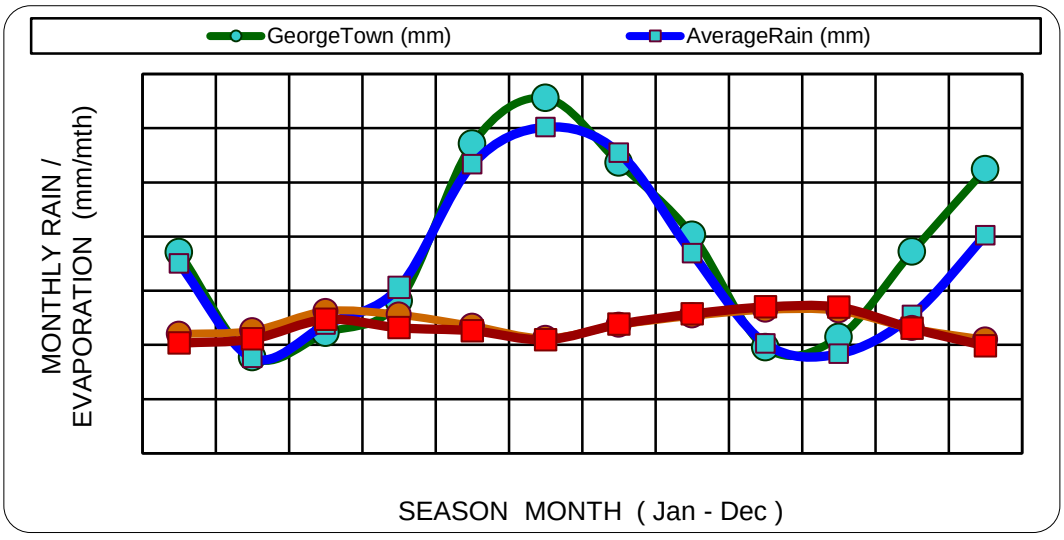
Present regulatory instruments are in place but are often not applied due to lack of funding or poor institutional capacity. Notwithstanding regulatory instruments, large urbanised front land areas put extra pressure on the drainage system due to poor access to corridors for maintenance purposes. Heavy squatting pressure and even permanent structures can be seen which hinder access for drain cleaning. Garbage loads and consequent siltation are high, resulting in reduced capacity of canal cross sections.

Studies carried out several decades ago by the Hydraulics Department of the Government of Guyana indicated a drainage parameter to remove 38mm (1.5") per day from the Estate areas before experiencing significant declines in cane yield. Excess water (rainfall runoff) inside these ring fenced Estates has to be removed throughout the year and the drainage systems have been designed accordingly. More recently as a result of extensive studies by McDonald *et al*. (2004), the National Drainage and Irrigation Authority (NDIA) is recommending 50mm (2") per day as a drainage parameter, which is a reflection of more recent and detailed analysis. This is a parameter around which drainage sizing and pumping requirements are designed – rainfall events in excess of this will cause flooding of cane production areas with a consequent reduction in cane yield. Consequently, the original drainage system on the Estates is considered under-designed and requires investment in order to upgrade them. (Cardno Emerging Markets, 2012).

Additionally, the Estates face severe drainage challenges due to an ageing infrastructure, changes in land use and restrictions on operational and capital spending, resulting in an overloaded drainage situation. This situation has resulted in prolonged short term flooding which causes:

- Water logging in the cane root zone, reducing cane growth, resulting in lower cane yields;
- Reduced time periods to carry out agricultural husbandry and maintenance activities (fertilising, spraying, tillage, conversions, drain maintenance etc.);
- Increased soil compaction and stool damage when working in wet fields, negatively affecting cane yields (see Figure 6 below on the rainfall pattern for Georgetown).

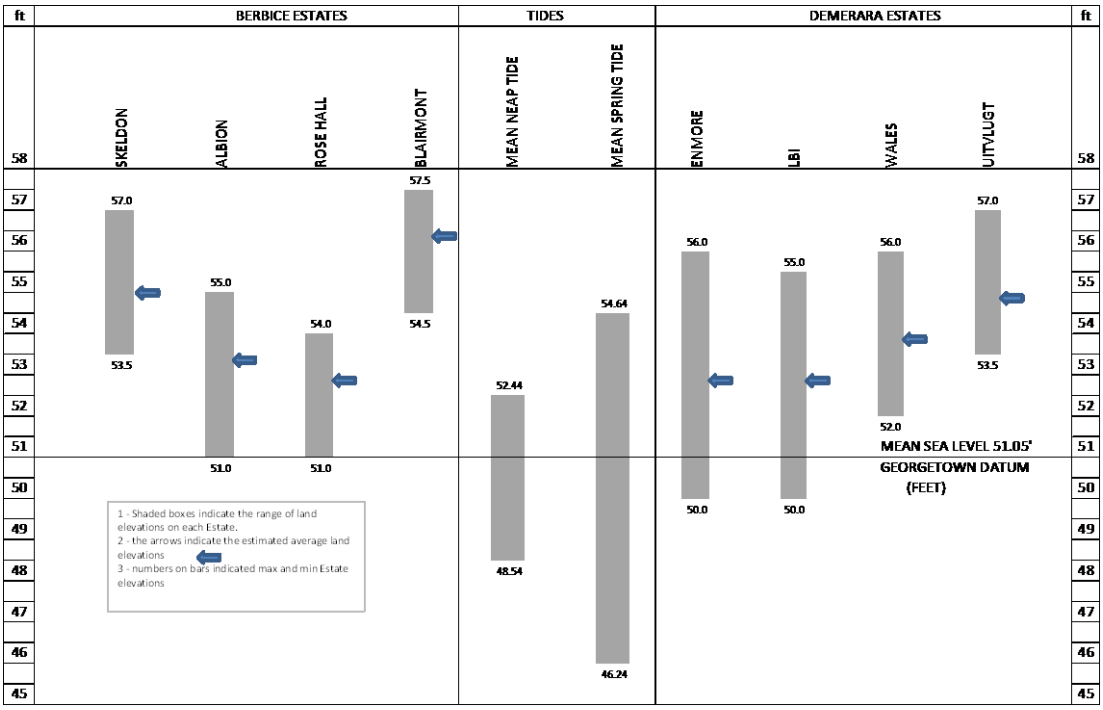
FIGURE 6 RAINFALL AND EVAPORATION DATA FOR GEORGETOWN



The success of agricultural developments hinges entirely on successful drainage by rapidly removing excess drainage water from the Estates, specifically that in cane fields that suffer from local flooding during heavy rainfall events, through to an efficient, clean and well maintained system.

Figure 7 shows the relative elevations of all the Estates with respect to the high and low tides and more clearly indicate the importance of effective drainage systems.

FIGURE 7 RELATIVE ELEVATIONS OF ALL ESTATES WITH RESPECT TO TIDAL LEVELS



Source: GuySuCo

A summary of the drainage system is presented in Table 15 below.

TABLE 15 GUYSUCO CANE AND TOTAL DRAINAGE AREAS WITH DRAINAGE SYSTEM

Estate	Enmore/LBI	Uitvlugt	Wales	Skeldon	Albion	Rose Hall	Blairmont
Cane Area (ha)	7,682	6,005	3,356	9,365	9,616	6,688	5,808
Drainage area (ha)	10,218	6,769	5,500	11,001	12,000	8,000	8,300
Cane: total area (%)	75%	89%	61%	85%	80%	84%	70%
Drainage system	Pumps & sluices	Sluices	Sluices	Pumps & sluices	Pumps & sluices	Pumps & sluices	Pumps & sluices

Source: GuySuCo Statistics Department

East Demerara Estates – LBI and Enmore

Enmore/LBI has a large urbanised front land area that puts extra pressure on the drainage system due to poor access to corridors for maintenance purposes. Heavy squatting pressure and even permanent structures can be seen which hinder access for drain cleaning. Garbage loads and consequent siltation are high, resulting in reduced capacity of canal cross sections. Sluice structures viewed are old, leaking and are in need of general maintenance to improve

their efficiency. Revetments are corroded and failing in places, reducing outflow efficiencies and threatening civil structures (sluices and pump stations). The outfall zones to the ocean are reported to be relatively clear of siltation despite both Estates being the lowest in elevation (see Figure 7). The pump station equipment (electrical and mechanical) are in a similar condition although availability is reported at over 90%, however, although a record is being kept it was very general. No other Estate had any records of pump station and/or sluice operation availability. (Cardno Emerging Markets, 2012).

The urban sprawl within the catchment area has exacerbated the problem with increased and accelerated runoff due to the negative change in runoff roughness (paved and roof surfaces). Furthermore, the ageing culverts and aqueducts are failing or are under-sized in many places, reducing the efficiency of the drainage system.

Prime movers of the pump stations were replaced in 2003 and are reported to be working well despite their age. The age of the pumps vary from modern (2000) to ancient (over 60 years old) but are all in working order. A new drainage pump unit (5.3 m^3/s) for Enmore was installed in 2012, to be operated by NDIA. This is in addition to the existing infrastructure and will go a long way to meeting the under-designed Estate system. Enmore/LBI Estate Capital investment plans promise to further improve drainage works with replacement of revetments, bridges and aqueducts.

West Demerara Estates – Uitvlugt/Leonora and Wales

Uitvlugt/Leonora Estates drain out to sea via sluices that are in reasonable condition. Extensive squatting has resulted in a loss of corridors to gain access for drain cleaning and garbage accumulation is also a problem. Uitvlugt/Leonora outfall zones are heavily silted, which impedes the gravity drainage system. These can only be dredged when there is adequate drainage flows, otherwise they silt-up within 2 weeks.

NDIA was to install a new pump unit (5.3m^3/s) at Uitvlugt in 2012. Estate Capital investment plans promise to improve drainage works with replacement of bridges and aqueducts. Added to this is the likely go-ahead of the Hope Canal project, which will control excess up-country (conservancies) water from flooding this area.

Wales Estate drainage is all done via sluices directed into the Demerara River, which is tidal. It is reported that since the new bridge was built across this river, siltation around the outfalls has increased. Wales Estate drains a relatively large area outside of its cane area. Wales faces the same constraints of loss of corridors and heavy siltation within the front area drains and the estate also needs to resuscitate some of the old sluices.

Wales Capital investment plans promise to improve drainage works with replacement of revetments, bridges and aqueduct.

East Berbice Estates – Albion and Rose Hall

Rose Hall drains into the Berbice River and Canje Creek with a combination of sluices and pumped outlets. It is reported that both rivers appear to have risen over the last several years from gradual siltation. Added to their constraints is the loss of corridors. It is felt an increase in drainage capacity would assist greatly in alleviating drainage constraints.

A new drainage pump for Rose Hall is to be installed and operated by NDIA during the year. This will be in addition to the existing infrastructure and should alleviate capacity constraints to a large degree. The Estate Capital investment plans promise to improve drainage works with replacement of revetments and aqueducts.

Albion Estate has a drainage system that feeds both into the Canje Creek and the ocean, relying heavily on pumped drainage. Pumping capacity is considered low for the 12,000 ha area to be drained. Corridor access has been reduced from high squatter activity.

Albion's Capital investment plans promise to improve drainage works with replacement of revetments, bridge and aqueducts.

West Berbice Estate – Blairmont

Blairmont Estate drains a third of its catchment area using pumps despite being the highest elevated Estate. The three sluices are working well but need constant maintenance on this relatively well drained system.

The NDIA was to install a new pump unit during 2012 of 5.3 m^3/s capacity. This will be in addition to the existing infrastructure. Capital investment planes promise to improve drainage works with replacement of aqueduct and bridges.

Skeldon Estate

Skeldon Estate drainage consists of two pump units discharging water into the Corentyne River along with sluices. By mid-2012 the new large Estate drainage pump station (7.5 m^3/s) has been commissioned extracting water from the extreme west of the estate. A new 5.3 m^3/s NDIA pump unit will be installed on the north-western side of the estate. Sluices are in reasonable condition and there are two disused sluices that could be resuscitated. Revetments around the sluices are worn out. Overall the Skeldon drainage system is reportedly under capacity for the area it commands and it has the largest cane area under full mechanised harvesting (chopper). Skeldon Estate is by far the highest elevated Estate (see Figure 7).

Sea defences

Under climate change sea level is projected to rise at a rate of 1 cm/year, about 40-60 cm by the end of the 21st century. Such rise in sea level may inundate wetlands and lowlands; accelerate coastal erosion; exacerbate coastal flooding; threaten or destroy coastal structures; raise water tables and increase the salinity of rivers and aquifers.

In protecting the coast from the Atlantic Ocean the government needs to fortify 360 km of sea defences at an approximate cost of US$4.4-6.4 million/km[14]. Guyana's vulnerability is further amplified with 90% of its population residing on the low-lying coastal plain, as well as the main agriculture lands, and all major administrative, economic, service and infrastructure facilities.

While sea levels are rising on a global scale at a rate of 2-4 mm/year (IPCC, 2007), this trend in sea level is consistent with the work conducted by Douglas (1995) and Smith *et al.* (1999)

[14] Approximately 3.5-5.2 M€/km.

which indicate that sea level in the region of Guyana is increasing at a rate in excess of 10 mm/year - or 2 to 5 times faster than the global estimate. Changes in the sea level, increases in the severity of individual rainfall events, and variations in annual rainfall levels pose significant threats to Guyana's East Demerara Water Conservancy system and drainage infrastructure; future agricultural production, and the overall welfare of inhabitants of the low-lying coastal zone of Guyana.

For the storm surge categories considered, the minimum (2.0 cm - moderate) scenario is very likely, whereas, the maximum (5.0 cm - catastrophic) scenario is less likely. The low - lying coastal plain is the most vulnerable to sea level rise from climate change. The projections show that by the year 2031 the increase in sea level could reach 26 cm and for 2071 it could reach as high as 51 cm. In addition, by 2031 storm surges could result in a 2.94 cm sea level rise (in a moderate scenario) and as high as 5.94 cm (in a catastrophic scenario).

Given these potential losses, investing in the most beneficial adaptation measures would significantly increase estimated national income in Guyana, and would likely be essential to attracting investors.

TABLE 16 PROJECTIONS OF LAND INUNDATION DURING MINIMUM AND MAXIMUM STORM SURGE

Model	Year	Land area in the coastal zone likely to be inundated (min-max) (ha)
CGCM2	2031	79,851 - 140,245
	2051	82,881 - 140,986
	2071	88,591 - 142,480
HadCM3	2031	75,578 - 139,123
	2051	78,038 - 139,784
	2071	79,483 - 140,152

Source: Second National Communication to the UNFCCC

The Sea and River Defence Board (SRDB) has the legal responsibility for all declared sea and river defences. The Hydraulic Division is the Board's executing agency and is part of the Ministry of Public Works and Communications. As such, it shares the institutional problems common to all ministries. To overcome these limitations, the Project Execution Unit was formed in 1994 to manage donor agencies-funded programmes and to train counterpart staff. It should be evident that the effective management of this organisation is vital. The Project Execution Unit has no formal legal mandate but was given some autonomy in accounting and procurement. It was envisaged as a temporary unit. Therefore, after the donor-supported rehabilitation of sea defences is completed, there will be need for an effective, permanent agency to manage maintenance tasks and ensure that maintenance works are not again neglected.

New policies are needed to ensure adequate funding for continuous maintenance of the sea walls. The lack of funding in the past has led to severe deterioration of the structures, and hence the current necessity to resort to external sources of funding for major rehabilitation.

Irrigation

The main irrigation systems available are variations of three basic types: surface (e.g. flood, furrow) methods, overhead sprinklers (e.g. solid set, dragline, rain guns and centre pivot) and surface/subsurface drip (trickle) systems. Surface irrigation tends to result in oversupply (with substantial drainage losses) of water, sprinkler irrigation results in losses of water intercepted by above-ground parts of the crop and drip/trickle methods have the greatest potential for maximising water use efficiency, but are relatively expensive to install.

5.2. OPTIONS TO ADDRESS THE KEY ISSUE

Climate change and sea level rise will pose serious threats to agriculture in areas where the greatest impact of adaptation, food security and poverty will be achieved. The agriculture sector, especially sugarcane, is very likely be negatively affected by climate change through decreasing yields caused by greater drought like conditions mainly. However, impacts on the water sector, through increasing drought conditions, or salinisation from sea level rise and storm surges may indirectly impact upon the agriculture sector. It is therefore imperative to develop a land use plan (land zoning strategy) to identify the best-suited land for sustainable agriculture in the future, including for sugar cane. The experience of 2005 flooding revealed that planning for disaster preparedness, relief and post disaster is critical, including the development and use of early warning systems and adequate maintenance of infrastructure and equipment (sea wall, sluices, pumps).

Drainage system

In view of the ageing infrastructure and old drainage runoff parameters, the present design capacity of the drainage systems is considered to be under capacity by 33%. Short-term local flooding is a result of under-capacity drainage systems that are costly to enlarge. This is compounded by the changes in the runoff characteristics in the Estate catchments and catchment conditions, which negatively affect cane yield through both local and short term flooding. There are several old and disused sluices in place which could be resuscitated and many of the existing sluices need maintenance to improve their efficiency and thus maximize drainage outflows.

Of all eight Estates, Skeldon, Blairmont and Uitvlugt are the highest elevated and should therefore have no problems draining into the sea even at high spring tides. The other five Estates are more susceptible to high tide pressures (see Figure 7).

The move to mechanisation will make it more even more important to have dry conditions for successful harvesting, putting more pressure on the drainage system working efficiently.

Overall the drainage system of the Estates is closely linked to the urban areas that serve them. In general the drainage system is operating acceptably but with extra effort paid towards improving the maintenance on the infrastructure (de-silting drains, stabilising civil structures, increasing culvert dimensions, maximising sluices and their efficiencies, maximising pump performance) the system will be in a far better position to drain out excess water after higher than normal rainfall events. This level of essential maintenance is estimated to cost approximately US$3.08 million.

In spite of the efforts carried out to upgrade drainage capacities to the new weather patterns, long-term considerations are still absent in the strategic planning framework for the drainage system by NDIA and GuySuCo.

Upgrading drainage capacities to cater for long-term climate change will most likely imply additional costs that, in the light of strict financial constraints, may be a serious obstacle to secure climate change adaptation. However, these additional costs have to be compared not only with the costs of simply upgrading to cater to current climatic conditions, but also to the potential future costs of not acting now. Various criteria will have to be defined in such an analysis, including the likelihood of future climatic conditions materialising under different climate change scenarios, and the identification of 'no-regrets', 'low-regrets' and/or robust measures (see Key Issue 2 below). Importantly, some international climate change adaptation funds would take as a criteria for a project to qualify for funding that it shows 'additionality' (i.e. that the costs to adapt to climate change would not have been incurred any way under the development project); so it is important to clearly identify and compare the costs to adapt to current climatic conditions as opposed to long-term climate change adaptation, as this can be an entry point to tap into international climate change funds.

With the present financial status of GuySuCo, investing in the upgrading and maintenance of the drainage and irrigation infrastructure will have a detrimental effect on the implementation of recommended actions.

Irrigation

The present irrigation system used by GuySuCo, field flooding and drainage of excess water, is the most inefficient water management irrigation system, with enormous quantities of water firstly to be applied to the field and the surplus subsequently drained from the field again. In the light of drought prediction under climate change, water saving measures at irrigation systems should be given a high priority. As a consequence of applying less water to the fields also less water should have to be evacuated from the fields, thus contributing to increase capacities of existing drainage systems. With lower water-consuming systems in place the draught condition predicted under climate change might be mitigated altogether.

Considerable improvements in water use efficiency can be achieved by shifting to furrow irrigation, and there are variations that can further increase irrigation efficiency (e.g. flooding alternate furrows, combining with mulching). Sprinkler irrigation in turn can produce substantial water savings in comparison with furrow irrigation, but the infrastructure is more expensive and may be more labour intensive to operate. Drip irrigation, which delivers water directly to the root system of the crop through frequent applications of relatively small amounts of water, is the most water efficient, albeit also the one that entails the highest installation and maintenance costs. (Cheesman, 2005).

The shift to water efficient irrigation in Guyana should respond to two main drivers:

1. Expected future drought conditions under climate change, consisting thus of a needed adaptation measure: *"Water deficits are expected during the period 2040-2069 and are* very likely *to result in reduction in sugarcane yield and livestock productivity"* (MoA, 2013); and
2. The opportunities to reduce the pressure on the drainage system by reducing the amounts of excess irrigation waters that are drained.

6. KEY ISSUE 2: INTEGRATION OF LONG-TERM CLIMATE CHANGE ADAPTATION IN THE SUGAR INDUSTRY AND KEY GOVERNMENT INSTITUTIONS (HIGHER PRIORITY)

6.1. CURRENT STATE

Climate change is well recognised in Guyana as a fact that is already affecting the performance of the agriculture sector in general, and the sugar sector in particular. Some of the policy documents capture climate change, although not in a systematic fashion. Nevertheless, the degree of implementation of such measures is very limited, and most efforts are focusing on adaptation to climate variability rather than long-term climate change.

Foreseen impacts

In the sugar sector the changing climate is resulting in a reduced number of 'opportunity days' in which field operations can be carried out, leading to decreased performance of the sector. Such impacts of climate change are highlighted in GuySuCo's Strategic Plan as one of the main causes behind the reduced yields and the non-achievement of some of its production objectives.

It is also recognised that climate change is compromising the capacities of the drainage system (see Key Issue 1 above), which need to be upgraded in order to cope with the changing weather patterns.

The sugar sector is identified as one of the most vulnerable to climate change:

"The agriculture sector, especially sugar-cane, would be very likely to be negatively affected by climate change through decreasing yields, mainly on account of greater droughtiness" (Government of Guyana, 2012 p. 225 – 2nd National Communication to the UNFCCC).

Non-traditional agriculture is also vulnerable to climate change, although it has not been subject to detailed vulnerability analysis:

"Other sub-sectors of agriculture, such as livestock and fisheries, may also be subject to similar types of climate and sea-level risks, e.g. livestock depend on the availability of grazing pastures which are at risk of being subjected to drought and flooding along the coast. In the case of freshwater fisheries and shrimp farms, saline intrusions and inundations deriving from sea-level rise and storm surges may also impact negatively on this sub-sector". (Government of Guyana, 2012 p. 225 – 2nd National Communication to the UNFCCC).

Based on crop modelling[15] for sugar cane yields in Region 6, and applying two different climate models[16] for the 2040-2069 period show that yield changes are significant: a change in mean yield of -40.85% (taking into account CO_2 fertilisation) and of -47.06% (without CO_2 fertilisation) according to the CGCM1 model, and of -33.33% and -38.89% (with and without CO_2 fertilisation) under the HadCM3 model (Government of Guyana, 2012 p. 221).

[15] DSSAT: Decision Support System for Agrotechnology Transfer.
[16] The CGCM1 and HadCM3 models.

The Disaster Risk Management Plan for the Agriculture Sector also points out the potential impacts of water deficits for the 2040-2069 period, which are deemed to be *"very likely to result in sugarcane yield and livestock productivity*" (Ministry of Agriculture, 2013 p. 7).

The impacts on non-traditional agriculture have not been studied in detail. The National Adaptation Strategy to Address Climate Change in the Agriculture Sector of Guyana, prepared for the Caribbean Community Climate Change Centre (CCCCC) captures some of the potential risks.

The climate change predictions are that there will be an increase in temperature, a decrease in total rainfall and a decrease in the length of the rainy period, meaning there will be more intense rainfall during the wet season. Agriculture sector productivity will be compromised by rising CO_2 levels, flooding, high temperature, high relative humidity, increased pest and disease incidence, salinity intrusion, high evaporation rates and greater plant stress. In spite of the CO_2 fertilisation effect, temperature changes may have a greater detrimental effect, resulting in a reduction in productivity for even small temperature increases due to increased plant transpiration rates and evaporation leading to deficits in soil moisture supply. Sea level rise is expected to result in greater risk of coastal erosion and also affect mangrove, threatening fertile agricultural lands behind these natural sea defences. (Development Policy and Management Consultants, 2009 p.30).

Potential impacts on non-traditional agriculture include the following:

- Impacts of saltwater intrusion and changing rainfall patterns on aquaculture productivity;
- Impacts on livestock development related to nutrition (reduced forage quantities and quality), disease (respiratory and digestive diseases may increase), and availability of food for human consumption (likely increased incidence of mastisis leading to lower levels of milk production);
- Potential impacts on crop growth due to temperature increases, water availability and increased incidence of pest and disease outbreaks. (Development Policy and Management Consultants, 2009 p.33-34).

Policy response

Climate change adaptation is addressed at the policy level to a limited extent. In relation to the agriculture sector, climate change adaptation is addressed under the LCDS, the National Adaptation Strategy to address climate change in the agriculture sector, and the Disaster Risk Management Plan for the Agriculture Sector. It is absent in other policy documents such as the Guyana National Livestock Development Policy and Strategy, the Aquaculture Development Policy and the Food and Nutrition Security Strategy, although various activities under these policies are conducive to increased adaptive capacity in their own right.

The **Low Carbon Development Strategy** (LCDS) will have an important focus on 'adaptation and climate resilience' in the period 2013-2015, in which up to US$100 million are to be allocated. Details are to be defined in a future **Climate Resilience Strategy** (expected by mid-2014), and which are expected to include:

- Upgrading and infrastructure and assets to protect against flooding through urgent, near-term measures;

- Hinterland adaptation measures, including reproduction and distribution of suitable plant varieties and crop management techniques, construction of all-weather roads and bridges, training and educational programmes, additional drainage and irrigation equipment in particularly vulnerable areas, etc;
- Addressing systematic and behavioural concerns, including revamping of the early warning system, improving the timely and accurate collection and dissemination of data and information on weather related events and their impacts on the ground, and setting up of an emergency response system;
- Developing innovative financial risk management and insurance measures to resiliency; and
- Switching to flood resistant crops. (Office of the President, 2013 pp. 31-32 – LCDS Update).

The **National Adaptation Strategy to Address Climate Change in the Agriculture Sector of Guyana** (2009) proposed actions under five focus areas: (1) capacity enhancement; (2) infrastructure management; (3) policy and legislation; (4) research and development; and (5) awareness and communication. 54 specific activities are proposed addressing the short-, medium- and long-term.

The **Disaster Risk Management Plan for the Agriculture Sector** addresses vulnerability to natural disasters, integrating climate change factors. Relevant actions promoted include:

- Develop codes and standards for agriculture infrastructure that strengthen resilience to natural hazards and climate risk;
- Implement strategies aimed at climate change adaptation in accordance with the Drainage and Irrigation Act, 2004;
- Work with research organisations at national, sub-national and international levels to develop: crop and livestock varieties that are tolerant to extreme climatic conditions to better meet the needs of the farming community, in particular small farmers;
- Develop a standardised methodology guided by regional and international best practice for conducting region-wide Vulnerability and Risk Assessments (VRA);
- Develop Community Based early warning systems for agriculture sector in high risk areas;
- Conduct research to determine resistant varieties of crops and breeds of livestock to drought, flood, pests and diseases and other improved management practices, and alternative economically profitable crop varieties that are less water demanding for adoption by the farming community;
- Conduct research to understand the impact of climate change and variability on the fisheries sub-sector.

The degree of implementation of such measures is very limited and is done in a piecemeal fashion, mainly under specific donor-supported projects. Attention is being given primarily to addressing climatic changes that are being experienced to date; as necessary as this is, the long-term implications are being neglected to a relatively large extent.

Institutional framework

Several institutions were set up to address climate change in Guyana:

The **Office of Climate Change** (OCC) is responsible for coordinating work on climate change adaptation, mitigation and forest conservation, as well as national consultations of the LCDS.

The **Project Management Office** (PMO) is responsible for accelerating implementation of key projects identified in the LCDS.

The **Guyana REDD+ Investment Fund** (GRIF) is a multi-contributor trust fund for the financing of activities identified under the LCDS. It was established in October 2010 following an agreement between Guyana and Norway, in which Norway agreed to provide Guyana up to US$250 million by 2015 in performance-based payments for avoided deforestation in support of the LCDS.

In the context of the LCDS a Multi-Stakeholder Steering Committee was established, and which meets regularly to review LCDS implementation.

The **National Climate Unit** of the Office of the President is the Designated National Authority (DNA) for the Clean Development Mechanism (CDM).

The **Guyana Hydrometeorological Service**, attached to the MoA, is responsible to monitor and evaluate the weather and water resources in Guyana. Hydromet is the focal point for the UNFCCC. It is involved in weather forecasting under climate change scenarios, although their capacities are still very limited in this respect. **GuySuCo** also has its own weather stations and shares information with Hydromet for weather forecasting.

Expected trends

In spite of the awareness of the risks associated to climate change for the agriculture sector in general, and the sugar industry in particular, the focus of attention has been the adaptation to climatic changes experienced to date.

Key areas of attention include the upgrading of drainage capacities to cope with increased rainfall intensity (see Key Issue 1 above) and the shift towards mechanisation in the sugar industry in order to increase harvesting capacities in the reduced number of 'opportunity days' available.

The long-term challenges of climate change are, however, being largely neglected. As discussed above, e.g. increased drought conditions affecting sugar cane growth, salinity intrusion affecting the livestock and aquaculture sub-sectors. For example, GuySuCo currently has no budget for research, whereas from a long-term climate change adaptation perspective, research is fundamental in order to understand the risks in the sector. Research areas of importance (which are recognised by GuySuCo staff but no necessarily supported by top management through allocation of funds) include pest & disease dynamics under climate change, water efficient irrigation systems under increased drought conditions, and sugar cane varieties.

Financial constraints certainly play a role in this situation. However there is also an important component associated to the lack of effective ('real') mainstreaming of climate change in the Ministry of Agriculture[17]. We can safely say that, in spite of awareness of significance, climate

[17] Reference is made to the MoA as this is the area of attention of the GNAP and this SEA. However, the argument can be applied more broadly to other sectoral institutions in Guyana.

change adaptation initiatives are still considered to be the subject matter of the 'climate change' institutions (e.g. under the LCDS)

Mainstreaming of climate change passes by recognising that addressing climate change in the sector is an integral component of sector performance, and is not a question of addressing an external (climate change) component.

This situation is in a way reinforced by the institutional structures in place, where climate change adaptation measures are to be defined under the LCDS (more specifically, the future Climate Resilience Strategy) and the OCC would assume the responsibility of mobilising funds for their implementation. As reasonable as this may sound from a climate change finance perspective (it can certainly be a more effective means to tap into international funds for climate change adaptation), it leaves the competent sectoral authority in the side-line of in terms of ownership.

Overlooking long-term implications of climate change will be felt in the coming decades and adaptation options are very likely to be more expensive than measures aimed at building resilience start to develop now. Climate change vulnerability thus increases with time.

To date, adaptation measures that have been defined in various policy documents remain largely unimplemented. This situation is not expected to change in the near future unless dedicated action is taken.

6.2. OPTIONS TO ADDRESS THE KEY ISSUE

Under important financial constraints it is only reasonable that responding to present-day challenges takes precedence over long-term planning. Immediate adaptation concerns, such as the upgrading of drainage systems and the mechanisation of sugar cane harvesting (in response to the reduced number of 'opportunity days') are necessary and clearly represent priority areas of action. Nevertheless, longer-term adaptation may also deserve priority attention if costs of inaction now will translate into considerably higher adaptation costs in the future. Addressing long-term climate change cannot be neglected without compromising future development in the agriculture sector.

In order to ensure a good degree of climate change mainstreaming in the agriculture sector it is important to (a) clearly understand the climate change vulnerabilities in the different sub-sectors, (b) identify and prioritise adaptation measures, (c) integrate adaptation into the MoA's own strategic development plan.

Understanding impacts and vulnerabilities and building institutional awareness

For Guyana's agriculture sector climate change impact and vulnerability has only been explored for the traditional crops (sugar and rice), and then only to a limited extent. Vulnerability of non-traditional agriculture has only been approached superficially.

Understanding vulnerability to climate change is fundamental for adequate strategic planning in a context of uncertainty. We must understand the different impacts expected and the aspects that contribute to vulnerability in order to know where action has to be taken. Such an impact and vulnerability assessment should move beyond the modelling of effects on crop yields associated to temperature, rainfall and humidity changes, and also integrate

critical variables such as salinity intrusion associated to sea level rise and pest & disease dynamics.

Only by understanding the links between sector performance and long-term climate change, will it be possible to further raise awareness of climate change within the MoA that will result in effective mainstreaming.

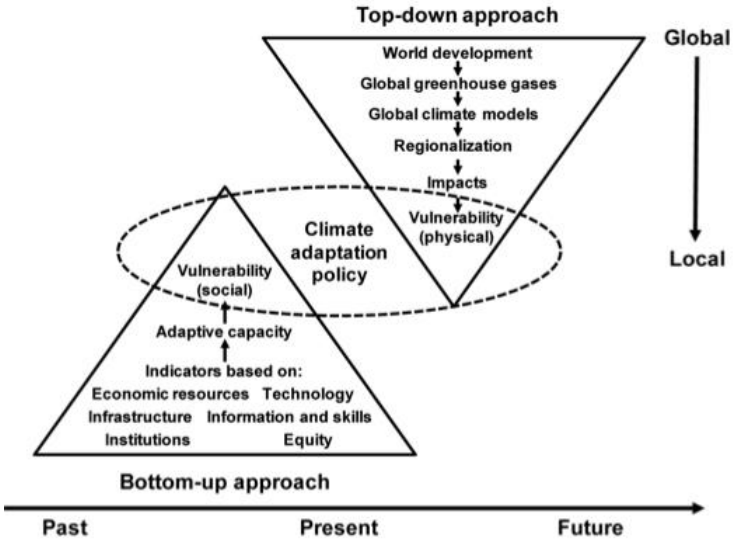
There are various elements of uncertainty associated to climate change modelling. As spelled out in the IPCC's Fourth Assessment Report: *"assessments of climate change impacts, adaptation and vulnerability are undertaken to inform decision-making in an environment of uncertainty"*. This is fundamental when impact and vulnerability assessments are to inform the definition of adaptation strategies and allocation of financial resources to address priorities, as should be the case in Guyana for the agriculture sector.

Vulnerability has been defined by the IPCC as *"the propensity to be adversely affected"*, where such predisposition constitutes an internal characteristic of the affected element (IPCC, 2012). Vulnerability is a result of diverse historical, social, economic, political, cultural, institutional, natural resource and environmental conditions and processes (IPCC, 2012). This definition differs from the previous understanding of vulnerability used by the IPCC as a function of exposure, sensitivity and adaptive capacity (IPCC, 2007), the difference being that, whereas under the former definition physical causes and their effects were considered as explicit aspects of vulnerability, under the new definition, vulnerability is independent of physical events (IPCC, 2012).

The three main dimensions to vulnerability are: exposure, sensitivity and adaptive capacity. For a climate change impact, different regions or social groups may be more vulnerable than others. **Exposure** refers to the exposure to the effects of climate change (for example, a heat wave can cover a whole region, but the person who works outdoors in the construction industry is more exposed than the person who works indoors with access to air conditioning). **Sensitivity** is normally associated to age, medical condition and gender (for example children, the elderly and pregnant women are normally more sensitive to adverse impacts); as well, women tend to be particularly sensitive to climate change (UNDP, 2012; Demetriades and Esplen, 2010). Finally a higher **adaptive capacity** will decrease vulnerability; adaptive capacity is associated to various socio-economic factors such as level of education, awareness of climate change, access to technology (e.g. irrigation, improved seeds), access to credit and insurance, and diversification of livelihoods. (Palerm, 2013).

There is a multiplicity of approaches to vulnerability assessments available. The so-called 'top-down' impact frameworks help understand the potential long-term impacts of climate change. Increasingly 'bottom-up' adaptation frameworks are being used, designed to focus on vulnerabilities and involving stakeholders. In the framework of the UNFCCC the Nairobi Work Programme provides assistance to improve the understanding and assessment of impacts, vulnerability and adaptation to climate change. (Palerm, 2013)

FIGURE 8 TOP-DOWN AND BOTTOM-UP APPROACHES TO INFORM CLIMATE ADAPTATION POLICY



Source: Dessai and Hulme (2004)

The approaches to assess impacts and vulnerability vary widely depending on the sector, time-frame of analysis required (e.g. near-term corresponding with annual crop planning or longer-term associated to life-span of infrastructure investment) and geographical coverage (e.g. inter-basin, local) (UNFCCC, nd).

It is not possible to provide a 'recipe' to select the appropriate approach and methodology. At a sectoral level there are various impact assessment methodologies. In the agriculture sector the FAO is developing an integrated methodology to assess climate change impacts on agriculture (Climate Change Impact Assessment Toolbox), which comprises four main software components: a downscaling method for processing Global Climate Model output data, a hydrological model for irrigation water resources estimation, a crop growth model to estimate crop yields and a Computable General Equilibrium Model to simulate the effect of changing agricultural yields on national economies (FAO, 2010).

Various approaches to participatory vulnerability assessments have been used, useful when dealing with community-based action for adaptation. We can highlight CARE's Toolkit for Community Based Adaptation (CARE, 2009) and the Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL)[18].

Data, information and capacity constraints for impact and vulnerability assessment

The specific approach to impact and vulnerability assessment for Guyana's agriculture sector has to be defined.

A good understanding will very likely require to move beyond climate change modelling at the regional (Caribbean) level and develop a **downscaled model** that would best capture the country's specificities. Downscaling is used to obtain local-scale surface weather from regional-scale atmospheric variables provided by Global Circulation Models (GCMs), and this can be done either by dynamic downscaling (where output from the GCM is used to drive a

[18] http://www.iisd.org/cristaltool/

regional, numerical model in higher spatial resolution in order to simulate local conditions in greater detail) or by statistical downscaling (where a statistical relationship is established from observations between large-scale variables).

Capacities within Hydromet are currently limited and would need to be assessed an upgraded in order to develop and run downscaled projections in the context of a comprehensive agriculture sector impact and vulnerability assessment (including human and technical/technological). Capacities within the MoA and GuySuCo would also have to be considered.

Such investment in capacities, equipment and research are necessary and worthwhile in order to engage in proper climate change adaptation strategic planning that addresses priority concerns and makes optimal use of available resources.

Identifying and prioritising adaptation measures

In the face of climate change and socio-economic uncertainties, many decision-makers are tempted to 'wait and see' before committing resources. However, the cost of inaction can be greater than the cost of acting now. While inaction is likely to have a cost, action may entail development co-benefits. Even in the face of uncertainty some types of measures are justified.

Adaptation of climate change in Guyana's agriculture sector has been reflected in a number of adaptation measures that are very broadly defined, in many cases without the backing of a detailed impact and vulnerability assessment, and without the benefit of a prioritisation that could inform allocation of resources.

Whereas the impact and vulnerability assessments explored above are a necessary starting point, the adaptation measures that get identified need to be put through a filter of prioritisation. It is useful to classify adaptation measures under the following categories: 'no-regrets' measures, 'low-regrets' measures and 'robust' measures.

'No-regrets' measures are those expected to produce net benefits to society even in the absence of climate change (adaptation) or independently of any 'reward' for mitigation. Typical examples include investment in agricultural practices that reduce/prevent soil degradation, in water conservation, in access to safe drinking water, in improved primary healthcare services, or in energy efficiency measures. (European Commission, nd).

'Low-regrets' measures are those expected to have a cost for society in the absence of climate change, but an acceptable one in view of the benefits they would bring if climate change turns out to produce significant effects (adaptation) – or to have a low net cost at zero or low carbon prices (mitigation). (European Commission, nd).

'Robust' measures are those that produce net benefits or deliver good outcomes across various possible climate change, economic development or carbon price scenarios (rather than just under the 'most likely' scenario). For instance, subject to calculations based on context-specific circumstances, the development of water-efficient irrigation systems to support agricultural production in rainfed systems may turn out to be a robust measure – or even a 'no-regrets' one. (European Commission, nd).

A well-grounded prioritisation of adaptation measures will be an important step to justify allocation of resources. Although any resources from the international community that could be mobilised would be welcome, the adaptation measures should become an integral part of the MoA's strategic planning, and thus considered within its own budgeting.

Currently there is a disconnect between the climate change adaptation planning carried out by the Office of Climate Change (OCC) and that carried out by line ministries and agencies. Although there are arguments to 'centralise' the adaptation portfolio under the OCC in order to better coordinate access to climate finance, this creates a situation where adaptation remains 'outside' the sectoral authorities, and thus not fully mainstreamed. The MoA should ensure that the adaptation measures that pertain to the agriculture sector are integrated into their own strategic planning, even if also reflected by the OCC (e.g. through the upcoming Climate Resilience Strategy). In this way the OCC can act more as a single window for climate finance, coordinating with the relevant sectoral authorities in helping secure finance for the different climate change projects and activities.

Securing effective mainstreaming in the budgeting process and climate markers

Effective mainstreaming of climate change necessarily has to include the consideration of climate change priorities in the budgeting process. Financial management through systems such as Medium-Term Expenditure Frameworks (MTEF) are very helpful to ensure budget allocations respond to national and sectoral priorities and objectives; however, MTEFs are complex instruments and their implementation remains incipient in various countries, including Guyana.

Once the MoA has a clear understanding of the climate change impacts and vulnerabilities to climate change, and has identified prioritised and costed adaptation measures, it would be useful to run a check on budget allocations and expenditures in order to verify that climate change priorities are addressed. A useful tool to this effect is the **Climate Public Expenditure and Institutional Review (CPEIR)**, based on the **Public Expenditure Review (PER)** and **Public Environmental Expenditure Review (PEER)** tools, as adapted to climate change by UNDP.

PERs involve the analysis of allocation and management of public expenditures and may cover all government expenditures, or focus on a few priority sectors. PER findings are used to provide guidance to strategic planning and budget preparation and to identify ways to improve efficiency and effectiveness of resource allocations. Increasingly PER processes are applied to expenditure management systems and institutions.

The CPEIR has been piloted by UNDP in Asia. The idea is that, by reviewing climate expenditures from both domestic and external sources of finance and identifying ways in which climate related expenditures can be tracked through time, the CPEIR will be a key building block for developing a comprehensive climate fiscal framework. It should serve as a tool to improve prioritisation, efficiency and effectiveness of all public resources in support of climate change adaptation and mitigation.[19]

Expenditure Reviews require an assessment of the alignment of resources with stated policy objectives and the means by which these policy objectives will be achieved. This analysis can serve as an input to the planning and budget process, contributing to the selection,

[19] http://www.aideffectiveness.org/CPEIR

prioritisation and allocation of resources to expenditure programmes. Public Expenditure Reviews can also contribute to good governance and can help mobilise resources, including strengthening arguments for budgetary support.

The CPEIR analysis meets the following objectives:

- It secures a better understanding of the formulation of climate change policy and its linkages to expenditure through national strategies and action plans;
- It improves understanding of the role and responsibilities of institutions involved in managing the response to climate change and their interaction; and
- It quantifies climate change related expenditures in the national budget, and through other funding channels, providing a baseline for future analysis (UNDP, 2012c).

Mainstreaming of climate change in budgeting corresponds primarily to the Ministry of Finance, in coordination with relevant line ministries (in this case, the MoA), and entry points for mainstreaming are to be found.

One of the challenges encountered by Guyana is securing funds to implement climate change mitigation and adaptation projects. The adoption of a system of 'climate markers' by the Ministry of Finance in its budget may be useful to clearly identify climate change components in different budgetary items and keep track of them, which would be useful in order to attract international climate finance. The use of climate markers may help secure eligibility for funding from specific climate funds that may emphasise a separation of adaptation from development-related costs and limit eligibility to the former (Burton & van Aalst 2004, Fankhauser & Schmidt-Traub 2010), or place a special emphasis on the 'additionality' of mitigation-related activities.

7. KEY ISSUE 3: MISSED OPPORTUNITIES ASSOCIATED TO NON-TRADITIONAL AGRICULTURE (HIGHER-PRIORITY)

7.1. CURRENT STATE AND TRENDS

Despite recent declines in extreme poverty, moving from 28.7% to 18.6%, in 2006 Guyana remains one of the poorest countries in Latin America and the Caribbean[20] with about 43% of the population living below the poverty line[21]. This situation may have been exacerbated by the removal of preferential market arrangements on the country's traditional agricultural exports (sugar).

Agricultural diversification is perceived to have the potential to bridge the gap in the traditional sub-sector and may relieve such a poverty situation. This aspect is promoted by the GNAP as the potential safeguard to food security, alternative livelihoods to job losses in the sugar sector and climate change eventualities. Other development strategies such as the NCS and ADS have also endorsed agricultural diversification as having the potential to increase the country's exports and have been spearheading the establishment of an appropriate institutional framework to drive the diversification process. Due to its low carbon development potential the advancement of non-traditional agriculture has been given special credence under the LCDS and is being earmarked for further support under its second phase. Particular attention is given to aquaculture, fruits and vegetables and livestock.

It should be noted that a lack of smart environmental practices among stakeholders engaging in non-traditional agriculture may result in major environmental risks that could be potentially damaging to the LCDS. For instance, the propagation of the current methods of growing non-traditional crops and livestock where traditional approaches are employed (unregulated use of agrochemicals, *ad hoc* disposal of waste, slash and burn, fragmented and disorganised systems of operations) may have far reaching implications on the LCDS.

Although there is no specific policy or legislation framework currently in place to drive agricultural diversification, most agricultural development plans/strategies have featured some elements of agricultural diversification. Currently, the Guyana's National Development Strategy (NDS) is driving the agricultural diversification process but it does not adequately address the potential negative impacts that are associated with the development of non-traditional agriculture. Notwithstanding, the NDS has seen the reform of both the crop and livestock subsectors to create NAREI, GLDA and the New Guyana Marketing Corporation (NGMC) to spearhead implementation of the major components of the ADP. While NAREI deals with all matters relating to crop production the GLDA is responsible for all matters relating to livestock production. The NGMC facilitates the marketing of Guyana's non-traditional agricultural products. There is an upgraded information-sharing unit for weather and climate data that is more user-friendly to farmers.

Despite the recognition of the importance of agricultural diversification, little attention is being given to its development under the GNAP. The EU supports the GNAP primarily on sugar. Other allied agencies such and IDB, FAO, UNDP and CIDA have provided support to

[20] http://www.ruralpovertyportal.org/country/home/tags/guyana
[21] the world bank, http://web.worldbank.org/wbsite/external/topics/extpoverty/extpa

agricultural diversification. Currently, the IDB is the major donor and supports agricultural diversification through its Agricultural Development Program.

The Issues of Land use development and biodiversity

In Guyana, the intermediate savannahs are earmarked for the development of non-traditional agriculture. However the intermediate savannahs, in spite of being noted for their vast wealth of biodiversity, do not enjoy of any degree of protection under the Guyana Protected Areas System (GPAS). While Guyana has recently achieved the promulgation of the Protected Areas Act in 2011 and has established the Protected Areas Commission (PAC) in 2012 the country still lags behind in achieving the Convention on Biological Diversity (CBD) target of earmarking 17% of the country's surface area as protected areas by 2020 (WWF Guianas, 2012) (currently only 10% of the territory is under protected area status), so it is likely that in the future the identification of biodiversity hotspots will ensure protection of that important ecosystem. The PAC is establishing the GPAS for which the MoNRE has benefited from a financing agreement with the German Development Bank (Office of the President, 2013b).

Such a lacklustre approach to protecting important ecosystems of new land areas could have major environmental implications with the introduction of agricultural diversification in these areas. Meanwhile, the current land administrative process may lack the requisite technical expertise to provide and in-depth and comprehensive land use plans that addresses a broad range of environmental issues.

Current progress on agricultural diversification

Aquaculture

In Guyana wetlands are converted into the growing of rice. With the rice sector being predominantly owned by a large number private operators who are not necessarily obliged to comply with any stipulated environmental regulations, promoting the integration of aquaculture in rice production among them may be a smart IMP strategy that could be beneficial to the environment. Such a practice could discourage the use of agrochemicals among rice farmers. Further, such an initiative may be extended to other aspects of farming, where aquaculture becomes a formidable part of an integrated farming system in the promotion of non-traditional agricultural production.

The promotion of aquaculture as a strategy for agricultural diversification is consistent with the GNAP. This is supported by several governments' and other allied agency frameworks that drive development of the non-traditional agricultural sector. The Government's Fishery policy gives credence to aquaculture as a high priority area for food security and for its potential to be integrated in cropping systems thereby improving productivity. In 1994, the Government obtained support from CIDA and formulated an aquaculture development plan that recommended the establishment of a freshwater fish culture station and creation of a separate aquaculture section in the Department of Fisheries. This was followed by support from FAO in 1998 to prepare fisheries and aquaculture legislation enacted in 2002[22]. FAO also provided programme support in 2004 to the GoG specifically for the establishment of demonstration plots that showcased the introduction of aquaculture and other integrated

[22] Ministry of Agriculture, 2004, FAO Project number TCP/RLA/3003 (D)

production management practices to rice farmers as possible options to diversify their operations.

Being a major supporter of the diversification component of the GNAP, the IDB also advance interest in the promotion of aquaculture as an important element in the diversification process. IDB reported that integrating aquaculture with rice production shows much promise but the buy-in by farmers and potential investors is discouraging. It could be that the farmers perceive engaging in aquaculture to be uneconomic, especially with an established local market for marine fish. They choose to remain focused on rice production as they are usually motivated by any market price differentials of this commodity.

Fruits and vegetables

Guyana is self-sufficient in fruits and vegetable except for garlic, peas, onion, carrot, turnip, beans, cauliflower and broccoli[23]. Since Guyana's market for fruits and vegetables is small any development in this sub-sector will need to target possible export markets. Meanwhile, only a small amount of fruits and vegetables are currently exported from Guyana primarily because of its inability to satisfy export requirements.

A recent IDB project identified a lack of volume of fruits and vegetable at the farm level to be the major constraint to the development of this sub-sector. A major weakness is the virtual absence of formal contract farming arrangements. Research and transfer of technology services are not effectively linked with specialised networks to facilitate the adaptation of new varieties for these products, and those will surely be needed to increase the supply. The fruit subsector also requires investing and retooling its phytosanitary systems to satisfy export requirements.

Although the GNAP and other development strategies such as LCDS, Food and Nutrition Strategy and the National Competitive Strategy highlight the fruits and vegetable sub-sector as an important element of Guyana's agricultural diversification strategy, a major constraint to development is the lack of specific policy and regulatory frameworks to drive the process. This sub-sector has a tendency to attract high usage of agrochemicals therefore any regulatory framework will need to include targeted strategies to curb possible negative technology impacts due to the development of fruits and vegetables sub-sector.

Currently the MOA has been promoting the use of protected agriculture (use of shade houses) and the use of drip irrigation during dry periods in the production of fruits and vegetables as a part of an adaptation strategy to deal with climate change issues and to foster year round production.

Livestock

The livestock component of the IDB programme targets large scale production of beef for export and identifies the Intermediate Savannahs and some coastline areas for the establishment of livestock clusters[24]. Land areas around the Berbice River, the intermediate savannah to its mouth near New Amsterdam were especially targeted. The intervention speaks to the establishment of a critical mass of suitable animals, the creation of an effective

[23] Homenauth, 2013, NAREI
[24] Ministry of Agriculture, 2005, Project Concept Document – GY-L1007

sanitary surveillance system that focuses on sanitary and phytosanitary (SPS) aspects, the need to establish a proper control system to monitor the movement of livestock within the country, the provision of an adequate legal framework, the provision of relevant infrastructure and facilities (abattoir), financial support and technical capacity as essential elements for successful realisation of its objectives.

The GNAP, LCDS, major Government policies and strategies support the exploitation of local resources for the benefit of the people; this has to be done in a coordinated and responsible manner. The steps outlined by the IDB intervention are important for the development of the livestock industry but may need greater focus on addressing important environmental issues. While it may be clear that the strategy for this livestock component is to establish and enforce an appropriate "sanitary island" where the rearing and fattening of livestock devoted to exports may occur a clear approach to address possible environmental implications is lacking. Besides the anticipated significant damage to important biodiversity with an intervention of such magnitude it is likely the coastline and major waterways will be contaminated with extracts (agrochemicals) from pasture developments, waste from the abattoir and other livestock activities.

There is legislation in place and a policy is being developed to drive development of the sub-sector through GLDA, which will facilitate export especially to CARICOM countries. There is an on-going strategy to revitalise pig production on other livestock enterprises. Laboratory facilities have been upgraded to satisfy market requirements. The issue is to obtain a cadre of resource personnel to make it functional.

7.2. OPTIONS TO ADDRESS THE KEY ISSUE

Adaptive Capacity of Non-traditional Agriculture to Climate Change

Generally many crops are known for carbon sequestration and some livestock operations such as beef and small ruminants will sequester carbon through pasture establishment. This suggests that the natural adaptive capacity of non-traditional agriculture to climate change may be promising for crops and livestock operations, although other factors may intervene in upsetting the balance, such as methane release from the breakdown on fertilisers and from animal manure, land use changes for grazing and land degradation (FAO, 2006).

With respect to weather, several reports have shown major changes in rainfall to climate change. In fact, in Guyana it is commonplace for reports to suggest that the country no longer experienced distinct dry or wet periods in recent years. Current weather forecast is predicting that Guyana will continue to experience frequent rainfall with strong intensities. This may lead to more flooding of low-lying areas. In addition, salt intrusion due to sea level rise may affect crops, livestock and aquaculture. These are important considerations if the non-traditional agricultural sector is to generate alternative livelihoods for Guyanese.

Fruits and vegetable production

The process of developing farming systems for fruits and vegetables lends itself readily to environmental adaptation strategies and should be promoted amongst stakeholders. A farmer may coordinate his farming system to withstand flooding, drought or the existing climatic conditions if he employs careful management strategies. In Guyana, the use of protected agriculture for fruits and vegetable production is being promoted amongst farmers

as a weather-neutral practice. The need to include indigenous materials in research and development is being promoted as a means of identifying species that are amenable to various climate conditions and farmers are encouraged to streamline production based on climate variability. To foster the development of climate change proof technology research strategy for fruits and vegetable should include the development of approaches to facilitate soil remediation. This should focus on the use organic manures, the use of biological controls for pest and disease and the establishment of farmers' cooperatives to enhance the coordination of operations and entrepreneurship.

These approaches are also fully in line with Output 4.1 of the Disaster Risk Management Plan for the Agriculture Sector 2013-2018, which calls for research on alternative economically profitable crop varieties that are less water demanding for adoption by the farming community.

Livestock production

In Guyana, weather related changes result in more frequent flooding. Smaller rivers and waterways overflowing their banks are affecting livestock. GoG recommended that famers construct dams near their livestock farms to manage floodwaters. Some farmers construct raised areas for animals to use in the event of flooding. There is also the incidence of drought due to less rainfall during certain time of the year. This results in limited water available for livestock and the destruction of pastures. The Ministry of Agriculture is considering the production of silage and the use of waste from other agricultural activities to supplement animal nutrition especially during dry periods.

Many livestock farmers are landless commercial pasture operators and their operations are being threatened by the development of housing communities and road construction. As a result, more farmers are forced to tie their animals or keep them near their homes. This becomes an unwelcoming event in residential settings especially with *ad hoc* disposal of waste and foul odour from the animals. Some farmers are occupying roadways resulting in traffic problems. The Government's response to such a situation is to strengthen its impounding laws for livestock in an attempt to restrict such an activity.

The production of livestock is amenable to an integrated type of farming system and should be encourages as a desirable option for livestock production. Such a system will reduce wastage through rigid recycling processes and may link to a bioenergy process where energy may be generated to run on-farm operations rather than relying on external sources, contributing also to climate change mitigation. Legumes and other nitrogen fixing plants may be included in pasture establishment programmes to improve soil nutrition thereby minimising the need for chemical fertilisers. In addition many plant species have good carbon sink potentials and should be included in sustainable pasture development programmes. It is also imperative that greater focus be made on including a logical approach to address major environmental concerns in the beef export chain. This should be identified by the project as a part of the important elements that require more specific detail in order to be carefully coordinated among government and the private sector under a long-term horizon.

Aquaculture production

Guyana has an abundance of water resources that may be exploited for aquaculture and inland fisheries. Moreover, aquaculture fits readily in an integrated farming system and

should be promoted as an environmentally friendly practice with strong economic potential. The Fisheries Department of the MoA reported that Guyana currently produces and average of 400 tonnes of aquaculture products, some of which are exported to CARICOM and North American Countries.

The Department also reported that while it is customary for Guyanese to consume large amounts of marine fish (averaging 58 kg/capita/year[25]) the contribution of aquaculture and inland fisheries to their diets is limited. Meanwhile, with current pressure on marine systems to produce fish (evidenced by the longer time spent at sea to obtain their usual catch) the potential exist for growth in the aquaculture industry and for sustainable development of inland fisheries. The rising demand for fish in urban centres in Guyana and in the Caribbean region further adds to the need for sustainable fisheries and aquaculture development.

The inclusion of aquaculture in rice farming should be encouraged on the basis that it discourages the use of agrochemicals in rice production and that it has a strong export market potential. Although it is cultural for Guyanese to consume marine fish there are some local species (Hassar species) that have high local demand and may be includes in the aquaculture program. Exploring the use of local products for feed could mitigate the constraint for feed and the costliness of the operation.

There are potential threat of some mangroves from aquaculture especially if such an establishment is done close to waterways. There are protected species in mangroves that could be threatened. As such aquaculture activities should be promoted away from major mangroves and restoration areas.

Land Development and Biodiversity

During the process of allocating land for agricultural diversification it might be necessary to consider mobilising abandoned or unused GuySuCo lands and other arable agricultural lands for the establishment of non-traditional agriculture before attempting to enter the intermediate savannahs and other virgin areas for development. Such an approach will not only increase the productivity of unused agricultural lands but may mitigate major cost associate the development of new areas and contribute to climate change mitigation. Some such costs include the provision of infrastructure to access new acreage, extensive economic cost to develop new areas for the intended purpose and the socio-economic costs associated with the disturbance of ecosystems and biodiversity of new areas.

Additionally, focus should be made on establishing deliberate strategy to protect biodiversity during the process of allocating land for agricultural diversification. Apiculture is essential for maintaining a balanced ecosystem and an important pollinator for crops. In terms of maintaining an ideal structured and naturally fertile soils it may be useful incorporate organic manure in the soil management process.

Integrated pest management

NAREI has been promoting the use of natural disease and pest management control as a crop diversification strategy. Rice farmers were allowed to participate in a ‘six point’ management

[25] Government of Guyana, National Policy on Inland Fisheries and Aquaculture

strategy in the growing of rice and obtained yields as high as 40-45 bags per acre[26]. The six point strategy requires farmers to conform strictly to prescribed time of sowing, planting density, seed treatment, early weed control, balanced fertilization and efficient water management in order to achieve best results.

Such a six point strategy requires that planting be done at a time that will allow for flowering to occur during periods of high light intensities to enhance pollination. A planting density of 15-22 plants per square foot is recommended as a means of improving tillage and reducing lodging and fungal diseases. Seed treatment should be done through careful application of prescribed chemicals before planting to protect the plants from early season pest and to withstand longer periods under water. Selected post emergent herbicides are used to control weeds during the early period of growth. All regiments for fertiliser applications are based on soil testing. The recommended water management strategy requires that fields remain adequately moist until the time of final drainage.

Options to address the key issue

The options to address the key issues regarding the advancement of agricultural diversification are addressed under three main categories – climate/environment, economic and social.

Climate/Environment

Variability due to climate change may result in weather changes (rising temperatures, shorter and more intense rainfall patterns). In this regard it will be necessary to carry out climate change impact and vulnerability assessment for non-traditional agriculture. The use of greenhouses technology (protected agriculture) to grow fruits and vegetables should be promoted. This should be supported by the use indigenous material in research and development to identify adaptable species. Meanwhile, production may be streamlined based on climate variability.

Climate change promulgates pest infestation and invasive species. Any worthwhile mitigation process should include the identification and use natural enemies and biological control in an attempt to maintain a balance population of flora and fauna. Every effort should be made to promote IMP strategies in production systems. It is important to devise regiments for rotational use of agrochemicals to ensure careful and responsible usage where necessary. Meanwhile, the act of employing appropriate management strategies such as crop rotation as a pest and disease control measure still remains an ideal option for the development of non-traditional agriculture.

Inadequate land use development may result in increase pressure on ecosystems and displacement of important flora and fauna. It is imperative that Government and other stakeholder employ deliberate strategies to protect biodiversity during the process of allocating lands for agricultural diversification. A plausible option may be to streamline abandoned/unused agricultural land into the diversification process as a first resort before thinking of entering into new areas. The inclusion of apiculture in the mix of possible options will cater to the need for more pollinators while replenishing biodiversity. Soils may be ameliorated using organic manure to improve soil structure, texture and soil nutrition.

[26] Guyana Rice Development Board, "Six Improved Management Practices for Higher Paddy Yields."

The requirements of the LCDS may be compromised due to an inadequate regulatory framework. Specific measures should be taken to strengthen the legislative framework to govern the agricultural diversification process. Any existing measures to identify biodiversity hotspots should be enhanced so as to declare such locations as protected areas. Efforts should be made to select crop species based on good carbon sink potentials and adopt integrated farming system approaches that have minimum reliance on agrochemicals or other commercial inputs. Legumes and other nitrogen fixing plants are especially important and may be included in pasture establishment programmes. Include permanent and medium term crops where possible in cropping systems. Guyana's current agricultural diversification programme should consider broadening the crop base to include maize and other varieties that act as good carbon sinks. This will strengthen the support of the sub-sector to LCDS initiatives.

The development of bioenergy becomes an option for new investments as a result of diversification. Most of the excrements and waste generated from non-traditional agriculture may be used to generate bioenergy and contribute to climate change mitigation.

Economic

An inadequate policy and regulatory framework may compromise the economic potentials of diversification. Guyana will need to rely heavily on private investment in order to establish a non-traditional agricultural sector that is sustainable. This can only be achieved with the appropriate regulatory framework in place to build investors' confidence. Government will need to take the lead by creating an enabling environment to foster value addition and advance the export market potentials of non-traditional agricultural commodities.

The non-traditional agricultural sector consists of a large number of limited resources small holders operating at subsistent levels. A good strategy is for Guyana to incentivise those farmers to adopt a business approach to their operations. This will entail the promotion of farmers' groups/clusters as an option for small holders to achieving maximum returns on their investments.

Currently, there are real threats to the traditional economic mainstay (sugar and rice) of Guyana due mainly to globalisation, which could posit major austerity measures to the country's economy. Non-traditional agriculture should be promoted as an important complement to other major economic activities that will stave off possible economic challenges. As such Government, financiers and other stakeholder should offer due diligence in the level of support provided to the development of the non-traditional agricultural sector.

The current focus is on beef production but consideration should be given to the inclusion of other livestock, especially small ruminants (sheep and goats). The small ruminant industry of Guyana is relatively large with many small holders averaging more than 50 animals. The industry is generally a low cost operation and animals feed on a wide range of grasses and other agricultural by-products readily available locally. Therefore there is an opportunity for Guyana to boost its local protein requirements and its exports potential from small ruminants, which is a low cost non-traditional agricultural operation.

Creation of Niche Markets – Guyana should be mindful that although it is targeting CARICOM as a potential market for its non-traditional agricultural exports many of its CARICOM counterparts are also actively engaged in related agricultural diversification programmes,

which often include similar commodities for export. Guyana should therefore consider developing niche markets that not only target CARICOM countries but extra-regional markets as well. This means that Guyana would have to build on its value added potentials for non-traditional agriculture. Such an approach has the potential to extend the shelf life of products through processing, minimise waste and to subsequently raise the income levels of farmers.

Social

Adherence to traditional farming methods and other compelling cultural attributes may impede the progress of the non-traditional agricultural sub-sector to achieve competitive advantage. Small farmers should be made to understand the need to adopt new and appropriate technology in their operations. Targeted promotional programmes should portray an understanding that the achievement of food security may have a direct link to threats to the environment and should showcase strategies to avert these. A robust information-sharing and data collection process should also speak to the connectivity of enterprise to environmental preservations.

Pervasiveness of poverty among small holders threatens food and nutritional security. An important option to address this issue is to develop healthy agricultural value chains for non-traditional agriculture products with a view to enhance income levels of small holders. This may be supported by appropriate strategies that promote agriculture as a desirable career option and encourage the involvement of youths in agriculture.

Organic Method of Agriculture – Any agricultural development initiative that targets new land areas such as the intermediate savannahs or the use of 'virgin' soils in Guyana should consider adopting an organic method of agriculture. Due to the fact that such new areas may have not yet been exposed to the use of synthetic petrochemicals it is more likely for Guyana to achieve international recognition as a certified organic agricultural producer under international standards such as the International Federation of Organic Agriculture Movements (IFOAM), in its bid to create niche markets. Further, consumers are becoming more health conscious thus there is an emerging market for organic agricultural products.

Targeted Training and Development - There are new training initiatives at the Guyana School of Agriculture (GSA) that are expected to contribute to a renewed capacity of the non-traditional agricultural sector. For instance, the GSA has been offering a certificate programmes in fisheries which include an aquaculture component. In 2013, the institution began a certificate programme in agro-processing. The institution's policy is to link its trainings with ensuing developments of the wider agricultural community to secure validity.

8. KEY ISSUE 4: MISSED OPPORTUNITIES AND POTENTIAL IMPACTS ASSOCIATED TO FUEL BLENDING (LOWER PRIORITY)

8.1. CURRENT STATE AND TRENDS

Production of ethanol from cane is promoted under the GNAP. The main motivation is export-oriented production to tap into the international bioethanol market, especially as Guyana could benefit from duty free and unlimited access to the USA market for ethanol and ethanol derivatives produced domestically in addition to duty free access to the EU markets. Guyana's Agro-energy Policy (AEP) (draft) recognises the country's potential for biofuel production (biodiesel and bioethanol).

Blending of gasoline with bioethanol has the potential to increase financial returns on investments related to the sugar cane industry through the sale of carbon credits derived from reductions in CO_2 emissions. These reductions can be obtained, directly or indirectly, through the use of bioethanol substituting for gasoline; cogeneration with bagasse and methane abatement from biofuel wastewater treatment processes.

Strategic Goals under the AEP include, *inter alia*: (1) Guyana becoming the lead country on Agro-energy in the Caribbean and (2) to assist the Government in developing a socially, economically and environmentally sustainable energy sector. NAREI is to be the lead agency with respect to the AEP. Implementation of the AEP required inter-agency coordination, which is to be secured by establishing an Agro-Energy Advisory Committee. To date there is no regulatory framework in place for fuel blending.

Gasoline can be blended with anhydrous bioethanol up to a 15% blend (E15) without having to modify vehicle motors. 10% blends are also common in various countries (E10) and Guyana is currently referring to such a blend.

There are economic benefits to be gained from fuel blending associated to reduced fuel dependency and reduced expenditures; there are also potential environmental and climate change mitigation benefits, but these may prove not to be significant.

The use of ethanol-blended gasoline reduces **atmospheric pollutants**[27], although there are not necessarily any significant health benefits. For example, Health Canada analysed emissions of E10 and found that the E10 improves the combustion efficiency of gasoline, reducing most exhaust emissions (e.g. CO, VOC, benzene, 1,3-Butadiene), some emissions were not affected (NO_X, $PM_{2.5}$, NH_3, SO_2), Formaldehyde emissions were slightly higher and those of Acetaldehyde considerably higher (due to higher levels of oxygen content in ethanol blends) (Vitale *et al.*, 2004). The results of the health risks assessment indicated *"no substantial differences in the predicted health effects for widespread use of E10 fuel compared to conventional gasoline"* (Health Canada, 2010). Uncertainty over possible increases of some pollutants with ethanol blends (in spite of reductions in other pollutants) is proving to be a hurdle for the increased use of biofuels in the USA (Coleman *et al.*, 2008).

[27] For example, in the USA the use of E10 was spurred by the Clean Air Act Amendments of 1990, which mandated the sale of oxygenated fuels in areas with unhealthy levels of CO.

With regards to **greenhouse gas emission** reductions, although some studies have shown carbon offsets when compared to the consumption of gasoline[28], the climate change mitigation benefits do not depend solely on the fuel, but must take into account the whole production cycle. For example, Acreche and Valeiro (2011) identified that sugarcane-based E10 in Northern Argentina actually resulted in an increase of GHG as compared to gasoline, sugar cane burning playing negatively on the equation.

In the case of Guyana the climate change mitigation benefits may therefore be considerably different if bioethanol is to be produced with by-products (molasses) of sugar production, than if additional sugar cane is to be grown specifically to produce ethanol, especially if pre-harvest cane burning is to be practiced.

Guyana shows a large dependency on the import of fuel, whose costs are volatile and have been increasing significantly. In 2005 gasoline imports corresponded to 8.6% of GDP. In spite the growth of the vehicle fleet, gasoline consumption has been relatively stable at around 115,900 m^3/yr, suggesting that the expansion corresponds mainly to the use of diesel. Total cost to the country from gasoline imports is about US$53.7 million. (ECLAC, 2007).

Environmental risks of vinasse management

Vinasse is a residual substance from the distillation process. It is a thick acid liquid containing a mixture of water and organic and inorganic compounds, and a very large BOD in the order of 30,000 – 40,000 mg/l. When distillation is produced from molasses, total solids are around 5-10%, and organic solids are in the 4-8% range. Other parameters include: potassium (0,48-1,2 wt%); phosphorous (0.0001-1.5 wt%); nitrogen (0.015-1.2 wt%); calcium (0.014-0.2 wt%); magnesium (0.006-0.15 wt%) and ash (1.5-5 wt%) (Cortez and Brossard Pérez, 1997). The Table below summarises the typical composition of vinasse from molasses (for some key physical-chemical parameters), and compares it to the World Bank's effluent discharge requirements[29] (general environment). Although precise figures may vary according to sources, the Table gives an idea of the magnitude of the contaminant load of vinasse.

TABLE 17 VINASSE COMPOSITION AND EFFLUENT STANDARDS

Parameter	Typical composition of vinasse	IFC effluent discharge requirements
Temperature	65 – 105 °C[30]	≤3°C difference
Total Suspended Solids (TSS)	1,500-14,000 mg/l[31]	50 mg/l
pH	4.0 – 4.5	6.0 – 9.0
COD	20,000 – 60,000 mg/l[32]	250 mg/l
BOD	25,000 – 50,000 mg/l[33]	50 mg/l
Phosphorous (total, as phosphates)	100-500 mg/l[34]	2 mg/l

[28] Center for Transportation Research (1999) identified a 1% reduction of GHG emissions for corn-based E10 in the USA; Macedo *et al.* (2002) found a reduction in emissions of 0.42 kg CO_2 equivalent.
[29] World Bank (1999).
[30] Baez-Smith (2006).
[31] Driessen *et al* (1994).
[32] Baez-Smith (2006).
[33] Cheesman (2005).
[34] Driessen *et al* (1994).

Vinasse is highly polluting and requires proper management and regulation. In addition to the high nutrient level, around 10-15 litres of vinasse are produced for every litre of ethanol produced (Cortez *et al*, 1998). Even dumping of vinasse by the rum distillery industry into the Atlantic Ocean and Caribbean Sea in massive quantities has challenged the dilution capacity of these water bodies (Alexander, 1985).

There are various alternatives to vinasse management. These include fertigation (i.e. mixing with irrigation waters and substituting for certain fertilisers), but which can lead to runoff into water bodies, especially during rainfall events; aerobic treatment using activated sludge; anaerobic bacterial digestion; and concentration by evaporation. Anaerobic digestion can be harnessed to produce biogas (mixture of CO_2 and methane) and fertiliser sludge (Cheesman, 2004). Concentration of vinasse allows recovery of water that can be fed back to the distillery process and yields concentrated molasses solubles/solids (CMS), which is a concentrated syrup of around 60% solids. The CMS can be neutralised with lime if necessary and used as fertiliser, in animal feed of as fuel in an appropriately designed furnace (the resulting ash can also be used as potash-rich fertiliser) (Cheesman, 2004).

Out of these main treatment methods, aerobic treatment can incur very high energy costs for distilleries and anaerobic treatment is not sufficient to bring BOD to acceptable levels. Even if treatment achieves 95% efficiency, the effluent's BOD may still be about three times higher than that for domestic sewage, so a follow-up treatment may be needed (Paturau, 1989).

At the moment there is only one distillery operating in Guyana, that of DDL, who produce methane through a biodigestion process.

Environmental regulatory framework for vinasse

There are two main elements in Guyana's environmental regulatory system that establishes control points for pollution prevention from effluent discharges: the EIA system and the system of environmental authorisations.

Under the Environmental Protection Act (1996), Part IV, any project which may significantly affect the environment has to apply to the EPA for an environmental permit and prepare an Environmental Impact Assessment, which shall be the basis for the consideration by the EPA to grant an environmental permit. Public authorities cannot give development consent where an environmental authorisation is required and has not been issued (Art. 14.1).

Although not specified in the Act, the EPA may require the preparation of an Environmental Management Plan (EMP), which is *"an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented, and that the positive benefits of the projects are enhanced"* (Lochner, 2005, cited in Environmental Protection Agency, 2013).

Under the Environmental Protection (Water Quality) Regulations (2000) and the Environmental Protection (Authorisations) Regulations (2000), a bioethanol distillery would also be subject to an environmental authorisation as it is a facility that will discharge effluent. The definition of "discharge"[35] is wide-encompassing and would cover not only discharges into water bodies but also onto land (e.g. through fertigation).

[35] *"'discharge' means to release, drain, deposit, spray, inject, abandon, spill, leak, pour, throw, dump, place, emit or cause the seepage of, and includes any entry of, a water contaminant"* (Art. 2(g)).

Parameters for effluent discharges are not yet defined in Guyana, but in their absence the EPA would normally make reference to international standards.

To date the EPA is not yet fully regulating those activities that were in place prior to the EPA's establishment, including DDL.

Trends in vinasse production

To date only a bioethanol distillery demonstration plant has been set up at the Albion sugar factory, producing 1,000 litres of anhydrous ethanol per day. The vinasse produced is currently discharged directly to the drainage system, together with other factory effluents.

The development of a large-scale bioethanol distillery has not yet materialised. Based on the options explored above, and considering an average production of vinasse of 10-15 litres per litre of anhydrous ethanol, we can expect a production of up to 174,000 m^3/yr of vinasse.

TABLE 18 POTENTIAL VINASSE PRODUCTION IN GUYANA

	Anhydrous ethanol production (m^3/yr)	Vinasse production (m^3/yr)
Large-scale (export-oriented) distillery[36]	37,200	372,000 - 558,000
Smaller-scale (fuel blending-oriented) distillery[37]	11,600	116,000 - 174,000

The facts that DDL treats its vinasse, and that the feasibility study carried out for a potential ethanol distillery at Skeldon considered the concentration of its solid content up to 54-55% for use as a component for fertiliser production (ECLAC, 2009) are indicators that there is a degree of awareness of the importance of vinasse treatment and management. However, the cited feasibility study also recognises that vinasse treatment, as it requires special equipment, installations and utilities input, it "negatively impacts the feasibility study".

Environmental Protection Agency (EPA) institutional capacities

The regulatory framework adequately provides for the management of pollution control. However the EPA's capacities to secure enforcement remain weak. This situation is well recognised and the MoNRE is now working on the restructuring of the EPA to enable more effective implementation of the environmental work programme. In an effort to build on existing capacity the compliance and Enforcement Division was established in 2013, responsible for ensuring compliance with the Environmetnal Protection Act and its regulations. The restructuring will further include the establishment of a Water Quality Management Unit within the EPA to focus on the implementation of the Environmental Protection (Water Quality Management) Regulations (2000) (MoNRE, 2012a) and the development of Compliance and Enforcement Regulations (currently being drafted by the EPA).

Such institutional strengthening will enhance the safeguards in place to ensure an adequate management of vinasse.

[36] As was suggested in the feasibility study for a distillery at Skeldon, producing 120 m^3/day and operating 310 days/yr (ECLAC, 2009).
[37] Based on ECLAC (2007).

8.2. OPTIONS TO ADDRESS THE KEY ISSUE

In order to achieve E10 and E15 blends, 11.6 and 17.4 million litres of ethanol are required respectively. From the exhausted molasses of 1 tonne of sugar cane, 8.8 litres of ethanol can be produced (ECLAC, 2007). Considering a national average production of 3.5 million tonnes of sugar cane, 30.8 million litres of ethanol from molasses can be produced, which is more than enough to satisfy the fuel blending market in Guyana without needing to expand the cultivated area.

The production of 10 litres of ethanol would roughly require 38 kg of molasses (Cheesman, 2005). This means that, in order to satisfy fuel blending requirements (E10 and E15), 44,080 and 66,120 tonnes of molasses are required. Currently GuySuCo is producing on average 120,000 tonnes of molasses, 90,000 of which are sold to DDL for the production of rum with some 30,000 tonnes remaining.

From this perspective, to satisfy the fuel blending requirements of Guyana under an E10 blend would imply reducing the amount of molasses sold to DDL (affecting in turn the performance of the rum industry), going for a lower blend (maximum 6.8%) or securing additional molasses from either an increase in land under sugar cane or importing ethanol. GuySuCo's sugar factories currently do not have the capacity to process additional sugar cane, being this one of the limiting factors in the production of sugar, and importing ethanol may be contradictory with the objectives of reducing the fuel import bill.

The GoG has been promoting foreign investment for the establishment of a large-scale distillery, with its own sugar cane Estate and factory and which would be primarily oriented to tap into the international market for ethanol. Interest was expressed by Trinidad-based company Ansa McAl, and the GoG had offered it lands in the intermediate savannahs. However, due to various reasons (primarily adequacy of available lands), the investment has not materialised.

From an environmental point of view, the establishment of a large-scale distillery may entail significant environmental impacts, and would thus need to be subject to a detailed EIA. As well, the use of fertilisers and harvesting practices (e.g. pre-harvesting cane burning) may impinge on potential carbon offsets from fuel blending. Economy of scale for such a complex would definitely require export of a large amount of the ethanol produced.

The option of building a smaller distillery attached to a sugar factory can have various advantages and deserves consideration. The inputs (molasses) would be produced in the location and the sugar factory already has the infrastructure to provide basic process services (e.g. electricity, steam). The cluster Albion- Rose Hall may be a good location as the two Estates are close by and could generate a large amount of the molasses required. Such a distillery oriented to satisfying the national fuel blending market does not depend on a number of the variables that are halting the large-scale development (e.g. availability of good quality lands, transport infrastructure).

Vinasse management

As indicated above, there are various options to deal with vinasse. The Table below synthesises some advantages and disadvantages of some of these options.

TABLE 19 STRENGTHS, OPPORTUNITIES, WEAKNESSES AND THREATS - VINASSE MANAGEMENT

Strengths and Opportunities	Weaknesses and Threats
Use of vinasse for fertigation	
• More environmentally sound method of disposal than discharge to the aquatic system • May require basic prior treatment only (e.g. lined settling ponds) • Reduction in application of synthetic fertilisers • It is very likely that there is sufficient land in the sugar estates for all vinasse to be applied	• Production of vinasse should be close to fields for method to be feasible • Risk of water contamination runoff and leaching, especially during rain events • May imply distillery operations cannot take place during rain events • EPA needs to ensure capacities to assess license applications • Materials for transport of vinasse must adequately deal with acidity
Aerobic treatment of vinasse using activated sludge	
• Technically can bring down load of contaminants to comply with standards • Allows year-round operation of distillery	• Standard waste water treatment plants would not suffice • Very high energy costs
Anaerobic treatment of vinasse (biodigestors)	
• If well designed can reduce load of contaminants to comply with standards (normally followed by aerobic treatment or lagooning) • Energy recovery (biogas) • Sludge can be used as fertiliser • Opportunity to generate carbon credits through the CDM[38]	• Expensive to implement • Even efficient treatment may be insufficient to bring levels to comply with standards, so follow-up treatment (aerobic treatment or lagooning) may be needed
Concentration of vinasse by evaporation	
• Allows recovery of water, which may be used in the factory • Yields concentrated syrup (CMS) which can be used as fertiliser, animal feed, or fuel	• Production of CMS involves additional costs to factory • High energy costs

Based on: Palerm *et al.* (2010)

Whatever the method of treatment/disposal is selected, the EPA will require the capacities to technically assess applications in order to evaluate environmental feasibility and establish appropriate safeguards. Strengthening of its enforcement and inspection capacities will also be required. In any case, the onus should be on the industry, who must ensure the disposal/treatment measures foreseen are compliant with applicable regulations.

[38] Only one CDM project has been registered for anaerobic treatment of vinasse in Nicaragua (Vianasse Anaerobic Treatment Project – Compañía Licorera de Nicaragua S.A.) where vinasse will be treated in two biodigestors whose energy output will be used in the factory operations. Output of the biodigestors is expected to generate about 119,589 tonnes of CO_2 equivalent in emissions reductions annually.

9. KEY ISSUE 5: MISSED OPPORTUNITIES ASSOCIATED TO CO-GENERATION (LOWER PRIORITY)

9.1. CURRENT STATE AND TRENDS

Co-generation plant

The GNAP promotes co-generation in order to increase the energy efficiency in the sugar factories. It originally foresaw the establishment of co-generation facilities at Skeldon, Albion and Enmore. To date, however, only the co-generation plant at Skeldon has been constructed and it operates under a Power Purchase Agreement (PPA) with the electricity company.

The bagasse-powered co-generation plant at Skeldon forms part of the on-going Skeldon Sugar Modernization Project (SSMP), which will allow the simultaneous production of electrical power for internal needs and for sale of excess power to the Berbice regional grid. The co-generation plant uses bagasse, a renewable fuel source from the sugar factory during the cane crop seasons, and is also equipped with diesel generating capacity for co-firing fuel oil during off-crop periods when bagasse stocks have been exhausted.

Under the on-going SSMP project, the existing sugarcane area in the Berbice County will be expanded. The cane supply will come from the Skeldon Estate (expanded from 5,727 to 10,412 ha) and from holdings of private farmers (expanded from 300 to 4,465 ha) who will cultivate cane exclusively for sale to GuySuCo.

Under the project scheme, surplus electricity will be generated at an average of 10 MW of electricity delivering approximately 77 GWh per year to the regional grid on a firm power, year-round basis. In addition to the export, 58.8 GWh per year will be produced for internal use at the sugar mill.

The co-generation project is essentially an addition to the new sugar mill that will result in increased efficiency in the use of bagasse leading to surplus production of electricity for sale to the grid. The project is meant to generate greenhouse gas emission reductions by displacing the use of light fuel oil in diesel engine-driven generators in the Berbice grid operated by the power utility, the Guyana Power and Light Inc. (GPL). As the utility currently has insufficient capacity, there is extensive use of self-generation by industries and households. The plant thus has the potential to displace a significant amount of this unregulated and inefficient self-generation as confidence in reliable supply is progressively built over time.

Co-generation contributes to national sustainable development through the following:

- **Increased competitiveness:** With more efficient energy generation for internal use in the new sugar factory, the co-generation plant contributes towards increased competitiveness of the country's sugar sector in the world market. The sugar industry generates about 30% of Guyana's agricultural GDP and is the largest net earner of foreign exchange in the country; it thus plays an important role in achieving trade balance.

- **Decreased dependency on fossil fuel:** Bagasse co-generation is important for the energy strategy of Guyana. Co-generation is an alternative that allows postponing

the installation and/or dispatch of thermal energy generation utilities. With the co-generation plant assisting the country to facilitate use of renewable energy resources such as biomass, the country's dependence on imported petroleum products is reduced.

- **Creation of local employment:** Guyana's sugar-based industry is a major employer of local labour. It directly employs 25,000 people or about 10% of the country's labour force.

- **Sustainable clean energy:** Bagasse co-generation displacing the use of fossil fuel results in a cleaner environment and attracts global climate change benefit support. The sale of the Carbon Emission Reductions (CERs) generated by the project will boost the attractiveness of bagasse co-generation projects and will help to increase the production of clean energy in Guyana. The co-generation project is registered under the Clean Development Mechanism (CDM), under which it is expected to receive payments associated to the carbon offsets if generates.

The cogeneration plant consists of a combined heat and power (CHP) cycle to allow the simultaneous production of electrical power for on-site use in the sugar factory and for sale to the regional grid. The bagasse is used as fuel in the boilers to generate superheated steam and initiate the co-generation process. The plant's CHP thermal cycle is based on the Rankine steam cycle, which is the predominant technology for generating megawatt (MW) levels of electricity from biomass residues. It consists of direct combustion of biomass residues in a boiler to raise steam, which is then expanded through a turbine. Most steam cycle plants are located at industrial and agro-industrial sites, where the waste heat from the steam turbine is recovered and used for meeting internal needs. Such combined CHP, or co-generation, systems provide greater levels of energy services per unit of biomass residues consumed than systems that generate power only. Steam, at 5400 kPa and 485°C, is generated in two bagasse-fired boilers, each with a maximum continuous rating of 125 t/h. The generation of electrical power utilises two turbo-alternators: a 15 MW backpressure unit (exhausting at 250 kPa) and a 15 MW extraction-condensing unit (exhausting at 250 kPa and 11 kPa), with the latter for use in the off-crop seasons when the sugar factory cannot take the exhaust steam.

In addition, it also has a 10 MW diesel generation capacity: one 2.5 MW diesel set for back-start and standby capability; and one 5MW and one 2.5 MW diesel sets dedicated to the grid for peaking purposes and for use during off-crop periods if the bagasse supply runs out. Diesel generation for these purposes allows the co-generation plant to supply power to the grid on a year-round basis. Of the 77 GWh of surplus power to be exported to the grid annually, about 85-90% is generated directly from bagasse, with the balance from fuel oil during off-crop periods once bagasse stocks have been consumed. The co-generation plant is connected to the GPL transmission and distribution network and transmits via an adequately rated transmission system to the load centres at New Amsterdam and Corriverton.

None of the other sugar factories in Guyana have a co-generation plant or are connected to the grid to supply their excess power. This is mainly due to the fact that the eight sugar mills operate at relatively low power efficiency and consume bagasse as fuel only to generate energy for their internal requirements. The co-generation plant at Skeldon is installed with high efficiency boilers of 54 bar pressure as compared to 15 bar pressure boilers used in existing electricity producing facilities at the other mills.

The new steam and power plant is a stand-alone facility within the confines of the new sugar factory and operates in the same way as an Independent Power Producer (IPP). This is a new concept within the sugar industry in Guyana and it requires energy dispatch procedures that are integrated with the grid utility's own dispatch procedures. Penalties for supply shortfall and interruption are imposed by a Power Purchase Agreement (PPA) that is signed between GuySuCo and the power company. The terms of the PPA require an operating philosophy that is very different to that of existing sugar factories as, for much of the year, it becomes more important to maintain energy flow to the grid than to maintain continuous sugar production.

In other words, the co-generation plant at Skeldon is obliged to supply electricity to the grid irrespective of their sugar production objective. This seems contradictory with the primary purpose of co-generation, which is to capitalise on an otherwise low-value by-product of sugar manufacturing.

The energy sector laws in Guyana are the Electricity Reform Act 1999; Hydro-Electric Power Act Ch.56:03; Public Utilities Commission Act 1999; Guyana Energy Agency Act 1997; Energy Sector (Harmonization of Laws) Act 2002; and Environmental Protection Act 1996. While the potential for the use of renewable energy sources (including biomass residues) is widely recognised in the country, only hydropower investments are explicitly covered in the present energy legislation. Nonetheless, Guyana has a regime of fiscal incentives for the industrial development of the country, which includes free taxation and duties of all renewable energy equipment and materials in order to attract foreign investment.

Due to irregular cane supply together with the continuous factory stoppages, bagasse supply to the co-generation plant was insufficient to guarantee a continuous power supply to the grid. In these instances the heavy fuel oil generators are started to compensate for the shortfall, defeating the whole objective of sustainable clean energy. For this reason, the co-generation plant has not yet generated any Carbon Emission Reductions (CERs), compromising its CDM register.

The irregular cane supply is caused by interrupted harvesting after high intense rainfall, lack of labour, etc. The continuous factory stoppages are caused, besides out of cane situation, by factory sections not operating at designed capacity and breakdowns.

Cane burning

The biomass that is burned can be used as fuel for co-generation systems, and thus the reason why it is considered in this section.

In Guyana burnt cane harvesting (BCH) is the norm. Green cane harvesting (GCG), in spite of its various benefits, is a much more time consuming and arduous task and for this reason it is often not practiced.

The burning of cane fields south of Georgetown has been identified as one of the contributing factors to Georgetown's low air quality (UNEP, 2010b). As well cane burning is a source of Persistent Organic Pollutants (POPs).

Persistent Organic Pollutants constitute a class of organic compounds that are toxic, resist natural degradation, bioaccumulate and are transported through air, water and migratory species over long distances. They accumulate in the fatty tissues of living organisms and their

concentration increases higher in the food chain. Exposure to POPs has been associated with adverse health effects such as cancer, reproductive defects, immune system suppression and hormonal disruptions.

The generation of POPs is regulated by the Stockholm Convention on Persistent Organic Pollutants, which has been ratified by Guyana. Article 5 of the Convention relates to the control of unintentional production of certain POPs, more specifically PCDD/PCDF (Polychlorinated dibenzo-p-dioxins and dibenzofurans), HCB (Hexachlorobenzene) and PCB (Polychlorinated biphenyls). Sources of PCDD/PCDF, HCB and PCB include open combustion. Countries have to take measures to reduce the total releases derived from anthropogenic sources on the chemicals listed in Annex C (i.e. PCDD/PCDF, HBC and PCB), *"with the goal of their continuing minimisation and, where feasible, ultimate elimination"*. To that effect Guyana has recently developed its National Implementation Plan.

Sugar cane burning is a source of unintended emission of POPs. For example, in Jamaica releases to air of dioxins and furans are dominated by burning of rubbish and sugar cane fields; in Mauritius sugar cane burning is also deemed a source of dioxins and furans and is an area where further research is focused. In both cases the corresponding NIPs call for a reduction, or even banning of sugar cane burning. Other countries that have recognised the emission of POPs from sugar cane burning include Kenya. (Palerm *et al*, 2010).

According to Guyana's NIP[39], 97% of the unintended emission of PCDD/PCDF can be attributed to open burning, mainly to the uncontrolled burning of domestic waste (88% of total). Sugar cane burning produces 0.258 g TEQ/yr emissions into air and 5.180 g TEQ/yr into land, with a total of 5.438 g TEQ/yr that corresponds to 4.5% of total unintended emission of PCDD/PCDF.

These emissions are calculated using the UNEP (2005) emission factors from open biomass burning of 0.5 µg TEQ/t and 10 µg TEQ/t of material burned for releases into air and onto land respectively.

9.2. OPTIONS TO ADDRESS THE KEY ISSUE

Co-generation plant

The effectiveness of the co-generation plant at Skeldon is directly linked to the overall performance of the field and sugar operations in the Estate and factory, as it relies on the constant and sufficient production of bagasse. In this way all initiatives that are being explored by GuySuCo to increase production of sugar and sugar cane will end up being reflected in the performance of the co-generation plant.

Opportunities are available to increase the supply of biomass by using sugar cane trash as fuel. This option is explored below as it is directly related to the opportunities under green cane harvesting.

With regards to the PPA, as it currently stands it can become an obstacle to factory efficiency, as instead of it merely being an outlet to canalise excess electricity produced,

[39] Pesticide and Toxic Chemicals Control Board (2013).

GuySuCo assumes responsibilities as a power producer for GPL, distracting it from its core business. GuySuCos Strategic Plan 2013-2017 indicates the need to revise the PPA on an annual basis, which would be a good opportunity to analyse in detail its convenience for GuySuCo.

A system of feed-in-tariffs could be explored by the GEA as an alternative mechanism to promote renewable energy generation by IPPs. In such a context the Government can purchase any excess electricity at a pre-defined price (based on the source of electricity), or allowing IPPs to take back any electricity they have transferred to the grid.

Green cane harvesting

Burnt Cane Harvesting (BCH) offers various advantages over Green Cane Harvesting (GCH). BCH is normally practiced for its immediate economic benefits: harvesting is approximately 50% faster, allowing lower cost per tonne for manual reaping, having lower haulage costs (as less trash) and thus getting greater payloads into haulage vehicles. However BCH has adverse effects on the processing quality of cane, soil properties and the environment[40]. Heat opens longitudinal cracks in the bark that allow microbes to enter, hastening post harvest deterioration and increasing dextran formation. Unless cut within 48 hours, moisture absorption from soil increases weight by up to 8%, diluting juices, and internal stalk temperature increases to 80-98°C, reducing sucrose and purity levels. As temperatures in the cane fires can approach 400°C, impacts on soil can include: volatilisation and loss of nitrogen, sulphur and carbon to the atmosphere; destruction of certain beneficial micro-organisms and earthworms in the surface layer; possible reduction of organic matter resulting in a reduction in soil friability and porosity, reducing capacity of soil to hold nutrients in the root zone; and possible compaction, drying and susceptibility to erosion. Burned cane kept for more than 24hr affects processing, mainly through a higher susceptibility to *Leuconostoc* development, leading to rapid dextran development affecting process efficiency and sugar quality. (Palerm *et al*, 2010).

Environmentally speaking, key impacts have been reported to be: (i) release of POPs into the atmosphere; (ii) health impacts through breathing of POPs and particles emitted as aerosol (e.g. boron, calcium, aluminium, silicon, manganese, potassium and sulphur) as well as carbon monoxide, ozone, particulate matter and volatile organic compounds (VOCs); (iii) smoke nuisance; (iv) exposure to high levels of dioxins could lead to: persistent acne, sarcoma, abnormality in children's teeth enamel and damage to the immune system. There is no epidemiological evidence that cane burning *per se* produces such dire consequences (Echavarria, 1996), but some effects on health have been identified, e.g. Cançado *et al* (2006) found that the increase in hospital admissions for respiratory affections in children and the elderly was directly related to cane burning practices in Piracicaba, Brazil. Apart from POPs, sugar cane burning produces other contaminants; emission factors have been calculated and are summarised below. GCH also allows mulching, which has the benefits of reducing weed growth and conserving soil moisture, thus reducing water requirements.

[40] Discussion on effects of BCH mainly based on Falloon (2009).

TABLE 20 EMISSION FACTORS FOR CANE BURNING (KG/TONNE)

Pollutant		Darley *et al*, 1975[41]		Universidad La Salle, 1992[42]	Jenkins, 1995[43]	US EPA, 1992[44]
		Whole cane	Trash			
Particulates	Average	3.60	2.70	2.80	5.60	
	Range	3.00-4.20	2.10-3.25	0.48-5.13		2.30-3.50
CO	Average	35.30	29.70		25.48	
	Range	30.00-40.60	23.90-35.60			30.00-41.00
VOC	Average				2.30	
	Range					2.60-2.80

Source: Echavarria (1996)

In GuySuCo, 12,879 ha[45] (27%) of sugar cane fields have been converted to a mechanical harvesting friendly layout, and the objective is to convert a total of 22,724 ha by 2017[46]. This means that the unintended emissions of PCDD/PCDF associated to cane burning can be reduced by around 27% at the moment and up to around 48%, as well as that of other associated atmospheric pollutants (such as particulates, CO and VOC).

GCH can offer other advantages. Tops and trash can be either left on the ground for mulching, and they can also be used as biomass fuel for co-generation.

Under **mulching** CO_2 is retained in the trash and released slowly to the atmosphere and partly through assimilation into soil organic matter; the increase in organic matter enhances soil quality. It can also increase available soil N and P, which can result in reduced need of fertiliser application (Cheesman, 2005). Mulching increases conservation of soil moisture, which can be beneficial but could become problematic in hyper-humid conditions.

Other benefits can include weed growth suppression, reducing use of herbicides and weed control costs, also as not burning the cane may contribute to the conservation of natural enemies of cane pests. It can also reduce diurnal temperature fluctuations in soil temperature and facilitate wet weather harvesting (Cheesman, 2005), which could contribute to climate change adaptation efforts in Guyana.

However mulching could have some disadvantages; in some cases it has led to re-emergence of pests; some authors have indicated that it may contribute to soil acidification (as pH-increasing ashes are no longer returned to the soil) and, where drainage is poor, it may produce allelopathic effects, with potential to suppress development of cane and other plants. Also, facilitation of wet-weather harvesting could increase soil compaction. (Cheesman, 2005).

[41] Cited in Echavarria (1996).
[42] *Idem*
[43] *Idem*
[44] *Idem*
[45] GNAP implementation progress report No. 11, August 2013.
[46] GuySuCo (2009).

However, GCH can increase the cost of mechanised harvesting operations in the order of 30-40% due to the need to maintain the cleaning system and additional fuel costs associated to cleaning conditions (Norris and Eastwood, nd).

As per the **use of trash as fuel for co-generation**, sugar cane trash (tops, dry and green leaves) has a similar calorific value to bagasse but has the advantage of having lower moisture content. The amount of trash produced depends on a number of factors, including pant age, crop variety and soil and weather conditions. It normally represents around 15% of the total above-ground biomass at harvest, equivalent to some 10-15 t/ha of dry matter. (Pankhurst, 2005).

Key aspects to solve for the use of trash in cogeneration include its recovery and transportation to the mill, for which there are various options available (e.g. baling, shredding and collecting trash separately from the cane, separating trash at the factory) (Pankhurst, 2005).

The energy value of most common forms of biomass, including bagasse and trash is around 15-17 GW/t on a dry-matter basis (Norris and Eastwood, nd).

There is no straightforward answer to the advantage of shifting from BCH to GCH. There are various environmental, agronomic and economic factors that require careful consideration. Some basic considerations to take into account are summarised below.

- Burnt Cane Harvesting or Green Cane Harvesting?
  - Reduced emission of POPs?
  - Increased KTM time?
  - Agronomic advantages?
  - Increased harvesting costs?
- Use of trash: mulching or co-generation?
  - Agronomic advantages/disadvantages of mulching? (e.g. moisture retention, weed growth suppression, weed control costs, crop yields, CO2 retention)
  - Trash transport and separation costs (for co-generation)?
  - Impacts on mill efficiency? (e.g. increased extraneous matter?)
  - Advantages of increased co-generation? (e.g. reduced fuel dependency, reduced GHG emissions, reduced energy costs, sales of excess electricity to the national grid?)

The shift to GCH and the use of trash for either mulching or co-generation can bring considerable advantages. However, many variables come into play and a detailed cost-benefit analysis of the different options available is necessary, but worthwhile pursuing by GuySuCo as part of its research activities.

10. PERFORMANCE INDICATORS

The EU support to the implementation of the GNAP is done through a budget support approach; performance indicators are agreed annually linked to the disbursement of fixed and variable tranches. The fixed tranche is associated to general conditions, whilst the variable tranche is linked to specific conditions. The Table below synthesises the essence of the performance indicators under the different Annual Action Plans (AAP), and are an indication of the priority areas for the EU support; the table also syntheses the relationship between the different indicators and the environment and climate change (mitigation and adaptation) dimensions.

We can identify a number of indicators that are promoting actions that contribute to environmental sustainability, climate change mitigation and climate change adaptation:

- Factory upgrades (positive impact, low significance), as they have the potential to decrease pollution emissions and contribute to energy savings by way of increasing process efficiency.

- Training in good agricultural practices for aquaculture and fruit & vegetables (positive impact, low significance) via training modules offered by the GSA will contribute to more efficient use of agrochemical products and environmentally-sound practices.

- Increased use of flood fallowing (positive impact, low significance) will contribute to weed suppression (thus reduced use of herbicides) and salt flushing in soils.

- Investments in mechanisation (positive impact, high significance) will contribute in a significant manner to increase climate change adaptation, by maximising harvesting capacity during the reduced number of 'opportunity days' being experience due to climate change. However, in environmental terms mechanisation has the potential to increase the risk of soil compaction.

- Investments in drainage pumps (positive impact, high significance) will contribute in a significant manner to increase climate change adaptation by addressing one of the key climate-related risks and will contribute to reduce risk of flooding. However, it only addresses current concerns and does not contribute to long-term climate change adaptation (i.e. drainage capacities under future climatic conditions) (as discussed under Key Issue 1 above).

- Increase in sugar cane production, including new lands under sugar cane (negative impacts of low significance on the environment and of medium significance on climate change adaptation) does not introduce any environmental safeguards, and thus farming and harvesting practices (e.g. use of agrochemicals and cane burning). However, it is recognised that GuySuCo promotes good agricultural practices, including via certification of Fair Trade for farmers, and thus the low significance of the potential associated impacts. In terms of climate change adaptation, the main concern is the lack of integration of long-term safeguards (via the wider set of indicators), such as climate change impact & vulnerability assessments and water efficient irrigation (as discussed under Key Issues 1 and 2 above).

In their own right the formulation of the indicators themselves is appropriate from an environmental and climate change point of view. This analysis, however, shows that the focus of the EU support is not necessarily targeting some of the key concerns identified in this SEA, but which could nevertheless still be addressed through *ad hoc* support measures as suggested in the Recommendations. Such 'other' issues include integration of long-term climate change adaptation considerations (including for drainage capacities and water efficient irrigation) and making use of opportunities to increase environmental performance in the sector (e.g. through green cane harvesting, optimising co-generation and fuel blending).

TABLE 21 VARIABLE TRANCHE PERFORMANCE INDICATORS AND THEIR ENVIRONMENTAL AND CLIMATE CHANGE IMPLICATIONS

AAP 2010	AAP 2011	AAP 2012	AAP 2013	Links to environment	Links to climate change mitigation	Links to climate change adaptation
Delivery of cane (tons) from private cane farmers from Skeldon to GuySuCo	Delivery of cane (tons) from private cane farmers from Skeldon to GuySuCo	Delivery of cane (tons) from private cane farmers from Skeldon to GuySuCo		Does not address any potential environmental impacts associated to cane farming (e.g. use of agrochemicals, cane burning)	None significant	Set of indicators does not address sustainability of cane production under long-term climate change (e.g. irrigation)
Increase area under sugar cane, excluding private farmers or land retired (or to be retired) from Diamond			Private cane farmers' involvement in industry expansion. Lease of land at Uitvlugt to private cane farmers	Idem	Idem	Idem
Replanting of GuySuCo land under cane	Replanting and supply of GuySuCo land	Replanting of GuySuCo land	Replanting of GuySuCo land	None significant	None significant	None significant
Conversion of fields to mechanically friendly layouts owned by GuySuCo	Conversion of fields to mechanically friendly layouts owned by GuySuCo	Conversion of fields to mechanically friendly layouts suitable to full mechanisation	Land conversion to machine friendly layouts suitable to full mechanisation	Potential soil compaction by mechanisation Opportunities to target green cane harvesting not addressed	None significant	Addresses adaptation by maximising productivity in context of decreased number of 'opportunity days'
		Mechanical harvesting capacity increased by purchasing new mechanical harvesters and associated equipment	Mechanical harvesting capacity increased, by purchasing new mechanical harvesters and associated equipment	Idem	Idem	Idem
Factory capacity expansion at Blairmont. Signing of Engineering, Procurement and Construction (EPC) contract		Factory improvements at Skeldon. Signing of EPC contract for specific factory improvements	Factory improvements at Skeldon. EPC contract signed for specific factory improvements	Increased process efficiency can lead to decreased pollution	Can lead to increased energy efficiency	None significant

AAP 2010	AAP 2011	AAP 2012	AAP 2013	Links to environment	Links to climate change mitigation	Links to climate change adaptation
Factory capacity expansion at Enmore. Signing of EPC contract		GuySuCo capital investment in drainage works	GuySuCo capital investment in drainage works	Idem	Idem	Idem
Training in good agricultural production standards at GSA (aquaculture and fruits & vegetables)				Will contribute to environmentally-sound agricultural practices, thus to reduced pollution levels	Can contribute to carbon offsets by reducing inorganic fertiliser consumption	Contributes to alternative livelihoods and therefore to increase adaptive capacity
		Installation by GuySuCo of new drainage pumps in Albion and Rose Hall	Installation by GuySuCo of new drainage pumps in Albion and Rose Hall	Will contribute to reduced risk of flooding and soil erosion	None significant	Will contribute to adapt to increased rainfall intensity experienced to date, but does not address long-term climate change
	Sales of packaged sugar of the packaging plant	Production of sugar by GuySuCo		None significant	None significant	None significant
			Completion of flood fallow in a given area for a 6-month period	Benefits associated to drainage of salts and weed suppression	None significant	None significant
	Implementation of full solution Single Window Automated Processing System (SWAPS)	Implementation of full solution Single Window Automated Processing System (SWAPS)	Implementation of full solution Single Window Automated Processing System (SWAPS)	None significant	None significant	None significant

PART III RECOMMENDATIONS

11. RECOMMENDATIONS ADDRESSING HIGHER-PRIORITY ISSUES

11.1. CAPACITY OF THE DRAINAGE AND IRRIGATION SYSTEM

Objectives and Proposed Actions	**Key actors and observations**
Objective 1: Upgrade the drainage capacities to take account of climate change	
Activity 1.1. Define drainage capacity to cope with current climatic conditions and climate change in the medium- and long-term **1.1.1.** Re-evaluate the present drainage parameter of 50 mm/24 hours in order to establish if the current drainage system can cope with the projected higher intensity precipitation, as it is not clear it is sufficient for accommodate increased rainfall intensity. **1.1.2.** Evaluate future drainage capacities under different climate change scenarios for the medium- and long-term. Carry out a feasibility study of the additional drainage capacity to cater for medium- and long-term climate change vis-à-vis, e.g. likelihood of climatic changes materialising, future adaptation costs (inaction now) *vs.* cost of upgrading capacities now, identification of possible 'no-regrets', 'low-regrets' and/or robust measures. **1.1.3.** Clearly distinguish between the costs to upgrade to existing climatic conditions *vs.* costs of adapting to long-term climate change. This defines the 'additionality', which can be an important criterion to tap into some international climate change adaptation funds.	**MoA, NDIA and GuySuCo:** carry out analysis of drainage capacities. **Hydromet:** assist in analysis of drainage capacities, especially in analysing capacities under climate change scenarios. May require capacity development as suggested under Key Issue 2 below. **EUD:** can provide *ad hoc* support to finance some specific analysis components through a short-term mission for recalculation of drainage designs, which could be complemented with capacity building on climate change (see Key Issue 2 below). **Office of Climate Change:** assist in the identification of potential international climate change adaptation funds that could cover the 'additional' costs.
Activity 1.2. Optimise existing drainage capacities **1.2.1.** Increase essential maintenance on drainage works as per the GuySuCo capital	

expenditure plan with emphasis on accelerating the drainage capability. **1.2.2.** The sugar Estates should manage their drainage infrastructure more closely to improve efficiency and availability of pump units and sluices in order to maximise drainage outflow capacity. **1.2.3.** The sugar Estates should resuscitate and install new sluices where practical, especially at Skeldon, Blairmont and Uitvlugt to maximise gravity outflows.	**GuySuCo**
Link to GuySuCo's Strategic Plan 2013-2017 These recommendations contribute directly to the objective of improving drainage. The Strategic Plan is not explicit on the dimension of such objectives except for stating that investments will be made to improve it. Any investments in drainage and infrastructure must take into account the risks associated to climate change in order to ensure its design capacity will be sustainable. They also contribute to objectives for the Agriculture Research Department, which include soil & water conservation through land development and efficient irrigation and drainage equipment.	
Objective 2: Achieve an adequate institutional and regulatory framework conducive to efficient and effective management of the drainage and irrigation system	
Activity 2.1. Review the legal mandates of all institutions involved or implicated in the management of the D&I system, their capacities and inter-institutional coordination mechanisms and prepare a firm proposal for any necessary institutional restructuring. **1.1.1.** Relevant institutions should also include those that make decisions that may interfere with the proper management of the D&I system, including those with competencies in housing, development consent, coastal management and agriculture.	**MoA:** lead in the process **EU:** can support a short-term mission to support a country-owned institutional analysis
Activity 2.2. Review the regulatory framework involved in the management of the D&I system and other activities that affect its efficiency, including its effectiveness and enforcement record. **1.1.2.** Urban planning should be subject of attention so that service areas on the margins	

of drainage canals are respected.	
Objective 3: Increase drainage efficiency	
Activity 3.1. Design and develop more appropriate field layout and drainage design that are mechanised harvesting friendly	**GuySuCo** **EU:** can support a short-term mission to introduce the idea of single slope with GuySuCo
3.1.1. Longer equipment runs will improve work efficiencies enormously. Conversion of the Dutch and English bed field layouts has started, but the conversion work carried out has not been fully effective. Fill areas have compacted, still producing dipped areas in the fields where water stays for long periods after rainfall, preventing mechanised operations. Land forming/levelling, using laser equipment and GIS are normal tools in the present-day land-forming environment and should be applied here as well. The land forming software will compensate fill areas for shrinkage, resulting in a completely levelled field after the operation. However an altogether different approach would be to level fields to a one-slope configuration, where mechanisation would be most effective and where the present irrigation concept should be changed completely. It is recommended that a ST mission is conducted to introduce the idea of single slope.	
Link to GuySuCo's Strategic Plan 2013-2017 These recommendations contribute directly to the objective of improving drainage.	
Objective 4: Increase water use efficiency in sugar cane cultivation as a climate change adaptation measure	
Activity 4.1. Develop alternative irrigation systems to mitigate drought conditions predicted under climate change	**GuySuCo:** lead in the research. **Hydromet:** assist in analysis of future water availability and climate change modelling. May require capacity development as suggested under Key Issue 2 below.
4.1.1. Carry out applied research on water efficient irrigation systems, taking into account future water availability restrictions under climate change, increase in water demand from other water users (e.g. rice cultivation, urbanisation) and contribution	

to reduce pressure on the overloaded drainage system. **4.1.2.** Carry out research into developing new cane varieties tolerant to water stress and inundation.	**OCC:** can provide support to secure funding from international climate change adaptation funds. **EUD:** could support the research through complementary short-term missions.
Activity 4.2. Carry out applied research into changing crop scheduling, planting at different times, and different systems of planting	**GuySuCo:** lead in the research. **Hydromet:** assist in analysis of future water availability and climate change modelling. May require capacity development as suggested under Key Issue 2 below. **OCC:** can provide support to secure funding from international climate change adaptation funds. **EUD:** could support the research through complementary short-term missions.
4.2.1. Different planting systems that may be explored include, e.g. on ridges, double row planting, hilling-up.	
Link to GuySuCo's Strategic Plan 2013-2017 These recommendations contribute indirectly to the objective of improving drainage. By improving irrigation efficiency, pressure on the drainage system will be reduced, thus contributing to its efficiency. They also contribute to objectives for the Agriculture Research Department, which include soil & water conservation through land development and efficient irrigation and drainage equipment.	

11.2. KEY ISSUE 2: LONG-TERM CLIMATE CHANGE ADAPTATION MAINSTREAMING

Objectives and Proposed Actions	Key actors and observations
Objective 5: Achieve a good understanding of climate change impacts and vulnerabilities in the agriculture sector	
Activity 5.1. Carry out a detailed impact and vulnerability assessment for the agriculture sector **5.1.1.** Identify, in a participative manner, the most adequate approach to an impact & vulnerability assessment such that it will provide all necessary outcomes. Key aspects may include: salinity intrusion and its effects on livestock and aquaculture sub-sectors; temperature, rainfall and humidity changes and their impacts on crop yields, livestock and aquaculture production, etc. It should also explore the exposure, sensitivity and adaptive capacity components of vulnerability. **5.1.2.** Develop capacities necessary for carrying out the impact & vulnerability assessment, this may include, e.g. downscaled modelling, capacity building of Hydromet staff, software, etc.	**MoA and GuySuCo:** should clearly define the purpose of the impact & vulnerability assessment and how its findings will be integrated into the ministry's strategic planning process. **EUD:** can consider providing specific support to capacity-building and for the undertaking of the impact & vulnerability assessment.
Activity 5.2. Identify and prioritise adaptation measures **5.2.1.** Define prioritisation criteria, taking into account aspects such as: degree of contribution to development regardless of climate change impacts ('no regrets', 'low regrets' and/or robust measures), cost of acting now as compared to potential future costs, cost-effectiveness, likelihood of impacts occurring, etc. Prioritisation criteria are fundamental in order to secure efficient and effective budgeting. Adaptation measures should address not only immediate concerns, but also longer-term ones.	**MoA and GuySuCo**
Activity 5.3. Prepare a climate change adaptation strategy for the agriculture sector and	**MoA:** should take full responsibility for the strategy

GuySuCo **5.3.1.** Coordinate with the Office of Climate Change to ensure consistency with the Climate Resilience Strategy **5.3.2.** All measures should be costed, responsibilities defined, time frames established and monitoring indicators defined	preparation process, in close coordination with other relevant stakeholders **GuySuCo:** should take responsibility and assume high level commitment for a long-term climate change adaptation strategy in the company
Link to GuySuCo's Strategic Plan 2013-2017 These recommendations contribute indirectly to the objectives of improving crop husbandry practices and the objectives for the Agriculture Research Department (development of high yielding cane varieties, soil & water conservation through land development and efficient irrigation and drainage equipment, development of environmentally responsible approaches to pest & weed management). Only by taking into account the potential impacts of and vulnerabilities to climate change is it possible to have a feasible research programme contributing to sustainability in the industry.	
Objective 6: Achieve a more effective institutionality for climate change that would promote effective mainstreaming in key sectors	
Activity 6.1. Review the role of the Office of Climate Change so it acts as broker for attracting climate finance for the adaptation and mitigation measures that form part of the strategic development plans of the different ministries and agencies Effective mainstreaming of climate change can only be achieved by full integration into sector strategies and thus full ownership. The OCC is a powerful institution to help mobilise resources, but could be better placed as a broker between climate finance and sectoral authorities rather than by managing the full portfolio of climate change mitigation and adaptation.	**GoG:** Consider review of role of the OCC vis-à-vis the sectoral authorities with regards to climate change strategies
Objective 7: Achieve a more effective mainstreaming of climate change in the budgeting process	
Activity 7.1. Carry out a Climate Public Expenditure and Institutional Review (CPEIR) in order to	**Ministry of Finance:** lead

identify the links between the budgeting process and climate change priorities.	**OCC:** close support to Ministry of Finance in process **EUD:** could support this exercise in close coordination with UNDP, who have developed this particular tool
Objective 8: Contribute to facilitate the access to international climate finance	
Activity 8.1. Devise a system of climate markers for the budgeting process, such that they would facilitate attraction of international climate finance	**Ministry of Finance:** lead **OCC:** close support to Ministry of Finance in process

11.3. KEY ISSUE 3: MISSED OPPORTUNITIES ASSOCIATED TO NON-TRADITIONAL AGRICULTURE

Objectives and Proposed Actions	**Key actors and observations**
Objective 9: Adopt a more strategic approach towards selecting and developing land for agricultural diversification	
Activity 9.1. Conduct an audit of all abandoned and unused agricultural land for consideration in the agricultural diversification process **9.1.1.** Conduct and inventory of abandoned/unused agricultural lands especially along the coastal plains **9.1.2.** Examine the feasibility of mobilising unused GuySuCo lands into non-traditional agriculture against cultivating and exploiting intermediate savannahs and other virgin lands **9.1.3.** Examine the possibility of upgrading existing infrastructure to provide better access to agricultural lands **9.1.4.** Establishment of a land cadastre to showcase allocated agricultural lands **9.1.5.** Revision of the legal framework on land tenure to ensure responsible development	**GL&SC:** Lead the auditing process **MoA and GuySuCo:** Provide technical support especially during the inventory and allocation stages

Activity 9.2. The land administrative process should optimise the use of technical expertise to provide advice on in depth environmental considerations of land use and development strategies **Activity 9.3.** Expedite biodiversity mapping programme to determine biodiversity hotspots especially within intermediate savannah for preservation	**GL&SC:** Foster strong collaborate with other relevant agencies such as WWF Guianas, Guyana Shield, Conservation International and international allied agencies **GL&SC and Conservation International**: Build on existing initiatives
Objective 10: Promote integrated farm management practices that fosters sustainable development	
Activity 10.1. Revisit the results of the FAO IPM pilot project, where the integration of aquaculture with rice production showed promising results with a view to encourage commercialization **10.1.1.** Build the capacity of relevant Government departments and agencies to ensure successful expansion of the technology. **10.1.2.** Examine the possibilities of extending the initiative to other agricultural enterprises	**MoA and GRDB:** The fisheries department of the Ministry of Agriculture should coordinate the process with strong collaboration from the Guyana Rice Development Board. **NAREI:** can consider providing support in research and development
Activity 10.2. Conduct research in the production of bioenergy from excrements and agricultural waste with a view to supply required *in situ* farm energy. **Activity 10.3**. Promote the adoption of agro-ecological approaches in the development farming systems.	**MoA:** should be responsible to establish this requirement through its bioenergy facility. **NAREI and GLDA**: Work collaboratively to train farmers in this initiative
Objective 11: To incentivise the initiatives of farmers to promote adaptation of new technology and advance development of the non-traditional sub-sectors	

Activity 11.1. Provide incentives to environmentally friendly, sustainable enterprises that seeks to protect the local biodiversity and enhance the natural ecosystem of Guyana **Activity 11.2**. Support the establishment of farmers' cooperatives, farmers' associations or clusters to be an efficient vehicle through which entrepreneurship among small farmers may best be promoted **Activity 11.3**. Promotion and research in alternative sources of staple foods and livelihoods	**MoA through NAREI and GLDA:** to spearhead development of these undertakings with relevant support from allied agencies such as Caribbean Agricultural Research Institute (CARDI), FAO, and Inter-Inter-American Institute for Cooperation on Agriculture (IICA)
Objective 12: Establish effective commodity value chain in a bid to strengthen the export potential of non-traditional agriculture	
Activity 12.1. Expand existing processing facilities to increase value added capacities of a wide range of non-traditional agricultural products **Activity 12.2.** Upgrade existing transportation, storage and packaging facilities and establish new ones in strategic location to enhance access to farmers **Activity 12.3.** Conduct training in processing and other value added activities **Activity 12.4.** Establish contact with COLEACP (Europe-Africa-Caribbean-Pacific Liaison Committee) and the PIP programme **Activity 12.5**. Revision of the current national and international legal frameworks	**MoA:** Need to assume leadership if the realisation of this activity. **NGMC:** may assume major coordinating role in the functionality of storage and packaging facilities **GSA:** besides the training of students the GSA may design specialized training packages in value added that target a range of stakeholders.

12. RECOMMENDATIONS ADDRESSING LOWER-PRIORITY ISSUES

12.1. KEY ISSUE 4: MISSED OPPORTUNITIES AND POTENTIAL IMPACTS ASSOCIATED TO FUEL BLENDING

Objectives and Proposed Actions	**Key actors and observations**
Objective 13: Secure the availability of ethanol blended fuel in the Guyana market	
Activity 13.1. Design and construct an ethanol distillery and blending facility attached to a sugar factory with capacity to satisfy the fuel blending market in Guyana **13.1.1.** Revise the agreement with DDL in order to guarantee sufficient molasses for the production of and E10 blend or target a lower ethanol-grade blend (maximum about 6.8%) **13.1.2.** Construct blending facility as close as possible to the distillery in order to minimise risks associated to the transport of ethanol	**MoA and GuySuCo:** lead in carrying out feasibility study and design of facilities
Activity 13.2. Develop the necessary policy and regulatory framework to guarantee a market for bioethanol in fuel blending	**GEA:** Facilitate development and approval of corresponding energy policy and regulatory framework **EUD:** can consider providing support in form of a short-term mission
Link to GuySuCo's Strategic Plan 2013-2017 These recommendations contribute to the objective for the Marketing Department, as it creates a new and alternative market for molasses.	
Objective 14: Minimise the environmental risks associated to vinasse management in the production of ethanol	
Activity 14.1. Proceed with the review and restructuring of the EPA	**MoNRE:** consideration of vinasse management as part of

14.1.1. In the strengthening of enforcement capacities for the implementation of the water quality regulations, integrate development of capacities with regards to vinasse management	institutional strengthening at the EPA. **EUD:** can consider providing support to the EPA's institutional strengthening, if there are funding gaps.
Activity 14.2. Ensure any bioethanol distillery integrates vinasse treatment to sufficient standard to comply with international effluent discharge standards	**MoA:** should be responsible to establish this requirement for any public or private developer. **GuySuCo:** responsible for integrating vinasse treatment if they are to establish a distillery.

12.2. KEY ISSUE 5: MISSED OPPORTUNITIES ASSOCIATED TO CO-GENERATION

Objectives and Proposed Actions	Key actors and observations
Objective 15: Increase the share of renewable energy use in Guyana through the role of Independent Power Producers (IPPs)	
Activity 15.1. Revise the PPA approach to co-generation by GuySuCo **15.1.1.** Explore a devise a feed-in-tariff system that would act as an effective incentive for IPPs to produce energy from renewable sources by allowing to sell excess electricity that may be generated to the grid, without imposing an obligation that pretends to convert the sugar industry into a *de facto* power producer for GPL	**GEA, GPL and GuySuCo:** undertake analysis and device a 'sustainability-oriented' feed-in-tariff system **EUD:** can consider providing financial support to the analysis.
Objective 16: Maximise the environmental and economic opportunities opened up by mechanised harvesting through a shift to green cane harvesting	
Activity 16.1. Carry out a detailed cost-benefit analysis of shifting to green cane harvesting and different trash use options **16.1.1.** In the analysis integrate environmental and economic sustainability criteria, such as reduced production of POPs, advantages and disadvantages of using trash for either	**GuySuCo:** undertake cost-benefit analysis as part of its research activities and translate findings into an operational plan **EUD:** can consider providing financial support to the

mulching or co-generation. In the analysis of the mulching option aspects to consider include: potential for weed growth suppression and associated weed control costs and reduced use of herbicides, effects of increased moisture retention, effects on crop yields, potential for harvesting during wet conditions, increased KTM time, reduced damage to micro-fauna, improved soil organic matter etc. In the analysis of the co-generation option aspects to consider include: trash transport and segregation methods and costs, contribution to reduced fuel dependency, reduced GHG emissions, reduced electricity expenditures, etc. General considerations of the shift to GCH include harvesting costs.	cost-benefit analysis.

Link to GuySuCo's Strategic Plan 2013-2017

These recommendations contribute indirectly to the objectives of the Agriculture and Research Department, more specifically with regards to the potential of mulching for soil & water conservation and for achieving a more efficient irrigation and drainage system.

13. RECOMMENDATIONS ADDRESSING OTHER ISSUES

The focus of this SEA is on the environmental and climate change adaptation/mitigation performance of the sugar sector and the GNAP. Nevertheless, due to the dire situation in which the sugar sector is currently found, Section 2.2 above expanded on some of the causes behind the low crop yield and low sugar production. Some recommendations are made below in relation to farming practices that should be conducive to increase yields and production, and for other aspects.

Recommendations on the use of this SEA report

- The findings of the SEA report should be discussed in the GNAP Steering Committee, and appropriate follow-up actions agreed, such as integration of the recommendations that are considered relevant into the action plan and monitoring of implementation on a par with other GNAP actions.

Recommendations to address sugar cane yields

- In order to mitigate the negative effects of the limited labour availability and the changing weather pattern, GuySuCo should invest in the equipment and technology needed to mechanise their operations as far and as soon as possible.

- Furthermore it is crucial that the maintenance, and/or replacement, of the existing, ageing processing infrastructure be improved, and even that a restructuring of the entire sugar industry on a rational basis be considered.

- To escape from the perpetual state of stagnated production, and based on analyses that shows GuySuCo's continuing slide into permanent insolvency, it is recommended that the present sugar industry retract within itself, shedding all un-economic fields and operations and concentrate only on the areas that are suitable to full or partial mechanisation and processing units that can operate efficiently. It is critical that these areas are brought back as soon as possible under the Plant and 4 Ratoon regime with equal areas for each class of cane to increase the yield levels. Harvesting should present fresh, clean cane to the processing units, in sufficient quantity to create continuous crushing and processing.

- **Alternative cane establishing and husbandry practices.** It has been observed that cane grown on the elevated field boundaries are producing better higher yielding cane stands. This phenomenon should be evaluated for introduction throughout the fields. This is only possible in combination with some of the previously recommended practices. Other more efficient cane husbandry practices, as well as potential changes in the cropping calendar, should be evaluated and introduced to halt the downward spiral in cane yields. It is recommended that a ST mission be conducted to evaluate and introduce alternative cane establishment and cane husbandry practises.

Recommendations at factory level

- Energy efficiency measures should be pursued based on the findings of the energy audits being carried out for all sugar mills. Energy efficiency will not only help address

competitiveness of the sugar industry by lowering energy costs, but will also contribute to Guyana's efforts towards climate change mitigation.

- As part of their environmental management system, GuySuCo must start moving forward to the implementation of good environmental management practices, demand for which will be forthcoming after the EPA's restructuring. Such measures should include the establishment of atmospheric pollution control systems in the stacks and the corresponding monitoring of atmospheric emissions and treatment of process waters (e.g. through a system of lagooning).

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ANNEXES

ANNEX 1: LEOPOLD-TYPE MATRICES AND CAUSE-EFFECT DIAGRAMS

FIGURE 9 MATRIX ON ENVIRONMENTAL IMPACTS ASSOCIATED TO GUYSUCO OPERATIONS

SUGAR INDUSTRY	Water balance	Cont. of groundwater	Cont. of surface water	Soil salinisation	Soil erosion	Soil compaction	Other soil characteristics	Ambient air quality	Greenhouse gas emissions	Protected areas	Deforestation	Biodiversity	Terrestrial flora and fauna	Aquatic flora and fauna	Wetland systems	Coastal water quality	Landscape	Respiratory disease	Other human health factors	Food security	Energy efficiency	Social conflict	Employment	Rural infrastructure
Field operations																								
Field expansion																								
Field preparation																								
Planting																								
Manual harvesting																								
Use of ripeners and herbicides																								
Use of inorganic fertilisers																								
Surface water abstraction																								
Irrigation - Furrow																								
Sugar cane burning																								
Transport of sugar cane to factories																								
Sugar factories																								
Disposal of water - mills and evaporators																								
Filter cake disposal (slurried)																								
Boiler ash and fly ash disposal																								
Boiler atmospheric emissions																								
Burning of bagasse																								
Co-generation																								

Colour key: Yellow: neg., low sign; Orange: neg., medium sign; Red: neg., high sign; Light green: positive, low sign.; Dark green: positive, high sign; Purple: negative of positive.

FIGURE 10 MATRIX ON POTENTIAL ENVIRONMENTAL IMPACTS ASSOCIATED TO GNAP IMPLEMENTATION

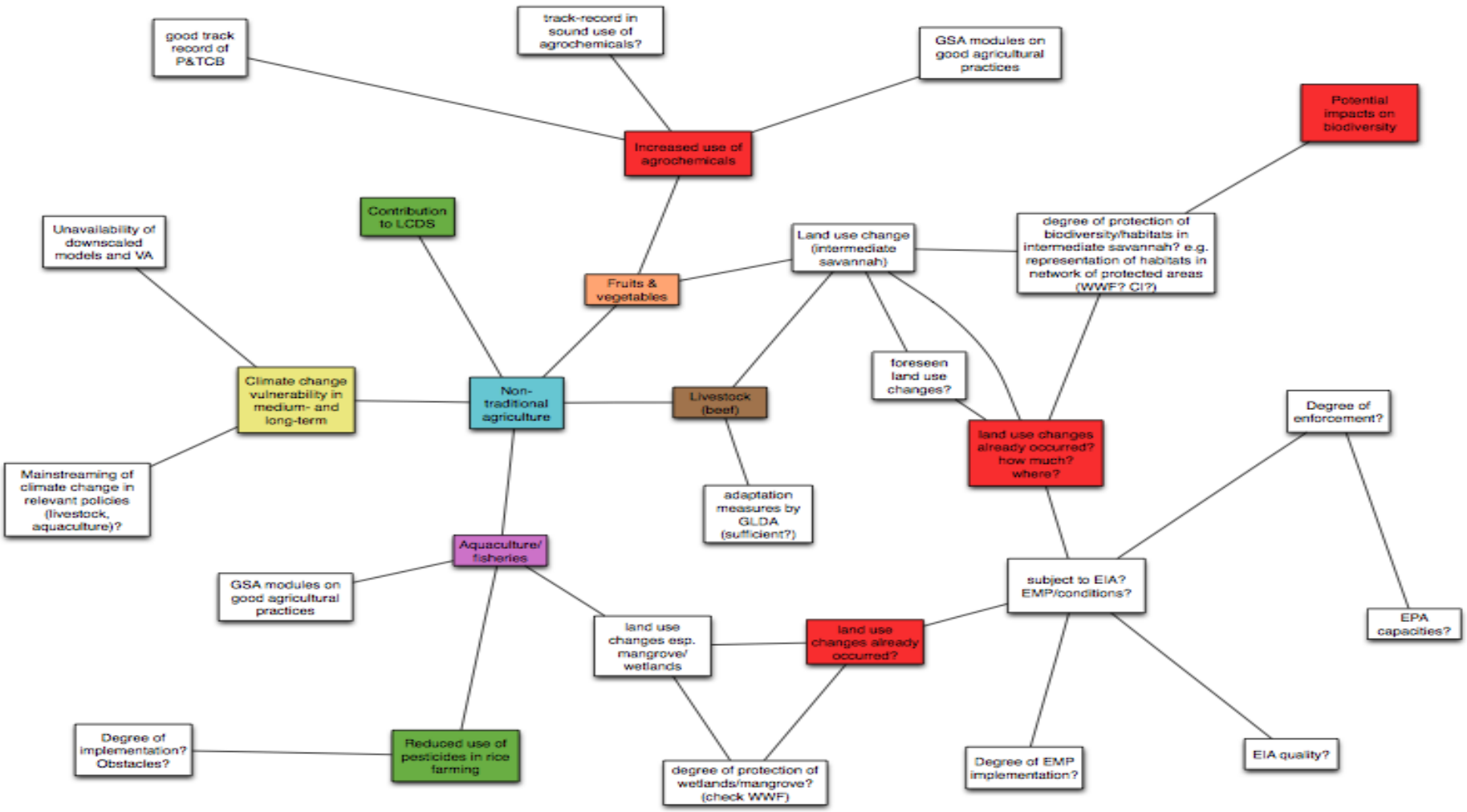
SUGAR INDUSTRY	Water balance	Cont. of groundwater	Cont. of surface water	Soil salinisation	Soil erosion	Soil compaction	Other soil characteristics	Ambient air quality	Greenhouse gas emissions	Protected areas	Deforestation	Biodiversity	Terrestrial flora and fauna	Aquatic flora and fauna	Wetland systems	Coastal water quality	Landscape	Respiratory disease	Other human health factors	Food security	Energy efficiency	Social conflict	Employment	Rural infrastructure
Objective 1: Supporting sustainable improvement in the competitiveness of the sugar sector																								
Conversion of fields to machine-friendly layout																								
Equipment required for mechanical harvesting and husbandry																								
Semi-mechanised harvesting in Dutch Bed layouts																								
Upgrade of all factories to improve competitiveness																								
Installation of a packaging plant at Enmore																								
Construction of raw sugar factory at Skeldon																								
Construction of refinery																								
Construction of a co-generation plant, Skeldon																								
Construction of a co-generation plant at Albion																								
Construction of a co-generation plant and expansion of Enmore																								
Blairmont expansion																								

SUGAR INDUSTRY	Water balance	Cont. of groundwater	Cont. of surface water	Soil salinisation	Soil erosion	Soil compaction	Other soil characteristics	Ambient air quality	Greenhouse gas emissions	Protected areas	Deforestation	Biodiversity	Terrestrial flora and fauna	Aquatic flora and fauna	Wetland systems	Coastal water quality	Landscape	Respiratory disease	Other human health factors	Food security	Energy efficiency	Social conflict	Employment	Rural infrastructure
Support to private cane farmers																								
West Demerara drainage																								
Construction of a deep water berth																								
Ethanol production from cane																								
Storage, shipping and logistics																								
Objective 2: Promoting non-traditional agriculture																								
Establishment of an Agriculture Business Development Unit																								
Plant health system																								
Support to fruit and vegetable sector																								
Animal health system																								
Support to beef sector																								
Creation of a semi-autonomous fisheries authority																								
Aquaculture and IPM																								
Strengthening the land lease allocation system																								
Credit facility for non-traditional agricultural exports																								
Objective 3: Promoting economic regeneration through infrastructural and human resource development support																								
Maintenance of D&I structures																								

SUGAR INDUSTRY	Water balance	Cont. of groundwater	Cont. of surface water	Soil salinisation	Soil erosion	Soil compaction	Other soil characteristics	Ambient air quality	Greenhouse gas emissions	Protected areas	Deforestation	Biodiversity	Terrestrial flora and fauna	Aquatic flora and fauna	Wetland systems	Coastal water quality	Landscape	Respiratory disease	Other human health factors	Food security	Energy efficiency	Social conflict	Employment	Rural infrastructure
All-weather farm access roads																								
Training programme for career development																								
Technical training programme																								
Objective 4: Return to the GoG its contribution to the Skeldon Project																								
Poverty Reduction Support Programme																								

Colour key: Yellow: neg., low sign; Orange: neg., medium sign; Red: neg., high sign; Light green: positive, low sign.; Dark green: positive, high sign; Purple: negative of positive

FIGURE 11 CAUSE-EFFECT DIAGRAM FOR KEY ENVIRONMENTAL INTERACTIONS IN DIVERSIFICATION TO NON-TRADITIONAL AGRICULTURE



ANNEX 2: KEY STAKEHOLDERS

Stakeholder	Description / relevance to the GNAP
Government	
Ministry of Agriculture (MoA)	The Ministry's mandate is to ensure the formulation and implementation of policies and programmes which facilitate the development of agriculture and fisheries in Guyana, thereby contributing to the enhancement of rural life; the sustained improvement of incomes of producers and other participants in the agricultural production and marketing chain; and the maintenance of a sound physical and institutional environment for present and future productive activities. The MoA is the main institutional stakeholder for the GNAP, due to its role in guiding policy development and implementation for traditional agriculture (including sugar) and non-traditional agriculture. It also takes responsibilities on the development of biofuels.
National Agriculture, Research & Extension Institute (NAREI)	As a part of its diversification programme the Ministry of Agriculture merged its Crop Production Research unit with Crop Extension and Quarantine services to form NAREI. Its mandate is to drive the development of crop production in Guyana and currently focuses on crop development and technology transfer. It is also responsible for the reinforcement of the national Plant Protection Act and to coordinate all crop development and support services for the country. NAREI currently gives particular attention to the diversification of the non-traditional crop production especially those with value added and export potentials. The institute is also currently charged with the responsibility to regulate the recently established national bio-energy policy through its Bio-Energy Department. In collaboration with GuySuCo, Guyana Energy Agency (GEA) and the Institute of Applied Science and Technology (IAST) the bio-ethanol demonstration plant at the Albion Sugar Estate was commissioned in August 2013 through the Department of Energy. NAREI is soon to be responsible to be responsible for the implementation of the National Mangrove Development Plan, which is currently being revised by the existing Guyana Mangrove Restoration Project (GMRP).
Guyana Livestock Development Authority (GLDA)	The GLDA was formed in 2010 under Ministry of Agriculture to deal with all matter relating of livestock development in Guyana (research, genetics, embryonic development, artificial insemination, animal breeding, livestock extension services, veterinary services and animal health). FAO in collaboration with the Government is currently undertaking a strategic development plan for development of the livestock sector of Guyana. The main output will be a diversification strategy and will include a National Policy document, a training of trainers manual and a farmer's manual. Land tenure, inappropriate slaughtering facilities and the utilization of local bi-products in animal feed are key issues relating to the development of the livestock industry.
National Drainage and Irrigation Authority (NDIA)	The Authority was initiated under the Drainage & Irrigation Act No.10 of 2004, which provides for the establishment of the NDIA. The

	Authority, formerly the National Drainage and Irrigation Board (NDIB), is a semi-autonomous agency to better manage the D&I system, which became effective on January 01, 2006. The NDIA functions as the Nation's apex organization dealing with all public matters pertaining to management, improvement, extension and provision of drainage, irrigation and flood control infrastructure and services in declared areas of the country. The NDIA is mandated to provide drainage and irrigation services in Declared Drainage and Irrigation Areas (DDIAs). All DDIAs are administered by the Regional Democratic Boards (RDB), which are responsible for maintenance of the conservancies, water allocation from the conservancies, operation of the reservoirs, and maintenance of the dams and head regulators. The RDBs do not themselves collect the water users' share of costs; this is the responsibility of the local authorities. Local authorities are required by the Drainage and Irrigation Act to assess the level of the drainage and irrigation rates on DDIAs and levy charges on landowners. While providing support and assistance to other public institutions dealing with connected activities, it shall also evolve mechanisms for improved water use with financial sustainability, equity and efficiency as the guiding principles. Drainage management is a fundamental issue for the sugar sector in general, as well as for agricultural diversification.
Pesticides and Toxic Chemicals Board	The Pesticide and Toxic Chemical Board was established in 2000 and guided by a pesticide Act that was amended in 2007. Based on such an Act the Board's primary responsibility is to regulate all matters concerning the handling and use of pesticides and toxic chemicals in Guyana. Through its comprehensive registrations process, training and awareness programmes and current stakeholder linkages the Board appears to be effective in the execution of its duties. However, there are issues regarding border control and concerns about the health situation to individuals who are exposed that may need to be examined. Currently, there is no established policy to guide the functions of the board but it is signatory to several related international conventions and is guided by certain obligations to secure its membership.
Sea and River Defence Board	The Sea and River Defence Board has the legal responsibility for all declared sea and river defences. The Hydraulic Division is the Board's executing agency and is part of the Ministry of Public Works and Communications. As such, it shares the institutional problems common to all ministries. To overcome these limitations, the Project Execution Unit was formed in 1994 to manage donor agencies-funded programmes and to train counterpart staff. It should be evident that the effective management of this organisation is vital. The Project Execution Unit has no formal legal mandate but was given some autonomy in accounting and procurement. It was envisaged as a temporary unit. Therefore, after the donor-supported rehabilitation of sea defences is completed, there will be need for an effective, permanent agency to manage maintenance tasks and ensure that maintenance works are not again neglected. New policies are needed to ensure adequate funding for maintenance of the sea walls on a continuing basis. The lack of such funding in the

	past has led to severe deterioration of the structures, and hence the current necessity to resort to external sources of funding for major rehabilitation. Sea defences are fundamental for the development of the sugar industry and non-traditional agriculture, which are located on the coastal plain, and thus rely on sea defences to protect them from intrusion of sea water.
Ministry of Natural Resources and the Environment (MoNRE)	Created in 2011 as an overarching authority that covers the following agencies: Guyana Geology & Mines Commission (GGMC), Guyana Gold Board (GGB), Guyana Forestry Commission (GFC), Guyana Lands and Survey Commission (GL&SC), Environmental Protection Agency (EPA), Protected Areas Commission (PAC), National Parks Commission (NPC) and Wildlife Management Authority (WMA). The MoNRE is responsible for the environmental policy, and is currently in a process of conformation, guided by its Costed Strategic Framework for the Ministry of Natural Resources and the Environment 2013-2018 (Strategic Environmental Advice, 2013).
Environmental Protection Agency (EPA)	The EPA is responsible for the Environmental Permitting System (EPS), aimed at pollution prevention and control and enforcement of environmental regulations. To date the EPA has not been addressing to any depth industries set before the EPA was established (1996), such as the sugar industry. However, the new Skeldon development is subject fully to the EPS.
Protected Areas Commission (PAC)	The PAC is an agency under the MoNRE that has as its mandate to establish, manage, maintain, promote and expand the National Protected Areas System (NPAS). The PAC is currently working with international NGOs in the identification of biodiversity hotspots that should result in an adequate degree of protection to the intermediate savannah ecosystem, currently under threat from agriculture expansion.
Office of Climate Change (OCC)	Established in 2009 within the Office of the President to coordinate all climate change initiatives, activities and organisations. The mandate of the OCC includes to (i) support work on climate adaptation, mitigation and forest conservation, (ii) align the efforts of various government agencies around the issue of climate change, (iii) coordinate the efforts of bilateral, multilateral, and non-governmental organisations assisting Guyana's climate change agenda, (iv) serve as the secretariat for the Multi-Stakeholder Steering Committee of the LCDS, and (v) provide support to negotiations at appropriate global and regional for a.
Guyana Hydrometeorological Service	Attached to the Ministry of Agriculture. It is responsible to monitor and evaluate the weather and water resources in the country. Meteorological data in the country is complemented by the weather stations operated by GuySuCo.
Guyana Forestry Commission (GFC)	The GFC is entrusted with the mandate to ensure Guyana's forest resources are sustainably managed and conserved. It is responsible for the National Forest Policy. The GFC is relevant to the GNAP with regards to its role in protecting mangrove, which act as natural sea defences that protect agricultural lands from sea water intrusion. The role of the GFC with regards to mangroves is recent, and came about from regulations making mangroves protected species, declared critical

	to the maintenance of Guyana's sea defences and the fishery industry. The GFC is also relevant in relation to land use changes (from forest to agriculture) that may be associated to expansion of non-traditional agriculture.
Guyana Energy Agency	Established under the Guyana Energy Agency Act (1997), it is responsible for, inter alia, the development and implementation of a national energy policy; undertaking research, including on energy efficiency; monitoring performance in the sector. The Agency is relevant due to its potential role with relation to the promotion of biofuels and ethanol fuel blending being promoted by the GNAP.
Lands and Surveys Commission (GL&SC)	The Commission was created in June, 2001 through an Act of Parliament to administer land, to maintain a land register and cadastral records, to optimize land use, to maintain a land information system, and to provide surveying and Geographic Information System services. The Commission is the custodian of all State and Government Lands in Guyana with four (4) Divisions and ten (10) Regional Offices. The main objectives of the Commission are: to prepare land use plans for Guyana or any part of Guyana, except any municipality which is subject to a planning scheme (or interim development control pending the preparation of a planning scheme) under the Town and Country Planning Act; to establish and maintain liaison with the responsible agencies to promote and monitor the use public lands, the maintenance of drainage and irrigation system, access roads and other infrastructure, through such measures as may be appropriate; to compile and maintain an inventory of all the land resources of Guyana, their quality, degree, pattern of utilization and related matters to advise the Government on policy relating to public land surveys; land surveys and any other matters related to the functions of Commission; to initiate studies into and formulate policy on the development of public lands, including the feasibility of specific land development projects.
Guyana Office for Investment (Go-Invest)	GO-Invest was established 1994 as a semi-autonomous body that operates under the purview of the Office of the President to promote and facilitate local and foreign private-sector investment and export in accordance with the country's approved investment and export strategies.
Ministry of Local Government and Regional Development	The mission of the Ministry is to supervise and maintain the legal regulatory framework of the system of local and regional administration and to encourage and facilitate the socio economic development of all the administrative regions in Guyana. With regards to the GNAP, this Ministry is relevant insofar as the facilitation of local development through agricultural diversification.
Guyana Rice Development Board (GRDB)	GRDB was established in 1994 to coordinate and regulate the manufacturing and marketing of rice in order to secure effective development of the rice industry in Guyana. The Board executes its duties mainly through research, promoting the expansion of the export

	trade, and engages in any activity that would foster the overall development of the industry. The industry is semiautonomous by nature and consists of a large number of private ownership. The Board adapts a general husbandry practice that focuses on minimal chemical and pesticide usage. Currently the GRDB maintains joint relationship with GuySuCo in the management of pertinent resources that commonly serve both industries. For instance both industries share in the management of major drainage facilities that serve both the sugarcane and rice sectors. It was reported that the wider farming and other communities also benefit from such a joint support of GRDB and GuySuCo and any major changes in such an arrangement could have large-scale socio-economic and environmental implications.
National Water Council	Established under the Water and Sewerage Act 2002, the National Water Council is responsible for the national water policy and has its interest in the conservation, protection and wise use of water resources.
Civil Defence Commission (CDC)	Responsible for the Disaster Management System. Developed the Disaster Risk Management Policy and the Integrated DRM plan for Guyana, in conformance to which the Agriculture Disaster Risk Management (ADRM) Plan was formulated with the Ministry of Agriculture.
Industry	
Guyana Sugar Corporation (GuySuCo)	The Guyana Sugar Corporation, best known by its acronym GuySuCo, is owned by the government. It is the country's largest cultivator and producer of sugar, a commodity responsible for approximately 20% of Guyana's annual revenue and 40% of all agricultural production. Its brown sugar is exported internationally to the European Union, the United States of America, and the Caribbean Community (CARICOM) countries The company GuySuCo was formed in 1976, when the GoG nationalised and merged the sugar estates The rapid nationalization of the sugar industry in the mid-1970s led to severe management difficulties and an emigration of talent, initially lacked needed experience and perhaps more importantly, did not have access to the reserves of foreign capital required to maintain sugar plantations and processing mills during economically difficult periods. In 2004 it was announced that Guyana was moving to modernize its sugar industry to cushion the impact of the African, Caribbean and Pacific (ACP) countries on the world market. As part of a strategic plan to reduce costs and improve productivity in 2004 a new factory was built at Skeldon, which included a cogeneration plant. A distillery and a refinery were to be constructed at a later stage. The agreement was also made in compliance with the World Bank targets and obligations to contribute to an overall reduction of global greenhouse gases and to introduce modern technologies to the sugar industry which would improve efficiency. In November 2007, sugar factory workers of GuySuCo trained in South Africa to become familiar with the new technology.
Demerara Distillers Limited	The only remaining distillery in Guyana, located on the East Bank of

(DDL)	Demerara, wholly owned and operated by Demerara Distillers Ltd. The distillery has the capacity to produce in excess of 26 M litres of pure alcohol annually, and is the largest supplier of bulk rums and alcohols from the Caribbean to brand owners in Europe and North America. In addition, the company has a gin-flavouring still, liqueur production facilities and raw sugar caramel plants. DDL also possesses its own CO_2 plant, utilising the waste product from the distillery to produce piped liquefied gas for their aerated beverage plant, as well as cylinder gas for industrial use and dry ice for the fishing and frozen food industries. DDL is considered a stakeholder in in the context of the GNAP as ethanol production by GuySuCo would use the molasses that are now being sold to DDL for the production of rum. In addition, vinasse management by DDL can give an idea of 'accepted' practices in Guyana.
Donors	
Inter-American Development Bank (IDB)	The IDB is one of the main donors supporting agricultural diversification (non-traditional agriculture) in Guyana, primarily through the Agricultural Diversification Programme (ADP). The ADP includes the following components: promote private sector entrepreneurship in agribusiness; improve capabilities of agribusiness expert and facilitation services; and strengthen and consolidate agricultural health and food safety services. IDB will also be supporting a project on Institutional Strengthening in Support of Guyana's Low Carbon Development Strategy, with the following specific objectives: to strengthen the technical and administrative capacity of the principal institutions responsible for implementing Guyana's LCDS; and develop and implement a Monitoring, Reporting and Verification (MRV) system at national level. This project is developed in the context of the GRIF enabling conditions.
Caribbean Development Bank (CDB)	The CDB helped finance the Skeldon Sugar Modernisation Project, mainly in relation to agricultural works.
World Bank	The World Bank has been involved in financing the Skeldon Sugar Modernisation Project (SSMP), including the bagasse co-generation component. The World Bank does not have a country office in Guyana.
European Union Delegation (EUD)	The GNAP is being supported by the European Commission (EC) through its Multi-annual Indicative Programme for the Accompanying Measures for Sugar (AMS).
UNDP	UNDP have some projects in Guyana on energy and environment, including the *Mainstreaming of Sustainable Land Management*, that will increase capacities for sustainable land management, especially in the context of desertification and the *Guiana Shield Facility*, which addresses biodiversity conservation through the implementation of valuation methodologies, payment for environmental services and adoption of new technologies.
FAO	The FAO has provided support to the development of agricultural diversification in Guyana at a policy and technical level. It provided assistance in the preparation of the Livestock Development Policy, and

	the subsequent Strategy and Action Plan. It also provided support for the preparation of the Policy and Strategic Plan for Fisheries and Aquaculture. It will also be providing assistance to NDIA for the development of a GIS system for the management of drainage & irrigation, which will integrate a climate change component in order to take into account added pressure on the D&I system due to climate change.
NGOs	
Conservation International – Guyana	International environmental NGO with interest in environmental protection, mainly involve with biodiversity conservation.
WWF Guianas	International environmental NGO with interest in environmental protection in the Guianas. In Guyana they are involved mainly with biodiversity conservation.
Academic and training	
Guyana School of Agriculture (GSA)	An allied training institution of the Ministry of Agriculture that focuses on agro-processing; the institution is slated to start a course in agro-processing in September 2013.
Labour Unions	
Guyana Agricultural & General Workers Union (GAWU)	The Guyana Agricultural and General Workers Union (GAWU) is the largest trade union in Guyana. It represents around 90% of GuySuCo's employees, including field foremen and forewomen (Ah-Kee, 2010).
National Association of Agricultural, Commercial and Industrial Employees (NAACIE)	The National Association of Agriculture, Commercial and Industrial Employees (NAACIE) is a trade union in Guyana, with members mainly from the office, commercial and industry sectors. They represent about 7% of GuySuCo's employees, mainly in clerical, technical and administrative areas (Ah-Kee, 2010).
Guyana Labour Union	The Guyana Labour Union represents mainly workers from the transport and dock sector. With regards to the sugar sector, it represents less than 1% of GuySuCo's employees who work at the East Coast Demerara sugar terminal (Ah-Kee, 2010).

ANNEX 3: RELEVANT POLICY DOCUMENTS

Policy, Plan or Programme	Description / relevance to the GNAP
National	
National Development Strategy (2000)	Although phased out in 2010, it remains a reference document for national and sectoral plans. It highlights that environmental considerations should underpin all aspects of development, establishes the precautionary principle, and refers to the principles of sustainable development. It promotes agricultural development and fisheries (including aquaculture), also captured by the GNAP.
National Competitiveness Strategy (2006)	With regards to sectoral development the National Competitiveness Strategy focuses on diversification. The Agricultural Export Diversification Programme aims at increasing income from export of non-traditional agricultural exports in the aquaculture, fruits & vegetables and livestock sub-sector. For the sugar industry it makes reference to all areas covered by the GNAP for the sector, including increased investments in drainage & irrigation. Of particular interest to this SEA is the policy that livestock development will only take place on non-forested land. Nevertheless, impacts on biodiversity from land use changes in the intermediate savannahs can still be an issue, especially as the do not receive any degree of protection.
Poverty Reduction Strategy (2000, 2004, 2011)	The PRS (2000) was reviewed in 2004 and 2011. The poverty reduction agenda for 2011-2015 is based on pillars that are in line with the LCDS: (a) broad-based, low-carbon led job creation economic growth; (b) stronger governance, institutional and regulatory structures; (c) accelerated investment in human capital and primary health; (d) accelerated investment in physical infrastructure in support of growth strategy; and (e) special intervention programmes to address regional and demographic pockets of poverty. It addresses the challenges of drainage & irrigation for agricultural development and sea defences recognises the risks and vulnerability associated to climate change and natural disasters. It also addresses the expansion of sugar cane cultivation and agricultural diversification.
Climate Change	
Guyana's Low Carbon Development Strategy (LCDS)	The LCDS sets out Guyana's vision to protect and maintain the country's forests in an effort to reduce global carbon emissions while promoting economic development at the same time. It demonstrates how developmental goals can be achieved in a low carbon, climate resilient, green economy and sets out two broad goals, as detailed in the LCDS Update (2013): ▪ Transforming the economy to deliver greater economic and social development by following a low carbon development path; and ▪ Providing a model for the world of how climate change can be addressed through low carbon development in developing countries, if the international community takes the necessary

	collective actions, especially relating to REDD+. The LCDS makes provisions for the development of a Climate Resilience Strategy, inclusive of measures to protect against flooding and restoring of the early warning systems. In addition, renewable energy is a priority under the LCDS and a critical element towards the transition to a low carbon economy, thus the LCDS makes provisions for investment in strategic low carbon economic infrastructure. The LCDS also makes provision for the use of more energy efficient devises and the application of energy efficient methods". The LCDS promotes investment in high-potential low carbon sectors, such as fruits and vegetables and aquaculture, addressed by the GNAP. Although not directly referred to in the LCDS, the co-generation components of GNAP will be contributing to climate change mitigation; more specifically the Skeldon co-generation facility is registered under the Clean Development Mechanism (CDM), although it is not yet generating carbon offsets. The LCDS will also be promoting climate change adaptation, more particularly with regards to canal rehabilitation, which will have a positive impact on the agriculture sector, including sugar.
Guyana Climate Change Action Plan (2001)	The Climate Change Action Plan is aimed at the implementation of areas of action identified in the Initial Communication to the UNFCCC and addressed short-term actions up to 2005. Longer-term actions are covered under the LCDS.
Agriculture	
National Policy on Inland Fisheries and Aquaculture (2012)	The National Policy on Inland Fisheries and Aquaculture in Guyana focuses on the management, regulation and promotion of the use of living aquatic resources in Guyana in a sustainable way to benefit the country. As a part of its guiding principles, the policy identifies a balance use of such aquatic resources and the conservation of the local bio-diversity as the overarching guidelines to its implementation. There is the charge for all stakeholders to exercise stewardship as the core value in the demonstration of their rights to access and use all aquatic resources. The GoG is currently working on associated regulations for fishery products, aquaculture and marine fishing.
Disaster Risk Management Plan for the Agriculture Sector 2013-2018	The ADRM strategy and implementation plan symbolises the commitment of the GoG and MoA to risk reduction and people focused development. It presents a framework for mainstreaming disaster risk reduction into the agriculture sub-sectors, with the long-term goal of protecting livelihoods, social capital, food and nutrition security. The strategic framework is in line with the national DRM, and is congruent with the Hyogo Framework for Action (HFA) and regional model of Comprehensive Disaster Management adopted by CARICOM.
Guyana National Livestock Development Policy (2013)	The Policy promotes the development of the livestock sector. The Guiding Principles for the policy include sustainability (including a balanced use of resources and conservation of biodiversity) and carbon neutrality (if developments lead to increased carbon emissions, they must be balanced by forms of carbon sequestration in accordance to the LCDS). The Policy is to become operationalized through the Guyana

	National Livestock Development Strategy (2013-2023).
National Adaptation Strategy to address climate change in the agriculture sector of Guyana (2009)	Prepared for the Caribbean Community Climate Change Centre (CCCCC). It provides an overview of the challenges faced by the agriculture sector with regards to climate change. It proposes a number of actions under the following Focus Areas: (a) enhancement of capacities (technical and institutional); (b) infrastructure management; (c) policy and legislation development; (d) research development; and (e) awareness raising and communication.
Food and Nutrition Security Strategy for Guyana (2011)	The Strategy's overall goal is to improve the health and well-being of all persons living in Guyana through enhanced food and nutrition security. To achieve this, it emphasises stable employment-generation opportunities, including in non-traditional agriculture, and reducing vulnerability/risk to natural disasters (especially coastal flooding); promote healthy foods for increased nutrition; and promoted increased institutional coordination. Its relevance to the GNAP manly relates to the promotion of non-traditional agriculture.
Sugar sector	
GuySuCo Strategic Blueprint and Business Plan	In response to the Government's concern about the performance of GuySuCo, in 2009 an Interim Board of shareholders was given the charge to draft a strategic blue print to guide the Corporation towards charting a viable and sustainable pathway for the success of the sugar industry. Such a plan was to create more competitive sugar industry that was cost effective and for production to surpass 450,000 tonnes of sugar per annum. However, the industry continues to realize a decline in production. The strategy focuses on three key aspects: improving production, reducing costs and value adding. The Strategic Blueprint will be superseded by the Strategic Plan (2013-2017).
GuySuCo Strategic Plan 2013-2018	The 5-year strategic plan (2013-2017) will further support the initial objectives of the Strategic Blueprint and will incorporate the new initiatives of major stakeholders in an effort to revive the industry. Some key elements of the new initiatives include the conversion of mechanically friendly layouts to full mechanization, increasing private cane farmers' partnership, return to best practices, achievement of tillage and planting programmes, continuing to produce market value added sugar, review of procurement policy and continued drainage and irrigation programmes.
Environment	
National Environmental Action Plan (NEAP)	The NEAP phased out in 2005 and has not been replaced by a new one responding to the new institutional context (e.g. establishment of the MoNRE), new policy context and changes in issues in the sector.
National Biodiversity Action Plan (1999-2004)	Based on the National Strategy for the Conservation and Sustainable Use of Guyana's Biological Diversity, it establishes Guyana's national policy position regarding the study of, conservation and sustainable use of biodiversity. It supports the implementation of the United Nations Convention on Biological Diversity (CBD). It is related to the GNAP insofar

	as activities promoted could interfere with the management and conservation of biodiversity (e.g. land use changes with regards to the promotion of non-traditional agriculture).
Mangrove Management Plan (2010)	The Mangrove Management Plan has its basis in the National Forestry Plan and is under the responsibility of the Guyana Forestry Commission. It aims at ensuring the sustainable management of mangroves. It is relevant to the GNAP as it contributes to sea defences, which are necessary to safeguard agricultural lands from sea water intrusion, and contribute to climate change adaptation in the context of sea level rise.
National Forest Policy Statement (NFPS) (2011)	It replaces the 1997 National Forest Policy Statement and has as its overall objective the conservation, protection, management and utilisation of Guyana's forest resources, while ensuring their productive capacity for goods and services is maintained and enhanced. It addresses the protection of mangroves.
National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (2013)	Developed in compliance with the Stockholm Convention on Persistent Organic Pollutants (POPs). Sugar cane burning is a source of POPs, although in the case of Guyana it was not determined to be a major source of POPs generation, and thus sugar cane burning is not addressed under the NIP.
Integrated Coastal Zone Management (ICZM) Action Plan 2002	The ICZM Action Plan is intended to guide stakeholders involved in ICZM. It provides technical information on natural resources, mangrove management, hydrological and climatological data, aerial photography, infrastructure monitoring, surveys and the legal and institutional set up.
National Water Policy	In October 2012 a workshop was held to develop a National Integrated Water Resources Management Policy and Roadmap, with the objective of better supporting sustainable development and management of water resources. After assessing the water situation in Guyana, it is key to note that the State should not be the one responsible alone for water resource management. The society should be urged to move away from the concept that water in Guyana is in abundance, and as such could be wasted. Its importance is that IWRM policy sets out a new vision for water management, noting that it is necessary as the world, with Guyana being no exception, currently faces the effects of climate change.
Energy	
Agro-energy Policy (AEP) (draft)	Developed by the Ministry of Agriculture to guide the work on biofuels development, including bioethanol from sugar cane. Policy developments in the energy sector are in the process of further development, partially based on assessment of the feasibility of the ethanol demonstration plant at Albion.
Land use planning	
Draft Land Use Policy (2007)	The draft land use policy used existing, approved policies and strategies and was first presented to government in 1998. It went through three drafts before being shelved. However, the introduction of the Poverty Reduction Strategy (PRS) in 2000 (q.v.), and updated in 2004, reawakened interest in land use policy since many of the recommendations of the NDS in 1996 (updated in 2001) were reaffirmed in the PRS and concerned natural resource management, land and land

	use planning, agriculture and environmental policy. Salient points were: The absence of clear policies and guidelines for integrated environmental management (especially of the coastal zone) was a major constraint; The lack of a general land use plan was seen to create land use conflicts which then had serious implications for the sustainable use of natural resources; As pressure on land resources increased, the need for a national land use policy and plan would become crucial, especially since such a national policy could be a strategy for attaining optimal land use towards national development. In 2004 a further draft of a national land use policy was produced. This was set within existing broad-based policy documents such as the NDS, the PRS and the Area Development Strategy for Amerindian Communities and took all existing sector policies and strategies into account. The policy identified the need for a National Physical Plan to provide a spatial element to the NDS. In addition, the draft policy identified criteria for the allocation of agricultural land and specifically allowed and promoted multiple land use. It also proposed the establishment of a co-ordinating National Land Resource and Land Use Working Group to co-ordinate land issues and to address and resolve land use conflicts. The draft policy was circulated in Government and associated Agencies but again was not ratified. However, an inter-agency land use co-operation committee was established to address issues of land use conflict. The policy was reconsidered in 2007 and re-issued as a shorter document comprising the policy statements only, without any appendices, setting the policy environment and context. This 4th draft was also not adopted. In 2012 the GL&SC, through the UNDP, produced a document integrating Sustainable Land Management (SLM) principles into the draft Land Use Policy. This concluded that Guyana would benefit greatly from a National Sustainable Land Management Policy document that would integrate land administration, land use planning and land management across all sectors incorporating social, economic and environmental concerns. A possible policy outline was produced.
National Land Use Plan (2013)	The primary objective of the National Land Use Plan (NLUP) is to provide a strategic framework to guide land development in Guyana. As such the NLUP is built upon a number of national policies and strategies that have a direct relevance for land use and land management. A main objective of the NLUP is to enable financial resources to be targeted at optimal land uses at the regional level. To this regard the NLUP has been compiled from a policy of active promotion of multiple land use. The NLUP is not prescriptive in that it does not aim to zone areas of the country for particular land uses, rather it aims to suggest a number of options for particular areas that can then guide decision-makers and attract inward investment. In conjunction with the above, a further aim of the NLUP is to provide a spatial element to development planning, to show on one map, or a series of maps, what the current situation is, where resources are

	located, where potential exists and what linkages may be necessary to develop those resources. The rationale behind the development of the NLUP is multi-faceted and includes: Climate change, adaptation, mitigation and a need to develop land away from the coastal plain; Land pressure on the coastal plain; The need for rational land use development as spelled out in many policies and strategies; Need for more effective management of competing land use claims; A legal requirement under the REDD+ Memorandum of Understanding (MoU); The need for linkage between regional development plans and national development; The desire for infrastructure linkages within the wider northern South America. The preparation of the national land use plan has taken place within the context of a number of policy and strategic documents that have guided plan formulation. These include the National Development Strategy (NDS 1996), the Poverty Reduction Strategy (PRS 2000, 2004, 2011), the Land Use Baseline Document (1996) which led to the Draft Land Use, Government of Guyana National Land Use Plan June 2013, Guyana Lands and Surveys Commission Policy (2004, 2007), the National Competitiveness Strategy (NCS 2006) and the Low Carbon Development Strategy (LCDS 2010).

ANNEX 4: RELEVANT LEGISLATION

Legislation	Description / relevance to the GNAP
Environmental Protection Act No. 11 of 1996	Framework environmental legislation for environmental protection. It defines Environmental Impact Assessment (EIA) (Part IV) as a key element in the permitting process of new developments; for example, the Skeldon factory was subject to an EIA and so will any ethanol distilleries that may be promoted. It also sets the basis for the environmental permitting system in the context of prevention and control of pollution in accordance with regulations. There are three types of permits: environmental permit (required for all new projects/development that may significantly affect the environment); operations permit (required for all existing and operating projects/industries that may be altering a process or rate of production which may result in a contaminant being discharged into the environment; and construction permit (required for the construction, alteration, extension or replacement of any plant, structure, equipment or mechanism that may discharge a contaminant into the environment for a new or existing project).
Environmental Protection (Authorisations) Regulations 2000	Establishes regulations for the issuance of environmental authorisations by the EPA. It establishes the EPA's duty to ensure compliance with the issued licences. In the case of GuySuCo, they submit water quality monitoring reports to the EPA as well as reports on the implementation of Skeldon's Environmental Management Plan (EMP).
Environmental Protection (Air Quality) Regulations 2000	Establishes provisions for the control of air pollution. All facilities that emit air contaminants must have an environmental authorisation by the EPA. Emission limits have not yet been established and implementation of the regulations remain weak. These regulations are relevant in relation to atmospheric emissions from sugar factories.
Environmental Protection (Water Quality) Regulations 2000	Establishes provisions for the control of water pollution. All facilities that discharge water contaminants must have an environmental authorisation by the EPA. Discharge limits have not yet been established and implementation of the regulations remain weak. These regulations are relevant in relation to effluent discharges from sugar factories.
Environmental Protection (Noise Management) Regulations 2000	Establishes provisions for the control of noise. All facilities that emit noise (which includes vibration under the definition given in the regulations) must have an environmental authorisation by the EPA. Discharge limits have not yet been established and implementation of the regulations remain weak.
Environmental Protection (Hazardous Wastes Management) Regulations 2000	Establishes provisions for the control of hazardous wastes. All facilities that generate, treat, store, dispose or transport hazardous wastes must notify the EPA, who will proceed to consider the granting of the corresponding authorisation. Implementation of the regulations remains weak. These regulations are relevant in relation to hazardous waste management in the sugar industry.
Environmental Guidelines for	An EMP is defined as "an environmental management tool used to

Preparation of an Environmental Management Plan (2013)	ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented, and that the positive benefits of the projects are enhanced". EMPs are prepared as part of the EIA process and provide a framework for the specifications associated to environmental permits. In the case of the Skeldon factory and EMP was agreed on the basis of which compliance is monitored.
Fisheries Act 2002	The Act promotes the sustainable development of the fisheries sector and relates primarily to sea fisheries. It provides for the declaration of marine reserves to protect flora and fauna of such areas. It regulates fishing vessels and fishing methods; use of explosives, position or other noxious substances is prohibited. The Act makes provision for Aquaculture Permits and for the Ministry of Health to establish an aquaculture monitoring programme for the detection of residues of veterinary products in aquaculture products, but is otherwise not regulating aquaculture practices.
Pesticides and Toxic Chemicals Control Act No. 13 of 2000	The Act establishes the Pesticides and Toxic Chemicals Control Board and the Register of Pesticides and Toxic Chemicals. The manufacture, importation and selling of a controlled product requires the appropriate licence. The Act also regulates the exportation, handling, use, storage, disposal and transport of controlled products. This Act is highly relevant for the control of agrochemical products used in the agriculture sector.
Environmental Guidelines – Transportation, storage and occupational handling of chemical/industrial hazardous waste (2011)	Guidelines issued by the EPA aimed at any person who operates a company, business or facility that transports, generates, stores, treats and disposes of chemical/industrial hazardous wastes. It includes information on procedures and requirements for transportation, storage and occupational handling of chemical/industrial hazardous waste.
Drainage and Irrigation Act (2004)	The NDIA was established under the Drainage & Irrigation Act No.10 of 2004. The Authority, formerly the National Drainage and Irrigation Board (NDIB) of the Ministry of Agriculture is a semi-autonomous agency to better manage the D&I system. NDIA became effective on January 01, 2006.
Water and Sewerage Act 2002	The Water and Sewerage Act establishes the National Water Council with the following mandate: Water resources are equitable allocation for the social and economic benefit of Guyana; Water resources are used in an efficient and sustainable manner; The water environment is adequately safeguarded; Communities and assets are protected from severe hydrological events; Changing patterns of water availability and use are sensibly accommodated; Develop a national water policy. The ownership of all water resources and the right to use, abstract, manage and control the flow of water are vested in the State.

ANNEX 5 PROFILE OF THE CONSULTANTS

Dr Juan PALERM is the Team Leader for this SEA. He holds an MSc in Environmental Technology and a PhD in environmental policy from Imperial College, London. Dr Palerm has 20 years of professional experience and has been working on Strategic Environmental Assessment for about 15 years in different countries. He was the lead author for the approach to SEA in the context of EU development cooperation, as reflected in the corresponding EU Guidance and participated in the preparation of the OECD DAC Guidance on SEA in development cooperation. He has been involved in the development of SEA systems in Chile and the Kyrgyz Republic. He has participated in a number of SEAs in Africa and Latin America and was Team Leader for the SEAs of sugar sector adaptation strategies in the context of the Sugar Accompanying Measures for Jamaica, Zambia and Swaziland. Dr Palerm has been providing training to staff from donor organisations and national governments on environment and climate change mainstreaming, where SEA figures prominently as a key tool for effective mainstreaming.

Mr Tonnis Jan SIEREVOGEL, our sugar expert on this mission, has a Bachelor of Science degree in Agriculture and a Master of Science degree in Tropical Crops, with a specialisation in Soil Science. He further has a post-graduate degree in Drainage and Irrigation. Mr Sierevogel is a Dutch national with over 40 years of experience as an international consultant and Team Leader in the agricultural sector. He has implemented 32 assignments related specifically to the development of the irrigated sugar cane industry primarily in Africa. As a result Mr Sierevogel has extensive knowledge of all aspects of sugar cane production (especially the organisation and management of outgrower schemes), different irrigation systems, sugar cane transport systems and sugar cane processing. Moreover he has carried out 12 assignments specific to the Accompanying Measures for former Sugar Protocol Countries and is experienced in the planning of measures to increase sugar industry productivity and to address socio-economic and land issues in sugar producing areas. He is an agriculturist with extensive experience in evaluation and monitoring of a wide range of development projects worldwide, covering rural development and infrastructure, agriculture and food security, water and environment, large and small scale irrigation projects, farmers and users associations; institutional strengthening, sector policy analysis and development. Moreover, Mr Sierevogel has extensive experience with environmental assessments and has conducted several SEAs.

Mr Glenroy Ennis is an expert agriculturalist with degrees in agricultural economics (MPhil), agricultural science (BSc) and education (BEd). Mr Ennis has more than 20 years of experience in agriculture; economics; education; project formulation, appraisal, evaluations and management; strategic planning; climate change, business management; value chain analysis; feasibility studies; pro-poor policy; food safety and security; financial analyses, marketing and gender equality primarily to micro, small and medium-sized enterprises (MSME), tropical agricultural, rural and sustainable development initiatives. Mr Ennis' major experience base includes ACP countries and Canada. Some related sectors and areas where such experiences were gained include: policy development and planning on agriculture, rural and community development; SEAs on National Adaptation Plans; business and project development focusing on designing strategies to attract venture capital, preparing concept papers, feasibility studies, logical framework, institutional strengthening, evaluations; education and training; private sector development analysing food security, value chains, climate change, business and sustainable development issues with a view to raise income levels among MSMEs; and research in crop and livestock production, agricultural trade, marketing and price analysis.