LINKING VULNERABILITY, ADAPTATION, AND MITIGATION IN SMALL ISLAND DEVELOPING STATES: CLIMATE CHANGE AND THE COMMUNITY OF GRANDE RIVIERE, TRINIDAD

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This study investigates the vulnerability level of the coastal community of Grande Riviere, Trinidad to climate change by developing and empirically applying a Vulnerability Index. Five pillars were developed that comprised different indicators and sub-indicators. These were then populated with a combination of primary and secondary data. The composite index suggested a scoring of 0.3371 as the vulnerability level for Grande Riviere, with the most and least vulnerable pillars being the human and social capital pillars respectively. Simulation exercises for a variety of policy options and exogenous shocks were conducted to examine how the index and its components would be impacted. These simulations led to a series of adaptation and mitigation strategies for climate change at the governmental, community and household levels. The end results underscore the need for communities of small island states such as Grande Riviere to adopt appropriate measures to deal with climate change collectively and effectively.

Keywords: Vulnerability, Vulnerability Index, Climate Change, Small Island Developing States (SIDS), Grande Riviere.

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1. Introduction

Climate Change in the Intergovernmental Panel on Climate Change (IPCC) usage refers to "*a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persist for an extended period, typically decades or longer*" It therefore refers to changes in climate whether due to natural variability or anthropogenic causes overtime. This definition differs from that used in the United Nations Framework Convention on Climate Change (UNFCCC), where it states that climate change is "*attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods*" (IPCC Synthesis Report- AR4). Regardless, of the definitions considered, changes in climate arise primarily from natural or human activity.

Countries, societies, individuals who have limited adaptive capacity, least resilience and who are exposed to hazards are those that are considered to be most vulnerable (Bohle et al., 1994). For some environmental economist, they view the most vulnerable as those countries, societies, or individuals who least contributed to the amount of greenhouse gas (GHG) emissions. Tol et al (2004) was one whose studies concluded that climate change will have severe impacts on the poorest people of the world because they are exposed to the weather, and face an already warm climate (Mendenlsohn et al., 2006).

On the contrary, recent development showed otherwise, in that wealthier nations with high emission levels may also be vulnerable. The study conducted by Yohe et al., (2006a,b) found Russia to be the most vulnerable country to climate change. The Environmental Vulnerability Index (EVI) developed by the South Pacific Geoscience Commission (SOPAC) (Kaly et al., 2004) contains a climate change sub-index (EVI-CC), suggesting interestingly, that most European countries are highly vulnerable while most African nations are least vulnerable. Diffenbaugh et al (2007) also arrived at similar conclusions.

Based on the above, there exist contradicting views as to who is considered most vulnerable. Thus to this end, Fussel (2010) sought to developed an indicator to establish if a significant positive correlation exists; an absence of a significant correlation exist; or to determine if a negative correlation prevails, that is double inequity. The end result of the study was that double inequity prevailed implying that those countries that least benefited from GHG experiences the bulk of the effects from climate change, as oppose to those that benefited fully from GHG (developed countries). Hence, it is to this end, emphasis will place on Small Island Developing States (SIDS) since such countries have high vulnerability accompanied by low adaptive capacity and resilience level.

The results derived from the study conducted by Fussel (2010) is applicable to Small Island Developing States (SIDS) in that they least contribute to GHG emissions but are mostly affected due the factors that make them most vulnerable. The composition of SIDS is grouped under 38 island states where these are clustered into 4 groups namely the Caribbean group, Pacific group, Indian Ocean group, and West African group comprising 15, 17, 4, and 2 respectively (Pelling and Uitto 2001).

SIDS as cited in TAR, exhibits characteristics that results in their high vulnerability levels namely their small size, insularity and remoteness, disaster proneness, environmental fragility, demographic factors, and dependence on foreign sources of finance. These factors were also identified by Briguglio (1995), and Pelling and Uitto (2001) in their quest to establish why SIDS are so vulnerable to natural disasters.

SIDS in the Caribbean region demonstrates inherent vulnerabilities which are driven by both internal and external factors. This vulnerability however, without adaptation can result in poor island conditions and well being, and vice versa if the appropriate adaption measures are not undertaken (Mimura et al 2007). This can be exemplified via the case of some projections as outlined by the IPCC below.

Climate and Weather: In the Caribbean, there has been an increase in heavy rainfall events that coincides with a decrease in the maximum number of consecutive dry days thereby resulting in a decrease in the amount of water that can be physically harvested, reduction in river flow, and slow rate of recharge of freshwater lenses, inevitably prolonging drought impacts.

Sea Level Rise: In the Caribbean region more than half of their population lives within 1.5 kilometres of its shoreline. According to the IPCC Fourth Assessment Report (AR4) (2007), if sea level rises by 50 centimetres, up to 60% of the beaches in Grenada will disappear. A 10-millimeter annual SLR could see mangrove ecosystems disappear from Antigua and Barbuda by as early as 2030-2035. Currently, Antigua and Barbuda loses its mangrove ecosystems at a rate of 1.5%-2.0% with a SLR of 3–4 millimetres annually. Likewise, in Jamaica, a one-meter SLR is projected to result in a complete collapse of the Port mangrove wetland since their system has shown little capacity to migrate over the last 300 years.

Socio-economic Stresses: Fisheries also contribute significantly to the Gross Domestic Product (GDP) where according to the Millennium Ecosystem Assessment (MEA) (2005), fishing is a significant provider of jobs and income in the Caribbean, where approximately 200,000 people are directly employed, either full time or part time as fishers, and some 100,000 jobs in the processing, marketing, and other spin off industries. Thus if the level of carbon dioxide (CO_2) amplifies, increasing the acidity of the ocean further, then the people of Caribbean will be heavily affected since the marine ecosystem provides jobs not only for the fishermen but for other supporting industries.

Increased pressure on island resources: According to AR4 (2007), a SLR of 0.5 meters is projected to account for a drop in turtle nesting habitats by up to 35%. Recent estimates also show that 70% of the Caribbean beaches are eroding at rates of between 0.25 and 9 meters per year, where the cost of beach nourishment; that is the

cost of artificially replacing the sand, can run into millions of dollars. This adverse effect on the beaches tend to increase costs in maintenance and can be transferred to tourists which coincides with a reduction in tourist arrivals brought about by high costs and a drastic reduction in the attractiveness of the beaches as the Caribbean is known for its “Sea, Sand and Sun” (MEA 2005).

Thus, having identified who is vulnerable and the projections that are carded to occur in SIDS, focus will now be placed on the ways in which vulnerability is measured.

2. Literature Review

Vulnerability is a term that is most often conceptualized as being composed of components that include exposure to perturbations or external stresses, sensitivity to perturbation and the coping capacity (Adger, 2006). Vulnerability according to the IPCC is "*the degree to which a system is susceptible to and is unable to cope with adverse effects to Climate Change including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variations to which a system is exposed, its sensitivity and its adaptive capacity"* (McCarthy et al., 2001). Furthermore, vulnerability according to Guillaumont (2010) is the risk of economic growth being clearly and durably reduced by shocks and can be seen as a result of three components; the size and frequency of the exogenous shocks; exposure to shocks; and the capacity to react to shocks or resilience. Defining vulnerability therefore entails defining the circumstances under which the term is going to be used as it does not exist in isolation (Adger, 2006; Brooks et al, 2005; Gallopin, 2006; Moser, 2009; Vogel et al, 2007). It was to this end that that Janssen and Ostrom (2006) stated that to understand the concept first requires knowledge on the intellectual history and origin.

Vulnerability to climate change is defined by Adger (2006) as a characteristic of a system and function of exposure, sensitivity and adaptive capacity. IPCC (2001) in the TAR concluded that "*given their high vulnerability and low adaptive capacity to climate change, communities in SIDS have legitimate concerns about their future on the basis of the past observational record and climate model projections".* Moreover, it is described as the "Babylonian Confusion" (Janssen and Ostrom, 2006). As seen, the term has various definitions where Thywissen (2006) listed 35 definitions, and Brooks (2003) stated that they are a "*bewildering array of terms*" that expresses similar ideas; hence, related in non trivial ways.

Vulnerability in the context of climate change must therefore embrace neglected socio-economic dimensions which are crucial factors applied in the estimation of

vulnerability levels (Kelly and Adger 2000). The rationale for proposing a vulnerability framework using such an approach follows from one of the viewpoints espoused by Adger (2006) where vulnerability research is classified in the following order into; vulnerability as exposure (conditions or circumstances that render people or places prone to hazard), vulnerability as a social condition (measure of resilience to hazards), and the integration of exposures and societal resilience with special emphasis on geographical location or region.

Additionally, there are different types of vulnerability that varies among economics, social, environmental, trade, disaster, and climate change vulnerability (Briguglio, 2003). Climate change is perhaps the single biggest threat to all sectors as it is increasingly being accepted as the major issue facing the socio-ecological systems in the 21st century. Therefore, it is a global problem that needs to be addressed globally as the causes are characterized by diverse actors, multiple stressors and time scales. "*Who, where and when vulnerability and disaster strikes, is determined by the human and physical forces that shape the allocation of these assets in society"* (Pelling and Uitto, 2001). Thus, climate change would affect the social-ecological system (SES) that is, the system that is composed of the societal and ecological subsystems that operates in mutual interactions (Gallopin, 1991). Hence, climate change would have dispersed effects on the different sectors; water, biodiversity and ecosystem, human welfare, and food security- thereby rendering the SES vulnerable, which in turn can therefore have effects on the different types of vulnerabilities.

Quantifying vulnerability to climate change on various sectors of an economy is established via the use of indices. A summary table of vulnerability indices as espoused by various environmental economists for different geographic and vulnerability focus would be demonstrated below.

Table 1: Summary Table of Vulnerability Indices

Reference	Geographic Focus	Vulnerability Index/Focus	Scale	Categories Chosen	Type of Data	Method of Aggregation
Skondras et.al (2011)	Greece	Environmental Vulnerability Index	Country	Hazards, resistance and damage. All the indicators identified from the original calculation of the EVI were used, with the exception of pesticides, spills and sanitation	Secondary data	Mapped onto a vulnerability scale ranging from 1-7 (lowest vulnerability to highest vulnerability)
Guillaumont (2010)	SIDS and Least Developed Countries	Economic Vulnerability Index	Country	Shocks (external shocks, inability of export , natural shocks) and exposure (small population size, export concentration)	Secondary data	Equal weights is given to the sum of shock indices and exposure indices
Fussel (2010)	Developed and developing countries	Who is most vulnerable?		Biophysical sensitivity, socio-economic exposure. Socio-economic capacity, and social impacts	Secondary data	Asymmetry is investigated using Spearman's ranking correlation coefficient whereby all countries are equally weighted
Hahn et al (2009)	Mozambique, comparing two communities	Climate Change	Community	Socio-Demographic, Profile, Livelihood Strategies, Social Networks, Health, Food, Water, and Natural Disasters and Climate Variability	Primary, survey-based	Equal weighting, within categories as well as to overall index
St Bernard (2007)	The Caribbean (Belize, Grenada, St. Kitts and Nevis, St. Lucia and St. Vincent and the Grenadines)	Social vulnerability	Country	Education, Health, Security Social Order and Governance, Resources Allocation, and Communications Architecture	Primary, survey based and Secondary data sourced from the Human development report	Equal weighting, within categories as well as to overall index
Turvey (2007)	Developing countries with	Composite vulnerability	Country	Coastal index (G_1), peripherality index (G_2),	Primary data- survey	Equal weighting were applied and an average was

Reference	Geographic Focus	Vulnerability Index/Focus	Scale	Categories Chosen	Type of Data	Method of Aggregation
	emphasis on SIDS	index		urbanisation indicator (G_3), vulnerability to natural disasters (G_4)	based	taken to form the index CVI= (G_1 + G_2 + G_3 + G_4)/4
Simpson and Katirai (2006)		Disaster preparedness index	Community	Hazards, community assets, social capital, system quality, planning, social services, and population demographics	Secondary data	DR_i = Preparedness Index / Vulnerability
UNDP (2004)	International comparison of countries	Disaster risk index	Country	Risk of death in disaster measure through- physical exposure, vulnerability, and risk	Secondary data	Kcyclones(PhExp0.63 cyclones • Pal0.66 • HDI-2.03 • e-15.86) + Kfloods (PhExpo-78 floods • GDP 0.45 cap •D-0.15 •e-5.22) + Kearthquakes (PhExp1.26 earthquakes • U12.27 g • e-16.27) + Kdroughts (PhExp3_501.26 • WAT-7.58 TOT • e 14.4)
Vincent (2004)	Africa	Social Vulnerability Index	Country	Economic well being and stability, demographic structure, institutional stability and strength of public infrastructure, global interconnectivity, and natural resource dependence	Secondary data sourced from World Bank, United nations, and others	Unequal weighting of 0.2 to economic wellbeing and stability, 0.2 to demographic structure, 0.4 to institutional and strength public infrastructure, 0.1 to global interconnectivity and 0.1 to natural resource dependence
Pratt et al (2004) (SOPAC); also the EVI Final Report and the EVI Calculator	SIDS with emphasis on South Pacific	Environmental vulnerability index	Country	Hazards, resistance and damage	Secondary data	Mapped onto a vulnerability scale ranging from 1-7 (lowest vulnerability to highest vulnerability). Overall average of all indicators is calculated to form the index via EVI= (REI + IRI + EDI)/3
Briguglio and Galea (2003)	SIDS	Economic vulnerability	Country	Economic openness, export concentration, peripherality,	Secondary data	Standardisation is used (X_i - Min X)/ (Max X – Min X)

Reference	Geographic Focus	Vulnerability Index/Focus	Scale	Categories Chosen	Type of Data	Method of Aggregation
		index adjusted for resilience		and dependence on strategic imports		Where X_i is an observed value in array of observed values for a given value, Max X is the highest and Min X is the lowest value in the same array. Equal weighting were assigned
Gowrie (2003)	Tobago	Environmental vulnerability index	Country	Environmental risk, intrinsic resilience, and environmental degradation	Secondary data	Mapped onto a vulnerability scale ranging from 1-7 (lowest vulnerability to highest vulnerability). Overall average of all indicators is calculated to form the index
Munich Re Group (2002) *Adopted from Simpson and Katirai (2006)	City	Natural hazards index	City	Hazards, vulnerability, and exposed values	Secondary data	Total Risk= hazards* vulnerability * exposed values. The sub-components were standardised, and total hazards was calculated by adding values for the average annual loss from hazards and weighting it at 80%. This value was then added to the highest value for the probable maximum loss and weighting that at 20%
Tapsell et al (2002) *Adopted from Simpson and Katirai (2006)	Small geographic areas	Social flood vulnerability index	County	Unemployment, overcrowding. None-car ownership, none-home ownership, long term sick, single parents, and the elderly	Secondary data	0.25 (financial deprivation + health problems + single parents + the elderly). Results were categorise into a limited number of bands where category 1,3,5 represented low, average and high vulnerability

Reference	Geographic Focus	Vulnerability Index/Focus	Scale	Categories Chosen	Type of Data	Method of Aggregation
						respectively
Adrianto and Matsuda (2002)	Small island region	Economic vulnerability index of natural disasters	Amami islands of Japan	Sea level rise and natural disaster impacts with a time span 1990-2000	Secondary data	Standardisation is used. DI_{mjt} (per capita – based value) = $[X_{mjt} / P_{jt}]$ 100; m = 1,2 DI = index of environmental disaster, m for small island j at year t; P_{jt} = total population j for year t; X_{mjt} = total impact of environmental disaster m for island j at year t
Brewster (2002)	SIDS with emphasis on Barbados	Littoral vulnerability assessment	Country	Environmental consideration, shoreline classification, coastal classification	Secondary data	Decision Support Scheme developed by Simeoni et al (1997) was adopted as part of the quantification process (morphology and sedimentology of coastline; presence of beach associated landforms; human intervention; morphology and sedimentation of sea floor)
Moss et al (2001)	Selection of developed and developing nations	Vulnerability resilience indicator prototype model	Country	Food sensitivity, ecosystem sensitivity, settlement sensitivity, economic coping capacity, human health sensitivity, human and civic resources, water resources sensitivity, and environmental coping capacity	Secondary data sourced from national data and those for the future were forecasted	Hierarchical aggregation of geometric means determined the values of sectoral indicators.
Pelling and Uttio (2001)	SIDS	Natural disaster vulnerability	Country	Human development index, debt service ratio, public expenditure on health, adult literacy, GDP per capita	Secondary data	Assigns importance to instability

Reference	Geographic Focus	Vulnerability Index/Focus	Scale	Categories Chosen	Type of Data	Method of Aggregation
Davidson and Lambert (2000) *Adopted from Simpson and Katirai (2006)	United States	Hurricane disaster risk	Country	Hazards, exposure, vulnerability, emergency response and recovery	Secondary data	HDRI= (H^{WH}) (E^{WE}) (V^{WV}) [0.1 (1-a) R+a] Mathematical index was developed to combine the indicators into two composite index values
Crowards (2000)	Caribbean	Comparative vulnerability to natural disasters	Country	Number of historical episodes over last 100 years, changes in macroeconomic variables, volatility of agricultural production, damage cost, number of persons affected, and number of deaths	Secondary data	Normalisation or standardisation is used where equal weights are applied
Crowards (1999) *Adopted from Vincent (2007)	Caribbean	Economic vulnerability index	Country	Peripheral, export concentration, convergence of export destination, dependence on import energy, reliance on external finance	Secondary data	Averaging across the selected series for each country with the variables grouped into 4 main parameters varying the transform component. Borda rule; use rank of component variables to assign aggregate rank. Equal weighting, condense decile normalisation. Principle component analysis
Easter (1999)	SIDS in the commonwealth	Commonwealth vulnerability index	Commonwealth countries	Impact component-Lack of diversification, export dependence, impact of natural disaster and resilience (2^{nd} component)	Secondary data	Impact indicators were combined using weights objectively determined through econometric procedure. Impact and resilience component using statistically derived weights
Davidson (1997)	Cities worldwide	Earthquake disaster risk index	Country	Hazards, exposure, vulnerability, external context, emergency response and	Secondary data	EDRI = $w_H H + w_E E + w_V V + w_C C + w_R R$ A linear combination was

Reference	Geographic Focus	Vulnerability Index/Focus	Scale	Categories Chosen	Type of Data	Method of Aggregation
				recovery capability		taken with scaling techniques of mean minus two standard deviation
Pelling (1997)	Georgetown, Guyana	What determines vulnerability to floods?	Community	Access to secure housing, adequate health care/education, economic resources, social resources	Primary data- survey based, interviews and observation Secondary data	Frequencies were taken and results were analysed from this
United Nations Conference on Trade and Development (1997) *Adopted from UNEP (2003)	SIDS	Vulnerability in the context of globalisation	Country	External shocks, economic performance, economic structure, intrinsic factors	Secondary data	Used economic specialisation as a benchmark-which is a sphere of analysis
Pantin (1997) *Adopted from UNEP (2003)	Developing countries with emphasis on SIDS	Ecological Vulnerability Index	Country	Economic indicators were used-namely imports, consumer price indices and external debt	Secondary data	The countries were grouped into three categories-SIDS, other islands, and non-islands
Commonwealth Secretariat-Chandler (1996) *Adopted from UNEP (2003)	Small states	Composite Vulnerability Index	Country	Ratio of export of goods and services, export concentration, ratio of long term capital flows to gross domestic investment, and ratio of imports	Secondary data	Standardisation and equal weights were used
Briguglio (1995)	SIDS	Economic vulnerability index	Country	Exposure to foreign economic condition, remoteness and insularity, and disaster proneness	Secondary data	Experimented with equal and non-equal weighting with the sub-indices

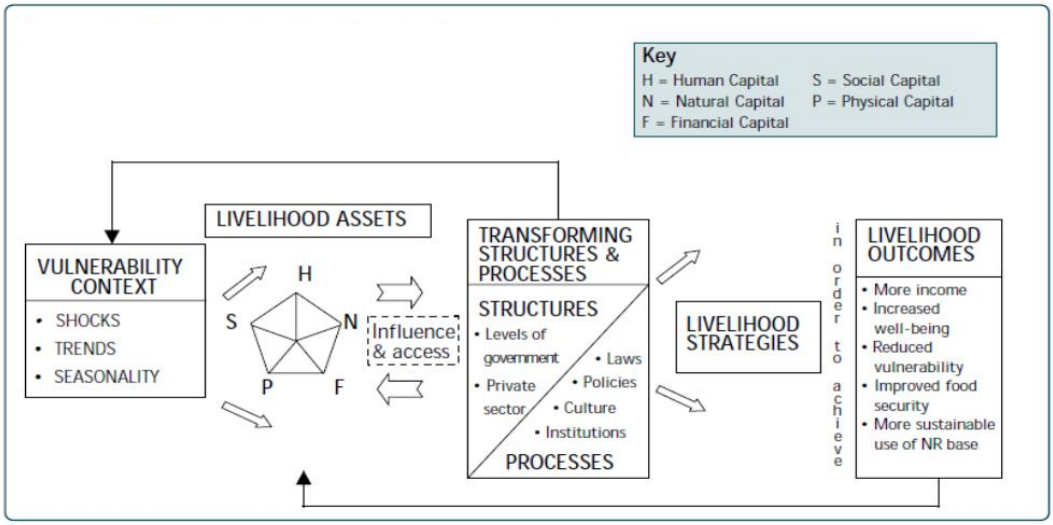
3. Methodology

An increasingly significant body of literature criticises many of the attempts that have been made at developing vulnerability indicators (Hinkel, 2010). Arguments put forward are that the purposes in which the vulnerability indicators shall be used are not often given, as policies and academic documents remain silent on such matter (Hinkel, 2010). Deductive argument, inductive, and normative argument are three arguments for developing vulnerability indicators. The deductive argument is based on existing theory; using data for building statistical models that observe harm through some indicating variable describes the inductive argument while the use of value judgment in the selection and aggregation of indicating variables speaks of the normative approach (Hinkel, 2010).

Building an index to focus on the SES requires capturing the impact of climate change induced changes of sea level rise on the sub-systems. This therefore means identifying the factors that influence vulnerability, namely; coping capacity, sensitivity and signifying vulnerability. Having made the choice based on the arguments identified above, indicators that are simple, comparable, cost effective, and within the constraints of data availability ought to be selected. The components utilised in this study follow somewhat similar approach to that of the Sustainable Livelihood Framework

The SLA framework is a tool that was developed by the Sustainable Rural Livelihood in an attempt to improve the understanding of livelihoods, with particular focus on the poor (Department for International Development (DFID), 1999). More specifically, it examines the main factors that influence livelihoods and relationships that exist as shown in figure 1.

Figure 1: Sustainable Livelihood Framework

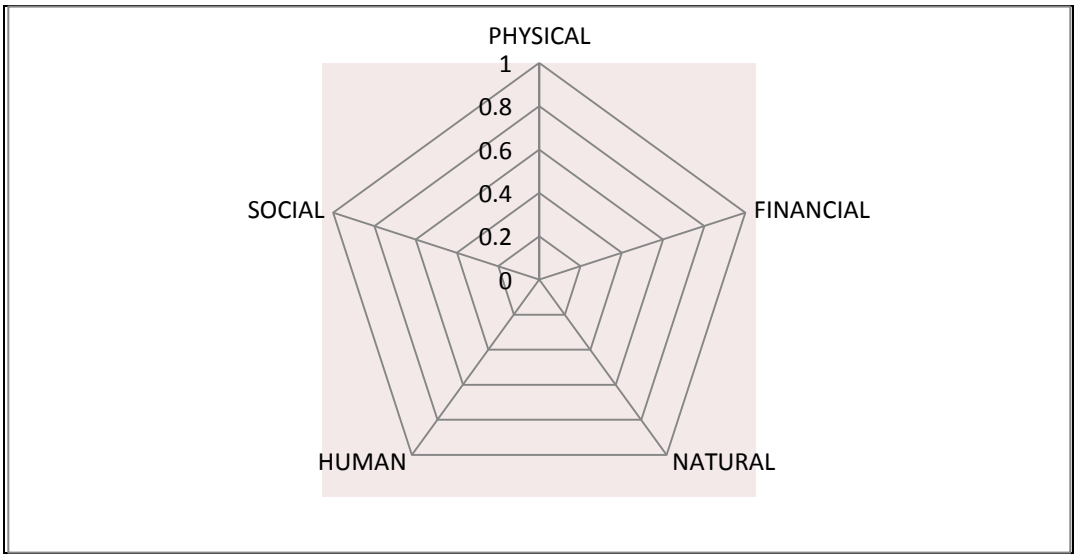


Source: DFID (1999)

Thus, the framework focuses on the vulnerability context in which a series of changes in the structures and processes are needed to achieve the livelihood outcomes, and these livelihoods in turn are influence by key forces (human, natural, financial, physical, and social capital) which in themselves are constantly changing. The framework therefore provides a checklist of important issues and sketches out the linkages, draws attention to core influences and processes, and emphasises on the multiple interaction between the key factors that shape livelihoods (DFID, 1999).

Consequently, focusing on the last objective of the framework, it is within this context the capital pillars will be examined but from the perspective of climate change as demonstrated in the asset pentagon in figure 2.

Figure 2: The Asset Pentagon showing the Capital Pillars



Environmental Capital

This asset refers to the natural resources of a country which is made up of renewable and non-renewable resources. Natural or environmental capital therefore varies from tangible (trees and land) and intangible services (ecosystem services and biodiversity) which are used by members of society. The environment is vital for sustainable development since there is a limit on the carrying capacity, in which the economy is a sub-system that operates within a close environmental system (Daly, 1996). More importantly, it is the link to human welfare.

Thus, as the economy grows, it will inevitably result in anti-economic; that is, a position where throughput growth, which relies on low entropy that is in scarce supply, may cause the environmental cost to increase faster than the benefits, thereby making society poorer and not richer (Daly, 1996). Hence, throughput growth starts with depletion and ends with pollution, which is the situation that prevails in the 21st century.

SOPAC developed an EVI to enhance the level of understanding of the issues facing the environment and resilience as a basis for ensuring sustainable development. It focused on the effects of the physical and biological aspects of ecosystems, diversity, population and communities of organisms, and species by inspecting the functions of vulnerability.

Similarly, in the calculation of the LVI (Hahn et al., 2009); they incorporated the component of natural disaster and climate variability which took into account the level of exposure while St Bernard (2007) in the calculation of the SVI considered resource allocation as one of the major component.

Hence, viewing the impact on the biophysical subsystem is vital in that households depend on the natural capital for the ecosystem services it provides. Thus, once impacted, a ripple effect will occur in that the welfare and benefits societies enjoy will be loss, which may further exacerbate the rate of poverty, thereby hindering the achievement of the Millennium Development Goals (MDGs). Therefore, as environment degradation increases due to natural or anthropogenic causes, the level of vulnerability increases simultaneously. Consequently, a positive correlation exists.

Questions or issues that can be asked for analysing this form of capital include the following:

1. How often do members of this household use ecosystem services?
2. How important are ecosystem services from nature to you?
3. Which groups have access to which type of natural resources? (DFID, 1999)
4. Has the amount of your harvest increased or decreased in the last three years? (questionnaire)
5. Has the amount of fish harvest increased in the last three years? (questionnaire)
6. Is there much spatial variability in the quality of the resources? (DFID, 1999)

7. How is resources affected by externalities? (DFID, 1999)
8. How many times have your area/community/country been affected by flood/cyclone/drought within the last three years?

Human Capital

Human capital exists in the knowledge, skills and personality attributed that an individual entails in the ability to perform labour so as to yield economic value or factor reward, which is acquired through education and experience. In analyzing human capital, indicators focusing on human health and education can be used, where both forms are crucial.

Education on risk caused by natural or human activities is important since it can result in an increase in the awareness level and so appropriate adaptive measures can be adopted. Climate change is a growing phenomenon and is considered to be the biggest threat in the 21st century. Hence, with increase education, households and communities can adopt the appropriate mitigation and adaptation measures which will prove to be fruitful as oppose to not being educated on the subject at hand.

Health, which is related to this form of capital can deteriorate by the impacts of climate change due to water-borne and vector borne diseases. For this reason education and heath, which was considered extensively in Hahn et al (2009) and the SLA and somewhat by St Bernard (2007) is an important component that can have negative impacts on the societal subsystem. The correlation with this asset and vulnerability will therefore vary with the question being asked, and as such can be positively or negatively correlated.

Questions or issues that can be asked for analysing this form of capital include the following:

1. How much do you know about climate change? (questionnaire)

2. Are you/your community aware of the causes on climate change? (questionnaire)
3. From where/ what sources is information access on climate change? (questionnaire)
4. Do people feel that they are particularly lacking in certain types of information? (DFID, 1999)
5. Are technologies in use from 'external' or 'internal' sources? (DFID, 1999)
6. What is the life expectancy at birth for the community/country? (questionnaire)
7. How long does it take you to get to a health facility?
8. Is vector-borne disease (malaria, dengue) a serious outbreak in your community?

Social Capital

There are debates escalating on what exactly does the term 'social capital' implies. This assets was used in the formation of the SLA, but was used in the circumstance to mean the social resources upon which society utilised to pursue their livelihood objectives (DFID, 1999). More specifically it is "*the social resources (networks, social claims, social relations, affiliations, associations) upon which people draw when pursuing different livelihood strategies requiring coordinated actions"* (Scoones, 2005). Hahn et al (2009) also included social networks as a major component, where similar to the SLA, focused was placed on the ratio of monies lend and received. However, within the context of this study, social capital is viewed in the manner with respect to security, social order and governance, which was the approach adopted by St Bernard (2007). It therefore relates to the social relationships and aspects of life that an individual or society can partake in without having to speculate about the security issues at hand.

Questions or issues that can be asked for analysing this form of capital include the following:

1. What is the crime rate like in your community/country?
2. Are the community/households victims of crime? (CSO)
3. Were you ever a victim of crime? (CSO)
4. Are such crimes reported? If not, why? (CSO)
5. Do you feel safe in social settings, given the rate of crime?
6. Do you feel safe at home?
7. Has crime affected the tourism rate in your country/community?
8. Do you believe sufficient measures are in place to combat crime?

Physical Capital

Physical capital is made up of the basic infrastructure and producer goods that are needed to support society, which consists of changes in the physical environment that assists individuals in meeting their basic needs (DFID, 1999). According to the SLA, infrastructure is a public good that is used without direct payment, with the exception being shelter. This component was included as one of the assets since assessments on participatory poverty found that a lack of particular types of infrastructure is indicated to be a core dimension of poverty (Scoones, 2005). Without the basic necessities of life, human health deteriorates with individuals becoming incompetent to work to maintain their standard of living. Thus, inspecting this component will give an indication as to how well the basic infrastructure of society is to combat the impacts associated with climate change. Evidently, those in society with poorer infrastructure will have a higher level of vulnerability rather than those with physically powerful infrastructure. Hence, it is from this aspect this factor was included.

Questions or issues that can be asked for analysing this form of capital include the following:

1. Have your home ever been affected by a natural disaster?
2. Do you think your home is strong enough to weather a storm?

3. What is the construction material of the outer wall? (questionnaire)
4. What is the material used for your roofing? (questionnaire)
5. What is the frequency of water supply? (CSO)
6. What is the lighting system used in your household? (CSO)
7. Is the infrastructure of you home appropriate for long term hazards?

Financial Capital

This form of capital inspects the financial resources that are used by society to achieve their livelihood strategy and goals. It therefore incorporates some form of human capital so as to earn an income which can contribute to consumption or saving. Livelihood strategies and objectives was the aim in which the SLA was developed (DFID, 1999). Thus, all components used in such index were linked to the aim. The LVI also incorporated livelihood as one of the major components, focusing on the status of the community members (Hahn et al., 2009). It was from this index the motive arose to include such asset. In tandem to this, financial assets are important in the daily lives of individual since it can be transformed into the other types of capital mention previously. To exemplify, once financial assets are available, society can enhance their education, health, put appropriate security systems in place which includes uplifting the status of homes and housing infrastructure. Thus, by extension, it contributes to the conservation of the environment since individuals will no longer be heavily reliant on the natural ecosystem for their basic necessities of life. However, such asset tends to be the least available to the poor who are highly reliant on the environment and hence the reason as to why the other components are vital to them.

Furthermore, even though this form of capital can influence the other forms, there are assets or desirable outcomes that may not be achieve through the medium of money, such as in the case of well being and knowledge of human rights (DFID, 1999).

Questions or issues that can be asked for analysing this form of capital include the following:

1. Which types of financial services organization exist (both informal and formal)? (DFID, 1999)
2. By who are you employed? (questionnaire)
3. What is your gross income per month from this job? (questionnaire)
4. How many households have family living away who remit money? (DFID, 1999)
5. How reliable are remittances? Do they vary by season? How much money is involved? (DFID, 1999)
6. Do members of your family work outside of the community?
7. Do the community/households rely on agriculture or farming for main livelihood?

Data Needs

The key form of data collection occurs in one of two ways-either via primary or secondary data or a combination of both. Regardless of the method selected, the principles of ethics are complied with. That is, the principle of autonomy-which refers to the obligation on the part of the researcher to respect each participant as a person capable of making an informed decision; principle of non-maleficence and beneficence which states that one should not harm another person intentionally; principle of justice- all should be treated equally and demands an equitable selection of participants; and finally, the principle of fidelity which involves being faithful, honest, loyal and keeping promises (Morris, 2008).

Secondary data refers to information and statistics that are already available to the public at large. It is the most widely and commonly used form of data collection which can be divided into two categories, printed and online sources. Reports from Non-Governmental Organisations, agencies, statistics publish by companies,

and press releases are just a few of the sources in which data can be collected. It is therefore data and information which have been collected by others and archived by some (Steward et al, 1993). However, even though such method is relatively inexpensive and easily accessible, there may be a lack of consistency in which the data were originally intended for. Thus, the drawbacks associated with secondary data may motivate a researcher to pursue primary data collection.

This form of data collection is data that has not yet been publish and therefore requires some means of gathering data for the first time. Primary data or field research therefore overcome the issues associated with secondary data. Interviews, survey, observations and experiments are all means by which primary data can be collected. With this form of data, participatory methods can also be adopted so as to obtain accurate data and feedback from the unit of analysis. Most studies are recognising the benefits of such method and are therefore adopting this technique. DFID (1999) utilised this method in the development of the SLA, Ford et al (2010), in a study conducted in the Canadian Inuit, and EACC study initiated by the World Bank (2008).

Regardless of the method chosen, the form of data collection will depend on the availability of robust and transparent comparable data. However mention ought to be made that problems may arise even if indicators are selected on the basis of data availability, as was encountered by SOPAC in the development of the EVI (Kaly et al., 1999) where the recommendation for ensuring that valid EVI scoring were not obtained.

Methods of Aggregation

Establishing the determinants and indicators to be used in the proposed framework, further methodological choices need to be made with respect to the standardisation of indicators and their means of combination into a composite index, thereby representing the Vulnerability Index (VI). With the progression of

time, sophisticated means of methodological consideration have been used for the transformation of sub-components or sub-indices which will be assessed to establish which method is justifiable in the context of a deductive and normative approach as adopted in this study.

Standardization of Indicators

It is necessary to ensure that indicators are standardised so as to meet the criterion of comparability. There are various techniques in which this occurs, as can be seen in the summary table. However, if viewed carefully, the methods for normalising/standardising the indicators are generally the same with minor adjustments made to the value being transformed. Apart from this, the equation use is similar to the one utilised in the Human Development Index to calculate the Life Expectancy Index (UNDP, 2007). Standardisation therefore seeks to fit the variables within a scoring range, where the most common is a scaling between 0 and 1 representing least and most vulnerable respectively. This method was adopted by St Bernard (2007), among others.

This study will however adopt similar format of a minimum of 0 and a maximum of 1 representing least and most vulnerable respectively.

Creating the Sub-Indices

Once the indicators are standardised, an appropriate means of creating sub-indices need to be chosen. A variety of aggregation choices have been utilised in existing indices[1] which mostly differ between selecting equal weighting or non-equal weighting. This therefore reflects the perceived importance of the various indicators used in the combining the index. Equal weighting were used in the calculation of the SVI (St Bernard, 2007). Briguglio (1995), however, experimented with two sets of weights in creating his index, the first being equally weighted index and the second assigning non-equally weighting to the sub-indices

[1] See Summary Table

to reflect the importance of the various indicators in promoting the vulnerability index. Thus, the inclusion of each indicator in the computation of an index therefore provides a strong basis that the indicators are important and there are no reasons to suggest that their roles are not equally important. Consequently, weighting is a subjective process, and those indicators that are considered to be of utmost importance are assigned a higher "weight" to indicate the importance of the specific indicator (Kaly et al. 1999).

Thus, the application of weighting is appropriate and in this study, the status quo will be maintained where the indicators will be aggregated on an equal basis. This is portrayed in the asset pentagon where one capital cannot be compensated or substituted for another and are equally important as seen by the proportions of the triangles; hence the reason for applying equal weighting to the components. Moreover, because the Vulnerability Index is developed as an assessment tool accessible to a diverse range of users, the simple approach of equal weighting is applied to all major components which could then be altered by future users as needed.

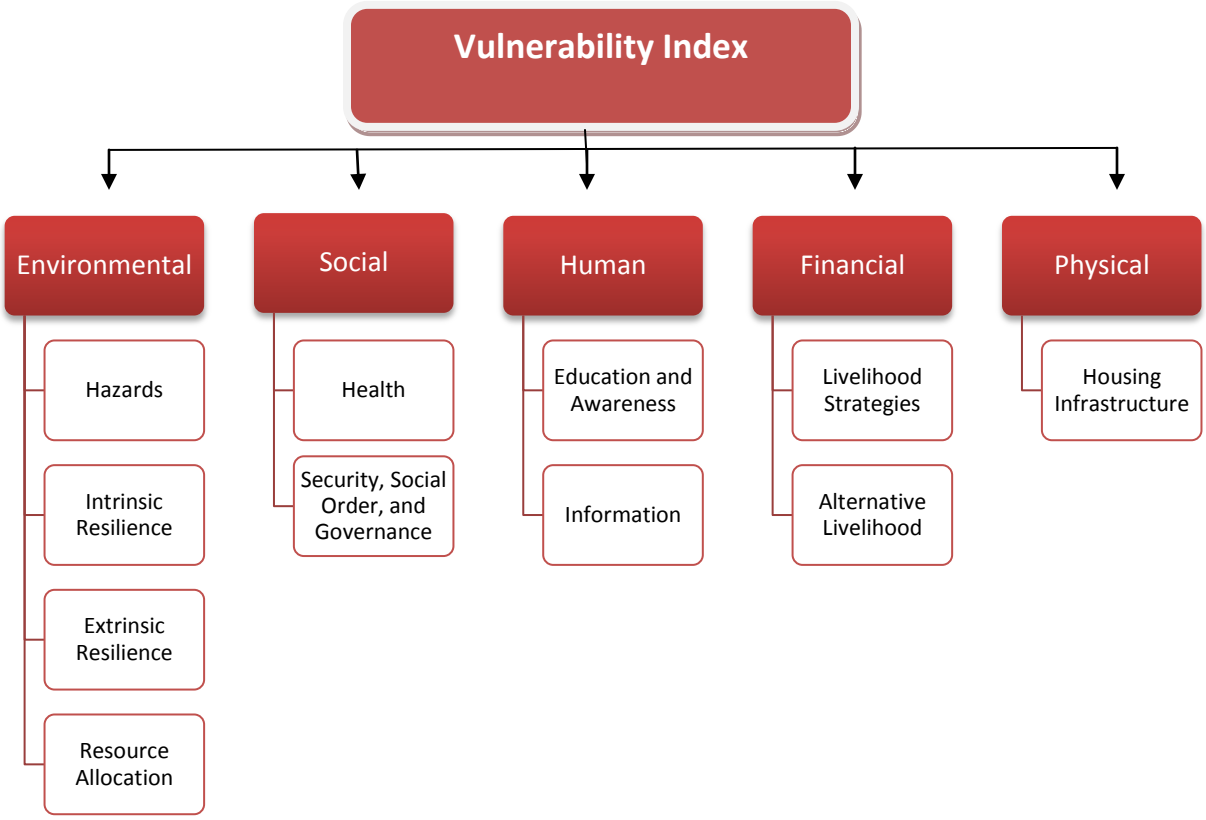
Combining the sub-indices to form the Vulnerability Index

Once the sub-indicators are derived, similar methodological concerns arises for the need to aggregate the various components into a composite index where various indices have utilised different methods.

In this study, the method that was utilised by Hahn et al (2009) will be employed with trivial alterations being made. The Vulnerability Index comprises five pillars which are made up of eleven major components, namely: *Financial Capital*- Livelihood Strategies, and Alternative Livelihoods; *Physical Capital*- Housing Infrastructure; *Environmental Capital*- Hazards, Intrinsic Resilience, Extrinsic Resilience, and Resource Allocation; *Human Capital*- Education and Awareness, and Information; and *Social Capital*- Health, and Security, Social Order and

Governance. However, each of these consists of several sub-components as outlined below. The major components and sub-components were developed based on a review of the literature, in addition to collecting the needed data through household surveys from the area of focus.

Figure 3: Showing the Development of the Vulnerability Index



In the research process of data processing, a number of steps needed to be completed prior to the standardisation stage. Firstly, the options given to the respondent were scaled on a range of 1 to 10, representing least and most vulnerable respectively. This was done to ensure that the value obtained for the averages corresponded to the weighting where higher values implied higher vulnerability while lower values indicated lower vulnerability. The frequency was

also calculated for each response given, as either of the two was employed in the transformation of the values in the standardisation process.

Subsequently, some of the questions which were initially considered to be included as part of the development of the Vulnerability Index needed to be excluded as it were difficult to determine which of the responses where most or least vulnerable. To exemplify, under the financial pillar, the question 'By who are you employed' was originally considered, with the various options being, private sector, private enterprise, state enterprise, self employed, retiree, public assistance or other. However, in processing the data, it was difficult to determine which of the choices would be classified as most or least vulnerable, hence the reason for its omission.

Having done this, the sub-components were standardised as each were measured on a different scale. The equation used for the transformation was:

$$\text{Index} = \frac{v - v_{min}}{v_{max} - v_{min}}$$

Where v is the original sub-component for the area of focus, and v_{min} and v_{max} are the minimum and maximum values respectively for each of the sub-component under question. To exemplify, for the question 'Proportion of household members that do not act as tour guides' (under indicator Livelihood Strategies- Financial capital pillar), the sub-component extreme range were 0 and 100. Majority of the sub-components were transformed using such minimum and maximum values.

After this, the standardised sub-components were averaged so as to arrive at the value for the major component using the following equation:

$M_c = \sum^{n}_{i=1} \text{index}_{sc\ i} / n$

Where M_c is one of the eleven major components; $index_{sc\ i}$ is the sub-components index by i which make up the each major component; and n is the number of sub-components in each of the major component.

Once the values for each of the eleven major components were calculated, an average was then found to derive at the Vulnerability Index using:

$$VI = \sum^{11}_{i=1} w_{Mi} M_c / \sum^{11}_{i=1} w_{Mi}$$

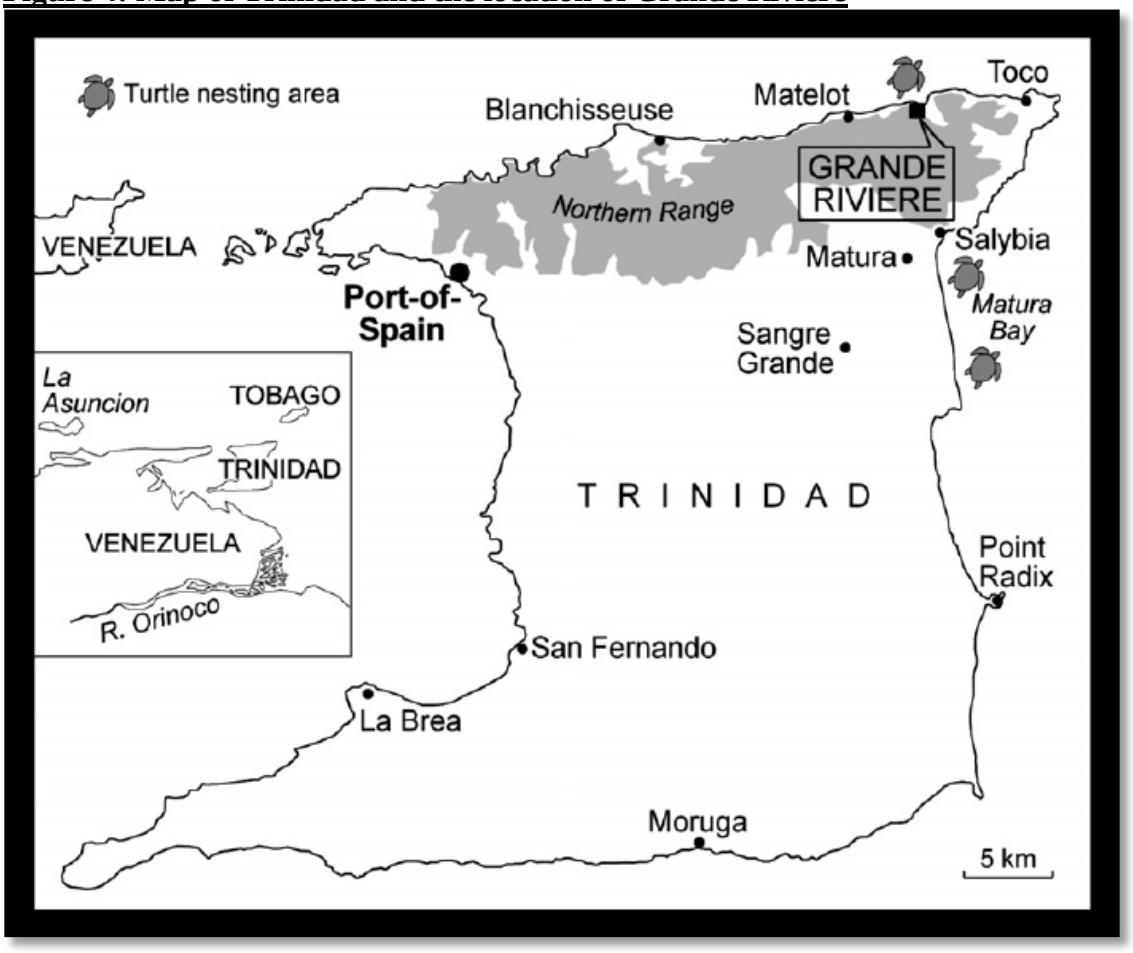
where VI is the Vulnerability Index for the area of focus, summing the weighted average of the eleven major components. The weights of each of the major component, w_{Mi}, are derived from the used of equal weighting since one pillar cannot be substituted for another as was mention previously.

The Vulnerability Index is scaled from 0 to 1, representing least and most vulnerable respectively, since the methodological consideration of standardisation scales the component to take a value between such ranges. That is, if the observed value is the minimum in the range, the value would be zero. Likewise, if the observed value is the maximum in the range, the value would be one.

4. Case Study

The area of focus for this study is Grande Riviere, a community that is located alongside the northeast coast of Trinidad, bordered by the Caribbean Sea. The community is one the of the 42 coastal communities situated in the Sangre Grande Regional Corporation, being 60 kilometres from the County of St David and 100 kilometres from Port of Spain (Harrison, 2007), the capital of Trinidad and Tobago. It is accessible via the use of a single paved road which runs from Toco in the west, and separated from the rest of the island by the Northern Range hills. A graphical depiction (figure 4) of the area of focus therefore shows that the village is located between Toco and Matelot.

Figure 4: Map of Trinidad and the location of Grande Riviere



Source: Harrison (2007)

The population of Grande Riviere comprised approximately of two hundred and ninety individuals (298) who belong to one hundred and forty seven households (147). This information is sourced from the 2000 Population and Housing Census, as data for the most recent census is yet to be revealed to the public at large. Similarly, from the 298 individuals living in the village, 54% were made up of males while 46% were females.

Furthermore, ethnicity background of the community comprised mainly of African descent while the second major ethnicity is made up of mixed descents, ranging from 75.25% and 23.76% respectively. The remaining 0.99% however, did not respond to the question when filling out the household questionnaires that was used in this study.

Majority of the individuals living in this relatively small area are not owners of the land in which their houses were built, where more than half the respondents answered no to such question when asked. Also, a widely held portion of the community work within the area where they are employed by the private sector.

The historical aspect of Grande Riviere reveals that the mountainous terrain of the area resulted in little or no slavery in the community which was considered unsuitable for sugar cultivation. Venezuelans peons were the first settlers in the village, who first went to Northeast Trinidad in the 1860s to escape the civil unrest (Harrison, 2007) and were later joined by immigrants from Tobago. During this period, the main source of income for more than one third of the village men were agriculture, with cocoa being the most important cash crop and bananas placing second. Subsistence crops from household garden and small plots made up of two to three acres, provided most of the food for the community, along with fishes from the local fishermen and "*wild meat from the forest and from the occasional Dermochelys coriacea (leatherback turtle), which had come to nest on the beach*" (Harrison, 2007). In the 1970s such turtles were invariably killed after facing considerable abuse for their meat which was distributed throughout the village.

However, with the passage of the new millennium the attitude and behaviour of the community members altered, with the greatest impact on the village life being the introduction of ecotourism. The consumption of turtle meat at Grande Riviere became rare since the ecotourism operation began in 1992-1993 and is now one of the only two villages in Trinidad with successful community-based turtle conservation (Waylen et al., (2009)). The leatherback turtle, Dermochelys coriacea, is categorised as critically endangered in the IUCN Red List (IUCN, 2008), where it has nested at most beaches in the coastal communities, reaching its highest densities in Trinidad on this relatively small beach name Grande Riviere (James and Fourniller, 1993). Thus, local conservation measures had recently been encouraged by the Wildlife section of the Department of Forestry (Livingstone, 2003), and in 1992 the Grande Riviere Environmental Awareness Trust (GREAT), and Grande Riviere Tour Guides Association (GRTGA) was establish with the aim of protecting and conserving the turtles. These measures and initiatives are essential for sustainable eco-tourism because of the decline in the world's population of leatherback turtles which is mostly accounted for by human pouching. In addition to this, measures by the fishermen are also needed since high mortalities arise with fishermen catch (Martinez, 2000).

Eco-Tourist development is the greatest in the village of Grande Riviere than in any other area. The number of visitors to Grande Riviere rose significantly in the years 2003-2004, with figures representing 3207 and 3710 respectively (Forestry Division). Thus, the coastal community of Grande Riviere is one of the most visited turtle beaches in the world, with as many as 15,000 people coming each year to view the laying and hatching of the endangered species. To accommodate for this, two small hotels situated next to the beach, Mt. Plaisir and Le Grande Almandier hotel were established in 1993 and 2000 respectively. In 2004, they were joined by the French-owned Acajou, which increased the number of permanent hotel rooms available at the tourist site to 38. Moreover, villagers soon began to render their rooms to tourist often on the recommendation by the hotels

and guesthouses during the peak season. "*Tourism has taken over from cocoa as the major source of employment and no village informant considered work in the hospitality sector demeaning"* (Harrison, 2007).

During the turtle laying and hatching season, between the hours of 18.00 and 06.00, access to the beach is prohibited without the purchase of a permit and visitors, who are international and national citizens, must be accompanied by an authorised guide or forest official (Waylen et al., 2009). During such seasons, visitors are asked to dim their lights due to the turtle's preference to darker beaches (Raymon, 1984; Witherington 1992), as brighter lighting system disturbs the direction of the turtles thereby resulting in missing sea turtles in the long run.

However, there is uncertainty around the reasoning as to why turtles began nesting at Grande Riviere in such numbers. The turtles visited the shores very infrequently in the early 70s but the frequency quickly changed in the 90s where reports indicated that approximately 300 leatherback turtles nested on the shores in 1991 (Maharaj and Erhardt, 2003). These numbers rose significantly throughout the years with villagers stating the reason to be due to the abundance of jelly fish- which is their main source of food; or simply due to beaches elsewhere becoming too developed. Furthermore, such turtles generally nest on sandy beaches, with the juveniles remaining in tropical waters warmer than 26^0C but no hotter than 33^0C; hence, the ideal temperature for nesting prevails in the Caribbean island of Trinidad. Similarly, a commonly held hypothesis is that turtles return to breed at the beach in which they were born providing that the environmental conditions remain stable; hence a possible reasoning for such numbers.

Thus, tourism and conservation have united to the mutual benefit of the turtles and villagers; this is not to say however that pouching of turtles has been totally eliminated in the community of focus as recent evidence showed otherwise. Nevertheless, "*once readily consumed as valued source of fresh meat, the leatherback turtle is now protected and a major attraction"*... Grande Riviere is

therefore "*linked to the outside world in ways which, a few decades ago, would have seemed unthinkable"* (Harrison, 2007).

5. Data Collection

Having identified the area of focus, data were then gathered for the pillars, and indicators while appropriate proxies were chosen based on the guidance of theoretical insights from past literature. The method of data collection used in this study is that of a combination of primary and secondary data.

Secondary data is data that were published in a different time period and for a different purpose. Such source of data came from a baseline study for the area of focus which was conducted previously under the Climate Change Project. The purpose of the baseline study was to identify sources of secondary data for Grande Riviere- namely literature review of books, journals, statistical and organisation reports; and to analyse and summarise the findings from it, which included data on the socio-economic profile, environmental, and ecotourism profile. Information from the Central Statistical Office (CSO) was also a major source of data for the baseline study. Thus, this formed the basis of the secondary data component utilised in this study.

Conversely, primary data or field research is data that were not previously collected. In this study, a survey was conducted where a community questionnaire was distributed among 101 households. The questionnaire comprised 5 sections; namely information on general, demographic, ecosystem services, eco-tourism and leatherback turtles, and awareness/knowledge of climate change. Within these sections, there were sub-categories mainly for the section that dealt with ecosystem services. Ecosystem services are the benefits that individuals obtain from the ecosystem which includes provisioning services-food, water, timber; regulating services-floods, disease, wastes and water quality; cultural services-recreational, aesthetics and spiritual benefits; supporting services-soil formation, photosynthesis and nutrient cycling (MEA, 2005). Thus, the sub-categories pertaining to this section asked questions relating solely to value and benefits derived from the ecosystem. With this form of data collection, measures were

undertaken to ensure that the ethical issues of voluntary participation, informed consent, deception, and confidentially were endorsed.

Data from both sources were therefore used to populate the major components of the proposed methodological framework which were shown in the pentagon assets-namely, environmental capital, social capital, human capital, physical capital and financial capital. Under each major components however, indicators were used to assist in clarifying what type of data were needed for the specific categories as was shown in figure 3.

6. Empirical Results

The results of the Vulnerability Index for Grande Riviere are presented in table 2, where it shows a value of 0.3371 being obtained.

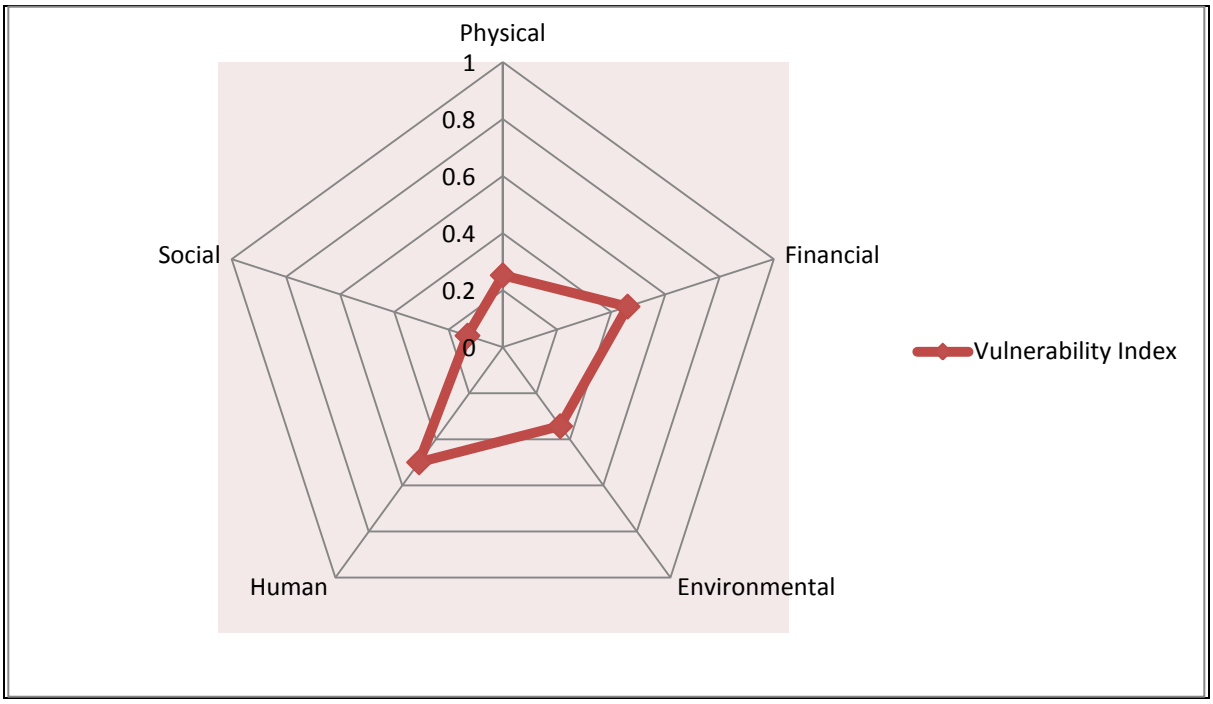
From this, the five pillars utilised in this study contributed differently to the overall index, with the human capital pillar attaining the highest vulnerability of 0.4997 amongst the remaining pillars whilst the social pillar contributed the least (0.1302) and as such are considered as the most and least vulnerable respectively. The ordering the vulnerability in the pillars are noted in the table, ranking from the most to least vulnerable.

Table 2: Showing results of the Vulnerability Index for Grande Riviere

Pillars	***Major component Values for Grande Riviere***
Human	0.4997
Financial	0.4604
Environmental	0.34288
Physical	0.2521
Social	0.1302
VULNERABILITY INDEX$_{\text{Grande Riviere}}$	**0.3371**

Additionally, to reiterate the above, the major components depicted in figure 5 provides information on which characteristic contributes the most to vulnerability in the community. As can be seen, the scale ranges from 0-1 which represents least and most vulnerable respectively. Thus, from among each of the major components, the human capital pillar is within the 0.4 ranging followed by the financial pillar while the physical and environmental lie within the 0.2 range. The social pillar however, lies within the 0 category, thereby confirming the above ranking.

Figure 5: Spider Diagram showing the Vulnerability Index in Grande Riviere and Pillars



As noted in the previous chapter, the major components comprise different indicators and sub-indicators/components. Thus, it is worthwhile to examine the various sub-components so as to add substance to the study and establish which of the sub-indicators are most and least vulnerable; such information will be of great importance in determining how resources ought to be allocated. The results for the individual indicators and sub-indicators are illustrated in table 3.

Table 3: Showing results for the Indicators and Sub-indicators

Pillars	***Indicators and Sub-Indicators***	***Sub-indicator Value***	***Index Value***
Environmental	Hazards • Resource and services • Intensive Farming • Productivity Overfishing • Climate and Weather	0.07420 0.0115 0.0328 0.1184	0.23693
	Intrinsic Resilience		0.0176
	Extrinsic Resilience • General • Endangered Species	0.00684 0.0305	0.03733
	Resource allocation		0.0510
Human	Education and Awareness		0.4409
	Information		0.0588
Physical	Housing Infrastructure		0.2521
Financial	Livelihood Strategies		0.1656
	Alternative Strategies		0.2948
Social	Health		0.1254
	Security, Social Order and Governance		0.00485
VULNERABILITY INDEX $_{Grande\ Riviere}$			***0.3371***

Environmental Pillar

From the above, it demonstrates that the total value of the environmental pillar consists of the, hazards, intrinsic resilience, extrinsic resilience, and resource allocation- which then entailed sub-indicators. Notably, there were only sub-indicators for this pillar as there was a need to ensure that all aspect of the environmental was being considered. Nevertheless, the environmental pillar which adopted a value of 0.34288, were made up of 0.23693, 0.0176, 0.03733, and 0.0510 representing hazards, intrinsic resilience, extrinsic resilience, and resource allocation respectively. From this then, it reveals that the indicator hazards are more vulnerable when compared to the others. Additionally, when the sub-indicators were examined the results signified that 'climate and weather' contributed the majority to the index value, followed by 'resource and services' and 'productivity overfishing' while 'intensive farming' contributed the least to the overall indicator 'hazards'. This therefore implies that the community of Grande Riviere have experienced and noticed weather pattern changes in recent times.

Similarly, the indicator, intrinsic resilience contributed an amount of 0.0176 while 0.03733 was the amount for the component extrinsic resilience. Examining the latter indicator further divulged that sub-indicator endangered species accounted for more than half of the respective value. Lastly, for the environmental pillar, resource allocation contributed an amount of 0.0510 to the overall major component of 0.34288.

Human Pillar

The Human capital pillar comprised primarily of two components, education and awareness, and information where the values that were obtained from the calculations for such indicators were 0.4409 and 0.0588 respectively. Notably, the value of 0.4409 is the principal reason for the human pillar being considered as the

most vulnerable as the value for information is relatively small, hence the need for effective and efficient measures.

Financial Pillar

Livelihood strategies and alternative livelihoods were the indicators that comprised the financial pillar, where the values obtained for such components were 0.1656 and 0.2648 respectively, resulting in an overall value of 0.4604. Thus, the latter indicator accounted for more than half of the overall vulnerability in the financial pillar. This indicates that if households were to engage in measures of creating an alternative means of livelihood; such as constructing a bar, restaurant, or gift shop; just to name a few, it would require degrading the environment while at the same time increasing the level of uncertainty in recovering the financial expenses occurred in such expenditure.

Physical Pillar

The value for the physical major component, 0.2521 represented the vulnerability level associated with the members of Grande Riviere housing infrastructure. The vulnerability level for this component is greater than the social pillar but less than the vulnerability associated for all other pillars. This therefore indicates that the infrastructures utilised by such households are in a somewhat favourable position to weather the effects of climate change.

Social Pillar

The least vulnerable pillar, social capital, accounted for a mere 0.1302, in which the indicator health contributed 0.1254 while security, social order and governance accounted for 0.00485; with the main reason for this being a lack of data and responses from the data source.

Nevertheless, when considered in its entirety, a value of 0.4471 was derived for the Vulnerability Index in Grande Riviere.

7. Policy Simulations

Establishing that the vulnerability level in Grande Riviere stands at 0.3371, policy measures will be recommended to reduce the level even further. Each measure were recommended not only at the governmental level but also at the community and households level so as to ensure that each unit is working together to achieve the cohesive goal of reducing vulnerability. Additionally, tests were conducted for each of the policy recommended at each level to determine that such measure would in fact reduce the vulnerability level.

Education and Awareness:

Government:

The government can adopt the policy of implementing climate change into school syllabus as this will have positive returns for the country of Trinidad and Tobago at large[2]. Approximately, an average of 1.84 households currently obtains their information on climate change from the Government. Implementing the said policy can lower the human component. However, the policy change will have a ripple effect in that its impacts will not only be felt in that sub-component but rather on other indicators. Some of these are the knowledge level of households, their level of consideration, the risk pose to Grande Riviere, and the causes of climate change and measures that can be adopted to cope with such changes.

However, even though implementing climate change into the school syllabus are projected to reduce the human component ceteris paribus, mention ought to be made that there is a possibility that the students may not be inclined by the area or may not take the topic seriously thereby hindering the overall purpose of the policy.

For this reason, the policies suggested by the researcher will not only place emphasis at the governmental level but rather, also at the community and household level.

[2] Climate change is taught in schools but not in great detail as focus is mostly placed on global warming

Community level:

The community of Grande Riviere can assist in enhancing the level of education and awareness by having frequent meetings with the community groups, organising lectures or workshops, or publishing the information via the use of pamphlets and posters. This procedure will educate not only the community of Grande Riviere but also those visiting the area as they are popularly known as a nesting site for the endangered leather back turtles. Thus, this can act as a medium for reducing the vulnerability level as the education level intensifies. To exemplify, an average of 1.20 households obtain information from organisational groups; therefore this figure reveals that it is an effective form of communicational tool in increasing the level of education and awareness. Thus, by having frequent meetings from community groups the level of vulnerability can be lowered.

Household:

The households of Grande Riviere can also assist in amplifying the level of education and awareness on climate change which is equally important as the other levels mention above. They can assist by ensuring that the students attend to school and educate themselves on the precautionary measures that ought to be adopted. Based on the information gathered from the 2000 Census, an average of 1.69 attended schools which therefore translated into a high proportion of the households not attaining development in their education as the average level of highest education attain was 8.23. This figure is extremely high and therefore demonstrates the need for appropriate measures to be adopted at this level.

In addition to this, households can increase their awareness and educational level by reading, listening, and watching more stories on climate change. In the information era, there is an overload of information waiting to be discover, hence households can and should take it upon themselves to become educated and aware on the area of focus.

Overall Effect on Vulnerability Index

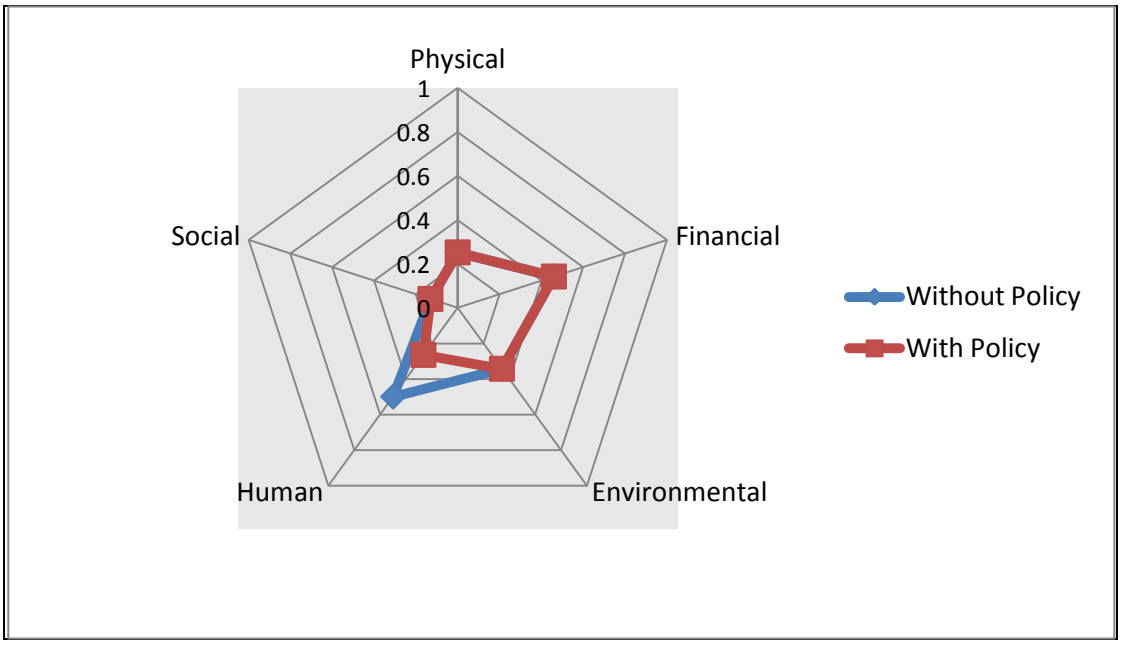
Consequently, considering the aforementioned policies at each level in its entirety, ceteris paribus, the Vulnerability Index reduces significantly to an amount of 0.2901 as compared to 0.3371. The results showing such change is illustrated in table 4, where the index with and without the policy is shown.

Table 4 showing change in Human Pillar and Vulnerability Index

Pillars	**Original Major component values for Grande Riviere**	**Major component values for Grande Riviere**	**Vulnerability Index**	
			Without Policy	**With Policy**
Physical	0.2521	0.2521	**0.3371**	**0.2901**
Financial	0.4604	0.4604		
Environmental	0.34288	0.34288		
Human	***0.4997***	***0.2648***		
Social	0.1302	0.1302		

Thus, by adopting the policy recommended, the vulnerability level in the community of Grande Riviere can be reduced drastically. To show the effects of enhancing education and awareness on the overall Vulnerability Index, ceteris paribus, consider the spider diagram below.

Figure 6: Spider Diagram showing the Pillars with and without the Policy



From the above cobweb, it reveals that with the policy recommended, the overall vulnerability for the area of focus reduces as compared to without the policy as shown by the red and blue lines respectively. Thus, with all other capital pillar remaining constant, the Vulnerability Index for Grande Riviere reduces significantly thereby suggesting that education and awareness can assist in lowering the vulnerability level.

Conservation of Ecosystem Services

Another policy that should be considered is the conservation of the ecosystem services which are services derived from the environment and are directly linked to the welfare of the people. Before proceeding forward, mention should be made that the policy identified above will have a positive spill over effect on the conservation level. That is, greater levels of education and awareness indicate a greater desire to preserve the environment in which humans are dependent upon.

Government:

Nevertheless, some policies in which the government can consider is the promotion of greater and stringent measures for recycling and reducing pollution

levels, and watershed protection. Such measures will ensure environmental sustainability and as such the achievement of goal 7 in the Millennium Development Goal (MDGs). From the study, an average of 1.53 households believes that the prevention of pollution is important. If however, the numbers were to increase the vulnerability level will lower.

Community Level:

The organisational groups can communicate to the community on the need for ecosystem services-that is, provisioning, recreational, supporting, and cultural services. More specifically, the groups can increase awareness on the importance of the services provided from nature, thereby resulting in a fall in the environmental major component, ceteris paribus.

Household:

Enhancing the level of communication and education on the importance of the ecosystem, households can assist in lowering the level of vulnerability. As it is, the community and households of Grande Riviere are highly dependent on the endangered leather back turtles for employment, livelihood, and the recreational services it provides. Hence, conserving such resources will ensure the sustainability of the species and livelihoods.

In addition to this, the environmental pillar will also be impacted upon in that if the average number of households that support the conservation and protection of turtles increase, then this will have a direct effect on the environmental major component and hence the Vulnerability Index. Tantamount to this is the importance that households place on the turtle nesting, their eggs and meat, the employment gain from such specie, pride it extends to the community, and its sustainability; where it will have the same effects mentioned above.

Overall Effect on Vulnerability Index

Examining the total effect on the Vulnerability Index due to the above policy, the index falls to an amount of 0.3317, where originally it was 0.3371 as demonstrated in the below table; thus, representing a lower level of vulnerability.

Table 5 showing change in Environmental Pillar and Vulnerability Index

Pillars	**Major component values for Grande Riviere**		**Vulnerability Index**	
	Without Policy	**With Policy**	**Without Policy**	**With Policy**
Physical	0.2521	0.2521	***0.3371***	***0.3317***
Financial	0.4604	0.4604		
Environmental	0.34288	**0.31598**		
Human	0.4997	0.4997		
Social	0.1302	0.1302		

The above table verifies that a positive correlation exist among the major components and index, in that as the values of the sub-components alter downwards representing a lower degree of vulnerability, the relevant major component follow suit thereby resulting in an overall fall in the Vulnerability Index for Grande Riviere. Hence, adopting the policy of conserving the environment at all levels results in a lower Vulnerability Index of 0.3066 as compared to 0.3371, the original vulnerability as was calculated previously.

Reduce Greenhouse (GHG) Emission (Mitigation)

Mitigation refers to the reduction in green house gas (GHG) emissions. Thus, if each level where to work in tandem in reducing the level of gaseous substance emitted into the atmosphere, the overall vulnerability level will fall, ceteris paribus.

Government:

The government can assist in lowering the GHG by setting limits on the number of lands allocated to agricultural farming since greater farming implies greater amount of fossil fuel being emitted into the atmosphere. However, even though this is a possible recommendation, agricultural farming is the main form of livelihood for the rural poor, in which little or no alternative exists. Thus, in such circumstance then the government can set a limit on how much gas can be emitted into the atmosphere from a particular community. This method will therefore be somewhat similar to the carbon markets that are applicable for industries. Thus, the use of such policy will assist in furthering lowering the emission levels of communities and households due to citizen's adherence.

Community and Household level:

The measures that the community/households can adopt to mitigate the problems associated with climate change is reducing the slash and burn method of land clearing, the number of land under cultivation, and time allocated to farming can lower the secretion from fossil fuel burning which contribute to climate change since such measure will result in less degradation and vulnerability. This is so primarily because the forest/tress acts as a sink in absorbing the CO_2 emitted into the atmosphere; hence fewer trees implies that more CO_2 will remain into the atmosphere thereby contributing to further changes in climate. This therefore represents the anthropogenic aspect that influences such changes in the climate; as such, reducing the land use can alleviate the changes. Associated with this, is the problem that arises when households reclaim land from the forest, as it will have similar effects since the reclaimed land are utilised for farming.

In addition to this, avoiding deforestation and promoting re-forestation will assist in reducing emission from land use changes and thereby restore the functioning of the environment as a sink in absorbing gaseous substance.

Overall Effect on Vulnerability Index

Consequently, considering the policy under question at each level in its entirety, ceteris paribus, results in an overall decline in the Vulnerability Index. That is, the index falls to a sum of 0.3329 as compared to 0.3371 which is the index level obtained without such policy measure in place, ceteris paribus.

Table 6 showing changes in Environmental Pillar and Vulnerability Index

Pillars	**Major component values for Grande Riviere**		**Vulnerability Index**	
	Without policy	**With policy**	**Without policy**	**With policy**
Physical	0.2521	0.2521	***0.3371***	***0.3329***
Financial	0.4604	0.4604		
Environmental	0.34288	**0.32162**		
Human	0.4997	0.4997		
Social	0.1302	0.1302		

Adopt No-Regret Options

Adopting No-Regret Options is a form of adaptation measure that is taken to cope with the vulnerability which is vital due to the high level of uncertainties associated with both the climate outcomes, and longer term projections of social and economic development. At the governmental level, they can enforce policies and measures in which permission is needed from the Ministry of Housing and Planning Development when establishing sites for industries, businesses, or houses in coastal areas as such district will be highly vulnerable to the effects of climate change. Additionally, each governmental body should have a department specifically dedicated to climate change which will ensures that the appropriate measures are adopted to cope with and reduce the impacts of such change. Considering such measure is vital since climate change can and will have diverse consequences on society, which in turn will have a negatively impact upon the

other sub-departments. Hence, screening each application is vital due to the high uncertainty levels associated with the future and by extension, climate.

Linked directly to this is the policy prescription recommended for the community and households where community buildings or housing facilities should not be built too close to the coastal zone. This is so primarily due to the high probability of increase wind storm related events, and the like, which will have disastrous effects. Thus, adopting the initiative to build a restaurant and bar in the community of focus, will not only result in a degradation of the environment but also the risk of being unable to repay debts or break even and hence make a profit.

Overall Effect on Vulnerability Index

Thus, adopting the said policy can reduce the vulnerability level of Grande Riviere to an amount of 0.3183. Table 6.4 illustrates the positive effect that the financial major component can have on the index. That is, as the pillar decreases from 0.4604 to 0.4525, all other pillars remaining constant, the Vulnerability Index follow in similar pattern as it reduces to 0.3183.

Table 7: showing changes in Financial Pillar and Vulnerability Index

Pillars	Major component values for Grande Riviere		Vulnerability Index
	Without policy	With policy	
Physical	0.2521	0.2521	***0.3183***
Financial	0.4604	**0.4525**	
Environmental	0.34288	0.34388	
Human	0.4657	0.4657	
Social	0.1302	0.1302	

Ensure Proper Infrastructural Material

Another policy recommended that can be adopted at all levels is ensuring that proper infrastructural material are utilised when constructing buildings, or housing facilities. Thus adopting a stance where each governmental and organisational

body have policies, standards, and procedures to follow that effectively deals with climate change will result in less infrastructural damage as the buildings will be able to effectively weather the impacts of climate change. Thus, similar to the above policy, change in climate will be taken into account when decisions are being undertaken thereby assisting in the allocation of resources.

From this, community and households will have to abide to such laws and so utilise stronger infrastructural material for outer walls and roofing.

Overall Effect on Vulnerability Index

From table 8, it reveals that with the adoption of the said policy the vulnerability Index reduces from a sum of 0.3371 to 0.3292, thereby indicating a lower level of vulnerability.

Table 8: showing changes in Physical Pillar and Vulnerability Index

Pillars	Major component values for Grande Riviere		Vulnerability Index	
	Without policy	**With policy**	**Without policy**	**With policy**
Physical	0.2521	**0.2130**	***0.3371***	***0.3292***
Financial	0.4604	0.4604		
Environmental	0.34288	0.34388		
Human	0.4657	0.4657		
Social	0.1302	0.1302		

Improve Health and Sanitation

Finally, climate change will inevitably have a negative impact on the health status of the economy in that there will be an increase outbreak of water and vector borne diseases. Thus, setting minimum standards in which governmental officials have frequent inspection of homes, commercial building, and businesses so as to ensure proper compliance with such standards will be vital. As a result, in an effort to comply with the laws, communities can form clean up groups thereby lowering the pollution level while simultaneously preventing the spread of such diseases. Households can ensure that container, tyres, and other form of water

storage are properly secured. Ensuring proper and frequent water flows and toilet linkages can also improve the health status. Moreover, cutting bushes/grass can prevent the spread of diseases and potential crime as criminals may hide in the nearby bushes before convicting in criminal acts.

Overall Effect on Vulnerability Index

Adopting the said policy can reduce the Social Pillar to an amount of 0.0227 where it was previously 0.1302. Injecting this change to compute the Vulnerability Index confirm the above findings in that positive relationship exist between the major component and the index. Thus, as the major component decrease, the Vulnerability Index decreases simultaneously to a total of 0.3156 as shown in table 9.

Table 9: showing changes in Social Pillar and Vulnerability Index

Pillars	**Major component values for Grande Riviere**		**Vulnerability Index**	
	Without policy	**With policy**	**Without policy**	**With policy**
Physical	0.2521	0.2521	***0.3371***	***0.3156***
Financial	0.4604	0.4604		
Environmental	0.34288	0.34388		
Human	0.4657	0.4657		
Social	0.1302	**0.0227**		

Accordingly, the above policy prescriptions illustrates that the vulnerability level of Grande Riviere can be reduce by employing the appropriate measures as the policies revealed. Furthermore, it demonstrates the need for a country, community and household to act together in an effort to reduce the impact of and cope with the changes in climate, as the vulnerability level can be reduced at a faster rate when such units work together as oppose to in separation.

Impact of an Exogenous Shock

To add further substance to this study, the impact of an exogenous shock will be examined to determine what effects such shocks will have on the pillars and overall Vulnerability Index for Grande Riviere. In this model, such shock can take the form of a hurricane, earthquake, volcanic eruption, tornado or even tsunami. The impact of any one of these shocks will follow in similar pattern where it will enhance the vulnerability level and thus, boost the value of the Vulnerability Index, components and sub-components that constitute such index.

To exemplify, consider the case of a hurricane as the exogenous shock on the coastal community of Grande Riviere. The impacts of this is an increase in sea level rise, beach and soil erosion, flooding, crime, vector and water borne disease, and loss of homes among other negative effects. These will therefore affect each of the capital pillars utilised in this study but with varying degrees, with perhaps the human pillar being least distressed. Thus, the consequences from such shock will not be looked at for each of the individual capital pillars but rather in its totality since each would be impacted upon simultaneously.

Viewing the physical pillar first, depending on the force of the winds, the construction of homes and roofing material used will be diminished. The water frequency, type lighting system and fuel used will also be negatively impacted upon. Tantamount to this, water borne diseases will increase as most of the households have their toilet facility linked via means of a Pit Latrine. Thus, the vulnerability level will rise significantly in the coastal community.

Additionally, the financial major component will also be negatively affected in that the average number of persons acting as tour guides (LS_1) in the community will decline due to the high probability of beach erosion occurrence during such shock.

Similarly, the environmental major component will face comparable effects as that of the financial pillar since the implication of beach erosion indicates that fewer turtles will be visiting the shores of Grande Riviere. Thus, the number of turtles caught while fishing will decline as well as the number of visits to the river and beach. Moreover, a shortage of plants, animals, soils and water will be experience, thereby impacting upon the number of days per week allocated towards farming and fishing. Thus, livelihood will be distressed since agriculture and farming is considered to be the main source of income for Grande Riviere; hence, demonstrating the link between the ecosystem services and human welfare.

From the exogenous shock, hurricane, the human capital pillar will be impacted upon in that the frequency in stories of climate change listen to/read/ watch will increase. Similarly, buildings such as schools may be destroyed thereby impacting the attendance rate and type of school attended to; thus, negatively affecting the vulnerability level in the community.

Finally the social major component will be adversely affected in that health facilities will be destroyed due to the force of the winds and disaster itself, thereby impacting on the life expectancy at birth. Moreover, such shock will reduce the amount of already scarce available resources in the community resulting in higher levels of crime as individuals seek to ration for such resources.

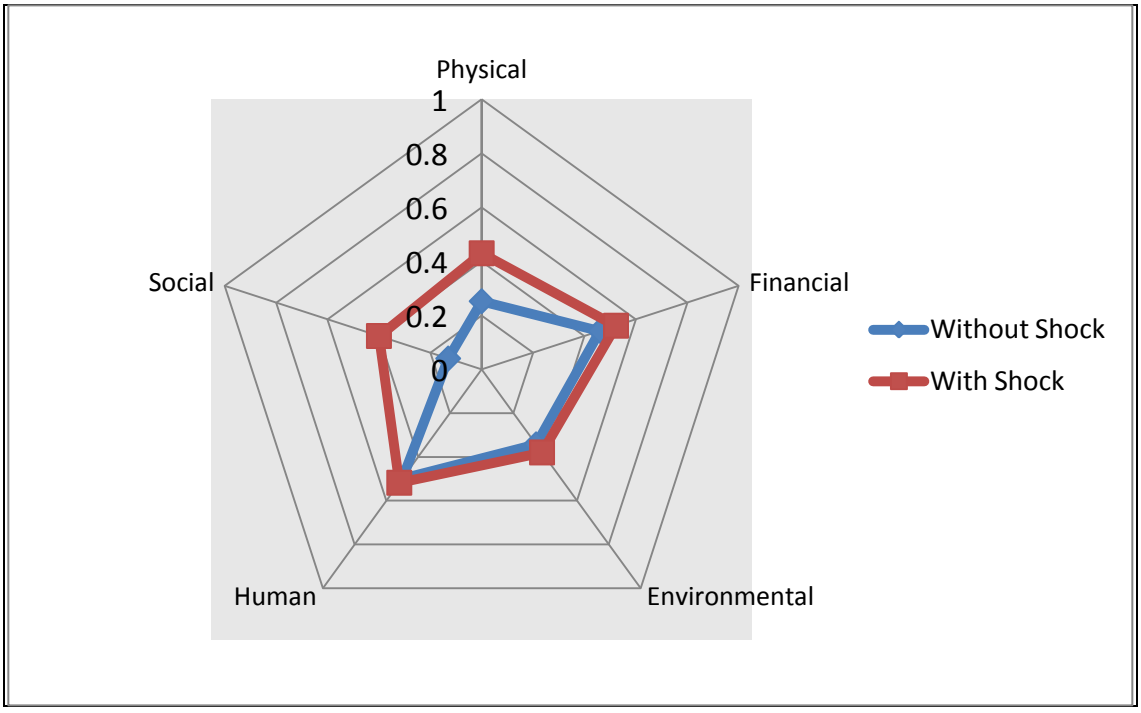
Having examined the impacts of a hurricane (exogenous shock) on the capital pillars, the combined effect on the overall Vulnerability Index for Grande Riviere is as follows: the Vulnerability Index will increase from 0.3371 to 0.4501. This therefore represents an overall increase in the index by 33.52%, and as such, a greater degree of vulnerability for the community. Examining the effects of the shock on the capital pillars is illustrated in table 10 which shows a comparison of the Vulnerability Index with and without the shock.

Table 10: showing changes in Pillars and Vulnerability Index from Shock

Pillars	Major Component Values for Grande Riviere		Vulnerability Index	
	Without Shock	With Shock	Without Shock	With Shock
Physical	0.2521	***0.4296***	***0.3371***	***0.4501***
Financial	0.4604	***0.5227***		
Environmental	0.34288	***0.38005***		
Human	0.4997	***0.5186***		
Social	0.1302	***0.3996***		

The above table demonstrates that results an exogenous shock, such as a hurricane, can have on each of the individual pillars and Vulnerability Index. As shown, each of the major component values corresponding to the capital pillar raised increasingly, which in turn resulted in an increase in the Vulnerability Index to an amount of 0.4501 when initially without the shock, it was 0.3371. Thus, this indicates a hurricane can have disastrous consequences for the community of Grande Riviere with varying outcomes for each of the capital pillar as shown in the cobweb diagram below.

Figure 7: Spider Diagram showing Pillars *with and without* an Exogenous Shock



Observing the effects of the shock on each of the capital pillars in the above spider diagram reiterated the point, that the human capital pillar will be least affected from a hurricane since the blue and red line which represents the value without and with a shock respectively, did not change to a significant degree. Similar patterns follow suit for the financial and environmental pillar. However, the gap corresponding to the social capital pillar with and without such shock is considerable thereby indicating that such pillar will be the most affected followed by the physical pillar, whose gap is not an exorbitant as the social pillar.

Hence, in chronological order from the most to least vulnerable pillar if such exogenous shock were to occur are, social pillar, physical pillar, financial pillar, environmental pillar and lastly, human pillar. These results are not surprising since the impact of an exogenous shock will have diverse effects on the different sub-component that comprise the pillars.

Likewise, the Vulnerability Index in Grande Riviere will increase drastically if an exogenous shock, in this case a hurricane, were to occur as can be seen from the table and spider web diagram. This therefore signals and provides greater reasoning for the community members to act together to reduce such vulnerability.

At this point, mention ought to be made that regardless of the type of exogenous shock, the effects will be somewhat similar where each of the pillars will be impacted upon thereby causing the Vulnerability Index to increase or decrease depending on the type and extent of shock being considered.

In essence, the Vulnerability Index can be reduced by adopting the right measures to suit the community under consideration, since different communities in the developing country of Trinidad will require different measures.

8. Conclusions

The benefits of the index developed for Grande Riviere consist of a number of benefits and functions, where it allows for the vulnerability level to be measure; disaggregation of vulnerability into component areas; comparison across other communities and countries; appropriate policies implementation; and measurement of impact and efficacy of such policies.

The Vulnerability Index utilised in this study allows for the vulnerability level in communities and countries to be calculated, thereby enhancing the level of awareness of the problem under consideration while simultaneously strengthening the resilience and adaptive capacity. Thus, by measuring vulnerability, the quantitative value derived can be used as a communicational tool for alerting stakeholders and drawing attention to the issue being investigated.

Moreover, an index often summarises complex phenomena, with the end result being a single value measure. The study utilised 11 major components which were segregated and included under the different pillars. Thus, inspecting each of the component areas revealed the individual values thereby allowing the researcher to be further educated on which indicator contributed to the overall value pertaining to the respective pillar, and hence adopting the appropriate measures to reduce such vulnerability.

The vulnerability index can allow for comparison over space and time among various countries and communities. The desirable attributes of simplicity, affordability, suitability, and transparency enhances the operationality of the Vulnerability Index such that the manner in which the index was calculated along with the data collection techniques can be applied to other area of focus thereby allowing for greater comparisons and discussions.

Furthermore, indices are of utmost importance in that it allows for different households, communities, and governments to adopt the appropriate policy

measurement so as to reduce the vulnerability level. This is vital since the development within countries or communities vary over time and space; hence, a policy measure that may be applicable for one community may not apply for another. Therefore, the Vulnerability Index can be used to set the direction of actions, justify certain priorities and resource allocation, and for setting targets.

Indices can also assist in measuring the impacts and efficiency of the policy measurement adopted so as to establish whether a policy or decision implemented is yielding the desirable results and to assess whether if directional changes are needed. Hence, policies and decisions implemented will not be taken blindly or based on emotional feelings, but rather based on information presented within the index format.

There are limitations and constraints of this study that must be considered which are principally associated with the subjective choice of variables, method of measurement, averaging procedure, reliability of data sources, and trade off among the pillars.

In developing an index, there is a certain degree of subjectivity in choosing variables which is difficult to resolve. In this study, the indicators selected ranged from among factors representing each of the pillar utilised, where variables were then decided upon to represent such components. Thus, selecting variables to signify the pillars required a certain degree of subjectivity. Nevertheless, this problem as outlined by Brigulio (1995; 1997) can be reduced if the index objective is clearly set. Thus, the focus of this index was to emphasis the vulnerability level in Grande Riviere to climate change; hence, the variables chosen for each pillar reflected this. As such, variables which relate to the inherent conditions, and reflect the damages from internal and external forces were included.

Another problem experienced is the problem of measurement due to the absence of data for certain components, and errors in measurement of the variables. The

most difficult area in constructing an index surrounds the section of data collection as problems are generally associated with a lack or shortage of data, and non homogenous definitions of the pillars across and within countries. The problem of data inadequacy arise primarily for the social capital pillar in which little or no data were provided as the scope of questions relating to such pillar were limited, or in circumstances where questions were asked the response rate were low. As such, the research may therefore have to restore to primary data collection so as to gather original data. At this point, mention ought to be made that the data utilised for the social pillar came solely from the CSO (secondary data source). Thus, even though the social pillar comprised two indicators (health, and security, social order and governance), its scope were limited as compared to the physical pillar which consisted of one indicator (housing infrastructure) that was diverse.

The overall Vulnerability Index obtained in this study is made up of average major component values in which the final index value derived may not reveal the degree of vulnerability between the individual components and the overall scoring itself. In this study, within the scaling of a maximum of 1 (most vulnerable) and a minimum of 0 (least vulnerable), a value of 0.3371 was obtained as the Vulnerability Index for Grande Riviere. However, upon examination of the individual pillars, the human capital pillar obtained a score of 0.4997 which indicates that the community is highly vulnerable within this aspect. Thus, if policy makers were to observe the composite index of 0.3371, the wrong conclusions may be drawn; hence concealing useful information.

Likewise, problems arise in determining whether to adopt an equal or unequal weighted average. In this study, the equal weighted approach was employed as the perceptions holds that each of the pillars utilised are off equal importance as was shown by the asset pentagon. Thus, the weighting procedure generally remains an issue of subjectivity when establishing indices, with the simple average/equal weighting procedure gaining preference on the grounds of simplicity.

The question of reliability also poses some issues in computing the index. The main technique of data collection for the majority of the pillars came from the community questionnaire (primary data source). However, even though it reduces some of the problems associated with secondary data, the question of reliability arises. That is, if a community questionnaire for Grande Riviere, with the identical questions were asked to the same unit of analysis within a selected time frame, will the same results be obtained? If not, then the reliability and accuracy of the Vulnerability Index calculated in this study will be under question.

A final constraint to note from this study is the existence of tradeoffs among the pillars that are not yet realised. That is, the capital pillars are examined in isolation rather than in a cohesive manner. Nevertheless, further research is currently being conducted into the pillars to refine the index, thereby overcoming such problem.

In conclusion, climate change is a global problem and therefore needs to be address globally since it is considered to be a public good, and like all public goods, regardless of the amount of GHG emitted into the atmosphere the effects would not be felt uniformly. Those countries that have high vulnerability levels accompanied by low adaptive capacity and resilience level would be heavily impacted upon. Small Island Developing States (SIDS), who share such characteristics, would therefore be negatively impacted upon; hence is essential that SIDS adopt the appropriate measures to reduce their vulnerability levels, enhance their coping capacity and resilience levels.

Thus, it is vital for such countries to adopt a climate smart policy, "*where they need to act now, act together, and act differently*" (World Development Report, 2010). By acting now, they can reduce their level of vulnerability and obtain an island condition and well being status of good; by acting together they achieve the Pareto Optimal position as known in the Prisoner's Dilemma game in that each country and community would be working towards the same goal; and by acting differently by adopting mitigation and adaptation measures. In this way, countries

and communities would be positioning themselves to avoid the unmanageable and to manage the unavoidable.

The index utilised in this study therefore allows for the vulnerability level to be measure; disaggregation of vulnerability into component areas; comparison across other communities and countries; appropriate policies implementation; and measurement of impact and efficacy of such policies. However, additional information can be gained when two or more study areas are compared as it would allow for a greater degree of discussion and comparison of vulnerability spider diagrams. Nevertheless, the limitations and constraints associated with this study ought not to be neglected as it can be used to enhance studies following similar pattern.

In essence, it is hoped that the Vulnerability Index utilised in this study will provide a useful tool for development planners in evaluating the vulnerability levels of communities or countries to climate change so as to develop and implement programmes, and policies to strengthen the most vulnerable pillars under consideration. Also, the Index utilised in this study can act as a communicational tool for alerting stakeholders about issues that are highly vulnerable, and assist in fostering awareness of the interconnection between the different aspects of vulnerability and promote the idea of integration actions, which is vital for sustainable development.

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