USING NATIONAL CENSUS DATA TO ASSESS SOCIAL VULNERABILITY OF VILLAGES TO MAJOR FLOODS: EAST COAST DEMERARA, GUYANA

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ABSTRACT

Objectives. *Village-level socioeconomic and demographic data were used to construct an index of social vulnerability to major flood events for seventy villages in Guyana.* ***Methods:*** *Data for eight indicators commonly used in such assessments were selected, normalized, weighted equally and summated to produce an initial social index for each village. These indices were then treated by a special factor based on the identification of so-called high-impact vulnerability factors to arrive at final composite indices.* ***Results:*** *Composite indices were separated into quintiles and results displayed on Google earth maps.* ***Conclusion.*** *The use of the special weighting factor to calculate indices of social vulnerability produced meaningful results that could be used to inform flood disaster management plans.*

Key words: Social vulnerability, floods, villages

INTRODUCTION

In Guyana, a major rain-induced coastal flood in January 2005 affected approximately 275,000 persons (about 35 per cent of its population), claimed an estimated 34 fatalities and left an estimated damage of US$ 465 million (Civil Defence Commission of Guyana, 2012). A year later,

according to the same source, in February 2006, a second flood affected 35,000 persons and caused an estimated damage of US$ 160 million.

Due to global climate change and local factors, flood events in Guyana are expected to increase in frequency and magnitude. Large parts of the country will be affected as a result of sea level rise, storm surges, increases in rainfall intensity, breaches of conservancy dams and sea defences, and overtopping of large rivers even in inland regions.

To what extent can communities in Guyana cope with such events? What socio-economic factors and conditions determine the capacity of citizens to resist and recover from repeated major floods? What measures could be taken to reduce the damage potential of floods and other natural hazards at the level of individuals, families and communities? These and other questions rest at the core of the concept of social vulnerability, the idea that the ability of people to resist and recover from a disaster depends not only on the magnitude of the disaster, but also on their social and economic conditions, such as their education and income levels.

This paper describes a recent study to measure social vulnerability at the scale of individual communities in Guyana by processing eight socio-economic indicators. Over seventy (70) villages along the coast, where most of the country's population and agriculture resources are, were included in the assessment (**Table 1** and **Map 1**). The main source of socio-economic data was the 2002 national population and household census, the most comprehensive that is available for the country.

Assessments of vulnerability at a local scale can provide specific answers to questions such as who is likely to be affected, to what extent, where and why (United Nations Environmental Programme, 2003). Such knowledge can be used to inform and guide key components of a disaster management plan, such as emergency preparedness and response, education and awareness, and loss reduction.

In addition, such studies fall within the ambit of Guyana's Low Carbon Development Strategy (LCDS). In its LCDS policy statement in 2009, the Government of Guyana identified a portfolio of urgent, near-term

investments in areas where population and economic activity are concentrated. Initiatives which relate to flood disaster management include strengthening building codes; expanding the early warning system and building an emergency response system; and developing financial and risk/insurance measures to boost resiliency post-flooding. These decisions and initiatives are informed by flood risks and vulnerability assessments. Already, some work has been completed in this regard, especially in terms of risk assessment and the economic dimension of vulnerability. The current study therefore sought to complement the on-going efforts by looking at the social dimension of vulnerability: that is, the capacity of individuals, households and communities to withstand and recover from floods based on such social factors as their gender and education level.

VULNERABILITY: SELECTED CONCEPTS AND METHODS

In the natural disaster literature, several definitions of vulnerability exist. In a 2003 report on assessing human vulnerability to environmental change, the United Nations Environmental Programme (UNEP) reviews the use of the term across several studies and researchers. The UNEP report distils vulnerability to be a function of two elements: damage potential and coping capacity. This study adopted this definition for its wide usage and simplicity.

Three dimensions of vulnerability are recognised (see, for example, Kumpulainen et al, 2006): (i) economic (any actual or potential damage that affects the economy, such as damage to infrastructure in terms of roads, communication, and power supply; and damage to commercial activities in terms of the production, distribution and consumption of goods and services); (ii) environmental (the extent of fragility of ecosystems and how they can withstand and recover from a disaster); and (iii) social (related to the characteristics of the people and their living conditions, and how these affect their ability to prepare for, respond to, and recover from a disaster).

The economic dimension of vulnerability is normally measured in monetary terms, while the environmental dimension is reported in terms of damage to ecosystems and habitats. On the other hand, the social dimension of vulnerability focuses directly on people as individuals, families and communities. The social dimension recognises, for example, that old people are more vulnerable than younger adults, poorly educated people are more vulnerable than the educated, and small farmers are more vulnerable than public servants and small miners. This study looked at this aspect of vulnerability.

The three main methods for vulnerability assessment are: analysis of statistical data, spatial analysis, and modeling. This study was mainly based on an analysis of statistical data.

FLOOD EVENTS IN GUYANA

Flooding events on the coast of Guyana have several characteristics that directly bear on the threat, risks and vulnerability they pose. These include:

i. Floods have multiple causes. Floods may be due to high rainfall; overtopping of conservancies and seawalls; release of excess water from conservancies through outlet canals; swelling of rivers; high tides and storm surges in the sea; and failures of sea and river engineering protection structures. Events are therefore frequent, with some areas experiencing several floods a year.

ii. Flood events are mainly slow onset in nature. The rise in water level during flood events on Guyana's flat coastland is much slower compared to events in countries with hilly topography. Flash floods and associated rapid and devastating mass movement events (such as mudflows and slumps) are therefore unheard of on Guyana's coast. The fact that most flood events onset slowly helps to reduce their impact by providing extended preparation and response time.

iii. Wide geographic extent. The global-scale rainfall zones that affect Guyana and the flat coastal topography allow floodwater to extend over extensive regions. Flood depths can reach as much as 2 metres.

iv. Substantial damage potential. Because most of the country's population and agriculture assets are concentrated on the coast, the potential for flood damage is high.

This study treated floods as uniform in magnitude and nature across all coastal communities. No account was taken of any differences such as causes of flooding, rate of onset, flood depth, and velocity. We posit that the results of the study would in no way be affected by this assumption.

PREVIOUS STUDIES IN GUYANA

Previous studies in Guyana on vulnerability of the coast have mainly focused on the economic and environmental dimensions of vulnerability, and mainly at the national scale. We describe three significant cases here to highlight differences in objectives, scales of observation, and methodologies from the current study.

(i**)** *Second National Communication (SNC) to the Conference of Parties of the United Nations Framework Convention on Climate Change.* This project, proposed in 2007, was geared to allow Guyana to comply with its obligations under the United Nations Framework Convention on Climate Change. Several vulnerability and assessment surveys were undertaken, with one focused on Guyana's Coastal Zone sector. Among its stated objectives, the study evaluated the impacts and vulnerabilities of climate-driven sea level rise and extreme storm surges on sensitive coastal zones, ecosystems and human settlements in Guyana. The project concentrated on the economic and environmental dimensions of vulnerability (but not on the social dimension) and on physical damage potential (but not on coping capacity of the population).

The methodology consisted of, first, the creation of the Digital Elevation Maps, followed by the identification of regions and land uses affected by future sea level rises, using the appropriate modules of the ARCGIS GIS software. Three future scenarios (for years 2031, 2051 and 2071) were constructed based on the Hadley Centre Atmosphere-ocean General Circulation Model simulations of sea level rise and storm surges, which were superimposed on local topography, land use, ecosystems and infrastructure facilities. The resolution used was 25 x 25 metres.

The results produced several flood hazard maps and calculations of economic loss in financial terms. In general, the results highlighted the high level of vulnerability of the coastal zone of Guyana to climate-driven sea level rise and the potential impacts of extreme events such as storm surges.

(ii) *Design and Implementation of an Integrated Disaster Risk Management Plan, Civil Defence Commission - 2010.* The stated objective of the IDB-funded project was to improve disaster risk management through the determination of a robust System of Indicators, developed by the Institute of Environmental Studies (IDEA in Spanish) of the National University of Colombia, Manizales. The System of Indicators, which could be used by countries as well as banks, has three specific objectives: i) improvement in the use and presentation of information on risk to assist policymakers in identifying investment priorities to reduce risk (such as prevention and mitigation measures), and to direct the post disaster recovery process; ii) to provide a way to measure key elements of vulnerability for countries facing natural phenomena. It also provides a way to identify national risk management capacities, as well as comparative data for evaluating the effects of policies and investments on risk management; and iii) application of the methodology to promote the exchange of technical information for public policy formulation and risk management programs throughout the region.

Four national indicators were calculated:

- The Disaster Deficit Index, DDI, measures country risk from a macro-economic and financial perspective when faced with possible catastrophic events.

- The Local Disaster Index, LDI, identifies the social and environmental risk that derives from more recurrent lower level events which are often chronic at the local and sub national levels.
- The Prevalent Vulnerability Index, PVI, is made up of a series of indicators that characterize prevailing vulnerability conditions reflected in exposure in prone areas, socioeconomic fragility and lack of resilience in general.
- The Risk Management Index, RMI, brings together a group of indicators related to the risk management performance of the country.

(iii) The Guyana Red Cross and other NGOs have conducted several street-level vulnerability assessments in selected communities across Guyana. The method normally involves house-by-house interviews. These assessments directly map social vulnerability. While, they are valuable to enable local people to organise to resist a flood, they provide no regional or national perspective.

SELECTION OF STUDY AREA

In any given year, several areas of Guyana experience severe flooding. The villages along the East Coast of Demerara on the country's Atlantic coast were selected for this study because of the severity and damage potential of floods there (MAP 1, TABLE 1). The extreme flood events in 2005 and 2006 were particularly devastating for the region. A total of 222,522 persons or 72% of the region's population were, for example, severely affected in the 2005 flood.

Because the national census contains the same datasets for all ten administrative regions of Guyana, such a study could be readily and uniformly replicated for other flood-prone areas, such as the West Demerara and the Pomeroon. We recommend such studies using the metric proposed in this study.

TABLE 1: Study area by village and NDC

List of NDCs (East Coast Demerara, Region #4)	Number of villages	Names of villages
Cane Grove Land Development Scheme	**8**	Cane Grove, Virginia, Uplands, Bagatelle, Strathavon, Joyce Phillips, La Bon Mere, Mary's Hope.
Vereeniging / Unity	**15**	Vereeniging, Supply, Belmont, Helena No.1, Helena No.2, Good Hope, Hand En Veldt, Voorzigtigheid, Good Intent, Cambridge, Tranquility Hall, Spring Hall, Mosquito Hall, Lancaster, Unity.
Grove / Haslington	**19**	Grove, Orange Nassau, Greenfield, Bee Hive, Clonbrook, Ann's Grove, Two Friends, Dochfour, Hope, Lowlands, Nooten Zuil, Belfield, Victoria, Craig Milne, Cove, John, Nabacalis, Golden Grove, Haslington.
Enmore / Hope	**2**	Enmore, Hope.
Foulis / Buxton	**12**	Foulis, Paradise, Bachelor's Adventure, Elizabeth Hall, Enterprise, Non Pariel, Coldingen, Strathspey, Bladen Hall, Vigilance, Friendship, Buxton.
La Reconnaissance / Mon Repos	**7**	La Reconnaissance, Annandale, Lusignan, Nog Eens and Two friends, Good Hope, De Endragt, Mon Repos.
Triumph / Beterverwagting	**2**	Beterverwagting, Triumph.
La Bonne Intention / Better Hope	**9**	La Bonne Intention, Chateau Margot, Success, Le Resouvenir, Felicity, Montrose, Brothers, Vryheids Lust, Better Hope.
Plaisance / Industry	**5**	Plaisance, Sparendaam, Goedverwagting, Ogle, Industry.

RESEARCH OBJECTIVES

The study sought to accomplish three objectives:

- to measure and map the level of social vulnerability of coastal communities of Guyana to flood hazards;
- to highlight any variations in social vulnerability across these communities;
- to propose and demonstrate the use of a metric to measure social vulnerability in Guyana which can be adopted as the standard approach to facilitate comparisons across time and space.

METHODOLOGY

The methodology involved five steps:

i. Setting down criteria for selection of indicators;
ii. The selection and assessment of social indicators of vulnerability;
iii. The normalisation and orienting of the selected social indicators;
iv. Calculation and ranking of social vulnerability across communities;
v. Verification of vulnerability assessment through other sources.

Setting down criteria for selection of indicators

Following the advice of Dwyer et al. (2004), this study selected vulnerability indicators to meet several criteria. In summary, these criteria are validity, data availability and quality, simplicity, recognition, objectivity and the able to be quantified.

Selection and assessment of social indicators of vulnerability

The study used the 2002 national census as the main source of data on indicators. The census datasets are disaggregated by villages. Within villages, the census disaggregates data by number of persons (e.g., to

quantify ethnicity and gender) and by number of households (e.g., to determine access to drinking water, and home ownership). For the study, the units of analysis used were the number of villages, the number of persons in a village, and the number of households in a village.

Eight variables from the Guyana 2002 census data were considered and are discussed in **Table 2**.

TABLE 2: Discussion of selected variables

SELECTED SOCIAL INDICATORS	**DISCUSSION**
Age	The two demographic groups most affected by disasters are children and the elderly. The higher the proportion of these categories in the population, the higher the level of vulnerability at the individual, household and community levels. Children and the elderly are more vulnerable during natural disasters because they are less independent and less able to move on their own. The study categorised children as persons under 5 years and the elderly as over 65 years.
Gender	Social vulnerability studies normally consider females to be more vulnerable than men in the face of natural disasters (see, for example, Cutter et al, 2003). The ECLAC report on Guyana's 2005 flood supports this hypothesis by identifying four causes of female vulnerability in Guyana: (i) the significant proportion of women who have responsibility for household management, estimated at over 30% of households. The report points to the continued emigration of men to the Caribbean and North America in search of employment as possibly exacerbating the situation. We can add another factor that of the exodus of men from coastal villages to the Hinterland mining districts in search of gold and diamonds. (ii) The low labour force participation rate of women (approximately 39% compared to the male rate of 81%, and the high level of female unemployment at 18%, twice that of the male rate). (iii) The burden for the rearing of children, and care for the elderly.

	(iv) Other forms of economic disempowerment, such as lack of access to bank credit, lack of training and other forms of support. (v) Incapacity to recover from flood losses, as a result of the factors stated above. In the absence of specific data at the village level on the female condition, this study used the proportion of women in the village population as a proxy measure of this indicator of social vulnerability.
Education	Persons with less education are considered more vulnerable than those with higher levels of education. This study considered persons with less than secondary education as the indicator of vulnerability.
Water	Households that depend on their drinking water supply from the pipes in the yard or standpipes are considered more vulnerable than the other categories in the census data.
Ownership/tenancy	Cutter et al (2003) argue that renters are more vulnerable than home owners because they are likely to be poorer and have fewer shelter options. We further assumed that renters, apart from having less financial resources than home owners, are likely have to wait on the willingness of their landlords to effect repairs to their dwellings caused by flooding. Renters are therefore less able to resist a flood as well as to recover from it.
Occupation	Villagers who engage in, and depend for a livelihood on, agriculture activities (such as cash crop farming, and animal rearing) and fishing are more vulnerable from flood damage. They are at risk of suffering greater financial losses. Their recovery depends on acquiring bank credit and government support.
Disability	Disabled persons are more vulnerable due to their less mobility.
Toilet type	Households who depend on pit latrines are more vulnerable because they would be unable to use the facility during a flood and may be at a greater health risk.

The census data do not provide a few other key indicators (either at all or at the suitable unit of analysis) useful for a social vulnerability assessment at the village scale in Guyana. These include family size within households (bigger households are considered more vulnerable than small ones), type of dwelling by height above ground (houses with ground floors would be more vulnerable than those raised on posts), and complete information on the living conditions of women (considered an important factor of coping capacity).

Ethnicity was not used as a possible indicator of vulnerability despite its use in several well-recognised studies (for example, see Cutter et al, 2003). Guyana is an ethnically diverse society in which real or perceived differences exist in how the national and local governments relate to citizens. The political climate in Guyana has long been characterised by persistent charges of discrimination, victimization and lack of transparency in the allocation of state resources such as land, contracts and job opportunities.

The response efforts by the government during the 2005 flood did not escape these allegations. Communities (mostly populated by Afro-Guyanese) that support the main opposition party felt they were receiving less aid than communities that supported the government electorally (mostly indo-Guyanese). Though ethnicity is an empirically-supported and commonly-used indicator in social vulnerability measurements, this study did not consider it for several reasons. For one, it would be difficult in Guyana to separate perception from reality. Secondly, hard and objective datasets are unavailable that compare the various ethnic groups in terms of their family structure, propensity for saving money, community support structures and other factors that may affect their relative vulnerability.

In addition, this study did not differentiate between the indicators that speak to people's capacity to resist a flooding event (such as income level, and type of dwelling) and those that relate to their capacity to recover after a flood (such as their source of livelihood, extent of family support network, and effectiveness of national and local administration). While resistance and recovery are a worthwhile distinction, the census data do not provide adequate indicators to make separate assessments of these two aspects of vulnerability.

It is acknowledged that an analysis based on twelve-year old census datasets may seem locally to be of limited value today. Notwithstanding the fact that no recent census data has been released, the use of the 2002 data carries two essential advantages for work of this nature:

(i) the major floods on the coast in 2005 and 2006, occurring several years after the census, could allow the conclusions in the study to be tested and

verified against actual events. This study did not undertake any such testing in this phase but strongly recommends such an approach should funding become available.

(ii) the analysis of 2002 data establishes a reference point for future vulnerability assessments using the next and subsequent census reports. Guyana can begin to track any trends in the social vulnerability of its people to floods.

Normalization and orienting of selected social indicators

For each selected indicator, the census datasets were normalised to per cent (or to the decimal equivalent) to convert the absolute values to relative numbers. These relative values for each indictor were then selected so that higher values would mean higher levels of social vulnerability, and lower values lower levels.

Determination and ranking of social vulnerability across communities

The study calculated a composite index of all the indicators for each village. The index was first calculated by attaching equal weight to all eight indicators and simply adding together their values. The use of equal weights is advised in light of the absence of local studies on the relative importance of the indicators. Regardless, we recommend the use of equal weights to avoid disparities across studies based on possible disagreements among researchers in determining relative weights.

In several other studies, the totals from the addition would then be categorised into high to low vulnerability by using quantiles or standard deviations above and below the mean. For our purposes, this initial computation of composite indices did not, however, disaggregate the villages in a satisfactory manner. Several villages, for instance, ended up with similar scores but had different distributions of values across the eight social indicators. The indicators in the village of Success, for example, were close to the average value for each indicator. Similarly-indexed Virginia, a village on the Upper East Coast, on the other hand, had several values well above the mean (**Table 3**).

Nor did the initial indices provide any idea of how many indicators were the main contributors to the index. Villages with similar scores could be vulnerable on account of one major social indicator or several high-value indicators. Without these insights, it is posited, a vulnerability assessment would be less useful for decision-making.

To compensate for these defects in the initial composite indices, the study introduced a second factor based on the number of high-impact vulnerability indicators for each village. A high-impact factor was defined as an indicator whose value is significantly higher than the mean of all values of that indicator across the villages. Through several iterations, it was found that 0.8 (80%) of the standard deviation provided the most appropriate one-size-fit-all threshold value across all indicators to identify high-impact indicators.

High-impact vulnerability indicators were identified for each village as those values equal to or greater than these threshold values, (shaded cells in **Table 3**). The number of such high-impact factors was multiplied by the initial composite indices to arrive at final composite indices. For villages with no high-impact indicator, the initial composite indices were used to rank them.

This approach allows a clearer insight into the causes and differences in vulnerabilities across villages. For example, the villages of Buxton, Helena No 1, Victoria and Lancaster have similar **initial** composite indices and consequently share the same ranking, although Buxton and Victoria are highly vulnerable across several social indicators, while Helena and Lancaster are less so (**Table 3**). Introducing the number of high-impact indicators in the index calculation separates the villages: Buxton and Victoria are now in the top 20% of vulnerable villages, Lancaster in the second 20% and Helena No. 1 in the fourth quintile. This approach therefore more effectively identifies villages that have several unfavourable social indicators.

The ranking of villages was based on quintiles (20% divisions), producing five groupings: high, high to medium, medium, medium to low, and low. The use of quintiles allowed for a more refined separation of indices and

prevented villages with large differences in indices to end up in the same class. Quintiles are also more likely to be understood by local stakeholders as compared to the rankings based on standard deviation.

Verification of assessment from other sources

In an attempt to test the measurements and conclusions on social vulnerability made in this study, we looked for evidence from other studies or reports. While this effort produced very little and inconclusive results, some lines of evidence supported the assessments in the study. We list these below:

(i) The Civil Defence Commission (CDC) in Guyana (the agency responsible for disaster preparedness and response) reports that in two agricultural villages just outside the eastern flank of the study area, the flood of 2005 damaged over 2000 acres of rice and several hundreds of thousands of US$ worth of cash crops. The 2008-2009 flood was worse, with water reaching about 7 feet (2.1 metre) in the agricultural land.

The study identified occupation (agriculture and fishing) for villages in this area as a high-risk indicator of vulnerability. The CDC data provide some good justification for this conclusion.

(ii) As reported on the website of the United Caribbean Trust, the Guyana Citizens Initiative for Flood Relief (GCIFR), a group of professionals formed to contribute to the national response to the disastrous 2005 flood, issued special appeals for aid for three communities: Buxton, Bachelor's Adventure, and Good Hope (**Table 3**), suggesting the existence of exceedingly dire circumstances in these villages. These villages have several high-risk vulnerability indicators and are in the first (high), second (high to medium) and third (medium) quintiles, respectively.

PRESENTATION AND DESCRIPTION OF RESULTS

For objectives 1 and 2, the results were shown in tables and maps. **Table 3** shows all the normalised values for the eight selected social variables for each village, in addition to the initial composite indices, the type and number of high-impact factors (shaded cells) and the final composite indices. **Table 4** shows the ranking by quintiles of the social vulnerability of villages to floods.

Results were also shown in overlays on Google Earth maps for each village within the study area. Only maps using the final composite indices were made. The colour code is explained underneath each map. Each of the maps shows the villages within their NDCs (see **Map 3 and 4** as examples). Displaying the village results by NDC allows assessments and interventions to be made conveniently within established local government units. **Map 5** shows the village results on one map.

Results for twelve villages were "not shown" on the map, either because of incomplete data on the selected indicators or extremely small populations at the time of the census.

TABLE 3: Determination of indices of social vulnerability of ECD villages to floods (orange cells indicate values => 80% SD + mean)

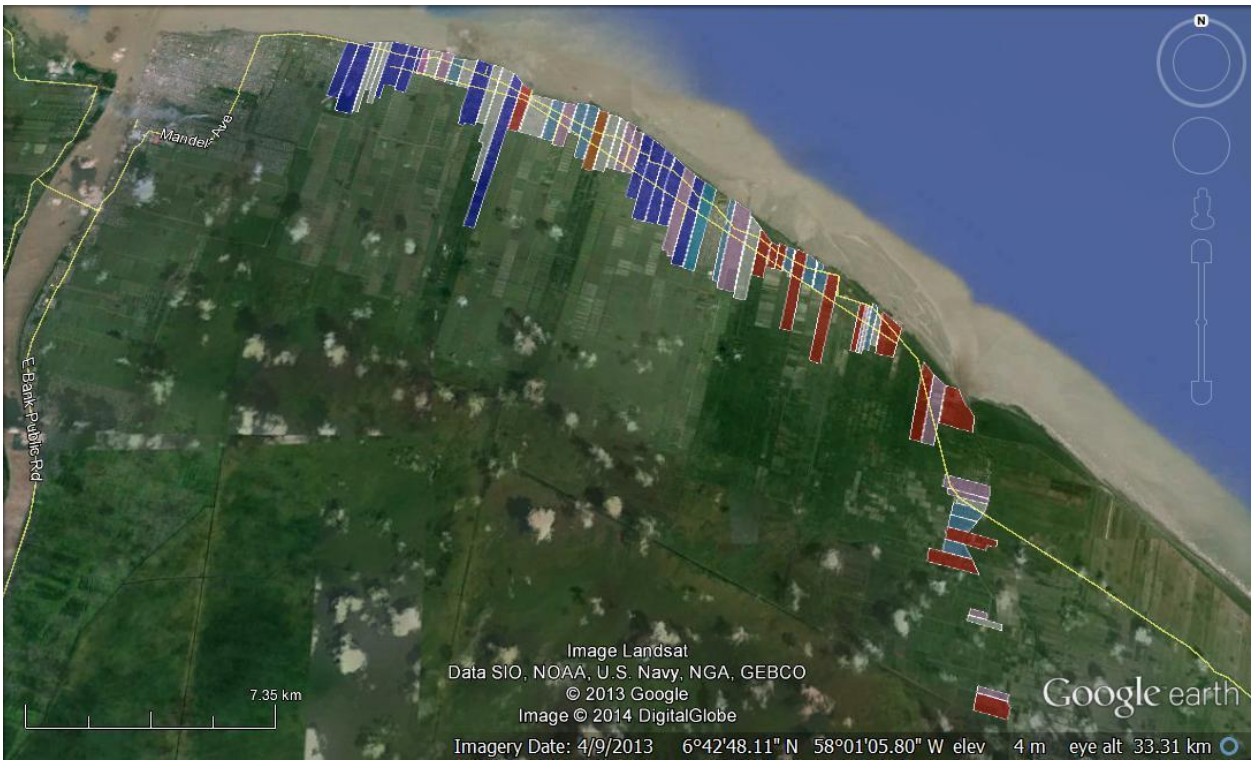
Vill #	Village name	AGE	GENDER	EDUCATION	WATER	OWNERSHIP	OCCUPATION	TOILET	DISABILITY	INITIAL COMPOSITE INDEX (C+D+E+F+G+H+I+J)	NUMBER OF HIGH IMPACT INDICATORS	FINAL COMPOSITE INDEX (K * L)
		% persons 5 yrs and younger and 65 yrs and older	% Females	% persons with education below secondary	% use of yard or standpipes by households	% renters by households	% persons engaged in agriculture and fishing	% latrines by households	% disabled			
A	B	C	D	E	F	G	H	I	J	K	L	M
5	Cane Grove	0.15	0.49	0.52	0.37	0.04	0.65	0.77	0.04	3.02	3	**9.07**
6	Virginia	0.17	0.49	0.35	0.31	0.08	0.55	0.70	0.03	2.68	3	**8.04**
11	Uplands*											-
12	Bagatelle	0.13	0.50	0.36	0.01	0.06	0.51	0.72	0.05	2.35	2	**4.69**
13	Strathavon	0.16	0.47	0.46	0.84	0.05	0.43	0.73	-	3.14	2	**6.29**
15	Joyce Phillips*	0.13	0.49	0.60			0.18		0.02			-
16	La Bon Mere*											-
18	Mary's Hope*											-
19	Vereeniging	0.18	0.51	0.54	0.52	0.03	0.44	0.89	0.01	3.14	4	**12.54**
20	Supply	0.18	0.49	0.47	0.59	0.09	0.39	0.76	0.02	2.99	1	**2.99**
21	Belmont	0.14	0.48	0.50	0.71	0.05	0.40	0.79	0.03	3.09	3	**9.28**
22	Helena No.1	0.17	0.49	0.43	0.57	0.15	0.28	0.76	0.02	2.86	1	**2.86**
23	Helena No.2	0.14	0.49	0.41	0.19	0.16	0.48	0.72	0.02	2.61	1	**2.61**
24	Good Hope	0.14	0.50	0.40			0.43		0.02	1.49	1	**1.49**
25	Hand En Veldt	0.15	0.51	0.44	0.53	0.13	0.34	0.81	0.03	2.93	2	**5.87**
26	Voorzigtigheid	0.15	0.52	0.23	0.65	0.14	0.15	0.85	0.02	2.71	3	**8.13**
27	Good Intent*											-
28	Cambridge*											-
29	Tranquility Hall*											-
30	Spring Hall*											-
31	Mosquito Hall	0.18	0.47	0.82	0.88	0.03	0.73	0.93	0.01	4.04	5	**20.21**
32	Lancaster	0.14	0.49	0.48	0.23	0.09	0.64	0.74	0.03	2.84	2	**5.68**
33	Unity	0.11	0.50	0.37	0.65	0.08	0.51	0.78	0.04	3.04	3	**9.13**
34	Grove*											-
35	Orange Nassau*											-
36	Greenfield	0.15	0.48	0.50	0.58	0.04	0.76	0.94	0.03	3.48	4	**13.93**
37	Bee Hive	0.17	0.52	0.48	0.02	0.07	0.35	0.63	0.02	2.25	2	**4.49**
38	Clonbrook	0.14	0.49	0.40	0.30	0.12	0.46	0.62	0.02	2.56	1	**2.56**

A	B	C	D	E	F	G	H	I	J	K	L	M
39	Anns Grove	0.19	0.50	0.34	0.39	0.16	0.13	0.73	0.06	2.50	2	**5.01**
40	Two Friends	0.18	0.50	0.28	0.48	0.14	0.19	0.82	0.02	2.62	2	**5.24**
41	Dochfour	0.18	0.50	0.41	1.00	0.08	0.60	0.99	0.01	3.76	4	**15.05**
42	Hope*											-
43	Lowlands	0.14	0.46	0.67	0.61	0.02	0.88	0.94	0.01	3.73	3	**11.19**
44	Nooten Zuil	0.13	0.49	0.42	0.46	0.03	0.26	0.79	0.02	2.60	0	-
45	Belfield	0.20	0.51	0.22	-	0.08	0.07	0.36	0.06	1.49	2	**2.98**
46	Victoria	0.18	0.50	0.29	0.70	0.18	0.18	0.80	0.01	2.84	4	**11.35**
47	Craig Milne	0.16	0.48	0.43	0.55	0.14	0.26	0.74	0.03	2.80	1	**2.80**
48	Cove	0.10	0.51	0.55	0.96	0.10	0.49	0.71	0.04	3.46	4	**13.85**
49	John	0.17	0.52	0.55	0.52	0.17	0.10	0.69	0.06	2.79	4	**11.14**
50	Nabaclis	0.20	0.53	0.29	0.66	0.18	0.18	0.69	0.02	2.74	4	**10.96**
51	Golden Grove	0.18	0.52	0.29	0.50	0.13	0.17	0.69	0.02	2.49	2	**4.98**
52	Haslington	0.18	0.51	0.30	0.65	0.08	0.22	0.78	0.02	2.74	2	**5.47**
53	Enmore	0.15	0.53	0.43	0.40	0.11	0.18	0.68	0.02	2.50	1	**2.50**
54	Hope*	0.14	0.49	0.43			0.25		0.04			-
55	Foulis	0.13	0.50	0.47	0.45	0.03	0.24	0.86	0.01	2.68	1	**2.68**
56	Paradise	0.14	0.52	0.29	0.25	0.10	0.09	0.35	0.01	1.76	1	**1.76**
57	Bachelor's Adventure	0.20	0.50	0.34	0.59	0.08	0.16	0.82	0.02	2.72	2	**5.44**
58	Elizabeth Hall	0.15	0.51	0.34	0.28	0.10	0.13	0.44	0.02	1.98	0	-
59	Enterprise	0.15	0.50	0.38	0.32	0.09	0.13	0.42	0.02	2.01	0	-
60	Non Pariel	0.15	0.50	0.45	0.37	0.06	0.31	0.60	0.01	2.45	0	-
61	Coldingen	0.17	0.47	0.43	0.32	0.11	0.04	0.49	0.02	2.06	1	**2.06**
62	Strathspey	0.15	0.52	0.48	0.50	0.10	0.18	0.85	0.02	2.79	2	**5.58**
63	Bladen Hall	0.14	0.52	0.37	0.62	0.06	0.18	0.78	0.02	2.68	2	**5.35**
64	Vigilance	0.16	0.52	0.40	0.54	0.08	0.13	0.77	0.02	2.61	1	**2.61**
65	Friendship	0.18	0.53	0.41	0.47	0.17	0.06	0.73	0.03	2.58	3	**7.75**
66	Buxton	0.18	0.54	0.29	0.72	0.20	0.17	0.76	0.03	2.88	5	**14.41**
67	La Reconnaissance	0.15	0.50	0.42	0.55	0.15	0.18	0.70	0.03	2.68	1	**2.68**
68	Annandale	0.13	0.51	0.48	0.41	0.15	0.30	0.68	0.03	2.70	1	**2.70**
69	Lusignan	0.15	0.49	0.52	0.42	0.10	0.20	0.77	0.03	2.68	2	**5.36**
70	Nog Eens and Two fri	0.14	0.49	0.47	0.50	0.11	0.12	0.70	0.03	2.54	1	**2.54**
71	Good Hope	0.16	0.49	0.50	0.40	0.05	0.15	0.80	0.02	2.56	2	**5.11**

A	B	C	D	E	F	G	H	I	J	K	L	M
72	De Endragt	0.13	0.50	0.51	0.57	0.09	0.22	0.80	0.04	2.86	3	**8.57**
73	Mon Repos	0.12	0.49	0.43	0.40	0.12	0.18	0.68	0.02	2.46	0	-
74	Triumph	0.14	0.50	0.38	0.53	0.19	0.17	0.61	0.03	2.56	2	**5.13**
75	Beterverwagting	0.17	0.51	0.27	0.46	0.24	0.12	0.58	0.02	2.37	2	**4.75**
76	La Bonne Intention	0.13	0.50	0.36	0.32	0.15	0.10	0.46	0.02	2.05	0	-
77	Chateau Margot	0.12	0.50	0.41	0.41	0.21	0.13	0.55	0.04	2.37	2	**4.74**
78	Success	0.15	0.49	0.46	0.58	0.14	0.14	0.68	0.02	2.67	0	-
79	Le Resouvenir	0.14	0.50	0.56	0.37	0.16	0.28	0.69	0.03	2.73	2	**5.46**
80	Felicity	0.13	0.51	0.49	0.02	0.23	0.04	0.25	0.01	1.67	2	**3.34**
81	Montrose	0.13	0.54	0.39	0.14	0.27	0.06	0.24	0.03	1.80	3	**5.39**
82	Brothers	0.14	0.52	0.38	0.30	0.13	0.18	0.42	0.02	2.09	1	**2.09**
83	Vryheids Lust	0.13	0.51	0.33	0.52	0.15	0.08	0.50	0.02	2.24	0	-
84	Better Hope	0.14	0.50	0.39	0.39	0.16	0.13	0.64	0.04	2.38	1	**2.38**
85	Plaisance	0.16	0.53	0.23	0.46	0.37	0.03	0.45	0.02	2.26	2	**4.52**
86	Sparendaam	0.16	0.53	0.29	0.45	0.25	0.03	0.52	0.02	2.26	2	**4.52**
87	Goedverwagting	0.15	0.52	0.31	0.49	0.19	0.03	0.51	0.02	2.22	2	**4.44**
88	Ogle	0.14	0.51	0.38	0.25	0.20	0.03	0.38	0.02	1.92	1	**1.92**
89	Industry	0.14	0.51	0.36	0.26	0.17	0.11	0.45	0.02	2.02	0	-
90	Cummings Lodge	0.12	0.50	0.36	0.32	0.18	0.06	-	0.02	1.56	1	**1.56**
MEAN		0.15	0.50	0.41	0.46	0.13	0.25	0.66	0.03	2.58		
Standard Deviation (SD)		0.02	0.02	0.10	0.21	0.07	0.20	0.19	0.01	0.51		
80% of SD		0.02	0.01	0.08	0.16	0.05	0.16	0.15	0.01	0.41		
80% SD + MEAN		**0.17**	**0.52**	**0.50**	**0.62**	**0.18**	**0.41**	**0.81**	**0.03**			

TABLE 4: Villages by social vulnerability index (in quintiles)		
VILLAGE #	NAME OF VILLAGE	FINAL COMPOSITE VULN INDEX
31	Mosquito Hall	20.21
41	Dochfour	15.05
66	Buxton	14.41
36	Greenfield	13.93
48	Cove	13.85
19	Vereeniging	12.54
46	Victoria	11.55
43	Lowlands	11.19
49	John	11.14
50	Nabaclis	10.96
21	Belmont	9.28
33	Unity	9.13
5	Cane Grove	9.07
72	De Endragt	8.57
26	Voorzigtigheid	8.13
6	Virginia	8.04
65	Friendship	7.75
13	Strathavon	6.29
25	Hand En Veldt	5.87
32	Lancaster	5.68
62	Strathspey	5.58
52	Haslington	5.47
79	Le Resouvenir	5.46
57	Bachelor's Adventure	5.44
81	Montrose	5.39
69	Lusignan	5.36
63	Bladen Hall	5.35
40	Two Friends	5.24
74	Triumph	5.13
71	Good Hope	5.11
39	Anns Grove	5.01
51	Golden Grove	4.98
75	Beterverwagting	4.75
77	Chateau Margot	4.74
12	Bagatelle	4.69
85	Plaisance	4.52
86	Sparendaam	4.52
37	Bee Hive	4.49
87	Goedverwagting	4.44
80	Felicity	3.34
20	Supply	2.99
45	Belfield	2.98
22	Helena No.1	2.86
47	Craig Milne	2.80
68	Annandale	2.70
55	Foulis	2.68
67	La Reconnaissance	2.68
78	Success	2.67
23	Helena No.2	2.61
64	Vigilance	2.61
44	Nooten Zuil	2.60
38	Clonbrook	2.56
70	Nog Eens and Two friends	2.54
53	Enmore	2.50
73	Mon Repos	2.46
60	Non Pariel	2.45
84	Better Hope	2.38
83	Vryheids Lust	2.24
82	Brothers	2.09
61	Coldingen	2.06
76	La Bonne Intention	2.05
89	Industry	2.02
59	Enterprise	2.01
58	Elizabeth Hall	1.98
88	Ogle	1.92
56	Paradise	1.76
90	Cummings Lodge	1.56
24	Good Hope	1.49

MAP 1: Social Vulnerability Map (Floods) – East Coast Demerara, Guyana	
Name of villages (W – E)	**Cummings Lodge to Cane Grove** (Villages are in order listed in Table 3)

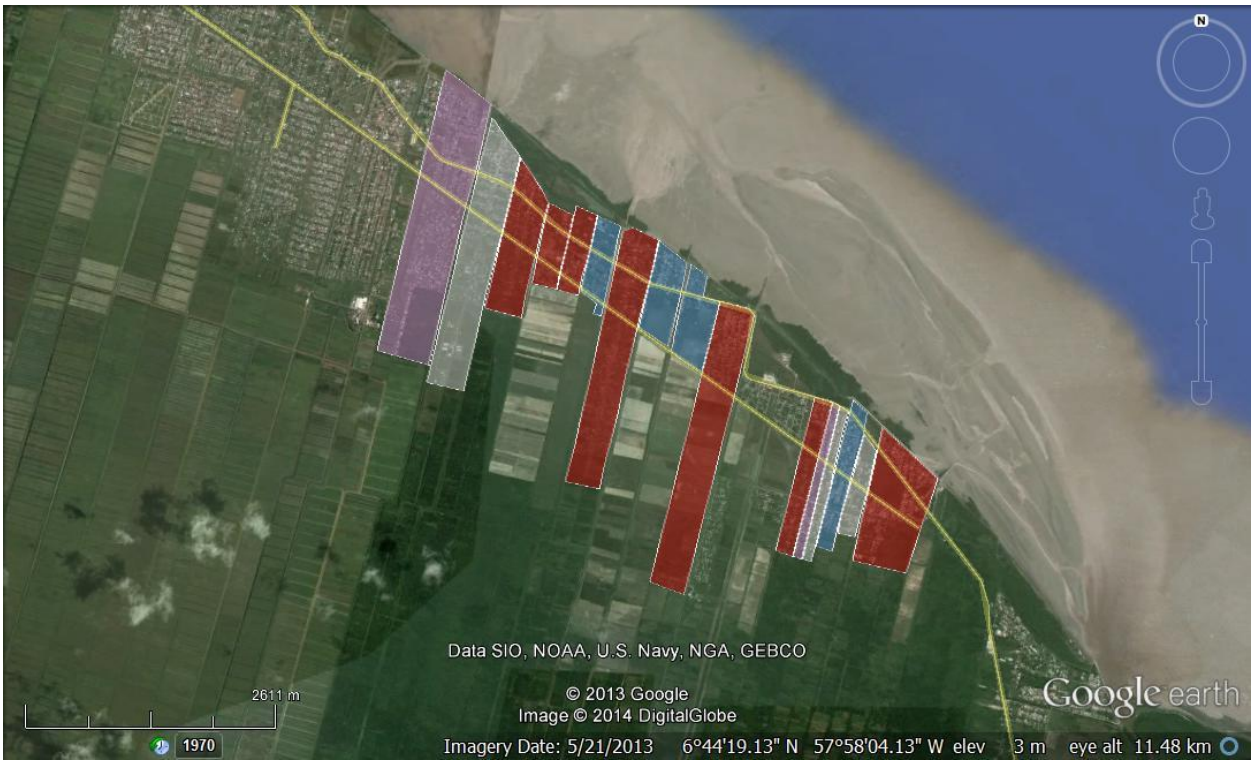


Composite Index of vulnerability	**High 20%**	**High-medium**	**Medium**	**Medium - low**	**Low 20%**

MAP 2: Social Vulnerability Map (Floods)	
Name of NDC	**La Reconnaissance- Mon Repos**
Name of villages (W - E)	Mon Repos, De Endragt, Good Hope, Nog Eens and Two friends, Lusignan, Annandale La Reconnaissance.

Composite Index of vulnerability	**High 20%**	**High-medium**	**Medium**	**Medium - low**	**Low 20%**

MAP 3: Social Vulnerability Map (Floods)	
Name of NDC	**Grove - Haslington**
Name of villages (W - E)	Haslington, Golden Grove, Nabaclis, John, Cove, Craig Milne, Victoria, Belfield, Nooten Zuil, Lowlands, Hope (not shown), Dochfour, Two Friends, Anns Grove, Clonbrook, Bee Hive, Greenfield, Orange Nassau (not shown), Grove (not shown).



Composite Index of vulnerability	**High 20%**	**High-medium**	**Medium**	**Medium - low**	**Low 20%**

DISCUSSION OF RESULTS

As the results in this study are based on the 2002 census data, several cautions need to be taken. For one, new housing schemes and population shifts would have changed the size of occupied areas, and the population size and composition within villages. A few socio-economic variables, however, would remain relatively stable over long periods of time, such as main economic activity and age composition. Nonetheless, the 2002 data, and conclusions drawn from them, should be interpreted only as indicative of the present-day situation.

As a base position, all villages along the coast of Guyana are significantly vulnerable to the impacts of floods. The results are therefore not to be interpreted as indicating absence or presence, or major or minor levels, of vulnerability across villages. Rather, the results allow decision-makers to gauge the coping capacity of communities to resist and recover from major flood events. They allow assessments to be made as to the extent and nature of this vulnerability. Interventions therefore could be targeted and informed. No doubt, villages with several high-impact vulnerability indicators will require special attention. But there is no such thing as a safe village.

The results show that even adjacent villages can have different levels of vulnerability. Mon Repos, for example, is classified in the low category of social vulnerability, while Triumph to its west is at a medium level, and De Endragt to its east is among the villages with the highest vulnerability (**Table 3** and **Map 2**). Such situations arise as a result of differences across short ranges in Guyana's population pattern, ethnicity, economic activity and occupation.

Villages in the upper East Coast of Demerara as a group are more vulnerable to flooding than those in the lower East Coast. Upper East Coast villages in general have higher proportions of their populations engaged in agriculture and with lower levels of education.

The influence of the number of rented households increases as a factor of social vulnerability the closer the villages are to Georgetown.

The data suggests that the cluster of villages between Buxton and Nabaclis has a small but noticeably higher proportion of females in their populations than other village clusters.

Use of yard pipes or standpipes by households is less a determinant of social vulnerability the closer the villages are to Georgetown (to the west).

Although this study did not separate coping capacity into capacity to resist and capacity to recover, we suggest that households and communities with high-risk vulnerability factors in agriculture/ fishing and renters would have a more difficult time to recover after a major flood.

Several factors possibly work to reduce social vulnerability on coastal Guyana, such as increased access to telecommunications and ownership of personal cell phones, increased ownership of televisions and radios, increased vehicle ownership, continued construction of new schools and other government buildings which could be used as shelters. On the other hand, factors tending to increase vulnerability may include continued lack of flood insurance, shortage of critical information on emergency response among villagers, and continued migration of men from the coast to the interior.

RECOMMENDATIONS

Assessment of social vulnerability at the village level should be an on-going exercise, well-planned and budgeted. To achieve greater impact and value, however, several requirements are advised:

(i) The official population and household surveys should be used to conduct social vulnerability assessments across all hazard-prone regions of Guyana. As the data cover all of Guyana, all areas could be assessed. The use of one and the same source of data will also allow consistency and reliability of measurements and comparisons across time and space.

(ii) The national census data should include village-level measurements of household size, height of dwelling above ground and more gender-specific information. Data on these indicators of social vulnerability can help to refine assessments of flood impacts.

(iii) The use of standard risk perception surveys should complement vulnerability assessments. Risk perception surveys measure people's knowledge, attitude, behaviour and feelings about flood hazards. According to Byrd (2009), questionnaires can provide valuable information to emergency management agencies for developing risk management procedures.

(iv) The results of vulnerability and other surveys should be disseminated in user-friendly formats to residents in villages. People in communities will be empowered to take action in their own interest.

(v) Systematic research should be conducted to test assumptions on correlation between social indicators and vulnerability of individuals, families and communities. While several assumptions may seem intuitively correct, or have been "proven" in other countries, such research in the Guyana context will increase reliability and accuracy of conclusions.

(vi) The weighted computation model used in this study should be further tested and adopted as the standard procedure. The use of a standard procedure would allow easier comparisons across time and space.

CONCLUSION

The ability of individuals and communities to resist and recover from disasters depends on their social and economic conditions, in particular their age, income level, access to health facilities, gender and education level. The UNEP's 2003 review of major vulnerability studies worldwide provides ample evidence of this functional relationship and the effort of governments and international agencies to understand and measure it.

Vulnerability assessments are policy oriented instruments aimed at mitigating or avoiding the negative impacts of disasters. They can be used to set priorities to ensure that mitigation measures protect the maximum number of people in a targeted and cost-effective manner.

The study shows that the national census datasets provide a highly useable and structured information base to assess social vulnerability to flooding of villages in Guyana. The periodic release of census data will facilitate periodic reviews of vulnerability and will therefore allow those involved in disaster management to refine and update their strategies.

We here emphasise that a weighting factor is necessary in calculations of vulnerability from the Guyana census data. Otherwise, the results would be hard to interpret and use.

The expected impacts of the study include:

- Improvement in flood disaster management at the national and community levels in terms of preparation, response and recovery.
- More data-based and research-based decision-making in terms of what, where and how resources should be deployed in disaster management planning.
- Empowerment of communities to self-organise in the face of flood risks.
- Advancement of the objectives of Guyana's Low Carbon Development Strategy.

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