Water and Water Resources: Key Drivers of Sustainable Development in the Caribbean.

Water Resources: Climate Change Predictions and Modelling

Vulnerability Assessment of Livelihoods in the Nariva Watershed, Trinidad and Tobago

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ABSTRACT

This study assessed the potential impact of climate variability on water access, water resources, ecosystem health, vulnerability and adaptive capacity, for residents of the Nariva watershed, Trinidad and Tobago.

The study calculated households' vulnerability levels, their use of water, and their observations of medium-term changes in the flora and fauna in their communities. A Livelihood Vulnerability Index (LVI) was created using six pillars: (i) environmental capital, (ii) physical capital, (iii) social capital, (iv) human capital, (v) economic capital, and (vi) natural disasters and perception of climate threat. This index was based on the Sustainable Livelihood Approach (SLA) framework.

The LVI for Nariva was 0.454 suggested medium vulnerability, a value of 1 indicates extreme vulnerability; 0 indicates little vulnerability. Of the six pillars, the environmental capital pillar contributed the most to vulnerability for Nariva (0.630) while the physical capital pillar contributed the least to vulnerability (0.351). One key result is that while the communities are classified as poor, most of the threat to water resources is derived from the ability to access and store sufficient quantities.

1. Introduction

Water is very important to the livelihoods of persons especially those living in developing countries. Availability and access to clean water is essential for promoting good health, several domestic uses, agriculture and in sustaining livelihoods. It is

important to assess the vulnerability of households, especially those in rural areas. This assessment is critical as it allows policy makers, state agencies and other support agencies such as NGOs to better understand the needs of those communities and so prioritize actions needed to reduce their vulnerabilities. According to Sullivan and Meigh (2005), as more and more persons have been impacted by both natural and man-made disasters, it has become necessary to get a clearer understanding of vulnerability in terms of what it means and how it can be measured.

In their 2007, report the IPCC defined vulnerability as "…the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC 2007)." Further, when assessing vulnerability especially as it relates to climate change, three key factors must be given consideration: exposure, sensitivity and adaptive capacity. As Fellman (2012) stated simply, a system that has high exposure and sensitivity, and low adaptive capacity is vulnerable as compared to a system where the reverse is true. Thus given the above mentioned facts, this paper constructed a Livelihood Vulnerability Index (LVI) to assess the vulnerability of households in the Nariva watershed. More specifically this study aims to calculate a Livelihood Vulnerability Index (LVI) for each household and for the community. Secondly, it identified the key sources of this vulnerability.

1.1. Site Description

Located on the east coast of Trinidad, the Nariva Swamp is the largest freshwater swamp in Trinidad and Tobago. The swamp covers an area of approximately 11,343 hectares and is considered very unique in the Caribbean due to its ecologically diverse system (IMA n.d.). The Nariva Swamp is one of only three (3) designated Ramsar sites

(1993) in Trinidad and Tobago, and its falls under three categories; a wildlife sanctuary, forest reserve and a prohibited area (Ramsar 1997). Traditionally, it has been used for small subsistence farming and artisanal fishing. The three main communities that were used for this study were Plum Mitan, Biche (situated on the north western side of the swamp) and Kernahan/Cascadoux (to the south east of the swamp).

2. Materials and Methods

In order to achieve the objectives set out, a survey of 343 households from Biche, Cascadoux/Kernahan and Plum Mitan was undertaken. The data which was collected through questionnaires via face to face interviews from August to October 2014 was pre-tested in March 2014. This questionnaire was broken up into six sections: (1) general environment; (2) change of climate; (3) benefits from nature; (4) access to water and quality of life; (5) family and community ties; and (6) socio-demographic information. Historical monthly total rainfall and monthly average temperature was obtained from the CIMH for the period 2004 to 2014.

The method of calculating the LVI is adopted from Hahn et al (2009) and Shah et al (2012) along with modifications that are relevant to the site and based on the inputs from the stakeholders within the communities.

For this study six (6) pillars were defined based on the available literature, they are (i) environmental capital, (ii) physical capital (iii) social capital, (iv) human capital (v) economic capital and (vi) natural disasters and climate variability. These pillars and their sub-components are depicted in Figure 1 below.

A five (5) step process was adopted for calculating the index. Firstly, questions were assigned to each sub-component, of each pillar. The direction of vulnerability was clearly established for each question. For questions such as "*How much water from all sources can you store at home?"*, persons who could store more water were deemed to have lower vulnerability. Answers ranged from [1] less than 100 gallons to [8] more than 800 gallons. Secondly, each response was normalized by applying the min-max normalisation formula $\left(\frac{S_d - S_{MIN}}{S_{MAX} - S_{MIN}} \right)$ so that all responses for all questions had the same range, 0 to 1. In this formula, S_d is the original response for household d and S_{MIN} and S_{MAX} are the minimum or maximum values of the responses for each question. Thirdly, the value of each household sub-component score was calculated as the average of all question scores for that sub-component. Fourthly, the household LVI score was calculated as the average of all sub-components. Finally, the watershed LVI was calculated as the weighted average of the community LVI scores, based on the number of households surveyed in Biche, Cascadoux/Kernahan and Plum Mitan.

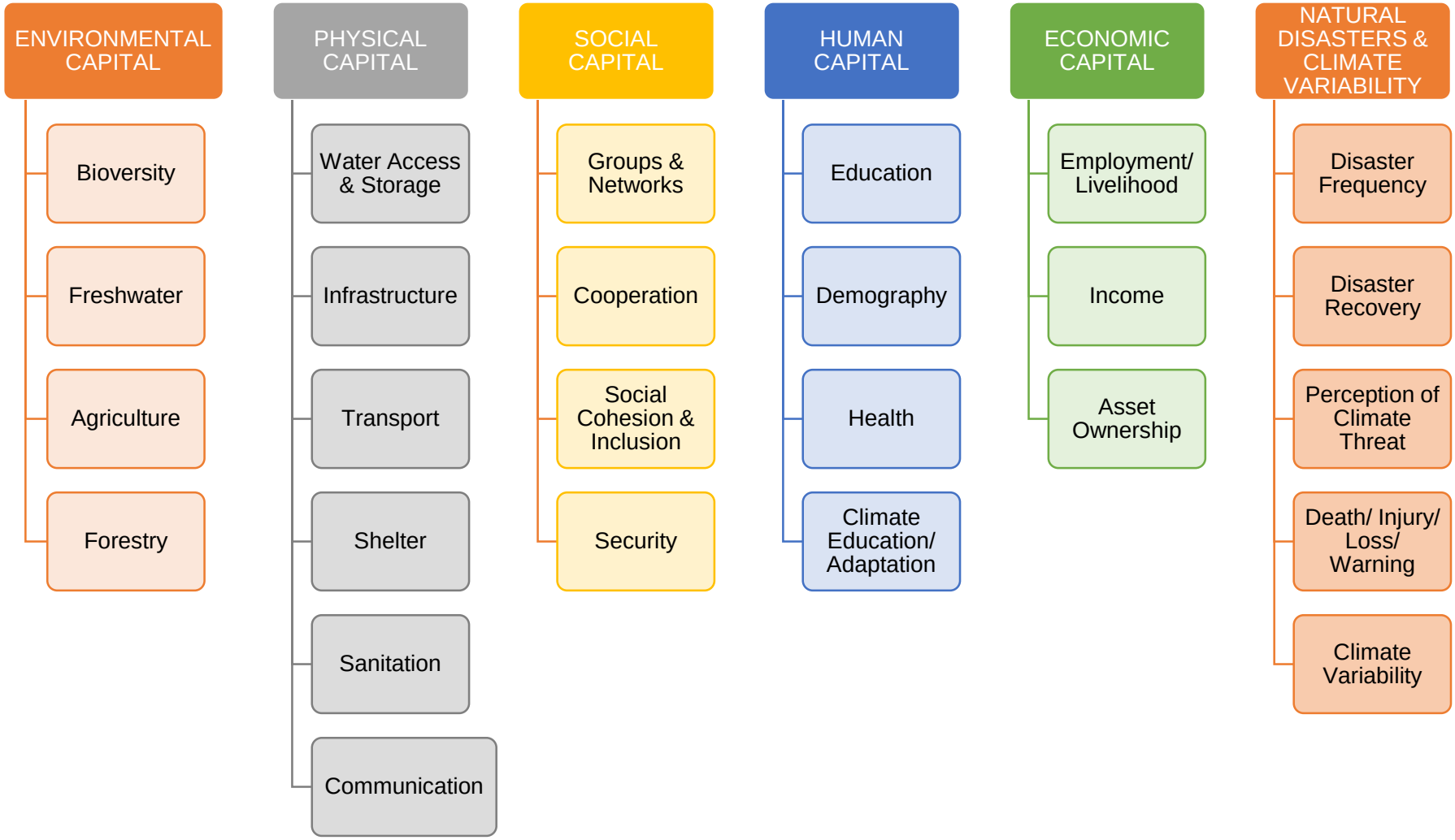

Figure 1: Pillars of the Livelihood Vulnerability Index (LVI) and their Sub-Components

Table 1 presents the breakdown of the range of vulnerability that can be achieved, where 0 indicates very low vulnerability and 1 indicates very high vulnerability.

Table 1: Categories and Description of the Different Vulnerably Levels

Very Low	Low	Medium Low	Medium	Medium High	High	Very High
0 - 0.14	0.15 - 0.28	0.29 - 0.42	0.43 - 0.56	0.57 - 0.70	0.71 - 0.84	0.85 - 1.00

Source: FEMA n.d.

3. Results and Discussion

The calculation of the LVI (see Figure 2) indicated that overall, Nariva had medium vulnerability (LVI = 0.454). Cascadoux/Kernahan was observed to be the most vulnerable community (not shown) while Plum Mitan was the least vulnerable of the three communities. As depicted in Figure 2, the Environmental capital pillar accounts for most of the vulnerability; LVI = 0.630 suggesting a medium high level of vulnerability. This vulnerability is attributed mainly to the agriculture sub-component. Based on the responses from Nariva, 48% of the respondents indicated they farmed that is, 11% indicated they engaged in livestock farming and 44% indicated they engaged in crop farming. Furthermore, for those respondents that indicated that they had farms, 36% were 5 or less acres in size.

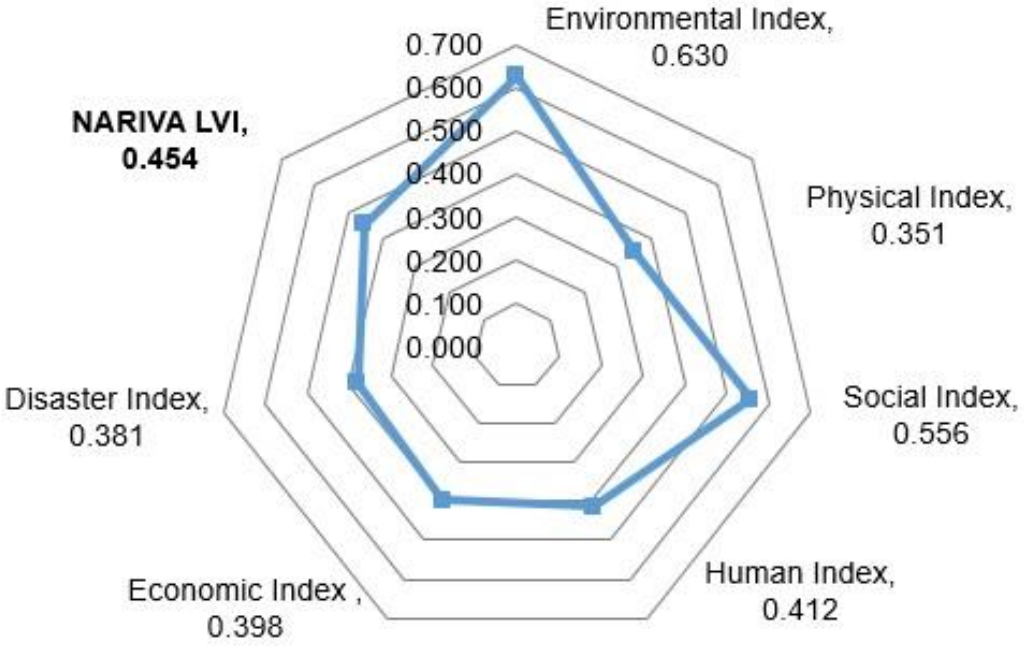

Figure 2: Livelihood Vulnerability Index Values by Pillar

After the Environmental capital pillar, the Social capital pillar (LVI = 0.556) accounted for the second highest level of vulnerability in the Nariva watershed, suggesting a medium level of vulnerability. This vulnerability is attributed to the cooperation and groups & networks sub-components which indicated that there was low participation in relying on groups as well as a low level of cooperation in the community. These results are supported by evidence obtained from the survey which indicated that more than half of the respondents, 62% indicated that they were not an active member of a community group or organization. Furthermore only 16% of the respondents stated that they obtained information on climate change from community groups while only 22.4% indicated that they strongly believed they could obtain assistance from persons in their community if the need arises. These results reflect similar findings to Hahn *et al* (2009)

that suggest that strong linkages in communities are crucial to reducing a community's vulnerability to extreme events.

The Physical capital pillar contributed the least to the vulnerability in Nariva (LVI = 0.351) suggesting a medium low level of vulnerability. Only 18% of respondents indicated that they received pipe borne water to their homes. This was a significant source of vulnerability in the watershed, however, more than half the respondents (58%) indicated that they can store more than 800 gallons of water which mitigated their vulnerability.

4. Conclusion

To conclude, the Nariva watershed has a medium level of vulnerability (LVI = 0.454) which indicates that there is room to further reduce their vulnerability. Furthermore, Cascadoux/Kernahan was observed to be the most vulnerable community while Plum Mitan was the least vulnerable of the three communities. The Environmental capital pillar accounted for most of the vulnerability; LVI = 0.630 suggesting a medium high level of vulnerability. This vulnerability is attributed mainly to the agriculture sub-component. Finally, the Social capital pillar accounted for the second highest level of vulnerability (LVI = 0.556) in the Nariva watershed, suggesting a medium level of vulnerability.

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