

# Vulnerability of the Fisheries Sector to Climate Change in Caribbean Small Island Developing States

## La Vulnerabilidad del Sector de la Pesca al Cambio Climático en el Caribe Los Pequeños Estados Insulares

## La Vulnérabilité Du Secteur de la Pêche aux Changements Climatiques dans les Caraïbes Petits États Insulaires

IRIS MONNEREAU<sup>1\*</sup>, ROBIN MAHON<sup>1</sup>, PATRICK MCCONNEY<sup>1</sup>, LEONARD NURSE<sup>1</sup>,  
RACHEL TURNER<sup>2</sup>, and HENRI VALLÈS<sup>3</sup>

<sup>1</sup>*CERMES, University of The West Indies (UWI), Cavehill Campus, St. Michael, BB 11000, Barbados.*

<sup>2</sup>*Environment and Sustainability Institute, University of Exeter, Penryn, Cornwall, TR10 9FE, United Kingdom.*

<sup>3</sup>*Department of Biological and Chemical Sciences, UWI, Cavehill Campus, St. Michael, BB 11000, Barbados.*

*\*[irismonnereau@gmail.com](mailto:irismonnereau@gmail.com).*

### ABSTRACT

*Climate change vulnerability has become prominent over the past decade in policy and academic literature. The impacts of climate change are considered to be highest in Least Developed Countries (LDCs) and Small Island Developing States (SIDS) compared to the other coastal nations. Furthermore, past national-level assessments of climate change vulnerability of fisheries sectors have indicated LDCs are most vulnerable than SIDS. We argue that the apparent higher vulnerability of LDCs relative to SIDS highlighted in previous assessments of the fishery sector is mainly due to methodological choices during these assessments, which conceal the vulnerability of the fisheries sector in SIDS. The latter can have widespread consequences for SIDS in the climate change debate. Guided by a vulnerability framework comprising three components – exposure, sensitivity and adaptive capacity - we have conducted a new national-level vulnerability assessment of the fisheries sector in LDCs, SIDS, and other coastal nations. Our results indicate that the vulnerability of the fisheries sector in SIDS is higher than suggested by previous assessments, showing that the choice methods during these assessments is important in determining the final outcome. We have also carried out a more detailed analysis of the vulnerability of the fisheries sector of the Caribbean SIDS using the same framework; this analysis shows the Caribbean SIDS are significantly more vulnerable to climate change than previous assessments have indicated. The fisheries sectors in the Greater Antilles and Lesser Antilles are particularly vulnerable to climate change.*

KEY WORDS: SIDS, climate change, vulnerability assessments

### INTRODUCTION

Climate change is one of the most serious threats facing all Caribbean countries. Projections for the Caribbean region by the Caribbean Community Climate Change Centre (CCCCC) and the recent AR5 report of the Intergovernmental Panel on Climate Change (IPCC) in 2014 underscore the urgent need for more attention to adaptation measures. Climate change impacts such as sea surface temperature increases, ocean acidification, increased intensity of storms, and sea level rise are expected to trigger a series of biophysical and socio-economic impacts on national fisheries (Brander 2007, Cheung et al. 2010, Mahon 2002). Increasing frequency and strength of extreme events such as tropical storms, hurricanes, and droughts also pose significant threats to coastal zones, maritime areas, and economies. The impacts on the fisheries sector will vary across regions and countries as a result of their exposure, sensitivity, and level of adaptive capacity. Understanding where the impacts of climate change on the fisheries sector have greatest social and economic significance is crucial as fisheries are important for food security, livelihoods and employment, and the generation of foreign exchange for national governments globally (Allison et al. 2009).

*Vulnerability assessments (VAs) based on a range of biophysical and socio-economic indicators have become the leading method to establish who and what is vulnerable to the negative effects of climate change Tschakert et al. 2013). VAs can help guide policy makers to target and implement effective adaptation initiatives by identifying those who are most vulnerable. There have been a number of VAs of the fisheries sector at the local and community level (Cinner et al. 2012; Marshall and Marshall 2007), yet only Allison et al. (2009) and Barange et al. (2014) have undertaken vulnerability assessments at the national-level to compare vulnerability levels among groups of states.*

In that regard, the two national-level studies on fisheries sector vulnerability to climate change identify Least Developed Countries (LDCs) as the most vulnerable country group relative to Small Island Developing States (SIDS). This outcome is interesting as although LDCs are considered to be vulnerable to extreme weather events and to lack the adaptive capacity needed to respond to climate change due to their fragile economies (Bruckner 2012, Soares et al. 2012), SIDS are also considered to be highly vulnerable to climate change. SIDS are often low-lying, small, and economically vulnerable states and located in the tropics and sub-tropics where changes in weather patterns due to climate change are expected to be most pronounced (Nurse et al. 2014).

The 51 recognized SIDS are dispersed across the Caribbean region and the Pacific, Atlantic, and Indian Oceans. There are 23 SIDS in the Caribbean, 20 in the Pacific, and 9 in the Atlantic, Indian, Mediterranean, and South China Sea (AIMS). Fisheries in the Caribbean provide important ecosystem services:

- i) Animal protein as many coastal communities consume fish as their main source of protein,
- ii) Livelihoods as the industry and trade generates direct and indirect employment,
- iii) Culture and aesthetics as featured domestically and in tourism marketing, and
- iv) As sources of income to governments through license fees, taxes, and foreign exchange earnings from exports.

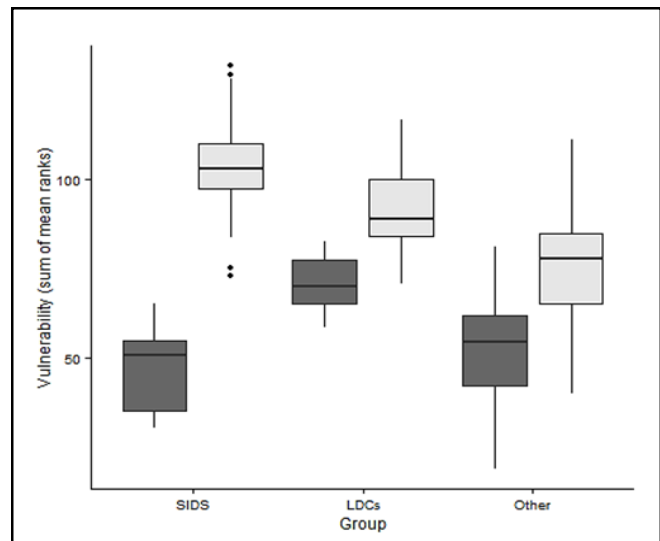
The challenges of sustainable development in the Caribbean region are numerous and diverse. The fisheries sector presents real opportunities for further economic growth, wealth creation and food security through diversification, innovation, market access, conservation, and regional cooperation (CRFM 2014). Caribbean fisheries, however, are under pressure from stressors including overfishing, loss of habitat, pollution, disturbance of coral reefs, and introduced species while climate change is expected to exacerbate this situation. Considering the high dependency of the sector in the region, and the pressures the sector is facing in the region examining the vulnerability of the fisheries sector in SIDS, is of particular importance both to help guide policy makers but also vulnerability rankings are used by large funders.

In this work in progress, we argue that the apparent higher vulnerability of LDCs relative to SIDS highlighted in the national-level vulnerability assessment of the fishery sector by Allison et al. 2009 is mainly the result of methodological choices during the assessments and that several shortcomings can be identified. The first is the use of a very small number of indicators, as a result of which the vulnerability outcome can be heavily influenced by one or two indicators. The second is the use of indicators for sensitivity and adaptive capacity that are not scaled to take into account the existing large differences among countries in human population size. The third is the varying representation of countries belonging to the LDCs and SIDS groups whereby often SIDS are being very poorly represented. The last is the lack of accounting for potential redundancy among indicators, which might lead to a disproportionate effect on the final vulnerability scores by those specific aspects of vulnerability that might be overrepresented with indicators. The sensitivity of vulnerability assessments to methodological choices is rarely examined in studies focusing on climate change. Guided by a vulnerability framework developed by Allison et al. 2009 comprising three components – exposure, sensitivity and adaptive capacity – we have re-assessed the

vulnerability of the fisheries sector to climate change in SIDS, LDCs, and other coastal nations after overcoming the four aforementioned methodological shortcomings. We have also focused in more detail on the outcome of these different assessments for the Caribbean region and concentrated in more detail on the vulnerability assessment of Caribbean countries. A more detailed understanding of the factors underlying exposure, sensitivity, and adaptive capacity can assist policymakers to make more appropriate choices regarding adaptation to climate change.

## RESULTS

Our results indicate that while SIDS were least vulnerable and LDCs most vulnerable in the analysis by Allison et al. 2009, in the re-assessments SIDS are most vulnerable (Figure 1) (Monnereau et al. 2015). This demonstrates that the very high vulnerability of the fisheries sector to climate change in SIDS has been concealed in previous national-level assessments. It also highlights that methodological choices made in VAs can have profound effects on outcome, and therefore, that these choices need to be made more explicit in these assessments. When we examined the underlying components our results showed that LDCs were most vulnerable in adaptive capacity while SIDS are most vulnerable in sensitivity.

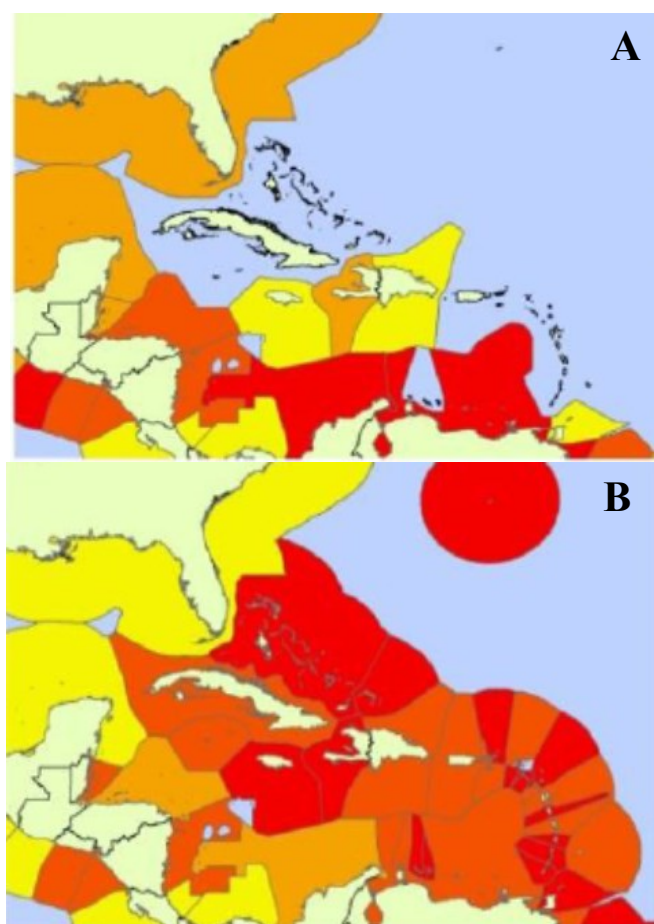


**Figure 1.** Change in vulnerability ranking of SIDS, LDCs and other coastal countries between Allison et al. 2009 and our final re-assessment.

Due to the high dependence in the Caribbean on marine resources, and the high vulnerability of fisherfolk and fisheries infrastructure in the coastal zone, plus increasing intensity of extreme-weather events, there is rising concern over the consequences of climate change and climate variability for the fisheries sector in the region. However, the Wider Caribbean region was particularly under-represented in the analysis by Allison et al. (2009), as only 14 out of the 28 Wider Caribbean states were in-

cluded and none of the small island overseas territories of the region. Figure 2 shows that successive analyses from the assessment based on the data by Allison et al. 2009 to our final re-assessment based on a much larger set of countries in the region and a broader set of indicators (35 versus 10). Figure 2 shows that while in the first analysis it is mostly coastal countries that are most vulnerable, and in the latter analysis the Lesser and Greater Antilles come out as most vulnerable. Inclusion of countries, choice of indicators and number of indicators as well as the type of statistical analysis thus all have explicit consequences for the vulnerability ranking of the fisheries sector in Caribbean countries.

Examination of the three components for all Caribbean SIDS shows that the Lesser Antilles and Greater Antilles are extremely vulnerable in exposure, yet their vulnerability in sensitivity show mixed results. For adaptive capacity, except for Haiti and Grenada, most Caribbean SIDS are not highly vulnerable in the adaptive capacity component. For the cumulative vulnerability score our results show that the fisheries sector in the Greater Antilles and Lesser Antilles are particularly vulnerable to climate change. The Central



**Figure 2.** Change in vulnerability ranking of countries in the Wider Caribbean region between Allison et al. 2009 and our final re-assessment.

American countries are somewhat less vulnerable to climate change in comparison. Analysis of the Caribbean data undertaken to identify whether ‘clusters’ of countries with similar characteristics exist showed that no distinct grouping emerged.

By means of a Principal Component Analysis (PCA) we have distinguished the main underlying subcomponents within each component. The PCA indicates that for the Caribbean region in exposure *thermal stress* and *sea surface temperature change* are important underlying subcomponents explaining 61% of the variance. For sensitivity *coastal vulnerability* and *coastal health and protection* are the main underlying subcomponents (explaining 36% of the variance). In adaptive capacity, *socio economic vulnerability* and *extent EEZ and Marine Protected Areas (MPAs)* came out most strongly (explaining 41% of the variance). Identifying the ranking of different countries on these PCAs per country can help identify the most important pathways for adaptation need to be incorporated at the national level to mitigate climate change impacts. The ranking of Caribbean countries on these PCAs identify the areas of greatest concern to the countries and can help make recommendations to support fisheries sector adaptation to climate change.

This implies, for example, that those countries in the region ranking highly vulnerable in exposure (including subcomponents of thermal stress and sea surface temperature change) need to improve coral reef ecosystem health to build resilience to combat coral bleaching by means of coral reef restoration programs and improvement of water quality, and need to develop local and national expertise for better management of coral reef ecosystems through training of resource managers and decision-makers. It is important for countries with a high vulnerability in sea-surface-temperature to develop downscaled data on sea-surface-temperature change projections to assess the impacts thereof on key fish species in the Caribbean region as the data generated by global assessments is too coarse to be used a regional or national scale.

Those Caribbean countries with high levels of vulnerability in sensitivity (includes coastal vulnerability, coastal health and protection, coastal development threat, and fisheries dependency) can be aided by developing downscaled local models on impact projections of extreme weather events (e.g. flooding, coastal erosion) on coastal zones to help determine the most vulnerable areas or communities and building climate proof critical infrastructure (and provide boat hauling equipment for example) or relocate crucial infrastructure. Improving coastal health and protection are crucial and restoration of coastal wetlands has great potential to minimize the impacts on coastal communities of stronger hurricanes associated with climate change. In addition, there is the need to rehabilitate and protect ecosystems, such as mangrove forests, wetlands, seagrass beds, and salt marshes by limiting fishing therein and banning the use of

damaging fishing techniques. Countries ranking highly vulnerable in adaptive capacity can be aided by expand Marine Protected Areas (MPAs) and improve their management effectiveness in safeguarding coral reef ecosystem health. Improving fisheries management is important which can be done by, but not limited to, applying an *Ecosystem-based Approach to Fisheries* and precautionary approach and improve early warning systems (to storms and hurricanes) for the fisheries sector by means of for example improved technology used by fishers can contribute to the achievement of this objective.

### DISCUSSION

This assessment has shown that methodological choices have a great impact on vulnerability outcome of countries and country groups. Even though SIDS were least vulnerable in the analysis based on the data by Allison et al. (2009), they were most vulnerable in our final re-assessment after we had addressed several methodological shortcomings. The first vulnerability assessments of the fisheries sector to climate change only included a small number of Caribbean countries and underestimated the region's vulnerability. The re-assessment has shown that at the global level the fisheries sector in the Caribbean region is highly vulnerable to climate change. Our study argues for a more adequate inclusion of SIDS, and in particular of Caribbean SIDS, in fisheries sector climate change vulnerability analyses as their exclusion has concealed their actual vulnerability. Providing a platform where data related to climate change vulnerability of the Caribbean countries can be accessed would support future inclusion in vulnerability assessments.

Analysis of the Caribbean data undertaken to identify whether 'clusters' of countries with similar characteristics exist showed that no distinct grouping emerged. The fact that the cluster analysis did not reveal any distinct groupings of Caribbean countries is an indication that interventions to promote adaptation will need to be at the national and local level and/or programmed to include sets of countries that exhibit particular aspects of vulnerability. This research, which is still work in progress, will identify the full scope of underlying subcomponents of vulnerability for each Caribbean nation. This can guide policy recommendations to help climate change adaptation of the fisheries sector.

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