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Assessing the vulnerability of fishery- dependent households to extreme weather events in St. Lucia and exploring the role of index-based insurance in increasing their adaptive capacity

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ABSTRACT OF THESIS submitted by:

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for the degree of Master of Science and entitled: Assessing the vulnerability of fishery- dependent households to extreme weather events in St. Lucia and exploring the role of index-based insurance in increasing their adaptive capacity.

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The impact climate variability and extreme weather events is placing an enormous burden on the Caribbean fishery sector, source of livelihood and food security for a large part of its population. In Saint Lucia, these events are diminishing the low capacity of the artisanal fisherfolk communities to secure a steady income and food for their families. Parametric insurance products aimed at providing financial assistance to individuals and communities after an extreme weather event have been promoted in the country as a strategy to increase their capacity to adapt to a changing climate. Nevertheless, low uptakes have shown there are various limitations that diminish their potential effectiveness.

Local vulnerability assessments aimed at understanding how social, economic and environmental factors influence people's ability to adapt to natural hazards, are an important step to identify suitable adaptation strategies. This is especially important in the fishery sector, as vulnerability assessments have generally focused on the national level. By applying a quantitative index-based approach, this research has aimed to fill this knowledge gap by analysing the factors that contribute to livelihood vulnerability of fishery-dependent households to climate change variability and extreme weather-related events in Soufriere, Saint Lucia. Based on the latter, the role and potential determinants for the uptake of index-based insurance products for this target group has been investigated. Results highlight the importance of context-based assessments and the need for implementing a comprehensive risk management and development approach. Based on the findings, recommendations for implementing index-based insurance product for the fishery sector are provided.

Keywords: vulnerability, fisher folk, extreme weather events, livelihood, parametric insurance, index-based insurance.

To my beloved family

Para ti ma, por siempre creer en mí y darme las fuerzas para seguir adelante.

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"When you start working in the sea, you don't leave it. I don't know what it is, there is something there, you just can't quit (…) I am a fisher, and I will be one until the day I die"

(Fisher comment. Baron's Drive fishing community, Soufriere-Saint Lucia)

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INTRODUCTION

The latest Intergovernmental Panel on Climate Change (IPCC) report has confirmed that the climate system is changing in an unequivocal and unprecedented ways not seen for millennia (IPCC, 2014). Today, its repercussions are no longer mere prediction, as its intensity and speed are already impacting socio-ecological systems and, predominantly, transforming the context of people whose livelihoods depend on natural resources. Due to its climate-sensitive economy, social instability and geographically small size, the Small Island Developing States (SIDS) in the Caribbean are exceptionally vulnerable to the consequences of climate change. As the majority of its population inhabit in the coastal areas, and are highly dependable on marine and other coastal resources, the fishery sector, which supports the region´s food security (FAO, 2015), is considered one the most sensitive sectors in the region.

While it is difficult to predict how the impact of climate change will affect marine ecosystems and the domino effect on commercial species´ distribution and abundance, it is believed that it will overall diminish fish stocks and the subsequent harvest decline will endanger the livelihoods and food security of fishery-dependent households (Monnereau & Oxenford, 2017). In addition, the impact of climate change induced extreme weather events, recognized as the most common significant environmental hazards in the Caribbean (CRFM, 2012), is already placing an enormous burden on this region's fishery sector. These impacts are primarily impacting artisanal fisherfolk, considered the backbone of this industry. Among the plethora of adaptation strategies, over the last years, special attention has been given to risk management and financial strategies. Risk transfer mechanisms, specifically Climate Risk Insurance (CRI), if integrated into a broader climate risk management approach, has been identified as a potential adaptation strategy aimed to decrease people's vulnerability to low-frequency high-severity events, such as hurricanes and floods. (Le Quesne et al., 2017). Nevertheless, while the literature has widely recognized the benefits of such insurance-based solutions, pilots around the world have demonstrated that there are still many challenges to bring the perceived benefit to local people into fruition (Cole et al., 2013). Moreover, empirical evidence of the impacts of CRI mechanisms on local people´s well-being and its influence on their disaster risk management strategies at the medium-long run is lacking (Fernández & Schaefer, 2018).

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As the potential risks of natural hazards impact local communities in different ways, undertaking context-based studies, which assess the real needs and conditions of the target population, have been suggested as a strategy to overcome the factors that influence insurance´s low uptakes so that

it can inform the development of more effective climate risk insurance schemes. Vulnerability assessments, that aim to understand how social, economic and environmental factors and their interaction with specific threats, influence people's ability to adapt to natural hazards, has been pointed out as one of the first steps to identify suitable adaptation strategies (Ford & Smit, 2014), such as climate risk insurance mechanisms.

This thesis was considered as a complementary study of a larger research project aimed to measuring the resilience impact of index-based insurance products in Saint Lucia, managed by the Munich Insurance Climate Initiative (MCII) and implemented by the Climate Risk Adaptation and Insurance in the Caribbean (CRAIC) Phase II Project. The data used in this paper is based on the fieldwork which has been collected in conjunction with the larger research project. Soufriere was considered for this thesis case study due to its relatively small size and high dependency of local livelihoods on the fishery sector among its residents. In this sense, this thesis envisioned an investigation of the factors that contribute to this community´s vulnerability to climate variability and extreme weather events, explore the potential impacts of index-based insurance products in increasing fishery-dependent household's adaptive capacity, and outline the potential limitations and opportunities for its implementation in Soufriere.

PROBLEM DEFINITION

Although the fishery sector only contributes less than 1% to Saint Lucia's GDP (Gov. Saint Lucia, 2018) it is considered a crucial aspect for the country's food security and a source of livelihood for a large part of its population, providing employment to 2319 registered fishermen around the island (FAO, 2007). Over the last years the increasing frequency and intensity of extreme weather-related events, such as hurricanes and floods, and on-going climate variability have significantly impacted Saint Lucia's economy and food security. Considering at the artisanal fisherfolk community, the backbone of Saint Lucia´s fishery sector, already has limited assets and lives in sensitive coastal areas (FAO, 2015), the impacts of climate variability and extreme weather events are further diminishing their already low capacity to adapt. As climate change projections foresee the intensity of extreme weather events will increase in the Caribbean in the coming years (Monnereau et al., 2015), there is an urgent need to identify sustainable strategies for fishery-dependent households to adapt to these changes.

Climate risk insurance (CRI) schemes, specifically index-based insurance solutions, which aim to provide security against the loss of assets and livelihoods in the face of extreme related weather

events, is one strategy being promoted in the Caribbean as a means to increase vulnerable people´s resilience. Nevertheless, evidence suggests low uptakes of these market-based products among developing countries, in addition to the lack of empirical evidence on the effects of these schemes on local´ people´s well-being at the medium-long run, is hindering their potential as a strategy to increase resilience of the most affected by natural disasters. What are the real needs of vulnerable people in terms of climate risk management? What factors influence their vulnerability and how insurance products could be linked with local people´s current risk management strategies are essential questions to ask prior to designing an effective CRI program? (Banerjee, Bénabou, & Mookherjee, 2006). Place and time specific vulnerability assessments can help us to understand the latter by investigating the factors that determine fishery-dependent households' ability to withstand and adapt to climate variability and change. In this sense, understanding the different factors that contribute to the vulnerability of a community to a specific hazard can provide important information to better design adaptation strategies aim to increase their resilience (Gbetibouo et al., 2010), such as CRI. Specifically, in the fishery sector, vulnerability assessments have relied on conventional quantitative top-down approaches to characterize and quantify the impacts of climate change, with less attention to applying bottom-up approaches in local settings (Brugère et al., 2015). This shortcoming is even more relevant within the Caribbean region. Despite its importance, most of the formal vulnerability assessments implemented within this region have focused assessing vulnerability at the national level, (Allison et al., 2009) while the examination of the vulnerability of climate-induced impacts within the local context of fishery-based livelihoods has remained limited (Islam, Sallu, Hubacek, & Paavola, 2014).

As assessing the vulnerability of local community implies exploring some multidimensional issues, many approaches have used indicators as means to characterized and quantify these aspects (Shah & Dulal, 2015). Index-based approaches, in addition to providing context-based information on the factors that influence vulnerability, can be used to standardize measurements to study the efficacy of adaptation strategies (Shah & Baptiste, 2013). The latter is highly important for CRI, as there is significant ambiguity in terms of which set of indicators would be the most suitable to monitor and evaluate the impact of insurance schemes in people´s resilience (Fernández & Schaefer, 2018).

Building on the latter, and aiming to fill this knowledge gap, this research adopts an index-based bottom-up approach to measure and analyze the factors that contribute to the relative vulnerability of fishery-dependent households to climate change variability and extreme weather-related events

in Soufriere, Saint Lucia. In addition, this study aims to investigate the potential impacts of index - based insurance products in increasing fishery-dependent household's adaptive capacity, and the potential limitations and opportunities for its implementation in Soufriere.

RESEARCH QUESTIONS – AIMS AND OBJECTIVES

- To identify the relative vulnerability of Soufriere´s fishery-based livelihoods to climate variability and extreme weather events at the household level.
- To examine the factors that contribute to different components of the vulnerability of Soufriere´s fishery-based livelihoods to climate variability and extreme weather events at the household level.
- To explore the potential impacts of index-based insurance schemes in increasing Soufriere's fishery-dependent household's adaptive capacity and the potential limitations and opportunities for its implementation in Soufriere.

THESIS STRUCTURE

Previously an introduction of this investigation, the problem it intends to address and the main research questions it expect to answer were described. In the succeeding chapters a more profound examination on the subject of the research will be developed according to the following: Chapter 1, establish the conceptual ground and set up the key definitions and approaches this investigations takes regarding vulnerability, adaptation and resilience. Chapter 2, outlines key concepts referred to climate risk insurance solutions and discuss its implications in increasing people´s resilience. Chapter 3, offers a background on the approach for vulnerability assessment considered in this investigation, as well as it provides an overview on the indicator-based methodology to measure vulnerability used in this study. Chapter 4, presents a description of the case study, the analytical framework as well as the methods used for the analysis. Chapter 5, details the results and analysis on this investigation by providing a description of Soufriere's artisanal fishery context as well as the results of the Livelihood Vulnerability Index. Based on the latter Chapter 6 provides a discussion on the influence of the main components of vulnerability in Soufriere's fishery-based livelihoods and the potential impact, limitation and opportunities of the implementation of index-based products. In addition this chapter outlines the main implications of the study for the design and potential implementation of index-based insurance scheme target to the fishing community in Soufriere. Finally Chapter 7 provides the final conclusion and outlines the main contributions of the thesis to the area of vulnerability assessment and climate risk insurance.

1. UNDERSTANDING VULNERABILITY

Over the last years, the concepts of vulnerability and its other related terms has been one of the most contested and discussed concepts within the climate change academic community. Although the purpose of this chapter is not to review the "state of the art" of climate change adaptation literature, it is considered necessary to establish the conceptual ground and set up the approach on vulnerability taken by this study. In this sense, based on a literature review, I will discuss the concept of vulnerability, and its interrelation with two other main terms: adaptive capacity and resilience.

1.1. Vulnerability

The term vulnerability has been extensively applied in various contexts and disciplines such as geography, economics, poverty, public health, food security and lately in climate change arena. Nevertheless, the term originated from the field of disaster and hazard research around mid 1970 and was strengthened as a concept within the scientific community from 1980 onwards (Birkmann et al, 2013). At that time, it was argued that, in addition to the presence of natural hazards and risks, the subsequent disaster was determined by the system's social, economic, political and cultural structures. The latter generated pre-conditions for humans to be harmed by natural hazards, which was referred to as "vulnerability" (Cutter et al., 2009). In this sense, vulnerability was understood as a critical element, which in addition to a specific hazard, generated the degree of risk in a system (Garschagen, 20014).

Since then, various conceptual frameworks of vulnerability, and therefore respective assessment models have been developed. According to Garschagen (2014) and Birkmann, J. (2013), two significant approaches to vulnerability can be categorized. The first approach, commonly used in disaster risk management, place vulnerability as a factor primarily determined by the impact of the hazard or disaster event itself (Muller-Manh, 2005 & Garschagen, 20014). This approach encompasses a perspective usually mentioned in the vulnerability literature reviewed for this investigation, where vulnerability is seen as an "outcome" or "endpoint" (O' Brien et al. 2007 & Kelly & Ager, 2000). Here, the effects of climate/environmental hazards are considered as the first point of departure and the main driver that determines the level of vulnerability of the system (Eakin, H. & Luers, 2006). In this sense, this approach tends to use model-based investigation approaches where physical climate change drivers are investigated. The second major approach, has been built from the context of development, livelihood, and entitlement (Birkmann, J. 2013).

According to Bohle (2001), vulnerability is seen as a double structure with an external and internal side. Vulnerability, is the result of, linking its internal side, which relates to the copying capacity, and its external side, which relates to the exposure to specific shocks and stresses (Bohle, H. 2001) overall placed under a set-up of the wider socio-economic and political system (Wisner et al., 2004). This perspective sees vulnerability as a "contextual" or "starting point" (O' Brien et al., 2004 & Kelly &Ager, 2000). Vulnerability is understood more holistically, recognizing is dependence on the existing capacity of the system to anticipate, cope with, resist and recover from the impact of a hazardous event influenced by the specific context in which the system is embedded (FAO, 2015). The latter is reflected in the fields of "social vulnerability" (Adger, 1999) and is usually considered in exploring vulnerability structures at small scales levels (Garschagen, 20014) and uses survey-based approaches to understand the multiple drives of vulnerability (FAO, 2015)

Within the climate change scholarship, vulnerability is framed as a property of the system components (Garschagen, 20014). In Turner´s comprehensive framework, vulnerability is linked in a so-called "human-environment systems" (Garschagen, 20014), and it is overall influenced by the "sensitivity" and "resilience" of the system (Turner et al., 2003). Based on this conception, the Intergovernmental Panel on Climate Change in its 4th Assessment Report, defined vulnerability as "the degree to which a system is susceptible to and unable to cope with adverse effects of climate change, including climate variability and extremes." (IPCC 2007). Here, vulnerability is explained as a function of the system exposure and sensitivity to hazardous conditions and its ability to cope, adapt or recover from those damaging conditions that could occur (Smith & Wandel, 2006). Exposure is considered the *"nature or degree to which a system experiences environmental or socio political stresses"* while sensitivity is the *"degree to which a system is modified or affected by perturbations"* (Adger, 2006). Both of them proposed as to be closely related terms (Smith & Wandel, 2006). As supported by Cannon, T., Twigg, J. & Rowell, J. (2003), the IPCC 4th Assessment Report conceptualization of vulnerability embraces that it is mainly driven by institutional and social settings which define the context in which a person or community can respond to the negative impacts of the hazard. (Cannon et al., 2003). In this sense, vulnerability is seen as a process, as a pre-existing human state before a potential hazard resembles, highly context-specific and determined by social, political and economic aspects.

This social construction of vulnerability has been underlined in the latest IPCC report (IPCC, 2014). This report links vulnerability to the sensitivity of the system to change and the capacity to adapt, while separates it from the exposure. In this model, vulnerability is no longer the core

concept and it is framed under the concept of risk. According to this notion, risk is a result of the interaction among a potential climate-related hazard, the exposure of the system to that particular hazard and the vulnerability specific context (FAO, 2015). Based on this notion a change (e.g., climate-related hazards) it's essential (or of high risk) if the ecosystem and society are exposed to it and if due to its current socio-economic conditions, is unable to adapt to this change (FAO, 2015). This latter conceptualization of vulnerability attempts to emphasize that vulnerability assessment should focus on exploring the characteristic of socio-ecological systems and is not to be reduced to a measure of exposure (Birkmann et al., 2013).

Due to methodological reasons, the conceptual framework used as the analytical tool for this study takes into consideration the definition of vulnerability proposed by the IPCC 4th Assessment Report (IPCC, 2007) and Turner et al. (2003). In this sense, in this investigation vulnerability is a function of exposure to climate variability and extreme weather events, its sensitivity and adaptive capacity (the concept of adaptive capacity will be further explained in the next section). This research recognized the "contextual" or "starting point" perspective of vulnerability, and recognizes vulnerability is a pre-existing state caused by different contextual factors but place the strongest emphasis in socio-economic aspects and processes.

1.2. Interrelation with other concepts: Adaptive capacity and Resilience

As mentioned previously, there are other important concepts that have been linked to vulnerability and are widely used within the climate change debate. While some of these terms, such as adaptability, adaptive capacity, resilience, coping ability are closely related, for the sake of this investigation the concepts of adaptive capacity and resilience and how they co-related with vulnerability are further discussed.

1.2.1. Adaptive capacity

Garschagen (2014), drawing from previous contributions proposed that, within socio-ecological systems, adaptive capacity corresponds to, "*the ability of actors and institutions to maintain or improve their conditions in the face of changes of their economic, social, political and natural environment, or improve them, even if* these environments do not change" (Garschagen, 2014). In climate change literature, the understanding of adaptive capacity is based on the latter but exclusively placed in a scenario of change. According to Adger (2006), the concept reflects the *"the ability or potential of a system to respond successfully to climate variability and change"*. The IPPC 4th report adds to this conceptualization and proposes that adaptive capacity does not only reflects the capacity to respond but to adjust to

potential damage and take advantage of the opportunities (IPPC, 2007). Along the same lines, but under a risk approach, the last IPCC 5th Report (IPCC, 2014) report indicates that adaptive capacity corresponds to the ability to anticipate risk, respond, recover and change, where planned efforts to reduce risks and manage effective response ex-ante and ex-post risk incidents are crucial.

Smith & Wandel (2006) & Garschagen (2014), among others indicates adaptive capacity is highly context specific and varies significantly in terms of space, time and scale. While financial or technological resources and infrastructure have been seen as influence factors (Kelly & Adger, 2000, Wisner et al., 2004), over the last years social factors, such as governance structure, management, and human capital have been increasingly seen as relevant in determining a system´s ability to adapt to climate change (Yohe & Tol, 2002). Garschagen (20014) underlines that the quality of livelihoods is a crucial determinant of a system´s adaptive capacity, as it encompasses its resources and capabilities to respond, recover and adapt to change.

In this sense, adaptive capacity plays a critical role in reducing vulnerability. As previously mentioned, in the vulnerability framework used by IPCC 4th Assessment Report (IPCC, 2007) and IPCC 5th Assessment Report (IPCC, 2014), adaptive capacity is framed as one of vulnerabilities' sub-components, along with exposure and sensitivity. In other words, the presence of adaptive capacity within the system would decrease the overall impact of a particular change and/or enable the system to recover (IPCC, 2014). As illustrated by Engle (2011), based on other authors, adaptive capacity´s critical role in vulnerability comes from its role in modulating exposure and sensitivity (See. Fig.1).This relationship has significant implications for vulnerability assessment and specifically for the aims of this research. As Adger et al. (2009) propose, identifying which internal and external factors of the system limits or enhance the capability to adapt is a critical aspect in vulnerability assessments. This will be further explored in the vulnerability assessment part of the research.

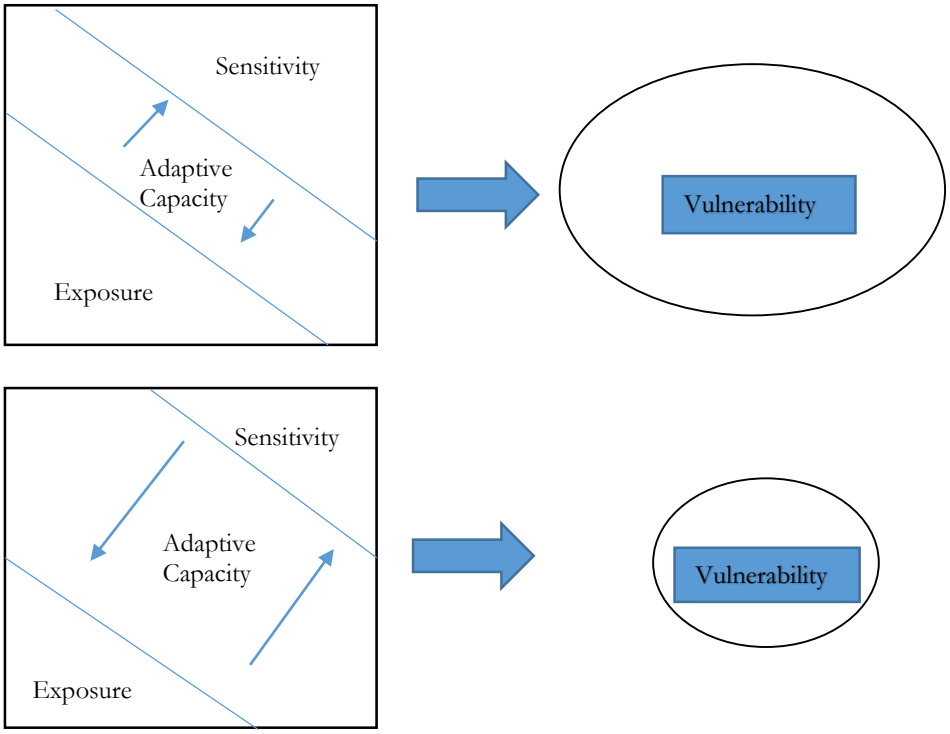

Figure 1. Relationship between adaptive capacity, vulnerability and exposure (Source: Engle 2011)

1.2.2. Resilience

While the relationship between vulnerability and adaptive capacity has been generally formulated among climate change scholars, the interlink between resilience and adaptive capacity/vulnerability is still an issue of interrogation and contestation.

According to Berkes et al. (2003) and Folke (2006), resilience is a property of a system determined by three main characteristics: 1) the ability to maintain its vital functions in the face of disturbance and/or stress 2) recovery from disturbance/stress, and 3) reorganization of its structures and processes to cope with the new conditions. Berkes et al. (2003) and Garschagen (2014), argue that considering many disciplines that use the concept of resilience recognize its interaction between social and environmental systems, emphasizing the need for learning and self-organizing, resilience theory moves closer to key ideas of adaptive capacity. The close relationship between resilience and adaptive capacity has, in fact, raised the question if resilience should be understood as the same as adaptive capacity (Smith & Wandel, 2006 & Gallopin, 2006). While in the resilience approach, adaptive capacity is seen as a property of the system which can enable it to reconfigure itself after a disturbance (Folke et al., 2002) (greater adaptive capacity, more likelihood for the system to be

resilient) some authors (Resilience Alliance, 2012) suggest that resilience refers to the ability of the system to increase adaptive capacity. Garschagen (20014) argues that this "cycle linkage" between adaptive capacity and resilience, instead of helping to create a more explicit causality framework for these two concepts add to the fuzziness and confusion of both discourses.

Moreover, how the concept of resilience relates to vulnerability is another interpretation largely contested and ambiguous. Assuming the direct relationship between resilience and adaptive capacity, resilience can be understood as the opposite of vulnerability, in this sense, a vulnerable system lack resilience (Folke, 2006 & Klein, 2003). Nevertheless, some authors such as Turner et al., 2003, refer to resilience as an independent term, and one of the components of vulnerability, therefore not having direct correspondent with vulnerability. (See Fig. 2. for an illustration of the conceptual linkages between vulnerability, resilience and adaptive capacity).

Although this investigation does not explicitly assess the impact of adaptation strategies on the adaptive capacity of the fishery-dependent households, it recognizes that an effective adaptation strategy, such as the implementation of climate risk insurance schemes, enhances their resilience in order to face the impacts of climate variability and change. The latter is considered essential to better understand the analysis and the discussion chapter further detailed in this study.

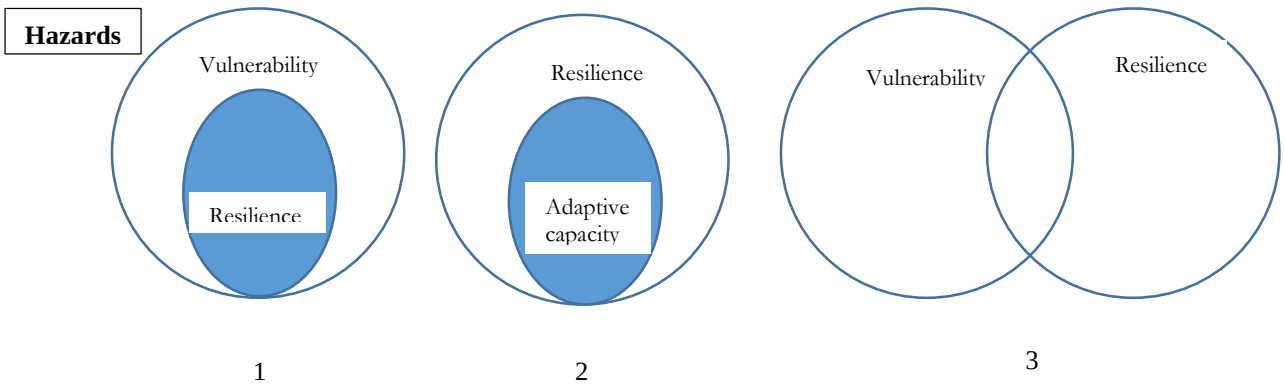

Figure 2. Three main conceptual linkages between vulnerability, resilience and adaptive capacity (Source: Cutter 2008)

2. CLIMATE RISK INSURANCE SOLUTIONS

As one of the objectives of this investigation is to assess the role of climate risk insurance (CRI) in reducing fishery-based dependent households' vulnerability to climate variability and change, this section will provide key conceptual information regarding CRI and an overview on its role in increasing people's adaptive capacity. First, the concept of CRI and its relevance in the Caribbean will be explained, followed by a discussion on the concept of index-based insurance and their implication in livelihood protection.

2.1. Climate Risk Insurance – Concept and Caribbean context

Climate risk insurance (CRI) schemes are financial strategies aimed at providing financial security to individuals, communities or regions against the loss of assets, livelihoods, and life resulted from climate related-risks (MCII, 2013). These market-based solutions aim at providing quick financial response to rapid onset events, such as hurricanes, cyclones or heavy precipitation. The latter is due the fact that, although manifested in a low frequency rate, these types of events are characterized by having a moderate to high severity impact which require an immediate response (Cutter et al., 2008), which CRI can provide. On the contrary, slow onset events, such as such as sea level rise or ocean acidification, although causing severe consequence on the long terms, due to its predictability and its ability to spread risk over time and regions, are usually not covered by traditional loss/based insurance mechanism (Kehinde, 2014).

These market based insurance solutions aim to cover loss and damage[1]. Rapid onset events are especially important within the Caribbean context, as it particular economic dependence on natural resources, social challenges and its level of exposure make the impacts of these extreme weather events specially relevant in this region (Lashley & Warner, 2015). This severe impact has been expressed in significant economic losses within the small Caribbean countries. The aggregated economic losses of this region due to heavy storm registered between 1979-2005 was of approximately USD $613 million annually (Ghesquiere, F. & Mahul, O., 2010) while USD 10 billion loses were register after the 2017 Hurricane season (CEDIM, 2017). Nonetheless, while the small Caribbean countries/territories are considered among the top 10 areas affected by storms in terms of losses as a percentage of GDP (UNISDR, 2018), with respect to insurance, these countries are the less insured against natural disasters compared to develop countries with less climate risks.

[1] Loss and damage refers to the impacts of climate change that occur despite the implementation of mitigation and adaptation strategies (UNFCCC 2012)

Considering the above mention, an initiative to limit the financial impact of weather-related risks such as hurricanes and earthquakes for Caribbean Governments was launched in 2007 through the Caribbean Catastrophe Risk Insurance Facility (CCRIF). The CCRIF is a multi-country risk pool for the Caribbean Island States and Central American governments which offer insurance products based on a parametric index. This parametric index uses wind speed for calculating government losses in case earthquake, tropical cyclone and excess rainfall. In this sense, it aims at providing governments short-term liquidly when a parametric insurance policy is triggered.

Although CCRIF is a well-suited mechanism to cover governments in case of severe events, small countries in the Caribbean are lacking access to finance for low and medium severity event. As a way to overcome the latter, the Munich Climate Insurance Initiative (MCII) and their partners at the Caribbean Catastrophe Risk Insurance Facility (CCRIF), the International Labor Organization (ILO) and Munich Re implemented in 2011 the Climate Risk Adaptation and Insurance in the Caribbean (CRAIC) Project. The CRAIC Project aims to promote weather-index based insurance as a risk management strategy to address climate change and promote the adaptation of low-income people from the Caribbean, while building a robust institutional framework for climate risk insurance in the Region. The Livelihood Protection Policy (LPP) is the product currently promoted by CRAIC, designed to help the most vulnerable individuals recover from damage caused by strong winds and/or heavy rainfall during hurricanes and tropical storms. The product is available across the region, including Saint Lucia, through local distribution channels, including cooperative banks, credit unions, and farmer associations.

2.2. Index base insurance scheme - Opportunities for livelihood protection and challenges for implementation

While there are several CRI schemes according to the level of risk covered and the scale, this investigation will only refer to index-based insurance. In this type of market-based insurance, pay-outs are provided once an index (typically weather based such as rainfall, temperature, or crop yield) has been triggered by exceeding a predefined threshold. One of the features of this type of insurance is its low premiums (compared to the traditional indemnity insurance) as the pay-out is provided without the need for the administrative costs of quantifying the losses, therefore the transaction costs are minimal (Bhojwani et al., 2007). In addition, this feature allows pay-outs to be distributed quicker thus providing rapid relief to policy holder soon after a disaster event. Index-based insurance products aim to cover livelihoods rather than specific assets, providing policy holders the freedom of using the compensation to replace the loss of income, finance any necessary repairs to assets or any other measure they consider relevant.

According to Schaefer and Waters (2016), integrated into a broader disaster risk management approach, climate risk insurance can contribute to the resilience building of individuals both ex-ante and ex-post of a disaster event by specifically increasing their anticipatory, absorptive, and adaptive capacities. Fig. 4 shows the detail on the contributions of CRI to resilience according to Schaefer and Waters (2016) proposal. According to the latter, index-based insurance mechanisms could play a crucial role in protecting vulnerable households. For instance, index weather insurance, by providing reliable and timely financial liquidity to households, could allow individuals to engage in adequate risk coping strategies and avoid others that could be contra productive or maladaptive in the long run (Schaefer & Waters, 2016). Rapid cash payments could allow families to decide whether to change their livelihood strategies (which often require capital investment) or maintain their current one (which would necessitate restocking damaged assets) after a catastrophic event occurs (Greatex et al., 2015). Additionally, by creating a secure environment and increasing certainty, individuals will be protected in case a disaster strikes, opportunities to invest in other sustainable activities, which over the long run could support them to escape poverty (Greatrex et al., 2014). In this sense, the financial stability provided by CRI scheme could strengthen building adaptive capacity for vulnerable individuals and households, strategy that could be used as part of a broader approach for their development.

Although, as previously argued, the benefits of index-based insurance in increasing the capacity of individuals to adapt to climate shocks seem promising, currently there is insufficient empirical data on the real impacts of insurance on the overall household resilience on the long term (Fernández & Schaefer, 2018). Additionally, due to the lack of impact evaluation on insurance, the experience of low uptake of the product in the developing world has proven there are still various limitations which could diminish the effectiveness of this scheme in supporting the most vulnerable. (Hermann et al., 2016). Basis risk, referred to the potential difference between the value of the losses as measured by the index and actual losses resulting from disaster, has been pointed out as one of the main drawbacks of the scheme (Collier, Skees, & Barnett, 2009). In addition, the displacement of insurance schemes by pre-existing coping strategies applied by local people has been proposed as another essential determinant for insurance uptake (Morduch, 2006 & Binswanger-Mkhize, 2012), while social capital and the participation of households in already existing informal networks has been highlighted as a factor that influenced their willingness to access to credit and purchase insurance (Okten & Osili, 2004 and Gine´ et al., 2008). Furthermore, several other determinants related to the economic, social and cultural factors such as access to credit, liquidity, risk aversion, lack of trust, financial literacy, informal sharing mechanisms, age,

gender, among others (Eling, Pradhan, & Schmit, 2013) have been proposed as important aspects that could influence the uptake of the product among community members.

Schaefer and Waters (2016), based on an analysis of eighteen climate insurance schemes, proposed 7 Pro-Poor Principles for Climate Risk Insurance, as the guiding foundations for practitioners to develop effective CRI mechanism. The first principle "Comprehensive needs-based solutions" underlines the importance of designing schemes tailored to the specific needs and conditions of the local target population (Schaefer & Waters, 2016). They suggest that through the implementation of risk and context assessment, real needs of vulnerable people in terms of climate risk management strategies can be identified and, based on this information, CRI schemes that are aligned to the specific context can be developed. In this sense, it is argued that the functionality and the impact of any CRI scheme are partly determinate to the extent of which the real needs of the target population are taken into consideration. This is especially important in the fishery sector, as most of the research on the determinants for index based insurance demand has been predominantly based on the agricultural and livestock sector (Fernández & Schaefer, 2018).

The arguments presented in this chapter have partly contributed to the rationality of this thesis, as this investigation acknowledge that getting a deeper understanding of the different aspects of an individual´s livelihood, and the factors that influence them to take certain risk-related preferences, are crucial aspects to develop effective tailor-made CRI schemes.

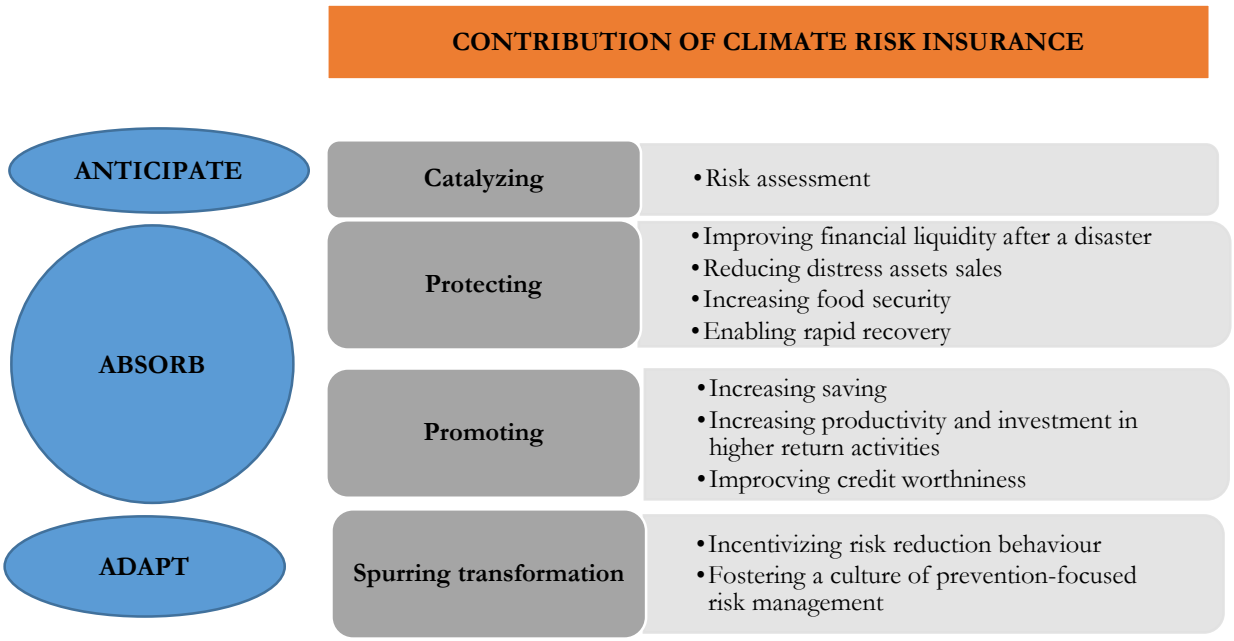

Figure 3. Contribution of climate risk insurance to resilience building (Source: Schaefer & Waters 2016)

3. MEASURING VULNERABILITY

The previous chapters provided an outline on the complexity of the vulnerability concept (and related terms) in the climate change and disaster and hazard disciplines, as well as presented CRI and its role in increasing adaptive of vulnerable people. In this chapter, the boundaries of the vulnerability assessment taken by this research will be provided, followed by an explanation of the conceptual model of vulnerability selected. Finally, a discussion on the vulnerability assessment techniques and specifically the indicator-based approach used in this investigation will be provided.

3.1. Boundaries of the vulnerability assessment

In order to clarify the boundaries of this research, I will answer the two questions Bohle (2008) argued researches need to ask at the beginning of each and every vulnerability assessment: vulnerability of what? and; vulnerability to what? (See Fig. 4).

While the process of climate variability and change is global, their impacts varies from scale and unit of analysis (Cutter et al., 2008). The question "**Vulnerability of what?"** is intended to help the researcher in establishing the system and the unit of concern that will be assessed, defined as a critical first step in a vulnerability assessment. In the Caribbean, climate variability and extreme weather events have a profound impact in the fishery sector at a national scale and local level. Impacts on coastal infrastructure, fishing assets and fishing operations, cause severe repercussion on national economy (e.g GPD) and on the overall livelihood of the people that depend on fishery as their main source of income. Considering that Soufriere´s main fishery and tourism infrastructures are built on the coastline and that most of its local population relies on the sea as the primary source of income and livelihood (fish catch, commercialization or tourism related activities), the livelihood of these target population are highly exposed. In this sense, this investigation focuses on assessing the vulnerability at the local scale, specifically at the fishery dependent household level, as it this level the repercussion of extreme weather events are more specific due to its exposure and livelihood conditions.

The selection of the rate of the event that will be measured is another crucial consideration for vulnerability assessment (Cutter et al., 2008). The question **Vulnerability to what?** Intends to identify clarify the latter, by selecting the bio-geophysical phenomena that threaten the unit of concern and will be consider in the assessment. Climate variability and change is expressed in rapid onset events, such as hurricanes, and slow onset events such as global temperature variations, sea level rise, drought, etc. While the latter have a profound impact in the marine ecosystem (IPCC,

2017) (e.g. coral bleaching, changing in timing and latitude upwelling) the impact on the fishery sector is still difficult to measure. On the contrary, the increase in frequency in climate variability an extreme weather events have a direct disruption on fishing operations, therefore causing immediate consequence on their livelihoods (Allison et al., 2007). As Saint Lucia´s climate change projection indicates the intensity of hurricanes and floods are likely to increase over the coming years, this research will pay particular attention to analysing the vulnerability of the livelihood of fishery-depend households to climate variability and extreme weather events. It is important to mention that even though climate variability, in terms of increase in rainfall or temperature, may not reach the level of natural disasters, these changes in the climate patterns affect the livelihood of rural communities and increase their vulnerability (Panthi et al., 2016), therefore it will be considered in this research.

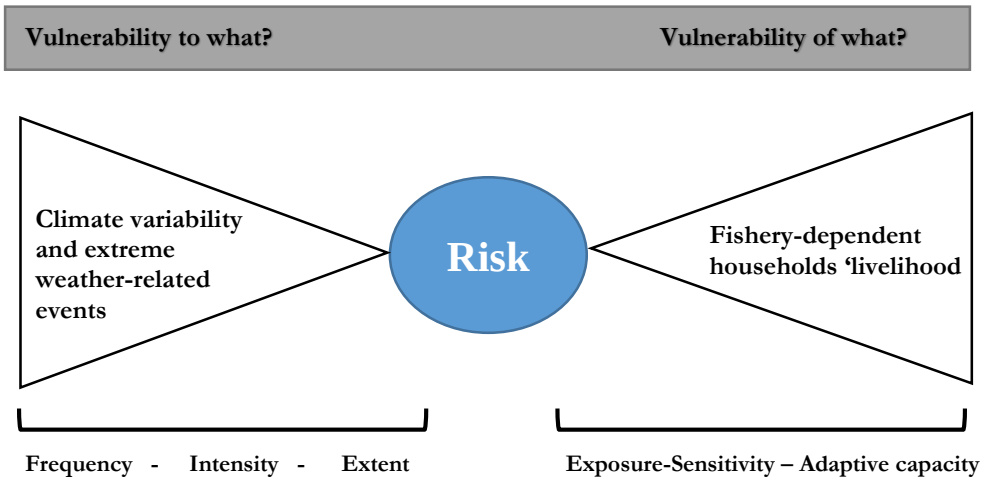

Figure 4. Research vulnerability assessment's boundaries (Based on: Garschagen, 2008)

3.2. The Sustainable Livelihood Approach.

According to Downing et al. (2004) selecting a conceptual model of vulnerability is an essential step prior to deciding a method for measuring it. As argued in the previous chapters, vulnerability is generated by multiple place-time processes that condition the system's ability to respond and adapt to stresses, therefore a context-specific method to measure it is required. Considering the latter the Sustainable Livelihood Approach (SLA) has been selected as the most suitable to assess the vulnerability of fishery-based livelihoods. The next paragraphs will provide a brief description of SLA as the primary conceptual tool used in this investigation to understand the livelihoods of fishery-dependent households and their relationship with vulnerability.

The SLA developed from the original conceptualization of "sustainable livelihoods" by Chamber and Conway (1999), and it has evolved to be one of the most influential approaches within the international development arena (Knutsson & Ostwald, 2006). In their work, "livelihood" was understood as the "capabilities, assets and activities required for a means of living". In this view, it was recognized that the poor are not only dependent on income generation to sustain their livelihoods. The system is much more complex and their well-being consists of an integration of a diverse set of means, capacities and social strategies (Small, 2007). "Sustainable" on the other hand, refers to the attribute of the system to cope with and recover from stress and shocks, maintain or enhance its capabilities and assets to provide livelihood´s opportunities on the short and long-term. In this sense, SLA refers to the ability of the poor to mobilize, combine or transform their assets and capital (make choices, access to opportunities and resources) to achieve long-term well-being (Badjeck, Allison, Halls, & Dulvy, 2010).

According to the most consistent livelihood framework used by practitioners and scholars, developed by Department for International Development (DFID) in 1999, five livelihood assets or "capitals" human, natural, financial, social and physical are essential for achieving livelihood outcomes. Vulnerability in this framework is understood as a broader concept, expressed by elements of shocks, trends, and seasonality (Birkmann et al. 2013). As indicated by Paavola (2008) in this context vulnerability relates to the inability of an individual or community to mobilize and manage their assets and sustain their livelihood in the face of changing conditions.

Although widely used in local vulnerability assessment, a few authors have criticized the SLA approach and claimed it to be somehow abstract (Haan & Zoomers, 2015). Adger (2006) has argued that SLA fails in integrating, besides other socio economic factors, other risks socio - ecological systems faced, such as natural hazards while Haan and Zoomers (2015), have argued that this framework does not adequately acknowledge the role of power relations in enabling the access to capital and assets. Some authors such as Badjeck et al. (2010) and Hahn, Riederer, and Foster (2009), by linking the impact of climate variability and change to the various elements of the livelihood framework such as financial, social and natural assets, have tried to overcome the limits on SLA of not taking into consideration the impact of physical hazards in shaping vulnerability of the system (Hahn et al., 2009). In this sense, they argue that SL frameworks are in fact a valuable approach to understand people's exposure and sensitivity to natural hazards and their capacity to cope with them.

Based on the above, the SLA conceptual framework has been selected as the basis for the empirical analysis of this investigation for three main reasons. First, due to this framework's focus on understanding local people's vulnerability based on their daily needs (Haan & Zoomers, 2015). Secondly, because it recognized that local people´s sustainable livelihood is shaped by the degree of their vulnerability, which at the same time is profoundly determined by contextual social factors. Lastly, because it is based on understanding the latter through bottom-up approaches (Knutsson & Ostwald, 2006). The mentioned faults of not taking into consideration the exposure and the fuzziness of the approach are intended to be overcome by considering an indicator-based approach, explained in the following section.

3.3. Indicator based approach to measure vulnerability

Due to the complex context nature of vulnerability, a wide range of techniques, which differ on scale, indicators and methodologies have been proposed to assess climate vulnerability (Hahn et al., 2009). Although, there is a quite range of approaches, vulnerability assessments have been usually characterized for having a few epistemological and methodological challenges. These challenges are mainly related to the fail in accounting the contextual cross-scale influence of different socio economic and biophysical uncertainties in vulnerability (FAO, 2015, Eakin & Luers, 2006). Additionally, the choice of indicators and indices, availability and confidence of data and the inability to apply the findings and tools to different scenarios has been proposed as other practical but crucial methodological drawbacks (Garschagen, 20014).

Overall, it has been argued that vulnerability assessments required context-specific methods able to capture its dynamic nature and multiple driving forces (Adger & Vincent, 2005). Index-based indicator approaches have been proposed to capture this complexity (See: (Etwire, Al-Hassan, Kuwornu, & Osei-Owusu, 2013; Hahn et al., 2009; Garschagen, 20014). This method, by selecting suitable context specific indicators as proxy for the different components of vulnerability for a specific system, aims to characterize and quantify the multidimensional aspects of vulnerability into a single composite index (Shah, Dulal, Johnson, & Baptiste, 2013).

One of the main advantages commonly reported in the literature of using this index based approach is that it could serve as mean to standardized vulnerability measures, therefore facilitate the comparison among different locations and context (Shah et al., 2013). The latter could support the evaluation of adaptation policy frameworks and prioritization of resource allocations for adaptation

and mitigations programs (Preston et al., 2011). Without compromising the latter, index-based assessments should be developed in a way that could be flexible enough to incorporate local and context specific variables (Eakin & Bojorquez-Tapia, 2008). Nevertheless, this customize approach brings up one of the main weakness of this technique. Subjectivity in selecting the indicators used to construct the vulnerability index and the fact that the local context play a crucial role in their design has been argued as a factor could reduce the credibility of the assessment (Etwire, 2013).

Several vulnerability assessments based on index based approaches have been developed. To name a couple. Pandey & Jha (2012) developed a climate vulnerability index (CVI) to measure the vulnerability to climate change in mountainous communities of rural lower Himalaya in India while Elbert et al. (2008) proposed a socio-economic vulnerability index, to assess vulnerability of coastal communities to climate change in Honduras. At the household level, index based methodologies framed under the Sustainable Livelihood Approach have been widely applied (See: Etwire et al., 2013; Shah et al., 2013), as it provides information on the capabilities, assets and activities required by a household to adapt and promote sustainable means of living (Chambers & Conway, 1992). One of these methodologies is the Livelihood Vulnerability Index – LVI developed by Hahn et al. (2009). The feature of SSA of incorporating indicators related to climate exposure as well as specific household adaptive practices has been argued as value in capturing differences in community level climate variability (Shah et al. 2013). In addition, the characteristics of LVI of relying mainly on primary data from households as well as secondary information related to natural risks to develop a strong set of tailor made indicators, has made this methodology attractive and therefore used by many scholars in different contexts (See: Aryal et al., 2014; Etwire et al., 2013; Pandey & Jha, 2012; Shah et al., 2013). Nevertheless, most of these studies have focused on the agricultural sector, while only a few (See: Islam et al., 2014) have applied this index-based approach to assess the livelihood of fishery-based households.

Considering the above argument, and aiming to fill this knowledge gap, this study applies an indicator-based approach, specifically the Livelihood Vulnerability Index – LVI, to assess the vulnerability of fishery-dependent household to climate variability and extreme weather events. In doing so it seeks to develop tailor-made indicators to, which could potentially be used to compare and contrast vulnerability in similar context within the Region. The indicator and overall framework of the index-based approach used in this investigation is further explained in Chapter 4.

4. CONCEPTUAL AND METHODOLOGICAL FRAMEWORK

This chapter will provide information on the analytical and methodological approach used in this research. As this thesis has been structured as an exploratory case study, first information on the general context and climate related risks of the case study selected will be provided. Secondly, the scope of this study will be settled and the analytical framework applied explained, followed by a description of the methodology and data analysis. Lastly, the limitations of the study are provided.

4.1. Case Study: Soufriere, Saint Lucia

This thesis was conducted in the framework of CRAIC Phase II Project managed by the Munich Insurance Climate Initiative (MCII). Soufriere was considered as the case study for this research due to its relative small size and that fishery is one of the most relevant livelihood among its residents. This section will provide a description of Saint Lucia and Soufriere's location, overall economic development and climate related risks.

- **Location and economic development**

Saint Lucia is located between the Caribbean Sea and the North Atlantic Ocean, specifically to the south of Martinique and northeast Saint Vicent and Grenada (13° 59'N, 61°W). Soufriere is located in the southwest part of the island, and it is considered the oldest town of Saint Lucia (See. Fig. 5). The overall country population is represented by 165,150 individuals (MAFFF, 2007) which nearly 4.6% of the total population (7,657 individuals) live in Soufriere. Soufriere has a total land area of 58.4 km2 and a coastline formed by a succession of beaches and cliffs which extends over 12 km. Soufriere bay is located at the center and is where the Soufriere's towns lie. (See Fig.6)

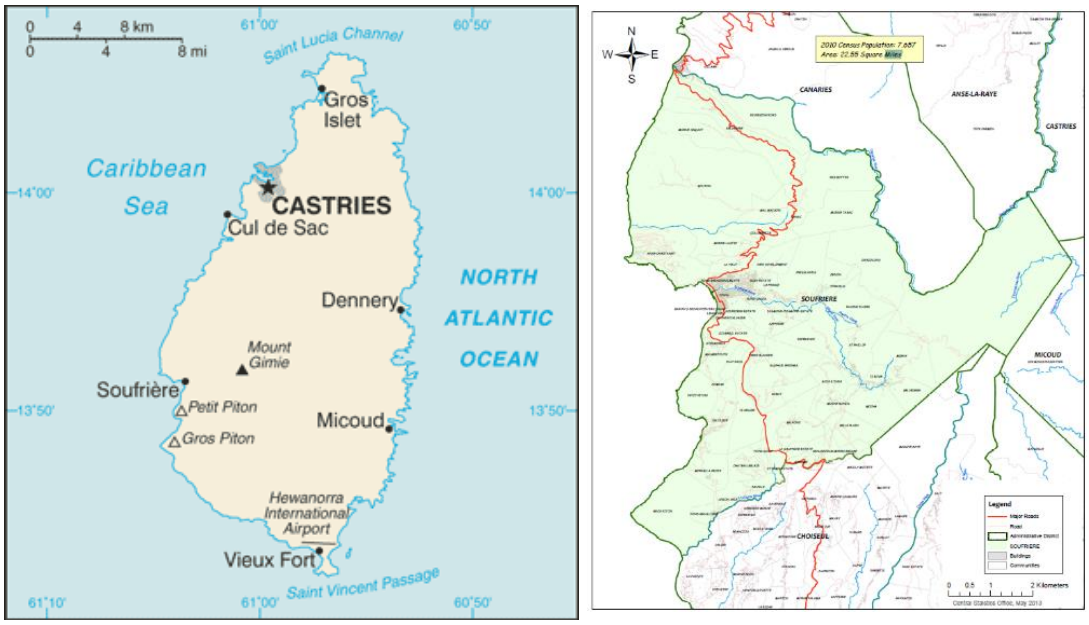

Figure 5. Map of Saint Lucia (CIA, 2019) Retrieved) and Soufriere (Government of Saint Lucia, 2019)

Figure 6. Soufriere Bay

Since its independence (1979) Saint Lucia has reported a remarkable economic growth in terms of its Gross Domestic Product (GDP) and is currently considered by the World's Bank as an Upper Middle-Income group. Saint Lucia's leading economic sectors are agriculture, specifically banana production, and tourism, which steady expansion accounted to the country's overall economic growth within the last years (Government of Saint Lucia, 2017). Soufriere's main economic activities rely on agriculture, fisheries, and tourism. The tourism boom started in the 1980s in Soufriere, and since then it has been expanded in terms of resort development, number of tourist and yacht, displacing other main economic activities such as agriculture and tourism (Hogarth & Wójcik, 2016).

- **Climate-related risks**

The small geographical area of the island and its location within the tropical cyclone belt, make this country particularly vulnerable to the impacts of climate variability and change. The island is vulnerable to hydro-meteorological events such as high winds, excess rainfall and hurricanes, and due to its volcanic origin to geophysical activities such as earthquakes and volcanic activity. Extreme hydro-meteorological events are associated with average annual economic losses which during the period 1992-2011 have been equivalent to approximately 2% of the island GDP (Monioudi, 2017). According to the Global Climate Risk Index 2018 developed by Germanwatch (Eckstein, Künzel & Schäfer, 2018). Saint Lucia ranks 5th at risk for natural disaster among all countries and is highly exposed to natural disasters which vary in intensity and severity, such as hurricanes (which season in the Caribbean starts from June to November of each year) and tropical storms.

Its significant economic dependence on natural resources, the fact that most of its population are located in low-lying exposed coastal areas, and the limited institutional capacity of the government to adequately respond/recover after a devastating weather event, aggravate the current risks from natural hazards (Government of Saint Lucia, 2018. This high vulnerability can be exemplified by the total impact suffered in the latest climate change induced natural disasters. In 2010, Hurricane Tomas lead to an estimated USD 336.2 million of losses, constituted more than 40% of the country´s GDP, mainly to its economic sector, public infrastructure, and housing (Hogarth & Wójcik, 2016). Similarly, the tropical trough experienced in December 2013 produced damages estimated to roughly 8% of the island´s GPD.

4.2. Delimitation and analytical framework

The investigative scope is limited to an assessment of the vulnerability of the fishery-dependent households in Soufriere to climate variability and extreme weather-related events as well as to explore the potential impacts, limitation and opportunities of climate risk insurance to increase their adaptive capacity.

This investigation's analytical framework considered is based on the conceptualization of vulnerability considered by the IPCC's Fourth Report (IPCC, 2007) and Turner et al. (2003) as well as the framework proposed by Schaefer and Waters (2016), regarding the impacts of climate risk insurance on resilience capacities. Exposure in this study refers to the, *"nature and degree to which a fishery-based livelihood system is exposed to significant climate variations"* (Islam et al., 2015 modified from IPCC 2001, p. 987). Sensitivity is understood as, *"the degree to which a fishery-based livelihood system is*

affected by or responsive to climate stimuli" (Islam et al., 2015, modified from IPCC 2007, p. 881). Lastly, adaptive capacity is the, *"ability or capacity of the fishery-based livelihood system to adjust to climate variability and extremes, to take advantages of the opportunities or to cope with the consequences"* (Islam et al., 2015 adapted from IPCC 2001, p. 982). In addition, this analytical framework recognizes that limitations for micro level insurance demand dependent on economic, socio–cultural and structural factors, according to the insurance demand framework proposed by Eling et al (2013).

The illustration of the analytical framework is presented in Fig. 07. This framework considers vulnerability as a result of exposure and sensitivity and its adaptive capacity to cope, adapt and recover from stress or shock. Exposure depends on the hazard´s characteristics such as frequency, magnitude, and duration while sensitivity depends on the interaction of the system with climate stimuli. Overall, vulnerability is context-specific and it is influenced by social and economic structure and processes. Climate risk insurance, if designed based on a comprehensive risk and contextual assessment, is foreseen to strengthening the adaptive capacity of the system by providing financial aid to support the community´s ability to anticipate, cope and adjust to climate hazards. Economic, social-cultural and structure factors specifically determinate by the contextual characteristic of the system influence in the insurance demand.

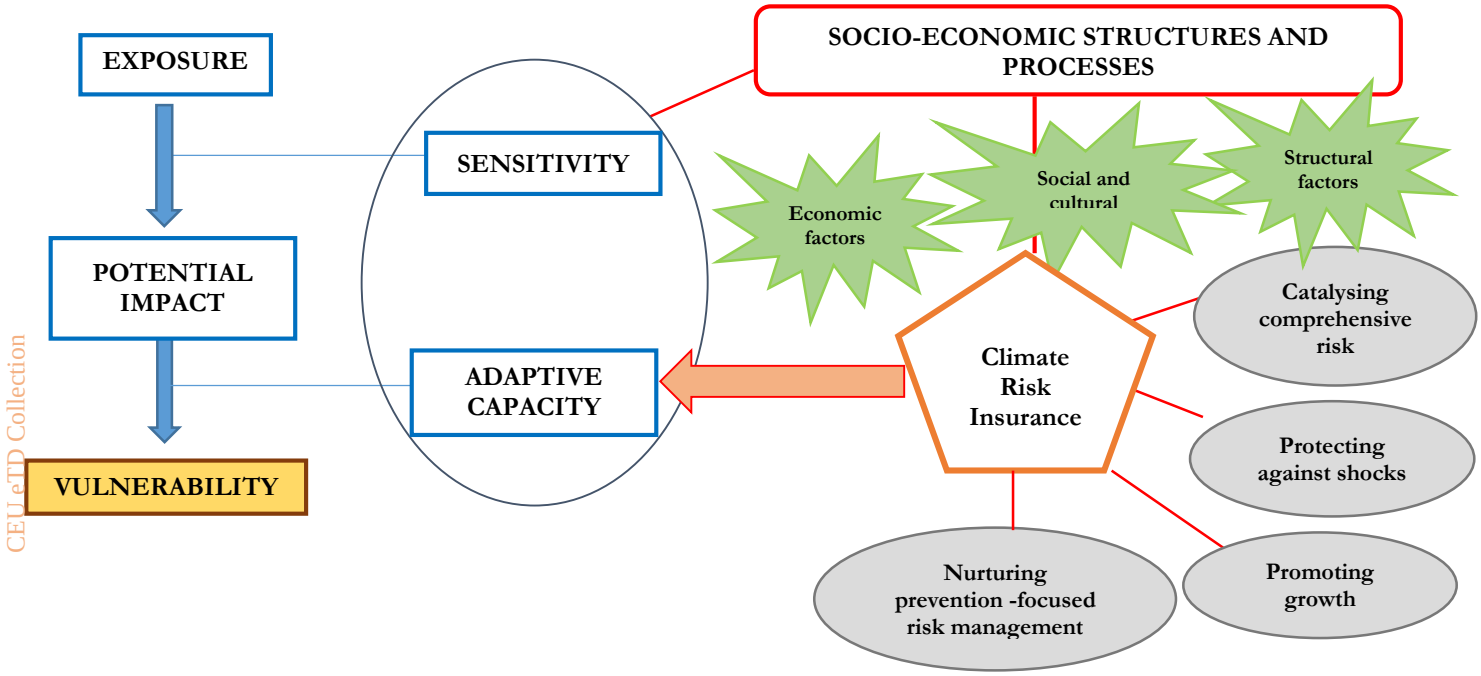

Figure 7. Analytical framework used in this investigation (Based from Turner et al (2003), IPCC (2007), Schaefer and Waters (2016) and Eling et al 2013).

4.3. Methods

As the objective of this research is to assess the relative vulnerability of fishery-based livelihoods at the household level to extreme weather events and explore the opportunities and challenges of climate risk insurance to increase their adaptive capacity, qualitative and quantitative research methodologies were employed using primary and secondary data collection.

The relative vulnerability was assessed by applying an indicator-based methodology: the ***Livelihood Vulnerability Index (LVI)*** developed by Hahn et al., 2009. This methodology was developed based on the Sustainable Livelihood Approach (SLA), and adds to it by integrating dimensions of climate exposure and household adaptation practices. Instead of considering just the five household assets of the SLA, the LVI considers seven major components. Each component comprises several sub components, related to exposure, sensitivity and adaptive capacity as a way to acquire a more comprehensive understanding of the complexity of livelihoods risks that determines local people´s vulnerability.

The LVI seven major components are: socio-demographic profile (SDP), livelihood strategies (LS), social networks (SN), health (H), food (F), water (W), climate variability (CV) and natural disasters (ND). This investigation, based on literature review and expert consultations, adds two more components: "physical assets" (PA) and "financial capability" (FC). The latter was considered to capture specific aspects of the household´s adaptive capacity that could be impacted by climate risk insurance mechanisms. Fig. 08 shows the SLI major components contribution to vulnerability in terms of exposure, adaptive capacity and sensitivity.

In addition, from the original set of 29 indicators proposed by Hahn et al., 2009, based on literature review and expert consultation, a few were modified, refined and others were added. The latter in order to suit the indicators of the local context of Saint Lucia and make them more relevant to fisherfolk. The total 10 components, 31 sub components, their explanation as well as assumed functional relationship of each of the sub components with vulnerability are show in Appendix 01.

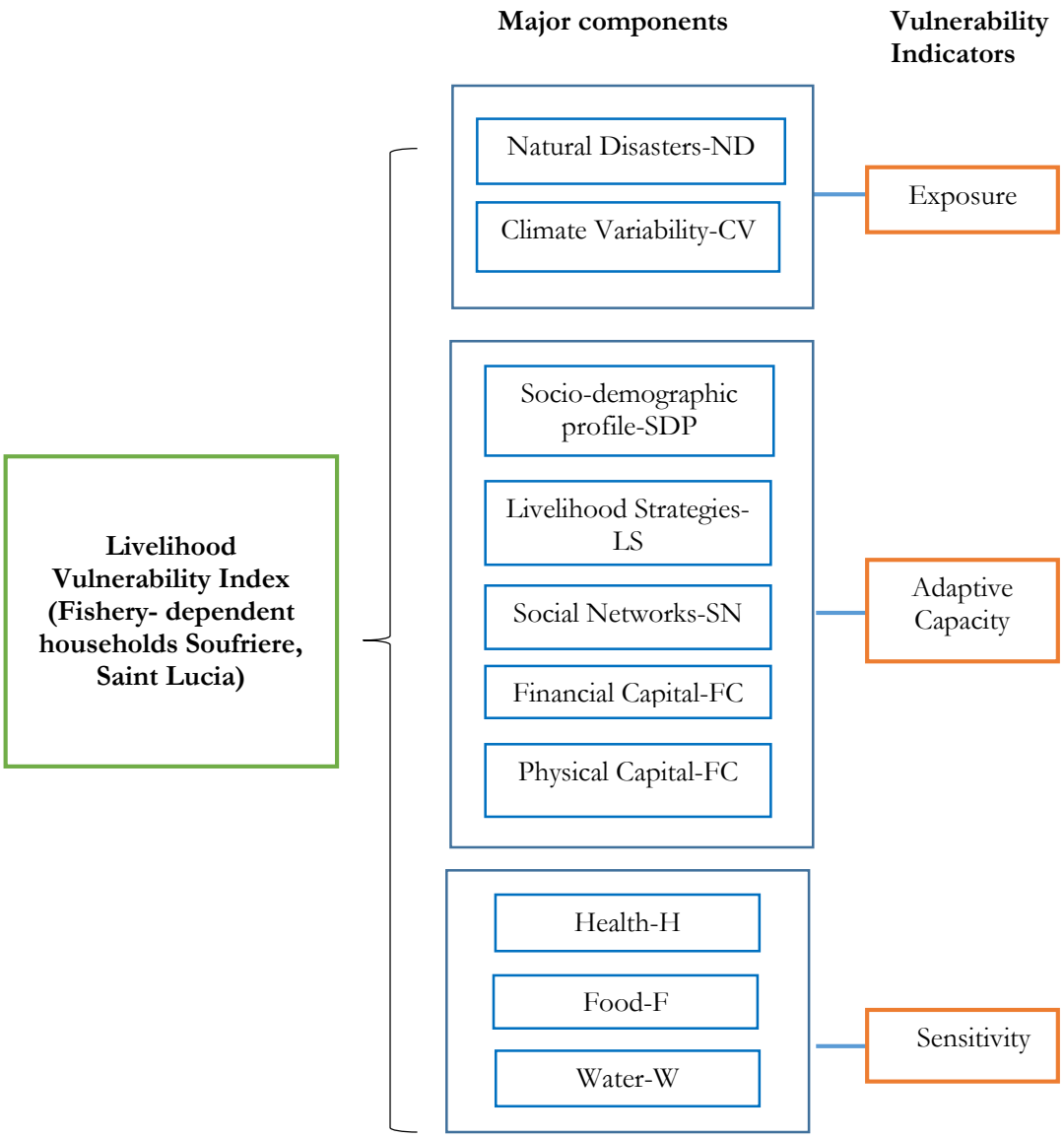

Figure 8. Sustainable Livelihood Index major components contribution to vulnerability for this study (Based: Hahn et al., 2009)

This study used the inductive approach of the grounded theory qualitative study design to assess the opportunities and challenges of implementing climate risk insurance with the aim to increase the adaptive capacity of fishery-based livelihoods in Soufriere. In this design, the researcher generates a general theory of a process based on the different views of the participants (Charmaz, 2006; Corbin & Strauss, 2007). In this sense, the analysis applied bottom up approaches in order to explore the challenges and opportunities of climate risk insurance in the context of Soufriere´s fishery community. Primary data collection through semi-structured interviews aimed at stakeholders related to the fishery sector in Soufriere employing researcher observations.

4.3.1. Primary data collection

The field work in Soufriere was conducted from March 25th to April 10th, 2019. Primary data consisted of surveys and semi-structured interviews. Although English is the country´s official language, most of its rural population speaks a "French Creole" dialect. For this reason a translator was hired in order to assist the researcher during the primary data collection, in case any of the interviewees were more comfortable talking in Creole. The surveys were mainly conducted in the Soufriere fishing village, "Barons' drive" located in the south coast of Soufriere's bay.

- **Surveys**

The questionnaire was part of a broader research design developed by the CRAIC II Project to assess the vulnerability of the local community and the potential impacts of insurance against climate risk. This initial questionnaire was modified/refined to incorporate relevant questions for the LVI calculation. The final survey consisted of 103 questions divided into four main categories: household characteristics, livelihood characteristics, exposure of household and livelihood to hazards. Once in the field, prior to the surveys, the questionnaire was pilot-tested with 4 fishers to analyze on the ground the adequacy of questions and information obtained. Based on the latter, several modifications were made to contextualized and reduce the length of the survey.

Thirty surveys were completed from March 28th to April 10th. The surveys were administered by the researcher and translator using a structured questionnaire. The surveys were carried out using the online QuestionPro platform and lasted for about one hour and 10 minutes each. Before the fieldwork, survey questions were entered into the online system, and during the surveys answers were registered online using tablets devices brand Lenovo Tab 4 10.

Based on stakeholders with experience in the fishery sector of Soufriere, the interviews were mainly conducted within the district fishers' village called Baron's Drive. Two approaches were used to conduct the surveys. The first approach applied was the "snowball" sampling method. First, the researcher made contact with local stakeholders who were consulted in the hope of identifying potential interviewees from the community. After the completion of an interview with the household head as recommended by the stakeholder, the interviewee was asked to identify other potential interviewees. Additionally to the "snowball" approach, and in occasions where the potential interviewees were not able to conduct the interview or suggest other potential responder, a simple random technique was applied. The research and translator stopped and interview fishers who were meet within the fisher's village, nearby the landsite, or in the coastal areas (after then

concluded their fishing operations). These techniques were applied until reaching 30 interviewees. In addition, follow up questions were asked, and informal conversations maintained while completing the interviews. The researcher took notes of these informal conversation and recorded when considered necessary (with prior consent of the interviewee).

- **Semi-structure interviews**

Face-to-face semi structured interviews were conducted with stakeholders involved in the fishery sector at the national and regional level. Additionally, stakeholders involved in disaster risk management and development were contacted and interviewed. Prior the field visit relevant stakeholders were identified and contacted to request individual interviews. In addition, once in the field "snowball" sampling was employed in order to identify and contact other potential interviewees.

The overall objectives of the semi-structured interviews was to obtain information on the impacts of extreme weather events on fishers' livelihoods, main challenges to the sector, explore the perception on insurance's impact in supporting fishery-based livelihoods and potential implementation of insurance mechanisms. The questions were drafted in the form of open-ended question, in order to obtain the perspective and opinion on the participants (Cresewell, 2003) and validated by experts. In this sense, the interviews took the form of open discussions, where according to the interviewee's interests and periodization of topics, follow up questions were asked in order to continue the flow of the discussion. (See Appendix 02 for the initial draft of the interview questions)

All interviews were recorded using a the Voice Recorder Mobil App (Version 1.5.6) installed in the mobile phone Motorola moto G6 Play (Motorola) and prior consent of each interviewee was secured. After each interview the researcher recorded her own impressions on the interviews. All interviews lasted approximately one hour. Appendix 03 shows the list of stakeholder's interviews.

4.3.2. Secondary data collection

Relevant grey literature and publish studies related to the topic of this investigation were identified through a desk-based research. In addition, data on natural disasters (tropical waves, cyclones, and troughs), temperature and precipitation used to calculate the LVI index components "Natural Disasters" and "Climate Variability" respectively was obtained from Saint Lucia Meteorological Services Office.

4.3.3. Data Analysis

The data used to calculate the LVI was obtained from the responses of the 30 surveys conducted among the fishery - dependent households in Soufriere. To calculate the LVI a balanced weighted average approach was applied following the methodology suggested by Hahn et al. (2009) and Pandey and Jha (2012). Microsoft Excel 2010 was used for the calculations.

The weighted average approach was applied since there are not valid weighting method for this sector as well as due to the complex relationship among the different components. In addition, using weighted average method is simpler in approach and interpretation (Pandey & Jha, 2012), besides to allowing adjusting the assessment tool developed for a diverse set of users (Shah et al., 2013). The following steps were followed to calculate the LVI:

a) Each sub-component was transformed into the appropriate measurement units (percentage, ratio and indices).
b) Based on the survey responses, the maximum and minimum value for each of the sub-component were determined (S_{min} = Minimum value, S_{max}= Maximum value) (e.g. Sub component SDP 9: average number of family members in the HHs; maximum value= 9; minimum value= 1).
c) The average value for each subcomponent (Ss) was calculated (e.g. Ss for subcomponent SDP 9: average number of family members in the HHs =3.83)
d) As each sub-component was determined by a different scale, all sub-components were normalized using the equation shown below (also used in constructing the Human Development Index) (UNDP 2007). In the formula (1), Ss refers to the original sub-component for the district, and S_{min} and S_{max} are the minimum and maximum values which reflect the low and high vulnerability, respectively, for each of the subcomponent using the data of all the households sampled.

$$Index\ Ss\ = \frac{Ss\ - Smin}{Smax\ - Smin} \quad (1)$$

e) Once the sub-components were normalized, the average of the sub-components standardized scores of each of the 10 main components was calculated using the formula shown below. This process generated the index value for each major component. In the formula (2) Ms is one of the 10 major components of the LVI in Soufriere, and Ss represent each of the sub-

components indexed by I, which make up the major component. (n) is the number of sub-components each major component has.

$$Ms = \frac{\sum_{i=1}^{n} index\ Ss_i}{n} \quad (2)$$

f) All weighted averages of the 10 major components were combined in order to generate the final LVI score for Soufriere using the equation shown below. The LVI is scaled from 0 (least vulnerable) to 1 (most vulnerable). In the formula (3) the LVIs is the LVI for Soufriere, which equals to the weighted average of the 10 major components.

$$LVIs = \frac{\sum_{i=1}^{10} Wm_i Ms_i}{\sum_{I=1}^{10} Wm_i} \quad (3)$$

4.4. Limitations

In terms of the quantitative methods, one important limitation of the study related to the selection of the indicators. Although, consultation with experts and an extensive review on literature was carried out to select indicators suitable to assess the vulnerability of fishery-based households, the choice of the final indicators to construct the vulnerability index can be considered to have some level of subjectivity. Time constrains compelled the investigation to focus in one village and consider a relative medium sample size, as compared to previous studies that have applied the LVI. Nonetheless, as this research focus on exploring the aspects that influence vulnerability of fishery-based household's vulnerability, it did not aim to claim statistical representativeness but instead to explore the utility of using an indicator-based approach to measure vulnerability. Furthermore, the location where the interviews took place may have narrowed the scope of interviewees and perceptions. Considering the recommendations of stakeholders, the majority of the surveys were conducted in Soufriere's fishing village (Baron's Drive) located in the coastal area of the south of Soufriere. Although the majority of Soufriere's fishers live in this area, this selection could have excluded fishery-dependent households that lived in other areas of the district (less exposed to coastal risks). The latter was overcome by conducting some interviews in others areas, such as near to the landing site or randomly within the beach shore where other fishers live. Finally, subjectivity of the researcher in presentation of the outcomes can be indicated as a fundamental limitation during the qualitative process of the study.

5. RESULTS AND ANALYSIS

This chapter provides the results of the investigation considering the research questions set at the beginning of this thesis. In order to understand the surrounding context of the fishery-based livelihoods in Soufriere, information regarding Soufriere´s artisanal fishery sector will first be given, followed by the results and analysis of the Livelihood Vulnerability Index applied to assess the fishery-dependent household vulnerability.

5.1. Soufriere´s artisanal fishery context

This section provides information on the artisanal fishery context in Soufriere in terms of its main fishing characteristics, its multilevel of governance and its main challenges. In addition, information regarding disaster risk management strategies applied by the fishing community as well as their economic characteristics and financial involvement are provided. The information presented in this section is based on literature review, results from the surveys conducted and interviews with fishers and stakeholders during the fieldwork.

5.1.1 Main fishing characteristics

Soufriere's fishery sector is primarily artisanal in terms of practices and assets, and considered a vital source of income and protein source for their residents (Sandersen, 1995). In Saint Lucia, over 1,179 households depend exclusively on the fishery sector for their livelihood (Government of Saint Lucia, 2018), while the industry provides direct employment to over 2,900 people in the country (FAO, 2016). In Soufriere, according to the latest fishery census, there are 92 full time and 61 part-time fisherfolk registered in the district (MAFFF, 2017). Nevertheless, this number is assumed to be higher, since other sectors such as tourism, considered the main economic activity in Soufriere, also indirectly depend on the fishery sector (Government of Saint Lucia, 2018).

Soufriere's main fisheries are the off-shore pelagic fishery and the coastal fishery (Sandersen, 1995). The off-shore pelagic fishery aims to catch migratory pelagic species such as dolphin fish, wahoo, tuna and tuna-like species (FAO, 2016) and uses a variety of fishing techniques such as hand trolling or loglines. Off-shore pelagic fishing became particularly significant in Soufriere since 1992 when a Fishing Aggregator Dispositive[2] (FAD) was installed at approximately 6 miles away from the coast of the city (Hakan T. Sandersen, Stephen Koester, 2000). Since Soufriere´s coastal line is

[2] A Fishing Aggregator Dispositive (FAD) is a man-made object which consist of buoys tethered to the ocean floor with block of concretes and is use to attract different species of pelagic fish.

located far from the off-shore eastern area of the island, where migratory pelagic schools of fish are generally found (Hakan et al., 2000), the installation of this device increased the possibilities of catch and provided an alternative to coastal fishing. In regards to coastal fishing, this type of fishery is considered the traditional type of fishing within Soufriere´s bay. There are three factors that make coastal fishing a productive alternative for artisanal fishers in Soufriere, the long distance from Soufriere´s coast to the off-shore fishing ground; the presence of a rich coral reef ecosystem located in its volcanic shorelines and the shallow shelf; and deep slopes of the coastal area. (Caribbean Coral Reef Collaboration, 2014). Gillnets, fish pots, balou nets, and fillet nets are commonly used in this type of fishing and the fishery takes places mainly in beaches with sandy bottom conditions (Murray, 2009). Fishing vessels are mostly composed of traditional wooden crafts under 12 meters in length with some fiberglass parts known as "pirogue" as well as small rudimentary canoes (FAO, 2016). See Appendix 4 for photos of coastal and fishing pots operations in Soufriere.

Fishing seasons in Soufriere are mainly determined by weather patterns. The low season for hook and line, characterized by heavy rainfall and extreme winds, is from July to November, while the high season, characterized by good weather patterns, is from January to May. In high and low season, most of the fishers go to the sea on average 5-6 days per week. Fishing trips to remote off-shore areas require 3-8 hours, and it is usually considered a one-day trip, while fishing trips to the FAD require fewer hours and are usually undertaken twice per day. Commonly, fishing operations take place during the day, beginning at around 4:00 a.m. until 12:00 p.m., some of the fishers indicated they sometimes go back to the sea (coastal areas) in the afternoon from approximately 3:00 p.m. to 7:00 p.m. During low fishing season (July to December) rough weather conditions in terms of rainfall, wind and wave action prevent fishers from pursuing their offshore pelagic fishing operations as often as twice or three times per week, and in case of strong storm or heavy rains, this period can be extended to over a week day. As mentioned by one fisher (in his 40s) "When it's too windy, we just go out twice a week, but sometimes when it's really windy, when it rains a lot and you expect a storm, you don't go out the whole week".

Fishing operations are primarily managed and led by fishers who possess fishing assets. The boat-engine owner is the one responsible for financing the fishing operation (purchasing the fuel, maintenance of the boat and or engine), as well the ones that face the cost repairing the boat-engine in case is damaged during fishing activities, as well as, to recover from potential boat-engine theft, situation that according to fishers is commonly reported in Soufriere. In addition, boat owners are

the ones who selected their crew members and the ones that decide, based on their expertise, whether to embark to the fishing operation during rough weather conditions.

5.1.2. Multilevel Governance

The Department of Fishery, part of the Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources, and Co-operatives, is responsible for the management, implementation of policies and development of fishery in the island. The Fishery Department has an extension officer in Soufriere. The fishery department's mainly activity is to govern the fishery regulatory framework, including the license to fishers for fishing operation and registration of vessels. Furthermore, within the provision of the Fisheries Incentive Act of 1972, Saint Lucia's government provides subsidies on fuel for fishing vessels, through duty-free concessions for fuel accounting to US$ 0.05 for every gallon of gasoline purchased. This support is given exclusively to fishers who have officially registered fishing assets (boats or engines) and are properly licensed to operate as fishers. The duty refund is managed by the Fishery department and administered by the fishing co-operative.

The Soufriere´s Fishers Cooperative is the community-based organization which constitutes the primary representation of the fishing community in Soufriere. It forms part of Saint Lucia's Fishing Association, an umbrella organization that unifies all nine fishings co-operatives in the island. The members of the board (5) are selected every year in their annual meeting held at the beginning of each year. Currently, ninety people are members of the cooperative (although not all of them active) and 25 are boat owners. All board members are boat owners and their involvement in the fishery sector is just part-time. In order to be part of the fishing cooperative members need to pay a one-time fee of 250 EC$ or 50 shares (5 EC$ each).

The main role of the Soufriere´s Fishers Cooperative is to administrate the financial subsidy provided by the government, specifically the duty-free refunds. These refunds are given in a quarterly basis exclusively to the members of the cooperative who have officially registered fishing assets (boats or engines) with the Fishery Department. In addition, the co-operative provides support to fishers who own fishing assets in case their boats or engines have been damaged during their fishing activities (accidents, strong winds, etc.), known as the "distress fund" which is deducted from the duty refund to all members by the Fishery Department. Through this fund, the cooperative can provide up to 55% of the total cost of the repair or maximum of 250 EC$. There is no maximum of times the fisher can apply to this fund, and the final decision on the amount provided depends on the board. Low level of attendance and participation from members was

reported by the manager of the Fisher´s co-operative. According to the surveys and informal conversations with fishers, on average the level of trust towards the fishers' co-operative was 2.5 a scale of 0 to 5 (zero being no trust at all and five complete trust). One of the main reason provided by the fishers for their mistrust was their perception of membership benefits being primarily provided to boat owners. In addition, a few fishers indicated they did not feel represented by the board member due to the difference in age (board members were older) and the fact that boat owners were not fully engaged in fishing activities, therefore, they were not aware of their challenges.

The Soufriere Marine Management Association (SMMA) is the NGO delegated by the Government of Saint Lucia to manage the Soufriere Marine Management Area – SMMA. The area was established in 1994 as a response to the rapid increase in tourism and the subsequent coastline multiplicity of uses and degradation of coastal resources (Renard, 2001). The activities developed by the SMMA include patrolling the coastal area, coordinating with the Soufriere fisher´s co-operative and fisherfolk to find better ways to manage the fishing priority areas and solving any potential conflicts with the tourism sector. On the other hand, the Soufriere Regional Development Foundation (SRDF) is a non-profit organization with political influence, in charge of facilitating and supporting local development initiatives among the town. Its activities include working towards the development of tourism-related activities through community participation and engagement.

5.1.3. Challenges for the fishing community

During the surveys with fisherfolk and interviews with stakeholders a few issues kept arising constantly as particular challenges faced by the Soufriere´s fishing community. Although not specifically related to climate variability and change, considering these factors is important to have a more comprehensive understanding of this fishing community's vulnerability. These aspects are related to the market conditions and conflict with tourism activities which are further detailed above.

- **Market conditions**

Although there are two small cold storage facilities in the district, one located in the Soufriere Fisher´s Cooperative and a rudimentary one situated in Baron´s drive (fishing village), most Soufriere's fisherfolk attempt to sell their daily catch, and rarely store unsold fish. The fish is sold

fresh by fisherfolk and/or individual vendors on the city´s provisional street market and in the city´s main supermarkets.

In case of a larger catch, fishers would usually sell the catch for a fixed price to the St. Lucia Fish Market Cooperative (SLFMC). The SLFMC managed a cold storage facility located in the district of Vieux Fort with a capacity of 250 tons and 8-ton ice-making facility, which permitsstoring the fish caught until it could be sold. After the SLFMC sold the catch to medium size buyers (usually restaurant and resorts), the SLFM reattribute the payment to fishers, usually after a week of purchasing their fish. According to fishers, the advantage of this system was that it stabilized the fish prices, as they would not have to hurry to sell the fish, sometimes at lower prices, as well avoided the problem of processing it and storing it. Nevertheless, the fact that the payment was done afterwards, and usually with a delay, was reported as a major inconvenient. According to the interviews with the fishery association and some fishers, this situation led fishers to not sell their catch to the SLFM anymore, which decreased economic benefits to the SLFM and forced them to close their operations.

Nonetheless the increase in tourism could be seen as a growing market for local fish products, but according to interviews with fishers, this is not the case in Soufriere. Only fishers who are well connected with the tourism sector are able to sell their catch directly to them. As mentioned by one fisher (in this 50s) "only the lucky ones are the ones that can sell the fish to local market and those who have connections; the rest of us have to struggle to sell our fish".

In this sense, the poor market conditions, aggravated by the fact the SLFM has temporarily closed their operations and the lack of proper storage facility or market distribution network in Soufriere, is consider a major problem by fishers who have to depend on the local market to sell their fish and the consequent fluctuation in prices.

- **Conflict with tourism**

Since the late 1980s Soufriere emerged as one of the major tourist destinations of Saint Lucia (Walters, 2016). The presence of the declared UNESCO World Heritage Pitons, waterfalls and its iconic cultural-historical landscape has drown tourism attention and promoted the construction/refurbishment of high-end resorts and hotels located in the shore or nearby hillside. These resorts´ main attractions are constituted by diving, yachting and beaches for recreation. As

well, maritime transportation heavily increased in terms of the charter boats and water taxi bringing visitors from the northern area (Castries) where most of the cruise ships arrive (Renard, 2001).

This increased multiplicity of uses within the coastal line of Soufriere originated conflict between fishers, yachtsmen, scuba divers and snorkels (Hogarth & Wójcik, 2016). As a response, and after a long consultation process among various stakeholders, in 1994 the Government of Saint Lucia approved the creation of the Soufriere Marine Management Area (SMMA) and it was launched in 2005 (SMMA, n.d). The SSMA covers 11 km of coastline with width extending either 100m off shore or a depth of 70 meters and established 5 different types of zones within the coastline: fishing priority areas; recreational areas; yachting areas; and one sanctuary, where no activity is permitted, except scientific studies. Five fishing priority areas have been established. These areas include the northern end of the Soufriere Bay (Anse Chastanet Bay), the south of Soufriere Bay, the central part of the Soufriere Bay (yacht main mooring area). These fishing priorities areas, where recreational snorkel, diving, and swimming are also performed, mainly comprised sand and reef substrates, with small patches of reef habitats (Renard, 2001). These areas are demarcated by signs, 42 mooning buoys and 22 demarcation and local dive buoys.

According to the interviews with stakeholders and fishers, although most of the coastal areas are established as priority fishing areas, tourism related activities developed there such as scuba diving, snorkeling, swimming, yacht anchorage and others compete with the artisanal fishery for the access to these coastal zones. This is specially affecting fishers who perform gill net fishery, as the fishing operations becomes more difficult due to the multiple uses in the coastal areas where they operate. In addition, fishers indicated that due to these activities school of fishes tent to go deeper and/or towards off shore areas, decreasing their opportunities to catch fish in coastal zone. Moreover, fishers, specifically the ones involved in pot fishers and divers, mentioned conflicts due to the increasing yacht traffic in the area. Yacht moving in high speed usually destroy the lines from the fishing pots laying on the surface of the sea causing the loss of the fisher pot and catch.

In this sense, fishers commented that although they considered tourism as an opportunity for Soufriere's development, tourism is still seen as a threat for their livelihood as it is pushing them away from their traditional fishing areas. As mentioned by the Soufriere's Fishers Cooperative President "Tourism has been a blessing and a crust, fishers being pressured to leave their traditional fishing grounds…tourism has heavily impacted the coastal area ".

5.1.4. Soufriere's fishers' socio-economic characteristics and involvement in financial/insurance market

This section provides information on the economic characteristics and financial involvement of Soufriere's fishing community, as well as the disaster risk management applied by the community previous and after a disaster event.

- **Fishers' socio-economic characteristics**

Although the poverty level in Saint Lucia has declined over the past few years, Soufriere continues to have one of the highest poverty rates in the country, despite the fact of being one of the most touristic points in the island (Hogarth & Wójcik, 2016). Nearly 70% of the fishers surveyed indicated their average monthly income was less than 800 EC$ while 23% reported that it varies from 800 EC$ to 1599 EC$. Around 66% of respondents mentioned their income has been decreasing over the last years and that climate variability and natural disaster were the main reasons for this decrease. It is essential to acknowledge that these income levels highly fluctuates between low and high fishing season, and especially within productive assets owners and fishers who are just crew members.

Involvement in the financial and insurance market seems to be low among the fishing community in Soufriere. Only 9% indicated getting a loan was the primary strategy that they used to recover from the last disaster event (H. Tomas), while 36% of the interviews reported they have some outstanding debts. Moreover, only 3% of the responders mentioned to be part of an insurance scheme (National Insurance Cooperation), and none of the interviewees indicated to be aware of the index - based insurance product "Livelihood Protection Policy" currently promoted in the Region. Although 100% of the interviewees indicated they believe insurance is an important strategy to recover from disaster, most of them indicated they were not economically stable to purchase insurance products. As mentioned by one fisher (in his 60s) "(…) yes, insurance is important, very important, it's a good thing, but for others, I am not able to afford it". In addition, average low levels of trust toward insurance companies was reported (2.5 out of 5 in a scale where 0 shows no trust at all and 5 complete trust).

Bad experiences from peers regarding insurance performance was mentioned as their main reason for their mistrust. One fisher (In his 50s) mentioned: "(…) my friend paid insurance for about 30 years, once his boat got damaged, he needed to present a huge amount of document, years have passed and he still have not received any payout, that's why I don't trust insurance companies". In addition, the fear of"non – performance" insurance was also mentioned. As indicated by one fisher

(In his 60s) "For me, makes no sense, you pay insurance for 30 years, and the month you skip they payment because something happens, you will not get your money back".

Preference on relying on savings, rather than getting involved in insurance scheme or soliciting credit was mentioned by a few fishers. As indicated by a few fishers: "I prefer saving money every month in the bank, at times when I need it I will just withdraw it, I don't want to drag myself to insurance" (fisher, in his 60s), "If you put 1000 EC$ in a society or credit union, you know you will get your money back. Saving money is better. If you have a business, yes, you need to take insurance, but not us" (fisher, in his 60s).

- **Disaster risk management strategies**

The National Emergency Management Organization-NEMO is the Saint Lucia's governmental entity in charge of managing disaster risk management strategies in the island. This is developed through the committee's representations across the 11 districts which oversee building local capacity and fostering community engagement in the risk management process.

In regards to the risk analysis, Saint Lucia Meteorological office (MET) is the entity in charge of processing weather data (e.g. wind speed, temperature, and precipitation) from the three operating automatic weather stations located in the south of the island. As these weather stations do not provide ocean-related data, the MET office collects data on tides fluctuation through two forecast models available online (Windy and the Global Forecast System). The mentioned data is presented to the general public through daily weather reports broadcasted in different media platforms such as: MET´s website, Facebook and Twitter, three times per day (6:00 a.m., 12:00 p.m., 6:00 p.m.). Marine forecast for sea in a 25 mile radio from Saint Lucia is presented as part of this daily weather report and contains specific information regarding tides, wave height and wind speed. These data is presented under 7 different categories: calm, slight, moderate, locally rough, rough, very rough and extremely rough, depending on the wave height and wind speed. In case of extreme weather related disasters, information is provided to the NEMO office, which is in charge of sending alters to the general public through text message, TV and radio.

There is one marine weather station located in the north of Soufriere's Bay. It has been installed by the Caribbean Community Climate Change Centre in collaboration with the National Oceanic and Atmospheric Administration-NOAA under the Coral Reef Early Warning System (CREWS) Project, to collect data on climate, marine, and biological parameters and to provide information

regarding the impact of climate change on coral reefs. The marine weather station is managed by the National Oceanic and Atmospheric Administration-NOAA.

According to the survey responses the primary coping mechanism used by fishers during time of low income or when they cannot purse their fishing operations due to rough weather conditions, is to make use of their savings (70% of the responders), while relying on the support (in-kind and cash transfers) from friends and family was also considered as a very important strategy. This mutual assistance mechanism seems to be of relevant importance for fishers in Soufriere, as almost half of the surveyed indicated this was the primary strategy used to recover from the last natural disaster event (Hurricane Tomas). Nonetheless, it is important to note that this support was mainly reported to be in-kind support (taking care of kids, food) with less of support given -received in terms of cash transfer. Only 13 of the interviewees indicated they received monetary support from friends and family and the same number reported that they gave monetary support.

Although most of the responders (70%) indicated they were able to fully recover from the past heavy storm (H. Tomas), the time needed to recover from the shock depended on the characteristics of each household. A few fishers indicated their economic activity was interrupted for several days after the storm had passed (from 5 to 12). Others, who lost their assets (boats or engine) or were severely damaged, indicated they were not able to engage in their regular fishing operations a longer time (up to 12 months).

5.2. Soufriere´s Livelihood Vulnerability Index

Overall the fishery-dependent households´ livelihood of Soufriere has a Livelihood Vulnerability Index (LVI) of 0.38. According to these results, the target group in Soufriere is more vulnerable in terms of social networks (0.59) and physical capital (0.54), followed by livelihood strategies (0.46), climate variability (0.41), health (0.37), socio-demographic profile (0.34) and financial capital (0.33). Water (0.07), natural disasters (0.27) and food (0.28) were the components which contributed the least in the vulnerability of this group. Table 01. shows the average, maximum and minimum value of each of the sub-components considering each sub-component unit while Table 02. presents the major components and sub-component of LVI. Table 3. presented at the end of this section outlines the main characteristics of each major component based on the results of this investigation.

IPCC contributing factors to vulnerability	Major component	N of indicator	Sub-components or indicators	Unit	Soufriere	Maximum value	Minium value	Soufriere Index
Exposure	Natural disaster - ND	ND1	Average number of tropical waves and hurricanes in the past 10 years (range: 0-10)	Count	0.24	3.00	0.00	0.08
		ND2	% of HHs with an injury or death as a result of natural disasters in the last 10 years	%	13.30	100.00	0.00	0.13
		ND3	% of HHs with losses to fishing assets or housing due to a natural disaster in the last 10 years?	%	60.00	100.00	0.00	0.60
	Climate variability - CV	CV4	Mean estándar deviation of monthly average of average max. daily temperature (2009-2018)	C°	0.52	0.75	0.22	0.57
		CV5	Mean estándar deviation of monthly average of average min. daily temperature (2009-2018)	C°	0.57	0.90	0.28	0.47
		CV6	Mean estándar deviation of monthly average precipitation (2009-2018)	mm	26.14	74.32	14.61	0.19
Adaptive Capacity	Socio-demographic profile - SDP	SDP7	Dependency ratio	Ratio	21.05	150.00	12.50	0.06
		SDP8	% of female-headed HH	%	0.00	100.00	0.00	0.00
		SDP9	Average number of family members in the HHs	Count	3.83	9.00	1.00	0.35
		SDP10	% HHs heads did not complete school	%	46.70	100.00	0.00	0.47
		SDP11	Average experience of household head in fisheries-related activities (years)	Years	26.17	50.00	5.00	0.47
		SDP12	% HH head is less than 50 years old	5	63.30	100.00	0.00	0.63
		SDP13	% of HHs where the household head is the only earning members	%	40.00	100.00	0.00	0.40
	Livelihood Strategies - LS	LS14	% of HHs income from fishery sector in the last year	%	76.13	100.00	0.00	0.76
		LS15	Average number of income-generating activities per household (1-4)	Count	1.57	3.00	1.00	0.28
		LS16	% of HHs with the family member working in a different community	%	33.33	100.00	0.00	0.33
	Social networks -SN	SN17	Average received: give ratio (shah)	Ratio	0.90	1.67	0.25	0.46
		SN18	% HHs that have not recieved any government assistance in the last 12 months	%	93.33	100.00	0.00	0.93
		SN19	%HHs who are not associated with a community organization	%	36.67	100.00	0.00	0.37
	Financial capital - FC	FC20	% of HHs that do not have savings to support in hard times	%	33.33	100.00	0.00	0.33
		FC21	% HHs that do not have access to credt	%	20.00	100.00	0.00	0.20
		FC22	Avg. borrow: lend ratio (range: 0.5-2)	Average ratio	1.17	2.00	0.50	0.44
	Physical capital - PC	PC23	% HHs without ownership of the houses they live on	%	40.00	100.00	0.00	0.40
		PC24	% Households without ownership of the lands they live on	%	66.67	100.00	0.00	0.67
		PC25	% HHs without ownership of vessels	%	60.00	100.00	0.00	0.60
		PC26	% Houses with weak storm resistance construction (wood, mud)	%	50.00	100.00	0.00	0.50
Sensitiviy	Health-H	H27	% HHs with members suffering a chronic illness	%	23.33	100.00	0.00	0.23
		H28	Average time to the health facility	Minutes	6.03	10.00	2.00	0.50
	Food - F	F29	% HHs depending significantly on fishing they catch (more than 50% of their catch is used as food)	%	20.00	100.00	0.00	0.20
		F30	Average number of months HHs struggle to find food	Months	1.43	4.00	0.00	0.36
	Water-W	W31	% HHs without pipe-borne water	%	6.67	100.00	0.00	0.07

Table 1. Sub-components average, minimum and maximum values – Soufriere, Saint Lucia

N of indicator	Sub-components or indicators	Sub-components - Index	Major components	Components - Index
ND1	Average number of tropical waves and hurricanes in the past 10 years (range: 0-10)	0.08	**Natural disaster - ND**	0.27
ND2	% of HHs with an injury or death as a result of natural disasters in the last 10 years	0.13		
ND3	% of HHs with losses to fishing assets or housing due to a natural disaster in the last 10 years?	0.60		
CV4	Mean estándar deviation of monthly average of average max. daily temperature (2009-2018)	0.57	**Climate variability - CV**	0.41
CV5	Mean estándar deviation of monthly average of average min. daily temperature (2009-2018)	0.47		
CV6	Mean estándar deviation of monthly average precipitation (2009-2018)	0.19		
SDP7	Dependency ratio	0.06	**Socio-demographic profile - SDP**	0.34
SDP8	% of female-headed HH	0.00		
SDP9	Average number of family members in the HHs	0.35		
SDP10	% HHs heads did not complete school	0.47		
SDP11	Average experience of household head in fisheries-related activities (years)	0.47		
SDP12	% HH head is less than 50 years old	0.63		
SDP13	% of HHs where the household head is the only earning members	0.40		
LS14	% of HHs income from fishery sector in the last year	0.76	**Livelihood Strategies - LS**	0.46
LS15	Average number of income-generating activities per household (1-4)	0.28		
LS16	% of HHs with the family member working in a different community	0.33		
SN17	Average received: give ratio (shah)	0.46	**Social networks -SN**	0.59
SN18	% HHs that have not recieved any government assistance in the last 12 months	0.93		
SN19	%HHs who are not associated with a community organization	0.37		
FC20	% of HHs that do not have savings to support in hard times	0.33	**Financial capital - FC**	0.33
FC21	% HHs that do not have access to credt	0.20		
FC22	Avg. borrow: lend ratio (range: 0.5-2)	0.44		
PC23	% HHs without ownership of the houses they live on	0.40	**Physical capital - PC**	0.54
PC24	% Households without ownership of the lands they live on	0.67		
PC25	% HHs without ownership of vessels	0.60		
PC26	% Houses with weak storm resistance construction (wood, mud)	0.50		
H27	% HHs with members suffering a chronic illness	0.23	**Health-H**	0.37
H28	Average time to the health facility	0.50		
F29	% HHs depending significantly on fishing they catch (more than 50% of their catch is used as food)	0.20	**Food - F**	0.28
F30	Average number of months HHs struggle to find food	0.36		
W31	% HHs without pipe-borne water	0.07	**Water-W**	0.07

Overall LVI Soufriere

LVI **0.379**

Table 2. Indexed sub-components, major components and overall LVI for Soufriere, Saint Lucia.

The results of the major components influencing the target group vulnerability are presented in a spider diagram (Fig.09). The scale of the diagram ranges from 0 to 1; 0 being the less vulnerable and located in the center of the web and 1 the most vulnerable and presented in the outside edge of the diagram.

The following sections include an analysis of the factors that contribute to the different significant vulnerability components, framed under its three main aspects: exposure, adaptive capacity, and sensitivity.. This analysis is based on the information gathered during the semi-structured interviews, conversations with fishers during the survey process and literature review

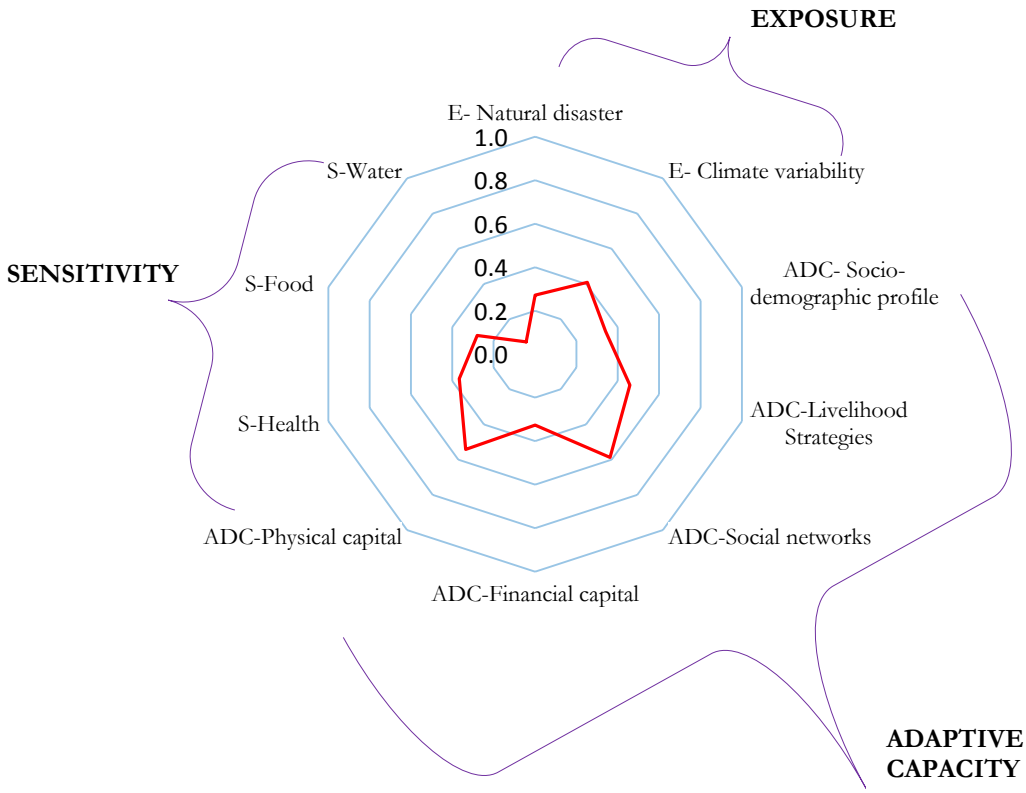

Figure 9. Vulnerability spider diagram of the major components of the Livelihood Vulnerability Index (LVI) for fishery-dependent household´s in Soufriere, Saint Lucia. (E: Exposure; ADC: Adaptive Capacity, S: Sensitivity)

5.2.1. Exposure

The major components related to exposure to the system in this research are climate variability and natural disasters. Fig. 10 shows the contribution of the index values of these two major components to the Exposure of the Livelihood Vulnerability Index (LVI). According to these results, climate variability has a more significant influence on the fishery-dependent household's vulnerability than natural disasters.

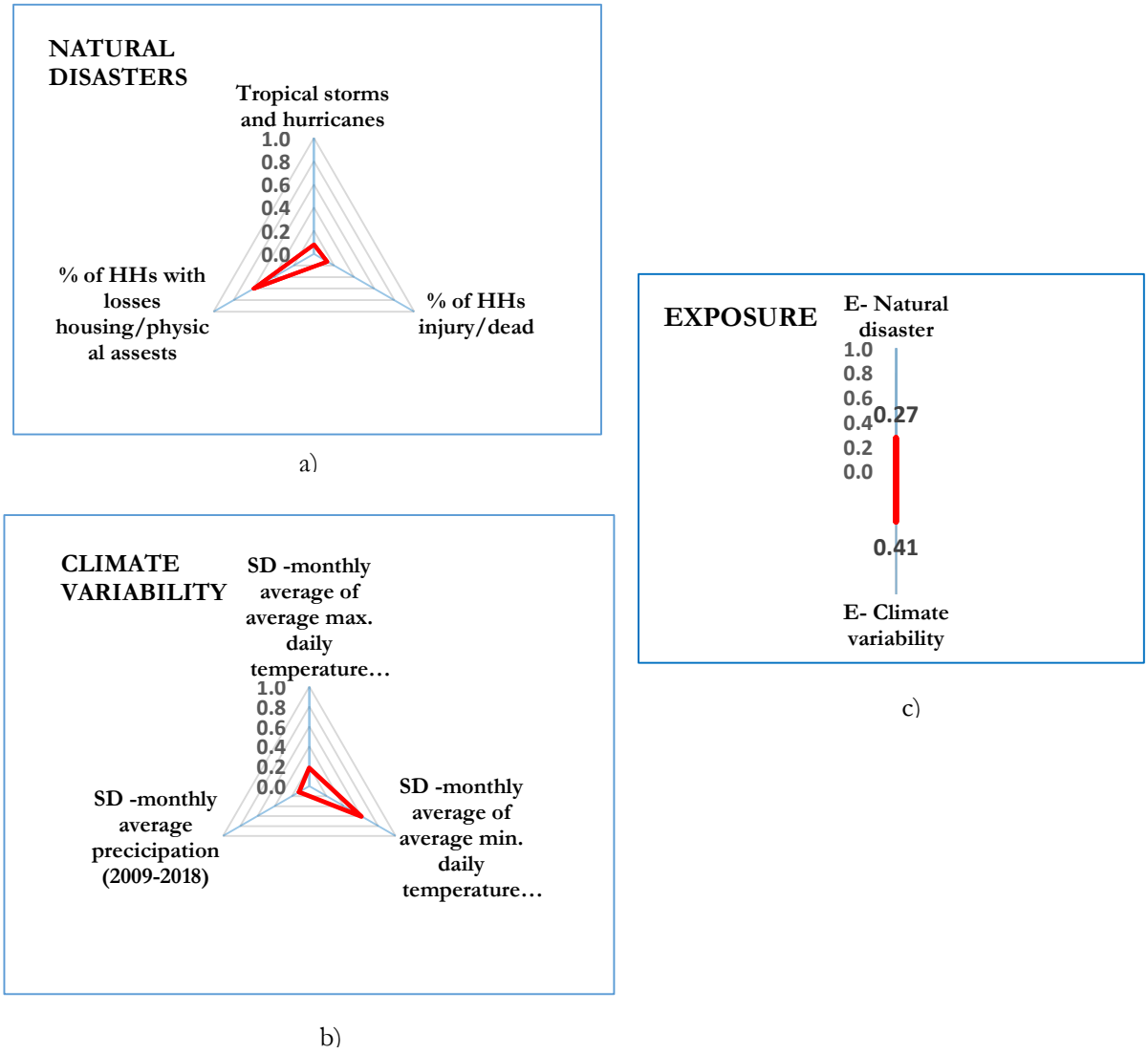

Figure 10. Vulnerability spider diagrams showing the contribution of Natural Disaster and Climate Variability major components to the Exposure factor of the Livelihood Vulnerability Index (LVI) for fishery-dependent household´s in Soufriere, Saint Lucia. (a) Sub components contribution to the Natural Disaster component; b) Sub components contribution to the Climate Variability component c) Exposure

5.2.1.1 Climate variability

The climate variability component is composed of sub-indicators related to the maximum and minimum average of temperature and precipitation (See fig. 10 b). Although the monthly average minimum temperature contributed the most to the component index, fluctuation in terms of temperature was not reported by fishers as an issue that directly impacted their livelihood. Increase in the rainfall patterns, mainly during October and November, was indicated by fishers as an issue that affected their livelihood. The movement of sediment due to the intense rainfall, low underwater visibility and decreased ability to catch target species was argued to reduce their effective operational days at the sea. Changes in the sea level and oceanographic variable (wind and wave actions) were not considered in the index as Saint Lucia´s Meteorological Services (MET) department is not equipped to monitor sea level changes and does not archive wind and wave action data. Changes in wind and wave actions were reported by fishers as the main factor that constrict their usual fishing operations.

Fisher's rely on the weather marine report provided by the MET office three times per day (social media, webpage, radio and TV) to decide whether to go or not to the sea. According to them at a wave height of maximum 6 feet and 25 min/wind speed, categorized as "locally rough conditions" by the MET's weather report, they decide not to pursue their normal operations. Nevertheless, others indicated they rely on their own intuition of risk based on their wide experience. As mentioned by one fisher (in his 60s) "I don't believe in the MET office, I believe in myself".

5.2.1.2. Natural disasters

The natural disaster component was composed by the number of extreme weather events in the past ten years, % of households who reported injury or death as a result of it and % of households that reported losses to physical assets. (See fig. 10 a). From these sub-indicators, losses to physical capital as a result of the natural disaster was the factor that influenced this major component the most. It is essential to specify that only the extreme weather events which are likely to affect fishery-dependent households, such as tropical waves, hurricanes, floods and troughs storms were considered for the index calculation and the source of information was official reports provided by the MET office.

- **Extreme weather events**

Although Saint Lucia is heavily exposed to severe storms impacts, due to its location in the Atlantic hurricane belt, extreme weather events have been rather infrequent in the island over the last years. An average of 0.24 number of tropical waves and hurricanes have been reported over the last ten years: Hurricane Tomas (2010), Christmas eve trough (2013) and the Tropical Storm Matthew (2016). (See appendix 5 for a list of the major weather related natural disaster events in Saint Lucia). Among the recent extreme weather events, Hurricane Tomas was reported by the interviewees as the one causing severe damage for their livelihoods. Atlantic hurricanes through the Caribbean usually follows an east-west trajectory, usually impacting the western coastlines of many of its islands (USAID, 2000). Although Hurricane Tomas followed this current trajectory, not directly impacting the coast of Soufriere, the almost 80mph recorded winds, heavy rainfall, and coastal erosion, severely impacted the city, mainly the public infrastructure and housing stock (Hogarth & Wójcik, 2016). Even though it was not under the scope of 10 years of assessment, most of the fishers surveyed and stakeholders interviewed indicated Tropical Storm Lening (1999) as being one of the most severe and destructive natural disaster experienced so far which profoundly impacted their livelihoods. Tropical Storm Lening, provoked waves up to 6-meter high which impacted the west coast area of Saint Lucia, being Soufriere the city that suffered the hardest (USAID, 2000). Baron´s Drive, the main fisher´s settlement in Soufriere was the village most severely damaged across the whole Soufriere Bay due to the high swell and surges generated by the storm (USAID, 2000). See appendix 6 for photos of the fishing village.

- **Loss of physical capital**

The loss of physical capital was the factor that influenced the most to the system's exposure and the most important consequence of the impact of these extreme weather events, compared with injury or death. 60% of the interviews reported physical assets such as housing, vessels, and fishing gear have been lost or damaged because of these extreme weather events. The lost or damageof these assets did not only provoke financial costs due to repairing but had a significant effect on the fisher's availability to be engaged in fishing activities long after the disaster passed. Fishers indicated they were not able to fish for several days (from a few days up to months to 2 weeks) after the disaster passed. Low visibility caused by the movement of the sediments due to the storm was indicated as one of the reasons they could not engage in their normal fishing operations after the disaster. Lack of water, electricity and fuel together with having to deal with personal shock provoked by the disaster was other reasons mentioned by the fishers. The livelihood interruption

was even more critical for fishers who lost their boat and/or engine, as they were not able to pursue their regular fishing activities for several months or even a year after the storm has passed .

This situation was illustrated by a fisher (boat owner in his 50s) who stated "(..) after Tomas, 3 weeks I could not go out to the sea, everything was a mess. The sea was still high, my boat got damaged, and the other boats were still at shore. We did not have electricity, no petrol to go out. It was a disaster for me"

5.2.2. Adaptive Capacity

The major components related to the adaptive capacity of the system in this investigation are social networks, physical capital, livelihood strategies, socio-demographic profile, and financial capital. Fig. 11. shows the contribution of the index values of these major components to the adaptive capacity. According to this result, social networks (0.59) and physical capital (0.54) are the factors that influence the most to Soufriere´s fishery-dependent households' adaptive capacity while livelihood strategies (0.46) socio-demographic profile (0.34) and lastly financial capital (0.33) are other factors that influence the target group adaptive capacity but in a lower degree.

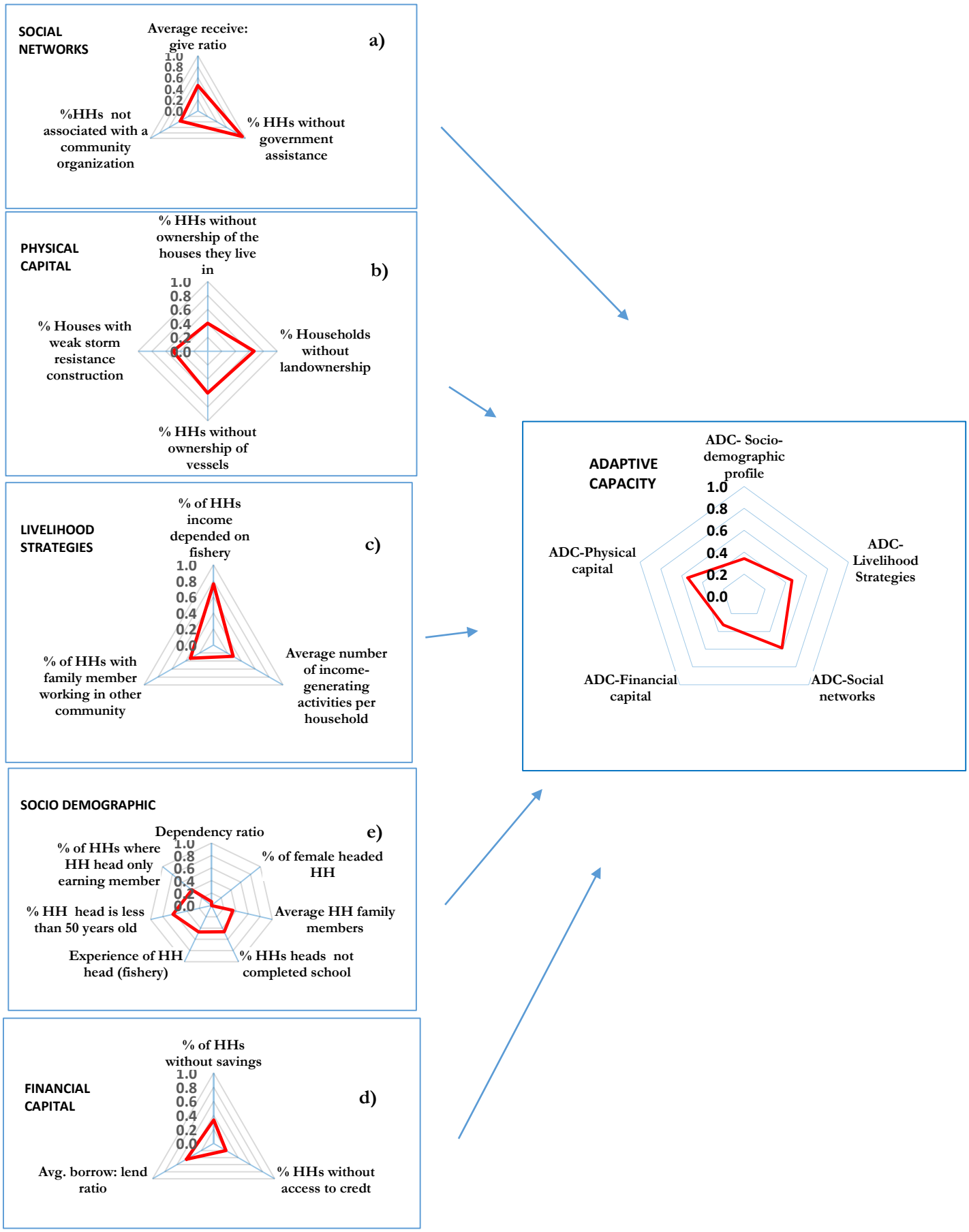

Figure 11. Vulnerability spider diagram showing the contribution of the different components to the Adaptive Capacity factor of the Livelihood Vulnerability Index (LVI) for fishery-dependent household´s in Soufriere, Saint Lucia. a) Socio demographic component, b) Livelihood strategies component, c)Social network component, d)Financial capital component, e) Physical capital component and f)Adaptive Capacity major components.

5.2.2.1. Social Networks

The social network (SN) component was assessed in terms of three sub-indicators: social protection, social capital, and the community's organizational structure. Social protection, in terms of % of households that did not receive any assistance, was identified as the sub-indicator that influence the most to this target group´s adaptive capacity, followed by social capital and lastly by the % of households that were not associated with any community group. (See Fig. 11 a).

- **Social Protection**

Although Saint Lucia's Government has prioritized the strengthen its social protection system (Government of Saint Lucia, 2015) and implemented a diverse of social protection programs such as social insurance, safety nets, labor market programs, among others, (SSNA), it seems these programs have not reached the fisher's community in Soufriere. Nearly 93% of the responders indicated that they are not part of any social security program and do not receive any assistance from the government.

Notably, the lack of a secure retirement program was mentioned among fishers as a critical aspect of concern. A few fishers mentioned the difficulty of being part of the national social insurance program "National Insurance Corporation", a national program which provides retirement, disability, and maternity benefits, due to the lack and instability of financial resources. As this program primarily functions through formal social employment (5% employee contribution and 5% employer contribution) the fishers who indicated to be part of this scheme mentioned it was due to causality reasons (they started to contribute when they were dependent workers, after which they decided to continue contributing). Relying on family members for subsistence was mentioned as their primary safety plan when the time they could no longer be involved in fishing comes. Fisher (In his 60s) "(…) my children will have to maintain me after I cannot go to the sea with them anymore, is the way it is"

Social protection during periods of natural disasters is particularly critical, especially in Saint Lucia due to its vulnerability to external shocks (UNICEF, 2017). The responders mentioned the lack of the latter as a critical issue of concern. In the case of Hurricane Thomas, the government focused their efforts to assist the "Fond St Jacques" area, located in the hills of the city, as it was the one that suffered the most due to the landslide caused by the hurricane. Fishers indicated they did not receive any support from the government to recover from Hurricane Thomas. In the case of Hurricane Lening (1996), few fishers mentioned the relocation program called "Lenny's Hill" led

by the government and which aimed to re-locate the most affected residents from Baron's drive (the most affected community in Soufriere) to area away from the coastline (Hogarth & Wójcik, 2016).

- **Social Capital**

Social capital refers to the informal networks of relationships and exchange of knowledge and resources across the community which at the same time is based on levels of trust and reciprocity (Baptiste & Kinlocke, 2016). In this study, the latter is measured by the average receive: give ratio. According to this radio, vulnerable households are likely to be the ones that receive support (kind-cash transfers) from other households but offers little assistance (Hahn et al., 2009). In Soufriere, the radio seems to be reasonably balanced (0.90) which could prove the existence of strong ties among members of the fishing community. The secure social connections through friendship and partnership have been demonstrated during times of disasters as most of the fishers interviewed (70%) indicated they received most of the support to recover from friends and family. As mentioned by one fisher (In his 40s) "(…) after Tomas, we did not have any support on the government, we just had each other, we were one". As well, during non-disaster times, fishers expressed their tendency to rely on each other to ensure their livelihoods are being met. In a time of low catch, few non-boat owner´s fishers indicated that even though each boat owner usually has a permanent crew, they occasionally took turns in order to allow other fishers to capture fish.

- **Community organization structure**

The role of local institutions in increasing the target group adaptive capacity was assessed in this study by measuring the number of households that were associated with some community group. 63% of the interviewees that indicated to be part of a community organization, 11 of them were associated with the Soufriere´s Fishers Co-operative while the others were part of the two credit cooperatives unions operating in the district: Fond St. Jacques Credit Co-operative Union and Choiseul Credit Co-operative Union. 60% of the fisher who indicated to be members of the fisher's co-operative were boat owners. The latter is closely related to the fact that fisher´s co-operatives in Saint Lucia were created in order to administrate the duty-free for fuel refunds provided by the government (Murray, 2009). As a result, fishers who are boat owners are the ones most attracted to become members of the co-operative due to this financial benefit. In this sense, as expressed by many fishers and the manager of Soufriere´s co-operative, the non-boat owner fishers are not interested in forming part of this association as they do not perceive any benefits As indicated by one fisher (In his 50s) "If you are member of the cooperative and don't have a boat, you don't get

any benefits, you don't get nothing… maybe trainings once a year, and that´s it". Acknowledging this situation, the manager of Soufriere´s Fishers Cooperative indicated "If I am a boat owner I get a duty refund every quarter, I don't have a boat, what I should be a member of the cooperative? This is how fishers think… so we must put some sort of benefit to non-boat owners, encourage them to be members"

According to the manager of the Soufriere´s Fishers Cooperative, 25 boat owners, out of the 80 registered in Soufriere, are enrolled in the fisher cooperative. Although it is important to note that not all registers boat owner are involved in fishing, as a great number are involved in marine fishing activities.

Almost half of the fishers interviewed (47%) indicated financial support and access to the loan was the main benefit from being part of these community organization, only 26% indicated knowledge sharing and network while 27% indicated they did not perceive any benefit of being part of the association.

5.2.2.2. Physical capital

The physical capital component was assessed through 4 sub-indicators: ownership of the house fishers lives in, ownership of the land they live on, ownership of vessels and the construction material of their houses. Lack of land ownership and vessels were considered the main two subcomponents that influence the fishers' capacity to adapt. (See Fig. 11 b). The high percentage of responders who do not own the land they live in (77%) and do not own vessels (60%) were considered the main subcomponents that influenced.

- **Land ownership**

Among the responders, 60% indicated they did not own the land they lived. Because the fisher's village is located in the coastline of Soufriere (more exposed to extreme weather events) the lack of land ownership may constitute an important aspect that increases the vulnerability of fishers in Soufriere. Moreover, the houses of most of the responders are made of a material less likely to resist natural disasters (wood/timber).

- **Vessel ownership**

Vessels ownership is an important indicator that influences fisher's vulnerability in Soufriere. 60% of the responders indicated they did not own a boat, therefore were involved in the fishing activities

as a crew member. As mentioned in section 5.1.1 of this chapter, fishing operation are financed, managed and lead by fishers who possess fishing assets (boats). In this sense, crew members do not carry the burden of potential financial losses during the fishing operations. The difference in losses and risk perception between boat owners and crew member could be illustrated by the following two fisher's comments: "The fuel is too high, the investment is too high, sometime you spend like 1000 EC$ in gas, go for a day, and not sure if you will get any return, sometimes you go out and don't catch anything" (Boat owner in his 50s), "I´m just part of the crew, I am not a captain…. I don't lose money on the fuel, so it's not my lost" (Crew member in his 50s).

Moreover, boat owners are the ones who selected the crew members that will participate in the fishing operation. The latter could restrict the crew member household´s choice for livelihood and forced them to adopt other livelihood strategies. Few fishers mentioned that in case the boat owner does not select them to be part of their crew, they would have to look for other opportunities to earn some profit.

5.2.2.3 Livelihood Strategies.

The livelihood strategy component was assessed in terms of three sub-indicators: high level of income generated from fishing activities, livelihood diversification, and migration. Income dependence on fishing activities was identified as the sub-indicator that influenced the most to this major component (See Fig. 11 c).

- **Income dependence on fishing activities**

76% of the responders indicated that their primary source of income comes from fishing activities. All the fishers who stated fishing is their sole source of income indicated that in times where due to unfavorable weather conditions, they cannot pursue their regular fishing operation they "sit and wait out" until the conditions enable them to fish. "I do nothing, I just have to wait until I can go to fish" (fisher, crew member in his 50s).

Many of the responder's comments could support the argument that due to fisheries' unpredictability in terms of seasonal and cyclical fluctuations in catch and location, fishing communities have learned to live with change and uncertainty. As stated by a fisher (In his 40s) " sometimes you get catch, sometimes you don't, this is how it is, it's not guarantee. I know this since I start in the business, it's just the way it is", as well, another fisher indicated (In his 50s) "you cannot do anything, storms are always there, you are in the Caribbean"

- **Livelihood diversification**

In average the responders are involved in at least two income generating activities besides fishing, although fishing continues to be their primary source of income. The diversification of fishing activities among the fishers surveyed focuses on non-fishing activities such as construction and tourism. Some fishers indicated they get involved in these activities, as the opportunity arises.

The strong occupational identity showed by some fishers whose primary source of income comes from fishing activities illustrated by some of their comments: "When you start working in the sea, you don't leave it. I don't know what is it…there is something there… you just can't quit" (fisher, in his 50s), "I'm a fisher, that is what I am, and I will continue doing it until the day I die" (fisher, in his 50s). The latter could be considered as one aspect that influences their decision to diversify their livelihood. When informal conversations were held with younger fishers, whose main livelihood is marine tourism and only pursue fishing activities occasionally, they did not show this attachment. As indicated by one fisher (in his 40s) "If I would have constant demand for fishing, I would be happy, but there is no demand. If the fishing is not selling, you have to low the price that is too risky for fishers. You have to wake up at 4 a.m in the morning, go fish and try to sell it, too much work, too risky"

According to informal conversations with the younger section of the fishing community, more or less 3/4 of the younger fishermen are getting involved more involved in marine tourism activities over the last years as they consider it as a more profitable and less risky livelihood. As mentioned by one fisher (In his 30s) "The youngers from the community are leaving, more people are following the step of younger from the community who work on water taxi, being a fisher is too much work, too much stress, is too risky,… I would never go back into fishing again, I rather be in the tourism industry, and every month I am sure am I doing certain amount". The latter goes in line with the progressing changes in the livelihood's sources of residents from Soufriere over the last years. Between 1991 and 2012, the proportion of resident of Soufriere involved in agriculture, fishing and forestry has declined from 25.5% to 8.3%, with a considerable portion employed in the tourism and manufacturing activities, which during that period almost doubled, from 15.6 to 2.9% (Hogarth & Wójcik, 2016).

- **Migration**

Migration to another community to work did not seem to be a livelihood strategy pursue by fisher's household in Soufriere, as only 33% of the responders indicated that some members of their

households work outside Soufriere. These family members are usually employed in non-fishery activities, mainly within the governmental offices Castries, Saint Lucia's capital.

5.2.2.4. Socio-demographic profile.

The socio-demographic profile component was explored in terms of five sub-indicators: dependency ratio, female as household head, level of education of the household head, the experience of the household head in fishery-related activities, presence of non-elderly household heads, and % of households where the households head is the only earning member of the family. Among these sub-indicators, experience in fishery-related activities, low educational level and the presence of non-elderly household heads were identified as the ones that influenced the most to this major component. (See Fig. 11 d).

- **Household head ages and experience in fishery -related activities**

The majority of the fishers surveyed were less than 50 years old (63%), and on average the experience of the household head in fishery/related activities was 26 years. Many of the responders indicated they had been involved in fishing activities since early stages of their lives, as they were a child of fishers who taught them the fishing techniques or were always surrounded by this type of livelihood, as they were born in the fishing village. The latter could be translated to the high level of occupational attachment identified during the surveys. When asked how many years they would be still engaged in the fishery sector, most of them indicated they would be involved in fishing as long as they can, even in the face of increasing pressures in terms of climate variability or decrease in fishing stock.

- **Level of education**

Almost half of the responders completed just primary school. Saint Lucia's education system characteristics could partly explain this result. Until 2006, secondary education was not mandatory for Saint Lucians, hence for people that began their education prior this year (all the interviewees) were not required to complete school. As indicated by the representative of Soufriere Regional Development Foundation, the lack of fishers' ability in Soufriere to express their concerns and problematic is considered one of the main barriers to implement development programs "Farmers in Soufriere can argue what are their main challenges and propose strategies, with fishers…they are not academically prepared, and it is difficult for them to even explain what their issues are and how they would like to solve them"

5.2.2.5. Financial capital

The financial capital (FC) component was assessed through three sub-indicators: availability of savings, access to credit and the average borrow: lend ratio. The average borrow: lend ratio was identified as the sub-indicator that influenced the most to this major component, closely followed by the availability of savings and lastly access to credit (See Fig. 11 e).

- **Average borrow/lend ratio**

According to this radio, vulnerable households are the ones that borrow money from other households, but they usually are not the ones that lend money. In Soufriere, the radio seems to be reasonably balanced. From all the responders, nearly 30% indicated they have borrowed or lend money to other houses.

- **Saving availability**

Savings seems to constitute an essential strategy for fishers. Nearly 70% indicated they possess savings, while 37% of the responders indicated the amount has been decreasing over the last years. A usual practice among the fishers is to accumulate savings during times of good income and deplete these savings in times of low catch to be able to have access to basic consumption needs. Nearly 90% indicated the primary strategy in times of low income is to make use of their savings, while the use of savings to invest in assets or productive activities inside or outside the fishery sector was not mentioned.

As well, considering fishers make use of their saving regularly during times of low income, the total amount of savings highly fluctuates over time. On average their savings would be able to support their households for no longer than two months (average 1.5 month) in case of non-income.

- **Access to credit**

80% of the interviews indicated they have easy access to credit or loan. Credit availability for fishers in Soufriere is provided mainly by the fishers' cooperative and the two credit co-operatives unions in the district: Choiseul Credit Co-operative Union and Fond St. Jacques Credit Co-operative Union. The details on the credit programs provided by the Soufriere's Fishers Cooperative were detail in the section 5.1.2 of this chapter.

Although there is no specific program to provide loans for fishers, both of the credit co-operatives unions provide fairly good opportunities to get access to credit. According to the credit co-

operatives union's managers, the evaluation for access to credit is conducted on an individual basis and considering each member commitment to pay and frequency of savings. The credit co-operative unions could also enhance the culture of saving.

5.2.3. Sensitivity

The major components related to the sensitivity of the system in this investigation are health (0.37), food (0.28) and water (0.07). Fig. 12 shows the contribution of the index values of these major components to the Sensivity. .According to this result, heath and food are the factors that influence the most of Soufriere's fishery-dependent households' sensitivity while water is the factor that influence the least.

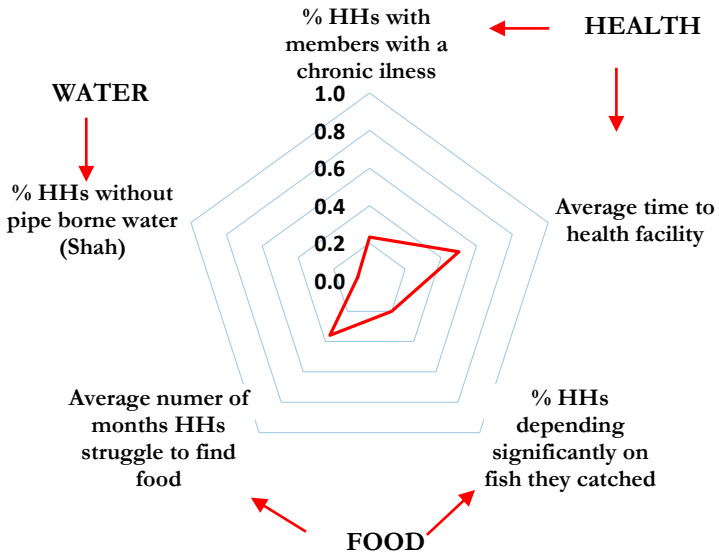

Figure 12. Vulnerability spider diagrams showing the contribution of the different components to the Sensitivity factor of the Livelihood Vulnerability Index (LVI) for fishery-dependent household´s in Soufriere, Saint Lucia.

5.2.3.1 Health

The Health (H) component was assessed through two sub-indicators: average time to get to a health facility center and % of HHs with members suffering a chronic illness. The former was identified as the sub-indicator that influenced the most to this major component. Soufriere has one health center and one policlinic located in the city town, approximately 5 minutes walking distance from the fishing village "Barons Drive", main reason why all the interviewees indicated the time to

get to the facility was not an issue. Saint Lucia does not have a Universal Health Care system, reason why some fishers indicated accessing to health care was challenging at times.

5.2.3.2. Food

The Food (F) component was assessed through two sub-indicators: % HHs depending significally on the fish they catch and the average number of month HHs struggle to find food. The latter was identified as the as the sub-indicator that influenced the most to this major component.

In Soufriere, most of the fishers interviewed indicated they consumed less than 25% of the fish they catch, either in high and low season, while just 20% of the interviewees indicated they consume more than 50% of the fishes they catch. In this sense, the fish they catch constitute only a small portion of Soufriere fishery dependent household's daily diet. In this sense, the quality of nutritious food they consume is strictly dependent on the revenue they obtained from their livelihoods. As mentioned by one fisher (In his 50s) "we sell fish to buy chicken". Fishers indicated that on average they struggle to get food for their household three months in a year, usually during the low season. Nevertheless, most of them indicated that they rely on friends and family in times of low catch. Although skipping meals did not constitute one of their main coping strategies, during time of low income they indicated they tend to opt for less expensive and less quality food.

5.2.3.3. Water

The Water (W) component was assessed through one sub-indicator: % HHs without pipe borne water. This sub indicator was considered the least factor that influenced the vulnerability of the target group. Soufriere's fishing village Barons' Drive has one public standpipe. In this sense, the fishery dependent households who live in this fishing village have constant access to clean water. It is important to notice that water shortages was considered an issue after the latest disaster event in Saint Lucia (H. Tomas). The latter due mainly to the consequent flooding and landslide in Soufriere, which severely damaged public water and sewage systems.

Major Component	Main characteristics
Natural Disasters	✓ Even though while infrequent, the occurrence of extreme weather events severely impact the livelihood of fishery/based community ✓ Loss of physical capital was the most important consequence. Besides of financial losses due to repairing the damage caused, the availability of fishers to be engaged in fishing activities decreased long after the disaster passed as they were not able to pursue their normal fishing operation an average of (from 5 days up to 12 months).
Climate variability	✓ Increase in the rainfall patterns and chances of oceanographic variables (wind and wave action) were reported by fishers as the main factor that constrict their usual fishing operations. ✓ At a wave height of maximum 6 feet and 25 min/wind speed they decide not pursue their normal operations. ✓ Although fishers consider the weather reports provided by the MET office, some fishers rely more on their own intuition of risk based on their experience. ✓ Rough weather conditions prevent off-shore pelagic as often as twice or three times per week, and in case of strong storms or heavy rains, this period can be extended to over a week. ✓ The decision of whether to embark to the fishing operation or not relies exclusively on the boat owner's decision and expertise.
Social networks	✓ Members of the fisher/s community are not part of any social security program and do not receive any assistance from the government. ✓ Specific social protection programs aimed to provide assistance to recover from disaster events is lacking (e.g. no assistance was reported after Hurricane Thomas). ✓ There are strong social connection through friendship and partnership among members of the fishing community, specially demonstrated during times of disaster. ✓ Boat owners are the ones more interested to be part of the Soufriere's Fishers Cooperative as they received direct financial benefits (duty refund from fuel). ✓ There is a medium trust level towards the Soufriere's Fishers Cooperative among the fishing community.
Physical capital	✓ *Lack of landownership is an issue* ✓ The majority of the houses in the fishing village are made of material less likely to resist to natural disasters. ✓ Boat owner is the one responsible to finance the fishing operation, determine if they go out to the sea and gather the fishing crew. In times of no profit, damaged or robbery of the vessels or engine they are the ones facing the financial losses.
Livelihood Strategies	✓ Although on average fishers are involved in others economic activities, such as tourism and construction, fishing activities continue to be their main source of income. ✓ Strong occupational identity seems to be an important factor that affect livelihood diversification. ✓ According to fishers, the younger section of the population are turning into marine tourism as a source of livelihood, as they find it less risky and more profitable.
Socio-demographic profile	✓ Fishers are involved in fishing activities science early stages of their lives, which could be a reason for their high sense of occupational attachment. ✓ Older fishermen indicated although in the face of increasing pressures, they would be still engage in fishing. ✓ Fishers present low level of education (primary school), which has been indicated by stakeholders as an aspect that constrict their involvement in development programs of the district.

Financial capital	✓ Savings constitute an important practice among fishers. In times of low income, the use of their saving is one of the main strategies they use to be able to access to basic consumption needs. Use of savings to invest in assets or productive activities inside or outside the fishery sector was not mentioned. ✓ Fishers can get easy access to credit through the Soufriere's Fishers Cooperative or the two credit union established in the district. Besides credit, fishers can access to the distress fund provided by the fishers cooperative, exclusively for boat engine owners to repair their assets in case of damaged during fishing operations.
Health	✓ Fishers can have easy access to the health center facility located in Soufriere (5 min walking distance), nevertheless they do not have free access to health system as there is no Universal Health Care system in Saint Lucia.
Food	✓ Fishers do not depend on their catch for to secure a protein rich diet. Quality of nutritious food they consume is strictly dependent on the revenue they obtained from their livelihoods ✓ During time of low income they tend to opt for less expensive and less quality food and do not skip meals.
Water	✓ Soufriere's fishers living Barons' Drive have constant access to water through the public standpipe. Nevertheless, water shortages was considered an issue after disaster events.

Table 3. Main characteristics of each major component that influence the vulnerability of fishery-dependent household´s in Soufriere, Saint Lucia.

6. DISCUSSION

This chapter provides a discussion of the relevant points that have arisen from the analysis provided in the result section. First, the influence of the main components of vulnerability: exposure, adaptive capacity, and sensitivity in Soufriere's fishery-based livelihoods will be examined. Secondly a discussion of the potential impacts of index -based insurance products in increasing Soufriere's fishery-dependent household's adaptive capacity, its limitation and opportunities for implementation will be presented and, lastly, the overall implications of the study will be outlined.

6.1. Vulnerability of Soufriere's fishery-based livelihoods

Soufriere's fishery- dependent households' vulnerability is shaped by a combination of various factors related to exposure, adaptation, and sensitivity, overall underpinned by its socioeconomic, demographic and cultural characteristics. According to the results of this research exposure is primarily influenced by climate variability, its adaptive capacity is mainly determinated by social networks, physical capital and livelihood strategies, while sensitivity is limited to health. Below I will further discuss the influence of these factors in the overall vulnerability of the sample group from the researcher perspective, based on the results of this investigation and Soufriere's fishing livelihood context, as well as literature review. Fig. 13 presented at the end of this section shows the different factors that determinate Soufriere´s fishery- dependent household's livelihoods and illustrates how they shape the vulnerability of this group.

- **Exposure**

Climate change is likely to be experienced through an increase in the climate variability, in terms of extreme daily temperatures or extreme daily rainfall amounts (Easterling et al., 2000) and an increased frequency of extreme events, such as hurricanes or flooding (Daw et al., 2009). According to the index results, climate variability was considered a crucial aspect that influences the vulnerability of Soufriere's fishery-dependent households compared to the occurrence of natural disaster events. The main consequence of these impacts on the fisher livelihoods is the high fluctuation of their income as consequence of: 1) reduction of effective working days at sea, where rough weather conditions prevent them from putting them out at sea (too dangerous) or 2) when they do, the catches are too low that the revenue generated cannot cover the initial investments or basic consumption needs. The low visibility leads to a sense of insecurity at sea and an inability to reach off -shore fishing grounds caused by the more frequent occurrence of heavy rains, strong winds and high waves, reduces the number of working days at the sea as often as 3 times per week during the hurricane season (July to November).

Weather relater natural disasters, such as hurricanes and tropical storms, according to the index, seems to have less influence in the vulnerability of the fishery dependent households. The latter, mainly due to the fact that these extreme events have occurred in a rather infrequent manner (3 hurricanes over the last 10 years). Nevertheless, as reported in this investigation, although these extreme events occur occasionally, these disasters event have a more profound and lasting impact on the vulnerability of Soufriere's fishers in terms of their livelihood assets and strategies. Specifically, severe hurricanes have negative consequences on the safety of fishers at sea, on their physical assets such as boats and fishing equipment (Barange et al., 2018). Especially in Soufriere, the loss or damage of physical capital (vessels and housing) after a weather-related disaster event, was one of the factors that contributed the most to their vulnerability. This is translated into significant economic risk, especially for fishers who own fishing assets. These fishers, as none of them have insurance, have to face the economic burden of repairing their boats, unable to continue with their operations even months after the natural disasters has passed.

Climate variability and weather-related disaster events severely impact the livelihood of fishery dependent households in Soufriere, not only due to decreased harvesting capacity (loss of operational days) but due to the impact on physical capital (housing infrastructure and fishing assets). According to the IPCC 2007, the increase in extreme weather events will mainly impact fishing communities who, due to its location in coastal or tropical storm areas, are more exposed. This is particularly important for the fishery community in Soufriere, as most of the fishers and their families live in Baron's drive, fisher's village located in the coast line of Soufriere's bay, therefore, the risk of housing infrastructure and property damaged due to natural disaster increases.

Although not considered within the scope of the vulnerability assessment of this investigation, it is important to note that oceanographic effects of climate change in marine ecosystems will greatly impact the livelihood of fishermen in Soufriere. Climate projections have suggested that the sea level will rise between 0.35 to 0.70 meters higher than present levels (IPCC, 2014), which will increase the likelihood of more intense cyclones and storm surges, directly increasing the exposure of fishery-based communities who live in coastal or low-lying areas (Dasgupta et al., 2009). This is especially important for the Soufriere fishing community, as most of the fishers live in the fishing village located in the coastal area. In addition, the predicted intensification of episodes of tropical storms and hurricanes in the Caribbean (CARIBSAVE, 2012) is expected to greatly affect the reef located in the coastal areas which is likely to impact resources availability and therefore the artisanal

fishery and tourism sector (Bell et al.,2011). Soufriere is considered one of the most productive reefs in the island (Australian Caribbean Coral Reef Collaboration, 2007), consequently the decrease in reef patch along the coast will cause direct impact to the livelihood of the fishers who depend on the coastal resources. According to the Australian Caribbean Coral Reef Collaboration (20014) combination of the Tropical Storm Debbie in 1994 and Hurricane Lenny in 1999 caused up to an estimated 50% mortality of the reefs around Soufriere Bay, directly impacting its fishery sector.

Even though Soufriere's fishing community is equally exposed to these climate related shocks, this study has shown that the ability to cope with these changes depended on a variety of factors which differ among households. The latter goes in line with what it has been argue by Islam et al. (2014), who stated that within a fishing community, with similar ranges of exposure, their adaptive capacity and sensitivity, influenced by socio economic inequalities, have an important influence in their livelihood vulnerability. The latter will be further explained in the next section.

- **Adaptive capacity**

Albeit adaptive capacity highly depends on each household's and community's socio-economic and cultural context, this study has found that the lack of social protection schemes, lack of land ownership and productive assets and high dependency on fisheries as the sole source of income are key determinants which mainly limit fishery-dependent households' adaptive capacity.

Social protection systems, such as social insurance and social assistance programs (including payments, in-kind transfers), are considered to be critical interventions through which the government could support the artisanal fishing community to better manage risk and reduce their vulnerability to shocks (Holzman & Jorgensen, 2001). This is especially important for the most vulnerable section of society, as protecting them against income loss or interruption due to natural disasters events would enhance their capacity to adapt and therefore prevent them from falling into poverty (Henry-Lee, Watson, Osei, & Trezelle, 2010). The high level of informality and income variability among the fishing community in Soufriere impede them to get involved in social protection systems provided by Saint Lucia's government, such as the national social insurance scheme. The latter is even more worrying among those in the fishing community, who do not possess productive assets and land and are highly dependent on friends and family or boat owners for income. In this sense, developing programs specifically designed to meet the reality of those members of the community who are particularly vulnerable is especially important to support them

to move out of poverty and to better deal with the risk of natural hazards and climate variability (FAO, 2017).

In addition to the lack of social protection programs to assist fishery-dependent households in Soufriere, the lack of land ownership and ownership of productive assets, such as vessels, boat engines and fishing gear, play a critical role in the financial stability and economic status of fishers and thus affects their capacity to adapt. Land ownership does not only provide security for a place to live but is essential for ensuring livelihood security in times of disaster as it works as a security for bank loans and source of wealth. In Soufriere the lack of land ownership could mean that in the face of natural hazards, individuals would be less likely to acquire a loan or receive financial assistance from the government to help rebuild their properties, hence overcoming the financial impact caused by damage property would be more challenging. The latter (accessing to government assistance) was mentioned as one barrier to get access to the re-location and reconstruction program provided by the government after the Hurricane Lenin, as property ownership was one of the pre/requested settled by the government to be shortlisted for potential assistance.

In regard to the ownership of productive assets scholars have suggested owning productive assets play a critical role in financial stability and capacity to adapt by fishers as it can be considered as a more accurate measure of a socio-economic status of an individual (Badjeck, 2008). The latter was reflected in the index applied, as vulnerability was directly correlated to the lack of vessel ownership. Nevertheless, considering this investigation is assessing the vulnerability to climate hazards and taking into account the particularities of fishing operations in Soufriere, both positive and negatives vulnerability aspects of owning a boat were identified. As fishing assets (vessels, engines or fishing gear) are more vulnerable to climate hazards such as tropical cyclones, fishers who own fishing assets are the ones facings the financial losses from potential damage of their assets as consequence of weather-related events. The latter was illustrated by the difference in the risk perception between crew members and fishers who own vessels. Moreover, the incapability of fishers to repair their assets soon after a weather-related disaster event has been seen to impede them from going back to the fishing operations even months after the event has passed. Additionally, as fishers who own fishing assets are the ones who fully finance the fishing operation, in case of financial losses from unsuccessful fishing trips due to rough weather conditions, they are the ones that have to carry the financial burden. In this sense, although owning assets provides boat/engine owners a better economic and social status within the community, the occurrence of

weather-related extreme events and increase in rough weather conditions, make this segment of the population particularly vulnerable to experience losses after a weather-related shock.

Considering that fishing an inherently high-risk occupation, characterized by highly unpredictable and dependent on seasonal stock and cyclical fluctuations (Béné et al. 2015) relying on other activities for income generations has always been considered as an important adaptive measure among fishers (Shaffril, 2013). Livelihood diversification reduces the risk of livelihood failure, support to even out fluctuations in revenue during low-income seasons and generate financial resources in times of market failure and uncertainties (Allison et al., 2001). Diversification of their livelihoods has been argued to increase the ability of fishery dependent households to adapt to changes, including climate variability and shocks (Allison et al., 2007). In Soufriere, despite responders claimed to be involved in two or more economic activities, their primary source of income came from the fishery sector. Although, this could be a consequence of the sampled method used, as interviews were conducted to members of the community who identified themselves as fishers, a few factors that influence members of the community to take the decision to diversity their livelihood were identified. First, occupational attachment to the fishery sector seemed to influence the decision of individuals to continue or not being fully engaged in fishing activities, though the imminent risk of this livelihood in terms of climate variability and catch availability. In Soufriere, the number of years involved in fishery-related activities was perceived as one of the reasons of this strong occupational attachment, as most of the interviewees who were primarily involved in fishing have been involved in this livelihood since early stages of their life. In addition, the notion of "free lifestyle" in terms of schedule and "being their own boss," was perceived as other reasons why they choose to be fully engaged in this livelihood. Individuals who show higher levels of occupational identity are often described as less able to adapt to changes as they are less willing to learn alternative skills, as this could be interpreted as a threat for their identity (Azril Mohamed Shaffril, Abu Samah, Lawrence D'Silva, & Sulaiman, 2013). In this sense, high occupational attachment identified within some members of Soufriere's fishing community could have significant implications in their capacity to face shocks. Additionally, to occupation identity, age and education level were identified as additional factors that influenced the responder's decision to diversify their livelihood. Usually, younger fishers who had higher levels of education (secondary school finished) did not show this level of occupational attachment and were the ones involved in other types of livelihood.

Although, promoting complementary livelihood occupations has not only been suggested as one critical path for future fisheries management but also as an essential strategy to support poverty reduction (Allison et al., 2007, Badjeck, 2010), encouraging fishers to substitute their livelihood to other more productive activities is not the solution for every context (Allison & Ellis, 2001). As indicated by Brugere et al. (2008) socio, cultural and economic aspects within the community need to be carefully analyzed before highly promoted diversification. Considering tourism is the main economic activity in Soufriere and that marine tourism in particular has increased in recent years, in recent years, diversifying their livelihood towards tourism related activities seemed to be the preferred option among the fisher's community. The fact that Soufriere's most popular beaches for recreational tourism (swimming, snorkel, scuba diving) are easily accessible by sea, has made water taxi and related activities, the most popular among the fishers who have decided to be diversified or changed livelihoods. In Soufriere, the administrative requirements to perform water taxi marine tourism activities would only allow fishers with higher and more stable financial resources to be involved in this activity, as they would need, among other requirements, to possess a fiberglass boat and acquire a property and liability insurance. In this sense, promoting diversification, specifically towards marine tourism activities in Soufriere, would not be an option for all the fisher's members of the community. In addition, as previously mentioned, besides financial capital, there are various factors that influence the decision of fishery-based households to diversify their occupation, such as lack of networks, skills, education and age. The latter illustrate the importance of implementing different strategies aiming to increase the financial and social security of the most vulnerable member of the community, before promoting any diversification program (Cinner et al., 2012).

Low education levels among the fishing community was identified as a factor that could limit their decision to pursue diversification of their livelihood (Iwasaki, Razafindrabe, & Shaw, 2009). In addition, as argued by some authors (Etwire et al., 2013, Cinner et al., 2012), and claimed by some stakeholders in Soufriere, low education levels among the fishing community reduces their abilities to formulate and assess potential solutions to improve their livelihood conditions. The latter could bring implication while designing and implementing adaptation projects aiming to the fishing community.

Aside from factors that constrict the adaptive capacity, a positive feature which enable fishery dependent households in Soufriere to increase their ability to adapt to changes and shocks have also been reported in this investigation. Soufriere´s strong social relationship and trust among members of the community has been considered as a crucial aspect that increases their abilities to

adapt to climate change, and primarily to deal with the emergency after disasters (Castle, 2002). This strong social network was demonstrated by the fact that the majority of the responders indicated that relying on the support of friends and family was the primary strategy to overcome times of low income and disasters. Nonetheless, it is essential to note that the benefits of this strong social relationship were mainly in- kind support. Although the latter is perceived as a relevant in times of low income, in times of disasters, when higher levels of support is needed, this assistance would not be enough to enable households to recover at the pace needed. As argued by Adger (2010), in addition to the strong bonds of friendship and trust among community members, high local level institutions play a crucial role in managing environmental risks. Individuals who belong to community-based organizations are more likely to have a stronger and more effective social network, therefore increasing the level of trust among them and access to information (Folke et al., 2005). In Soufriere, the fact that only fishers who own productive assets such as boats or engines are the ones more interested in joining the Soufriere's fishers cooperative, due to the financial benefits provided and administrated by it, make them the ones more likely to obtain the benefits from belonging to this community organization. The latter confirms what has been argued by some authors, who point out that financial and social inequalities among members of society reduce the adaptive capacity of the fewer privilege ones (Islam, 2014)

Nonetheless, the affiliation to a community organization does not necessarily mean strengthening the ability of an individual to adapt. The managing quality of the institution is an essential factor that could boost or hinder the capacity of social groups to strengthen their social networks (Adger, 2010). Although the Soufriere fishing cooperative has played an essential role within the local fishery sector since 1970 (Sandersen, 1995), the low level of trust demonstrated by fishers who own fishing assets as well as crew members could negatively influence its potential impact in increasing their abilities to adapt to climate variability and change. Moreover, in addition to the levels of trust, the potential benefits the community perceived they could receive from being part of an organization is another factor that relates to social capital and therefore their adaptive capacity (Badjeck, 2008, Adger, 2010). In Soufriere, financial benefits (only for boat owners) was the primarily benefit perceived of being part of the Soufriere's Fishers Cooperative, a situation that diminish community members, specially crew members, eagerness to get involved in this community organization.

Although, access to credit did not seem to be an issue for Soufriere's fishing community, relying on financial credit in times of low income or recovery from a disaster did not seem to be a preferred

strategy among members of Soufriere's fishing community. The fact that fishers prefer to rely on their saving during the time of low income and to recover from disasters could negatively influence their ability to adapt. This coping strategy could prevent fishers to invest their saving in a more productive manner, such as boat quality and safety, or get involved into more risky options, such as diversifying their livelihoods (Islam, Hubacek & Paavola, 2014). The latter is even more important in Soufriere, as the increase in tourism activities within Soufriere coastline is reducing fishing operations within the coast and continuously forcing fishers to fish deeper to reach more productive fishing grounds. In this sense, investing in more sophisticated fishing technology (e.g. the use of GPS, more secure and mechanized boats, efficient fishing gears) is becoming a particular important strategy among fishers.

- **Sensitivity**

Although not assessed through the indicators of the LVI, the lack of a universal free health care system was considered a worrying aspect for the fishing community in Soufriere, as opposed to the average time to travel to the local health facility. Bearing in mind that fishing is considered one of the most dangerous livelihoods there is, with high records of incidents of injuries and fatalities at the sea, the latter could be seen as a crucial factor influencing the vulnerability of this group. In addition, considering weather-related extreme events and fluctuations in the temperature have been linked to the outbreak of diseases transmitted by mosquitos (e.g. malaria and dengue fever) as well as surge of respiratory diseases, heat stress, skin diseases and asthma) (Kovats et al., 2003) the increase in intensity of extreme weather events and temperature foresee in the Caribbean Region (CARIBSAVE, 2012) will place an enormous burden in fishing community, constraining their availability to recover from these shocks. It is worth to mention as well that the experience of the impact of disaster events and the decrease in fishing trip dates caused by rough weather conditions, has been argued to increase the level of stress among small scale artisanal fishermen (Kucera & McDonald, 2010; Salagrama, 2012), situation reported during the interviews, which could also influence the health conditions of this group.

In this sense, health vulnerability within Soufriere's small-scale fishers mainly reflect, as previously described, the lack of a social protection programs aimed to protect the most marginalized segment of the population. The few fishers that were part of the "National Insurance Corporation" indicated they had health benefits, nevertheless as previously mentioned, most of the fishery dependent households in Soufriere were not part of this insurance. A related point to consider in addition to diseases are behavioral issues in terms of drug and alcohol abuse, commonly described

as problems in certain fishing communities (Béné et al., 2015). In Soufriere, even though not assessed through the LVI, the alcohol abuse among the fishers was highly noted during the field research and interviews. In this sense, behavioral change programs aimed at the fishing community regarding sensitization and awareness are important aspect to consider within an adaptation program aimed to the artisanal fishery sector in Soufriere.

The decrease in affordability of nutritious food during periods in which fishers cannot perform operations, due to rough weather conditions or post disaster, could add an additional health burden for this fishing community, directly affecting their availability to adapt to changes in the long run. Although high dependence on their catch as a source of animal protein was not reported in Soufriere, high fluctuation of their income due to climate variability and extreme disaster events were describe as an important factor that reduces their availability to purchase nutritious food, directly affecting their adaptive capacity (Allison et al., 2009). In this sense, facilitating programs aimed to provide financial support during these times, could help to ensure food security and high nutrition levels among the community, with direct positive consequences in their adaptive capacity at the long run.

Although the water component was not considered influential in the overall vulnerability of the fishery depended households, as the fishing community has a permanent access to pipe born water, clean water availability after a disaster event and water pollution were considered important aspects affecting their livelihood. During Hurricane Tomas, inaccessibility of clear water due to the damage of the sewage system resulted from the extreme event and subsequent flooding and landslide was indicated as a major issue (fishers comment). In addition, the intensive agricultural practices taken place within Soufriere's hills, was mentioned as having a devastating effect downhill, specifically contaminating the sea water with severe effects on the reef around Soufriere Bay (Hogarth, J., & Wójcik, D., 2016).

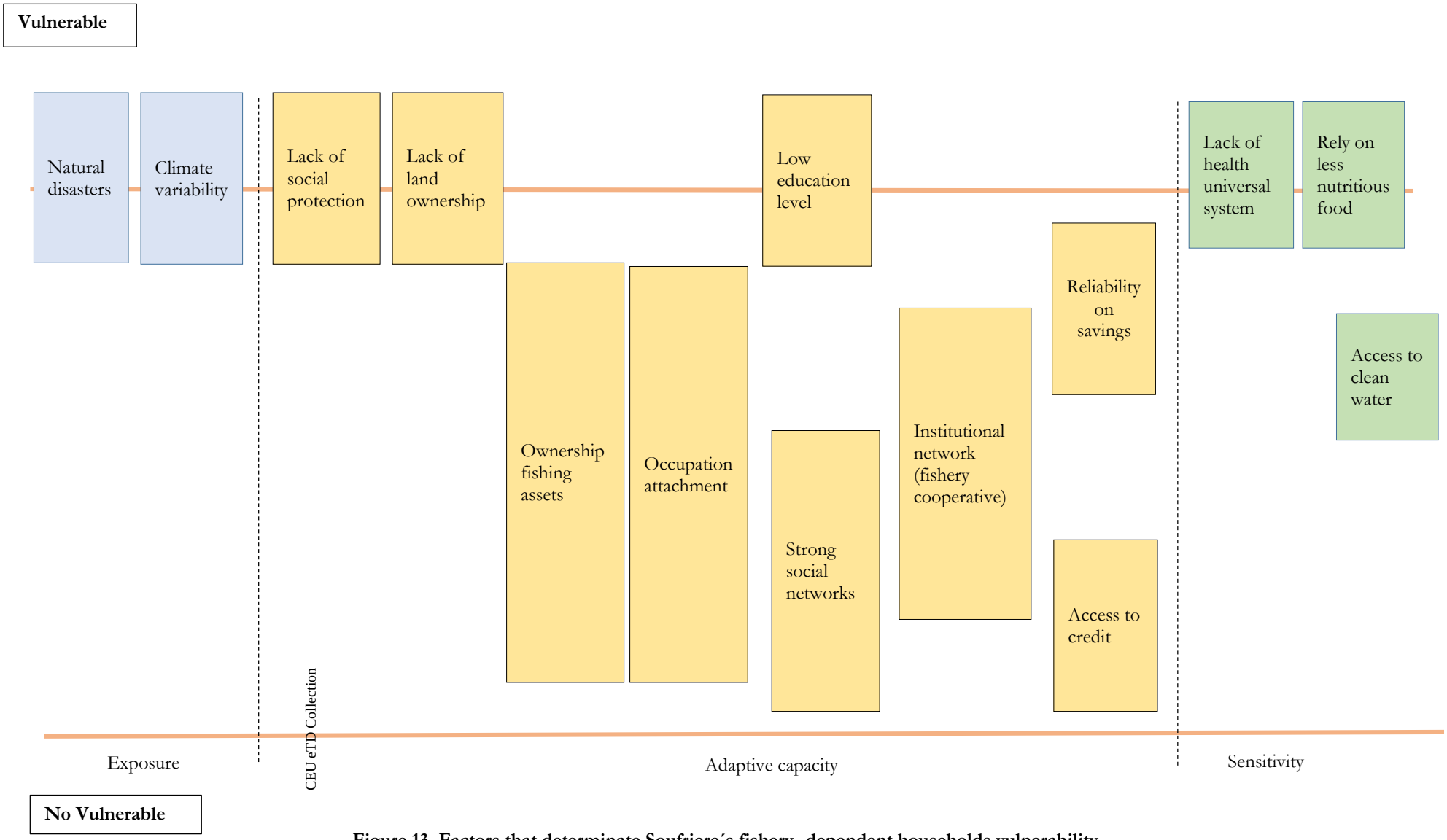

Figure 13. Factors that determinate Soufriere´s fishery- dependent households vulnerability

6.2. Potential impacts, limitations and opportunities of index-based insurance in Soufriere.

Market based insurance solutions, specifically index-based insurance products, have been proposed as a potential adaptation mechanism which, by providing financial assistance immediately after an extreme weather event, could increase the resilience of individuals and community to adapt to climate related impacts (Schaefer & Waters, 2016). Nevertheless, low uptake in the developing world have shown there are various limitations that could prevent their effective implementation and diminish their potential benefits (Hermann, Köferl, & Mairhöfer, 2016). In this section, considering the different aspects that influence Soufriere's fishery dependent household's vulnerability previously discussed, the potential impact, limitations and opportunities for the implementation of index-based insurance schemes for this target group will be examined.

6.2.1. Potential impacts of index based insurance

Considering Schaefer and Waters (2016) framework on the contribution of climate risk insurance in resilience building, a discussion on how index-based insurance could contribute in Soufriere's fishery dependent household's adaptive capacity is presented below. Fig. 14 compile the potential impacts of the index -based insurance products in increasing Soufriere's fishery-dependent household's adaptive capacity presented in this section.

- **Protecting against shocks.**

Index-based insurance schemes are designed to provide financial support for the impact caused by low frequency and major disasters (MCII, 2013). In this sense, its characteristic of providing reliable and quick financial liquidly soon after a severe shock has passed would support the section of the fishers population who incur the most damage during extreme weather events. In Soufriere, loss or damage of physical assets, such as vessels or engines, and damage of physical infrastructure, such as housing, are direct consequences of the impacts of extreme weather related events. These consequence force members of the fishing community to rely on their savings and family or friends to recover from the shock. Damage to the fishing vessels impede all fishers to continue their fishing operation after the event has passed, particularly affecting fishers who own fishing assets, as the financial consequences of the disaster are more significant to them and the time to recover is longer.

Reliable and quick financial liquidly soon after a disaster event provided through index-based insurance would support fishers who own fishing assets to repair their vessels or engine quicker and enable them to continue fishing operations short after the event. The latter, would not only

benefit this segment of the community, but considering the way fishing operations are managed in Soufriere, it could have positive implications for the less affluent members of the community (e.g. crew members) as it would enable them to engage in fishing operations quicker.

Moreover, the particularity of index-based insurance in providing payouts which are not based on actual damaged or damage assessment, could enable fishers to invest in other recovery actions such as housing and infrastructure reconstruction. This is particularly important in Soufriere, where the damage in housing infrastructure was reported as one of the main consequences of extreme disaster events.

Besides of allowing fishers to continue their fishing operations sooner, rapid and reliable payouts provided shortly after the disaster event would reduce the likelihood of fishers to engage in maladaptation strategies, such as opting for poorer quality food. This is especially important in Soufriere, as households mainly depend on their income to secure a protein rich diet, earnings that in case of disaster event are severely diminish. Nevertheless, as indicated by Schaefer and Waters (2016) to assure the latte, insurance schemes should be integrated into a broader disaster risk management with a food security component, as there is no enough conclusive evidence on the direct impact of insurance schemes in ensuring food security.

- **Catalyzing comprehensive risk management**

Designing insurance products specifically aimed at protecting the livelihood of fisher folk would require incorporating ocean-related data into the traditional risk models for extreme weather events (Niehörster & Murnane, 2018). In this sense, the potential implementation of index based products aimed to the artisanal fishery sector could facilitate the development of ocean parameters database for Saint Lucia, currently nonexistent, as this data set would be a required for characterizing the risks for the fishery sector and to clearly determine thresholds that would trigger the insurance payment.

The fact that Soufriere already has a weather and biological monitoring station owned by the Coral Reef Early Warning System Project in the north part of Soufriere's Bay would be a positive asset in developing long time series of physical data. Even though the main focus of this monitoring station is to conduct research regarding the impacts on climate change on coral reefs, during the interviews stakeholders pointed out that it could also represent an opportunity to use the data generated through this station for risk assessment, specifically for the fishery sector.

- **Promoting growth by unlocking opportunities**

One of the main coping mechanism applied by fishers in Soufriere to recover from natural disasters is making use of their saving to repair assets, provide food for their households or cover basic expenses (e.g. rent, bills) during the time they cannot go back to their fishing operations.

Higher liquidity and financial stability provided by index-based insurance products would potentially reduce their dependence on their savings and avoid its high fluctuations. The latter could enable fishers to increase what is has been referred by some scholars as "positive risk taking" (Hallegatte, Mook, & Marie, 2015), empowering them to invest their saving in a more productive manner, such as acquiring fishing technology (gps, more efficient fishing gear) or diversifying their livelihoods (e.g. water taxi activities) with could bring positive impacts on their livelihood. Investing in fishing technology would allow fishers to reach far off shore pelagic grounds and increase their security at the sea, enabling them to continue fishing during rough weather conditions, while diversifying their livelihood would allow spreading the risk of livelihood failure across other sources of income (Allison & Ellis, 2001).

Nevertheless, as indicated by Surminski and Oramas-Dorta (2013) this "positive risk taking" mindset could also turn into a false sense of security. Possessing more secure boats and fishing technology that enable fishers to get into more off-shore fishing ground could motivate them to take more risky decision and less preventive measures during fishing operations. The latter could potentially increase their vulnerability to extreme weather events.

- **Nurturing a culture of prevention-focused risk management**

Although the link between insurance and risk reduction behavior has not yet been proven, it is argued that the requirement of some insurance schemes, such as contingency plans, could boost the attention to develop disaster relief mechanisms in communities where insurance products are implemented (Matias et al. 2018).

The institutional framework in which insurance product are implemented would play an important role in influencing how effectively insurance schemes could reshape ex ante risk management strategies. Experience showed that community-based organizations, besides of strengthening the index-based insurance distribution mechanisms among locals, play an important role in engaging community members in risk prevention measures and training them in disaster risk management (Dick & Wang, 2010). In Soufriere, if insurance products are enforce through one of its community based organizations, such as the Soufriere's Fishers Cooperative, risk awareness raising initiatives

aimed to share risk/relevant information for fishery dependent households can be strengthen. In addition, considering the Soufriere's Fishers Cooperative has already credit and administrative mechanisms in place (e.g. duty refund, credit, distress fund) there could be an opportunity to link risk reduction incentive programs with insurance products (e.g. premiums relates to having implemented risk reduction measures within their households).

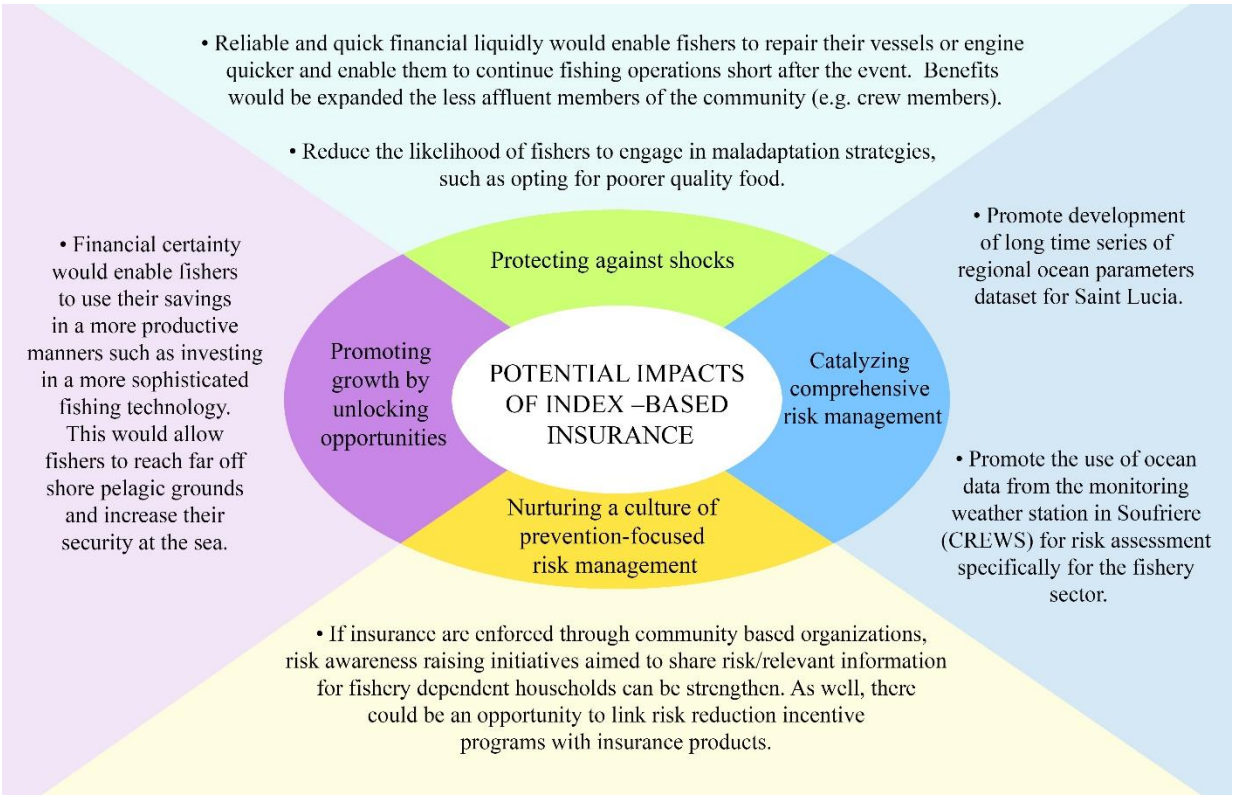

Figure 14. Potential impacts of index based insurance products for fishery-dependent household´s in Soufriere, Saint Lucia (Based on Schaefer and Waters, 2016)

6.2.2. Limitations and opportunities for index-based insurance product uptake in Soufriere

Based on Eling, Pardhan and Schmit (2013) framework for micro insurance demand, key factors that can be considered as limitations for the implementation of index -based insurance schemes aimed to increase the adaptive capacity of Soufriere's fishery depend households are discussed below. In addition, considering the specific context of Soufriere, potential opportunities for its implementation are presented. This information is based on the empirical evidence obtained in the fieldwork and analyzed in the previous chapter. Fig. 15. compile the potential limitations and opportunities for the implementation of index-based insurance scheme presented in this section.

- **Economic factors**

It has been argued that liquidly constraints are a significant barrier for microinsurance demand (Eling et al., 2013). Accordingly, it has been claimed that households with medium to a high level of wealth, and therefore higher liquidly, are more likely to purchase insurance (Cole et al., 2013). In this sense, the poorest segment of the community, would not be able to purchase insurance, even in a scenario where the premium is low.

Within fishing communities, the ownership of assets has been argued to be a more accurate measure of the socio-economic status of an individual than their income level (Badjeck, 2008). The latter seemed to be the case in Soufriere, where financial benefits of owning a boat or engine are evident. Fishers who own fishing assets have higher probabilities of earning a continue income, as they do not depend on others to embark in fishing operations, while the percentage of revenue for each fishing trip, compared to crew members, is higher. Additionally, this segment of the community are the ones who receive the financial and social benefits of being a member of the fishers' cooperative. The argument that crew members (fishers who do not own fishing assets) are less financial stable to purchase insurance product was mentioned during the interviews. Although this group recognized insurance as a "very important" measure to reduce the negative impacts of natural disasters on their livelihood, their lack of financial resources and unpredictable income, motivated them to claim that this adaptation measure was not viable for them.

In this sense, the lack of financial resources and unpredictability of income is a determinate for insurance uptake within Soufriere's fishing community, which seems to differ between fishers who own fishing assets and the ones who don't. Nonetheless, it is important to note that evidence in the agricultural sector shows that flexibility in terms of premium payment make the insurance product more appealing to low income members of the society (Carter, 2014, Hellmuth et al., 2009). Flexibility in collecting premiums in times when policy holders are most able to pay therefore could increase insurance uptake within this group. In Soufriere an arrangement where insurance premiums could be collected specifically during the high season (January to May), where fishers have greater income level, would increase their willingness to be engage in insurance schemes. In addition, a mechanism where premium payment for an index-based insurance product is linked to the purchase of fuel or other fishing asset (provided by the Soufriere's Fishing Cooperative) could potentially be another strategy to increase product uptake among the fishing community.

- **Social and cultural factors: Risk aversion, trust, basic risk and limited experience with insurance**

Risk aversion has been suggested as one factor that could determine uptake of the insurance products (Eling et al., 2013). A few authors have reported the negative correlation between risk aversion with insurance demand (Gine, Townsend & Vickery, 2008, Giesbert, Steiner & Bendig, (2011). The interpretation of this phenomenon is that risk-averse households are unwilling to purchase insurance due to the fear of "non - performance" coming from the lack of trust in the product. In addition, and specifically related to index-based insurance schemes, concerns of a potential discrepancy between the insurance pay-out and the actual losses, commonly known as basic risk is also reported as a major shortcoming for insurance uptake. As indicated by Coler et al. (2013), positive experiences of past successful pay-outs from peers could boost the level of trust in insurance products among the community. Nevertheless, it could also be the other way round, as reported in Soufriere. In Soufriere, the fear of "non-performance of insurance companies" due to negative experiences from friends and family were the main factors for their distrust in insurance. Nevertheless it is important to note that this previous experiences are specifically related to the traditional indemnity insurance. In this sense, the characteristics of parametric insurance in terms of providing payouts which are not based on damage assessment (e.g. no administrative paper work), would potentially make the index-based insurance product more attractive to the target group. It is worth to mention as well that when the features of index-based insurance was briefly explained to the interviewees, the fear of basic risk was claimed as one of their concerns. Nevertheless, the low familiarity on index-based insurance products could be the main reason of this fear.

In addition, limited experience in the insurance market, financial literacy and lack of understanding of insurance products have been suggested as other potential causes for this inverse correlation (Cole et al., 2010). In Soufriere, low experience within the financial and insurance market could be cumbersome for implementing insurance schemes. Nevertheless, it is important to point out that fishers who own a fishing assets and are members of Soufriere's Fishers Cooperative are likely to have more financial literacy than the rest of the fishermen, as they are involved in financial programs provided or administrated by the fisher's cooperative such as duty refund, distress fund, and credit. On the other hand, strong social networks in a community has been indicated to play a critical role in promoting insurance uptake (Akotey, Osei, & Gemegah, 2011). Providing financial education specifically about insurance to fishers who own fishing assets through the Soufriere Soufriere's Fishers Cooperative could be later diffuse to all the community through the strong

social networks reported in the fishing village. In addition, if index-based insurance scheme are provided through a meso level approach (e.g. through the Soufriere's Fishers Cooperative), information about the attributes of insurance could be disseminated among its members in a more effective way, resulting in a potential uptake increase (Matias et al. 2018).

It is important to note that low levels of trust towards the Soufriere's Fishers Cooperative reported in this investigation could be seen as a drawback to implement group insurance policies through community organizations. Nevertheless, promoting insurance products through others institutions closely related to the artisanal fishery sector in Soufriere, such as the Soufriere Marine Management Association and the Soufriere Regional Development Foundation, in whom fishers show a higher level of trust, would be an advantage in attempting to increase the level of trust and uptake in insurance products.

- **Structural factors**

Based on the experience in micro insurance schemes implementation within developing countries, some authors have argued that individuals with high levels of social capital, in terms of strong networks between individuals, are less likely to take up insurance, as the support of friends and family would crowd out this formal market-based scheme (Jowett, 2003). In the case of Soufriere, although risk sharing mechanism among members of the community in terms has been reported as one of the main strategies used by fishers, support from friends and family is mainly given in forms of in-kind provision (no cash transfers). In this sense, insurance products which provide liquidity to enable recovery from financial losses resulted from disaster events that largely affect the entire community could be seen as a complementary risk management mechanism and not be seen as substitute.

In term of risk exposure, some authors have suggested there is a positive correlation between it perception, due to the effects of past disaster events, and micro insurance demand (Arun, 2012) while others have found that experience of past shocks does not affect people perception of risks (Galarza and Carter, 2010). In Soufriere, sense of fatalism in term of accepting the level of risk of this type of livelihood was reported as one aspect that could decrease their willingness to take insurance products. Besides of the latter, it is essential to note that in Soufriere the perception of the level of risk differ from fisher who own productive assets and fishers who are crew members. In this sense, as the formers are the ones directly facing the economic losses due to damage on their fishing assets or low catch during rough weather conditions, it could be stated that this segment of the community would be more willing to acquire index-based insurance product.

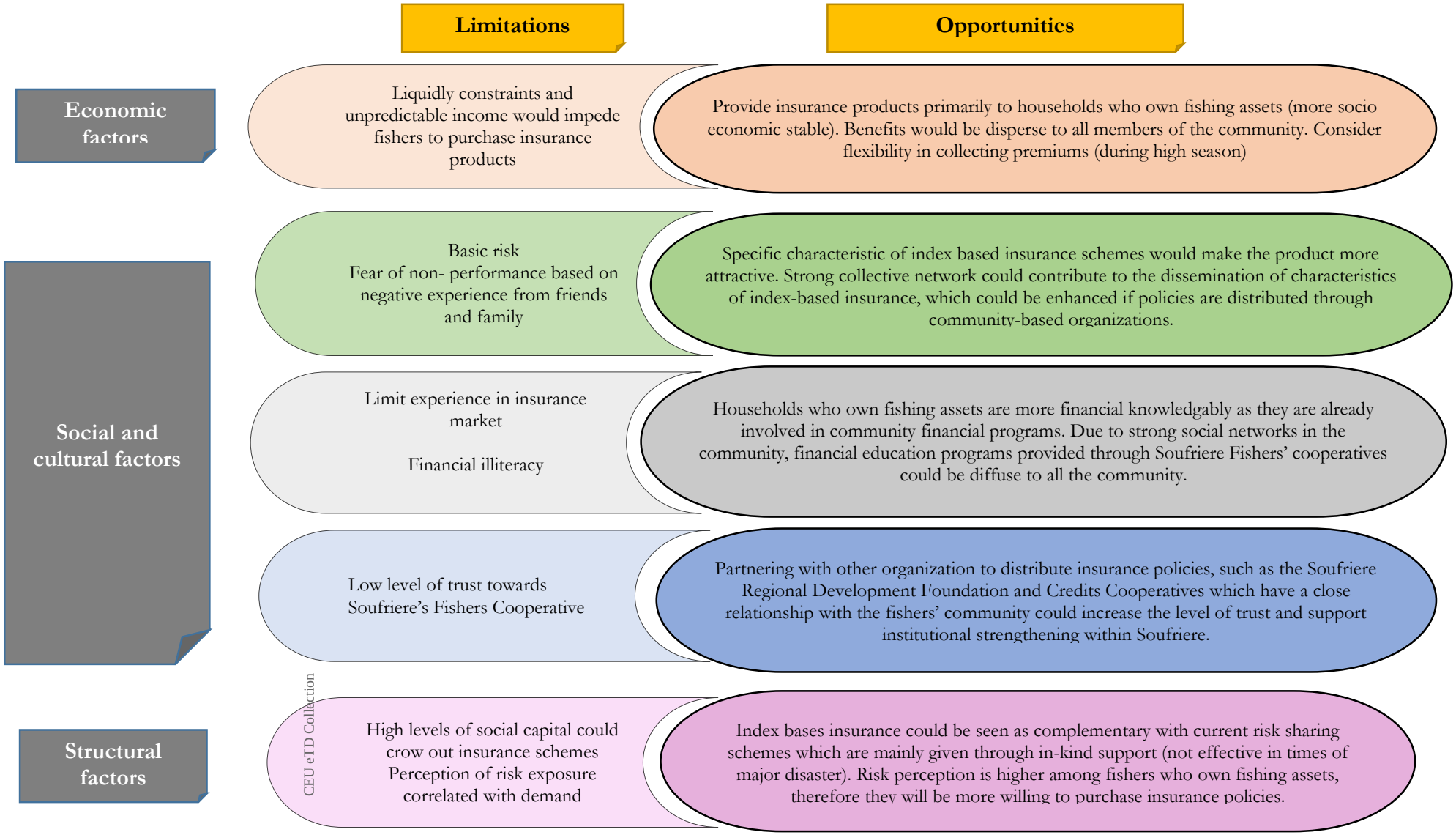

Figure 15. Limitations and opportunities for the uptake of index based insurance products among fishery-dependent household´s in Soufriere, Saint Lucia .

6.3. Implications of the findings

In this study, the different components of vulnerability (exposure, sensitivity, and adaptation) were found to have a significant influence on the livelihood of the fishery-dependent households of Soufriere, in different ways and at different scales. A strong relationship between climate variability, extreme weather events and the economic status and overall well-being of all fisher- depend households in Soufriere has been shown. Although all members of the community are equally exposed to these events, as argued by different authors (Islam et al., 2013; Smit & Wandel 2006), these effects do not impact their livelihood equally.

In Soufriere, the different sub-components of the fishery-dependent households' adaptive capacity seemed to have influenced the unequal levels of vulnerability reported among households and individuals. Specifically, notable differences between the adaptive capacity of fishers who own productive assets and crew members were reported, primarily in regards to their financial capital and social networks. Fishers who own fishing assets are the ones leading the fishing operations (e.g. decide when and under which climatic conditions to go fishing) the ones possessing more financial stability, and receiving the economic and social benefits of being a member of the local fishing cooperative. On the other hand, crew members (fishers who do not possess vessels) possess less and more variable income, are dependent on boat owners to pursue their livelihood and do not receive benefits from being affiliated with the fishing co-operative.

Furthermore, it is essential to note that the interrelationship among the different sub-components of adaptive capacity, such as financial capital with food security and education (Islam et al., 2014) and their unequal impact among members of the community is likely to decrease the ability of the most vulnerable members of the community to adapt to climate change in the long run. In this sense, it has been shown that socioeconomic inequalities in Soufriere are a crucial factor that influence the different levels of vulnerability among the fishing community, especially in the less privileged segments of the community. This situation highlights the relevance of designing a comprehensive range of contextually fine-tuned adaptation strategies and tools that target the different needs of the fishery-dependent households in Soufriere, which will enable members of the community to increase their adaptive capacity to deal with climate variability and change.

Climate risk insurance solutions, specifically index-based insurance schemes, have the potential to support Soufriere's fishing community to cope and adapt to these shocks effectively. Nevertheless, based on the results of this investigation, considerations in terms of the level of risk to be insured, target groups, type of scheme and institutional framework in which the insurance scheme is promoted need to be taken into consideration to ensure effective implementation. As reported in this study, climate variability, in terms of more frequent episodes of high level of wind, rain and waves, cause a more frequent impact on the vulnerability of fishers in Soufriere, due to the consequent high fluctuations in their income, as a result of the inability to go out to sea (too dangerous) or unsuccessful fishing trips with low or non-revenues. On the other hand, weather-related extreme events, such as the last reported hurricane (Hurricane Tomas, category 2) in Saint Lucia, although infrequent, have a greater and long-lasting impact in their livelihood. Partial or full damage to their physical assets (housing infrastructure, vessels, engines and fishing gear) which prevent them from continuing their fishing operations long after the event has passed severely affect, their capacity to recover from the shock, specifically for fishers who own fishing assets.

Risk transfer mechanisms, such as insurance, are designed to provide support in overcoming the extensive losses caused by low-frequency and highly-severe events (MCII, 2013). The high frequency of climate variability episodes that have been reported to have a great influence on the livelihood of the fishing community in Soufriere would be a factor that hinders the insurability of these events. As premiums reflect the level of risk, insurance to cover these frequent episodes is likely to be unaffordable and less cost-effective for community members. The latter highlights the need of conducting accurate modelling and risk assessment at the individual and community levels, in order to determine the risk levels on which to base the produce price (Warner et al., 2009).

In this regard, it is suggested that promote index-based insurance products aimed to cover risk associated with extreme weather events such as hurricanes or tropical storms, which could potentially cause damage or loss of assets, or impede them to work in the sea for several days per year. This would be a more feasible mechanism to increase the capacity of fishery-dependent household to face and adapt to climate change.

Due to the greater availability of resources and the fact that there is no need to wait for a harvesting time (unlike in agriculture), fishers can go back to their livelihood at any time (or shortly) after any

event as long as they have functioning boats (Béné, Devereux & Roelen, 2015). Consequently, market-based solutions that would enable fishers to repair their damaged assets promptly, and therefore return to their fishing operations earlier would be more effective in increasing their ability to cope and adapt to change. This is even more relevant in Soufriere because as previously mentioned, the loss and damage of fishing assets is one of the main consequences of disaster events reported in this community. Index-based insurance products, characteristics of providing payouts within days, and not months, as traditional indemnity insurance would enables fishers to significantly reduce the working days that are lost due to the damage to their boats or engines after a disaster event. Considering fishers' incomes depend on their daily catch, pay-outs from index-based insurance products would greatly benefit their financial stability. Additionally of permitting to repair their assets more quickly and prevent losing more working days at sea, the financial security provided by index-based insurance would allow boat owners to avoid continuing using their savings (the main coping strategy reported among households) and enabled them to invest it more productively. Investing in more sophisticated fishing technology would have direct positive implications in their operations, as they could reach more productive offshore fishing grounds, as well as increasing their security at sea. Doing so is especially crucial in Soufriere, considering fishers are continually being forced to fish in offshore areas, due to the increasing conflict in coastal resources that are a result of the growth in marine tourism activities.

This research has found that targeting index-based insurance products to fishers who own productive assets (boat or engine) would be a more effective way to introduce this market-based solution among the fishing community. On the one hand, the higher sense of risk and potential loss in the face of weather-related events, higher cash availability and financial stability, greater financial literacy and involvement in socials networks would potentially enable insurance enrolment within this group. On the other hand, providing financial security to boat/engine owners through index-based insurance schemes would not only have a direct impact on this segment of the community but, considering the way fishing operations are managed in Soufriere, it would have positive implications on crew members' livelihood, as they would be able to be more involve in fishing operations more quickly. Nonetheless positive implications for crew members are also foreseen, implementation of supplementary strategies such as governmental protection programs is essential to provide support and increase adaptive capacity of this segment of the fishing community.

A higher sense of financial security and risk-taking of boat owners, more sophisticated technology and quicker amendment of their fishing assets, will enable crew members to get involved in fishing activities sooner, and depend less on their savings, which will have direct implications on their livelihoods. Although crew members' low adaptive capacity makes them more vulnerable to the effects of climate variability and weather-related extreme events, their low income, their decrease financial literacy and infrequent involvement in formal social networks, would potentially prevent them from acquiring insurance products. As a result, the manager of Soufriere's Fishers cooperative proposed an arrangement in which boat owners purchase insurance products, but divide the premium among their permanent crew, as a potential strategy to involved crew members in insurance mechanisms. The higher level of social capital reported in the community could potentially enable this risk aggregation scheme.

Without compromising the latter, this investigation has showed that implementing social protection interventions aimed at the most vulnerable members of the community, which in Soufriere are usually the ones that do not possess fishing assets, is a critical aspect to consider to strengthen the resilience of this groups and increase their adaptive capacity to face to climate-related shocks.

Providing index-based insurance products through meso-insurance schemes, where community-based organizations and micro financial institutions act as policyholders, is proposed to be a feasible option that would promote greater enrolment of the insurance product in Soufriere. Nevertheless, while multiple benefits can come from promoting group contracts, such as reducing transaction costs, facilitating distribution, reducing basic risks and promoting disaster risk management (Matias et al. 2018), the specific contextual reality in Soufriere needs to be taken into account. On the one hand, the fact that the Soufriere's fishers cooperative already has administrative and financial instruments in place aimed to support fishers who own fishing assets (e.g. duty refund, credits, ..) could be taken as an opportunity for index-based insurance to be offered as a complementary product. Although, high levels of mistrust towards the fishers' cooperative could be considered as an essential drawback, Soufriere's robust institutional setup could be taken as an advantage. Partnering with organizations which have a close relationship with the fisher's community such as the Soufriere Regional Development Foundation and the Soufriere Marine Management Association , to offer index-based insurance products, could increase the level of trust and product enrolment among community members. Enhancing participation and strengthening institutions in Soufriere would not only benefit

index-based insurance product uptake but is considered to be a critical resilience building strategy to support the community to adapt in the long run (Shaffril et al., 2013).

Fishing is inherently a high risk occupation, as revenues and security at sea highly depend on various changing factors, such as climate variability, extreme weather events, and resources mobility (Béné et al., 2015). Considering how the intensity and frequency of climate-related disaster events are impacting socio-ecological systems as such a rate that has never been experienced before, implementing adaptation strategies to protect the livelihood of fishers and people involved in fishery type of activities is more important than ever. This is particularly urgent in the Caribbean and specifically in Saint Lucia, where according to climate model projections, more intense episodes of tropical storms and hurricane are expected (CARIBSAVE, 2012). Nonetheless, as shown in this thesis, there are various factors that affect the livelihood of the fishing community, climate variability and change being only one of them.

For fishery dependent households in Soufriere, fuel costs, unsustainable market conditions, and competition with tourism for the same resources were reported as other pressing factors that restrict decrease the livelihood of fishery community. These issues, in addition to profound structural elements, such as low education, food insecurity, lack of social security assistance, decrease the community capacity to adapt (Badjeck et al., 2010)

The previous arguments presented in this section highlight what has been widely argued within insurance schemes. Insurance is not always the most effective or only mechanism to support individuals in managing climate-related risks. Its effectiveness in increasing individuals' adaptive capacity will depend on how this mechanism is integrated into a comprehensive risk reduction (MCII, 2013, Warner et al., 2009). In Soufriere, in order to promote effective strategies to increase fishery-dependent household's capacity to adapt to climate variability and extreme weather events, insurance schemes should be integrated into wider disaster risk management approaches and be considered as a complementary mechanisms of a broader development strategies.

7. CONCLUSION

The relative vulnerability of Soufriere's fishery-depended households to climate variability and extreme weather events has been assessed by applying the Livelihood Vulnerability Index (LVI). Based on the latter as well as considering this fishing community's socio-economic characteristics and current disaster risk management strategies, the potential impacts, limitations and opportunities of implementing an index-based insurance scheme aimed at supporting individuals to manage climate-related risks was evaluated.

In this sense, the findings and approach used in this thesis contributes to the area of vulnerability assessments and climate risk insurance in three different ways. First, it offers a baseline of the factors that influence the vulnerability of fishery community to climate variability and extreme weather events in Soufriere, Saint Lucia. Lack of governmental assistance, lack of ownership of fishing assets, and the fact that the majority of the target group highly depend on fishery for their income was found to be the main aspects that influence the vulnerability of this target group. This information can be used to inform policy decision and design climate adaptation strategies aimed to increase resilience of this target group. Secondly, it provides a tool to assess vulnerability at the community level with specific indicators related to the livelihood of artisanal fishing community in the Saint Lucia which can be tailored to other local fishing contexts within the Caribbean. This is especially important in this region as much of vulnerability assessments in this sector have generally focused on the national level with less attention to characterize the impacts at a local level. Moreover, the index-based indicator design provided in this thesis could be used by other scholars to compare and contrast vulnerability of fishery dependent households among other communities in the region. Finally, it delivers an overview of the considerations to be taken into account in order to implement index-based insurance schemes aimed to improve the adaptive capacity of an artisanal fishing community in the context of the Caribbean Region. The latter is particularly significant in the index-base insurance arena, as most of the studies have focused on the agricultural and livestock sector.

This research argues that index-based insurance, if only embedded into a broader development approach, could support increasing the adaptive capacity of fishery-based dependent households to face climate variability and change in the long term. Specifically for Soufriere's context, implementing index-based insurance schemes at the meso level through community based organizations (e.g. fisher's cooperative) and focus initially on fishers who own fishing assets would increase their capacity to

manage disaster risk in a more effective manner, positive effect that would be disseminated to all members of the fishing community. Social protection programs aimed at the poorest and most vulnerable segment of the community has been claimed to be critical to support this group to increase their adaptive capacity on the long run.

Nonetheless, climate risk insurance mechanisms are considered as a relevant strategy to support individual to cover losses and damages originated from weather related disaster events, it is worth to highlight that insurance would not address the fundamental issue of climate change risks. In a scenario where climate projections foresee more intense and frequent weather-related disaster events as consequence of climate change, is its fair to question if the implementation of insurance schemes would be sustainable in such an extreme scenario. In this sense, climate adaptation and mitigation strategies that complement risk transfer mechanisms are critical pieces in the puzzle to reduce the impact of climate change within the most vulnerable population.

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Appendix 01. LVI Components and Sub/ components considered in this investigation, their explanation and assumed functional relationship with vulnerability.

IPCC contributing factors to vulnerability	Major component	N of indicator	Sub component or indicators	Unit	Explanation of sub-components	Assume functional relationship with vulnerability	Source of sub-component
Exposure	Natural disaster - ND	ND1	Average number of tropical waves and hurricanes reported in the past 10 years (range: 0-10)	Count	Average number of tropical waves and hurricanes reported in the past 10 years (range: 0-10)	Higher reflects relates to higher exposure	Adapted from Hahn et al. 2009
		ND2	% of HHs with an injury or dead as a result of natural disasters in the las 10 years	%	Percentage of households that report that injury or death due to flood, cyclones, drought, sea surge, or any other extreme climatic event within the las 10 years.		Hahn et al. 2009
		ND3	% of HHs with losses to physical assests (mestead/agril/equipment/machinery) or housing due to natural disaster in the last 10 years?	%	Percentage of household reported loss of assest of property (ie. Equipment, machinry...) that causes loss/damage of livelihood		Shah et al. 2013
	Climate variability - CV	CV4	Mean estándar deviation of monthly average of average max. daily temperature (2009-2018)	C°	Standar deviation of the average daily maximum temperature by month between 2008-2018 average for each district.	Highest variability relates to higher exposure	Hahn et al. 2009
		CV5	Mean estándar deviation of monthly average of average min. daily temperature (2009-2018)	C°	Standar deviation of the average daily maximum temperature by month between 2008-2018 average for each district.		Hahn et al. 2009
		CV6	Mean estándar deviation of monthly average precicipation (2009-2018)	mm	Estándar deviation of the average montly precipitation between between 2008-2018 was averaged for each area		Hahn et al. 2009

IPCC contributing factors to vulnerability	Major component	N of indicator	Sub component or indicators	Unit	Explanation of sub-components	Assume functional relationship with vulnerability	Source of sub-component
Sensitiviy	Health-H	H27	% HHs with members suffering a chronic ilness	%	Percentage of households reporting at least 1 member with chronic disease	Higher percentage of members suffering a chronic disease, higher the vulnerability	Hahn et al. 2009
		H28	Average time to health facility	Minutes	Average time it takes the households to get to the nearest health facility.	The shorter the time to get to a health facility, the less the vulnerability	Hahn et al. 2009
	Food - F	F29	% HHs depending significantly on fishing they catched (more than 50% of their catch is used as food)	%	Percentage of households that get their food primarly from what is fished (more than 80%)	More limited sources of food, the more sensitivity	Shah et al. 2013
		F30	Average numer of months HHs struggle to find food	Months	Average number of months households struggle to obtain food for their family.	More months the household struggle to find food, the more sensitivity	Hahn et al. 2009
	Water-W	W31	% HHs without pipe borne water (Shah)	%	Percentage of households not receiving water through the public water system	Higher the number of households without pipe born water, higher the possibilities to use unsafe drinking water	Shah et al. 2013

IPCC contributing factors to vulnerability	Major component	N of indicator	Sub component or indicators	Unit	Explanation of sub-components	Assume functional relationship with vulnerability	Source of sub-component
Adaptive Capacity	Socio-demographic profile - SDP	SDP7	Dependency ratio	Ratio	Number of household members within working age (18–60 years) divided by household size. The ratio lies between 0 and 1. The closer the value to 0, the higher the vulnerability	Higher dependency, less capacity to adapt	Hahn et al. 2009.
		SDP8	% of female headed HH	%	Percentage of households where the primary adult is female.	Generally, women typically have less capacity to adapt	Hahn et al. 2009
		SDP9	Average number of family members in the HHs	Count	Average number of family members in the household	Higher number of family members relates to higher vulnerability	Alam 2016.
		SDP10	% HHs heads did not complete school	%	Percentage of households where the head of the household reports that they have attended 0 years of school.	Higher education level would enable people to be more aware of risks and able to adjust to changing conditions	Amos 2016
		SDP11	Experience of household head in fisheries-related activities (years)	Years	Numbers of years the household head is invovled in fishery-related activities	Higher the number of years (experience) the more adaptive capacity	Islam et al. 14
		SDP12	% HH head is less than 50 years old	5	% of household head which age is less than 50 years old	The youngest the household head, the most probablity to adjust to changing conditions	Islam et al. 14
		SDP13	% of HHs where household head is the only earning members	%	Percentage of HHs earning members to total family to total family members	More earning household members would reduce vulnerability	Alam 2016.
	Livelihood Strategies - LS	LS14	% of HHs income from fishery sector in the last year	%	Percentage of income of a HHs that comes from the fishery sector	Higher the percentage of income that comes from fishery sector increase vulnerability	Islam et al. 14
		LS15	Average number of income-generating activities per household (1-4)	Count	Average number of income-generating actitvies per household (fishery, tourism, construction, business, others)	Higher number of income generating activities pursue by household members reduces their vulnerability	Islam et al. 14
		LS16	% of HHs with the family member working in a different community	%	Percentage of households that report at least 1 family member who works outside of the community for their primary work activity.	Higher number of family members working in another community reflects higher vulnerability, as the low work opportunities or less income to survive force them to work in another area.	Hahn et al. 2009
	Social networks - SN	SN17	Average receive: give ratio (shah)	Ratio	Ratio of (the number of types of help received by a household in the past month +1) to (number of types of help given by household to another household in the past month +1)	High amount of help recieve indicates higher levels of stress, less capacity to adapt	Hahn et al. 2009/Shah et al. 2013
		SN18	% HHs that have not recieved any government assistance assistance in last 12 months	%	Percentage of households that reported that they have not recieved any assistance from the goverment in the past 12 months	Assistance and services provided by the goverment increase adaptive capacity	Hahn et al. 2009
		SN19	%HHs who are not associated with an community organization	%	Percenge of households who are not associateed with a organization (cooperative, groups)	Association to a community organization enhance sharing information and access to other services, increasing adaptive capacity	Hahn et al. 2009
	Financial capital - FC	FC20	% of HHs that dont have savings to support in hardsh times	%	Percentage of households that report having saving s	Access to savings strengthen adaptive capacity	Added
		FC21	% HHs that have not access to credt	%	Percentage of households with easy access to credit	Access to credit strengthen adaptive capacity	Added
		FC22	Ave borrow: lend ratio (range: 0.5-2)	Average ratio	Ratio of a household borrowing money in the past month to a household lending money in the past month. If a household borrowed money but if not lend money, the ratio = 2:1 or 2 and if they lent money but did not borrow any, the ratio= 1:2 or 0.5	High amount of borrowing relates to less adaptive capacity, as financial stress is higher	Hahn et al. 2009
	Physical capital - PC	PC23	% HHs without ownership of the houses they live on	%	Percentage of households which do not own the house they live on.	Higher households without ownership of the houses they live in increase vulnerability	Shah et al. 2013,
		PC24	% Households without ownership of the lands they live on	%	Percentage of households which do not own the land they live on.	Higher households without ownership of the land they live in increase vulnerability	Shah et al. 2013
		PC25	% HHs without ownership of vessels	%	Percentahe of household head who owns their fishing assets	Higher households heads without ownership of fishery equipment and vessels incrase their vulnerability, as they depend in others to pursue their livelihood	Added
		PC26	% Houses with weak storm resistance construction (wood, mud)	%	Percentage of the houses that will be unable to windstand a severe climae event (e.g. hurricane, winds).	Families living in houses with weak construction are more vulnerable	Shah et al. 2013

Appendix 02. Initial draft of the interview questions.

I. Community- based organizations

1. General

- ✓ What is the organization management structure?
- ✓ How is the decision making process within the organization?
- ✓ What type of activities is the organization involved in? (specifically in terms of fishery)
- ✓ Does the organization receive any benefits from the government?
- ✓ How your organization does provides support to its members in face of a natural disaster or to protect their livelihood?

2. Members

- ✓ What kind of benefits does your organization provides to its members? (Monetary, social network?)
- ✓ How involved are the members of your cooperative in the activities promoted by it? (e.g. attendance to meetings, active participation in cooperative decisions)

3. Impacts

- ✓ What do you see as the main issues affecting the fisheries sector in Saint Lucia? In Soufriere?
- ✓ What do you think are the best strategies or mitigation measures to face these potential risks?
- ✓ How does your organization support its members after natural hazards has affected them? Is there any financial/non-financial support provided?

4. Insurance

- ✓ Have you heard about livelihood insurance products?
- ✓ What factors do you think would restrict fishers from purchasing insurance?
- ✓ What role do you think your organization could take in case insurance products were developed specifically to protect fishermen's livelihoods?
- ✓ Do you have any other comments or suggestions regarding how we can decrease the vulnerability of fishery-based dependent households?

II. Fishery Department

1. General

- ✓ What is your department/office role and responsibilities in the fishery sector in Saint Lucia?
- ✓ What do you see as the main issues affecting the fishery sector in Saint Lucia, and specifically Soufriere?

2. Programs

- ✓ What activities are being implemented by your department to assist fishers in improving their livelihoods?
- ✓ Is there any social assistance program aimed to fishers?

- ✓ Does your department provide any financial or non/financial assistance to the fishery community in Soufriere to recover from extreme weather events?

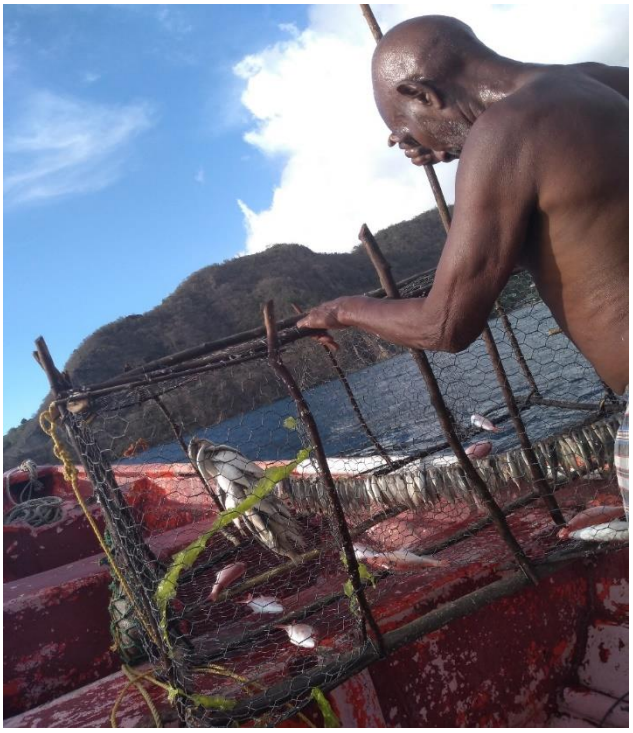
3. Insurance

- ✓ Do you have any information on fisher's insurance coverage (health, property, accidents)?
- ✓ Have you heard about LPP? (If not, explain)
- ✓ What are the strategies do you think could support fishers to deal with the impact of extreme weather events?
- ✓ What role do you think your department/office could take in an insurance scheme aimed to protect fishers livelihoods?

Appendix 03. List of stakeholders interviewed.

Organization	**Interviewee's role in the organization**	**Date of the interviewee**
Soufriere Fishery Cooperative	Manager	March 23th, 2019
	President	
Fishery Department from the Municipality	Head of the Department	March 26th, 2019
National Emergency Management Organization(NEMO)–Soufriere's Committee	President of the Committee	April 4th, 2019
	Representative Fishery Sector	April 8th, 2019
Saint Lucia Meteorological Services Office-MET	Head of the Department	April 2nd, 2019
Soufriere Regional Development Foundation	Head of the department of Community Engagement	April 11nd, 2019
Credit Union	Manager	April 9th, 2019
Fond St. Jacques Credit Union	Manager	April 9th, 2019

Appendix 04. Fishing operations in Soufriere. a) Fishing pots, b) Coastal fishing



a)

b)

Appendix 05. Major natural disaster events reported in Saint Lucia (Source MET Office)

Month/Year	Event	Impact	Number of people affected
Aug. 1980	H. Allen	Widespread wind damage, coastal erosion, flooding and landslides in some areas.	80,000
Sep. 1989	H. Gabriel	Peripheral wind bands- Heavy seas, coastal erosion mainly along North and East coast.	--
Sep. 1989	H. Hugo	Peripheral rain bands- some wind damage, flooding and coastal erosion	--
Sep. 1994	T.s. Debby	Widespread flooding and landslides	750
Aug. 1995	T.s. Iris	Coastal erosion	--
Sep. 1995	T.s. Lewis	Peripheral wind bands- slight wind damage	--
Sep. 1995	T.s. Marilyn	Coastal erosion	--
Oct. 1996	Tropical wave	Widespread Flooding and landslides (worst at Soufriere)	175
Nov. 1999	T.s. Lenny	Severe Coastal erosion, some wind damage and flooding	200
Sep. 2002	T.s. Lili	Widespread wind damage, mainly over southern half of island	--
Sep. 2004	H. Ivan	Widespread Coastal erosion, mainly along east and south coast	--
Aug.2007	H. Dean	Wind damage along west coast, heavy seas and rain.	--
Oct. 2010	H. Tomas	Widespread flooding and landslides, some coastal erosion	172,370
Dec. 2013	Christmas eve trough	Widespread flooding and landslides.	2,000
Sep. 2016	T.s. Matthew	Some wind damage and flooding.	19,984

Appendix 06. Location of Soufriere's fishing village Baron's Drive