GIVRAPD
Global Islands' Vulnerability Research Adaptation Policy and Development

The Adaptive Capacity of Whitehouse, Jamaica to Climate Change

1. Introduction

Over the coming years, the Caribbean islands are expected to experience increasing temperatures and changes in wind and rainfall patterns. These climate changes are likely to result in a variety of other changes including sea level rise, ocean warming, coral bleaching, the loss of marine biodiversity, increased coastal erosion and landslides, changes in growing seasons, and increased prevalence of pests, invasive species and contagious diseases.

This paper is part of a larger ongoing research project called the Global Islands' Vulnerability Research Adaptation Policy Development (GIVRAPD), which focuses on vulnerability and adaptation to climate change in four island communities in the Caribbean (St Lucia and Jamaica) and the Indian Ocean (Mauritius and Seychelles). Led by the not-for-profit organisation INTASAVE, the project aims to identify the multi-scale socio-cultural, economic, institutional and ecological factors that shape local vulnerability. This paper focuses specifically on the capacity of Whitehouse, Jamaica to adapt to climate change. Whitehouse is a small town located in the southeast corner of Westmoreland parish, on the south coast of Jamaica. The boundaries of the area studied were defined as those of the Whitehouse Development Area, an administrative unit of the Government of Jamaica's Social Development Commission (SDC) that includes Whitehouse and the adjacent communities of Bluefields and Beeston Springs (see Figure 1). In 2008, the populations of Whitehouse, Bluefields and Beeston Springs were estimated to be 3476, 4708 and 1989, respectively (SDC 2014). Henceforth, the area as a whole will be referred to as Whitehouse, and the town will be referred to as Whitehouse Town.

As described in the subsequent two sections, the project used a methodology that combined qualitative research methods with the Local Adaptive Capacity (LAC) framework. The LAC framework was developed by the Overseas Development Institute in 2010 during its Africa Climate Change Resilience Alliance project. It characterises adaptive capacity based on five elements: asset base; institutions and entitlements; knowledge and information; innovation; and flexible forward-looking decision-making and governance. The selection of these elements was based on the empirical experience of the ODI research team. However, the LAC framework has not yet been applied in different contexts; nor has it been sufficiently grounded in academic theory.

Therefore, beyond offering a case study on the capacity of Whitehouse to adapt to climate change, this paper will contribute to the literature in two ways. First, it will argue that the LAC's focus on institutions, knowledge, innovation and flexibility in decision-making and governance corresponds with an evolutionary perspective on adaptive capacity (as elaborated in Hogarth, Campbell and Wandell 2014). Second, by piloting the LAC framework in the Whitehouse, it will offer a critical

assessment of whether the tool captures important elements of adaptive capacity across different geographical contexts.

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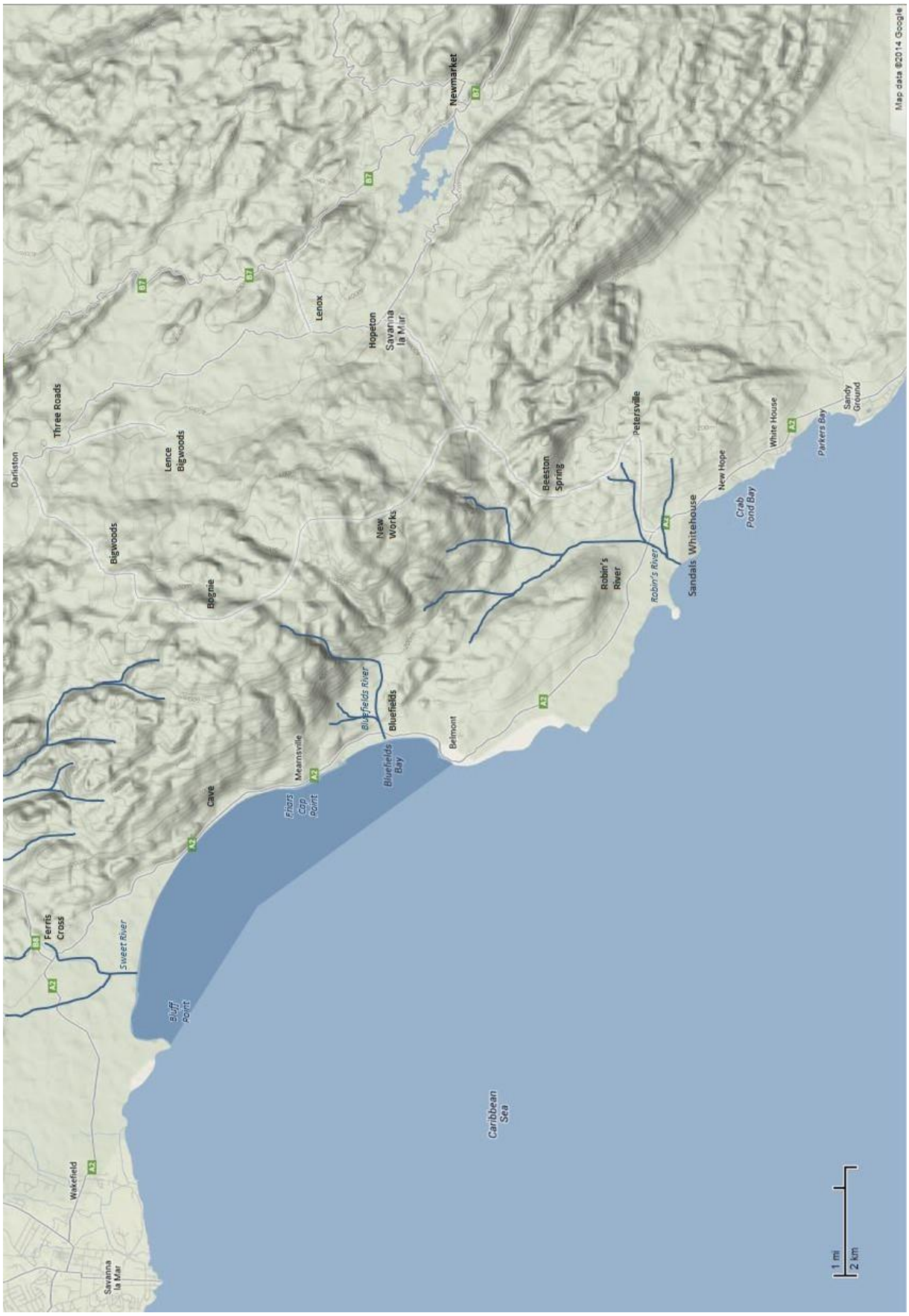

Figure 1. Map of Whitehouse and Bluefields (GoogleMaps 2014)

2. Conceptualising Adaptive Capacity

Human systems are thought to gradually adapt to local environmental and climatic conditions. From an evolutionary perspective, adaptation occurs when a behavioural routine, an institution or a technology that provides a competitive advantage within local conditions is selected and retained. This process is sometimes path dependent and irreversible in that events and decisions made in the past will limit the adaptive options available the future.

Over time, higher-level structural change will lead to a different selection environment in which current routines and technologies are less well adapted or even *maladapted*. Shifts in the selection environment can be driven by climatic, ecological, technological, cultural or institutional change. Such shifts can be gradual or rapid, and can be triggered by processes at a variety of *scales* (community, regional, national and global), not only by the micro-economic processes at the level of the individual and firm. Multiple shifts can occur simultaneously making it difficult, if not impossible, to predict local outcomes.

Adaptive capacity refers to the ability of human systems to adjust to changes in selective pressures, including changes in climatic stimuli. To evaluate a system's adaptive capacity, it is first necessary to determine the elements that promote or hinder adaptation. Many frameworks for assessing adaptive capacity have focused on the different types of capital (natural, financial, human, physical and social) that the agents within a system have available to deal with changing selection pressures. While the availability of assets is essential, as argued by Jones Ludi and Levine (2010) "(...) asset-oriented approaches typically mask the importance of processes and functions in supporting adaptive capacity." They fail to capture the role of agency in adaptation, i.e. the behaviour, creativity and entrepreneurialism of the individuals and organisations within the system, as well as the role that historical and structural factors play in constraining or enhancing those agents' adaptive choices. Relevant structural factors could exist at a variety of different scales and, among others, could include class systems, gender inequalities, dysfunctional political systems, underdeveloped financial markets, and institutions[1] governing land-use, resource extraction, and domestic and international trade. Finally, asset-oriented approaches fail to give weight to agents' ability to access information about hazards and adaptive options (Fankhauser and Tol 1997).

Therefore, beyond an evaluation of the asset base, a framework for assessing adaptive capacity must evaluate the adaptive flexibility of institutions and governance structures in response changing conditions. It must assess a system's ability to generate knowledge about hazards and adaptive options, and to disseminate that knowledge. Finally, it must take into account a system's ability to retain diversity – for example, through institutions that promote cultural or ecological conservation – and foster diversity through innovative processes that add novelty to the system such as entrepreneurialism, academia, R&D and technology transfer. To this end, Jones, Ludie and Levine

[1] Institutions are the 'rules of the game' that structure behaviour, determine how assets are distributed, how decisions are made, and who has access to decision-making processes (Jones, Ludi and Levine 2010).

(2010) developed the LAC framework. Table 1 describes the different elements that make up the LAC framework. Section 4 will assess each of these elements in the context of Whitehouse.

Table 1. Local Adaptive Capacity Framework (Jones, Ludi and Levine 2010)

Characteristic	Description
Asset Base	Tangible (natural, physical and financial) and intangible (human and social) capitals
Institutions & entitlements	Equitability of access to key assets and the process through which institutions evolve
Knowledge & information	The system's ability to generate and disseminate information
Innovation	Degree to which the system fosters and retains novel behaviour, technology and institutions
Decision-making & governance	Degree to which governance and decision-making systems anticipate change and respond accordingly

3. Methodology

The GIVRAPD project employed a community-based vulnerability assessment (CBVA) methodology based on the work of Smit and Wandel (2006). Prior to a field study, interviews with key informants were carried out to determine which site-specific topics would be covered in addition to the general topics described below. The field study comprised semi-structured interviews with community members within or related to the tourism, fisheries and agricultural sectors. Local partners became part of the research team, with involvement ranging from introducing the GIVRAPD team to the field site to actively participating in interviews. Where English was not the respondent's first language, local interpreters joined the researchers. Respondents were selected through a snowball sampling methodology in which interviewed individuals were asked to suggest additional interview subjects. To ensure adequate representation of the population, multiple 'snowballs' were initiated, and interviews were carried out until 'saturation' was reached, i.e. no new information was being revealed by each additional interview. In total, 120 interviews were carried out in Whitehouse, distributed approximately equally between the three sectors.

Semi-structured interviews were based on an interview guide with thematic topics. Researchers guided the conversation and adjusted their questions based on respondents' situations. Each interview began with contextual questions about the individual's social and economic situation, followed by open-ended questions designed to explore, not probe. General topics that were covered at each field site included, among others, (1) changes that the respondent has observed in their community, regarding culture, social dynamics, environment and/or climate; (2) their livelihood strategies and the specific challenges that they face; (3) the diversity of practices and technologies within their occupation, how these have changed over the years, and whether these are 'good practice' in terms of quality, environment impacts, etc.; (4) interactions that they have had with their

governments and/or other community organisations; (5) their access to insurance, credit, and other sources of financial capital; (6) experiences that they have had with climate-related stimuli, including both sudden shocks and slow onset stresses; and (7) the diversity of coping strategies that they have at their disposal to deal with those challenges. After an open-ended phase of the interview, in which the discussion was led by the respondent, the interviewers probed into any specific topics that had not yet been covered. Finally, the interviewer would ask the respondent about whether they were aware of anticipated changes in the climate, how potential changes in their exposure to climate-related stimuli might affect their livelihoods and communities, and what coping strategies they might employ in different scenarios.

The interviews were transcribed, and the software NVivo was used to 'code' the transcriptions according to the themes outlined in the LAC framework. The process of coding allowed for reflection on each interview adding rigour to the analysis. Findings were triangulated using a variety of third-party sources, including other studies, government documents and historical records. Section 4 presents the findings.

4. Results

4.1 The Asset Base

This section examines the stock of natural, financial, human, physical and social capital available to residents of Whitehouse, how that stock affects their ability to deal with changing selection pressures, and, if applicable, how that stock may be affected by climate change.

Financial Capital

The main income generating activities in Whitehouse are fishing, farming and the service sector. Tourism is less developed in Whitehouse than in the city of Negril, on the western tip of Westmoreland Parish, and the northern part of the island. Despite the nascence of the industry, a major development in the last decade was the addition of the 360 room all-inclusive resort, Sandals Whitehouse, about four kilometres to the northwest of Whitehouse.

While respondents in the tourism industry painted a picture of an industry with significant growth potential, interviewed fishers described an industry in decline due to depleted fish stocks. Whitehouse Town, a community built on fishing, has especially suffered from the industry's downturn:

> *Boy, let me tell you it has really changed because it is we as fishermen that really support the shopkeepers and the taxi drivers, and now that fishing is not doing well they are suffering the consequences… So it's a whole community of people within the district, and even people outside of the district, that have been affected right now at Whitehouse…*

The fishing sector in Whitehouse can be divided into three categories: small-scale artisanal fishers that use seine nets and fish pots in the near shore waters; medium-sized commercial operations,

most of which fish for pelagic fish, conch and lobsters off Pedro Cays, located about 80 kilometres south-south-west of Jamaica; and an increasing number of spear fishermen.

Most agriculture in the study area is concentrated in Beeston Springs and Bluefields. Westmoreland, as a whole, produces approximately 20% of Jamaica's total food production, and exports cane sugar, cocoa, coconut, coffee, citrus and pimento (Carroll 2013). However, most farming in the study area occurred at a small-scale, with produce sold to local markets in Whitehouse or New Market in St Elizabeth. Farmers interviewed in the study repeatedly discussed how these local markets, which were almost exclusively supplied by small-scale farmers prior to 1990, had been flooded by cheap imports in recent years:

> *Farming has changed… There's no market. Imported goods are destroying everything… It's 'cause they are cheaper, people want them more. For instance, many tomatoes are planted in Jamaica… You can't get any sale for them, because crates of tomatoes are coming into the country…*

The challenges faced by the fishing and agriculture sectors are particularly concerning, because these are the industries that have traditionally absorbed surplus labour. According to a 2009 socio-economic survey conducted by the SDC, 17.9% and 18% of households in Bluefields and Beeston Springs were headed by unemployed individuals, respectively (SDC 2014). Similar local data is unavailable for Whitehouse Town.

With such high unemployment levels, financial capital in Whitehouse is limited. A 2008 Survey of Living Conditions found that mean per capita consumption in Westmoreland was J$188 thousand (US$1677) per year,[2] 12% below the national average. An estimated 10.7% of Westmoreland's population lived below the national poverty line[3] (PIOJ and SIOJ 2013). Most of Westmoreland's population is concentrated in the larger centres of Negril and Savanna-la-Mar, and parish-level statistics hide significant inequality between rural and urban areas. The most up-to-date local data for Whitehouse is based on the 2002 Survey of Living Conditions, which found the poverty rates in Whitehouse to be between 21.8 and 32.9% in 2002. Since this survey, the national trend was a decline in rural poverty from 25.1% in 2002 to a low of 15.3% in 2007 (Government of Jamaica 2009). However, rural poverty in Jamaica increased to 23.2% in 2010 (Henry-Lee 2012; Planning Institute of Jamaica 2010).

With little financial capital to invest in adaptive measures, the adaptive capacity of many of the residents in Whitehouse and Bluefields is severely curtailed. Many respondents explained that they lacked the financial capital to invest in adaptive technologies such as drip irrigation systems and greenhouses. Others were unable to invest in higher education. Some who wished to start a new business, for example, in agroprocessing or ecotourism, were hampered by their lack of investment

[2] Exchange rate, 14 September 2014 on www.xe.com: J$1 = US$0.0089047

[3] The official poverty line in Jamaica is based on a level of consumption expenditure necessary to purchase a basket of goods and services deemed adequate to provide the "minimum nutrition and associated basic necessities" (Government of Jamaica, 2009). Between 1999 and 2009 this line progressively increased from J$38,049 (US$348.15) per year to J$110,099.56 (US$1007.41) per year (Henry-Lee, 2012).

capital. Of immediate concern, lack of financial capital also limited the capacity of the lowest income population to cope with current climatic conditions:

> *When the storm was coming here, only thing I bought, a pack of candles… No food. I didn't have no money to prepare no food... Every time storm coming I don't have no money to prepare no food so if famine to come, I surely know that I am going to die before it reach. I can't prepare for it. I don't have the funds.*

Also reducing coping capacity is the lack of insurance against climate-related damages. In a national household survey conducted for the Planning Institute of Jamaica, only 14.7% of respondents reported having home insurance, of which only 28.6% had insurance against climate-related events such as hurricanes or other natural hazards (Caribbean Institute of Media and Communications 2012). Our research identified no farmers that had purchased crop insurance against weather-related risks, nor any financial institution providing such insurance products.

Beyond the lack of private financial capital in Whitehouse, there is also a significant lack of public financial capital, which undermines the performance of local public institutions that are vital to maintaining and increasing adaptive capacity. For decades, the government has borrowed extensively from capital markets causing its debt to grow from 83% of its GDP in 1999 to 147% in 2012 (see Figure 2). As a result, the government had to allocate almost half of its revenue to debt servicing in 2011, leaving very little funds for public investment (see Figure 3) (International Monetary Fund 2014).

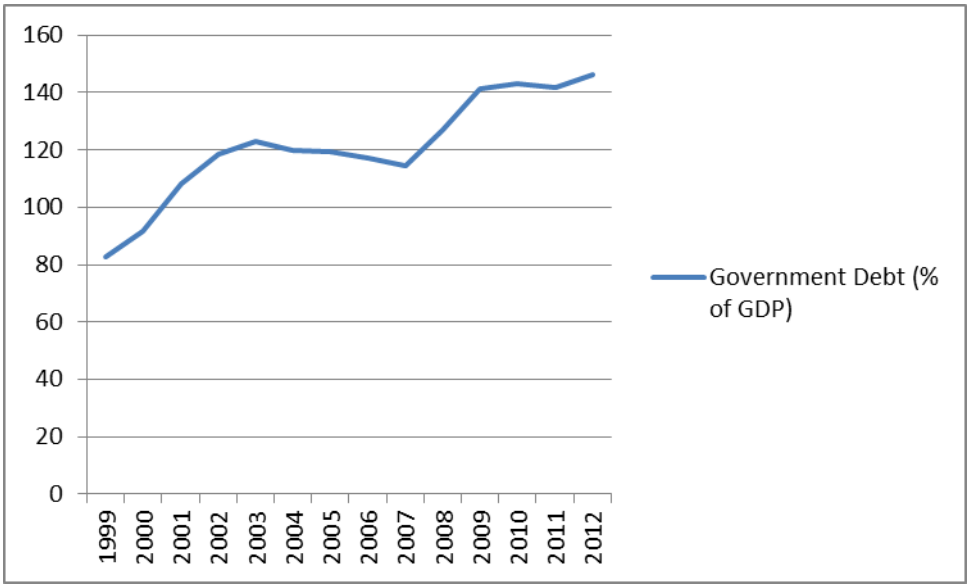

Figure 2. Government Debt to Gross Domestic Product, 1999-2012 (International Monetary Fund 2014)

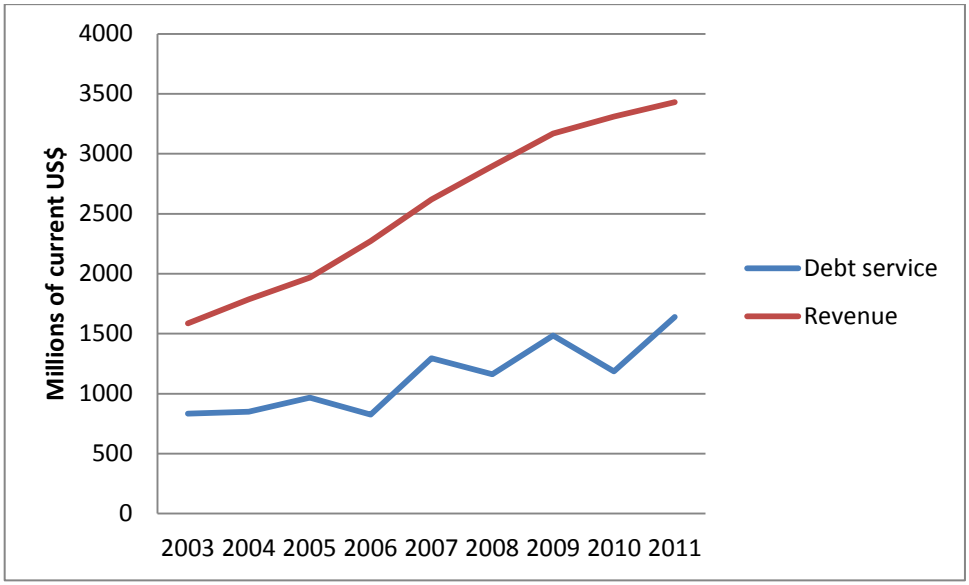

Figure 3. Government Debt Service to Revenue, 2003-2011 (International Monetary Fund 2014)

Insufficient public financial capital was seen as the main issue preventing enforcement of fishing regulations, particularly along Pedro Cays where 'pirates' from Central American countries were fishing illegally and stealing fish and lobsters from Jamaicans' fish pots. It also threatens to undermine operations of a series of nine marine protected areas (MPAs) that were established around the island in 2009, including the Bluefields Bay Special Fisheries Conservation Area, which is discussed in detail in Section 4.2.

Human Capital

While the population of Whitehouse possesses a wealth of knowledge surrounding fishing techniques and locations, ocean currents, soil types, local weather patterns, etc., a large portion lacks the type of human capital required to compete in a modern economy. In 2008, only 72.5% of individuals 15 years and older in Westmoreland were functionally literate. 12.2% had basic literacy and 15.3% were illiterate, the highest illiteracy rate in the country. Primary school was the highest level of education completed by 31.4% of those that were the heads of their households. 64.5% had attained secondary education, and only 4.1% had benefited from tertiary education. This situation was improving. Westmoreland achieved universal enrolment for those aged 3-14 in 2008, and the enrolment rate for those aged 17-18 was 40.8%, and increase of 19% over 2002 (PIOJ and SIOJ 2013).

Employment opportunities in Whitehouse are in short supply, and with the downturn in the fishing industry, older fishers in particular have found limited employment. Most opportunities existed within the tourism industry, and most require formal education.

Recently, the Ministry of Education and Youth established a HEART Trust Vocational Training Centre in Whitehouse. The Centre has partnered with Sandals Whitehouse to match students with jobs one they complete their programme. However, given the limited number of employment

opportunities in the area, many of those that graduate from high school or the Heart Trust Centre move to larger cities or overseas creating a brain drain.

Respondents explained that the lack of human capital in Whitehouse has not only reduced individual's adaptive capacity, it has also undermined the effectiveness of organisations, including the local government, and caused significant barriers in implementing adaptive strategies.

Natural Capital

Natural capital underpins each of the three industries examined in this project. Tourists are drawn to Whitehouse for its hospitable climate, its sandy beaches and to dive and snorkel along its coral reefs. Both tourism and agriculture rely on Soufriere's reliable supply of freshwater. There are only a few sources of fresh water in the area, including Robin's River, Bluefields River and Beeston Spring. Without irrigation, the vast majority of farms in Whitehouse and Bluefields are watered by hand with watering cans or rain-fed and depend on sufficient and predictable precipitation. Finally, the fishing industry in Whitehouse depends on a renewable stock of pelagic fish, conch, lobster, and near-shore fish populations that inhabit ecosystems based in coral reefs, sea grass beds and mangroves.

Much of the natural capital that is vital to fisheries, agriculture and tourism is at risk from local human activity and climate change, and it is likely that without institutional or technical intervention, projected declines in natural capital will reduce Whitehouse's adaptive capacity. Downscaled Regional Circulation Models (RCMs) based on the IPCC's higher emissions scenario project[4] that mean annual temperatures in Jamaica will increase by between 2.9˚C and 3.4˚C by 2080 relative to the 1970-1999 mean. While it is not yet possible to determine exactly what impact climate change will have on precipitation in Jamaica, most climate models point to a decrease in precipitation. Depending on what parameters are fed into General Circulation Models (GCM), projections of the change in average monthly precipitation range from a large decrease of 40 mm (–55%) to a moderate increase of 11 mm (+18%) by 2080 (CARIBSAVE 2012).

There was consensus among the respondents that rainfall patterns in Whitehouse have already been changing. Without the financial capital to invest in irrigation systems, changes in weather patterns have caused many farmers to leave their fields fallow when they could be producing:

> *Farmers in this general area don't do commercial irrigation. They depend on rain-fed irrigation. So when the dry periods become longer and the wet periods become more intense, you find out that it affects production. That affects the whole scheme of production and income into the farmer's pocket.*

The IPCC (2014) projects that warming ocean temperatures caused by climate change will lead to a poleward shift in the distribution of pelagic fish species. If these projections are accurate, Jamaica, at a latitude of 18° North, will likely experience a decrease in pelagic fish stock. Pauly (2009)

[4] The IPCC's A2 scenario

estimated that by 2050 global warming will cause the Caribbean Large Marine Ecosystem to experience a decrease in catch potential of 10 – 20% relative to 2005 levels (all other things remaining constant).

Currently, when the catch is poor offshore, fishers tend to rely on fishing in shallow waters. However, this adaptive strategy may not be an option in the future, because Whitehouse's coral reefs and associate fish species, as well as its lobster stocks, are also under threat. Much of the decline has been driven by overfishing and damaging fishing practices (see Section 4.2). Where possible, fishermen target larger fish, because they capture the highest market value. As a result, over the years, not only has the quantity of fish caught by fishers decrease, the average weight of the catch has also declined (Carroll 2013). Schofield (2009) argues that a decline in large predatory fish has been an enabling factor in the most recent pressure on fish populations – a rapid invasion of the Indo-Pacific lionfish:

> *The lionfish! Almighty! They dominate the whole place. They dominate the whole Pedro bank. I have been fishing, over thirty years now. I have never seen those fish until recently. And right now, when you go to the sea and haul in a pot, if one hundred fish is in there, ninety of them are lionfish… Three and a half years now we have been noticing them.*

The lionfish has become an apex predator in local waters, feeding on large quantities of other species, particularly juveniles. Lionfish also have poisonous spines that can land victims in the hospital, creating a serious hazard for snorkelers and divers. The Ministry of Agriculture and Fisheries, along with numerous other institutions, has launched a campaign promoting the culling and eating of lionfish, but it is unclear whether these measures will have a significant impact.

Destruction of habitats and spawning grounds is further threat to fish populations. Some of the depletion is driven by coastal development:

> *Uncontrolled beach development, housing in the mangroves, removal of mangroves wholesale for construction of hotels – not that that's a crime, but it's an ecological crime… A lot of the hotels are building in nursery areas. Some of them – to facilitate what they think the tourists need – clear the sea grass beds. They dig it up and dump it so you have this white sand, not realising that… what is in there is fish and stuff that the tourists might want to snorkel and see.*

Coral reefs habitats are especially under threat. Respondents cited a variety of different pressures. Run-off during construction, particularly of limestone, which is used as a building material, has also been damaging for coral reefs. Some fishing practices have also been damaging, including nets being drawn along the corals and spear fishers breaking off coral to retrieve prey. In previous decades the most destructive fishing practice was dynamiting:

> *In the Belmont and Whitehouse area, before we introduced the protected areas, there was rampant dynamiting… I used to scuba dive in that area... Some places between*

> *Whitehouse, Bluefields, and up to Sav-La-Mar… look like a moonscape. Craters… Of course, there's no fish. No coral. Nothing! Just rubble and holes that look like the surface of the moon.*

On top of these various pressures, perhaps the greatest threat to coral reefs is climate change. The IPCC (2014) predicted with *high confidence* that globally, even under the most projections, warming oceans and ocean acidification will cause a 50% loss of coral to bleaching by 2050. While the extent that coral bleaching will affect the near-shore fish stock in Whitehouse is not yet clear, Pratchett et al. (2011) predicted that in a higher emissions scenario productivity of coastal fisheries in the Pacific will decrease by between 10 and 35% by 2100. Beyond the decline in fish stocks, were the coral reefs to recede, Whitehouse would be at risk of losing its biggest tourist attractions. The quality of snorkelling and scuba diving would decline, and the beach would be more exposed to storm activity and more susceptible to erosion.

There is also risk that climate change will cause Whitehouse's temperature and weather patterns to become less hospitable. Increased frequency of heat waves, water shortages, flooding, intensity of storms and risk of vector borne diseases such as dengue fever and malaria, combined with biodiversity loss and shoreline erosion, may reduce the attractiveness of Whitehouse as a tropical destination (CARIBSAVE 2012; Simpson, Gossling and Scott 2008).

Physical Capital

Whitehouse is lacking in physical capital, and that which exists is of poor quality and ill equipped to deal with current climate pressures. Moreover, there is risk that with climate change, Whitehouse's infrastructure will become increasingly maladapted. For example, Whitehouse currently experiences prolonged periods without precipitation, and as discussed in the previous section on natural capital, climate change is expected to cause average monthly precipitation to decrease. The majority of households in Westmoreland lack piped water and rely instead on rainwater catchments (see Figure 4). Currently during periods of low rainfall difficult, those without water will either travel to Beeston Springs on their own to fill up drums of water, or they will pay for truckloads of water to be delivered to their empty catchments. In emergencies, the government will also provide water to households by truck. Lack of piped water is also a major challenge for farms, which will often lay unnecessarily fallow during periods without rain.

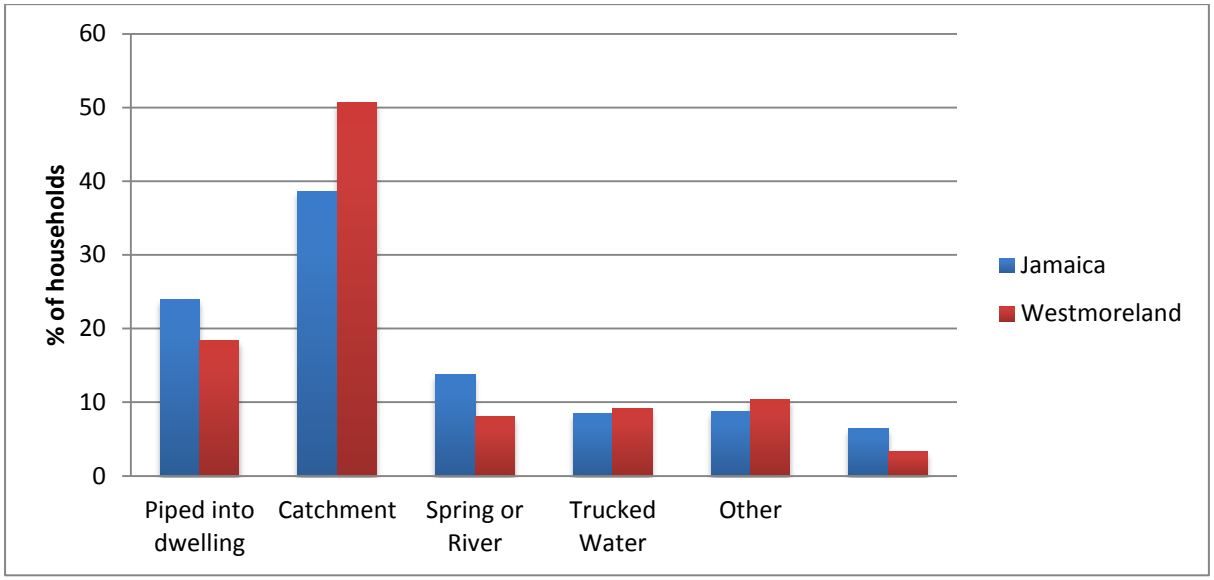

Figure 4. Type of water source for domestic use (Jamaica 2011)

Whitehouse, located on the windward side of Jamaica, is also highly exposed to hurricanes. Historically, the mean hurricane strike rate in the northern Caribbean has been one per year (Campbell and Beckford 2009; Spence, Katada and Clerveaux 2005). Figure 5 tracks the historical hurricanes and tropical storms in the vicinity of Jamaica, giving a further indication of frequency. The frequency of hurricanes and large tropical depressions has increased since the turn of the century with one hurricane striking in 2001, two in 2004, three in 2005, one in 2007 and one in 2012.

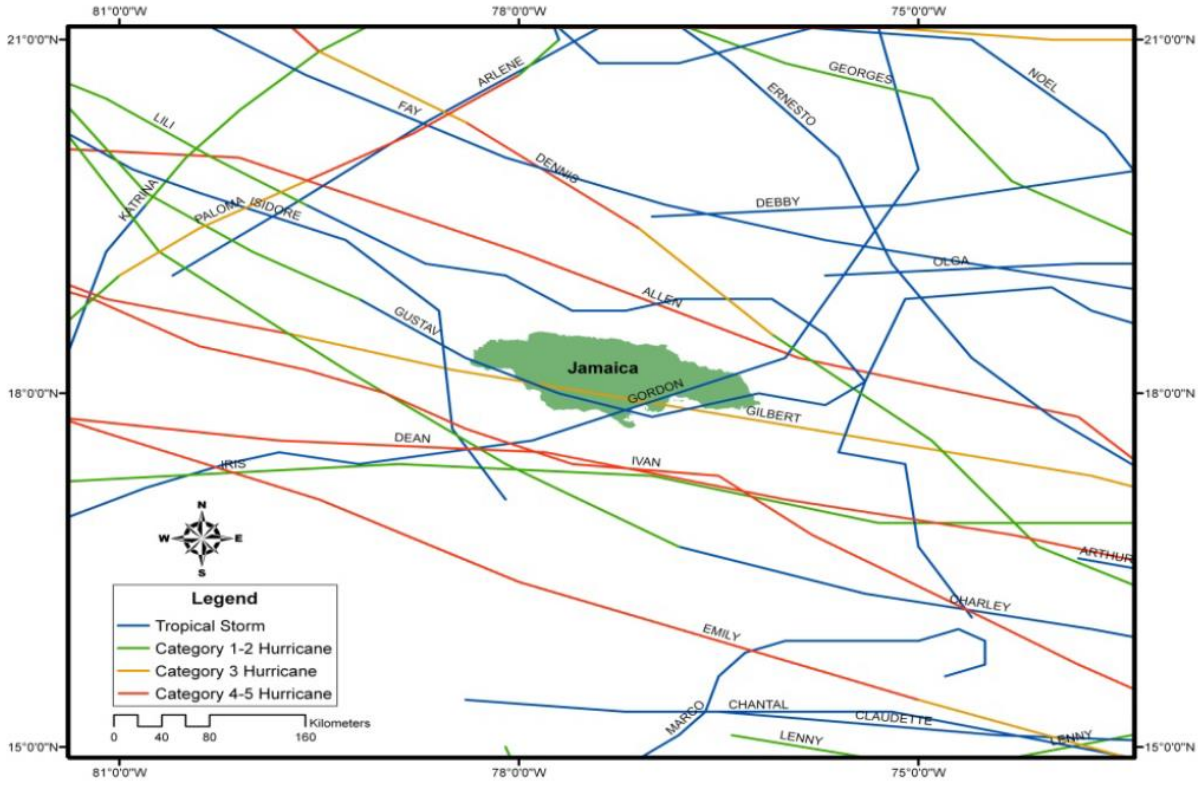

Figure 5. Hurricane and tropical storms that affected Jamaica, 1980 – 2008 (Campbell and Beckford 2009)

It is currently unclear from climate models what effect climate change will have on the frequency of hurricanes, however climate change is predicted to cause an increase in the intensity of storms, and possibly an increase in frequency. These changes would lead to greater exposure of Whitehouse's physical capital to extreme wind and rainfall, storm surge and erosion.

The infrastructure of Whitehouse is ill equipped to deal with the current frequencies and intensities of storms, nor the extreme levels of rainfall that they bring. The drainage system in particular is poorly constructed to prevent flooding:

> *One of the things [the government] would have to be able to address is to have all our drains concreted, because when you have the earthling drains the silt builds up, and we do not even having the funding to clean it. I believe that that money should be used to put in something more permanent, so we can be able, in the long-term, to mitigate against flooding.*

In 1979, a tropical depression dumped 865 mm of rain in an 8 to 10 hour period. Bluefields River and Robin's River flooded due to the high water table and impermeable underlying limestone. Parish-wide, the flood killed 41 individuals and caused J$100 million ($56 million) (Scolaro 2013). Locally, the flood damaged roads and water infrastructure, devastated crops, rerouted the Bluefields River and washed away much the sand on the Bluefields Fishing Beach (Carroll 2013; Scolaro 2013).

Increased storm surge from more intense storms also presents risks to Whitehouse Town and Bluefields. Respondents reported that waves regularly crash over the coastal road going through Bluefields and Belmont during storms in September and October. Following the category 4 Hurricane Ivan in September 2004, the Mines and Geology Division conducted a storm surge assessment that found that Bluefields and Cave areas experienced storm surge with heights up 1.5 meters that ran up to 50 meters inland (Carroll 2013; Parish Council of Westmoreland 2008). It predicted that a category 5 hurricane would cause sea waves of over 5 meters in height (Carroll 2013).

Beyond the risk of increased intensity of hurricanes and storm surge, climate change also threatens Whitehouse's coastal infrastructure through sea level rise. While the IPCC predicts that in the year 2100 the global average sea level will be between 0.35 to 0.70 meters higher than present day due primarily to thermal expansion, there is low likelihood of large and irreversible sea level rise from ice sheet loss[5] (Church and Clark 2014). While the onset of sea level rise will be slow, the adaptive capacity of infrastructure tends to be low due to the long life spans and the large sunken costs involved in constructing road networks, buildings, water and sewerage systems, electricity grids, etc.

[5] Church and Clark (2007) projected that sustained warming could lead to the near-complete loss of the Greenland ice sheet over the next millennium or more, which would result in up to 7 meters rise in average global sea-levels.

The Mona Geoinformatics Institute at the University of the West Indies mapped the areas of the country that are at risk of being inundated by rising sea levels. As seen in Figure 6, some of the coastal road along Bluefields Bay as well as the waterfront location of Sandals Whitehouse would be underwater were the sea level to increase one meter above present level. The area is less exposed to sea level rise than other parts of the parish, especially the cities Negril and Savanna la Mar. However, given the importance of these two cities to the populations of Whitehouse in terms of services and employment, and that the four locations compete for public funds from the same government coffer, it is not hard to imagine that impacts from sea level rise on Negril and Savanna la Mar might have knock-on effects locally.

Figure 6. Topographically low-lying regions (Richards 2008)

Social Capital

Social capital refers to the norms of reciprocity and trustworthiness between individuals. Social capital is thought to facilitate co-operation within communities because it reduces uncertainty and costs involved in enforcing contracts (Putnam 1993). Therefore, communities with higher levels of social capital are better able to overcome problems of collective action.

Most respondents felt that the communities of Whitehouse Town, Bluefields and Beeston Springs had a high degree of social capital. Many discussed the low rates of crime relative to other parts of the country and reported that residents would regularly share the fruits of their labour with those less fortunate. Social capital was also seen as particularly important in the functioning of local organisations.

In some ways, high levels of social capital can alleviate the lacking physical and financial capital. To illustrate, the following response describing Bluefields' approach to dealing with hurricanes illustrates the importance that social capital has played in responding to extreme events:

> *We have an unwritten disaster plan... First thing, when there is a threat, all the equipment is secured… All the fishermen come together and pull the boats out of the water. Then all of the persons go and they batten up their windows as much as they can. Then we make sure that the senior citizens in the community that don't have anybody living with them, they are brought over to other homes... After the storm the first thing that we do is we try to clear the roads, our streets, and we remove any trees that have fallen on electricity wires... We assist as much as possible in terms of clearing all of the lanes and streets... Some people who have family abroad, as soon as their phones get recharged they start getting calls to ensure everyone is ok and to send them money via Western Union. We want to have a disaster committee… We might put [a formal disaster management plan] down on paper, but the informal one has been working.*

One area where social capital appeared to be lacking was on Pedro Cay. Fishers unanimously agreed that illegal fishers coming from Nicaragua, Honduras, Columbia and the Dominican Republic were a threat to their livelihood. Fishers reported that they commonly witnessed offshore trade in guns, marijuana and cocaine. Many were concerned about the potential impact that these activities would have back on shore, for example on the tourism industry.

4.2 Institutions and Entitlements

Central to adaptive capacity of human systems is the adaptive flexibility of institutions and governance structures in responding to changing conditions. Well-designed institutions can promote rational forward-looking decision-making, the creation of economic opportunity and the conservation of diversity. Poorly designed or enforced institutions can reduce economic opportunity, undermine the functioning of organisations and promote irrational and myopic decision-making. This section will discuss institutions at different scales that respondents highlighted as having influence on their adaptive capacity.

The historical institutions of a plantation economy

During the 17 and 18th centuries, Jamaica was England's leading sugar producing colony. By the 1770s, it produced more sugar than all of the other English islands combined. Historical maps show that during this period numerous sugar estates were established within the study area[6] (Scolaro 2013). On these estates, imported slaves, primarily from West and Central Africa, worked the field and cut cane. It was not until the 1930s, that the British Parliament passed the 'Act for the abolition of slavery throughout the British colonies'.

Beyond the potential psychological and social legacy, which is difficult to measure, the pattern of land ownership is a concrete structural remnant of slavery that limits the adaptive capacity of the lowest income strata in Jamaica to this day. After Emancipation, many of the plantations in Jamaica continued to operate, and still controlled the most fertile agricultural land. To fill the gap in labour created by Emancipation, many estates brought in indentured servants from India and China. Other estates maintained their labour force by hiring the newly freedmen as wage labourers, and providing them with land for subsistence farming and rent-free accommodation. Historical accounts suggest that this latter model existed in the estates surrounding Bluefields Bay.[7] Other newly freed men preferred to leave the estates and work as independent farmers and/or fishermen. Those who farmed were largely forced onto marginal lands in the interior.[8] In the absence of comprehensive land reform, the current land ownership pattern in Jamaica is very much a path-dependent product of slavery. In 1998, the Statistical Institute of Jamaica's Census of Agriculture revealed that 65% of Jamaica's agricultural land was controlled by only 4% of the landowners. The remaining 96% of landholders owned 35% the land, divided into small plots averaging 0.83 hectares (Weis 2004). The farms observed within our study area fell exclusively into the latter variety.

These land ownership patterns create severe structural impediments to adaptation and lead to unsafe conditions. As explained by Weis (2004), "One hundred and sixty years after Emancipation, most small farmers continue to operate on small, steep hillside plots that severely constrain their production options and efficiency. In particular, the lack of irrigation limits the variety and timing of cropping patterns, and steep land gradients and poor infrastructure make labour less efficient, limit mechanized tillage, force more land clearance when soils get exhausted, make it difficult to get produce to the market, and simply increase the arduousness of everyday tasks."

Structural adjustment programmes and international trade law

[6] There were sugar estates along Bluefields Bay, Orange Grove, Beeston Spring, Lenox, Grand Vale, Bog, Content, Petersville, Culloden, Belmont, and along Bluefields River. There may also have been a cotton, indigo and cocoa plantation along Bluefields Bay. Maps and archaeological evidence also show that there were waterwheels and watermills to process the cane on Robin's River, Sweet River and Bluefields River, and cattle-powered mills in Content, Petersville and Culloden (Scolaro, 2013).

[7] During a trip to Bluefields in 1844, the British naturalist Philip Henry Gosse observed that Belmont had been "apportioned out in small… allotments, and cultivated in gardens" (Gosse 1851:87 as cited in Scolaro 2013).

[8] In some areas, such as Beeston Springs[8], Christian missionaries bought large plots of land and established 'free villages' with schools, farms, and churches for the newly freed peasants. For example, In Beeston Springs, in 1860, a Moravian missionary named Alfred B. Lind purchased Salem Estate at Beeston Springs and founded a free village with a teacher's cottage (Scolaro 2013).

In the 1970s, under a government controlled by Michael Manley's leftist Peoples National Party (PNP), small-scale farmers enjoyed significant public support in the form of publicly leased land[9]; public investment in agricultural cooperatives, rural infrastructure, agricultural research and extension services; and government efforts to improve access to credit and tenure security. During this time, employment levels and domestic food production increased[10] (Weis 2004). However, in the late 1970s and early 1980s, Jamaica experienced an increasing balance-of-payments deficit driven by the rising cost of oil, and received a series of IMF stabilisation loans and World Bank Structural Adjustment Loans. These loans were conditional on spending cuts,[11] reductions in tariffs and the removal other barriers to imports. Structural adjustments continued through the 1990s with privatisation of state-run enterprises and further reductions in tariffs. The formation of the WTO entrenched these tariff reductions by creating tariff ceilings. It also limited 'trade-distorting' domestic price supports, while permitting so-called 'non-trade distorting' subsidies – a loophole that allowed developed countries to spend billions of dollars each year on agricultural subsidies that distorted trade in their favour. The result in Jamaica was a rapid increase in imports, especially food products,[12] and a mounting trade deficit (see Figure 7). In 2012, the value of Jamaica's imports equalled 175% of its exports.

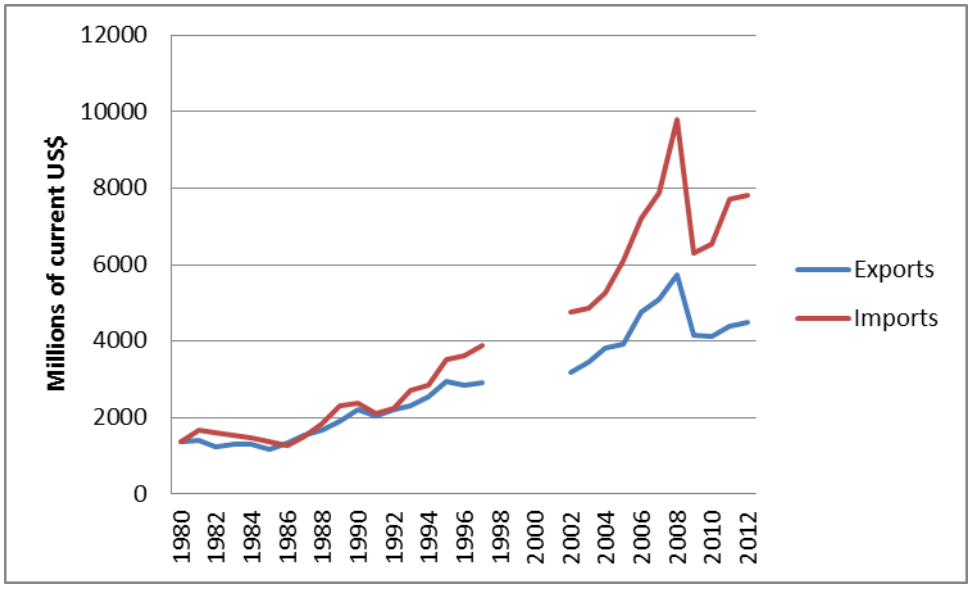

Figure 7. Jamaica's trade exports and imports, 1980-2012 (International Monetary Fund 2014)

[9] 36 thousand hectares of (albeit marginal) public land was leased to 36 thousand small farmers (Weis, 2004).
[10] Domestic food production increased by 10–20 per cent between 1977 and 1979. Between 1977 and 1980 agriculture accounted for 36–39 per cent of employment (Weis 2004)
[11] Between 1981 and 1985, government expenditure on agriculture as a percentage of GDP declined fourfold. This was not only due to a shrinking overall budget associated with debt and austerity; agricultural spending was also de-prioritized – in 1974–5, agriculture received over 19 per cent of government expenditure, but by 1990–1 this had fallen to less than 4 per cent. (Weis, 2004).
[12] Jamaica's food and beverage more than doubled between 1991 and 2001 from US$199m to US$503m (Weis 2004)

As stated in the section on financial capital, respondents repeatedly explained that local markets were being undercut by cheaper imported products. However, WTO rules limit tariffs and subsidies, hence reducing the Government of Jamaica's flexibility to intervene in its agricultural markets (Weis 2004). These limitations, in turn, reduce the capacity of small-scale farmers to adapt to changing market conditions, and the resulting lack of financial capital limits their capacity to adapt to climate change.

Fishing Regulations

There were grave concerns among respondents about effectiveness of fishing regulations. These regulations have significant implications for Whitehouse's adaptive capacity due to their impact on its natural capital. Not only were regulations insufficient, respondents explained that enforcement was poor, partly due to the limited financial capital of the government for monitoring personnel and equipment.

Historically, fishers used fish pots and fine mesh seine nets. Fine mesh seine nets are particularly harmful because they capture everything, i.e. they do not differentiate between large and small fish. They also damage the seabed, destroying breeding grounds. Many countries have banned fishing with seine nets, but Jamaica has not. Only recently did it institute a minimum mesh size on its nets and traps.

Regulations surrounding lobster and conch fishing are more stringent. Lobster fishing is open for nine-month seasons (August through July) and closed for three months (April through June). Harvesting of female lobsters, identified through the presence of eggs, is banned. Conch fishing is likewise regulated through closed seasons, as well as through export quotas. The driving force behind these regulations is partly pressure from the international Convention on International Trade in Endangered Species (CITES), which lists conch under Appendix II, meaning that it is considered not necessarily at risk of extinction, but may become at risk unless trade is closely controlled. Jamaica follows CITES guidelines voluntarily (Cartarci 2004).

Bluefields Bay Special Conservation Area

In 2008 a new government, led by the Jamaican Labour Party, announced a national target of protecting 20% of its marine and coastal habitats by 2020, and that it aimed to establish nine marine protected areas (MPAs), five of which would be on the south coast. With the vast majority of local fishers in favour of establishing a fish sanctuary, the Bluefields Bay Fishermen's Friendly Society (BBFFS) quickly approached the government and established the largest conservation area in Jamaica. The Bluefields Bay Special Fisheries Conservation Area[13] encompasses 3054 acres and stretches 12 kms along the coast (see Figure 1). The zone is patrolled 24 hours a day by wardens that have the authority to fine fishers for infringements and to seize their equipment.

[13] The designation was changed from MPA to a Special Fisheries Conservation Area to allow for research and culling of lionfish. Fishers are not allowed to enter the area without a permit.

The Conservation Area has enhanced Bluefields' adaptive capacity in multiple ways. First, early evidence suggests that the fish populations within the zone are recovering, enhancing natural capital (Rudolph 2012). It is hoped that the 'spill-over' effect from the area will increase fishers' catch outside of it (Roberts et al. 2001). Second, as a flagship conservation programme, it has attracted significant financial capital for Bluefields in the form of international grants,[14] which have been directed to operation expenses of the Conservation Area, as well as projects to create alternative livelihoods for local residents (discussed in Section 4.4). Third, community discussions prior to implementation of the Conservation Area worked to increase awareness of the harmful consequences of overfishing. Finally, it can be argued that the communal effort involved in establishing the Conservation Area has enhanced and reinforced social capital in Bluefields. The wardens explained that this communal effort continues as community members have occasionally reported infringements within the area that occurred beyond the sight of the warden's vantage point.

4.3 Knowledge and Information

Adaptation to any change in selection pressures requires that agents have an understanding, not only about the pressure itself, but also about their adaptive options (Fankhauser and Tol 1997). A recent study carried out by the Planning Institute of Jamaica (PIOJ) assessed the population's knowledge of climate change through quantitative household and industry surveys and qualitative focus groups. It found that Jamaicans have a high understanding about climate change, and a moderately good understanding of its causes and potential impacts.[15] Our research corroborated these findings.

The Jamaican population's high-level of understanding about the risks of climate change is partly the result of various initiatives to generate and disseminate information. Research into the effects of climate change in Jamaica is driven by a network of international organisations, such as the World Meteorological Organisation and CARICOM's Caribbean Community Climate Change Centre; government agencies, including the Met Office and the Water Resources Authority; NGOs, including CARIBSAVE; and universities, particularly the Climate Studies Group at the University of the West Indies (UWI).[16] The CARIBSAVE Partnership has been influential in disseminating the results of

[14] However, in November 2012, BBFFS signed a Memorandum of Agreement with the CARIBSAVE Partnership,[14] from which BBFFS will receive US$91 thousand. These funds will go towards the purchase of a new patrol boat, the wages of three new wardens and a supervisor, and the construction of a floating platform to assist with enforcement and research.

[15] Over 80% of respondents in the household survey had heard of the term climate change. Most respondents identified hurricanes (83.7%), droughts (84.5%), floods (76.9%) and increases in air temperature (74.9%) as events related to climate change. The focus groups also found that Jamaicans have a high understanding about the impacts of climate change. Participants identified hotter days, stronger hurricanes, shorter growing seasons, and increased floods and droughts as potential consequences of climate change, and discussed how construction in hazard-prone areas increases potential impacts (PIOJ 2012).

[16] Regionally, the World Meteorological Organisation heads a Caribbean Hydrologic Cycle Observation System, which produces research on climate, weather and water cycles. The Met Office of Jamaica is the country representative to the programme. Between 2004 and 2007, the World Bank and CARICOM's Caribbean Community Climate Change Centre carried out a project called Mainstreaming Adaptation to Climate Change

downscaled climate models through an easily interpreted Climate Change Risk Atlas (CARIBSAVE 2012). NEPA has also been influential in communicating information to the general population by hiring a community animator to liaison with community groups and by working with musicians and other popular culture figures. Nonetheless, respondents explained that the main reason why awareness is high amongst Jamaicans is that they have observed climate changes in their everyday lives and are receptive to explanations.

Despite the high-level of awareness about the risks of climate change, there is limited understanding about adaptive options. One important area where knowledge is lacking in Whitehouse is how agricultural practices mush shift to deal with climate change. Respondent from Jamaica's Rural Agricultural Development Agency (RADA), the government agency responsible for agricultural extension services, explained that to improve general understanding about adaptive options, extension officers would require specialised training and there would need to be an increase in the number extension officers per farmer.

Respondents explained that knowledge is also lacking about proper management of coral reefs. Multiple agencies are involved in sensitising local residents and tourists about coral reef preservation. Sandals Whitehouse and the Natural Resources Conservational Authority have held workshops and community education programmes about fishing practices and protection of sea life and the coral reef. However, further education is required among decision-makers that are responsible for the non-direct sources of pressure on the reef including run-off from construction and agriculture.

An effective mechanism to disseminate information about environment management has been school programmes. Since 1997, the Jamaican Environment Trust has held workshops twice per year to train teachers to lead class sessions on subjects such as management of coral reefs, wetlands and human waste. By 2003, the environment programme was operating in a third of Jamaican schools. A similar school programme, run by an American NGO, is Project WET, which trains teachers to lead class sessions on water resource management.

Respondents felt that Jamaica's early warning system for hurricanes was also effective at rapidly disseminating information, and that it had matured significantly as a result of having to deal with an increased number of storms since the turn of the century. The MET office monitors incoming storm systems and red flags any approach storms for the Office of Disaster Preparedness and Emergency Management (ODPEM). In the event of a storm warning, ODPEM disseminates information through Parish-level Disaster Coordinators, which contact community groups and leaders, shelter managers, and media outlets to get the word out to general public. In partnership

(MACC), which produced downscaled climate models and scenarios regarding the impact of climate change on water resources, sea level rise, temperature, and movement of the seawater. The Climate Studies Group at UWI has produced further models of future hydrological scenarios, which use rainfall data collected by the Met Office and stream flow data collected by the Water Resources Authority. To ensure reliable and continuous data, the Water Resource Authority is installing additional rainfall gauges in the different areas across the country, including rainfall intensity gauges.

with the Water Resources Authority, ODPEM has also developed early warning systems for flooding and produced maps of flood plains for use in land-use planning and flood hazard management.

4.4 Innovation

Innovation is the process through which economic agents 'search' for new products, processes and forms of organisation that offer a competitive advantage in local selection pressures, and bring those novelties into use (Nelson and Winter 1982). It is a socio-technical process that involves dynamic interplay between knowledge flows, market forces, social norms, politics and institutions (Sovacool 2009). The diffusion of knowledge about the new behaviour or technology and the development of skills, organisational structures, and financing mechanisms necessary to apply it, are often as important as the discovery of product or practice. Innovation is central to adapting to climate change, because it involves the adoption of new behaviours and technologies that are more suited to changing local conditions.

Innovativeness varied a great deal between industries in Whitehouse. The fishing industry demonstrated particularly little capacity to innovate. Despite the severe reduction in catch, most fishers continued to fish in the overexploited near-shore using the same techniques. When the catch was not sufficient, many would simply pull their boats up on shore and deplete their savings. Few fishers had switched to alternative industries. As discussed earlier, this lack of adaptive capacity was partly a result of limited human and financial capital. However, respondents also cited other barriers, such as people's tendency to act according to heuristics and the deep-rooted nature of fishing in the culture of Whitehouse:

> *"Too many people are going into fishing, so we are trying to move them away from that, though some are a bit stubborn because it seems as if salt water is in their blood."*

The 'search' processes that did exist in the fishing industry were primarily driven by the government, and involved transferring technology from other countries. For example, the Fisheries Department recently partnered with a Cuban marine biologist that had designed lobster condominiums or 'lobster casitas' out of PVC pipe, and installed 16 of them within the Bluefields Bay Special Fisheries Conservation Area to trial the technology. The government had also contracted an American company, EcoReefs, Inc., to install 350 artificial reefs in Bluefields Bay. Pictured in Figure 8, the units are ceramic and anchored to the sea floor using rebar. They are designed to mimic staghorn coral, which, respondents explained, had been greatly depleted in the area by successive hurricanes since the 1980s. The artificial reefs facilitate the growth of coral reefs by slow the water flow, stabilising sediment and providing a microporous surface for coral adhesion. In the process, they also increase fish populations. Rudolph (2012) conducted a baseline survey of fish populations in June 2011, and subsequent surveys in January 2012 and June 2012. The study showed that fish abundance and diversity increased significantly: "Once modules were emplaced, colonization occurred quickly by a number of species. A year later, 8195 individuals were documented over three fifteen minute transects compared to the original 115 individual fish noted at the artificial reef site" (Rudolph 2012).

Figure 8. Artificial Reef in Bluefields Bay Special Fisheries Conservation Area (Beckman 2013; Carroll 2013)

Within the farming population, innovativeness was more varied. Respondents explained that most farmers were risk adverse, and would not adopt a new technology or practice until it had been proven to work. However, others would actively 'search' for new techniques and technologies. For example, one new and growing practice in Bluefields and Beeston Springs was apiculture. One beekeeper explained that the industry had great potential for growth in Whitehouse considering the size of the overseas market for honey, but that capitalising on the opportunity required government intervention to build knowledge and human capital. Another group of farmers in Bluefields recently joined the Jamaican Organic Agricultural Movement (JOAM). While the practice of organic farming is deeply rooted in Jamaica's Rastafarian community, training from JOAM had led to a variety new practices and enterprises. The farmers started an agroprocessing cooperative to produce jams and wine from sorrel and june plums, which they sold to local hotels. They also started a small demonstration plot to showcase organic practices. The motivations of organic farmers were primarily to produce healthier food in a more environmentally friendly manner. However, many felt that organic farming had advantages when it came to adapting to climate change:

> *The organic way contributes to how to deal with weather patterns... You have to organise your farm with shades to cover some of the plants from sun with other plants. You have to organise it for windbreaks, to [prevent] blow down of the crop when strange winds come in. And you have to organise it with contours, so that if there's a flood your farm can survive.*

Farmers were acutely aware of recently changing weather patterns. One technology that many felt would allow them to deal with these changes was greenhouses. A respondent from RADA explained how Jamaicans had made incremental innovations in the design of greenhouses to make them more fit for the local environment:

> *When you introduce a new technology sometimes you realize that you need to improve on it… It was after the experience of strong winds or a hurricane that we realized that it's best to install [greenhouses] in such a way where we can remove the roofs. I would imagine that all the greenhouses that are going up now would be constructed in such a way, because we have a greenhouse unit now throughout the island and they meet from time to time. They would pass on this information to the growers.*

Despite the improvement, financial barriers still prevented most farmers from obtaining greenhouses. Likewise, financial constraints were the primary barrier preventing diffusion of drip irrigation systems, which farmers felt would help them cope with increasing dry spells:

> *The only adaptation would be to look towards, in the drier periods, using irrigation techniques such as drip irrigation systems. It is quite expensive and most farmers cannot afford. They try their best to use innovative ways to ensure that the crop has water during that period… But sometimes what happens, it cuts people out of production during that period of time, because they cannot afford an irrigation system. So they wait on the rainfall period.*

The local tourism industry in Whitehouse also exhibited limited innovative capacity. Most entrepreneurship was driven by returning expatriates and foreign nationals that had more financial capital and technical training than local residents, and much of the recent development emulated Negril's all-inclusive beach resorts. In Bluefields Bay, a few local respondents expressed the desire to launch ecotourism companies engaged in bird watching, hiking, spelunking and snorkelling, and heritage tourism companies based on Bluefield's Bay historical significance as a one-time colonial centre and pirate stronghold and the birthplace of famous Reggae musicians. Nonetheless, like the fishing and agriculture industries, these innovative aspirations were largely constrained by limited financial and human capital.

4.5 Flexible forward-looking decision-making and governance

Central to the adaptive capacity of a system is the capacity of the agents within that organisations to anticipate changes in selection pressures and to respond accordingly (Jones, Ludi and Levine 2010). Responding to an anticipated change often requires long-term planning in order to prevent maladaptive behaviour (Ayers and Huq 2009).

Flexible and forward-looking governance of land-use is particularly important due to the frequently myopic decision-making of private individuals and the slow changing and commonly irreversible nature of land-use. Jamaica already has a significant amount of infrastructure built along its coastline and in flood-prone areas. Flexible and forward-looking land-use planning would take into consideration the projected changes in climate and sea level. To this end, NEPA is in the process of creating a *National Spatial Plan* that will provide guidance for the layout of developments across the island. At the time of research, a committee in the Office of the Prime Minster was preparing legislation to submit to the Cabinet that would create coastal setbacks and no-build zones, particularly in flood-prone areas.

Given the projected increase in intensity of storm activity in the Caribbean, flexible forward-looking governance would entail improvements in disaster risk reduction, as well as disaster response systems. When ODPEM was established in 1980, its mandate focused on disaster response coordination and education about hazard risks. Over time, this mandate evolved to include the integration of disaster risk reduction into development planning as a whole. Parish Councils have employed Parish Disaster Coordinators, whom act as a bridge between ODPEM and communities and whom are responsible for ensuring that communities are ready to respond to disasters. As was done in Whitehouse, Parish Disaster Coordinators and ODPEM host community meetings with local community members to identify vulnerabilities, increase awareness, establish storm shelters and shelter managers, and formulate community response plans. ODPEM has also worked with communities and other government departments to increase resilience of physical infrastructure through drainage systems and slope stabalisation mechanisms, and to rebuild important natural systems, for example, through mangrove replanting exercises.

Despite these (pending) improvements in governance of land-use and disaster risk reduction, flexible and forward-looking governance has been lacking in Jamaica's fishing industry. Given the severity of the threats imposed by climate change on Jamaica's fishing industry, it is highly likely that communities that specialise in fishing, such as Whitehouse Town, will need to undergo a transformative adaptation or face collapse. However, the policies necessary to support such a transformation have not been implemented. Jamaica's Fishing Industry Act, established in 1975, is severely outdated. A first draft of a new Fisheries Bill, with tougher regulations and penalties, was tabled in parliament in 1996. Since then, the bill has not reached a vote in Parliament. The bill would introduce a measure to reduce fishing effort through a moratorium on new fishing licenses:

> *We are going to look at a three-for-one system. Say, for argument sake, here in Whitehouse at least three fishermen have to come out of the sea before we put one in.*

One respondent estimated that 15-20% of fishers already fish without licenses, and stressed that were a moratorium to be successful, it must be accompanied by increased enforcement. Such top-down policies will likely need to be accompanied by bottom-up support for alternative livelihoods. The Climate Change Adaptation and Disaster Risk Reduction project, implemented between 2011 and 2013 by the Government of Jamaica, the European Union and the United Nations Environment

Programme, aimed to provide such support for alternative livelihoods.[17] Island-wide, J$15 million (US$133.6 thousand) in grant funding was provided to 14 enterprises (Jamaica Observer 2013; Mcintosh 2014). In Bluefields, three grants were awarded to projects promoting beekeeping, ecotourism and organic farming (GCCA 2012). The project demonstrates how international support can promote more flexible and forward-looking decision-making and governance at the local and national levels.

5. Discussion and Conclusion

This case study demonstrated that when assessing Whitehouse's adaptive capacity, it is important to consider not only the assets that it has at its disposal. It is also necessary to consider the processes whereby decisions are made, knowledge is generated and disseminated, novel practices and technologies are introduced and retained, and institutions evolve to govern private behaviour. The LAC framework provides a useful tool for capturing different elements.

With little financial capital to invest in adaptive measures, the adaptive capacity of many of the residents is severely curtailed. For example, agriculture is highly susceptible to increased dry spells and more variable weather patterns. Greenhouses and drip irrigation could offer technical solutions to this problem that would lengthen growing seasons and increase production. However, most farmers lacked the financial capital to invest in these adaptive technologies. Likewise, many respondents that wished to start a new business were hampered by both a lack of investment capital and inadequate human capital.

Much of the natural capital that underpins the economy of Whitehouse is under threat from climate change and other stressors. Fisheries in Whitehouse and Bluefields are highly likely to be degraded from climate change. Off-shore fish populations will likely migrate further northwards with rising ocean temperatures, and those near-shore fish populations that depend on coral reefs will likely be affected by coral bleaching resulting from rising ocean temperatures and ocean acidification. Already, these fish populations are under immense pressure from pollution, habitat destruction and overfishing. The fishing industry will likely need to be transformed of face collapse.

An understanding of Whitehouse's capacity to adapt to the threats posed to its natural capital would be incomplete without an examination of its institutions, capacity to innovation and to govern resources in a flexible and forward-looking manner. In general, fishing regulations designed to protect existing fish populations are both insufficient and poorly enforced. Moreover, the fishing industry has demonstrated little capacity to innovate to reduce its pressure on the near-shore resources. There is potential for an expanded tourism industry to absorb some of the excess labour from the fishing sector. However, human capital of the type needed in the service sector is lacking amongst fishers.

[17] The EU Global Climate Change Alliance provided funding of EUR 4.13 million, and UNEP provided technical support.

An exception to this pessimistic outlook is in Bluefields, where new institutions and technologies have been developed to conserve and enhance local marine resources. These include the Bluefields Bay Special Conservation Area, artificial reefs, and lobster condominiums. Moreover, significant financial support from international organisations has been provided to enhance enforcement and management of the Conservation Area, and to enhance promote alternative local livelihoods in ecotourism, apiculture and organic agriculture. To increase Whitehouse capacity to adapt to climate change and other major challenges that the future may hold, further support should be provided to the development of institutions that aim to conserve and foster a diversity of adaptive options.

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