Destruction in Paradise: Using the capabilities approach to assess the causes of marine debris in the Bahamas

The case of Hurricane Dorian and informal settlements in the Abaco Islands

Greta Simonaviciute

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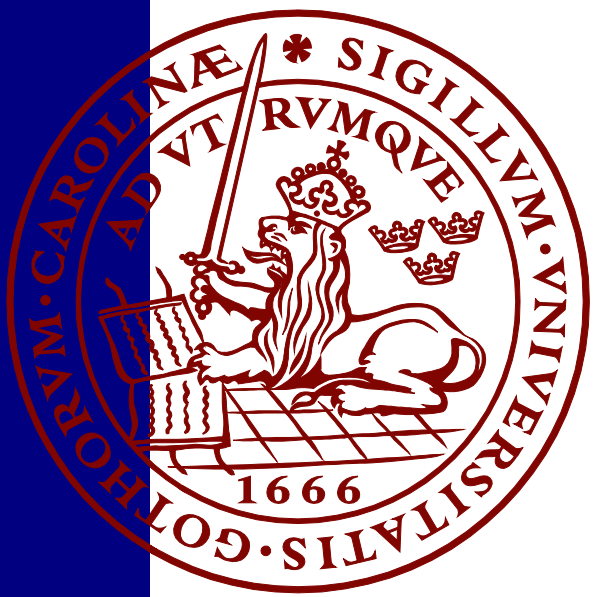

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Supervisor: Chad Boda, LUCSUS, Lund University

Abstract

Marine debris is a major threat to wildlife and human health. This study examines the socioeconomic vulnerability of informal housing as arguably one of the main drivers of the abundance of marine debris in the aftermath of a tropical cyclone. Using the Abaco Islands, Bahamas, as a case, the study applies the capabilities approach to assess the societal impact of Hurricane Dorian. Findings indicate that capabilities were already deprived in analyzed areas before Dorian, resulting in vulnerable informal settlements easily destroyed by the storm, leading to both large amounts of marine debris and massive social suffering. From this, the study argues that restoring capabilities to what they were before a disaster is insufficient. Instead, efforts should aim to enhance capabilities to reduce housing vulnerability. The study suggests that better data collection and recognition of land rights, among other factors, would improve the capabilities of informal communities, ultimately mitigating marine debris.

Keywords: marine debris, capabilities approach, informal housing, disaster impact index, sustainable development, the Bahamas

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1 Introduction

Over the past years, marine debris has become one of the emerging global challenges drawing wide international attention (Murray et al., 2018). It is a global problem that results in local impacts on both wildlife and human health (Gall and Thompson, 2015; Borrele et al., 2020). Tropical cyclones (hereafter TCs) such as hurricanes are associated with storm surges, flash floods, and waves that destroy coastal infrastructure, adding to the abundance of marine debris in open waters (Hidalgo-Ruiz et al., 2018; Murray et al., 2018; Wang et al., 2019; Lo et al., 2020). However, the abundance of marine debris created can also be determined by the pre-existing socioeconomic vulnerability of affected communities, including the amount and quality of infrastructure exposed to hazards and whether communities can cope with impacts and recovery (Hewitt, 2007; Wisner et al., 2004; von Meding et al., 2019), which is reflective of the community's level of development. While climate change is projected to increase the intensity of TCs, and thus potentially the quantity of marine debris (Hori et al., 2020), how communities develop and overcome socioeconomic vulnerabilities will only increase in importance.

To contribute to the field of marine debris research, this paper emphasizes the valuable role of social dimensions as part of the cause and prevention mechanism for marine debris. This paper specifically focuses on the relationship between sustainable development, marine debris, and housing. Sustainable development in this paper refers to the process by which individuals are empowered to achieve the kind of lives they have reason to value (Gardoni and Murphy, 2009). When TCs strike, quality housing is important both in terms of social disaster and prevention of marine debris. The housing sector experiences the maximum impact during the TCs and other disasters (Lyons, 2009; Ahmed and Mcdonell, 2020). Different types of housing are constructed with different building standards, so when TCs strike, some houses cannot withstand the event and are destroyed. Once washed out to sea, they become marine debris. The ability to mitigate damage and the recovery process often depends on the capabilities of the affected communities. With deprived capabilities, these communities can be forced into a cycle of poor housing and low capabilities where the consequence is both increased marine debris and increased social vulnerability.

This study investigates the relationship between housing, marine debris and TCs through the following research question: How does housing quality in the Bahamas affect the creation of marine debris during TCs? Thus, this paper outlines a conceptual framework based on the capabilities approach to sustainable development, which is applied to assess the causes of housing impacts of a climate-related extreme event, namely Hurricane Dorian. Capabilities refer to the individual's ability to achieve valuable doings and beings (e.g., being nutritious and being sheltered) also known as "functionings" (Gardoni and Murphy, 2010). The importance of looking at the capabilities of the least well-off communities, arguably, will help to identify the reasons for housing vulnerability and therefore the cause and possibilities for prevention of marine debris. This study uses focused document analysis and semi-structured interviews to assess the capabilities of the informal settlements in the Bahamas affected by Hurricane Dorian.

The paper is structured as follows. Following this introduction, **Section 2** briefly outlines the context, scope, and relevance of the study background and examines and synthesizes numerous existing literatures to ascertain the state of knowledge linking TCs, housing, and vulnerability to the production of marine debris. Building on this review, **Section 3**, introduces the capability approach to sustainable development and housing which is used to assess the societal impact of Hurricane Dorian in the Mudd and Pigeons Pea informal settlements on Abaco Island. **Section 4** outlines the process of data collection and analysis. **Sections 5** and **6** present the results and discuss their implications. **Section 7** provides conclusions relevant to a wider audience.

2 Housing, tropical cyclones, and the production of marine debris

2.1 Marine debris and tropical cyclones

TCs associated with storm surges, flash floods, and waves carry a significant portion of pollutants into the marine environment. Several studies have demonstrated a remarkable increase in the abundance of marine debris during the TCs - especially when it winds up in nearshore and coastal waters (FDEP-FCO, 2018; Hidalgo-Ruiz et al., 2018; Murray et al., 2018; Wang et al., 2019; Lo et al., 2020). It is important to note that marine debris associated with these major hazardous events is different from general marine debris because the source and date of dislodgement or entry into the ocean are well known and fixed in time (Murray et al., 2018). While general marine debris presents relatively small plastic items, TCs debris includes large items such as vessels, floating docks, and many other large objects from broken homes (FDEP-FCO, 2018). Specifically, the full extent of damage to the housing sector produces a massive amount of debris entering open waters (Ahmed and Mcdonell, 2020). Once debris enters oceans, it is difficult to understand the source and direction

making it challenging to mitigate and control (Murray et al., 2018). Marine debris coming from TCs presents a hazard to health, safe navigation, economy, sustainable development, and the natural environment (FDEP-FCO, 2018). Moreover, TCs marine debris diminishes opportunities to exploit marine environments for livelihoods, further complicating the recovery process (Faris and Hart, 1994). These economic costs are lost benefits to society. Considering that the Bahamas population depends on marine resources, the impacts of marine debris on the marine environment have the potential to create massive harm to already vulnerable coastal communities.

The Wider Caribbean Region is thought to be especially vulnerable to various stressors from climate change, in particular TCs activity ranging from tropical storms and depressions to category five hurricanes (ECLAC, 2004; Hori et al., 2020). These TCs can result in a large number of marine debris which leads to reduced revenues from the tourism and fishing sectors that these countries depend on, and although countermeasures are growing through various action plans and other marine and environmental policies, these remain limited, fragmented, and insufficient at the national level (The World Bank, 2019).

2.2 Hurricane Dorian and the Mudd and Pigeons Pea settlements in the Bahamas

Hurricane Dorian is the most intense and powerful Category 5 Atlantic hurricane in history. It first formed as a tropical storm in the Central Atlantic and intensified into a hurricane before making a two-day landfall in the Bahamas, a large archipelago of over 700 islands in the western Atlantic Ocean, on 1, September 2019 (Zegarra et al., 2020). Figure 1 illustrates the maximum Hurricane Dorian sustained winds passage of 295 km/h, wind gusts up to 360 km/h, and a minimum sea-level pressure of 910 Mb (de Brujin et al., 2022). The storm caused approximately $3.4 billion in damages, which equals one-quarter of The Bahamas' gross national product (Deopersad et al., 2020). It impacted in particular the Northern islands in the Bahamas archipelago (Fig. 2), resulting in lost lives and heavy damage to housing, the latter of which led to a large amount of debris entering the ocean (ECLAC, 2019). It has been nearly 3 years since the devastating storm hit the Bahamas, however, scars from the hazard remain. Marine debris is still to be collected, ecosystems are yet to recover, and vulnerable coastal communities' efforts to rebuild after Hurricane Dorian are still in the process of long-term recovery.

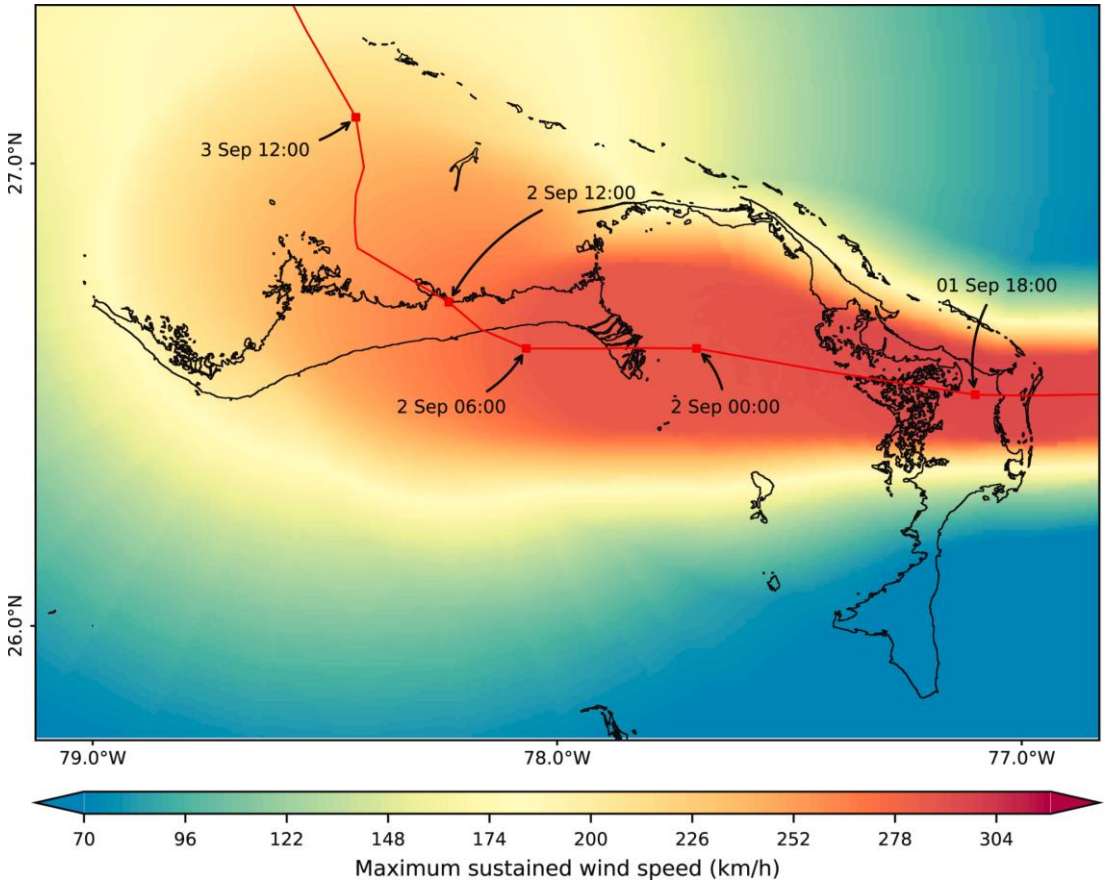

Figure 1. Maximum sustained wind speed (km/h) passage over the Bahamas in September 2019. Timestamps are given in UTC. The scale represents the strength of the sustained wind speed at 10 m above surface level. While the blue color on the right side of the scale visualizes the weakest wind speed, the red color points to the strongest sustained wind speed. The map represents Grand Bahama (on the left) and Abaco Islands (on the right). From "Using rapid damage observations for Bayesian updating of hurricane vulnerability functions: A case study of Hurricane Dorian using social media" by Brujin et al., 2022, *International Journal of Disaster Risk Reduction* (72).

2.2.1 Topographic and climate-related risk factors

Aspects of its physical geography and land-use legacy leave the Bahamas highly vulnerable to exposure to TCs-related hazards (Prevatt et al., 2010). Many Bahamian islands are susceptible to flooding caused by storm surges and sea-level rise due to their low-lying topography (Deopersad et al., 2020). Around 82% of the Bahamas population lives in the Low Elevation Coastal Zones within 5 km of the coastline (Silver et al., 2019), where the area along the coast is less than 10m above sea level and is therefore susceptible to severe damage from storm surge (Mycoo, 2018).

Due to its location in the Atlantic hurricane belt, the Bahamas is one of the most vulnerable countries in the world to the impacts of climate change (Wong et al., 2014; Thomas and Benjamin, 2017; Thomas et al., 2020; Deopersad et al., 2020; Pathak et al., 2021). Among the negative impacts

of climate change, TCs are projected to increase in intensity in terms of flooding, rainfall, wind speeds, and storm surge, and become more destructive as higher sea temperatures will increase their strength (Thomas and Benjamin, 2017). Additionally, the increase in water sea surface temperatures (Hay et al., 2015), and increased fluctuations in the Bermuda-Azores high-pressure system (Prevatt et al., 2010) are likely to contribute to a tendency for cyclones to be more intense and thus potentially destructive (Elner, 2008; Holland and Bruyere, 2014; Ares et al., 2020). This could lead to more housing damage and pollution to vulnerable coastal regions and ecosystems (Kijewski-Correa et al., 2021). Finally, the economic reliance on the tourism industry and foreign investment/aid along with housing infrastructure along the coastal areas increases the potential impacts of climate change (Thomas and Benjamin, 2017). The changing climate change trends will likely increase the risk of large amounts of marine debris being carried into the open waters caused by the TCs.

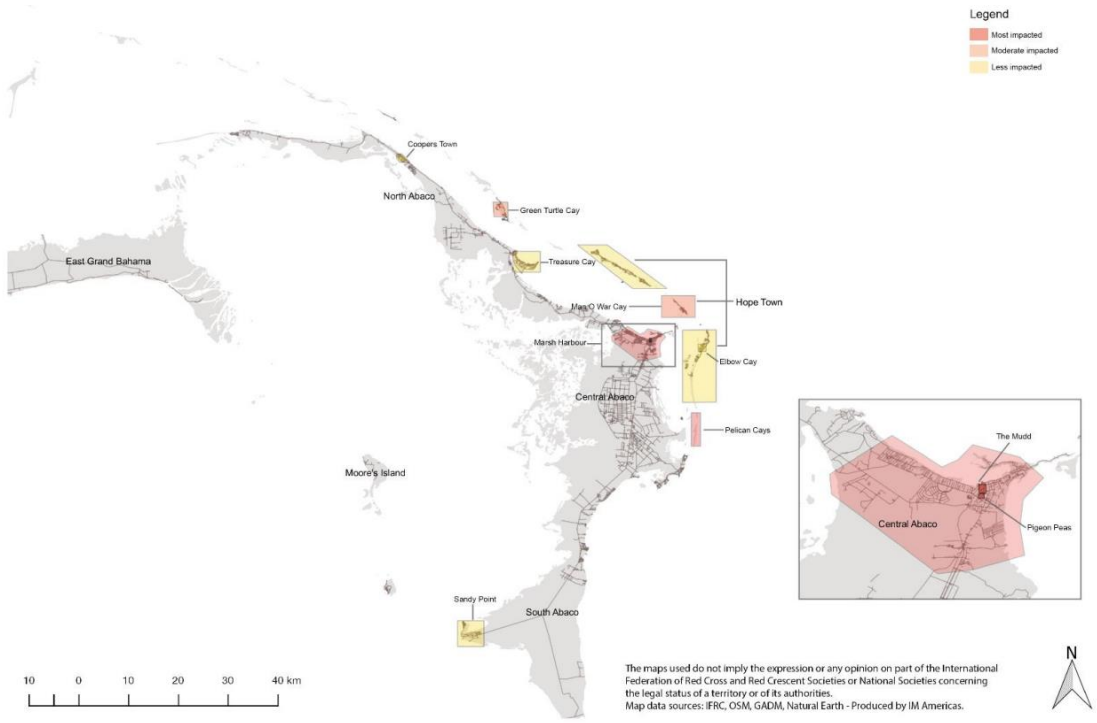

Figure 2. Map of the Abaco Islands: measured areas by impact. This figure illustrates the map of measured areas by the impact on the Abaco Islands' aftermath of Hurricane Dorian. The red-colored parts represent the strongest hit areas while yellow represents the least affected areas in the Abaco Islands. From "Revised Emergency Appeal the Bahamas: Hurricane Dorian" by IFRC, 2019.

2.2.2 Socioeconomic risk factors

The Bahamas is a comparatively wealthy Caribbean country where financial and tourism services are the highest contributors to the GDP, accounting for 20% of financial and 50% of tourism sectors in total (GoB, n.d.). The balance is spread among retail and wholesale trade, fishing, manufacturing, and agriculture (Silver et al., 2019). The Bahamas is a low-tax environment thus accommodating a large number of wealthy individuals. As a result, the Bahamas has one of the highest average incomes per capita worldwide (Deopersad et al., 2020). Bahama's wealth has attracted migrant communities looking for better opportunities. More than a quarter of the Bahamas population is made up of Haitian migrants (Louis, 2019). The main Haitian communities are to be found on the most populated and developed islands of which the Abaco Islands host the largest groups of the Haitian population, who have mostly settled in informal areas (Perry, 2022). Most Haitian migrants take low-paid employment in domestic service, agriculture, construction, and informal-sector trading (Louis, 2019). Overall, Haitians in the Bahamas are a highly stigmatized group constantly threatened with deportation raids (Perry, 2022). As a result, these communities remain largely separated from the mainstream Bahamian society thus often residing in low-quality housing that is detached from the main city services (Kijewski-Correa et al., 2021). Among the hardest-hit communities during Dorian were "The Mudd" and "Pigeon Peas" informal settlements, home to many undocumented Haitians in Marsh Harbor, central Abaco (UNDP, 2020a). According to the shantytown report 2018, approximately 700 homes and an estimated population of 3,000 people are living in these informal settlements (Moxy, 2018).

2.2.3 TCs marine debris management in the aftermath of Hurricane Dorian

Hurricane Dorian generated large quantities of debris and rubble (UNDP, 2020a), totaling approximately 40,000 tons (Maycock, 2021). Debris sources included parts from the damaged houses, vegetation, displaced, and damaged vessels and vehicles, fishing gear, and other personal property (UNDP, 2020a).

Preliminary estimates from Katherine Forbes-Smith, Managing Director of the Bahamas Disaster Reconstruction Authority, accounted for $20 million in debris cleaning costs in the Abaco Islands (GoB, 2020a). Less visible yet potentially as harmful as land debris, marine debris that originated from both land and water-based sources, poses a significant threat to health, economy, and environment (FDEP-FCO, 2018). Although statistics and physical identification of marine debris are generally unavailable or difficult to collect, considering the geography of the Abaco Islands and the rain, flood, and wind speeds during the cyclone, one can assume that a relatively large percentage of

the total land debris has been washed away to the open waters. Factors for limited data on marine debris include weather conditions, water clarity, and depth, debris buoyancy (FDEP-FCO, 2018), and lack of immediate response and capacity from the Bahamas government (Thomas et al, 2021).

The National Emergency Management Agency (NEMA) in close coordination with the Caribbean Disaster Emergency Management Agency (CDEMA) was a governmental organization that handled the response to the hurricane (OCHA, 2019). In addition, the private sector, UN agencies, and other humanitarian organizations supported the Hurricane Dorian response by providing emergency aid, assisting with debris removal, and providing first aid to the affected communities (EEC, 2019). Other American organizations as well as the Dutch Military, Jamaica Defense Forces, and Turks & Caicos Defense forces supported government-led responses with search, rescue, and evacuation efforts (UNDP, 2020a). The response to Hurricane Dorian demonstrated the value of the civilians who also participated in the emergency relief actions (Thomas et al., 2021). Although marine debris clearance was initiated in the immediate response phase, little action was taken to clear the debris (EEC, 2019).

Taking into consideration, that marine debris from TCs primarily originates from destroyed and damaged housing (Lyons, 2009; Ahmed and Mcdonell, 2020), it is necessary to understand and discuss the housing quality, impacts, and revolving factors. Therefore, the following section continues the discussion of the connection between housing and marine debris.

2.3 Housing in the Bahamas

2.3.1 Overview of Hurricane Dorian's impacts on housing

According to Deopersad et al. (2020), the human landscape was the most severely affected sector by high winds, storm surges, and flooding, caused by Hurricane Dorian. The housing damage accounts for $ 1.48 billion (Zegarra et al., 2020) of which 90% was located in the Abaco islands (Deopersad et al., 2020). In Abaco, housing damage accounts for more than 75% of the houses being impacted from which nearly 57% were severely damaged (Deopersad et al., 2020), and only 38% of these losses were insured (Kijewski-Correa et al., 2021). The informal housing - The Pigeon Pea and Mudd settlements sustained catastrophic damage accounting for 100% of the loss (Fig. 2) (IFRC, 2019). The damages were made to the structural elements such as frames, walls, roofs, doors, windows, and other components of the building (Deopersad et al., 2020). The exterior structural damage was caused mainly by extreme winds while surging flood-damaged interior contents (Kijewski-Correa et al., 2021). The affected housing included family homes, tourism properties, industrial facilities,

governmental buildings (Kijewski-Correa et al., 2021), and commercial construction that serves a high proportion of the tourism industry (de Bruijn et al. 2020) among others. The destruction was exacerbated by the limited application of the building code and poor construction practices (de Bruijn et al. 2020).

2.3.2 Housing performance and regulatory environment in the Bahamas

Within the Abaco Islands, housing construction typically consists of single-story houses and concrete block apartments built using one of three material typologies: load-bearing masonry (76%), wood-frame (15%), and reinforced concrete (9%) (Karamlou and Ramanathan 2019; Kijewski-Correa et al., 2021). The hurricane-resistant construction is supported by the steel reinforcing bars to reinforce the exterior walls, and sand/cement plaster on the surfaces which increases water penetration resistance (Prevatt et al., 2010). Current formal households are typically built on good soil (Kijewski-Correa et al., 2021). Further, since the 1970s construction started to be regulated within the adoption of the mandatory Bahamas Building Code (BBC) (Kijewski-Correa et al., 2021). The purpose of the BCC is to provide building standards for safe and stable building design and construction methods (GoB, 2003). In 2003 the BCC was strengthened thus adding a mandatory installation of hurricane shutters for all applicable new buildings (Karamlou and Ramanathan 2019). Since then, the building codes are considered adequate for strong winds, however, compliance with the codes in informal settlements is often lacking (Deopersad et al., 2020). In addition, the BBC has been criticized for lacking the capacity to strictly enforce building code standards thus resulting in deficiencies and unregulated construction (Prevatt et al., 2010; Karamlou and Ramanathan 2019). Finally, the residential buildings' quality of construction and material choices are highly influenced by the economic capacity of the owner (Brujin et al., 2020).

2.3.3 Informal housing in the Bahamas

Informal housing or informal settlement - buildings that do not conform to the parameters of planning and construction regulations, exist on a global scale in both rural and urban settings (Harris, 2018). That is to say, any form of housing that is illegal and falls outside the government control and regulation is part of the informal sector (Harry, 2018). The reasons to reside in informal settlements include low levels of state regulations and enforcement of building regulations (Prevatt et al., 2010), high costs of formal construction (Talbot et al., 2022), and residents' limited capacities to conform to regulations (Harry, 2018). Informal housing in the Bahamas is called “shantytowns” which are defined as a “cluster of dwellings which do not meet minimum environmental or regulatory standards concerning water supply, solid waste management, sewage disposal, general aesthetics

and structure" (UN-Habitat, 2020, p.22). Shantytowns in the Bahamas developed spontaneously without control, or engineered supervision, accommodating mainly Haitian migrants (Louis, 2019). The majority of the houses in the informal settlements are built using poor construction materials in low-lying areas vulnerable to flooding (UN-Habitat, 2020). Poor construction practices are linked to the lack of knowledge and training skills of builders (Prevatt et al., 2010) which consequently leads to housing damage and the creation of huge amounts of disaster waste (EEC, 2019).

Von Meding et al (2019) write, "For every inadequate building, there is a social context". The current Bahamas housing sector is rooted in the historical development and origins of the Caribbean people. The impacts of colonialism, slavery, and discrimination based on class, and race among others highlight costly Hurricane Dorian recovery inequalities in societal vulnerability (von Meding et al., 2019). Historically, Caribbean society has been divided into economic parts - formal and informal (e.g., ex-slave populations, indentured servants). These economic differences developed the current housing environment which reflects social vulnerabilities in the Bahamas (Prevatt et al., 2010). The presence of socioeconomic vulnerabilities, such as a lack of education or language barriers in the legal system, increases the likelihood of residing in informal housing (Way, 2009). In the Bahamas, the existing legal system often alienates undocumented communities that reside in informal settlements, making it impossible to secure formal housing (von Meding et al., 2019).

2.3.4 Gaps in post-disaster response and long-term recovery processes

Since Hurricane Dorian hit the Bahamas, the post-disaster recovery process has been slow and filled with controversy. Issues such as unequally divided emergency response (von Meding et al., 2019), inadequate institutional support and funding (Zegarra et al., 2020), lack of coordinated immediate emergency response (Thomas et al., 2021), and limited access to information about support and resources (Russell, 2019) have affected many vulnerable communities across the Abaco Islands. In Thomas et al. 's (2021) interpretation, government agencies have bureaucratic systems that are inflexible while the public sector lacks adequate resources for effective mitigation.

Many humanitarian organizations provided emergency responses for clean-up and housing repair. However, due to the high cost of reconstruction, international response primarily aimed at households that suffered minor damage (UNDP, 2020a). Similarly, the national response support included the 'Small Home Repair Program' to repair and reconstruct houses thus offering cash grants from USD 2,500 for minor damage up to USD 10,000 for a total loss of properties (CDEMA, 2019). However, these housing relief funds contributed only to a small part of house reconstruction since to fully rebuild, for example, a small 2-bedroom house would cost from 60,000 to 100,000 US dollars

(Shelter Cluster, 2019). Among other response initiatives, the Department of Social Services (DoSS) provided rental support for six months (CDEMA, 2019). Yet, the DoSS department's support was inadequate due to limited resources thus calling for international organizations to assist in relief operations (IFRC, 2021). As such, in the immediate aftermath of Hurricane Dorian, emergency response and short-term housing were completed rather quickly, however, the long-term recovery has been limited (von Meding et al., 2019). Although housing damage after Hurricane Dorian was widespread, houses intentionally built to resist cyclones fared much better (Marshal et al, 2019).

Furthermore, the Bahamas response strategy was primarily aimed at the Bahamas citizens, meaning that non-citizens such as undocumented Haitian migrants received limited or no housing assistance (Shelter Cluster, 2019; Marazita, 2020). Moreover, although humanitarian organizations provided help to all people based on humanitarian needs regardless of status, undocumented migrants went into hiding because of the threat of deportation from the Bahamian government (IFRC, 2021). In addition, policy and economic gaps remained in the households that were under-insured and lacked documentation (Marazita, 2020). Consequently, many households have relied on informal housing reconstruction using self-recovery or self-build using their resources (OHCHR, 2021). This can lead to the further exclusion of households from official financial assistance such as government programs when they rebuild their homes informally (Talbot et al., 2022).

The question still stands, how does housing quality in the Bahamas affect the creation of marine debris during TCs? In addition, how can one analyze such a complex situation? The capabilities approach is a multifaceted framework to assess the change in individuals' capabilities. With this approach, one can connect the housing impacts, sustainable development, and marine debris. Also, with this theory, one can outline and identify solutions to a lack of adequate recovery.

3 Theory

3.1 Capabilities approach to sustainable development

The capabilities approach was developed by Amartya Sen (1985, 2001, 2003) and further expanded by other scholars in political psychology, economics, social science, and humanities such as Nussbaum (1988, 2000), Robeyns (2006), Berry (2017) among others, mostly used for evaluating the multidimensional aspects of the development of societies. Both Sen and Nussbaum argue that the well-being of individuals should be defined and evaluated in terms of their capabilities. Capabilities in this context refer to the freedoms of individuals to achieve valuable functionings to lead effective lifestyles (Gardoni and Murphy, 2010). These functionings include many states of doings and beings

such as being alive, healthy, educated, adequately nourished, and having decent shelter (Sen, 2001). Capabilities can thus be used to describe an individual's assets and opportunities to achieve these functionings.

The capabilities approach to development reorients the focus from the mainstream economic approach centered on well-being as represented by income to well-being understood as freedoms or capabilities - what individuals do/are and their opportunities (Gardoni and Murphy, 2009). Contrary to utilities, capabilities do not reflect individuals' preferences, but rather their true opportunities (Sen, 2001). An individual's ability to convert a set of means into a functioning depends on certain personal, sociopolitical, and environmental conversion factors (Gardoni and Murphy, 2010). To this end, sustainable development, according to the capabilities approach, refers to the process by which individuals are empowered, and understood in terms of capabilities and functionings (Gardoni and Murphy, 2009). Further, because the capability approach focuses directly on enhancing human freedom, it pays special attention to the least well-off (Boda et al., 2022). This is because the removal of unfreedoms is viewed in the capabilities approach as both the ends and the means of development.

3.2 Capabilities approach to housing impact assessment

In this paper, housing plays an important role. It is important because deprived capabilities lead to low-quality housing which in turn increases the abundance of marine debris in geographical locations where TCs occur. Furthermore, housing is used as a conversion factor to achieve a wide variety of capabilities such as being healthy, employed, and educated. From this perspective, access to safe and adequate housing is a basic necessity thus being crucial for human survival (Boda et al., 2022). The adequacy of housing also relates to other capabilities such as living a meaningful life, having a sense of belonging, and higher self-respect among others (Coates et al., 2015). Home is where one finds rest and satisfaction (Sirgy and Cornwell, 2002), as well as promotes security and identity (Easthope, 2004). A loss of housing in this context can significantly contribute to the reduction of capabilities and increase further exclusion from achieving sustainable development. Exclusion in this perspective refers to a process that results in disadvantages and denial of opportunities for individuals due to interdependent social, economic, and power inequalities (Talbot et al., 2022). Thus, the impact of Hurricane Dorian on housing is measured in terms of changes in the individuals' capabilities, recognizing that there is a different scale of capability deprivation connected to pre-existing inequalities in capabilities such as quality housing.

The capability-based approach provides a good theoretical foundation for understanding and evaluating the societal impact of disasters and explaining why these impacts are in fact significant while quantifying the changes in individuals' capabilities (Murphy and Gardoni, 2006). Using this approach, the quality of life of individuals is defined in broader constitutive dimensions (Gardoni and Murphy, 2010). In addition to its value, the capabilities framework helps reorient the focus from economic concerns to contributions to sustainable development as an end goal instead of means (Coates et al., 2015). Contrary to mainstream utilitarian approaches, the capabilities approach allows one to see the real damage made by disasters moving beyond the life losses and monetary costs. For example, comparing damaged housing from each approach has different outcomes. From the mainstream approach, the housing damage is only seen from the economic value while the capabilities approach can capture the differences in the use and meaning for the individual. The following example illustrates this view:

> Say there are two houses of exactly the same value, both of which are destroyed by an earthquake. The first house is the primary and only house of an individual. The second house is a secondary summer house for an individual. If they are both destroyed by a hazard, the economic loss is the same. Given that there are no other losses, the monetary loss or utility in this. Example would be the same. However, the impact on the lives of the two individuals, and what they are able to do, is substantively different. (Gardoni and Murphy, 2010, p.33).

Therefore, the capabilities approach can capture both economic and social impacts. Additionally, it can capture the impacts and differences as well as individuals' capabilities. As such the consequences of the TCs are quantified and evaluated in terms of changes in capabilities (Murphy and Gardoni, 2012). Finally, the capability approach has the advantage of indicating the exact reasons for policy failures and the causal factors involved (Coates et al., 2015). For example, the capability approach can identify what within the policy failures cause the problem. In this case, deprived capabilities lead individuals to reside in low-quality housing thus increasing the probability of marine debris. The approach has the potential to suggest future mitigation strategies (Gardoni and Murphy, 2010). As such, the capabilities approach may also provide a measure of the potential mitigation of marine debris entering open waters aftermath of a disaster.

3.3 Outlining the list of capabilities

In this study, the capabilities approach is adapted from Gardoni and Murphy's (2009) previous assessment studies about the societal impact of a disaster risk analysis on the capabilities of

individuals, and so, on their well-being (Table 1). Murphy and Gardoni (2008, 2010, 2012) and Gardoni and Murphy (2009, 2010) suggest that social impacts should be based on likely changes in individuals' capabilities which are determined by their resources and what they can do with them. To that end, scholars emphasize a person's capabilities dependency on both, individuals' resources as well as the institutional environment such as physical infrastructure, norms, and legislation.

Table 1. Adapted Gardoni and Murphy's capabilities approach framework

Capability group	Capability (being able to. . .)	Indicator
Longevity	. . . live to the normal end of life	No. of individuals killed
Physical and mental health	. . . avoid injuries	No. of individuals injured
	. . . have adequate and permanent shelter	No. of individuals left homeless
	. . . have adequate nourishment	Correlated
	. . . live in a healthy environment	No. of individuals without access to water supply
Affiliation and mobility	. . . engage in forms of interaction with others	No. of individuals unemployed due to the disaster
	. . . move freely from place to place	Correlated
Command over resources	. . . hold property	Direct economic losses [$]

Table 1 illustrates the capabilities approach framework, specifically applied to the current study. The table identifies capability groups, capabilities, and corresponding indicators that are used for studying Hurricane Dorian's impacts on the communities living in the informal settlements in the Abaco Islands. From "Gauging the societal impacts of natural disasters using a capability approach", by Gardoni, P., & Murphy, C., 2010, *Disasters*, 34(3), p. 642.

This scheme developed by Gardoni, and Murphy (2010, Table 1) outlines four selected capabilities commonly impacted by disasters, (1) longevity; (2) physical and mental health; (3) affiliation and mobility; and (4) command over resources, as well as the corresponding indicators for measuring these capabilities. This study builds on this framework to assess the impacts of Hurricane Dorian. The paper refines the list of capabilities to fit the context of informal housing in the Bahamas, as is consistent with the capabilities approach's sensitivity to context.

As pointed out by Gardoni and Murphy (2009), it is impossible to *directly* measure changes to capabilities since capabilities are not quantifiable because they are substantive opportunities rather than outcomes. Therefore, the selected capabilities need to be matched with a set of indicators capable of representing each capability to indirectly measure the level an of individual's functionings in practice. Gardoni and Murphy (2010) propose the immediate consequences of a disaster such as

casualties, injuries, the destruction of homes, and access to water and food supplies among others as examples of relevant indicators for the capabilities outlined in Table 1. From these indicators, measurement of capability impacts can be quantified and combined into a common scale to create an indicator index of various capabilities. Finally, the indicator indices are combined to create the disaster impact index (DII). The DII is an index measuring the overall impact of a disaster on individuals' capabilities per capita (Gardoni and Murphy, 2009). Specifically, in this paper, the DII helps to combine views on the impacts on individuals' capabilities after Hurricane Dorian, taking into consideration the pre-existing capability deprivations as well. When selecting indicators for capabilities, Gardoni and Murphy emphasize two criteria, which include (i) being representative of the corresponding capability which refers to the tracking of the relevance of a particular capability, and (ii) being intuitively plausible which refers to the indicator's transparency and level of understanding to the public and policymakers (Gardoni and Murphy, 2010). Applying these criteria, I identified a set of indicators capable of representing the capabilities evaluated in this study, which can be summarized in Tables 3 and 4. A detailed description of how the indicators are used, scaled, and combined is provided later in the methods section.

4 Materials and methods

The capabilities approach framework is applied in the context of Hurricane Dorian in the Bahamas, particularly to the two communities living in the Mudd and Pigeons Pea informal areas, located in Marsh Harbor in central Abaco. The data development for the capability's framework was collected through the focused document analysis and interviews. The reviewed documents included formal and informal information such as academic journals, governmental and non-governmental reports, and locally and internationally written newspapers covering the impact of Hurricane Dorian in the Abaco Islands. The main limitation was access to official information due to limited data on the informal settlements in the Bahamas. This limitation was overcome by undertaking several interviews.

4.1 Document analysis

The raw data that is used to quantify the values of the indicators are primarily derived from analysis of official and unofficial documents. The approach of the analysis was used to systematically collect and synthesize previous research about the societal impacts of Hurricane Dorian. Instead of mapping every possible capability, the data collection is scoped around the capability's framework developed by Gardoni and Murphy for assessing disasters, as outlined above. It helped to identify specifically selected capabilities relevant to the case of Hurricane Dorian in the Bahamas. Thus, these data

categories allow a more focused and efficient review of the literature. Finally, the analysis extracted data from a total of 44 sources, including 6 scientific articles, 12 non-governmental reports and appeals, 5 governmental reports, and 12 locally and 9 internationally written newspaper articles covering the event. The list of documents analyzed to inform data collection is listed in Appendix A.

The exact data sources to examine the potential correlation among different indicators included The International Federation of Red Cross and Red Crescent Societies, Internal Displacement Monitoring Center, Inter-American Development Bank, UN-Habitat appeals, and reports. Governmental data sources included statistics from the latest years such as human rights and shantytown reports. Since the Mudd and Pigeons Pea informal settlements are not broadly discussed in the scientific literature, the existing literature gaps were filled with a variety of local newspapers such as the Tribune, and The Nassau Guardian. In addition, other international newspapers such as The Guardian and Conventional were used to support data collection. These data sources were selected to reflect a broad range of literature written on the issue. Hence, diversity contributes to the research validity. In addition, to contribute to the research reliability, all the selected documents are available to a large segment of the world's population on the internet or publicly through the Lund university's library base.

4.2 Interviews

Interviews were conducted to support certain aspects that could not be studied through the document analysis. Interviews were carried out in a semi-structured way. That is to say, certain questions were sent before the interviews, while the rest of the questions were not planned. As a result, open interviews allowed respondents and an interviewee to bring new ideas during the interview which in return revealed a wider perspective on how respondents understand and frame issues of interest (Bryman, 2008). Finally, interview questions were based on the identified capabilities and their indicators.

In total five interviews were carried out to close gaps in the required data. The purposive sampling approach and so personal judgment was applied to select informants. This approach improves the rigor of a study and ensures the integrity of its data thus resulting in a more accurate matching of the selected to the aims and objectives of the study (Bernard et al., 2016). To that end, the choice of interviewees was based on their knowledge and expertise in the field of informal housing, marine debris, local communities in the Abaco Islands, general understanding of the Bahamas, and their personal experiences of Hurricane Dorian during the actual event and the recovery stage. The first interview was held with the IDEA Relief (Immediate Disaster and Emergency Assistance)

representative - Jim Richard who is a chief operations officer, mainly working with the Hurricane Dorian marine debris removal procedures. Interviewee 2 - Lianna Burrows is an outreach coordinator at the local NGO - Friends of the Environment, working with the local communities by bringing knowledge about the environment through education to the young people living in the Bahamas. Interviewee 3 - Kristal Ambrose - founder and director of a local NGO - Bahamas Plastic Movement and a Ph.D. student within the marine debris field. Interviewee 4 - O'Neal Ambrose is a building inspector at the Ministry of the Bahamas. Interviewee 5 - Leanne Russel - local artist and a cultural worker in the Abaco Islands. The final list of interview transcripts is listed in Appendix B.

Many other invitations for interviews were sent to different governmental agencies and other representatives such as journalists from the local newspapers who have been writing about the shantytown's situation in the central Abaco Islands. The contacted government agencies included the Bahamas Disaster Reconstruction Authority, Bahamas Ministry of Public Services, Bahamas Ministry of Economic Affairs, and Bahamas Insurance Association among others. Unfortunately, none of these contacted entities responded to the invitations. That may be due to sensitive topics such as the Haitian situation and the informal housing in the Bahamas. Nevertheless, the conducted interviews have been valuable in understanding and further exploring the research topic.

4.3 Data construction

The DII, in this paper, is a summary measure of change in capabilities to assess the societal impact of the Mudd and Pigeons Peas informal communities caused by Hurricane Dorian in the Bahamas. The construction process of the DII is modeled on the United Nations framework that is used to calculate the Human Development Index (Fig. 3) while using Gardoni and Murphy's capabilities approach adjusted to the disaster assessment. The following discusses in detail undertaken steps in constructing and calculating the DII.

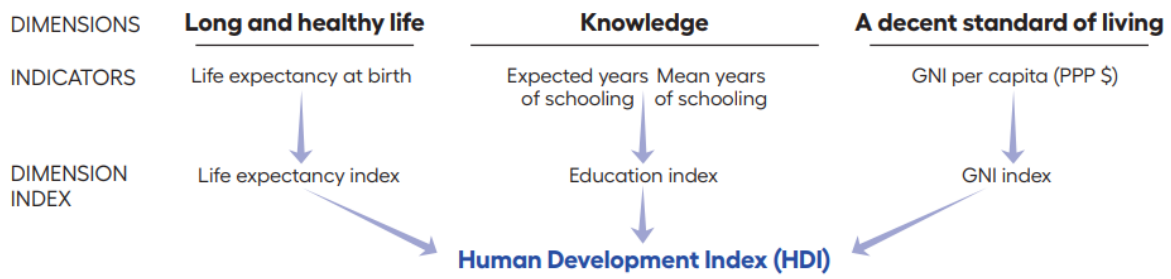

Figure 3. This figure illustrates the Human Development Index framework that this study uses to explain the process and steps of constructing the DII. From, "HDR Technical Notes 2020", by UNDP 2020b.

To start with, the relevant capability groups linked to indicators were selected based on Gardoni and Murphy's (2010) capability approach framework (Tables 3 and 4). These capability groups and their corresponding indicators include (1) longevity; (2) physical and mental health; (3) affiliation and mobility (see Table 1). Note that the capability group - command over resources that corresponds to the ability to hold property is not included in this paper because by definition informal housing is not officially property. That is, individuals living in the informal settlements have no possibility of holding property officially (UN-Habitat, 2016), and therefore all individuals in an informal settlement can be assumed to have negligible command over resources. Instead, the indicators of "adequate housing" and "left homeless" are used to capture the housing dimension in these communities.

Before moving to the DII calculation section, it is important to mention that data collection to evaluate societal impact, pre-and post-Hurricane Dorian, were measured using both qualitative and quantitative data. This is due to the limited quantitative data on the Mudd and Pigeons Pea settlements. For instance, there was limited data considering the unemployment aftermath of the disaster. However, a large amount of textual data stated that many businesses were closed due to disaster thus causing a high level of unemployment (Rolle, 2020; Deopersad et al., 2022). As a result, the qualitative data has been marked as *low* and *high* (indexed as 0 and 1, respectively), depending on the statements in the textual data. Hence, mixed-method research was applied to identify the maximum and actual posts of each indicator.

After indicating data, the maximum and actual posts were selected for each indicator (Table 2). In this way, the maximum post data refers to the maximum possible outcome while the actual posts refer to the actual measured/observed state. To understand the significance of consequences, the actual indicator value was indexed in relation to the maximum possible post of each indicator.

Table 2. Maximum and actual posts for calculating the indicator indices aftermath of Hurricane Dorian

Indicator	Maximum post	Actual post
No. of individuals killed	2971	56
No. of individuals injured	2971	265
No. of individuals left homeless	2971	2971
No. of individuals without access to the water supply	2971	2971
No. of businesses closed due to disaster	High	High

Note. Table 2 illustrates the maximum and actual posts for calculating the indicator indices aftermath of Hurricane Dorian. Author's own compilation.

In this table, the maximum post numbers represent the official number of total size of the Mudd and the Pigeons Pea population, thus accounting for 2971 people in total. As mentioned above, qualitative data was measured in words as *low* and *high*. In some cases, the numerical data in the literature has been converted from percentages to numerical quantitative data. For example, finding several individuals being left homeless, the total population of both settlements which includes 2971 people was combined with an official report which stated that informal settlements faced catastrophic damage in 100% of the houses (Deopersad et al., 2020). As a result, the number of individuals being left homeless accounts for 2971 people.

The next step included transforming the maximum and actual posts expressed in different units into indices between 0 and 1. This process refers to the normalizing the values of each indicator into a common scale (index) thus making the qualitative and quantitative data comparable with a common metric (Gardoni and Murphy, 2010). In other words, the collected value for each indicator was converted into a common scale to understand the whole picture of the societal impact of Hurricane Dorian, as determined by the impact of a variety of capabilities. The scale was ranked such that, 0 represents no changes in capabilities, 0.5 indicates medium changes in capabilities, and 1 represents maximum changes in capabilities in the aftermath of the event. Both qualitative and quantitative data were applied to the common scale. Scaling, thus, makes it possible to combine various types of selected data into a comparable index (Gardoni and Murphy, 2010).

4.3.1 Calculating Disaster Impact Index

Having defined the maximum and minimum posts, the dimension indexes were calculated as follows:

$$\text{Dimension index} = \frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

This equation was applied to each indicator, based on their minimum and maximum values. Table 3 represents the indexes results between 0 and 1, calculated according to the formula. Note, that calculated values are rounded. This calculation method was mainly applied to the quantitative data. Qualitative data was transformed into indices in closer relation to the common scale measurements, in turn, resulting in numbers such as 0, 0.5, and 1.

Table 3. Calculated indicators indexes

Indicator	Maximum post	Actual post	Index
No. of individuals killed	2971	56	0.02
No. of individuals injured	2971	265	0.09
No. of individuals left homeless	2971	2971	1
No. of individuals without access to the water supply	2971	2971	1
No. of businesses closed due to disaster	High	High	1

Note that table 3 illustrates calculated indicators' indexes for the after-Hurricane Dorian. Author's own compilation.

To compare change and understand the general impact on individuals' capabilities, the Table 4 represents the calculations of the pre-existing socioeconomic impacts before Hurricane Dorian. The calculations applied the same construction and calculation logic as the previous table. Naturally, the indicators were slightly different than measuring the impact after a disaster. However, selected indicators followed the same relevancy of the capability groups to make both tables comparable.

Table 4. Outlined indicators and calculated indexes for the pre-existing vulnerabilities

Indicator	Maximum post	Actual post	Index
Life expectancy	85	70	0.7
No. of disabilities	2971	Low	0
No. of inadequate housing	2971	2971	1
No. of access to water	2971	2014	0.7
No. of households employed	2971	2169	0.7

Note. Table 4 lists indicators and their calculated indexes before Hurricane Dorian. Author's own compilation.

In Table 4, the maximum post numbers represent the official size of the Mudd and Pigeons Pea population. The calculation of life expectancy was a bit different. Instead of placing the minimum number of 0 years for life expectancy, the number 20 was used in the equation to count the indicator's index. The justification for placing the minimum number as 20 for life expectancy is based on the historical evidence that no country in early-modern times had a life expectancy of fewer than 20 years (UNDP, 2020b). Maximum life expectancy is set at 85 – an aspirational target for many countries, number 70 represents a number that represents official Bahamian life expectancy number.

Having identified the indicators' indexes, the last step of calculating the DII was performed using the following equation:

$$\text{Disaster impact index (DII)} = \frac{\left(\frac{\text{total number of indexes}}{\text{total number of capabilities}}\right)}{P}$$

To uncover a full understanding of Hurricane Dorian's impact on the chosen case study, the following calculation included the size of the Mudd and Pigeons Pea population size. Gardoni and Murphy (2010) emphasize that the actual impact of a disaster varies based on the size of society. For instance, the Abaco and Nassau Islands in the Bahamas have different sizes populations so a disaster with identical economic losses has a different impact on the Abaco than Nassau Islands. Other examples can include the comparison of different countries, regions, and sub-groups of population among others. The p represents the number of individuals living in the Mudd and Pigeons Pea informal settlements that share the burden of impacts of disaster.

4.3.2 Weighting indicator indices

Although the capabilities approach allows the weighting of different indicator indices, this study chooses not to do so. Instead, this study views all indicators as having equal weight. The main reason for this decision is that capabilities cannot be substituted with one another because each of them is very different (Gardoni and Murphy, 2010). For instance, no affiliation and mobility can compensate the lack of physical and mental health such as having adequate housing and vice versa. To that end, because they represent different dimensions, there is no reason to assign different weights to each index since a substitution cannot be assumed between them (Gardoni and Murphy, 2009).

5 Results

5.1 Overview of impact on capabilities

Results indicate that the Mudd and Pigeons Pea informal settlements are residential areas where individuals do not have access to adequate housing and have limited access to basic services and city infrastructure. Informal housing does not comply with the building code regulations and is situated in the geographically and environmentally sensitive areas in Marsh Harbor. Calculating the disaster impact index and pre-existing capabilities index, the results are as follows. The DII accounts for 0.000209 while the pre-existing capabilities account for 0.000208. Each of these numbers represents the capability per documented individual living in the Mudd and Pigeons Pea settlements. These

numbers indicate no significant difference between pre and post individuals capabilities living in the informal settlements. However, rather than indicating little impact, these results show that both communities were in a severely capability-deprived state before Hurricane Dorian, which left little room for a further decrease in capabilities occurring after the event.

5.1.1 Longevity

The selected dimension - longevity represents individuals' capability of living their life to the normal length (Boakye et al., 2022). Deaths occurring during the TCs are the consequences that change this capability. The results of the longevity index of 0.02 indicate a low impact on the capability to live a normal end of life. Nevertheless, 56 people were deprived of the capability of living a long life. However, even before the hurricane, an index of 0.7 shows that the ability to live a normal end of life was somewhat reduced. A realistic maximum aspirational target for many countries is set at 85 years (UNDP, 2020b). However, data shows that life expectancy in the Bahamas is estimated to be 70+ (Moxey, 2018). This can be linked to the issues that the Bahamas face, as shown in the early pre-hurricane indexes (Table 4). Further, it is important to note that the number of 56 people being killed in the Abaco islands refers to the estimates of the official data. Local newspapers, informants, and other international bodies reported that undocumented Haitians living in the Mudd, and Pigeons Pea settlements may not have been accounted for in the official death data because their residency was not formally registered with the authorities (Deopersad et al., 2020). UN-Habitat (2020) report estimated dozens to be dead remaining under the rubble in shantytowns, however, the exact number was not provided due to similar reasons. Other sources list more than 1,300 people being killed that is officially unaccounted for while many more are injured (Doods, 2019). All the interviewees confirmed that the number of 56 is vastly understated, guessing that the number of deaths might be around 1000 deaths. This would significantly change the indicator's index and thus affect the DII number. Aftermath Hurricane Dorian, people living in the informal settlements were affected by the fear of repercussions for their irregular status thus fearing deportation (Marazita, 2020).

5.1.2 Physical and mental health

Physical and mental health included capabilities such as avoidance of injuries, being adequality sheltered, nourished, and living in a healthy environment. The index of 1 shows that all these capabilities experienced the aftermath of the maximum changes in the event (Table 3). Analysis reveals a catastrophic failure in 100% of the houses in Mudd and Pigeons Pea informal settlements.

That means that 2971 people living in the 644 households, as reported in the Shanty Towns report 2018, lost their homes (Moxey, 2018). According to the official data, 85 % of the Haitian population coming from these settlements were displaced (Deopersad et al., 2020). After the hurricane, the government declared a ban on rebuilding shantytowns in the Marsh Harbor (Russel, 2019) which were later demolished by the Bahamas government (Rolle, 2020). As a result, migrant communities were displaced to other smaller shantytown communities in the North of Abaco. Many households relied on reconstructing using informal means, and resources to return to daily life as quickly as possible (Rolle, 2020).

The results of the capability to an adequate housing before Hurricane Dorian indicates the maximum impact being measured by number 1. The majority of households in the Mudd and Pigeons Pea settlements had vulnerable housing infrastructure before Dorian (de Bruijn et al. 2020). In this case, individuals' capability of living in a healthy environment was deprived before the hurricane. Households were built with poor construction equipment and materials in low-lying areas that are prone to frequent flooding (EEC, 2019). Hence, no housing regulations, building codes, or any type of insurance were applied to these households (Kijewski-Correa et al 2021).

Further, the number of individuals being injured resulted in an index number of 0.09. The index compared to the scale between 0 and 1 is relatively low. The injuries mainly included skin infections, dehydration, minor trauma, wounds, and lacerations, as well as mental and psychological traumas (Deopersad et al., 2020). These injuries disabled 265 people to reach other capabilities such as being healthy because of the injuries they sustained. Similar to the data on the number of deaths, the official data on individuals being injured may lack sufficient information due to unregistered residents and hiding people from threats of being deported (UN-Habitat, 2020). Thus, access to adequate data may change the results for this indicator.

The indicator measuring access to water and food shows the indices of 1 – a maximum impact of the Hurricane Dorian on the informal communities. Wells in the Mudd and Pigeons Pea settlements were flooded with ocean water (IMO-UN, 2019), leaving 2971 people without safe water for drinking and hygiene (RNAT, 2019). Thus LIana (2019) writes, that two months after the hazard, informal settlements still had no access to clean water. Access to food was limited as well (RNAT, 2019). Index for prior Hurricane result in 0.7. According to official data, 67.6% of people had access to hand-pump well water (Moxey, 2018), however, the quality of the water is unknown. None of the shantytown households have access to the city water (Dodds, 2019). Deliberately, poor housing conditions and living environment are generally interlinked to mental ill-health (Shultz, et al., 2020).

Discrimination and violence can also increase an individual's physical and mental health issues. People living in the Mudd, and Pigeons Pea settlements have long faced discrimination, stigmatization, and violence thus being strained from full participation in society by the Bahamas government (Fielding et al., 2008; Knowles, 2018; Louis, 2019). The existing legal system alienates people living in informal settlements. For example, informal communities do not have any protection under local laws regarding housing, labor, and health, among others (Immigration and Refugee Board of Canada Report, 2012). This is due to the irregular and weak citizenship status (GoB, 2020b). Since 2014, the Bahamas started requiring passports leading to an increase in deportation raids. Although certain rights of irregular migrants are being protected under international conventions, informal communities often fail to provide official documentation to secure legal residency status (Dodds, 2019). As such communities are not secure against violent assaults either (IOM-UN, 2019). As a result, people living in the informal settlements largely remain a distinct community. Thus, this exclusion directly influences disaster response processes.

The chaotic aftermath of Hurricane Dorian has intensified violence and discrimination regarding the informal communities. The Bahamas government soon after the devastating hurricane started the deportation process of illegal immigrants (Jones et al., 2019). Within the first two weeks, around 340 Haitian migrant workers have been deported (Louis, 2019). Moreover, increasing hate speech was recorded on social media shared by Bahamians calling Haitians "thugs" and requiring them to be "shot in the head" in case of any crime they commit (Louis, 2019). In addition, IFRC (2019) reported increased violence and discrimination against women. On top of that, many people fleeing their homes lost all of their documents (IOM-UN, 2019). This has increased the fear of being deported. These widely held exclusions strain the informal communities from the right to health care and adequate housing among other social services systems.

5.1.3 Affiliation and mobility

Capability group of affiliation and mobility before and post Hurricane Dorian was measured primarily in financial aspects such as employment opportunities. The ability to move freely from place to place was also taken into consideration. The employment indicator's index of 0.7 revealed a relatively high number of people being employed before the event. However, it is important to mention that almost half of the households, accounting for 45.3%, only had one person per household working. Note that around four people are officially estimated to live in one household (Moxey, 2018). Additionally, more than half, 61.7% of these households report earning the minimum wage of $5.25

an hour or less (Louis, 2019). As a result, the poverty rate amongst Haitian nationals is much higher than the national average (UN-Habitat, 2020).

Further, the post-Hurricane Dorian calculated affiliation and capability index of 1 indicates the maximum impact. The productive sector suffered damage mainly in tourism, followed by commerce, fisheries, and agriculture sectors. Abaco islands accounted for 83.8% of those losses (Deopersad et al., 2020). All these sectors are primarily employees of the individuals living in the Mudd and Pigeons Pea settlements (Louis, 2019). As a result, a great number of the people employed in these sectors experienced a loss of employment resulting in a loss in income (Deopersad et al., 2020). The Abaco Islands' commerce was estimated to recover within the full three years (Hori et al., 2020). Thus, the change in the capability of being employed has been highly affected.

Mobility refers to the ability to move freely from place to place (Boakye et al., 2022). The indexes of mobility correlate to the number of individuals being unemployed due to disaster (Gardoni and Murphy, 2010). Many migrant workers were unable to move freely because of government barriers in the Bahamas. They could either choose to stay in risky areas or risk losing their legal status, arrest, and deportation (Marazita, 2020). After Hurricane Dorian, the strains on mobility increased. For example, the movements between different islands' borders were controlled where the documentation was required (Marazita, 2020). Many Haitian migrants lack documentation while others lost their papers during the event (Russel, 2019). On top of that, harbor and road infrastructure including vehicles was seriously damaged (Deopersad et al., 2020). This has increased the restrictions on individuals' mobility.

5.2 Major differences between pre-and post-storm capabilities

The DII indicates no significant impact on capabilities. This is because the capabilities were already deprived before Hurricane Dorian. This indicates that already poor situation got worse. These deprived capabilities of individuals are the result of people residing in the vulnerable housing which suggests the need for addressing these underlying capability issues to solve the informal housing problem and thus the marine debris. Tables 3 and 4 list capabilities, their indicators, and calculated indexes. The major differences between pre-and post-hurricane capabilities were indicated in the capability groups such as physical and mental health and affiliation and mobility. Thus, the capabilities to be able to have adequate and permanent shelter, live in a healthy environment, and engage in forms of interaction with others, indicated the major differences. For example, housing experienced catastrophic damage leaving all the individuals from the Mudd and Pigeons Pea

informal settlements homeless and displaced. The results also indicate that the recovery back to the same state as before Dorian is inadequate. Contrary, the focus should be on the development and therefore enhancement of individuals' capabilities. This type of development provides a context where people will not be vulnerable after a hurricane. As a result, increased capabilities thus mitigate marine debris. These ideas will be further expanded in the discussion section.

6 Discussion

The results show the importance of capabilities indicators, longevity, mental and physical health, affiliation, and mobility. With these indicators, one can determine the cause and prevention of marine debris. To that end, the results suggest that informal housing in the Bahamas is itself the result of the deprived capabilities of individuals from specific ethnic groups. The capabilities approach together with the results can then be used as a baseline to identify challenges and solutions to mitigate marine debris. To negate deprived capabilities and thus marine debris, four areas for policy improvement have been identified. First, is a negative circle where capabilities are not improved after a TC. They are only restored. Second, is the importance of enhancing capabilities. Third, the challenges, and final, possible solutions to develop more sustainable communities in the Bahamas.

Capabilities analysis after Dorian showed an increase in impacts on individuals' well-being. People were left homeless, without access to food and fresh water or any other assistance. On top of that, in the immediate aftermath of Dorian, the Bahamas government began deportations, making people hide, and started the housing demolishing process of what was left in both settlements (Rolle, 2020). This has challenged and prolonged the post-disaster recovery process thus leading many households to rely on informal housing reconstruction by using their resources and efforts (Jones et al., 2019). This highlights the need for a post-disaster recovery process that targets the underlying causes of informal housing if the major source of marine debris is going to be reduced.

6.1 A negative circle

The study shows that the destruction from Hurricane Dorian is a result of human decision-making that disproportionately affected the least well-off communities. The results show that there exist structural inequalities in the Bahamas. These inequalities are a result of historical and current discrimination. As a consequence, the inequalities can be seen in the recovery stage through imbalances (von Meding et al., 2019). In this context, each component of a disaster - vulnerability,

preparedness, response, and rebuilding involves a certain degree of social calculus (Steinberg, 2000; Ahmann, 2018). Consequently, determining who fully recovers is also linked to human decisions (Kelman, 2020). In this paper, this implies the development strategy applied by the Bahamas government.

To effectively mitigate TC marine debris, it is important to take into consideration the socioeconomic vulnerabilities, processes that produce these vulnerabilities, and how catastrophic events such as hurricanes exacerbate existing inequalities. For example, this study demonstrated how pre-existing vulnerabilities caused many Haitian immigrants to build informal housing, and how the same vulnerabilities got increased by the hurricane thus resulting in huge amounts of marine debris as well as wide-spread social impacts. The Bahamas recovery approach threatened deportation and demolished the Mudd and Pigeons Pea settlements. Given the poor economic conditions, demolition has proved unsustainable, since it intensified informal housing construction in other parts of the Abaco Islands using self-rebuild (Rolle, 2020). Self-rebuilding of informal housing poses the risk of perpetuating disaster vulnerability due to unsafe locations, and a lack of safety measures (Talbot et al., 2022). This shows that neglect of the capabilities of the informal community will not solve the problem. Instead, the problem will just be created elsewhere. Such patterns represent a negative circle that drawback both the Bahamas and excluded communities to reach sustainable development and secure the prevention mechanism of marine debris entering open waters.

6.2 Enhancing capabilities in the recovery process

Damage from Hurricane Dorian presents opportunities to rebuild and enhance capabilities to better standards (Boakye et al., 2020). For example, individuals from informal settlements could be allowed to rebuild better infrastructure on better land. In this case, the number of people without access to adequate housing could be reduced. In return, it would also improve other individuals' opportunities since housing is an important conversion factor to achieve a wide variety of other capabilities such as being healthy, employed, and educated (Gardoni and Murphy, 2010). In this context, reducing informal settlements' vulnerabilities means improving the capabilities which the individuals then can use to improve their living conditions. Ultimately, the goal of capabilities improvement presents an ability to be effective in strengthening communities' resilience to extreme climate events and thus can have a strong impact on marine debris governance policies.

Continuing with the enhancement of capabilities in the context of the housing sector in the informal

settlements, the Bahamas government could benefit by addressing physical vulnerability with improved social policies regarding the Haitian community such as increasing compliance with building codes for low-income housing, providing basic infrastructure before settlements are built (Kachenje, 2020), readjusting land rights policies (Durand-Lasserve and Selod, 2007; Collier et al., 2018); transforming response strategies from demolition to regularization (De Soto, 2000); and integrating informal settlements into the formal society and its economy (UN-Habitat, 2016; Hermanson, 2016). All of the listed options require recognition and inclusion of the informal settlements by the Bahamas government. Additional financial resources could address these options as well.

6.3 Challenges

The effectiveness of new strategies is influenced by a range of factors such as weak governance, economic vulnerability, low-paid work, marginalization, and lack of affordable housing among others that affect the well-being of individuals living in informal settlements. In addition, a range of economic, legal, and cultural conditions play a significant role in determining access to mitigation, preparedness, and response programs.

The social exclusion of Haitian migrants from the mainstream Bahamian society represents a challenge. This research showed that informal communities are “invisible” and therefore not integrated into the Bahamas context. Shantytown populations are excluded from broader society’s systems, have no rights in political participation, and fear discrimination, hostility, and injustice by the Bahamian authorities (van Meding et al., 2019; Louis, 2019). This neglect is directly undermining the sustainable development and prosperity of the residents living in the informal settlements in the Abaco Islands. Informal housing in this case is an outcome of the deprived capabilities of the Haitian migrants in the Bahamas. Further, marginalization is a challenge in addressing the informal housing sector (Kachenje, 2020). Living in informal settlements disproportionately and adversely affects Haitian migrants, simply by their ethnicity. Informal settlements in the Bahamas are located in the riskiest areas such as flood-prone zones (Deopersad et al., 2020). Since there are no alternatives for residents who live in these informal areas, they face a continually life-threatening situation. In addition, climate change exacerbates informal settlement vulnerabilities (Kijewski-Correa et al., 2021; Talbot et al., 2022).

Even if Haitian migrants were included, data availability on informal settlements presents another

challenge in building sustainable communities that need to be improved. Currently, accurate qualitative and quantitative data on informal housing in the Bahamas is inadequate. Therefore, it is difficult to monitor where and how many informal settlements are located, and what are the exact living conditions in these settlements among others. As such, it is difficult to draw a comprehensive picture of informal communities. This creates a gap in knowledge about informal settlements which in turn challenges the planning of the policies and affects the quality and efficiency of disaster management decisions (Jayawardene et al., 2021).

Finally, funding is one of the major challenges in implementing affordable housing projects in developing countries (Kachenje, 2020). The Bahamas government's housing finance options are limited, and the government is avoiding a direct role in the provision of the informal housing sector. Especially for the Haitian migrants living in informal settlements, community-based finances are disconnected from the mainstream financial support, despite playing a crucial role for informal settlements to engage in savings to afford better-quality housing. On top of that, post-Hurricane Dorian housing market suffers from the decline of affordable housing thus further increasing the housing inequalities in the Bahamas (Shelter Cluster, 2021). As a result, the private sector's interest dominates the housing market. This needs to be considered and planned to ensure long-term inclusive financial investments.

6.4 Policy implications

Since the 1950s Haitian migrants have been residing in the Bahamas for better employment and life opportunities (Knowles, 2018). Although the Bahamas government tries to restrict the migrant flow with rules and threats of deportation, the Haitian-Bahamian community continues to grow, currently accounting for about 25% of the Bahamas population (Louis, 2019). Due to deprived capabilities, these Haitian groups reside in informal settlements thus further expanding social vulnerabilities. Therefore, there is still a need to address the current policies and their implications for informal settlements.

Looking at the social dimensions as one of the main factors of increased marine debris, disaster planners and recovery practitioners, as well as researchers in this area, need a framework capable of conceptualizing and measuring the causes of informal housing and thus marine debris. The capabilities approach framework to development demonstrates how one can effectively evaluate and draw a wider picture of the impacts of a communities well-being, as well as their sensitivity to

disaster (Gardoni and Murphy, 2010). In addition, the framework allows one to quantify the effect of Hurricane Dorian and account for inequalities present before and after the event. Policymakers should focus their attention on the development of communities of low capabilities. Long-term this type of policy will create a more sustainable region where marine debris is a low-income factor of sustainable development. To that end, policymakers can develop inclusive disaster and climate resilience mechanisms by enhancing individuals' capabilities in the recovery process.

Recognition of informal settlements and integration of people is necessary to open many more possibilities for people living in these areas to enhance their capabilities (UN-Habitat, 2016). That is to say, the treatment of the individuals living in the informal settlements should be elevated, and so their contributions such as work, livelihood, and taxes are recognized, just as their rights to adequate housing. Pivotal to recognizing the needs of individuals living in informal settlements are the policies and strategies of city governments (Kachenje, 2020). The recognition, from this perspective, should be taken by the Bahamas government through newly adopted rights-based policies. These new policies could include a more flexible land procurement strategies and alternative arrangements for securing land for people living in informal settlements (Collier et al., 2018). Recognition of informal settlements through the new land arrangements, in turn, could increase individual security by ensuring a long-term perspective and thus incentivizing residents to invest their resources in higher quality housing (Kachenje, 2020). The Bahamas government can gain from it as well. For example, through recognition of informal settlements, tax collection is made possible (Najum and Babere, 2020). In turn, collection of taxes can increase the Bahamas government's capital and thus capital to improve sustainability.

This study has highlighted a lack of data on informal settlements in the Bahamas as one of the challenges in dealing with housing informality and thus marine debris. Qualitative and quantitative data collection is needed to understand informal settlements in a more accessible manner. Data collection could benefit from including participatory, robust, and standardized approaches. That could be achieved, for example, by engaging community involvement in mapping the informal settlements, and participatory sessions. Taking into consideration the current governmental approach to informal settlements, the engagement and thus participatory sessions of the communities could be assigned to the local or international non-governmental organizations. Local statistics collection should be improved by different entities of the Bahamas government. After collecting data on informal settlements, data should be standardized to capture a comprehensive,

up-to-date picture of the informal communities (UN-Habitat, 2016). In this case, it will be easier through capabilities analysis to compare and understand the real and long-term inclusive picture of the informal settlements living situation. For example, the data compiled in Table 3 was constructed through official data. However, informants and NGOs differ in their evaluation of the people being killed. This can give an inaccurate capabilities analysis of the DII. Therefore, improved and standardized data is vital to monitor development. This can inform a capabilities-based vulnerability index which identifies deprived areas and thus facilitates the prevention and mitigation of possible TC impacts, which in turn will help reduce the quantity of marine debris when TC does hit.

Funding is one of the instruments that could reduce social vulnerabilities in informal settlements. To that end, major financial institutions can be encouraged to provide financial support for the most vulnerable communities, possibly coming from local and international climate-related funds. Additionally, the Bahamas government could improve informal communities living environment by other resources such as workforce and equipment that are available to the government. Other international and private investments are also vital. For example, local and international NGOs could contribute with both financial and other resources such as materials, volunteer labor, and knowledge as well. Additionally, both government, NGOs, and informal communities could partner with their resources and funds to work together. For example, the state might have the finances for in primary stages of construction, NGOs might have funds and knowledge to construct stable houses, while local communities might be employed to build the houses. However, for these options to be viable solutions, the Bahamas government should recognize the informal settlements.

7 Conclusion

This study has been primarily interested in the marine debris caused by TCs. To contribute to the field of marine debris research, the special focus of this paper was set on the relationship between marine debris, sustainable development, and housing. This study applied the capabilities approach theory, adapted from Gardoni, and Murphy's (2010) previous research on natural disasters. The capabilities approach theory was used to identify the change in individuals capabilities living in the Mudd and Pigeons Pea informal settlements in the Abaco Islands, Bahamas.

The calculations indicated no significant difference between pre and post Hurricane Dorian individuals capabilities living in the informal settlements. However, rather than indicating little impact, the results suggested that many of these capabilities were already deprived before Dorian, which left little room for a further decrease in capabilities occurring after the event. These deprived

capabilities are the result of people residing in informal housing, which suggests the need to address these underlying capabilities to solve the housing informality and thus marine debris. The example of informal housing, Hurricane Dorian, and capabilities analysis has provided important information which policymakers can consider when developing new strategies to mitigate marine debris. Areas policymakers need to consider are recognition and integration of informal settlements, improved access to the data, and funding allocation.

As to future research, this study calls for more attention to informal settlements since they are one of the major drivers of marine debris. Within the Bahamas, it would be of great importance to go in-depth into other informal settlements. Expanding the scope to other areas, regions, and even countries could bring a new light on the marine debris issue and its causes. Moreover, there are different types of capabilities frameworks. That is to say, the use of other frameworks could expand and focus the understanding of the marine debris issue. Even though there is still much to do, there is still light at the end of the tunnel.

8 References

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9 Appendices

Appendix A. List of data sources for capabilities approach framework

Local newspapers:

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Appendix B. Interview transcripts

Interview 1

Interview date: 2022, April 26

Jim Richard - Chief Operations Officer at IDEA (Immediate disaster and emergency assistance)

Introduction: So, I have lived in Abaco since 2000 in Cooperstown and then Marsh Harbor. I have been in the Bahamas for 25 years, but I grew up in Michigan in the US. I have been in education in the Bahamas for most of that time teaching and being the principal. After Hurricane Dorian, I transitioned out of teaching because all of the schools were destroyed. I have been working in disaster relief. Currently, I work with IDEA relief, which is in the recovery phase of Dorian. We have a team right now that is just literally removing marine debris from the different harbors and mangrove areas and wetlands. So that's what we're doing currently, we're also preparing for the next hurricane season. So, we do a lot of training courses in first aid and disaster response. And also, I do a lot of grant writing for outfitting persons with kits for first aid kits and emergency response kits. And then this fall, I should get back into education. And of course, I'm trying to find a way to stay with IDEA relief and teach and do both at the same time. So that's me in a nutshell.

1. Societal ties: What were the societal ties among individuals living in the Mudd and Pigeons Pea areas before and after Hurricane Dorian?

I think the most important thing to realize is that these communities don't exist anymore. So, the Mudd and the Peas are just fenced off - empty spaces. Most of the persons that survived the storm have moved and rebuilt in other locations. So, it's, it's very different now than it was before the storm. Before the storm, I think it was very, it's a very fluid community, but people coming and going. It's not stable. But I think the people that are there because they have that bond, that most of them come from one specific part of Haiti. They have that culture and the language in common. I think that you know, they do support each other. They go to the same churches. I think there's a lot of support. And I think that that happened right up to the storm. But it may be different after the storm.

1.1 Follow-up question: Where did displaced people move to rebuild their houses?

Would say almost all of them stayed in Abaco. They started to rebuild informal communities just outside of marsh harbor. Particularly men, I think, you know, there's a lot of men that have different construction jobs for the rebuild. A lot of families stayed but a lot of new young Bahamian Haitian men moved into new houses.

1.2 Follow-up question: What has been done with the demolished Mudd and Pigeons Pea areas?

Right now, there's nothing there. It is just a fenced-off space. They're putting a memorial there for the persons that died. There are all sorts of rumors you hear. For example, the Chinese are going to put in a waterpark. The location is right in the middle of town, literally. But right. It's three years later, and nothing has happened.

1.3 Follow-up question: Where are new informal settlements located?

New informal settlements are built in the north, along the highway on both sides. They call it a New Place or New Town or the New Mudd. It is rapidly growing, and it is easily visible from the highway. The government isn't doing anything about it.

1.4 Follow-up question: What is the situation of land/house ownerships, building codes appliances, and house insurance in the informal settlements?

They're never worried about building codes and insurance. In the Bahamas, very few people have insurance. And the persons that do have insurance are because they have a mortgage with the bank. The mortgage and the bank require them to have insurance, but not a lot of regular Bahamians have it. Even the houses that have been built with a hurricane building code, do not have insurance. Very cost prohibitive.

2. According to official statistics, the number of official deaths reached up to 56 people while injuries accounted for around 300 people. Do you know whether the number of killings and injuries have been different in the informal settlements?

There’s no real number. The number of 56 I think is vastly understated. It probably is in the hundreds, I don't think the 1000s of people died, but it may be close to 1000. And the vast majority of those are going to be undocumented persons. That is because they weren't documented. We'll just never know.

3. How many people approximately live in one household?

I don't think anyone knows the answer. I think the national average is four. That's what we estimated for the National Food task force after the storms. I think the number of people living in these households is probably higher than that. I don't know how you would ever estimate. And you know, because there are so many single men here now, maybe four is a good average.

4. Access to safe water. What was the situation before and after Hurricane Dorian?

I don't think there's any running water. There may be hand pumps. But I don't know how deep the wells are. I don't know-how, you know, if everyone has an open cesspit, I don't know how clean that water is. I guess I would assume they had them in the Mudd. But the Mudd is below sea level and right next to the ocean. So yeah, I doubt it.

5. Access to adequate housing: What was the situation before and after Hurricane Dorian?

So, I mean, I'm sitting here looking at a construction site. I see there is leftover wood. They'll carry it home, I see people walking past my house, you know, a two by four by 16 on their shoulder, we're doing marine debris removal. And if they find windows in boats that are still good, like, they save every window for their house. So they are kind of put together with scraps. But the interesting difference after the storm is you just have a lot of NGOs that work directly with churches. And so there were a lot of people that are in much better housing now than they were in, in those informal communities before the storm. A lot of the Haitian pastors worked for the NGOs to get help from their parishioners for the people in their church. And so you find that even in my subdivision, which is primarily Bahamian, there's a lot more young Haitian families that have been able to build and have been able to put up metal roofs because the pastor's going to bat for them with the NGOs. So a lot of people are in more stable housing and more secure housing than they were before the storm.

5.1 Follow-up question: What was the role of the government and NGOs in strengthening housing infrastructure?

Not the government. NGOs. And a lot of the NGOs are faith-based. They're Christian. And so they chose only to work with pastors. So if you didn't have a letter, if you didn't have a letter from your pastor, if you didn't attend church, you kind of out of the loop, but the Haitian community looks out for each other. And so those pastors, you know, they really, they found a way to use that to help their community. However, it upsets Bahamians, because in a lot of cases they're building on land that's not theirs. They're building informal settlements. But you know, these NGOs are coming in and building them nice structures.

6. Employment: When did the first business open aftermath, Dorian? Is there any approximate time when people living in the informal settlements returned to work?

I think they were some of the first people to go back to get into work. It might have been different from what they were doing before, where a lot of them were doing housekeeping and landscaping. After a lot of them did go into clearing up the houses, removing debris. They had a lot of security from the NGOs. They hired persons for security to provide 24 hours security to the work camps. And then slowly as things began to open, we find a lot of them have gone back to work in tourism-related fields, particularly housekeeping landscaping, in some cases translating for the NGOs. We're working with the patient pastors and the churches. So that's been a kind of a new employment field as well.

7. Access to education: Have people from informal settlements have access to education?

The right to education is in the Education Act. So, between the age of five and 15 people have the right to free health care and free education. So, whether they came legally, illegally, or if it's a tourist child that wants to go to school, you literally cannot deny them to a public school, if they have their vaccinations, proper identification, and check. Those are free things.

8. Mobility: Could people move freely from place to place in the aftermath of Hurricane Dorian?

It was easier for undocumented persons to travel to leave after the storm, anybody could relate to you. They were evacuating people, and by any means necessary. But then to return to the island, the persons that were documented, had a much easier time getting on a flight, getting back to Abaco. But undocumented persons, in a lot of cases, had to sneak back to the island. Now, whether it be on a private boat, but even, you know, to go on a government boat, or to go on a plane, you need, you need identification.

9. Marine debris: How does that affect local people? Who undertook the cleaning process?

Within the first week, probably the first six-seven days, the government had cleared the navigational channels into the major harbors so boats could get into rescue people to bring in supplies. In that first week after the storm, it was mostly flatboats and small inflatable boats that could have rescued a few people at a time. But within I'd say seven or eight days, those channels were open so big boats could get in to rescue large numbers of people out of places. The government didn't put much focus on marine debris at all. Marine debris removal from the water requires a lot of specific equipment and a lot of funding. It is a little controversial because really, all you're doing is taking it out of the water, moving it to a landfill on the land. So, you're kind of just moving it around. But because our economy is based on tourism, it needs to look pretty. And we also need to move it before the next storm, you know, before storms push it back into the navigational channels. We also feel that if we

remove marine debris, it gives those ecosystems a better chance of recovery. So the seagrass beds and the mangroves can come back faster if they're not covered in debris. The most debris came from roofing, siding from houses, docks, boat lifts, lawn furniture, porch furniture, a lot of air conditioning units, a lot of cars, car parts, a lot of boats, rope, wood, metal siding. What we found was that because the storm came out of the east, it kind of pushed everything up onto the land. So there wasn't a lot of debris in the water along the coast, which was good. But where you had harbors, those harbors kind of became sinks and trapped debris. They trapped boats in the mangroves, and they trapped things on the bottom. So, we've spent the majority of our time cleaning out harbors based on the shape of the harbor and how well those harbors flush. Some are much dirtier than others. I don't know if that answered all your questions. I could talk about marine debris all day. You know, people were angry with us for removing cars from the harbor in Marsh Harbor, because there were so many lobsters living in them. And they could go down and catch lobster. And it was like an artificial reef that they didn't have to place. And they didn't have to maintain it was just there and they could go get lobster anytime they wanted. And when we start removing these cars that are navigational hazards, yeah, they were upset. They were mad. I think the only answer then is to remove it sooner. I think, you know if it's going to move in the next storm and become a hazard it has to be removed, whether it's become a habitat or not.

9.1 Follow-up question: Where does most of the marine debris land? Does it travel to other countries?

I would say 100% of it is still there. The DRA (Disaster Reconstruction Authority) has two waste management sites in the Abaco Islands. They're giant landfills. And all they do is separate, you know, tires, fiberglass and plywood, and appliances. I don't know if any of that debris will ever be recycled or moved to America. It's just, that I don't think there's a long-term plan. It's not being burned, which is great. It's not going into the atmosphere for us to breathe. But I don't know if there's funding or a plan for that to ever leave the island. Then the next storm comes and takes those waste back to the water.

9.2 Follow-up question: What would be possible marine debris mitigation strategies?

I think that we need to, in future hurricanes, need to have the removal of marine debris as part of the plan. That wasn't done in the past. I think we've learned some best practices for removing marine debris. As far as mapping out areas and doing assessments before and after separating metals that can be recycled, you know wood that can be burned and plastics that need to go to the landfill. So, I think we've learned a lot of lessons. I think people here are acutely aware that storms are getting stronger and more frequent and believe in climate change more than anyone else in the world probably. But I don't know if there's an answer to your question. I don't know how we handle it. I don't know how we limit marine debris in a Category five storm like Dorian. We have a very strong building code. But we have very little enforcement.

10. Political participation: What is the level of political participation of the informal communities in the decision-making process?

I don't think there is any. I think they probably feel disenfranchised, where they don't have a lot to say in politics. They don't have representatives on the local government board now. The only people that go for their rights are their pastors and I don't think there's a lot of political influence there. A lot of Haitians are looked down on. Therefore, they rely on each other, and they don't have to rely on the government.

Interview 2

Interview date: 2022, April 26

Lianna Burrows - Outreach coordinator at Friends of the Environment

Introduction: Hi. I am Lianna. I have been in Abaco since 2017. I grew up in Nassau, which is the capital of the Bahamas. And I got offered a job at Friends of the environment after doing an internship with them in the summer after I graduated from college. So I have a Bachelor of Science in marine science. I am an outreach coordinator. So we work with all of the schools in Abaco. So we do like hands-on education and in-person field trips, and classroom presentations and stuff like that just to get kids out of their classroom and into their natural environment. So that's mainly the main part of my job, but I also help with fundraising because we are a non-profit.

1. Societal ties: What were the societal ties among individuals living in the Mudd and Pigeons Pea areas before and after Hurricane Dorian?

Even though I've only been here for five years, I know, those communities have existed for a long time. I'm not sure for how long exactly. But a lot of them like in our experience with friends, you know, we a lot of them attended. I know we'll get to this, but you know, a lot of them attended school with Bahamians. And that's, that's like their whole life. They were born in those communities. And so, a lot of there's a lot of like Haitian Bahamian mix in there. But then there's also some, you know, just Haitian communities. So, you know, there's a lot of people coming and going, but there are also people who had been there just as long as those communities had been.

1.1 Follow-up question: Where did displaced people move to rebuild their houses?

They stayed in the Abaco Islands. If anything, I almost feel like more people have come. I could be wrong. I don't know. But sometimes it feels like more people have come into these new informal communities. That story.

1.2 Follow-up question: What has been done with the demolished Mudd and Pigeons Pea areas?

I live on a key in Abaco. So, it's like a 20-minute ferry ride from the mainland, it's called elbow key, or the settlement is called Hopetown. There is a Haitian community here as well. There used to be several others as well. But new owners have bought that. And so, everybody who was living there had to move because they had started construction on that piece of land. And, you know, I was around when everybody was moving. I saw everybody has maybe like two boxes to their name, pretty much. Their houses were kind of built from pallets, like shipping pallets and stuff. A lot of them just ended up in the dump. And so, they moved to a new location. A lot of those people living there are documented. They have a right to work and they're part of our community. But it is such a small island, and you notice when there are new faces and there have been a lot of new faces that nobody's sure who they are, do they have proper paperwork? The ones in our community who are a part of the community are super hard working. They want to come here to send money back to their family. Some people probably don't require them to have papers and kind of have some people working under the table.

2. According to official statistics, the number of official deaths reached up to 56 people while injuries accounted for around 300 people. Do you know whether the number of killings and injuries have been different in the informal settlements?

I don't think anybody has that number, you know, the exact number, but anybody who was here would know that. It's not 56, even though that was the official number reported.

3. How many people approximately live in one household?

I think like even from my understanding, even if you saw us, you know, a house with one roof. That didn't necessarily mean that one family was in that house. Because when you go inside the house, it's like being divided. So I feel like it's hard to say a number like Jim said because it's different in different houses. And depending on the number of kids each family has, it could be different, but I'm not. I honestly don't know about the number of kids who are in these informal settlements now. I'm not too sure about that.

4. Access to safe water: What was the situation before and after Hurricane Dorian?

None of the communities have access to city water. But they do, you know, they have the option of buying water if they want to, but and or if they can afford it, but they don't have access to be connected to the city water. After Dorian, some NGOs were providing safe drinking water. I don't know if there are still any water stations. I think everything now is paid. But that went on for at least two years, maybe a year and a half.

5. Access to adequate housing: What was the situation before and after Hurricane Dorian?

The structure of their buildings is not hurricane-proof, you know, and they're kind of just throwing up with the materials that they can find, and everything. So I just think that it's, it's not, I don't know exactly the materials they use. I know they use, like scraps of wood that they find and things like that. But it's not under Hurricane standards, Hurricane build standards.

6. Employment: When did the first business open aftermath, Dorian? Is there any approximate time when people living in the informal settlements returned to work?

I kind of feel they were in these communities, some of the first people back to work after Dorian. And it's because they were offering to do pretty much whatever to earn some money. I don't know the exact timeline, but they were, you know, they were willing to help with clearing. For example, here in my hometown where I live, there's a large population of second homeowners. So it's their vacation home. They don't live here year-round, and they are willing to pay for help on their house that, you know, had damage after Dorian. So here I saw a lot of people getting paid as early as October after the storm.

7. Access to education: Do people from informal settlements have access to education?

Yes. I don't know if we mentioned schools Earlier you asked but I forgot but the in the Bahamas, you can't deny an education as a right.

8. Political participation: What is the level of political participation of the informal communities in the decision-making process?

None, I think. They do not have any representation. I think they're still very dedicated to their lives, of Haitian descent if that makes sense. Like they, like they still see their Haitian Prime Minister as their leader, even though they live here. That's what I noticed at least. And it's like, they still celebrate that and or not, that's just this is how I see it, but that they're not too informed like our political parties and stuff like that.

9. Marine debris: How does that affect local people? Who undertook the cleaning process?

It wasn't addressed immediately. So, a lot of the things that came up when removing debris is that you know, some animals have found their home on this debris. It is hard to remove an octopus that's in a piece of debris. Then I need to decide whether I leave this piece of debris now because this is home. Or do I kill the octopus in the process? You know, I mean, I just remember talking to staff at IDEA and them telling us, you know, how much how many animals they found, like living in this debris, because it had been there for so long. So, it just became not all of it has been removed. In some of it, you know, just kind of became part of the environment.

Interview 3

Interview date: 2022, April 27

Kristal Ambrose - founder and director of a Bahamas Plastic Movement & Ph.D. student within the marine debris field.

Introduction: My name is Krystal Ambrose. Also known as Krystal Ocean. I am from the Bahamas, from Nassau, the Bahamas to be exact. I've been in the field of Marine Science for almost 15 years. But I've been studying marine debris for the last 10 years. I am the founder and director of a nonprofit organization called Bahamas plastic movement, where we find solutions to plastic pollution within the Bahamas, using research, education, citizen science, and policy change. Currently, I'm a Ph.D. student studying marine debris in Malmo, Sweden.

1. Societal ties: What were the societal ties among individuals living in the Mudd and Pigeons Pea areas before and after Hurricane Dorian?

I don't have a lot of personal experience with informal settlements or an understanding of how they work. It's only been through, you know, through hearsay and experiences. Since I've grown up, have always heard about the Mudd and Pigeon Pea, even in Bahamian songs they talk about it. And you know, it's predominantly the Haitian community. So before Hurricane Dorian, all I knew was that you know, those communities existed. They were mostly Haitians. I guess, you know, low economic class, one would assume. And then following Hurricane Dorian, we know that community time was kind of broken due to the storm, due to you know, the number of injuries and death following and displacement following Hurricane Dorian. And then also the destruction of those communities. So that's all I know, just through hearsay, no real personal experience there.

2. According to official statistics, the number of official deaths reached up to 56 people while injuries accounted for around 300 people. Do you know whether the number of killings and injuries have been different in the informal settlements?

Again, this is to hearsay, it's not on record, you know, but I do remember following the storm, there were way more than 56 people that died collectively, Hurricane Dorian. How much of those were from the settlement, I don't know. I remember seeing pictures, you know, of bodies stiff on the side of the road, and people would say stories of, you know, walking through Marsh Harbor, in Abaco, in those communities, and how the Mudd and Pigeon Pea was gone, you know, and how the bodies were under the rubble and things like that. And, you know, to my understanding, again, through hearsay, is that a lot of those bodies from those communities were not documented in terms of

honoring those, the death of those who passed from those communities now, so I can give the false specific answer.

3. Access to safe water. What was the situation before and after Hurricane Dorian?

Again, I don't know because I am not from that community. So I can't say for sure. And I don't know what access to fresh water would be. So I don't want to misspeak. But I know, in January, when I was in Nassau, I got to visit a Haitian community. And basically, it was very much like a common generator. So it's like shared electricity among everyone. I don't know what the water situation was. But sometimes, there's access to public pumps, where you can go and just fill the bottles and take water back to your house or whatever. It's very plausible that a lot of those places may have had running water. And it's also possible that they didn't, but I can't say for sure if they did, pre or post-the-storm. But then following the storm, there was no electricity and running water on the island.

4. Access to adequate housing: What was the situation before and after Hurricane Dorian?

Again, when I imagine you know, or the access to housing was within the settlement like they had a place to stay. Following Hurricane Dorian, a lot of those homes were destroyed, and there was a lot of displacement. A lot of those people had to leave not only from that community but from the entire island to seek shelter in other parts of the Bahamas, right. So they got evacuated, either by personal boats, or you know, flights, and they ended up in Eleuthera or Nassau. And I was in an Eleuthera, at the time following Hurricane Dorian, where we received a lot of the people from Abaco. A few people who I managed to speak with were actually of Haitian descent. Now, if they were from the Mudd, or Pigeon Pea, I can't confirm.

5. Mobility: Could people move freely from place to place in the aftermath of Hurricane Dorian?

I don't think it was restricted. You know, there's there was freedom of movement. Once you had an ID, you could travel within the country. I think if you could show, you know, your documentation, you're able to move in between islands. And the same following the storm. But that may have been harder, right? Because a lot of people lost a lot of their documents and didn't have any identity. So that made it harder.

6. Employment: When did the first business open aftermath, Dorian? Is there any approximate time when people living in the informal settlements returned to work?

Yeah, that's the Abaco-specific question. I don't have an answer to that. I know now, a lot of hotels and things, reopening in Abaco.

7. Political participation: What is the level of political participation of the informal communities in the decision-making process regarding households, education, and health, among others.

That's a good question. I know, people were lobbying on their behalf there were different, organizations within the Bahamas, mostly that are focused on human rights related to Haitians residing in the Bahamas, that were lobbying against that demolishing. And I don't know how persuasive they were not because it still got bulldozed, even with the United Nations intervention. I don't know how deep the intervention from the UN Human Rights was, but they addressed it.

8. Marine debris: Where did it come from? How does that affect the Bahamas and local people?

During storms, any elevated oceanic activity, marine debris comes from the ocean, back to the shores of the Bahamas, that debris that washes ashore doesn't necessarily mean that the debris originated from the Bahamas. And also, when we have something like Hurricane Dorian, we have a twofold issue where we're getting debris that's going in and coming out. Right. So debris goes into the land from the ocean and debris that's coming from the land goes back out to the sea. And that's what you had happened with Hurricane Dorian, all the cars that went into the sea, all the boats that came into shore, all of the plastic debris that washed ashore, all of the lumber and things that may be mostly stayed inland. But also a lot of it ended up going out to sea, potentially as well. Or even if it didn't go out to sea, it ended up in the environment in some regard, right. And then you put that on top of the waste management trying to manage all of it, you know when we already have poor waste management systems in place. So that's the extent of marine debris, as far as I see it now quantifying it to say, how much of it following the storm? How much of that went back into the marine environment? How much came from the marine environment to land? What was the composition of that debris? I don't know. I don't know how much of that data was collected. So that makes it tricky to quantify.

9. Do you have a vision of how to prevent marine debris during tropical cyclones?

I mean, it's hard to reduce it, right. But it's, I think it's, you cannot reduce it, but you can mitigate following, right, if we know a storm is coming. This is in my opinion, right. And this is the power of marine debris monitoring and understanding the geophysics and the geography of particular beaches. And what that means for debris influx, right. So if I know that this particular beach, when the winds coming from this particular direction at this speed, and this is an accumulation zone, I can anticipate that following a storm, this is going to be a hotspot that's going to be filled with debris. And we know that following the storm once we then get everything in place, these are the sites that we need to come and remediate. Alright, so for when the storm comes and hits, I can't do anything, right, that debris has to end up somewhere. But after the storm goes, I know that I can direct my efforts here for removal, and also for monitoring and quantification. Data gathering. Right? So So I think that's, that's the best thing we can do. And that's what I'm trying to figure out now. But when it comes to monitoring, like how do we understand what's there before and how can we compare what's happening after not only just storms but also day today? And also seasonal?

Interview 4

Interview date: 2022, April 28

O'Neal Ambrose - building inspector at the Ministry of the Bahamas

Introduction: My name is O'Neal Ambrose. I am a building inspector within the Ministry of the Bahamas under the housing department. As building inspectors, we control the flow of construction within the Bahamas in terms of making sure that constructions follow the regulations of the Bahamas building code. Also, other building inspectors help in assessing natural disasters such as hurricanes like Hurricane Dorian.

1. Access to adequate housing: What was the situation in the Mudd and Pigeons Pea areas before and after Hurricane Dorian? Building code appliance?

Before Dorian in our country, we had many squatters building on the land that is not third. The land was occupied by Haitian nationals. It just keeps expanding and the construction of the home does not apply to the building code due to inequality here in the Bahamas. The type of construction, we call them a shanty construction whereby they come up with poor materials just put something together over the head just to live. The structure is not structurally good, it was just basically there just to put a roofing structure over their head for them to live. In terms of accessibility, the houses were built very close together. So to say, if you walk into one house, you continue walking into another and another and another door. This how close the housing was in the Mudd and Pigeon Pea area. As to the foundation, there is none, and houses are not elevated off the ground. They have flat surfaces on the ground whereby in the Bahamas when we do construction, we normally do dig a trench depending on different types of construction. The foundation is built on stilts that you build out of some piles and so on. But in the Mudd and Pigeon Pea, this was/is not the case. You just go there, build a house from wood and that's it. No form of steel no prepared structure in terms of protection from storms, hurricanes, and so on. They just build a structure for living purposes. No consideration of the building code and don't protect themselves from storms and any natural disasters.

1.1 Follow-up question: What was the housing situation after Hurricane Dorian in the Mudd and Pigeons Pea settlements?

After the situation, Dorian, the Pigeon Peas, and the Mudd, a lot of the homes were destroyed - completely wiped out. Because the area of the settlement where they were, we call them - facility low line area. With a very low line, I mean, areas that can easily be flooded during a heavy downpour of rain or flooding. A lot of houses there were not constructed properly and therefore construction got destroyed during the hurricane. Before the hurricane, the government issued a warning to the people in particular areas in terms of the Pigeon Peas and the Mudd. After the destruction, people were allowed to come to Nassau to stay with their relatives and get subsidies help. However, many of them did not take that opportunity because of their illegal status. So, because they came illegally into the country, they were scared of deportation to their homeland. So, because of that, they stayed in their homes. So, as we saw them staying in their homes, many of them died during the hurricane. Even up to this day, nobody knows how many people have been killed during the storm.

1.2 Follow-up question: Are the Mudd and Pigeons Pea settlements there up to this day?

Right now, the Pigeon Pea and Mudd are completely declared. They are not allowed to do any type of construction because of the result of the hurricane.

1.3 Follow-up question: Where did people from the informal settlements in the Mudd and Pigeons Pea reside after Hurricane Dorian?

Some came to Nassau and then went upstate. Others ended up building houses in other areas of the Abaco Island, deep into the bush. They went there to rebuild shantytowns without any appliance of the building codes. So again, in terms of flooding the houses will result in the same damage.

2. Do houses in the Mudd and Pigeons Pea settlements have insurance?

None whatsoever.

3. Access to safe water. What was the situation before and after Hurricane Dorian?

In the shantytown, this is how it works - if I'm Haitian national or foreign, and I used to have a house, most likely allowed running in water or electricity or whatever. So I invite other foreigners who have the same nationality that I am. Okay? You give me a code, and you get water and electricity from me. But at the end of the month, you pay me to rent for the use of my utilities either by a week or by month. So basically, I can supply a whole town in terms of water and electricity. As to the water, shantytowns often have outside wells than running water inside houses.

3.1 Follow-up question: Is the water safe to drink?

Some people do drink it because it's from the ground. The only way they will drink it. After Hurricane Dorian, the water was contaminated by seawater, so it was not safe to drink.

> 4. Mobility: Could people move freely from place to place in the aftermath of Hurricane Dorian?

People who are the legal ones could move freely. Now the ones who are illegal were afraid of deportation. They went deep into the bush whereby they can get the property rented from the local officials. To say they were a danger and tried to avoid the local authority. So they wouldn't be able to get captured to go back.

> 5. Employment: When did the first business open aftermath, Dorian? Is there any approximate time when people living in the informal settlements returned to work?

After Dorian, a lot of them got displaced in terms of work because businesses got destroyed. So instead, they went on in the rebuilding process. There is a lot of work in terms of construction going on. So, some of them who were in the construction still has a job because they get hired by a local contractor depending on their skills level and knowledge of construction. But some people who served as gardeners and fishermen lost jobs.

> 6. How many people approximately live in one household?

Close to too many. That is a tricky question. When you go there at night you see many more people living in one house than they state to the official data. I say, between 10 people.

> 7. Political participation: What is the level of political participation of the informal communities in the decision-making process regarding households, education, and health, among others.

They have no say. Like I said earlier, most of them are illegal in terms of their status in the country. Those who do have the status might have somewhat a little say but if they are here illegally, they have no say. Most of the people who build shantytowns are the ones most likely illegal.

> 8. What is the level of social ties within formal and informal communities?

Yes, they do. Ask as I said, the Pigeons Pea and the Mudd got so big because if I come there and my nationality, I get some utility. My house will be able to keep expanding from now. It's easy.

Interview 5

Date: 2022, May 03

Leanne Russel - artist and a cultural worker in the Abaco Islands.

Introduction: Leanne Russell - artist and a cultural worker in the Abaco, which is one of the family islands in the Bahamas, and I live on Green Turtle Key, which is a small island located on the mainland of Abaco.

1. Societal ties: What were the social ties among individuals living in the Mudd and Pigeons Pea areas before and after Hurricane Dorian? What are societal ties between individuals living in informal and formal settlements?

Background on the Pigeon, and the Mud, they were formed in the 50s and 60s. And the land was affiliated with a farm operation that was outside of Marsh Harbor. So the Muds in the Pigeon are located in or were located in Marsh Harbor. And these communities were created by Haitian migrant workers who were given work permits to come and work on the farm. In the 50s and 60s, they were allowed to build on this land. And this was a self-contained community for these workers. That kind of catalyzed an influx of you know, people coming in and moving in their families. And then, unfortunately, with the political situation in Haiti, following up the disaster from multiple earthquakes and different environmental disasters, and the migration from Haiti to the Bahamas. It caused an even larger influx of undocumented immigrants who then because of familial ties with the already established Haitian population there, that was kind of the basis of how that community kind of grew. By the time of Dorian, an estimated 10,000 people were living in those two communities with about 3000, of which being documented, and by documented the Bahamas government refers to persons who either are naturalized citizens, which means they were born in the Bahamas to documented Haitian migrants or persons with work from it. A lot of other migrant workers were there, but about 99% of the population were either Haitian or Haitian-Bahamians, naturalized Haitian Bahamian citizens, or Bahamians born to Haitian parents. That being said, of course, a lot of the population would be under the radar if they were not documented, but there was a very large population within those communities who operated within the regular community of, you know, of Marsh Harbor. So there is the thing about Abaco is that compared to other places in the Bahamas, where there is a lot of xenophobia toward foreigners, undocumented immigrants, or Haitians period. In Abaco, there's a lot more socialization.

2. According to official statistics, the number of official deaths reached up to 56 people while injuries accounted for around 300 people. Do you know whether the number of killings and injuries have been different in the informal settlements?

From the persons that I know in the Defense Force, the estimated numbers, from when they came into Marsh Harbor and into the Pigeon Peas in the Mudd, the death toll reached from 1000 to 1500. There have been direct accounts that I have heard of mass graves then being instructed to collect the dead, especially within the Mud and the Pigeon Peas, and discard them because of the high incidence of death, but also because there were so many. The number that you saw was the number of bodies that ally cataloged and stored in refrigerated containers. And the majority of those were never identified either and were buried in unmarked graves as well.

3. Access to safe water. What was the situation before and after Hurricane Dorian?

Drinking water was available to all the settlements. In the Turtle Key, we have systems if you are not on what you call city water, which is on the government, well, grid. You catch water in containment systems, which was also the case in the Mudd in the Pigeons. They either had cisterns or they had ground well capabilities. So the further you got into the center of the community, the more I guess off the grid you would get but those people had access to either portable water through a drinking pump or well water. So there was access to clean, potable water throughout. After Hurricane Dorian, through the Water Mission, which is an NGO that came in after the storm, they have small desalinization, a small self-contained water processing unit that is capable of making like 300 gallons a day. And they have those set up in strategic areas for people or communities that don't have government access to provided water. They now have access to clean drinking water or water, you know, for everyday use in their household.

4. Access to adequate housing: What was the situation before and after Hurricane Dorian?

Well, as I said, those communities no longer exist. So they were the whatever remained was demolished within a couple of weeks after the storm and cleaned up and now it's been fenced off. So those communities have now relocated to other kinds of smaller communities that are off the grid that do not have access to power or water. Housing in Abaco experiences shortages. That is causing a spike even in rentals. And, you know, the formal areas like Marsh Harbor and Treasure Key experience a shortage in housing. An apartment, a two-bedroom apartment that might have been rented for $900, before Dorian is now renting for $1,500. So there's an extreme shortage. People who were displaced, estimate that approximately 40% of the population has come back to Abaco. The remaining population does not have the funds to move back home. As far as people who were displaced from the Mud and the Pigeon Peas, as I said, they're now operating in smaller little shantytowns, which would be either on the highway in Marsh Harbor or village called the Farm Road, which is located in the north in Abaco.

5. Mobility: Could people move freely from place to place in the aftermath of Hurricane Dorian?

It was difficult to move around because many did not have a travel document or had lost it and they were scared to move from the fear of being picked up by immigration and not having the proper documentation. I know that it has gotten a lot easier now. A lot of people have had the chance to gain papers that were needed to get their papers back. What is interesting to note at this point is that persons who can gain their citizenship through naturalization can only start the process at 18. So if it was someone who was under the age of 18, they would be considered a stateless citizen, because Haiti also does not give citizenship to persons who are not born in the country. So if you are under 18, and you were born to Haitian parents who might not have the proper documentation to be in the country, you have to then wait until you're 18. So even persons that may have been documented, but then had undocumented children who were considered stateless if they lost what they call their travel document, which is a piece of the paper stamp to say you're born in the Bahamas, and acts as a travel document until the age that you can apply for citizenship. If you lose that, then basically, you have no documentation of citizenship at all, you cannot travel, which also I would imagine would be very frightening to parents, who then had children who faced either deportation or themselves being put in precarious citizens a precarious situation where they do not have documentation, or they do and, you know, they could not be in the country legally. Which meant that many people were afraid to move from place to place.

6. Employment: When did the first business open aftermath, Dorian? Is there any approximate time when people living in the informal settlements returned to work?

A lot of businesses that applied for work permits for Haitian nationals, because they no longer were employing them, would make their work permits null, which would mean they would have to travel back home. Now that many hotels and private homes are back (they are the ones who would apply for those work permits) more people are employed. However, after the storm in the first year or so after the storm, that was a very big concern. Some businesses are still rebuilding, some resorts are, you know, slowly coming back online. Baker's Bay was a major private community that functions as a resort that was then the biggest employer here, and they did not fully come back online until last year. So that was almost two years after Dorian. The other major grocery stores did not come back online until a year and a half afterward. So there was a period of about 300 to 500 days post story and nothing was functional. As a result, everyone's work permit would have lapsed, because no one was applying for it. You have to pay to have these work permits renewed. So, you're facing this period nothing was open and nothing was functional, so no one is renewing work permits. So, then your citizenship or your right to be in the country, in essence, lapsed. So, then you have these absent flows of people kind of living under the radar. And, you know, waiting it out, hoping that their former employee will once again apply but not wanting to go to Haiti, because not the situation is so precarious, not knowing if you're going to make it back not knowing if you're not in the country, is your employer going to send for you again? Are they going to give the job to somebody else? So, it was a waiting game, in essence, for this contingent of the population waiting to see when there was some kind of functionality in the community to where they would have normalcy in their life.

7. How many people approximately live in one household?

I would say around eight people per household.

8. Political participation: What is the level of political participation of the informal communities in the decision-making process regarding households, education, and health, among others.

The Bahamas operates as a third-world country as far as how much the government contributes to infrastructure. So, it's very nominal. I mean, very rudimentary, as far as what they can provide outside of the basic amenities, which would be power and water, which still is on the verge of third world infrastructure. You know, we have power outages here, all the time. In Green Turtle Key, our water still cuts off the majority of the time every day after four o'clock, because there's not enough water pressure to pump the water from the mainland across to here, you know, so when you consider the funds that it took to even get us back online. Even before Dorian, there was nothing as far as government supplements and housing, and even less now, whereas government employees, would have a housing stipend before. You need certain people to be on the ground. To make an island run you need. You know, we have national insurance. We have people who will work in social services, we have government licensing officers, we have environmental health, we have all of these people who were then displaced who were needed to move back home and there just wasn't housing. So, after speaking specifically to government workers, they would have been given government housing before Dorian. They were moved back and were living in trailers purchased by the government. That was for government workers, a housing solution that was then considered feasible and within the budget, became what we call dome village. And initially, with the number of donations that were coming in, and with what the government was going to contribute as I said, they were going to build what they were calling a housing block. For people, it would be the equivalent of low-income housing and in other countries, the budget ran out and it was not there. So, their solution was to buy these domes and set them up. And people are still living in dorms. You know, people could purchase the domes from anywhere 10 from 10 to $20,000, initially, and that's what a lot of people did. And now, you know, three years later, a lot of people are still living in dorm villages where sanitation was conceptualized to be a short-term solution. And now it's been three years so obviously the sanitation it's unsanitary there is no septic system. It has a very rudimentary

water facility for water coming into the community. So it is in essence now once again, a shantytown that is not that was never intended to be a long-term solution.

9. Marine debris: How does that affect local people? Who undertook the cleaning process? How does that affect the Mudd and Pigeons Pea communities?

We now still have, as I said earlier, there are two specific ways the Mudd in the Pigeons, informal communities were impacted, and to their detriment by marine debris from their proximity to the port. So with the tsunami, and with this huge wave that came in from the ocean to Marsh Harbor, because Marsh Harbor received the majority of its damage from tidal surge, and from just this huge wall of water that came in after the eye of the storm, which forced everything that was on the coast, into the land. So there was this wall of water that just forced all of these shipping containers and leveled this community. And other communities like where I am from because we are small, you know, historically, we're a fishing village. So everyone operates out of boats. A main mode of transportation is boats. A lot of our marine debris came from either dock or from boats, boats that had been anchored in the mangroves that then became discarded.