

Assessment of the Effects and Impacts of Hurricane Dorian in the Bahamas

Executive Summary



Introduction

Hurricane Dorian is not an isolated occurrence, but the latest example of recurrent extreme climate events that have changed the Bahamian landscape and impacted its economy. The increase in water temperatures is likely to contribute to a tendency for tropical storms to be, on average, stronger than they have been in the past (Bruyere, Holland, 2014; Balaguru, Foltz 2018; Bathia, Vechia et al, 2019; Trenberg, Cheng et al, 2018). Due to its location in the Atlantic hurricane belt and like other Small Island Developing States (SIDS), The Bahamas is extremely vulnerable to the effects of disasters and climate change, as some 80 percent of the landmass is within 5 ft (1.5 m) of mean sea level and coastal areas hold the majority of the population and economic activity. Another relevant vulnerability is access to drinking water, which is made worse by contamination of water resources caused by storm surges. In the upcoming years, the country will face difficult questions of whether to relocate coastal populations and how to smartly invest in more resilient infrastructure. It is, therefore, imperative for The Bahamas, as a country, to establish a comprehensive approach to meeting these challenges and to incorporate considerations for disaster risk management into all features of national development.

Disasters are described as a combination of exposure to hazard and conditions of vulnerability. Greater vulnerability is usually linked to socio-economic and territorial aspects, as poorer populations tend to live in at-risk areas disregarded by formal planning systems, all but ensuring a greater exposure to hazards. This exposure of social and economic assets to hazards can be somewhat balanced with measures to mitigate vulnerabilities, such as investments in early warning and preparedness, and addressing pre-existing social issues such as informal settlements.

Disasters set accomplishments back in social and economic arenas and put a strain on national budgets. This is of concern for The Bahamas, a country not eligible to receive official development assistance (ODA) and where government debt, for example, doubled from 32 percent of GDP in 2007 to 65 percent of GDP in 2014. In this regard, the DaLA assessments of Hurricanes Joaquin, Mathew, Irma and now Dorian offer a historical record of the cumulative effects and impacts on economy, infrastructure and society from recurrent disasters and offers guidance for future decision-making processes.

In The Bahamas, the characteristics of its territory and dispersed population in the Family Islands adds extra challenges for planning and recovery. Settlements are usually dispersed and contain small populations, which increases the costs associated with the provision of public utilities and the development of infrastructure which needs to be extended for long distances to supply communities. Dispersion of population also contributes to inequitable access to social services of varying quality. Additionally, the islands face economic vulnerabilities. Tourism and fishing are, together with public employment, a plurality of the jobs in the Family Islands. Dorian, like other hurricanes, caused widespread damage that directly and indirectly affected these productive activities.

The Bahamas has made important efforts in mitigating risks and improving resilience through instruments such as hard engineering and a modern building code, along with

the enactment of the Disaster Preparedness and Response Act from 2006 (amended in 2011). The subjects dealt with in the Act are also reflected in the Vision 2040, the National Development Plan of The Bahamas, which frames the country's development agenda within the Sustainable Development Goals (SDGs). Nevertheless, the effects of Hurricane Dorian brought to light many areas that still require improvement, not only in terms of physical risk, but in social and economic aspects.

Resilience involves identifying these risks and developing measures to reduce them, such as enhancing infrastructure and land-use planning and financial protection. Addressing physical vulnerability must be accompanied by social policies to protect the livelihoods of the most vulnerable groups. Special attention should be given to the particularities and constraints of the Family Islands, such as the challenges to enforce and verify compliance with building codes. Specific policies and programs and possibly additional financial resources should address these. Education and public awareness are also important mechanisms and should be a crosscutting component of any disaster risk management plan. Although a strong system of risk modeling and disaster data management is a must, the population needs to understand the kind of risk they are exposed to and be provided with the tools and capacity to act accordingly at times of emergencies.

On 1 September 2019, the eye of Hurricane Dorian made landfall on the Abaco islands with maximum sustained winds of 185 mph (280 km/h), wind gusts over 220 mph (335 km/h), and central barometric pressure of 911 millibars (26.9 inHg). Abaco and its cays along the eastern side were the most affected areas. According to the trajectory of the hurricane, the central and northern part of the island were affected by hurricane force winds, storm surge and flooding. According to the Bahamas Department of Meteorology, the storm surge provoked storm tide of 20 to 25 ft (6.1 to 7.6 m). Dorian also dropped an estimated 3 ft (0.91 m) of rain over The Bahamas. Therefore, Dorian is considered the strongest hurricane on record to affect The Bahamas, not only because of its wind intensity, but also due to the storm surges. The storm surges provoked extensive damage in the most proximal zones to the coasts and lowlands.

On 2 September, the eye of Dorian moved over the eastern side of Grand Bahama and drifted across the island as a Category 5. The hurricane then stalled over Grand Bahama for another day, finally pulling away from the island on 3 September. According to the descriptions of the Department of Meteorology, storm surge and flooding were the events provoked by hurricane Dorian that caused the most severe damage, especially in the eastern side of the island. The flooding on Grand Bahama began from the north and northeast towards the south of the island, this phenomenon was due to the trajectory of the hurricane and the period that Dorian remained in the northern part of The Bahamas in open ocean.

After hurricane Dorian and the provision of initial emergency services, the government of The Bahamas asked the Inter-American Development Bank (IDB) to assess the resulting damage, losses and Additional costs. The IDB requested the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) for technical assistance with the assessment. This report presents the results of this assessment. It also brings recommendations to guide a resilient reconstruction process that can reduce vulnerabilities and risks for the population and for every sector of the economy. Since 2015, it is the fourth assessment in this kind conducted by IDB and ECLAC in The Bahamas.

The report is divided into two sections. The first section contains the description of event, affected population and detailed explanation of damage, losses and Additional costs in all social, infrastructure and productive sectors. Additionally, this part includes an analysis of environmental effects and the macroeconomic impact. The second part introduces recommendations for resilient reconstruction based on the findings of technical experts and best-practices and is divided in five pillars: risk identification, risk reduction, preparedness, financial protection and resilient recovery. The upcoming section will summarize the main findings and the document and briefly describe the conclusions of each chapter. All monetary estimates are made in Bahamian dollars; to simplify the symbol \$ is used.

Summary of Damage, Losses and Additional costs

Hurricane Dorian's greatest impact was felt on Grand Bahama and Abaco, although some impact also occurred on the island of New Providence. Damage resulted from high winds and storm surge and was exacerbated by poor construction practices and communities and infrastructure located in vulnerable areas. Given the magnitude of this event, the reconstruction efforts will last many years and it will require major assistance from financing institutions. Reconstruction is expected to be a long-term process, which tests the strength of a country's institutions. However, it is important that those directly affected by the disaster feel the presence and solidarity of the government throughout the process.

The costs consist of three elements: direct physical damage, revenue and other income losses, and Additional costs—chiefly debris removal. Table 1 summarizes estimates of Damage, Losses and Additional costs for the four primary sectors on the affected islands: social, infrastructure, productive and environment. The estimated damage is \$2.5 billion, of which nine percent is public and 91 percent private. Abaco suffered 87 percent of the damage and Grand Bahama 13 percent. Losses are estimated as \$717.3 million and were sustained primarily in the private sector, which accounted for 84 percent of the total. Seventy percent of the losses took place on Abaco, 15 percent on Grand Bahama, and nine percent in other islands. Additional costs add up to \$220.9 million, 46.4 percent of those costs were in the environment sector and are associated to the cleaning of the oil spill. A major part of the remainder of the additional costs is related to debris removal and demolition.

Damage in the social sector was \$1.6 billion, 85.3 percent took place on Abaco. Ninety-three percent of the damage was in housing, 4.6 percent in education while 2.4 percent occurred in the health sector. Approximately 93.8 percent of the damage in the social sector happened to private property and the remaining 6.2 percent in public property. The productive sector suffered damage estimated to be \$620.9 million, most of them in tourism (\$529.6 million), followed by commerce (\$77.6 million), and fisheries and agriculture (\$13.6 million). All damage in the productive sector happened in the private sector. Infrastructure experienced damage amounting to \$239.1 million. The power sector represents 54.1 percent of the total. The telecommunications sector suffered damage of \$42.1 million, transport accounted for \$50.8 million and water and sanitation \$14.9 million. Approximately 48.6 percent of the damage in the infrastructure sector was to private property and the remaining 51.4 percent was to public property. 66.8 percent of damage of the infrastructure sector took place on Abaco.

Losses for the social sector are estimated to be \$92.4 million, of those \$65 million were in housing, \$21.4 million in health and \$6 million in education. Losses in the Environmental sector were estimated at 27.5 million. Losses for the productive sector were estimated at approximately \$400.3 million. Abaco suffered 83.8 percent of those losses. Tourism accounted for most of the losses (81.2 percent) and suffered the greatest effects. This sector suffered a loss of \$325.2 million. The losses in commerce were \$65 million and in fisheries and agriculture, \$10.1 million. All losses to the productive sector were private. The losses in the Infrastructure sector were estimated at \$197.1 million. Most of the losses were in the power sector (35 percent), followed by telecommunication (27.6 percent). The losses in water and sanitation and transportation were near \$19 million each. The public losses in the infrastructure sector were smaller (38.8 percent) than the private sectors (61.2 percent). Abaco suffered 60 percent of the losses of the infrastructure sector.

Additional costs were estimated as \$200.9 million, 46.4 percent of those costs were in the environment sector associated to the cleaning of the oil spill. The additional costs of the social sector were \$37.2 million, followed by the productive sector, \$9 million, and infrastructure, \$7.4 million. An important part of these costs is related to debris removal and demolition. Costs associated with the emergency response were only partially provided, for example, costs of evacuation were not made available at the time of the finalization of the report.

Table 1- Summary of Effects of Hurricane Dorian

| | Damage | Losses | Additional costs |
|----------------------------------|-----------------|---------------|-------------------------|
| Social | 1,597,290,766 | 92,391,720 | 82,254,021 |
| Housing | 1,487,167,663 | 65,014,267 | 57,809,391 |
| Education | 72,406,603 | 6,026,073 | 19,100,000 |
| Health | 37,716,500 | 21,351,380 | 5,344,630 |
| Infrastructure | 239,135,274 | 197,136,671 | 16,236,779 |
| Power | 131,355,000 | 68,924,558 | 6,335,000 |
| Telecommunications | 42,150,000 | 54,380,149 | 1,039,960 |
| Water and Sanitation | 14,853,000 | 36,624,014 | 2,289,200 |
| Transport | 50,777,274 | 37,207,950 | 6,572,619 |
| Productive | 620,650,850 | 400,285,030 | 19,954,141 |
| Tourism | 529,550,208 | 325,199,267 | 15,146,625 |
| Commerce | 77,584,545 | 64,973,002 | 4,807,516 |
| Fisheries and Agriculture | 13,516,097 | 10,112,761 | |
| Environment | 7,146,963 | 27,435,048 | 102,473,000 |
| Total | \$2,464,223,852 | \$717,248,469 | \$220,917,941 |

Source: Assessment team 2019

The estimated impact of Hurricane Dorian is one percentage point of the GDP. This implies that post-disaster, the economy is expected to grow 0.9 percent. This will result in a decrease in salaries of \$51.3 million and capital income of \$60.9 million. The situation is different when the focus is on local economic activity. In the case of Abaco, the impact was estimated at 7.3 percent

of its GDP, which is estimated to be 47 percent and 60 percent decrease of the country's remuneration and capital, respectively. On Grand Bahama, the impact was 2.0 of its GDP.

Methodological approach

The assessment of the effects and impacts caused by Hurricane Dorian follows the Disaster Assessment Methodology developed by the Economic Commission for Latin America and the Caribbean. The methodology allows standardized data collection and analysis on a sectoral basis, applying the same criteria to every sector under study. In this regard, the following concepts are used in the assessment¹:

(i) Effects: Damage, Losses and Additional costs

- Damage: the effect the disaster has on the assets of each sector, expressed in monetary terms
- Losses: goods that go unproduced and services that go unprovided during a period running from the time the disaster occurs until full recovery and reconstruction is achieved
- Additional costs: outlays required to produce goods and provide services as a result of the disaster

These represent a response by both the public and the private sectors, and may take the form of additional spending or a recomposition of spending.

(ii) Impacts: consequences of the effects on macroeconomic variables, such as GDP, public finance and balance of payments

Based on the information gathered during field visits and interviews, the social sector analysis focuses on affected population, housing, health and education. The infrastructure sector comprises transportation, telecommunications, power and water and sanitation. The productive sectors analyzed are tourism, and agriculture and fisheries. Additionally, the report includes a cross-cutting assessment of the effects suffered by the environmental sector. The Assessment team visited The Bahamas from 31 September to 5 October 2019 to collect data and obtain an overview of the effects of the hurricane on the country. Between 1 and 2 of October, team members visited the most affected areas, including Eastern Grand Bahama, Freeport and Marsh Harbour, as well as the surrounding regions. In addition, the Assessment team held meetings and interviews with representatives from government agencies responsible for each sector under analysis.

The assessment was carried out using official data provided by the government, interviews with the private sector and academia, and observations from the field visits. However, as it will be detailed in each pertinent sector, the main limitation of the assessment was access to information, either due to unavailability during the assessment or because it is not yet collected/produced in the country. This limitation was overcome by creating

¹ ECLAC (2014), Handbook for Disaster Assessment

reasonable assumptions where data was unavailable. Both official information and informed assumptions were used to estimate the effects of the hurricane and are presented in each section.

Summary of Affected population

Most inhabitants of Abaco and Grand Bahama were affected by the passage of Hurricane Dorian in one way or another. The Assessment team estimated that approximately 29,472 persons were affected by the hurricane as a result of some sort of damage to their homes and assets. There were 67 confirmed deaths and 282 persons still missing as of 18 October 2019. The number of related injuries recorded by the health authorities was over 200 a week after the passage of the hurricane.

Approximately 4,861 persons were registered by the Department of Social Services during the evacuation process. However, it should be noted that not all evacuees would have been accounted for, as some used private transport to evacuate to Eleuthera and the United States of America. With the passage of Hurricane Dorian, the government was faced with accommodating thousands of displaced persons in shelters across New Providence, in some cases up to two months after the event. The number of displaced persons in shelters on Abaco and Grand Bahama was comparatively less as most had evacuated to New Providence.

In terms of access to services, most of the population of Abaco and Grand Bahama suffered interruptions in utilities like telecommunications, electricity and water. Approximately 10,546 students were affected as a result of a suspension of primary and secondary school classes in both islands. This created a significant loss in teaching time, as most school facilities were damaged in the affected islands. Furthermore, a great number of the population employed in the commerce and tourism sectors experienced disruptions in employment due to damaged properties.

In addition to the regional and international partners that aided in the early phases of emergency and relief response, the government of The Bahamas, through its various institutions, allocated around \$7 million for the attention of the emergency and relief efforts.

Summary of Housing and Public Buildings

Housing was the sector most severely affected by Hurricane Dorian. Several residential settlements along or near the coastline suffered heavy damage as a result of the intense force of winds and storm surge or was impacted by falling trees and flying debris. Houses and residences suffered significant damage to the structural elements, roofs, flood damage, and other components of the buildings.

Approximately 9,000 homes and in excess of 11 million square feet of structures have sustained some damage on the two islands. On Abaco more than 75 percent of the dwellings were somehow affected, approximately 57 percent of the houses were severely damaged. Central Abaco (Marsh Harbour), Treasure Cay, and Hope Town were the most affected locations. Vulnerable settlements in Marsh Harbour were also destroyed. Damage to the housing sector on the islands of Abaco and Grand Bahama is estimated at \$1.48 billion, 88.9 percent of which took place on Abaco.

Losses in the housing sector are attributed to the interruption of accommodation and rental services due to severe damage or destruction of the house, making it temporarily or permanently uninhabitable. The Assessment team estimated losses at \$56.8 million resulting from 2,894 homes left uninhabitable after the hurricane.

Additional costs included in this assessment are refer to the cost of demolition of the most affected dwellings, debris cleaning, and labor and equipment rental cost. Additional costs are estimated at \$45.9 million.

In total, 31 public buildings (excluding schools, hospitals/clinics and shelters that were assessed in other sectors) and government offices were affected. Damage to the public building sector is estimated at \$10.6 million. Additional costs to demolition and debris removal in public buildings are estimated at \$1.0 million. There was no losses related to public buildings.

Summary Health

The hurricane severely affected the infrastructure, equipment, medical supplies and electrical and water supply on Abaco and Grand Bahama. Therefore, the capacity of the healthcare delivery system has been significantly hampered on Abaco and Grand Bahama.

Hurricane Dorian damaged most of the healthcare facilities in both affected islands, with severe damage to the Rand Memorial Hospital (RMH) and four clinics located in the eastern part of Grand Bahama. Additionally, significant damage was also evidenced in medical equipment, furniture, and vehicles from extensive and prolonged flooding, very high humidity and high temperatures during and after the storm. The estimated damage in infrastructure, medical equipment, furniture, supplies and others to the health sector on Abaco and Grand Bahamas attributable to hurricane Dorian has been estimated in \$37.7 million.

A total of \$21.4 million is the estimated cost of health services operations disruption. The disruption covers three time periods: before, during and after the hurricane.

Additional costs are related to the emergency response and provision of temporary relief and are estimated as \$5.3 million

Summary of Education

Following the passage of the category 5 Hurricane Dorian, Grand Bahama and Abaco were the two hardest hit islands, incurring widespread damage to most educational facilities. Across the both islands, there were 45 educational facilities experiencing varying levels of damage with 10,546 students and 796 teachers affected. Seven schools were altogether destroyed. On Abaco, there were 23 educational facilities impacted with 3,512 students and 211 teachers affected while Grand Bahama had 24 educational facilities impacted with 7,034 students and 585 teachers affected. At the time of this report and following the registration drive conducted by the Ministry of Education, approximately 1,500 displaced students had been reassigned to alternative schools across the islands of The Bahamas.

The widespread damage to educational facilities amounted to \$72 million. Losses in the subsector which comprises the estimated value of lost instruction time along with the value of

tuition refunds for students no longer returning for post-secondary level education totaled \$6.8 million. The remaining costs included Additional costs incurred during the recovery efforts, which amounted to \$21 million. They include the removal of rubble, school furniture to accommodate re-assigned students and teachers, special equipment to conduct classes, fencing, security, school meals, payment of grants, security, psychosocial support to teachers and staff, enrollment fees and costs associated with the enrollment drive conducted by the Ministry of Education for displaced students. The estimated costs across the two islands were equally distributed despite the student and teacher population on Abaco being significantly smaller than that of Grand Bahama; an indication of the magnitude of the damage on Abaco. Public sector institutions incurred the brunt of the costs across the affected islands with a total estimated cost of \$74 million. The limited data available on private sector schools across the both islands contributed to the significantly smaller private sector cost.

Summary of roads, airports and ports

The transport infrastructure, including roads, ports and airports was damaged on Abaco and Grand Bahama. Structural damage was related to storm surge and high-speed winds and the most affected infrastructures were located near the shore. The airports suffered high operational damage due to flooding and roof failure due to high-speed winds, and seaports were impacted by waves, storm surge, and wind.

The estimated transportation infrastructure damage is approximately \$51 million for the whole country, 53 percent of the damage took place on Grand Bahama, where 93 percent was sustained at the Grand Bahama International Airport.

The losses are estimated considering the decrease in tourism and cargo in both Abaco and Grand Bahama and its effects on the collection of port charges and services. The estimated economic losses associated with the interruption of transportation services is \$37 million. It is estimated that 44 percent of the losses will take place in 2019, 39.2 percent in 2020 and 16.8 percent in 2021.

Finally, the additional costs associated with the construction of temporary infrastructure and removal of debris are \$6.6 million.

Summary of Telecommunications

The telecommunications sector suffered considerable damage to infrastructure because of Hurricane Dorian. Gale force winds caused damage to above ground network elements, while flooding caused unexpected damage to various types of ground level telecommunications equipment. Total damage to the telecommunications sector was estimated at \$42.1 million. Water damage to electronic systems rendered many parts of the network inoperable during and after the hurricane, whilst the high saline content of the floodwater caused corrosion to various types of wiring and conductors. Due to the high flood levels, buried fiber optic cables and copper wires were damaged to the point where they emerged from the ground to connect to above ground equipment. Heavy winds also caused the more typical type of damage associated with

hurricanes, seriously damaging wireless infrastructure such as antennae, base transceiver stations and satellite dishes.

The losses are estimated at \$54.4 million and the most significant losses occur on Abaco, where services could not be provided to end users due to widespread destruction. Losses estimates were projected until December 2021, as recovery is expected to take at least this time or even longer to return to normal levels. An estimated loss of \$13.7 million was made for the remainder of the year 2019; \$16.3 million for the year 2020; and \$24.4 million for the year 2021. Losses were primarily as a result of the absence of commercial power, the extended time needed for network restoration, and the loss of clientele. On Abaco, where the effects of the hurricane were the hardest, it is expected that there will be a long road to recovery of the services that require a wired telecommunications network infrastructure.

Additional costs were estimated at approximately one million dollars, mainly reflecting the labor-related costs required to perform repairs, as well as generator fuel burned in the absence of commercial power.

Summary of Power

Hurricane Dorian caused extensive damage to the power generation, transmission and distribution systems on the islands of Abaco and Grand Bahama.

Total damage in the power sector was estimated at \$131.3 million, of which the largest line-items were \$80.4 million in damage to the transmission and distribution networks on Abaco and \$21 million in damage to the flooded power generation plant on Grand Bahama.

Total losses were estimated at \$68.9 million, reflecting the value of power that was not sold, both because of damage to the transmission and distribution network and because of the reduction in demand for electricity as a result of storm damage. Losses were estimated until December 2021 as recovery is expected to take at least this time or even longer to return to normal levels. An estimated loss of \$22 million was made for the remainder of the year 2019; \$40 million for the year 2020; and \$6.8 million for the year 2021.

Additional costs were estimated at \$6.3 million, which mainly reflects extraordinary labor and labor-support costs.

Summary of Water and Sanitation

Damage to facilities and assets associated with water and sanitation are estimated at \$14.8 million. The hurricane primarily affected water pumping systems, storage tanks, distribution system and its related damage related to WSC assets that were destroyed in the event.

Losses are related to interruption of piped water service both residential and other economic sectors, losses of volumes of water due to system leaks, sewerage and waste collection and estimated at \$36.6 million. The decrease in water demand during the recovery period due to the decline in tourist numbers and commercial activity is considered a loss through the end of 2019 for an estimated period of 28 months on Abaco and six months on Grand Bahama as well as an estimated of loss of demand from 7,339 severely damage houses on both Islands.

Additional costs such as additional labor and construction equipment, emergency power generation and solid waste management is estimated at \$2.3 million. These costs also referred to the expense of managing cleaning activities, costs for disaster assessment and recovery teams deployed, and payment to fulfill restoration work.

Summary of Tourism

Hurricane Dorian impacted two major tourist destinations of The Bahamas and disrupted the tourist flows for several days before and after the storm in the rest of the Lucayan Archipelago. The hurricane also caused significant damage to tourism infrastructure on Abaco and in East End of Grand Bahama; in some locations the damage was catastrophic. The total damage in the tourist sector was \$530 million. A large majority of the damage occurred on Abaco.

In this occasion the forecasted losses are less than the damage and amount to \$325 million. They are related to the disruption in the flow of tourists as result of the storm and a changed public perception due to the damaged structures. Most of the losses will be accrued in the high season of 2019 and 2020, tapering off as the recovery is expected to gain momentum.

There were also additional costs for \$15 million related to demolition, debris removal and salvaging of sunken ships.

Summary of Fisheries and Agriculture

The impact of Hurricane Dorian in the fisheries and agriculture sector of Abaco and Grand Bahama was significant. All the fishing processing facilities were affected, either by wind damage or storm surge, with all the consequences of water damage. For the agricultural sector, several green houses were decimated, and many perennial crops were damaged by wind and salt-water intrusion. A poultry processing facility was also destroyed on Abaco.

The total damage in fisheries was \$11 million including damage to vessels, processing facilities and fishing gear. Considering the seasons for spiny lobster and stone crab, the losses in fisheries will be \$7.0 million and will represent a big fraction of the total losses. In agriculture the losses will be \$2.0 million, considering perennial and annual crops, and for poultry, over \$1.5 million. The total losses for fisheries and agriculture are estimated at \$10 million.

Summary of Commerce

The effect on the commerce sector was greater on Abaco than Grand Bahama due to the path of the hurricane, as the eye of the storm passed through the commercial center of Marsh Harbour. The structures that were made of concrete survived with less damage, while those made of lighter materials fared much worse. The total damage was estimated at \$77.5 million for the commerce sector: \$71.4 million on Abaco, and \$6.2 million on Grand Bahama.

The losses to the sector are projected to occur over the expected length of recovery. On Grand Bahama, the losses are expected to accrue over just four months, while on Abaco it is expected to take a full three years. Due to the destruction of property and vital infrastructure, as well as the evacuation of residents, commercial expenditure will fall to zero in the month of the

disaster and then gradually make its way back to pre-disaster levels as the recovery goes on. The total losses estimated for the commerce sector are \$65 million: \$64.5 million on Abaco and \$0.5 million on Grand Bahama. Assessing over time, losses will be \$22.1 million or 34 percent of the total in 2019, \$34.9 million or 54 percent in 2020, \$7.2 million or 11 percent in 2021, and 0.8 million or 1 percent in 2022.

The additional costs for this sector comprise debris removal and demolition. At the time of the Assessment team's site visit to Abaco, there was still an extensive amount of debris in Marsh Harbour. Debris removal and demolition of damaged properties will be expensive and will take additional time on Abaco. The total Additional costs for the commerce sector are estimated at \$4.8 million: \$3.8 million on Abaco and \$1 million on Grand Bahama.

Summary of Environment

Although previous assessments in The Bahamas indicate that ecosystems in the country have adapted over time to become resilient to tropical weather, the intensity and duration of Hurricane Dorian still caused moderate to significant environmental effects. Wave action, storm surge and high winds have produced partial to severe destruction to mangroves, coral reefs, seagrass beds and forests on both Abaco and Grand Bahama. As a result, ecosystems were left in a critical state and pre-existent vulnerabilities were exacerbated with an expected decrease in ecosystem services provision in the short and medium term. These ecosystems are home to a wide variety of species of flora and fauna and provide services that are essential to the development of the country.

Damage to mangroves, coral reefs, seagrass beds and protected areas account for around \$7 million. This damage is a product of impacts on coral reefs, seagrass beds, mangroves, beaches and on the infrastructure of protected zones. Due to the inherent difficulty of assigning a price tag to some of these assets, the value reflected in this damage estimation is only based on a global average of the cost of restoration projects. Numbers could go higher depending on factors such as equipment availability, local workforce, planning and monitoring.

The impacts to natural resources are not only expected to cause changes in biodiversity, disappearance of habitats, and displacement of species, but also affect Bahamians who depend on healthy ecosystems to maintain their livelihoods and economies. For example, the damage to seagrasses beds is likely to have short- to medium-term effects (2 to 4 years) on the services they provide to fisheries, which makes the losses represent the most significant public costs. Since ecosystems are crucial to the economy and society in The Bahamas, it is expected that the impacts of the hurricane on their ecosystem services will result in losses of approximately \$27 million.

Additional costs entail the costs of future environmental assessments, organic debris removal, fire control measures and a significant private cost related to the oil spill on Grand Bahama. These costs are estimated to be \$102 million.

These estimates are based on a limited amount of information available at this time and on initial assessments, long term impact studies will be further required. There are also

environmental elements that suffered damage (such as water resources) for which there is no economic quantification due to the limited availability of information.