



Annex G: Hurricanes

(Annex to PREMB Puerto Rico All-Hazards Plan)

April 2021



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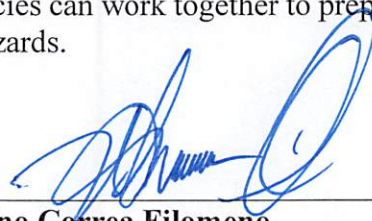
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Foreword

The Puerto Rico Emergency Management Bureau (PREMB) Puerto Rico All-Hazards Plan (AHP) describes the response, recovery and mitigation operations that are applicable across a broad spectrum of potential threats and hazards to support the Commonwealth of Puerto Rico and their survivors. This plan provides general guidance and optionality to support the delivery of emergency management support and describes how PREMB implements the federally adopted *Community Lifelines Construct* and guides how PREMB applies these concepts to disaster operations.

The whole community approach reinforces the fact that PREMB is only one part of the emergency management team that includes partners at the federal, commonwealth, and local levels, non-governmental organizations such as faith-based and nonprofit groups, private-sector businesses, and citizens.

The Commonwealth response and recovery efforts must be integrated and coordinated with the other Commonwealth Government agencies, reflecting individual jurisdictional capabilities, and the unique requirements of any disaster. A common framework supported by standard operating procedures provide a basis from which multiple agencies can work together to prepare for, protect against, respond to, recover from, and mitigate all hazards.



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Document Change Log

The most current copy of this document, including any changed pages, is available on the WebEOC platform and PREMB Preparedness Division. Send recommended changes or comments to PREMB Email Drop Box: eoc-planning@prema.pr.gov.

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Annex G: Hurricanes

1 Introduction

The geographical location of Puerto Rico, between the Atlantic Ocean and the Caribbean Sea, places the island on the path of weather events, such as hurricanes. This factor causes the island to face a hurricane season that runs officially from June 1 to November 30 every year. The long period of time that this season spans, the magnitude of these phenomena and their potential impact make hurricanes and tropical storms the most frequent natural hazard in Puerto Rico.

In order to develop the planning and preparation actions necessary to safeguard life and resources in Puerto Rico, information is continuously studied related to this type of event. The scientific information used in Puerto Rico related to hurricane occurrence is from the U.S. National Oceanic and Atmospheric Administration. This unit has the National Weather Service (NWS), an agency with the necessary resources and technology to be able to predict atmospheric and climate events. The NWS through the National Hurricane Center (NHC) continuously updates information related to weather activities.

Hurricanes are dangerous because of their spontaneous formation and erratic movement, as well as their potential for destruction and the ability to affect large areas. One of the consequences of hurricanes is torrential rains. These, in turn, can lead to severe flooding and landslides that change them into serious threats because of the damage they cause after passing through. To guarantee that all the necessary steps are taken to safeguard the life and property of citizens, vigilance, activation of protocols and other preventive measures are necessary before the arrival of a hurricane. This annex is one of the components of the Specific Hazards or Incidents Annex of the Puerto Rico All-Hazards Plan (AHP), as developed by the Puerto Rico Emergency Management Bureau (PREMB by its English acronym). This document details emergency management actions in the event of natural hazards caused by atmospheric events, such as hurricanes.

1.1 Purpose

The purpose of this Hurricane-Specific Hazards Annex is to serve as a guiding tool for emergency planning, preparedness and response actions to the dangers posed to the island by the occurrence of a hurricane.

1.2 Scope

This Hurricane-Specific Hazards Annex applies to all government agencies (state and local), the private sector, non-governmental organizations (NGOs) and the general public in Puerto Rico's jurisdiction.

1.3 Situation

To carry out proper planning, action strategies are designed based on the worst-case scenario that poses a threat and danger to Puerto Rico. Before an atmospheric natural hazard occurs, the impact of a Category 4 hurricane is described, as well as the desired outcome. The situation used for planning envisages a possible scenario as discussed in the Threat and Hazard Identification and Risk Analysis (THIRA) for Puerto Rico, 2019.

1.3.1 Risk Analysis Summary

As established above, the planning described in detail in this annex is based on a possible hurricane hazard scenario for Puerto Rico. Given that, THIRA 2019 saw a hurricane with sustained winds of 140 mph (Category 4) making landfall in the Municipality of Humacao in the east coast of Puerto Rico at 02:00 a.m. It is moving westward at a speed of 12mph. The hurricane is causing catastrophic effects on the ground for 8 straight hours in the whole island as it cross and left the island thru the northwest coast (Municipality of Aguadilla). On higher grounds, gusts exceed 162 mph winds (Cat 5 hurricane). Eighty percent (80%) of the island is without water and 100% without electricity. There are floods of over 4 feet of water in different municipalities of the island and blocked and intransitable roads due to poles and fallen trees. The rivers have burst its banks and there is no communication by cell phone and telephone. The citizenship is desperate due to the lack of communication and the hospitals are at capacity and operating with an electric plant.

1.3.2 Core Capabilities Assessment

This annex has adopted the Core Capabilities established in the National Preparedness Goal (NPG). They are grouped into five mission areas: prevention, protection, mitigation, response and recovery. These Core Capabilities will provide the structure for preparedness and to strengthen the capabilities of response teams to handle incidents while facing the threat and dangers posed to Puerto Rico by the occurrence of a hurricane.

Below is a table with a detailed description of these capabilities, as grouped by each mission area with corresponding actions while facing of the threat from a hurricane.

Table 1: Core Capabilities or Mission Area while facing the threat of a hurricane

Mission Area	Core Capabilities	Actions
Common (applies to the 5 mission areas)	Planning	Execute the preparation of Puerto Rico's All-Hazards Plan (AHP) and personal plans before the phenomenon makes landfall.
	Notification and Public Information	Disseminate coordinated and reliable information.
	Operations Coordination	Coordinate operations across all levels in Puerto Rico.
Prevention	Forensics and Assignment (Attribution)	Conduct forensic analysis for the preparation of a phenomenon in an effort to prevent initial or follow-on emergency and/or swiftly develop counter-options.
Prevention/ Protection	Intelligence and Shared Information	Provide timely, accurate, and actionable information resulting from the planning, direction, collection, exploitation, processing, analysis, production, dissemination, evaluation, and feedback of available information concerning physical.
	Interdiction and Intervention	Delay, divert, intercept, halt, or secure threats and/or hazards.

	Screening, Search and Detection	Identify, discover, or locate threats and/or hazards through active and passive surveillance and search procedures.
Protection	Access Control ID Check	Provide physical security to protect and control access to critical infrastructure during the emergency.
	Cyber Security	Ensuring the safety, reliability and availability of critical information by activating emergency SOPs.
	Physical Protective Measures	Implement procedures and policies to protect critical infrastructure.
	Risk Management for Protection Programs and Activities	Identify and assess hazards, vulnerabilities and consequences for critical infrastructure.
	Provide Integrity and Safety in Series	Safeguarding ports, oil refineries, roads and distribution centers.
Mitigation	Community Resilience	Make available to the community any risk analysis-related to study of the mitigation program.
	Long-term Vulnerability Reduction	Reduce critical infrastructure vulnerability using the Risk Management study. Information related to critical infrastructure has the following sectors and will be validated with DHS Critical Infrastructure POC, the sectors are defined as: Communications & IT, Banking and Finance, Energy, Water and Waste Water, Dams, Transportation, Critical Manufacturing, Defense Industrial Bases, Commercial Facilities, Government Facilities, Food and Agriculture, Chemical Sector, and Healthcare and Public Health Sector. Those areas will be merged into the Response Community Lifelines as well.
	Risk and Disaster Resilience Analysis	Community-wide participation, including the private sector, in the development and maintenance of plans that incorporate hazard mitigation and risks.
	Identifying Hazards and Threats	Prepare the Community Emergency Plan using information about hazards or risks during a hurricane.
	Critical Transportation	Coordinate with Emergency Support Functions (ESFs) #1, #6, #7, #8, #9 and #16 during conditions requiring the following: <ul style="list-style-type: none"> ❖ Assess the conditions of the island's main roads.

<p>Response</p>		<ul style="list-style-type: none"> ❖ Provide transportation to shelters for an estimate of 20K citizens. ❖ Provide transportation for the injured citizens of Vieques and Culebra to travel to Ceiba. ❖ It is estimated that < 40% of the rural roads will be blocked. ❖ Mass transportation systems (TU and AMA) will be inoperative.
	<p>Environmental Response/Health and Safety</p>	<p>Coordinate with ESFs #8, #11 during conditions requiring the following:</p> <ul style="list-style-type: none"> ❖ Monitor water quality considering an estimate of 2 treatment plants are inoperative. ❖ Plan for fuel shortages due to damages in the ports' storage spaces. ❖ Removal and disposal of an estimated 1M yards³ of debris. ❖ Assist about 2.5K individuals who will need medical care. ❖ Dispose of dead animals having an estimate of 2K remains.
	<p>Fatality Management Services</p>	<p>Coordinate with ESF #8 possible activation of the Mass Fatality Plan based on the Annex of the Puerto Rico Forensic Sciences Bureau that involves more than 100 fatalities.</p>
	<p>Mass Search and Rescue Operations</p>	<p>Coordinate with ESF #9 conditions requiring search operations in around 15K affected structures, estimating 75% dwellings and 40% having domestic pets.</p>
<p>Response</p>	<p>Mass Care</p>	<p>Coordinate with ESF #6, #7, #8, #11 about conditions requiring the following:</p> <ul style="list-style-type: none"> ❖ Shelter capacity 83K people. Pandemic conditions safety measures, shelters capacity 42K. ❖ Approximately 700K people have functional and access needs. ❖ Provide food services to 500K people. ❖ Shelter and feed an estimate of 1K pets. ❖ Coordinate transportation and accommodation to a safe place in Ceiba to an estimated 500 tourists located in Vieques and Culebra.

Response	Safety and Protection On Site	Coordinate with ESF #13 and ESF #16 for conditions requiring support to the 78 municipalities, active shelters, and distribution centers.
	Operational Communications	Coordinate with ESF #2, Puerto Rico Telecommunications Bureau on the possibility that 60% of the first responders' communication network is inoperative and will affect the data access.
	Public and Private Resources and Services	<p>These actions should be carried out within a 72-hour period maintaining coordination with ESFs #3, #4, #6, #7, #13, #17, #18 during conditions requiring the following:</p> <ul style="list-style-type: none"> ❖ Mobilize and deliver resources and services to meet the needs of the population. ❖ Two (2) water treatment plants are inoperative. ❖ Five (5) of the fuel stations used by the first responders are inoperative. ❖ The fuel port terminal is inoperative. ❖ All airports are inoperative. ❖ 95% of the island is without electricity. <p>Coordinate the needed support with the private sector for ESF's activities.</p>
	Public Health and Medical Services	<p>Coordinate with ESF #8 the necessary actions within a 72-hour period under conditions that overload medical services and require public health measures due to the following:</p> <ul style="list-style-type: none"> ❖ Provide medical assistance to over 6K victims. <p>The possible activation of the Mass Fatality Plan based on the Puerto Rico Forensic Sciences Bureau Annex that involves more than 100 fatalities.</p>
	Situational Assessment	In a 36-hour period, corresponding actions should be taken in coordination with all ESFs (#1-19), to deliver needed information for decision-making involving government, private sector and civic resources in a scenario in which 60% of the information is not available due to

		communication problems and system access.
Response/Recovery	Infrastructure Systems	<p>Necessary actions must be taken to restore critical infrastructure in affected areas during a 90-day period maintaining coordination with ESFs #1, #3, #10 and #17 due the following conditions:</p> <ul style="list-style-type: none"> ❖ 20 healthcare facilities have been affected. ❖ 3 emergency management facilities have been damaged. ❖ 60% of the communications network is inoperative. ❖ Total Puerto Rico’s population of 3,293,526 have been impacted (<i>source: U.S. Census 2015-2019</i>).
Recovery	Economic Recovery	<p>In a 30-day period, appropriate actions should be taken to assess the economic impact and prepare an economic recovery plan considering the following:</p> <ul style="list-style-type: none"> ❖ An estimated damage of \$120M in direct losses. ❖ An estimate of about \$200M in indirect losses in businesses. ❖ 40% of the community's shops (supermarkets, banks, pharmacies, etc.) will be closed.
	Health and Social Services	<p>In a 30-day period, appropriate actions to restore basic health and social services functions should be carried out, maintaining coordination with ESF #8, as well as address mental and physical health needs in areas where conditions such as the following:</p> <ul style="list-style-type: none"> ❖ 2 major private hospitals have been impacted. ❖ 1 of the psychiatric hospitals in San Juan has been damaged. ❖ 5 community health facilities have been damaged.
	Housing	<p>These actions should be carried out within 60 days, maintaining coordination with ESF #6, to define housing requirements and identify those available including accessible options to meet the following conditions:</p>

Recovery		<ul style="list-style-type: none"> ❖ About 35K sheltered people. ❖ An estimate of 1K animals needing shelter. ❖ About 2.5K destroyed dwellings. ❖ People requiring temporary, non-congregate housing 15K.
	Natural and Cultural Resources	<p>Within 60 days, the environmental and cultural impact should be assessed, in coordination with the ESFs #3 and #11, in the following conditions:</p> <ul style="list-style-type: none"> ❖ An impacted 30 historical facilities. ❖ About 80K yards³ of vegetative debris generated. ❖ About 40K yards³ of debris produced from other materials. ❖ About 5K yards³ of hazardous debris.
	Community Planning Capacity Building (CPCB)	<ul style="list-style-type: none"> ❖ Provide education by peer-to-peer forums and workshops to recovery planners and officials. ❖ In charge of supporting the Recovery Planning in the communities and all stakeholders to begin an organized process. ❖ Manage the capacity needed to implement recovery plans to help communities quickly define local capacity building needs and identify post-disaster resources to fill those needs. ❖ Training and other just-in-time materials are available through the Community Recovery Management Toolkit and other partner resources.

1.4 Planning Assumptions

Puerto Rico, due to its geographical location, is subject to the impact of naturally originating incidents, such as hurricanes. The consequences of this type of atmospheric hazard could lead to a local emergency or result in a catastrophic event. For these purposes, this annex is based on the planning assumptions set out in Puerto Rico All-Hazards Plan (AHP). In addition, there are certain emergency considerations that are generated as a result of a hurricane in which the following planning assumptions will be adopted.

- ❖ Puerto Rico faces a hurricane season that extends officially from June 1st to November 30th each year. Therefore, the occurrence of an atmospheric disturbance with scalable capacity can arise at any time during that period.

- ❖ The hurricane or potential weather systems imminence alert for the area will be received at least 120 hours in advance through the National Weather Service and the National Hurricane Center.
- ❖ The alerting time will be used for the preparation of the jurisdiction of Puerto Rico implementing the plans, protocols and procedures previously established in coordination with this annex and the Puerto Rico AHP.
- ❖ There will be enough preparation time to implement this annex and mobilize the necessary resources. This is assuming that hurricane watch will be issued at least 36 hours before the period when the phenomenon is expected to make landfall and/or hurricane advisory or warning will be 24 hours before.
- ❖ The Governor of Puerto Rico, based on the recommendation of the Commissioner of PREMB, may declare a state of emergency to suspend regular government functions.
- ❖ The population of Puerto Rico will respond to evacuation orders or else they will carry out personal and family preparedness measures to stay in their homes in the imminence of a hurricane.
- ❖ Actions of evacuation must be completed 24 hours before the phenomenon is close to landfall.
- ❖ A hurricane, in any of its phases of development, can cause large amounts of rain that can produce flooding and landslides.

2 Operations Concept

Planning, preparedness and response operations for an atmospheric hazard such as a hurricane will be carried out as established in this annex in compliance with the provisions of Puerto Rico All-Hazards Plan (AHP). These operations will start locally with state assistance. This in case that resources at the local level have been exhausted or do not exist.

2.1 Advisory and Warning

Information related to alerts about the incidence of an atmospheric event affecting the jurisdiction of Puerto Rico will be received from the National Weather Service (NWS). In Puerto Rico, weather conditions are monitored year-round, with a particular vigilance during the official hurricane season (June 1 to November 30). This allows us to enjoy a time period of approximately 120 hours to learn about the development of a disturbance that may affect the area. Within this time span, it is expected that NWS will be able to provide information regarding the phenomenon, including releases of hurricane notices (see Appendix G-2), about 36 hours before the period when the phenomenon is expected to make landfall. As well as the issuance of the hurricane advisory or warning (see Appendix G-2) 24 hours before the risk of landfall.

2.2 Activation and Implementation

The activation of this annex will be carried out by the Governor of Puerto Rico or their authorized representative, following the recommendation of the Commissioner of PREMB. Such activation will require the execution of certain actions to ensure the implementation of preparedness and response activities in the event of a hurricane. Operation levels will be used in order to carry out the corresponding actions. The time period is determined for these levels, before the arrival of tropical storm speed winds (see Appendix G-1), as well as the expected response actions. This information is detailed in the next section. This phenomenon can cause flooding and other effects as dams damages that will require attention (see Appendix G-5 and G-6).

2.3 Levels of Activation

This annex includes five (5) Levels of Activation with Level 1 being the largest. At the time of activation, the Governor, Secretary of the Department of Public Safety, PREMB Commissioner, or their designees will determine which activation level will be used. A vast majority of all incidents are a Level 5 to Level 3 activation. The table is presenting a brief summary of the activities to be carried out when confronting the threat of an atmospheric event as a result of a hurricane. These levels establish a structure of preparedness and response across time periods to execute different actions aimed at safeguarding life and property of the Puerto Rican population. With the purpose of determining response actions in these levels, different time periods are utilized as a reference before the arrival of wind with a tropical storm speed. The above considerations are described in the table below:

Figure 1: Levels of Activation

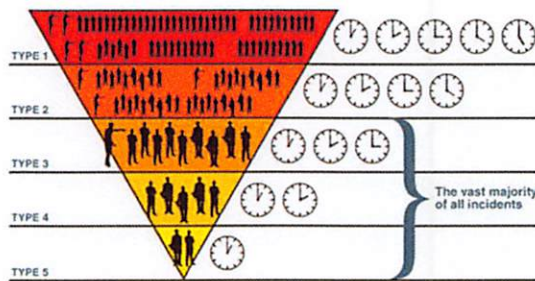


Table 2: Levels of Activation for Tropical Storms

Levels of Activation for Tropical Storms		
Level of Activation	Time Period	Actions
5	June 1- November 30 of each year	<ul style="list-style-type: none"> ❖ Includes normal day-to-day operations during which there is no weather threat. ❖ The Emergency Operations Center (EOC) is not activated. ❖ Weather activity in the area is monitored as reported by the National Weather Service. ❖ PREMB Control is monitoring activities. ❖ In this monitoring phase, plans, guides, protocols, procedures, policies, etc., are reviewed, updated, and developed.

<p>4</p>	<p>120 hours</p>	<ul style="list-style-type: none"> ❖ A tropical storm is involved with potential impact in 5 days within the capacities of the municipalities. ❖ Appropriate plans, protocols and procedures are activated in preparation for the tropical storm advisory. ❖ Involves an incident or likely event that is within the capabilities of the local government and the results are limited to the need for Commonwealth assistance. ❖ The notification, which could be generated by a 9-1-1 call, is limited to Commonwealth agencies that have regulatory or normal day emergency responsibilities as requirements. ❖ The Municipal Emergency Management Offices (OMME) will maintain communication with the corresponding PREMB Zone to monitor the situation and respond to requests for assistance.
<p>3</p>	<p>72 hours</p>	<ul style="list-style-type: none"> ❖ Giving follow-up to the tropical storm advisory with the potential to become a hurricane that will likely require the assistance of some state agencies. ❖ Applicable state agencies will be alerted. ❖ A limited staff will be in the PREMB EOC with the interagency essential for the response. ❖ Daily activities are altered to respond to the situation. ❖ Shelters are prepared to receive citizens once evacuation orders are issued.
<p>2</p>	<p>48 hours</p>	<ul style="list-style-type: none"> ❖ Monitoring is maintained on the process of the phenomenon. ❖ The PREMB EOC is activated to maintain monitoring of the system and initiate preparedness actions facing the imminence of a phenomenon, having the potential of activating this annex. ❖ The Command Staff, Operations Section, Planning Section, Logistics Section, and Finance/Administration Section, EOC Branches and PREMB Zones are at least partially activated 24 hours a day at the PREMB EOC. ❖ Public announcements and press conferences are coordinated. ❖ The Governor of Puerto Rico may declare a State of Emergency to suspend regular government functions. ❖ Shelters are opened and evacuations are ordered for areas posing the risk of impact from the phenomenon.

1	24 hours	<ul style="list-style-type: none"> ❖ The potential impact of the phenomenon is expected within 24 hours for Puerto Rico. ❖ All protective actions in preparation for potential impact must be completed. ❖ Evaluating with ESF #1 agencies decisions related to the boats system and operating schedules. ❖ Evacuation activities must be completed, and shelter management supported. ❖ The Governor of Puerto Rico may declare a State of Emergency. ❖ PREMB EOC is fully staffed and continues activated with the relevant interagency liaisons updating their information. ❖ The Zones requests assistance from PREMB through the implementation of the emergency response network (ERN). ❖ The presence of federal support from Region II, the State Liaisons, and IMAT should be necessary, if they have not previously been requested.
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3 Response

Response actions for an atmospheric hazard caused by a hurricane begin with the notification of an atmospheric event with potential of direct and indirect impact to the Puerto Rico region. These actions involve numerous efforts to safeguard life and property. Once an event is notified, the operating levels will change from Level 5 to Level 4 and a particular priority will be given to the efforts to achieve full compliance with the actions. The actions outlined in the Communications section of this Annex and the Puerto Rico All-Hazards Plan (AHP) will implement the corresponding communications with agencies, municipalities and other concerned parties regarding the emergency. As the activity related to the phenomenon changes, response actions will be modified, including those involved.

Response to the imminence of this type of hazard will be supported by the provisions of the Emergency Support Functions (ESFs) of the AHP. This annex includes the central areas to attend to the operations of any type of emergencies and/or disasters on the island (see Appendix G-3 and G-4 for reference). Some general areas considered during the response to an emergency resulting from a weather phenomenon are then broken down by the occurrence of a hurricane with its corresponding efforts.

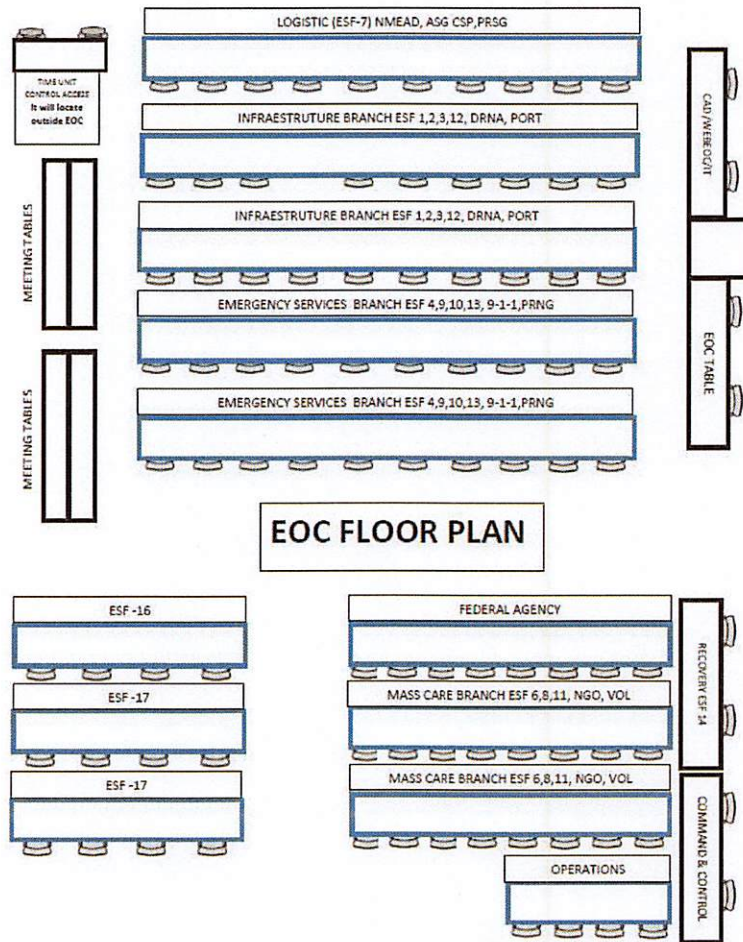
Table 3: Response / Recovery Operational Phases

Recovery / Response Operational Phases								
1			2			3		
Pre-Incident Operations			Incident Operations			Recovery and Restoration Operations		
1a	1b	1c	2a	2b	2c	3a	3b	3c
Monitor Threat	Elevated Threat	Credible Threat	Immediate Response	Community Stabilization	Sustained Operations	JFO Program Delivery	Long-term Recovery Operations	Regional Closeout

Table 4: Puerto Rico Emergency Support Functions (ESFs)

Puerto Rico Emergency Support Functions (ESF)					
#	ESF	Function	#	ESF	Function
1	ESF #1	Transportation	11	ES #11	Agriculture
2	ESF #2	Communications	12	ESF #12	Energy
3	ESF #3	Public Works	13	ESF #13	Public Safety
4	ESF #4	Firefighting	14	ESF #14	Recovery
5	ESF #5	Planning & Emergency Management	15	ESF #15	Emergency Public Information
6	ESF #6	Mass Care	16	ESF #16	Military Support
7	ESF #7	Logistics	17	ESF #17	Business and Industry
8	ESF #8	Health and Medical Services	18	ESF #18	Government Services
9	ESF #9	Search and Rescue	19	ESF #19	Volunteers
10	ESF#10	Hazardous Materials			

Figure 2: Emergency Operation Center (EOC) Floor Plan



3.1 Evacuation

Weather hazards pose a significant challenge in relation to the activities related to emergencies and disasters. These phenomena have the potential to change their course of action in short periods of time, which often impacts the operations to be performed in response to the event. Evacuation is one of the elements that is considered in anticipation of this type of hazard along with its changing nature.

Puerto Rico's geographical reality exposes its population to a particular vulnerability to weather events. A considerable part of the island's citizens resides in coastal areas; therefore, an atmospheric phenomenon exposes them to the onslaught of cyclonic tides. This type of activity requires these individuals to move to safe areas in advance. In addition, Puerto Rico has a wide mountainous zone that historically has been victim of landslides caused by the after-effects of inclement weather events. This also requires advance notification and relocation of those at risk in these hazards. The evacuation actions to be executed under this annex are those designed by each municipality evacuation plan which is reviewed on a yearly basis.

3.2 Shelters

The management of shelters depends mostly on the strategies designed by ESF #6 - Mass Care, Emergency Assistance, Housing and Human Services. As established by ESF #6, PREMB plays the leading role in these actions supported by other government agencies, as well as of voluntary and non-governmental organizations.

3.2.1 General shelters

In Puerto Rico, 338 facilities have been identified with the ability to be used as shelters to house individuals in the event of an emergency such as the incidence of a hurricane. The facilities, distributed throughout the 78 municipalities, are classified as shelters. These shelters are mostly public schools, a total of 269, of the Puerto Rico Department of Education (DE). The remaining 69 are either private facilities or facilities of the municipalities. Shelters enabled in Puerto Rico to provide accommodation to citizens in the event of an emergency caused by a weather hazard have the capacity to house 83,416 people. However, to maintain social distancing due to a pandemic situation, the capacity for accommodation and shelter would be for 41,708 people. As part of the sheltering plan, an outline to transition to non-congregate sheltering as alternate options will be evaluated with federal assistance. These facilities, when facing a catastrophic emergency, without a pandemic condition, could expand their accommodation capacity and shelter some 96,038 people.

3.3 Vulnerable Populations

Emergencies and disasters are characterized by generating a number of casualties that can vary depending on the magnitude of the event. Among these victims are certain populations that are more vulnerable than others to the consequences of the incidents. They are identified as vulnerable populations since they have characteristics requiring attention in the delivery of services and resources.

3.3.1 People with functional and access needs

These individuals will be identified using the and U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates and Puerto Rico Department of Health Registry of Population with Functional and Access Needs. This registration is a voluntary census through which citizens with this type of need, or a representative, register to assist them in case they need support with evacuating and sheltering in the event of an emergency. According to the Department of Health, people enrolled in this registry may have a physical, sensory, or cognitive impairment that makes it difficult to evacuate them. In order to guarantee and safeguard the lives of these individuals, the Department of Health will work in coordination with other support agencies through ESF #8 - Public Health and Medical Services to manage the mobilization of needed resources for the corresponding evacuation. People with functional and access needs represent a 21% of the population.

Table 5: Census Population with Functional and Access Needs

Total Population Hearing Difficulty	Total Population Vision Difficulty	Total Population Cognitive Difficulty	Total Population Ambulatory Difficulty	Total Population Self-care Difficulty	Total Population Independent Living Difficulty
143,659	211,395	307,734	388,279	168,038	311,622

3.3.2 Institutionalized people

Institutionalized persons are individuals who are receiving treatment, care or are supervised in certain facilities such as hospitals, nursing homes and/or prisons. These people rely heavily on the assistance of caregivers and supervisors who guarantee their complete well-being. That is why institutions serving this type of population must comply with the necessary planning and preparation measures by taking the pertinent precautions to safeguard the lives of individuals, as well as care for staff in their facilities. These institutions must maintain their plans and protocols up to date in order to respond to an emergency caused by a hurricane. They need to coordinate in advance with the municipal government in which they are located if they require any assistance with their preparation. It is also necessary to maintain communication networks to request support or assistance during or after the incidence of the phenomenon.

3.3.3 Minors

As established in ESF #6 - Mass Care, Emergency Assistance, Housing and Human Services, the State's response to communities recognizes the diverse and special requirements of minors. This way, the state response should ensure that the physical and mental needs of minors are adequately addressed and that minors will remain with their families or caregivers as much as possible during evacuation, transportation, shelter or other services. For these purposes, ESF #6 actions aimed at this group, including those for the Puerto Rico Department of Family Affairs and the other participating support agencies, will ensure that the needs of this population are met.

3.3.4 Individuals with language barriers

The language barrier occurs when communication between individuals are affected as a result of speaking different languages. In the case of Puerto Rico, these individuals may be identified as people who do not speak Spanish and/or English. In the event of an emergency, these individuals require additional assistance of people proficient in their language, such as translators. In order to guarantee this type of assistance, it is necessary to coordinate relevant arrangements with the consulates having headquarters on the island, through the Department of State. In addition, other arrangements can be coordinated with the University of Puerto Rico, as well as with the private sector.

3.3.5 Pets

Law 154 of 2008 — Law on the Welfare and Protection of Animals, states that animals are "a fundamental part of the lives of citizens and, consequently, of society". Because of this, pets are an important consideration during the of preparedness and response actions for a weather-related emergency event. For these purposes, individuals are advised to take the necessary measures in the family plans to provide safety and protection for their pets during an emergency and/or disaster event.

As established in the General Environmental Health Rules and Regulations of the Department of Health, every pet owner must register it in the municipality of residence. This regulation stipulates that municipalities will be responsible for such pet registration, as well as for maintaining regional or municipal shelters. These facilities, in prior coordination, can be accommodation spaces for pets.

4 Recovery

4.1.1 Debris Removal

One of the main consequences of atmospheric events such as hurricanes is the generation or occurrence of debris as a result of the onslaught of the weather phenomenon. In the event that a hurricane hits the island of Puerto Rico, it will be necessary to coordinate pertinent efforts for debris removal, of all kinds, as a result of the phenomenon. For these purposes, each municipality should have available their own debris management plan and related tasks will be coordinated through ESF #3 - Public Works and Engineering and ESF #11 - Agriculture and Natural Resources to ensure that work is carried out with the collaboration of support agencies and, if necessary, request additional assistance, as required.

Within the Puerto Rico Department of Transportation and Public Works (DTOP) response plan they account for the debris removal of all the state roads. As for the municipal roads rest on the responsibility of each municipality in coordination with the Solid Waste Authority of the Puerto Rico Department of Natural and Environmental Resources.

4.1.2 Public Health

Emergencies and disasters have the potential to generate a large number of casualties, including those of a fatal nature. These victims often require medical care or care from one of the different health disciplines, which could overload the service delivery scenarios and resource availability. To ensure adequate care for the health of the population, relevant tasks will be coordinated related to health care, public health, mental health, fatality management, among others, through ESF #8 - Public Health and Medical Services including the implementation of pandemic measures during hurricane response operations.

5 Organization and Assignment of Responsibilities

The Hurricane-Specific Hazards Annex, in accordance with Puerto Rico All-Hazards Plan (AHP) and National Response Framework, will organize its operations based on the Emergency Support Functions (ESFs). Through the activation, as necessary, of the different ESFs, coordination will be ensured to provide the necessary assistance to local governments or other sectors that require it (see section 2.3 of Emergency Support Function Mission Areas of the Puerto Rico AHP). In addition, it also specifies in the Puerto Rico AHP the responsibilities of the different government and private sectors that will participate in handling any type of incident in the jurisdiction of Puerto Rico.

Table 6: Emergency Support Function Coordinators and their Mission Area

ESF	ESF Lead Agency	ESF Support Agency (Coordinator)	Mission Area
ESF 1: Transportation	Department of Transportation and Public Works (DTOP)	Port Authority, Transportation Bureau and Other Public Services (NTSP), Highways, ATM, AMA, ATI	It coordinates the support, management of transport systems and infrastructure, transport regulation manages the state's airspace, and ensures the security of the national transport system.

			<p>Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Management and control of transportation systems ❖ Transportation security ❖ Stabilization and restoration of transportation infrastructure ❖ Movement restrictions ❖ Damage and impact assessment
ESF 2: Communications	Telecommunications Bureau	<p>PREMB (Radio Operators/Dispatch), Permit Management Office (OGPe), E-9-1-1 Call Centers</p>	<p>It coordinates the restoration of critical communications infrastructure, facilitates the stabilization of systems and applications to cyber-attacks, and coordinates communications support during response efforts. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Coordination with the telecommunications and computer industries ❖ The restoration and repair of telecommunications infrastructures ❖ Protection, restoration, maintenance of national cybernetic networks and information technology resources ❖ The supervision of communications within state response structures
ESF 3: Public Works	Department of Transportation and Public Works (DTOP)	<p>Electric Power Authority (AEE), Aqueduct and Sewer Authority (AAA), Department of Natural and Environmental Resources (DNRA) and Permit Management Office (OGPe)</p>	<p>Coordinates the capabilities and resources that facilitate the provision of services, technical assistance, engineering expertise, construction management, and other support to prepare for, respond to, and/or recover from a disaster or incident. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Infrastructure protection and emergency repairs ❖ Restoration of critical infrastructure

			<ul style="list-style-type: none"> ❖ Engineering and construction management services ❖ Emergency contracting support for lifesaving and life-sustaining services
ESF 4: Firefighting	Puerto Rico Fire Department	Department of Natural and Environmental Resources (DNRA), Civil Air Patrol (CAP), National Guard, U.S. Fire Service (USFS)	<p>Coordinates support for fire detection and suppression Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Urban, forest and rural fire suppression operations
ESF 5: Planning and Emergency Management	Puerto Rico Emergency Management Bureau (PREMB)	P.R. Planning Board, National Weather Service (NWS), Seismic Network of Puerto Rico	<p>Supports and facilitates multi-agency planning and coordination for operations in incidents that require State coordination. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Incident action planning ❖ Information gathering, analysis and dissemination ❖ Incident Assessment ❖ Incident Command ❖ Operations Center
ESF 6: Mass Care	Puerto Rico Emergency Management Bureau (PREMB)	Department of Housing, Department of Family, Department of Education, Mental Services, Chaplain Corps, Department of Health, DPI, Tourism Company	<p>Coordinates mass care and emergency assistance services, including:</p> <ul style="list-style-type: none"> ❖ Mass care ❖ Emergency assistance ❖ Housing during a disaster ❖ Human Services
ESF 7: Logistics	Puerto Rico Emergency Management Bureau (PREMB)	General Services Administration (GSA), Port Authority, Department of Treasury, Office of Management and Budget	<p>It coordinates the integration of incident planning resources, management and sustainment of logistical capabilities to meet the needs of survivors and rescuers. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ The integration of logistics planning into national incidents and the management and

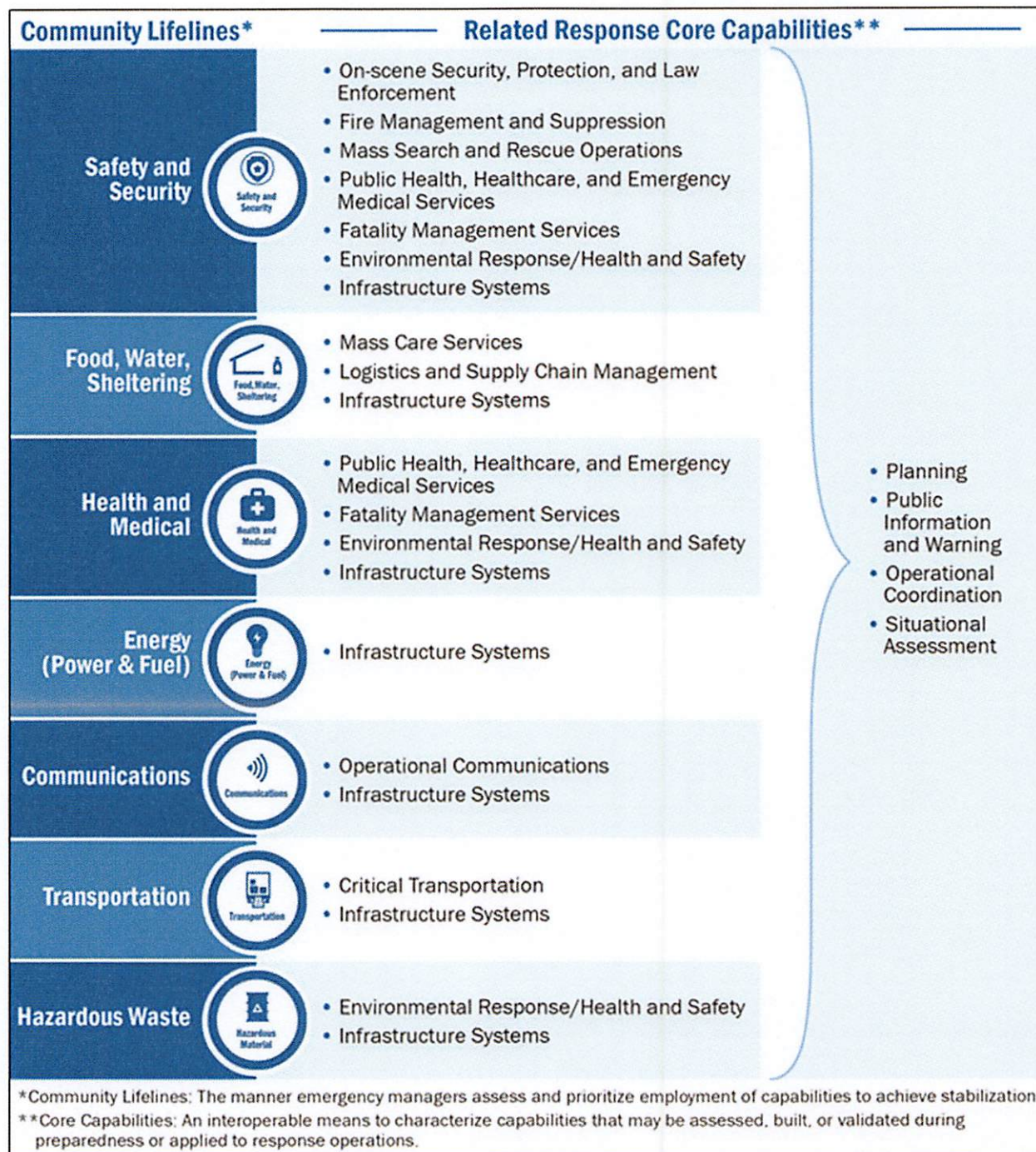
			<p>sustainment of capabilities</p> <ul style="list-style-type: none"> ❖ Resource support (e.g., facility space, office equipment and supplies, service contracting)
ESF 8: Health and Medical	Puerto Rico Department of Health (PRDOH)	Forensic Sciences Bureau, Medical Emergencies Bureau	<p>It coordinates the assistance mechanisms in response to a potential public health and medical emergency. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Public health ❖ Supporting the escalation of medical situations including the movement of patients ❖ Mental health services ❖ Mass Fatality Management
ESF 9: Search and Rescue	Puerto Rico Emergency Management Bureau (PREMB)	Firefighters (NBPR), Police Bureau (FURA), Department of Natural and Environmental Resources (DNRA), Civil Air Patrol (CAP)	<p>It coordinates the immediate deployment of search and rescue resources to provide specialized life-saving assistance. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Search and rescue in collapsed (urban) structures ❖ Maritime/coastal search and rescue ❖ Ground search and rescue
ESF 10: Hazardous Materials	Department of Natural and Environmental Resources (DNRA)	Firefighters (NCBPR), Transportation Bureau and Other Public Services (NTSP), Environmental Quality Board (JCA-DRNA)	<p>Coordinates support in actual or potential response to an oil or other hazardous material discharge and/or release. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Environmental assessment of the nature and extent of contamination of oil and hazardous materials ❖ Decontamination and cleanup of the environment
ESF 11: Agriculture	Department of Agriculture	Department of Natural and Environmental	<p>It coordinates a variety of functions designed to protect the state's food supply, respond to plant and animal pests and disease outbreaks, and protect</p>

		Resources: Vigilant Corps (DRNA)	<p>natural and cultural resources. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Nutritional assistance ❖ Responses to agricultural and animal health situations ❖ Technical assistance, coordination and support in the management of emergencies related to the agricultural and animal sector ❖ Safety and security of meat products, poultry and processed eggs ❖ Protection of natural and cultural resources and historical properties
ESF 12: Energy	Energy Bureau	PR Energy and Electric Power Authority (AEE)	<p>It facilitates the restoration of damaged power systems and components and provides technical expertise during an incident with radiological/nuclear materials. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Evaluation of power infrastructure, repair and restoration ❖ Coordination of power industry utilities ❖ Energy forecasting
ESF 13: Public Safety	Puerto Rico Police Bureau (PRPD)	Department of Corrections, Bureau of Special Investigations, Department of Justice, Vigilant Corps, Forensic Sciences Bureau, Port Authority, Department of Treasury	<p>It coordinates the integration of public protection, security capabilities and resources to support the full range of activities during incident management. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Security of facilities and resources ❖ Security planning and technical resource assistance ❖ Public protection and security support ❖ Access, traffic and crowd control support

<p>ESF 14: Recovery</p>	<p>Puerto Rico Emergency Management Bureau (PREMB)</p>	<p>Governor's Authorized Representative</p>	<p>Provides and manages the breadth of short- and long-term recovery support services required during the recovery phase of an emergency or disaster event.</p>
<p>ESF 15: Emergency Public Information</p>	<p>Puerto Rico Emergency Management Bureau (PREMB)</p>	<p>Joint Information Center (JIC)</p>	<p>It coordinates the accurate, coordinated, timely, and accessible dissemination of public information to affected audiences, including government, media, non-governmental organizations, and the private sector. It works closely with state and local officials to ensure dissemination to the entire community. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Public Affairs and the Joint Information Center (JIC) ❖ Intergovernmental Affairs (local, state) ❖ Private sector outreach ❖ Community relations
<p>ESF 16: Military Support</p>	<p>Puerto Rico National Guard</p>	<p>Army Reserve, Civil Air Patrol, State Guard, U.S. Coast Guard, DoD</p>	<p>Coordinates the actions of the Puerto Rico National Guard (PRNG) and other military branches, in support of the activities and efforts of the Government of Puerto Rico before, during and after incidents or disasters that put at risk by natural hazards and/or by human hands, the security/safety of citizens, public and/or private property, the environment and the preservation of law and constitutional order.</p>
<p>ESF 17: Business and Industry</p>	<p>PREMB Private Sector Liaison</p>	<p>Banks, Office of Insurance, Insurance Agencies, Commercial Businesses, Pharmaceuticals, Food Industry, Manufacturing Industry, Chemical</p>	<p>Coordinates the actions of Municipal, Commonwealth and Federal agencies and organizations to provide immediate short-term assistance for business, industry and economic stabilization needs. Works closely with state and local officials to ensure operability and services.</p>

		Industry, Tourism Industry	
ESF 18: Government Services	Governor's Office (La Fortaleza)	State Department, Legislative Branch, Judicial Branch, Superintendent of the Capital, Department of Treasury, Dept of Consumer Affairs	<p>It coordinates with the Government Agencies, the Legislative Branch, the Judicial Branch the essential services for the citizens and the continuity of the basic services for the security and protection of the citizens. It works closely with state and local officials to ensure that services are provided. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Consumer Services (DACO) ❖ Intergovernmental Affairs (local, state) ❖ Community relations
ESF 19: Volunteers	Puerto Rico Emergency Management Bureau (PREMB)	PR VOAD	<p>Coordinate with state and local governments effectively pre-identified and established activities or management with volunteer groups and faith-based organizations for donations and citizen support services. Work closely with state and local officials to ensure distribution and access of assistance to the entire community. Functions include, but are not limited to:</p> <ul style="list-style-type: none"> ❖ Coordination of solicited and unsolicited donations (physical and monetary) ❖ Private sector outreach and volunteer support groups ❖ Community relations

Figure 3: Community Lifelines and Related Core Capabilities



6 Direction, Control and Coordination

The direction, control, and coordination of the operations of this annex will be carried out in accordance with what is established in the Puerto Rico All-Hazards Plan (AHP) and Emergency Operations Center (EOC) Standard Operating Procedure (SOP), as adopted of the National Response Framework, keeping the specified organizational elements. In addition, all activities to

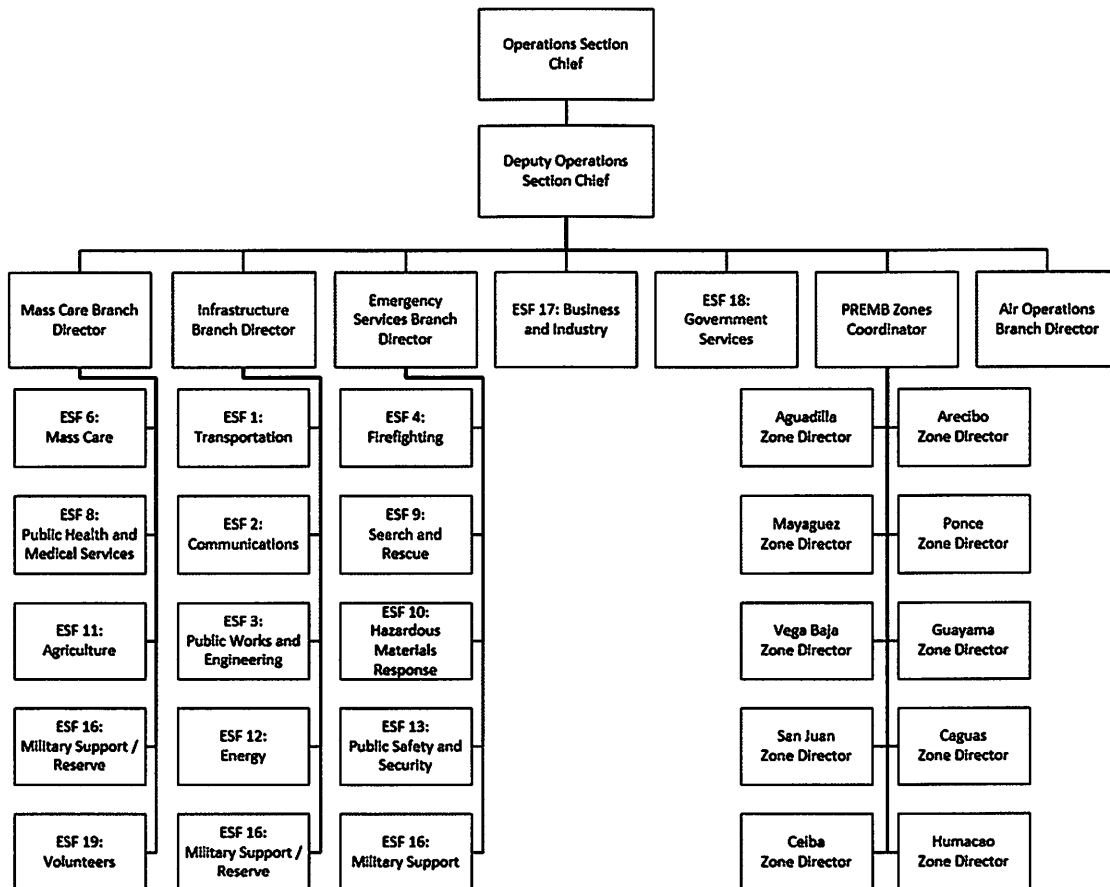
be carried out will maintain the command and coordination structure of the Incident Command System, as detailed in the Puerto Rico AHP.

7 Information Gathering, Analysis and Dissemination

The gathering, analysis and dissemination of incident-related information and response actions will be directed from the EOC. This will be supported by the gathering of hurricane-related information from the National Weather Service (NWS) and the National Hurricane Center (NHC), agencies of the U.S. National Oceanic and Atmospheric Administration (NOAA).

The NWS through its resources and technology is responsible for predicting atmospheric and climate events. The NWS through the NHC continuously updates information related to meteorological activities. The information provided by these agencies will be used to carry out the proper planning and preparation for the incidence of weather events on the island. In addition, this information will be shared with ESFs leaders in the EOC who must keep their information on damage assessments and resource status up to date to expedite decision-making. PREMB will be developing the Information Collection Plan to ensure the accurate and timely flow of information.

Figure 4: EOC Organizational Chart - Operations



8 Communications

As mentioned before, the agency responsible for providing information related to weather events is the National Weather Service (NWS). In Puerto Rico, NWS offices are located on Highway 190 in the Municipality of Carolina. The NWS maintains communication with PREMB to notify potential disturbances that may threaten lives or property at the local level or throughout Puerto Rico's jurisdiction, including coastal areas.

The NWS uses the Emergency Alert System (EAS) operated by the Federal Communications Commission (FCC) to issue emergency communications related to weather events. When faced with the specific need to alert the people of Puerto Rico about an atmospheric event, the NWS in collaboration with PREMB, will activate the EAS. This alert system activates a communications network, through radio and television stations, cable television, billboards, loud speakers in communities, radio amateurs, radio broadcasters, IPAWS, HDTV and satellites, which transmits the corresponding alert to the public.

9 Finance and Administration

PREMB, represented through General Service Administration (ASG), is the central point of contact for all emergency requisitions process. Department of Public Safety (DSP) will support this process with the administrative and finance personal staff, as establish in the Circular Letter ASG CC-2021-03.

Each agency purchasing agent will be responsible to process/activate procurement process for the specific agency using the tool created in the WebEOC system. A record of each transaction should be file and secure for auditing purpose.

10 Development and Maintenance

This document, prepared by PREMB Preparedness Division staff, has been developed using FEMA's "Developing and Maintaining Emergency Operations Plans-Comprehensive Preparedness Guide" (CPG) 101 version 2.0 November 2010, as a guide. As well as other related guides, codes or statutes. The maintenance of the document will be carried out by the Planning Division and the Operations Division of PREMB, who maintains direct coordination in the maintenance procedures of this document.

11 Authorities and References

A. Authorities

- ❖ United States Robert T. Stafford Disaster Relief and Emergency Assistance Act Disaster and Emergency Assistance Act.
- ❖ HSPD-5 - Domestic Incidents Management of the United States Department of Homeland Security.
- ❖ HSPD-8 - National Preparedness of the U.S. Department of Homeland Security.
- ❖ Law No. 20, April 10, 2017 - Law of the Department of Public Safety that integrates PREMB.

- ❖ Law 154 of 2008 -Law for the Welfare and Protection of Animals of the Commonwealth of Puerto Rico.
- ❖ Public Law 109-308, October 6, 2006 - Pets Evacuation and Transportation Standards Act of 2006.
- ❖ Executive Order 2014 -44 - Executive Order of the Commonwealth of Puerto Rico.
- ❖ General Regulations on Environmental Health – Department of Health of the Commonwealth of Puerto Rico.

B. References

- ❖ Department of Homeland Security. (May 2013). National Response Framework (NRF), Second Edition.
- ❖ Department of Homeland Security. National Incident Management System (NIMS).
- ❖ Department of Homeland Security. Incident Command System (ICS).
- ❖ Department of Homeland Security. Federal Emergency Management Agency. (November 2010). Comprehensive Preparedness Guide (CPG) 101 version 2.0.

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Appendix G-1: Development Stages of Hurricanes

1 Hurricanes

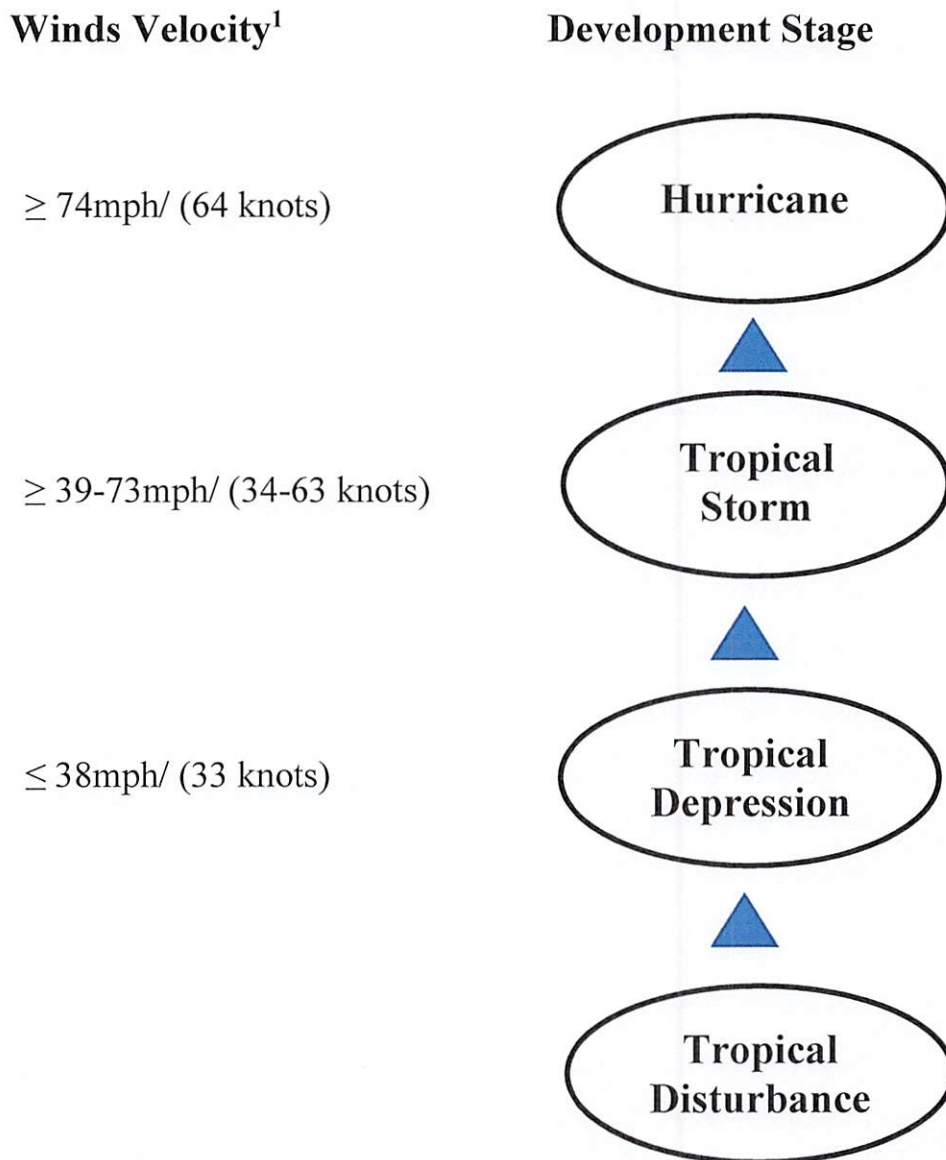
Hurricane is the term used to describe a severe tropical storm that originates in the Atlantic Ocean and the eastern Pacific Ocean. This type of storm is scientifically known as a tropical cyclone. These atmospheric phenomena are classified differently as there are changes in the winds generated by the air that form it.

These modifications in the sustained winds intensity allow the tropical cyclones to be classified into the following stages of development:

- ❖ **Tropical Disturbance** - It is a discrete atmospheric system with an apparent organization that generally has a diameter of 200 to 600 km with a movement nature that maintains its identity for a period of 24 hours or more.
- ❖ **Tropical Depression** - It is an organized system of clouds with a defined circulation in which the maximum speed of sustained winds is less than 39 miles per hour.
- ❖ **Tropical Storm** - It is an organized system of clouds with a defined circulation in which the maximum speed of sustained winds fluctuates between 39 and 73 miles per hour.
- ❖ **Hurricane** - It is a tropical cyclone with a maximum intensity in which maximum sustained winds that reaches or exceeds 74 miles per hour. This type of storm has a defined center that has a very low barometric pressure. This center is commonly known as the "eye", a space of calm around the winds that the phenomenon blows. The "eye" of the hurricane is generally about 20 to 30 miles long in diameter, located inside the storm that can extend up to 400 miles from that center.

As the hurricane approaches, the skies can turn dark and the wind tends to blow with greater force. This proximity of the phenomenon with the land frequently causes torrential rains, strong winds and electric discharge. The consequences of the incidents produced by the hurricanes make them serious threats due to the damage they generate after the hurricane. Below are two illustrations of the stages of development of a hurricane.

Figure 5: Stages of development of a Hurricane according to the speed of winds



¹ The winds speed is measured in units of distance reached in a period of time. Knots are used to frequently measure the speed of a boat or airplane. 1 knot = 1 nautical mile per hour = 6.076 Feet per hour; 1 Mile per hour = 5,280 feet per hour

Figure 6: Depiction of a hurricane life cycle



Depiction of a hurricane life cycle, from a tropical disturbance (easterly wave off the West coast of Africa) to a fully formed hurricane. Image credit: NOAA/NHC.

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Appendix G-2: Hurricane Alerts and Classification

The stages of hurricane development are usually accompanied by alerts, known as a watch, an advisory or a warning, that allows appropriate preparedness measures to be implemented. These alerts provide different spaces or time windows to perform the corresponding preparation actions. As established by the National Hurricane Center of the National Weather Service, understanding the difference between alert types is critical to being prepared for dangerous weather-related threats. For these purposes, they state that a watch is a notification that weather conditions are favorable for the occurrence of a threat or danger. An advisory or warning requires immediate action. These alerts are classified as follows:

- ❖ Tropical Storm Watch: This is the announcement that tropical storm conditions are possible within the specified area.
- ❖ Hurricane Watch: This is the announcement that hurricane conditions are possible within the specified area.
- ❖ Tropical Storm Advisory or Warning: This is the announcement that tropical storm conditions are expected within the specified area.
- ❖ Hurricane Warning: This is the announcement that hurricane conditions are expected within the specified area.

Due to the time required for preparation actions, these alerts are issued in advance of the incidence of the phenomena. Therefore, the alerts are issued 48 hours before the start of the winds with tropical storm force. On the other hand, an advisory or warning is issued 36 hours before the start of tropical storm force winds.

Once the winds of a tropical storm reach a certain speed, its classification changes to a hurricane. Hurricanes, according to the speed of their winds, are classified and identified by categories. The Saffir-Simpson scale is the measure used to establish the corresponding classification categories. The scale provides an estimate of the storm's strength and potential damage to structures based on the maximum speed of the hurricane's sustained winds. Below is the scale that categorizes hurricanes according to wind speed, estimated potential of wave height or cyclonic surge wave and types of damage.

Table 7: Saffir- Simpson Scale

Category	Wind Speed (mph)	Damages on land	Surge Heights (Feet)
1	74-95	Minimum	4-5
2	96-110	Moderate	6-8
3	111-129	Extensive	9-12
4	130-156	External	13-18
5	>157	Catastrophic	19 or >

Sources: <https://spaceplace.nasa.gov/hurricanes/sp/> / http://www.nhc.noaa.gov/pdf/sshws_2012rev.pdf

One of the incidents that causes damages representing a risk to life and property during a hurricane is the cyclonic storm surge. A cyclone surge is the abnormal increase in the level or height of the tide on the coasts during a hurricane. Sometimes the surge exceeds its height in meters and its amplitude can cover more than a mile along the coast. The cyclonic surge can begin to be seen up to 5 hours before the storm arrives and its destructive effect can affect low altitude coastal areas.

It is especially harmful when that effect adds up to the high tide, which causes greater damage and loss of life.

The cyclonic surge is a long dome-like effect that can extend from 50 to 100 miles along the coastline from the point where the hurricane makes landfall. The cyclonic surge reaches 4 to 5 feet during a Category 1 hurricane but can reach up to 20 feet in those of catastrophic impact or Category 5. The surge moving with high waves has a devastating effect on the coast and on the infrastructure that receives its energy. The higher the category of the hurricane and the lower the depth of the coast, the larger the size of the surge and therefore its effects. Along the coast, where the effects of the hurricane are directly received, the cyclonic storm surge will have a greater potential risk to life and property. In turn, the strength and intensity of the winds in that area will be greater.

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Appendix G-3: Hurricanes in Puerto Rico

Hurricanes are formed over the seas or tropical waters in the summer. These phenomena of nature are known throughout the northern and southern hemispheres maritime area, in the eastern and western sections of the Southern Indian Ocean and in the western section of the South Pacific Ocean, eastern Australia. In the case of Puerto Rico, the geographical location of the island places it in the trajectory of this type of phenomenon. Due to this particularity, we face a hurricane season that extends officially from June 1 to November 30 every year.

Hurricanes and tropical storms are the most common natural hazard in Puerto Rico. Cyclones that pose a danger to the island originate to the east of the Lesser Antilles between latitudes 100N and 180N. This type of phenomenon has consequences that cause extensive damages and losses.

The following table presents the types of tropical cyclone events (Cat. 1-5, tropical storm, sub-tropical storm, depression, extra-tropical and low) in Puerto Rico between 1867 and 2017. The information is based on the storms and hurricanes whose center made landfall over Puerto Rico or up to 86 miles from its coasts.

Table 8: Tropical Cyclone Statistics in Puerto Rico between 1867- 2017

Statistics	Storms and Cyclones that made landfall in Puerto Rico	Storms that hit Puerto Rico within 86 miles without landfall	Total storms that have affected Puerto Rico
Number of Storms	29	65	94
Average years between storms	16.1	1.10	0.91

Source: Publication, Cyclonic Activity of PR and its surroundings: 1867-2017, from Tania del Mar López Marrero and Abimael Castro Rivera. Project 1867 Disasters and Memories in PR

On September 20, 2017, the powerful Hurricane Maria entered Puerto Rico through the southeast of the island with winds of 155 mph. Nearly two decades passed from an intense hurricane over Puerto Rico, Hurricane Georges in 1998, and nearly 90 years in which the island was not hit by a hurricane with winds of such magnitude. Therefore, María became the second most intense hurricane recorded to hit the island after St. Philip II, in 1928, whose winds were estimated at 160 mph.

Of the 29 hurricanes that hit Puerto Rico directly between 1867 and 2017, 9 were severe hurricanes (Map 3, Table 1). Of these, 5 were hurricane Category 3: San Narciso (1867), San Felipe I (1876), San Roque (1893), San Ciriaco (1932) and Georges (1998); 3 were hurricane Category 4: San Ciriaco (1899), Hugo (1989) and María (2017); while 1 was Category 5: St. Philip II (1928). Most of these hurricanes, 8 of them, moved across the island; its trajectories from southeast to northwest or east to west impacted across Puerto Rico. While one of the hurricanes, Hugo, moved through part of the island: through Vieques, Culebra and through the northeast of Puerto Rico.

Figure 7: Map of the trajectory of cyclones over Puerto Rico or at 86 miles from its shores: 1867-2017

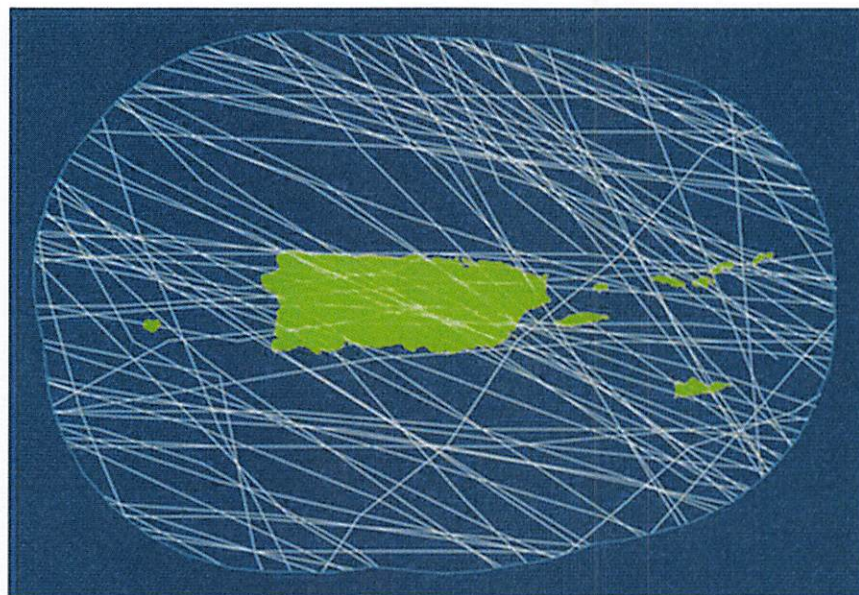


Table 9: General characteristics of the intense hurricanes that directly impacted Puerto Rico

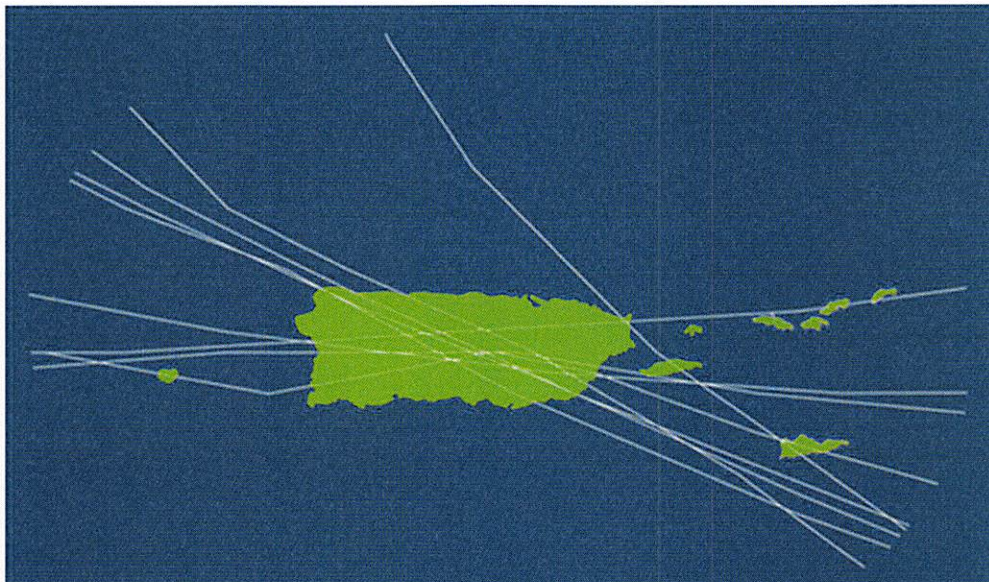
Hurricane	Date	Category	Approximate Trajectory
San Narciso	October 29, 1867	Category 3	Entered through Fajardo and exited through Mayagüez
San Felipe I	September 13, 1876	Category 3	Entered through Humacao-Yabucoa and exited through Mayagüez
San Roque	August 16, 1893	Category 3	Entered through Maunabo and exited through Quebradillas-Isabela
San Ciriaco	August 8, 1899	Category 4	Entered through Guayama-Arroyo and exited through Aguadilla
San Felipe II	September 13, 1928	Category 5	Entered through Yabucoa-Maunabo and exited through Aguadilla
San Ciprian	September 26, 1932	Category 3	Entered through Humacao and exited through Mayagüez
Hugo	September 18, 1989	Category 4	Passed through Vieques and then entered through Fajardo
Georges	September 21, 1998	Category 3	Entered through Humacao-Yabucoa and exited through Cabo Rojo
María	September 20, 2017	Category 4	Entered through Yabucoa and exited between Arecibo-Isabela

Source: <http://uprm.edu/cms/index.php?a=file&fid=17127>

Figure 8: Map of the trajectory of hurricanes over Puerto Rico: 1867-2017

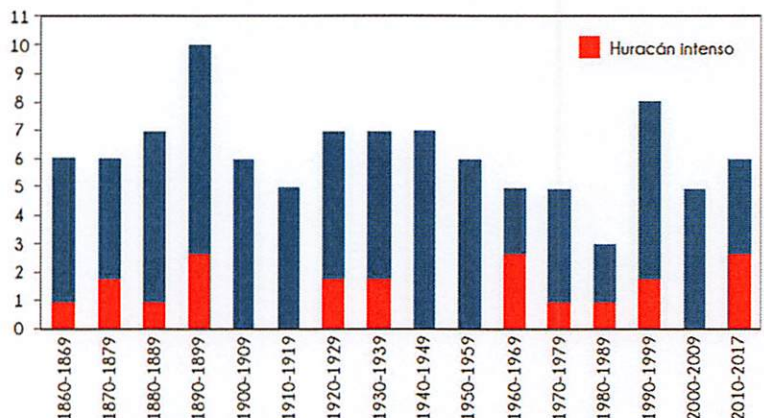


Figure 9: Map of the trajectory of intense hurricanes over Puerto Rico: 1867- 2017



The graph below shows the trend of tropical systems affecting Puerto Rico by decade. It shows the variability in the number of tropical systems since 1867. The first trend that can be observed are natural cycles of increases and decreases marking extremely active decades compared with other decades of lower activity. Another notable trend is the overall increase in the number of storms. This increase in the trend can be explained by improved and modern observation tools, particularly the use of satellites, and new analysis techniques used by the National Hurricane Center.

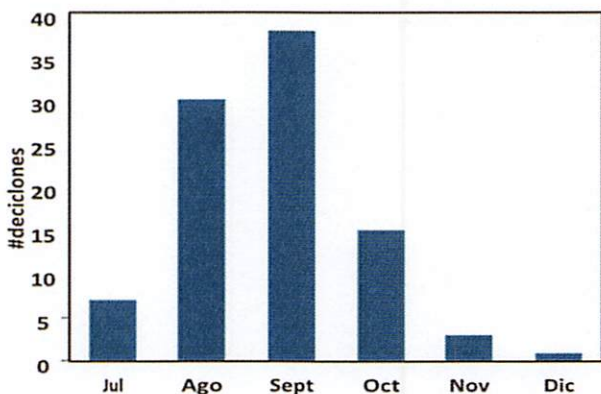
Figure 10: Total storms per decade affecting Puerto Rico 1867-2017



The 1890s and 1990s were the most active, with 10 and 8 systems, respectively (Graphic 1). In contrast, it was the 1960s and 2010s that had a greater occurrence of intense hurricane; this, despite the relatively low cyclonic activity. In the 1960s, 3 of the 5 cyclones were intense hurricanes, while during 2010, 3 of the 6 were intense.

In terms of the frequency of cyclones per month, the months of August and September had the highest cyclonic activity, with 30 and 38 cyclones, respectively (Graphic 2). There were no cyclones in June, while in December 2007 there was an off-season cyclonic system. This was the tropical storm Olga, which entered through the north of Puerto Rico on the 11th of that month.

Figure 11: Cyclone distribution according to their month of occurrence



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Appendix G-4: Hurricane Maria Lesson Learned

Focus Area 1: Scaling a Response for Concurrent, Complex Incidents

- ❖ Revise and improve the planning process to the Response Operational Plan to respond to significant operational challenges and guide response operations during hurricane season.
- ❖ Create preparedness and planning products that are easily accessible, modular, inclusive, and readily executable.
- ❖ Leverage open-source information and preparedness data, such as capability assessments and exercise findings.

Focus Area 2: Staffing for Concurrent, Complex Incidents

- ❖ Build and maintain a State incident workforce that include local emergency managers.
- ❖ Maintain financial support to build greater capacity to respond and recover from disasters.
- ❖ Streamline and increase certifications across the Commonwealth's incident workforce.

Focus Area 3: Sustained Whole Community Logistics Operations

- ❖ Strengthen a state-managed, locally executed logistics operations.
- ❖ Increase transportation planning, management, contract support capacities
- ❖ Broaden PREMB's capability to quickly get teams on the ground to stage and deliver key commodities to disaster survivors, even in isolated communities.
- ❖ Develop stronger relationships with critical private sector partners to support rapid restoration in response to catastrophic incidents.

Focus Area 4: Responding During Long-Term Infrastructure Outages

- ❖ Encourage investment redundant assets to maintain communications and supply temporary power.
- ❖ Encourage critical infrastructure owners and operators, and the Commonwealth to invest in more resilient infrastructure.
- ❖ Include continuity and resilient all-hazards communications capabilities in plans and guidance.

Table 10: Hurricane Maria Lessons Learned

Core Capability - Response	Finding Strength (STR), Area for Improvement (AFI), Potential Best Practice (PBP)
Operational Coordination	<p>(AFI): PREMB Zones were ineffective during early response operations due to communications outages, staffing shortages, poor coordination among state and federal agencies operating in the area, and a lack of emergency operations plans and familiarity with the resource request process at the municipal level, often leading to duplication of effort and conflicting resource requests.</p>
	<p>(AFI): Limited training and exercises to prepare newly elected officials and their staff for a disaster contributed to a lack of leadership and personnel with an understanding of the Incident Command System (ICS), roles and responsibility, and All-Hazards Plan and Standard Operating Procedures, leading to poor interagency coordination of response and recovery efforts, slowing and reducing overall service to survivors.</p>
	<p>(PBP): Collocating state and federal operations at the Convention Center (IOF/JFO) improved information sharing and coordination among state and federal partners improving the overall effectiveness of the response.</p>
Critical Transportation	<p>(AFI): Despite the initial prioritization of route clearance, the process was uncoordinated at the state level, and, while some communities had the capabilities to clear debris from local roads, not all did. This lack of coordination and varying levels of capabilities led to delays in the ability to achieve access, assess damages, and identify survivor needs, particularly in mountainous areas.</p>
Infrastructure Systems	<p>(AFI): Information was not collected or shared in a consistent or coordinated manner across state agencies, hindering the ability to establish a common operating picture and prioritize critical infrastructure restoration.</p>
	<p>(AFI): The lack of a comprehensive catalog of critical infrastructure impacted the ability of federal, state, and municipal responders to assess damages and prioritize restoration, resulting in the delay of critical services to survivors.</p>
	<p>(STR): Private sector cooperation accelerated communications recovery.</p>
Logistics and Supply Chain Management	<p>(AFI): There was ample fuel on the island to support emergency response efforts following Hurricane Maria, but the state lacked enough personnel and fuel tankers to meet the delivery demand, as well as the ability to track and communicate distribution.</p>
	<p>(AFI): The centralized resource request system was challenged by communications outages and unfamiliarity with the process which slowed commodity distribution.</p>
Operational Communications	<p>(AFI): Communications and power outages significantly impacted all aspects of the response including the ability to assess and report impacts and prioritize and effectively coordinate response efforts.</p>
	<p>(AFI): Many state agencies reported having satellite phones either before or soon after impact, but they did not work due to contracting, registration issues, lack of training or larger failures in communication systems.</p>
Mass Care Services	<p>(AFI): Mass care operations were conducted out of pre-identified schools that met a minimum set of requirements, however, they did not have enough resources including pre-staged generators sustain operations and the comfort of survivors for the extended operation.</p>

Core Capability - Response	Finding Strength (STR), Area for Improvement (AFI), Potential Best Practice (PBP)
<p>Public Health, Medical and Emergency Medical Services</p>	<p>(AFI): Hospitals and specialty care facilities struggled to cope and maintain delivery of services post-landfall of Hurricane Maria for a variety of reason to include: Accepting patients from the US Virgin Islands after Irma, loss of power and communications during Maria, physical damage to facilities, debris inhibiting facility access, impact to pharmaceutical and oxygen suppliers, improper use of the facilities by those seeking shelter and non-emergent care, and poor coordination with some outside supporting elements.</p>
<p>Planning</p>	<p>(AFI): Many state agencies reported that while they maintain an All-Hazards Plan, they are not built to catastrophic thresholds and do not account for 100% loss of communications.</p> <p>(AFI): Community needs assessments identified resources and services that would be required from state and NGO agencies during a response, but the lack of preparedness in areas that could not receive assistance due to communication and transportation issues highlighted a need to build both community and individual readiness.</p>
<p>Continuity of Operations</p>	<p>(AFI): The catastrophic impacts of the storm challenged continuity of operations plans, facilities, and access to important information systems. In addition, all emergency responders were also survivors, which impacted their ability to serve the greater population.</p>

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Appendix G-5: Dams

There are 36 main reservoirs in Puerto Rico, formed by dams, mostly in the interior of the mountainous region at the foot of the rivers. There are two outside the pluvial basin, the Fajardo and Río Blanco reservoirs.

The construction time of these reservoirs varies from 1913 to the most recent in 2008. Most of them exceed 50 years since their construction.

It should be noted that in Puerto Rico there are no natural lakes, but reservoirs formed by dams built in the riverbeds.

Total capacity built from 1913 to the present is approximately 375,000 acre-feet. Current capacity is approximately 275,000 acre-feet 27% less, due to progressive sedimentation over the years.

The age of our reservoirs and sediment accumulation along with flood erosion, accumulation of pollutants and excessive water withdrawal, among other factors, make the reservoir a potential risk to the public.

Adequate organization and means to obtain and communicate information on incidents, the communication of alerts and the activation, if necessary, of the alarm systems that will be established are preferred measures.

Purpose: Establish a general guideline for an appropriate course of action in the event of flooding due to reservoir breakage or failure. Determine the flood zone in the event of a breach and perform the corresponding risk analysis. The size of the adjacent community and the type of surrounding structures must be taken into consideration.

Scope: The Annex is a procedure that applies to all state and local government agencies, the private sector, non-governmental organizations, and the general public.

Situation: Recognizing that any dam in Puerto Rico is a potential risk of danger to the entire surrounding population, a major damage is considered in the development of this document. The floods created by the rupture of a dam can cause very serious damage to the life and safety of people and their property. We use as a parameter the risk that arose with the bursting of the Guajataca Dam. The situation was described as "extremely dangerous" where the possible eviction of some 70,000 people was determined in anticipation of a dam burst.

Risk analysis: The plan will describe the details of a dam break and its flooding effects on adjacent areas, taking as an example the Guajataca Dam, a 316-meter dam, built around 1928, with a reservoir covering some five square kilometers. Nearly 40 centimeters of water fell into the surrounding mountains after the Category 4 hurricane left the island, which filled the reservoir to capacity. After an inspection by the engineer in charge, authorities determined a crack that could be the beginning of a total failure of the dam. The rains continue and flooding of over 4 feet of water in surrounding municipalities is imminent. Debris is a hindrance to proper

evacuation in the affected municipalities and the lack of adequate and safe transportation worsens the situation. There are not enough shelters to house 70,000 people, most of whom are children and the elderly. Not all the dams belong to the Puerto Rico Electric Power Authority, which owns 19 of them. The Puerto Rico Aqueduct and Sewer Authority is responsible for eight (8) dams in different parts of the Island and Puerto Rico Natural Resources maintains four (4) under its custody. In addition, the municipality of Comerío retains two (2) and the remaining three (3) are privately owned by the Serrallés family. For this reason, a course of action has been standardized in case an emergency occurs in any of the reservoirs. Each dam has an Emergency Action Plan (EAP) which indicates how to address the danger and risks in the event of a breach, failure or overtopping of the water level. This plan has a list of agencies to be alerted, along with flood maps and susceptible areas that require evacuation to address the situation. Many of the dams have a siren warning system that can be activated if necessary, at the discretion of authorized personnel.

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Appendix G-6: Flooding

Hurricanes often produce widespread, torrential rains in excess of 6 inches, which may result in deadly and destructive floods. In fact, flooding is the major threat from tropical cyclones for people living inland. Flash flooding, defined as a rapid rise in water levels, can occur quickly due to intense rainfall. Longer term flooding on rivers and streams can persist for several days after the storm.

To search for visibility and details on the flooding areas the use of an interactive tool is recommended. The tool can be accessed by using this link: [Puerto Rico Planning Viewer](#). Then, look for the Layer List at the top right corner and select the following layers from the drop-down menu: Municipios and Advisory Base Flood Elevations (ABFE 1%). This tool will allow the user to zoom-in/zoom-out, to better understand the extent and area of the flood zones, in a given location. Users are not required a username or password. A QR Code was also created to maximize the outreach and sharing capability to the public (see below).

Figure 12: PR Planning Viewer Landing Page



Figure 13: Showing Selection of Layers

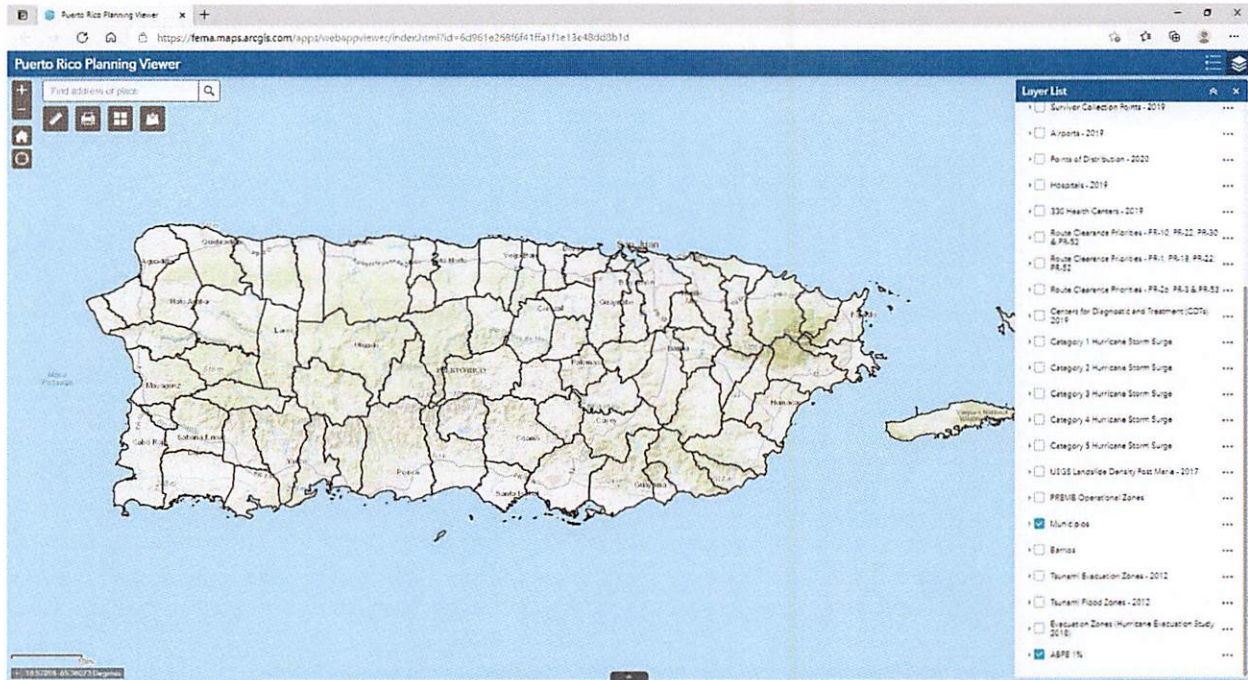


Figure 14: Zoom-in Example Municipality of Cataño

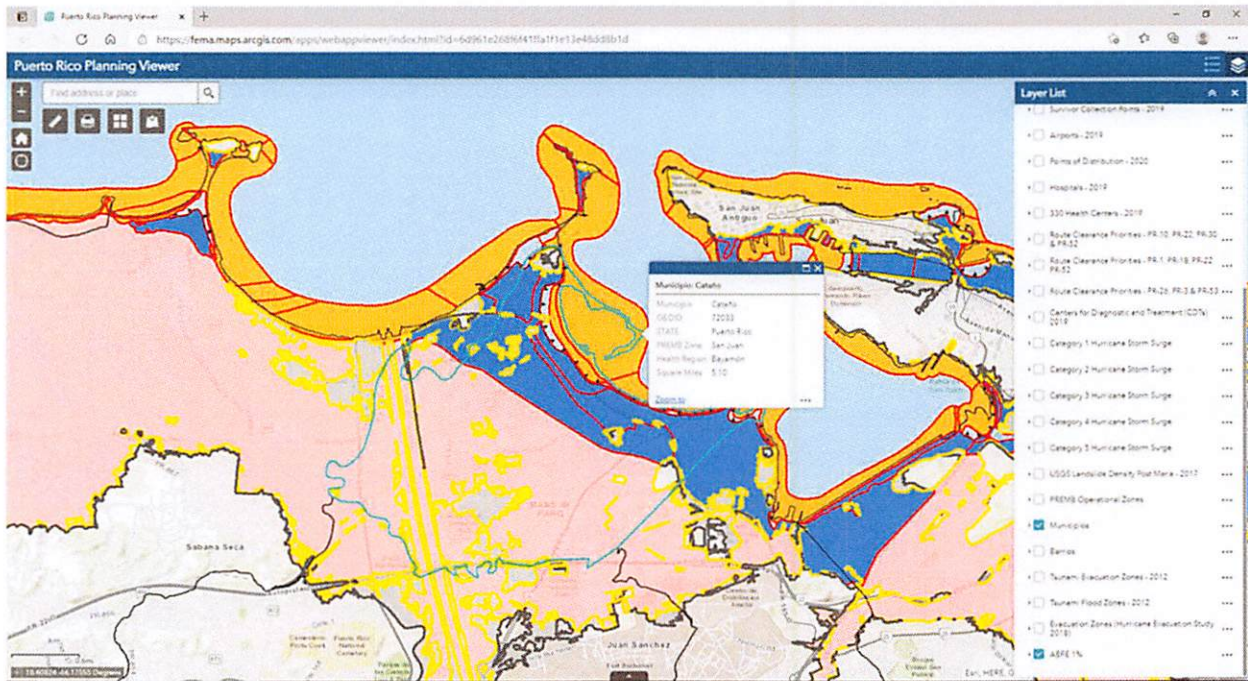


Figure 15: With Legend On

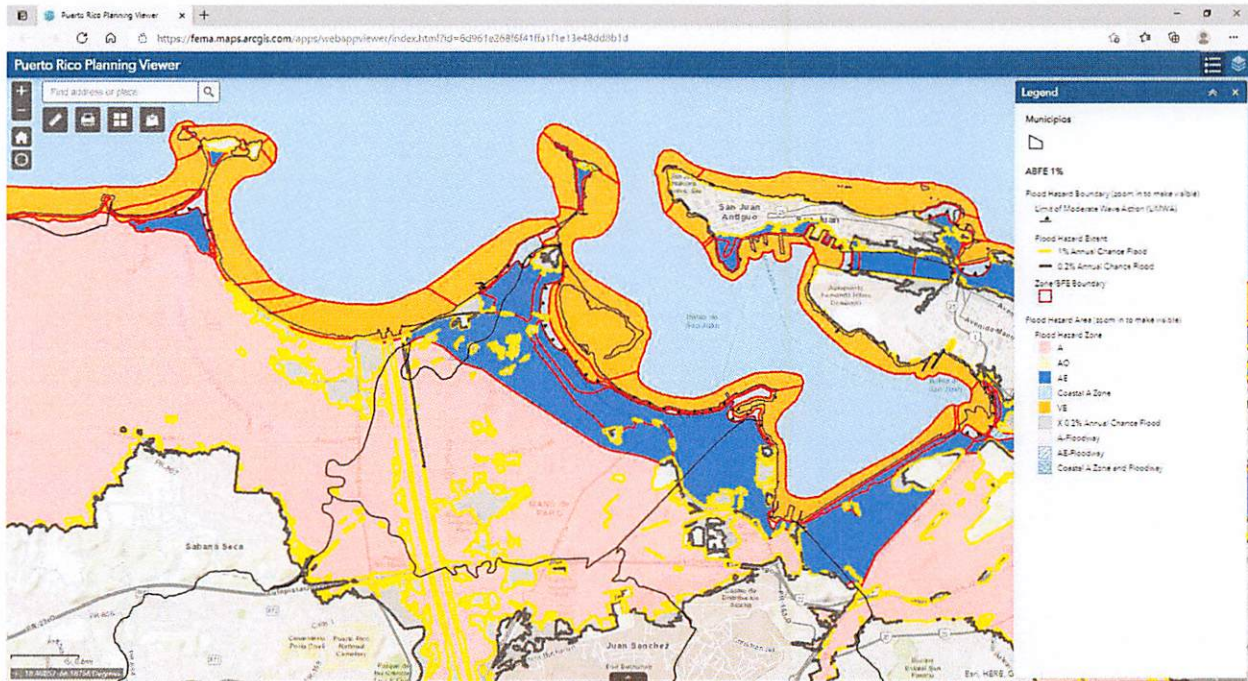


Figure 16: QR Code



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