PUERTO RICO
PLANNING BOARD
GOVERNMENT OF PUERTO RICO

2026

# LOCAL HAZARD MITIGATION PLAN

## Municipality of

LOCAL HAZARD MITIGATION PLANS

Protect Through Planning

# PROFESIONAL LICENSED PLANNER CERTIFICATION

As per Act 160-1996 as amended (20 L.P.R.A § 3501 - 20 L.P.R.A § 3515), I _____, who bears Puerto Rico professional planning license number___, certify that this document has been prepared using the best available sources and is in accordance with the best practices of the planning profession as of _____, 2026. And I certify this herewith my professional seal.

# FEMA Approval

This Local Hazard Mitigation Plan for the Municipality of San German was approved by FEMA on

_____

# Statement of Funding

This Local Hazard Mitigation Plan was prepared for the Municipality of Yabucoa and the Puerto Rico Planning Board by the consulting firm AtkinsRéalis Caribe, LLP as per the stipulations of contract number 2026-000032 and any amendment thereof, duly registered in Puerto Rico's Office of the Comptroller.

# Language Requirement

In Accordance with Presidential Executive Order #14224, the 2026 version of the Yabucoa Local Hazard Mitigation Plan has been prepared in English for submission and consideration of FEMA.

A non-certified translation of the final draft for public discussion and the final approved LHMP to Spanish was prepared for the benefit of the population that is not English proficient.

Should any discrepancy arise between the English and the Spanish text, the English one shall prevail.

# Statement on maps

The maps presented on this document are related to a planning exercise. It is not the intention of these maps to establish any regulatory requirement, procedure or benefit.

# Government Officials

**Municipality of Yabucoa**

Hon. Rafael Surillo Ruiz
Mayor

**Puerto Rico Planning Board**

Héctor Morales Martínez, esq.
President

Rebeca Rivera Torres, PLP
Alternate Member

Luis Lamboy Torres, PLP
Alternate Member

Emanuel Gómez Veléz, PLP
Alternate Member

# Collaborators

**Municipality of Yabucoa**

Luis G. Rivera, Special Aide
Aileen Laboy, Executive Assistant
Wanda Castro, Executive Assistant
Miguel Flores, Director Municipal Emergency Management Office

**Puerto Rico Planning Board**

Ivette Colon, PLP
Vanessa Marrero, PLP
Erica Rivera Felicié, PLP
Onix Concepción Rodríguez, PLP

**AtkinsRealis Caribe, LLP**

Ivelisse R. Gorbea Class, PLP
Yashira Santos, SIT, BSCE
Juan Rotger, PE
Yesenia Rodríguez, MArch, MLArch
Celso Ruiz, PMP
Ronald Pérez, PMP, PE
Alexander Burke, AICP
Hannah Heath
William Pitre Cipolla, PMP, PLP
Diana Castro, PE
Allison Lee, PE
Mohammad Ghaneeizad
Gopal BS
Manoj Mallesha Nayaka

# Table of Contents

List of Maps ..... xiv
List of Tables ..... xvi
List of Figures ..... xviii
List of Selected Acronyms ..... xix
Executive Summary ..... 1
1. Introduction and Background ..... 15
1.1 Applicable Public Policies ..... 16
1.1.1 Federal Policies ..... 16
1.1.1.1 Federal Laws ..... 16
1.1.1.2 Federal Regulations ..... 18
1.1.2 Government of Puerto Rico Policies ..... 22
1.1.2.1 Puerto Rico Laws ..... 22
1.1.2.2 Puerto Rico Regulations ..... 24
1.1.3 Municipal Policies ..... 27
1.2 Scope and Previous Versions ..... 29
1.2.1 Primary Objectives ..... 29
1.2.2 Previous FEMA Comments ..... 29
1.3 LHMP Organization ..... 31
1.4 Changes to the Yabucoa LHMP (E2-a) ..... 33
2. Planning Process ..... 35
2.1 Planning Process Regulation ..... 35
2.2 General Description of the 2026 LHMP ..... 35
2.3 History of the LHMP ..... 35
2.4 Plan Preparation, Revision Schedule and Methodology (a1-a) ..... 36
2.5 Planning Committee (A1-a, A1-b) ..... 36
2.6 Citizen participation (A3-a) ..... 37
2.6.1 Community Outreach and Public Participation Strategies ..... 37
2.6.2 Community Outreach and Public Participation Results ..... 38
2.7 Stakeholder involvement (A2-a) ..... 39
2.7.1 Hazard Analysis Data Sources ..... 40
2.8 FEMA Lifelines ..... 40
3. Municipal Profile ..... 43
3.1 Data Sources for Municipal Profile ..... 43

3.2 Brief Historical Background....43
3.3 Geography....44
3.3.1 Physiography....47
3.3.2 Geology....49
3.3.3 Soils....50
3.3.4 Hydrography....50
3.3.5 Precipitation....53
3.3.6 Temperature....54
3.4 Demographics....54
3.4.1 Current Population....54
3.4.2 Socio-economic Characteristics....59
3.4.2.1 Employment....59
3.4.2.2 Employment by Industry....60
3.4.2.3 Poverty Level....63
3.4.2.4 Income....63
**3.4.2.5** Population with disabilities....64
**3.4.2.6** Population receiving supplemental nutritional support....65
3.4.2.7 Health Insurance Coverage....65
3.4.3 Housing stock and other related details....66
3.5 Critical Infrastructure....67
3.5.1 Lifeline: Safety and Security....68
3.5.2 Lifeline: Food, Hydration and Shelter....69
3.5.3 Lifeline: Health and Medicine....69
3.5.4 Lifeline: Energy....70
3.5.5 Lifeline: Communications....70
3.5.6 Lifeline: Transportation....71
3.5.7 Lifeline: Hazardous Materials....72
3.5.8 Lifeline: Water Systems....72
3.6 Recent Development (E1-a)....74
4. Hazard Profiles and Risk Assessment....79
4.1 Note on the Discussion of Hazards....79
4.2 Regulatory Requirements....79
4.3 Hazards that can Affect the Municipality....80
4.4 Chronology of Events....83

4.5 Risk Assessment Methodology ..... 83
4.5.1.1 HAZUS 6.1 ..... 84
4.5.1.2 Alternative GIS modeling ..... 84
4.5.1.3 Stochastic Risk Assessment ..... 84
4.6 Earthquake ..... 85
4.6.1 Description (B1-a) ..... 85
4.6.1.1 Affected Area (B1-b) ..... 87
4.6.1.2 Risk Magnitude (B1-c) ..... 92
4.6.1.3 Past Events (B1-d) ..... 93
4.6.1.4 Future Event Probabilities (B1-e) ..... 101
4.6.2 Risk Analysis (B2-a, B2-b) ..... 102
4.6.2.1 Estimated Loses ..... 102
4.6.2.2 Lifelines and Critical Infrastructure ..... 103
4.6.2.3 Social Vulnerabilities ..... 106
4.6.2.4 Natural and Cultural Resources ..... 109
4.6.2.5 Future Conditions (E1-a) ..... 110
4.7 Landslides ..... 112
4.7.1 Description (B1-a) ..... 112
4.7.1.1 Affected Area (B1-b) ..... 114
4.7.1.2 Risk Magnitude (B1-c) ..... 115
4.7.1.3 Past Events ..... 116
4.7.1.4 Future Event Probabilities ..... 117
4.7.2 Risk Analysis ..... 118
4.7.2.1 Estimated Loses ..... 118
4.7.2.2 Lifelines and Critical Infrastructure ..... 119
4.7.2.3 Social Vulnerabilities ..... 121
4.7.2.4 Natural and Cultural Resources ..... 123
4.7.2.5 Future Conditions (E1-a) ..... 124
4.8 Tsunami ..... 125
4.8.1 Description (B1-a) ..... 125
4.8.1.1 Affected Area (B1-b) ..... 127
4.8.1.2 Risk Magnitude (B1-c) ..... 127

4.8.1.3 Past Events (B1-d) ..... 129
4.8.1.4 Future event probabilities (B1-e) ..... 132
4.8.2 Risk Analysis (B2-a, B2-b) ..... 132
4.8.2.1 Estimated Loses ..... 132
4.8.2.2 Critical Infrastructure and Lifelines ..... 133
4.8.2.3 Social Vulnerabilities ..... 135
4.8.2.4 Natural and Cultural Resources ..... 137
4.8.2.5 Future Conditions (E1-a) ..... 138
4.9 Flooding ..... 139
4.9.1 Description (B1-a) ..... 139
4.9.1.1 Affected Area ..... 141
4.9.1.2 Risk Magnitude (B1-c) ..... 151
4.9.1.3 Past Events (B1-d) ..... 153
4.9.1.4 Special Consideration: Floods by Stormwater Management Deficiencies ..... 160
4.9.1.5 Future Event Probabilities (B1-e) ..... 161
4.9.2 Risk Analysis (B2-a, B2-b) ..... 161
4.9.2.1 Estimated Loses ..... 162
4.9.2.2 Lifelines and Critical Infrastructure ..... 166
4.9.2.3 Social Vulnerabilities ..... 169
4.9.2.4 Natural and Cultural Resources ..... 170
4.9.2.5 Special Consideration: Repetitive Loses and Severe Repetitive Losses ..... 171
4.9.2.6 Future Conditions (E1-a) ..... 172
4.10 Tropical Cyclones and other Extreme Wind Events ..... 173
4.10.1 Description (B1-a) ..... 173
4.10.1.1 Affected Area (B1-b) ..... 175
4.10.1.2 Risk Magnitude (B1-c) ..... 175
4.10.1.3 Past Events (B1-d) ..... 177
4.10.1.4 Tornados ..... 183
4.10.1.5 Future event probabilities (B1-e) ..... 183
4.10.2 Risk Analysis (B2-a, B2-b) ..... 183
4.10.2.1 Estimated Loses ..... 183
4.10.2.2 Lifelines and Critical Infrastructure ..... 188

4.10.2.3 Social Vulnerabilities ..... 190
4.10.2.4 Natural and Cultural Resources ..... 190
4.10.2.5 Future Conditions (E1-a) ..... 190
4.11 Storm Surge ..... 191
4.11.1 Description ..... 191
4.11.1.1 Affected Area ..... 192
4.11.1.2 Risk Magnitude ..... 193
4.11.1.3 Past Events ..... 194
4.11.1.4 Future Events Probability ..... 195
4.11.2 Risk Analysis ..... 195
4.11.2.1 Estimated Loses ..... 195
4.11.2.2 Lifelines and Critical Infrastructure ..... 195
4.11.2.3 Social Vulnerabilities ..... 199
4.11.2.4 Natural and Cultural Resources ..... 202
4.11.2.5 Future Conditions (E1-a) ..... 203
4.12 Extreme Heat ..... 207
4.12.1 Description (B1-a) ..... 207
4.12.1.1 Affected Area (B1-b) ..... 208
4.12.1.2 Risk Magnitude (B1-c) ..... 209
4.12.1.3 Past Events (B1-d) ..... 211
4.12.1.4 Future event probabilities (B1-e) ..... 212
4.12.2 Risk Analysis (B2-a, B2-b) ..... 212
4.12.2.1 Estimated Loses ..... 212
4.12.2.2 Lifelines and Critical Infrastructure ..... 213
4.12.2.3 Social Vulnerabilities ..... 214
4.12.2.4 Natural and Cultural Resources ..... 214
4.12.2.5 Future Conditions (E1-a) ..... 216
4.13 Drought ..... 216
*4.13.1 Description (B1-a)* ..... 216
4.13.1.1 Affected Area ..... 218
4.13.1.2 Risk Magnitude (B1-c) ..... 218
4.13.1.3 Past Events (B1-d) ..... 219

4.13.1.4 Future event probabilities (B1-e) ..... 221
4.13.2 Risk Analysis (B2-a, B2-b) ..... 222
4.13.2.1 Estimated Loses ..... 222
4.13.2.2 Lifelines Critical and Infrastructure ..... 223
4.13.2.3 Social Vulnerabilities ..... 223
4.13.2.4 Natural and Cultural Resources ..... 224
4.13.2.5 Future Event Probabilities ..... 224
4.14 Wildfire (E1-a) ..... 225
4.14.1 Description (B1-a) ..... 225
4.14.1.1 Risk Magnitude ..... 226
4.14.1.2 Affected Area (B1-b) ..... 227
4.14.1.3 Risk Magnitude (B1-c) ..... 228
4.14.1.4 Past Events (B1-d) ..... 229
4.14.1.5 Future Event Probability (B1-e) ..... 230
4.14.2 Risk Analysis (B2-a, B2-b) ..... 231
4.14.2.1 Estimated Loses ..... 231
4.14.2.2 Lifelines and Critical Infrastructure ..... 231
4.14.2.3 Social Vulnerability ..... 232
4.14.2.4 Natural and Cultural Resources ..... 233
4.14.2.5 Future Conditions (E1-a) ..... 235
4.15 Long term Coastal Dynamics ..... 235
4.15.1 Description ..... 235
4.15.1.1 Affected Area ..... 238
4.15.1.2 Risk Magnitude ..... 243
4.15.1.3 Past Events ..... 249
4.15.1.4 Future Events Probability ..... 251
4.15.2 Risk Analysis ..... 252
4.15.2.1 Estimated Loses ..... 252
4.15.2.2 Lifelines and Critical Infrastructure ..... 252
4.15.2.3 Social Vulnerabilities ..... 256
4.15.2.4 Natural and Cultural Resources ..... 257
4.15.2.5 Future Conditions (E1-a) ..... 257

4.16 Pandemic/Epidemic ..... 258
4.16.1 Description (B1-a) ..... 258
4.16.1.1 Affected Area (B1-b) ..... 258
4.16.1.2 Risk Magnitude (B1-c) ..... 258
4.16.1.3 Past Events (B1-d) ..... 259
4.16.1.4 Future Events Probability (B1-e) ..... 262
4.16.2 Risk Assessment (B2-a, B2-b) ..... 262
4.16.2.1 Estimated Loses ..... 262
4.16.2.2 Critical Infrastructure and Lifelines ..... 263
4.16.2.3 Social Vulnerability ..... 263
4.16.2.4 Natural and Cultural Resources ..... 264
4.16.2.5 Future Conditions (E1-a) ..... 265
**4.17 Planning Mechanism** ..... 266
4.17.1 Joint Regulation for the Evaluation and Issuance of Permits Related to Development, Land Use, and Business Operations (2023) ..... 266
4.17.2 Special Flood Hazards Areas Regulation (2021) ..... 267
4.17.3 Puerto Rico Building Code ..... 268
4.17.4 Regulation for the Design, Operation Criteria and Maintenance of Stormwater Systems in Puerto Rico ..... 268
4.17.5 Yabucoa Land Use Plan (2025) ..... 269
4.17.6 Yabucoa Emergency Operation Plan ..... 270
4.17.7 National Flood Insurance Program ..... 270
4.17.8 National Pollutant Discharge Elimination System (NPDES) ..... 271
4.17.9 Operational Guidelines for Determining Damages and Substantial Improvements in Puerto Rico (2025) ..... 272
4.17.10 Green Infrastructure and Nature Based Solutions ..... 272
4.17.11 Four – Year Investment Program ..... 274
5. Municipal Capacities ..... 276
**5.1** Regulatory and Planning Mechanism (C1-a**)** ..... 276
5.2 Technical and Administrative Capacities (C1-a) ..... 276
5.3 Financial Capacity (C1-a) ..... 278
5.3.1 FEMA Funding Streams ..... 278
5.3.2 Non-FEMA Federal Funding Streams ..... 280
5.3.3 Local Funds ..... 282
5.4 Outreach and Communications Capacity (C1-a) ..... 283

5.5 Capacity Development (C1-b) ..... 284
6. Mitigation Strategies ..... 285
6.1 Mitigation Strategies Requirements ..... 285
6.2 Mitigation Goals (C3-a) ..... 286
6.2.1 Municipal Goals and Objectives ..... 286
6.2.2 National Mitigation Investment Strategy ..... 290
6.3 Mitigation Strategy Selection Criteria ..... 291
6.4 Mitigation Strategy Categorization ..... 292
6.5 Mitigation Strategies (C4-a, C4-b, C5-a, C5-b, E2.b) ..... 294
6.6 Participation in the NFIP ..... 304
7. Plan Maintenance ..... 305
7.1 Point of Contact ..... 305
7.2 Continuous Public Participation (D1-a) ..... 305
7.3 LHMP Oversight (D2-a) ..... 306
7.4 LHMP Evaluation and Monitoring ..... 307
7.5 LHMP Update and Revision (D2-c, D3-a) ..... 308
7.5.1 Revision Following a Major Disaster ..... 308
7.5.2 Five-Year Comprehensive Update ..... 308
7.6 Integration with Other Planning Mechanisms (D3-a) ..... 308
8. Adoption and Approval (F1-a, F1-b) ..... 310
8.1 LHMP Adoption ..... 310
8.2 LHMP Approval ..... 310
References ..... 311
Appendix A: Adoption and Approval ..... 322
Adoption ..... 322
Approval by FEMA ..... 323
FEMA APA Letter ..... 324
FEMA Review Tool ..... 325
Appendix B: Planning Committee ..... 326
Planning Committee Appointments ..... 328
First Planning Committee Meeting ..... 330
Presentation ..... 330
Documentation ..... 333
Second Planning Committee Meeting ..... 338
Presentation ..... 338

9.3.3 Documentation ..... 339
Appendix C – Public Participation and Outreach ..... 340
First Public Meeting Notification ..... 340
9.4 Documentation ..... 342
Appendix D – Stakeholder Involvement ..... 343
11. Appendix E – OrgChart ..... 344

# List of Maps


Map 1: Yabucoa Geographic Area ..... 46
Map 2: Yabucoa – Wards Subdivision ..... 47
Map 3: Physiography ..... 48
Map 4: Hydrography ..... 51
Map 5 Hydrographic Watershed ..... 52
Map 6: Yabucoa Sub-Watershed ..... 53
Map 7: Population by Census Tract ..... 59
Map 8: Critical Infrastructure by Lifeline ..... 73
Map 9: Roadways ..... 74
Map 10: Recent Developments 2020 -2022 ..... 77
Map 11: Recent Development 2023 - 2026 ..... 78
Map 12: Earthquake: Spectral Acceleration at 0.3 sec ..... 89
Map 13: Earthquake: Spectral Acceleration at 1.0 sec ..... 90
Map 14: Earthquake Spectral Displacement at 0.3 sec ..... 91
Map 15 Earthquake - Spatial Displacement t 1.0 sec ..... 92
Map 16: Earthquake Critical Facilities Exposure to Spectral Acceleration at 1.0 sec ..... 105
Map 17: Earthquake - Critical Facilities exposure to spectral acceleration at 0.3 sec ..... 106
Map 18: Earthquake: Population Exposed to Spectral Acceleration at 1.0 (g) sec ..... 108
Map 19 Earthquake: Population Exposure to Spectral Acceleration at 0.3 sec (g) ..... 109
Map 20: Earthquake: Recent Development Exposure to Spectral Acceleration at 0.3 sec ..... 111
Map 21: Earthquake: Recent Development Exposure to Spectral Acceleration at 0.3 sec (g) ..... 112
Map 22: Landslide Susceptibility ..... 115
Map 23: Landslides Reported in the Aftermath of Hurricane María ..... 117
Map 24: Landslide: Critical Infrastructure Exposure ..... 121
Map 25: Landslide Recent Development Exposure ..... 125
Map 26: Tsunami Impact Area ..... 129
Map 27: Tsunami: Critical Infrastructure Exposure ..... 135
Map 28: Tsunami: Population Exposure ..... 137
Map 29: Tsunami: Recent Development Exposure ..... 139
Map 30: Flood Hazard Zones ..... 143
Map 31: 2026 Hazus Analysis 500 year (0.2%) ..... 151
Map 32: Building Loss to Flood Exposure 500 – year flood ..... 163
Map 33: Flood - Building Loss to Exposure 100 - year Flood ..... 164
Map 34: Flood Critical Facilities Exposure ..... 168
Map 35: Flood: Population Exposure ..... 170
Map 36: Flood Recent Development Exposure ..... 173
Map 37: Tropical Cyclone - Total Damaged Buildings 100 – Year Event ..... 185
Map 38: Tropical Cyclone - Total Damaged Building 500 - Year Event ..... 186
Map 39; Tropical Cyclone: Economic Loss 100 year event ..... 187
Map 40: Tropical Cyclone: Economic Loss 500 year event ..... 188
Map 41: Category 1 Storm Surge Impact Area ..... 192
Map 42: Category 5 Storm Surge Impact Area ..... 193
Map 43: Critical Infrastructure exposure to Category 1 Hurricane Surge ..... 198
Map 44: Storm Surge: Critical Infrastructure exposure to Category 5 Hurricane Surge ..... 199
Map 45: Storm Surge: Population Exposure to Category 1 Surge ..... 201

Map 46: Strom Surge: Population Exposure to Category 5 Surge ..... 202
Map 47: Recent Development and Category 1 Storm Surge Impact ..... 205
Map 48: Storm Surge: Recent Development Exposure Category 5 Surge ..... 206

# List of Tables

Table 1': LHMP Organization ....31
Table 2: Changes to the Yabucoa LHMP....33
Table 3: Planning Committe ....37
Table 4: Hazard and Risk Assessment of Data Sources ....40
Table 5: Population by Age Group 2024 ACS vs 2019 ACS ....56
Table 6: Yabucoa - Current Labor Force Statistics ....60
Table 7: Employment by Industry 2024 ACS vs 2019 ACS ....61
Table 8: 2024 ACS Poverty Level....63
Table 9: 2024 ACS Income and Benefits per Household ....63
Table 10; Yabucoa Population living with disabilities ....64
Table 11: Population receiving food aid ....65
Table 12: 2024 ACS Health Insurance Data....66
Table 13: 2024 ACS - Housing Units Year of Construction....66
Table 14: 2024 ACS - Vehicle per occupied housing unit....67
Table 15: Construction Permits Approved....75
Table 16: Historical Hazard Inventory ....80
Table 17: Order of Hazards to be Assessed ....83
Table 18: Moment - Magnitude Scale....93
Table 19: Puerto Ric Seismic Activity 2013-2024 ....95
Table 20: Exposure to Earthquake Hazard....102
Table 21: Expected Annual Loss to Earthquake ....103
Table 22: Landslide Risk Categories ....116
Table 23: Tsunami events in Puerto Rico ....129
Table 24: Tsunami Exposure....132
Table 25: Expected Annual Loss to Tsunami ....133
Table 26: Puerto Rico Flood Zones ....140
Table 27: Major flooding events in Puerto Rico 2010-2025 ....154
Table 28 Flood Exposure....162
Table 29:Expected Annual Loss to Flood ....162
Table 30: Total de Pérdidas de Estructuras....165
Table 31: Total de Pérdidas de Estructuras....165
Table 32: Pérdidas No Residenciales Detalladas ....165
Table 33: Pérdidas Residenciales Detalladas....165
Table 34: NFIP Policies in force and coverage ....171
Table 35: NFIP Repetitive Loses ....171
Table 36: NFIP Severe Repetitive Loses ....172
Table 37: Saffir-Simpson Hurricane Scale....176
Table 38: Tropical Cyclone Disaster Declarations since 2000 ....179
Table 39: Tropical Cyclone Exposure ....183
Table 40: Expected Annual Loss to Tropical Cyclone ....184
Table 41: Types of Droughts ....217
Table 42: US Drought Monitor Categories ....218
Table 43: Registered Wildfires....230
Table 44: Sea Base Mean Level Readings in Puerto Rico....248
Table 45: Pandemics and Epidemic in Puerto Rico 1855 - 2020....259

Table 46: Number of People in Choose an item. without Healthcare Coverage ..... 264
Table 47: Municipal Technical and Administrative Human Resources ..... 276
Table 48: Outreach and Communications Tools ..... 283
Table 49: Mitigation Strategies – Prevention (Local Regulations and Policies) ..... 296
Table 50: Mitigation Strategies – Property Protection ..... 298
Table 51: Mitigation Strategies Structural Projects ..... 300
Table 52: Mitigation Strategies - Emergency Services ..... 301
Table 53: Mitigation Strategies - Education and Outreach ..... 303
Table 54: Preliminary Planning Committee Meeting Schedule ..... 307

# List of Figures

Figure 1: Cover of FEMA's Local Mitigation Planning Policy Guide ....18
Figure 2: Cover of FEMA's Local Mitigation Planning Handbook ....19
Figure 3: National Disaster Recovery Framework Cover ....20
Figure 4: PUT-PR Coversheet ....24
Figure 5: Puerto Rico SHMP Cover....25
Figure 6: Puerto Rico Mitigation Action Plan Cover ....26
Figure 7: Yabucoa Hazard Mitigation ....27
Figure 8: Yabucoa Municipal Recovery Plan Cover ....28
Figure 9: Yabucoa Population by Sex (2024 ACS)....55
Figure 10: Yabucoa Population by Age Group (ACS 2024) ....57
Figure 11: Yabucoa Population Pyramid (2024 ACS)....58
Figure 12: Yabucoa: Approved Construction Permits 2020-2025....76
Figure 13: PRSN - 2024 Earthquakes Epicenter screengrab (PRSN, 2025)....94
Figure 14: Mean Annual Rainfall 1991-2020 (PR & USVI)....118
Figure 15: Yabucoa Tsunami Evacuation Map ....127
Figure 16: National Flood Hazard Layer FIRMette (Yabucoa Centro)....144
Figure 17: National Flood Hazard Layer FIRMette (Jardines de Yabucoa)....145
Figure 18: National Flood Hazard Layer FIRMette (Port of Yabucoa) ....146
Figure 19: National Flood Hazard Layer FIRMette Comunidad Martorell)....147
Figure 20: FIRM vs ABFE Coverage....149
Figure 21: Hurricane Tracks 1989-2017 (only Cat 2-5) ....174
Figure 22: Hurricane María (2017) as it approaches Puerto Rico ....175
Figure 23: Heat Island Effect Diagram (EPA, 2025) ....211
Figure 24 Puerto Rico Percent Area in U.S. Drought Monitor Categories ....220
Figure 25: Yabucoa US Percent Area in Drought Category....221
Figure 26: Overview of areas of Puerto Rico, Vieques and Culebra under different levels of wildlife incidence accounting to SFLA ....228
Figure 27: Yabucoa State of the Coast Study (in Spanish) ....240
Figure 28: State of the Beach September 2017 vs. July 2018 (in Spanish) ....241
Figure 30: Yabucoa Changes to Width of the Beach 9/2017 - 7/20218 ....242
Figure 31: Short – Term shoreline change rates ....251
Figure 336: Regulation 40 Cover....268
Figure 327: Yabucoa Land Draft Land Use Plan Cover Page ....269
Figure 34: New ID Nomenclature ....295

# List of Selected Acronyms

| | |
|---|---|
| AMMED | Municipal Agency for Disaster and Emergency Management, by its Spanish Acronym |
| CEACC | Comité de Expertos y Asesores sobre Cambio Climático |
| DHS | Department of Homeland Security |
| DNER | Department of Natural and Environmental Resources |
| DPS | Department of Public Safety |
| DTPW | Department of Transportation and Public Works |
| EPA | Environmental Protection Agency |
| FEMA | Federal Emergency Management Agency |
| FHWA | Federal Highway Administration |
| FRA | Federal Railroad Administration |
| FTA | Federal Transit Administration |
| IFRC | International Federation of the Red Cross |
| IRRM | Interim Risk Reduction Measures |
| LUMA | Luma Energy |
| mph | Miles per hour |
| NDRF | National Disaster Recovery Framework |
| NIMS | National Incident Management System |
| NIST | National Institute of Standards and Technology |
| OPM | Municipal Public Works, by is Spanish acronym |
| PRASA | Puerto Rico Aqueduct and Sewers Authority |
| PREMB | Puerto Rico Emergency Management Bureau |
| PREPA | Puerto Rico Electric Power Authority |
| PRHTA | Puerto Rico Highway and Transportation Authority |
| PRPB | Puerto Rico Planning Board |
| PRSN | Puerto Rico Seismic Network |
| PT | Territorial Plan, by its Spanish acronym |
| PUT-PR | Puerto Rico Land Use Plan, by its Spanish acronym |
| SFLA | Southern Federal Land Assessment |
| UHI | Extreme Heat Island |
| USACE | United States Army Corps of Engineers |
| USDOT | United States Department of Transportation |
| USGS | United States Geological Survey |

# Executive Summary

This document is the 2026 update of the Local Hazard Mitigation Plan (LHMP) for the Municipality of Yabucoa, Puerto Rico. It is prepared to reduce risks associated with natural hazards and enhance community resilience by identifying hazards, assessing risks, and proposing mitigation strategies. The plan complies with federal regulations, including the Stafford Act and Disaster Mitigation Act of 2000, and incorporates public participation and interagency coordination. It is funded by a grant from the Puerto Rico Planning Board and prepared by AtkinsRéalis Caribe, LLP.

**Introduction and Background**

The Municipality of Yabucoa and the Puerto Rico Planning Board are committed to protecting residents by updating the LHMP, which provides a structured approach to hazard mitigation consistent with federal, state, and local policies. The plan identifies natural hazards, evaluates risks, and supports land use planning to achieve sustainability and resilience. It also complies with FEMA requirements to maintain eligibility for federal funding and is regularly updated to reflect evolving conditions.

This plan follows the following objectives

- Identify and evaluate natural hazards threatening the municipality.
- Establish strategies to reduce risks to life, property, and services.
- Promote interagency coordination and community involvement

**Public Policy**

The plan aligns with federal, Puerto Rico, and municipal policies guiding hazard mitigation and resilience for example.

- The Stafford Act and its Hazard Mitigation Grant Program provide funding for cost-effective mitigation.
- The Disaster Mitigation Act of 2000 requires LHMP adoption for federal funding eligibility.

- The National Flood Insurance Act establishes the NFIP to provide flood insurance and encourages floodplain management.
- FEMA's regulations (44 CFR Part 201) and planning guides outline requirements and procedures for mitigation planning.
- The National Disaster Recovery Framework guides recovery coordination.
- The National Earthquake Hazards Reduction Program and National Incident Management System that support seismic risk reduction and emergency response.

Puerto Rico Policies

- Act No. 161-2009 reforms the permitting system to improve efficiency.
- Act No. 33-2019 mandates mitigation and resilience measures in response to changing weather patterns.
- Act No. 107-2020 (Municipal Code) which gives municipalities some powers for regulating land use.
- The Puerto Rico Land Use Plan (that PUT-PR) classifies land and guides sustainable development.
- The Puerto Rico State Natural Hazard Mitigation Plan (2021) provides a jurisdiction-wide framework.
- The Puerto Rico Mitigation Action Plan (CDBG-DR MIT) directs federal mitigation funds post-hurricanes Irma and María.
- The Yabucoa LHMP (2020) and Municipal Recovery Plan establishes prior mitigation frameworks and recovery priorities.

**Planning Process**

The 2026 LHMP update follows FEMA guidelines and includes a Planning Committee with municipal officials, public outreach through meetings and notifications, and stakeholder involvement. Public participation included three community meetings with opportunities for feedback. The plan integrates FEMA Lifelines (Safety and Security, Food, Hydration and Shelter, Health and Medicine, Energy, Communications, Transportation, Hazardous Materials, Water Systems) to prioritize critical services.

**Municipal Profile**

Yabucoa is a landlocked municipality in southwest Puerto Rico, with 19 wards (barrios). It has a rich historical background from Indigenous Taíno culture through Spanish colonial times, with a historic urban core featuring significant architectural heritage.

Geography includes the Sabana Grande Valley and surrounding hills, influencing settlement and hazard exposure. The municipality covers about 141.2 km². Key findings of the municipal assessment include:

*Demographics*

According to the 2024 ACS, the Municipality of Yabucoa has an estimated population of 31,305 residents, composed of 48.57 percent males and 51.43 percent females. The municipality's demographic profile reflects important considerations for hazard mitigation planning, particularly because 34.3 percent of the population is considered vulnerable due to being under 19 years of age or over 65 years of age. The age distribution also indicates a declining youth population and a growing elderly population, a trend that may increase the demand for targeted emergency preparedness, evacuation assistance, health services, and long-term resilience measures.

*Socioeconomic Conditions*

Socioeconomic conditions further shape the municipality's exposure and capacity to prepare for, respond to, and recover from hazard events. Labor force participation is estimated at 35 percent, with an unemployment rate of 8.2 percent. Major employment sectors include education, healthcare, retail trade, and professional services. At the same time, 49.6 percent of individuals live below the poverty level, the median household income is $18,317, and 27.5 percent of households earn less than $10,000 annually. These conditions indicate that a substantial portion of the population may have limited financial resources to undertake preparedness measures, retrofit homes, relocate from hazard-prone areas, or recover after disasters.

Additional indicators of social vulnerability include the increase in the number of individuals living with disabilities, which rose to 4,563 people, representing a 39.35 percent increase. In addition, 52.5 percent of households receive food assistance and approximately 5 percent of the population is uninsured. These factors underscore the importance of prioritizing mitigation actions that strengthen access to essential services, improve continuity of operations, and address the needs of residents who may require additional support before, during, and after emergency events.

*Housing*

Housing and infrastructure conditions are also central to the municipality's risk profile.

Yabucoa has 16,255 housing units, of which 27 percent are vacant. A significant share of the housing stock was constructed before the adoption of current building codes, with 97.6 percent of units built prior to 2011. This condition may increase structural vulnerability to earthquakes, tropical cyclones, flooding, and other hazards. Transportation access is another important consideration, as 15.8 percent of households have no vehicle available, which may affect evacuation capacity and access to emergency services.

**Critical Infrastructure and FEMA Lifelines**

The LHMP assesses municipal infrastructure in alignment with FEMA Lifelines, including safety and security; food, hydration, and shelter; health and medical services; energy; communications; transportation; hazardous materials; and water systems. Critical facilities such as hospitals, police facilities, emergency centers, shelters, and related assets are mapped and evaluated to understand their exposure and role in supporting emergency response and community recovery. This lifeline-based approach helps identify where mitigation investments can protect essential services and reduce cascading impacts during hazard events.

**Recent Development**

Recent development patterns were also reviewed as part of the municipal profile. From 2020 through mid-2026, construction permits averaged approximately 55 permits per year, with development activity distributed primarily near the historic center and other urbanized areas. Understanding where recent development has occurred allows the municipality to evaluate whether new growth is taking place in or near hazard-prone areas and to integrate mitigation considerations into land use, permitting, infrastructure planning, and future investment decisions.

**Hazard Profiles and Risk Assessment**

The LHMP evaluates eight prioritized hazards: earthquake, landslides, flooding, tropical cyclones/extreme winds, extreme heat, drought, wildfire, and pandemic/epidemic. Each hazard is described with its characteristics, affected areas, risk magnitude, past events, future probabilities, risk analysis, social vulnerabilities, and impacts on natural and cultural resources.

*Earthquake*

Puerto Rico is located within a tectonically active region characterized by multiple fault systems, making earthquake risk a significant concern for Yabucoa. The assessment considers earthquake intensity, magnitude, spectral acceleration, and ground motion as key indicators of potential impacts. The highest spectral acceleration zones are located in the northern portion of the municipality, including areas near the historic urban core, where older structures and cultural resources may be especially vulnerable.

Estimated annualized earthquake losses are approximately $3.73 million, reflecting the potential for substantial damage to buildings, infrastructure, and essential services. Earthquakes may affect all FEMA Social vulnerability is heightened by poverty, aging infrastructure, limited household resources, and the presence of residents who may require additional assistance during response, and recovery.

Recent seismic activity, including the significant 2020 southwestern Puerto Rico earthquake sequence, demonstrates that earthquake hazards remain an ongoing concern for the municipality. Because of Puerto Rico's tectonic setting, future earthquake risk is expected to remain high, requiring continued attention to structural resilience, emergency preparedness, critical facility protection, and mitigation measures that reduce potential damages and service disruptions.

*Landslides*

Landslides in Yabucoa are primarily triggered by intense rainfall and are influenced by slope conditions, soil characteristics, geology, land cover, drainage patterns, and human activity. The most susceptible areas are generally located in the mountainous northern wards, where steep terrain and infrastructure access constraints can increase both exposure and response challenges.

Although precise monetary loss estimates are not available for landslides, the hazard can disrupt transportation corridors, utility systems, emergency access, and other essential services. Social vulnerability is closely tied to geographic isolation, road access limitations, infrastructure fragility, and the ability of residents to receive timely assistance during and after hazard events.

Past landslide impacts were notably observed after Hurricane María in 2017, when intense rainfall produced slope failures across many areas of Puerto Rico. Given the

municipality's terrain, rainfall patterns, and the presence of development in susceptible areas, landslide risk is expected to continue and should remain a priority for mitigation, land use planning, infrastructure maintenance, and emergency response coordination.

*Tsunami*

Tsunamis are rapid-onset coastal hazards generally caused by undersea earthquakes, although submarine landslides and volcanic activity may also generate them. While they travel quickly and remain relatively low in deep water, their speed decreases and wave height rises sharply near shore, producing destructive flooding, strong currents, erosion, and debris impacts. Natural warning signs may include sudden sea withdrawal or rise and a loud ocean roar; because the hazard cannot be prevented, effective risk reduction depends on alert systems, evacuation planning, public education, drills, and coordinated initiatives such as the National Tsunami Hazard Mitigation Program and NOAA's TsunamiReady Program.

In Yabucoa, the principal areas exposed to tsunami inundation are the Camino Nuevo, Juan Martín, and Playa wards, where coastal morphology could amplify wave effects; modeling indicates possible impacts from Playa Santa Lucía to Playa Guayanés and limited exposure near the PR-53 bridge. Puerto Rico's historical record—including the destructive tsunamis of 1867, 1918, and 1946—demonstrates the hazard's potential for fatalities, displacement, structural damage, and rapid inland flooding. Although tsunamis are infrequent and cannot be predicted precisely, the island's surrounding offshore seismic zones create a continuing possibility that a strong earthquake could generate another event, reinforcing the importance of Yabucoa's evacuation map and TsunamiReady certification.

Tsunami consequences can cascade across community lifelines by disrupting emergency services, housing, healthcare, power, communications, transportation, ports, and water and wastewater systems, while also damaging coastal ecosystems and cultural resources. National Risk Index data identify a small exposed area and population but substantial total exposure value, even though modeled expected annual losses are reported as zero; the document also notes that Yabucoa's port facilities are the most notable critical infrastructure concern and that overall population exposure is limited. Nevertheless, lower-income residents, older adults, people with disabilities, households without reliable transportation, and socially isolated populations may face greater evacuation and recovery challenges, while the scarcity of approved construction permits within the modeled impact area from 2020

through 2026 suggests that recent development has generally avoided the highest-risk zone.

*Flooding*

Flooding in Yabucoa includes both general flooding and flash flooding, most often associated with tropical weather systems and intense rainfall events. Flood hazard areas are mapped extensively along the Guanajibo River Valley, where floodwaters can affect residential areas, infrastructure, transportation routes, and critical services.

The risk assessment identifies flooding as a high-probability hazard with the potential to cause significant property damage, health risks, and infrastructure impacts. Estimated flood exposure includes more than $263 million in building value. While flood control projects are present and the municipality participates in the NFIP with 137 policies in force, including some repetitive loss properties, flooding remains a persistent concern that requires continued mitigation, floodplain management, and public preparedness actions.

Social vulnerability to flooding is especially high among low-income residents, mobility-limited populations, and households with limited access to transportation or financial resources. These conditions can affect the ability of residents to evacuate, protect property, obtain insurance, or recover after flood events. As a result, flood mitigation remains a central priority for reducing losses, protecting public health, and strengthening community resilience.

*Tropical Cyclones/Extreme Winds*

Tropical cyclones and extreme wind events represent some of the most frequent and damaging hazards affecting Yabucoa. These events range from tropical storms to Category 5 hurricanes, as classified by the Saffir-Simpson Hurricane Wind Scale. The entire municipality is considered exposed to their impact.

Historic hurricanes, including Irma and María in 2017, demonstrate the municipality's exposure to severe wind that can cause power outages, infrastructure damage, economic disruption, and extended recovery needs. The risk assessment maps estimated building damage and economic losses for both 100-year and 500-year events, illustrating the potential severity of future hurricane impacts.

Because tropical cyclones can affect all FEMA Lifelines, including energy,

communications, transportation, safety and security, health and medical services, food and shelter, water systems, and hazardous materials, their impacts can cascade across the community. Social vulnerability is considered widespread due to the municipality-wide exposure of residents, housing, infrastructure, and essential services.

*Storm Surge*

Storm surge is the abnormal inland movement of seawater caused primarily by the strong winds and low atmospheric pressure associated with hurricanes and tropical storms. Its magnitude depends on storm intensity, size, speed, angle of approach, coastal configuration, topography, and bathymetry, with the most severe impacts occurring when surge coincides with high tide and strong wave action. Yabucoa is particularly susceptible because of its eastern coastal location and history of exposure to tropical cyclones, and mapped scenarios indicate that a Category 5 surge could extend inland toward the PR-53 bridge, surrounding agricultural lands, Playa Lucía, and the Playa Guayanés community.

The hazard could produce cascading impacts on Yabucoa's community lifelines and critical infrastructure. Flooding could disrupt roads, bridges, port operations, communications, electric power, fuel distribution, healthcare, water and wastewater services, and emergency response. The Yabucoa port and petroleum storage facility face especially serious risks, including damage to docks, tanks, pipelines, pumping systems, and electrical controls; a major failure could interrupt fuel supplies, delay recovery operations, and release petroleum into coastal waters and nearby ecosystems.

Although the mapped population and recent development directly exposed to storm surge appear limited, impacts could fall disproportionately on low-income households, older adults, residents with limited transportation or healthcare access, and communities with fewer recovery resources. Storm surge may also damage agriculture through crop loss and soil salinization, degrade wetlands, mangroves, beaches, fisheries, and water quality, and threaten cultural sites and coastal community identity. Future planning should therefore integrate hazard mitigation, lifeline stabilization, protection of natural and cultural resources, equitable recovery, and measures to reduce hazardous-material releases and long-term economic disruption.

*Extreme Heat*

Extreme heat is defined as prolonged periods of temperatures above 90 degrees Fahrenheit combined with high humidity, conditions that can increase health risks and place stress on infrastructure systems. Developed areas may experience higher temperatures due to the urban heat island effect, increasing exposure for residents in more urbanized portions of the municipality.

Extreme heat can affect public health, energy demand, transportation systems, communications, and other essential services. Older adults and other vulnerable populations may face elevated risk, particularly when risk perception is low or when access to cooling, medical care, or reliable transportation is limited. Health impacts may include heat-related illness and increased mortality among sensitive populations.

Future projections indicate that temperatures and the frequency of extreme heat events are expected to rise, reinforcing the need for mitigation actions such as public outreach, urban greening, shade improvements, cooling strategies, and infrastructure adaptation. These measures can reduce exposure, improve preparedness, and protect vulnerable residents during periods of excessive heat.

*Drought*

Drought in Yabucoa is characterized by prolonged precipitation deficits that can affect water supply, agricultural activity, economic conditions, and the continuity of essential services. This hazard may occur as a meteorological, agricultural, hydrological, or socioeconomic drought. All this types of droughts can impact water availability and community functions.

Drought conditions can lead to water rationing, affect economic and agricultural activities, increase stress on households and businesses, and contribute to increased wildfire potential. Previous drought events have been documented through federal declarations, demonstrating that the hazard has affected Puerto Rico in the past and remains relevant to local mitigation planning.

Future drought frequency is expected to increase, reinforcing the need to strengthen water conservation, emergency water supply planning, infrastructure resilience, public awareness, and coordination with regional water providers. Social vulnerability is particularly important for elderly residents and low-income households, which may

have fewer resources to adapt to water interruptions, higher utility costs, or related public health and economic impacts.

*Wildfire*

Wildfire consists of uncontrolled fires that may occur in vegetated or dry forest areas and may be intensified by drought conditions and long-term climate trends. Wildfire behavior may include surface fires, crown fires, ground fires, and interface fires where developed areas meet wildland vegetation, creating potential risks to residents, structures, infrastructure, and natural resources.

Yabucoa has historically experienced a relatively low incidence of wildfire; however, some areas near municipal borders present higher potential risk. Wildfires can threaten natural ecosystems, cultural resources, public infrastructure, transportation access, and nearby communities. Recent 2024 wildfire data identified multiple small incidents, indicating that the hazard should continue to be monitored as part of the municipality's risk profile.

Social vulnerability to wildfire is associated with poverty, disability prevalence, limited evacuation capacity, and constraints on household preparedness. Although current wildfire incidence is comparatively low, future risk may increase as dry conditions become more frequent and vegetation stress intensifies. Mitigation measures such as public education, defensible space practices, vegetation management, emergency access improvements, and interagency coordination can reduce potential impacts.

*Long Term Coastal Dynamics*

Long-term coastal dynamics are the gradual processes that reshape coastlines through erosion, accretion, sediment movement, and variations in mean sea level. Unlike isolated storm impacts, these processes unfold over years or decades and progressively alter shoreline position, coastal stability, and exposure to flooding and wave action. Their combined effects can reduce beach width, weaken dunes and other natural buffers, and cause the shoreline to migrate inland, making them an important consideration in hazard mitigation, land-use planning, and infrastructure investment.

Yabucoa has approximately 19.5 kilometers of coastline composed mainly of beaches and rocky shores. Post-Hurricane María assessments found substantial but uneven shoreline change: although about 71 percent of the municipality's beaches initially

exhibited sediment accretion, erosion affected several locations and intensified in portions of Guayanés, Lucía, and Teresa Beaches during the following ten months. By July 2018, about 1.84 kilometers of shoreline showed landward waterline migration, and approximately 1.65 kilometers of beach shoreline had moved inland, particularly along Yabucoa and Lucía Beaches.

Coastal erosion may occur episodically during major storms or chronically through persistent sediment deficits, rising water levels, land subsidence, altered river sediment delivery, coastal development, and damage to natural protective systems. Accretion may temporarily or persistently widen beaches and strengthen dunes, but it is not uniform or necessarily permanent and may reflect sediment transferred from another shoreline segment. Human interventions, including coastal structures, dredging, development, and beach nourishment, can modify both erosion and accretion patterns and may create benefits in one area while increasing vulnerability elsewhere.

Observed sea-level trends reinforce the municipality's long-term coastal risk. Puerto Rico tide gauges cited in the document show increasing relative sea levels, with trends of approximately 2.06 millimeters per year at Magueyes Island and 2.16 millimeters per year at San Juan through 2025. Gradual increases in the coastal water-level baseline can intensify routine tidal flooding, accelerate shoreline adjustment, expose low-lying areas, and reduce the effectiveness of natural and engineered protective features even without a major storm.

These dynamics threaten multiple Community Lifelines, including emergency services, water and wastewater systems, healthcare access, energy, communications, transportation, and hazardous-material facilities. They also disproportionately affect low-income households, renters, older adults, people with disabilities or chronic health conditions, and communities dependent on coastal livelihoods, while endangering beaches, dunes, wetlands, mangroves, coral reefs, historic sites, and other cultural resources. Because future coastal change in Yabucoa is considered highly likely, the document supports sustained shoreline monitoring, nature-based solutions, land-use controls, resilient infrastructure siting, adaptive shoreline management, and mitigation actions that protect essential services and vulnerable populations.
Pandemic/Epidemic

Pandemic and epidemic hazards include localized disease outbreaks as well as widespread events that can extend across regions, nations, or globally. For planning purposes, the entire municipality is considered vulnerable because infectious disease

impacts can affect residents, institutions, workplaces, schools, healthcare providers, and essential services throughout Yabucoa.

Puerto Rico has experienced several historic outbreaks, including cholera in 1855, measles in 1917, the Spanish Flu in 1918, polio in 1960, as well as, dengue, chikungunya, Zika, and COVID-19 in recent years. The COVID-19 pandemic produced significant health, economic, and social impacts locally and illustrated how disease events can disrupt normal community functions, increase demand for public health services, and affect vulnerable populations.

During pandemic and epidemic events, the healthcare lifeline is typically the most directly affected; however, other FEMA Lifelines may also experience disruptions, including communications, transportation, food supply, shelter operations, public safety, and continuity of government functions. Future pandemic risk remains elevated due to changing environmental conditions, population characteristics, travel patterns, and the continued emergence of infectious diseases. Mitigation and preparedness efforts should therefore emphasize public health coordination, risk communication, continuity planning, support for vulnerable populations, and sustained emergency management capacity.

**Hazard Prioritization**

The Planning Committee used the results of the hazard profiles and risk assessment to establish mitigation priorities for the Municipality of Yabucoa. Based on the analysis, earthquakes, landslides, flooding, tropical cyclones and extreme winds, extreme heat, drought, and wildfire were identified as high-priority hazards. Pandemic and epidemic hazards were categorized as mid-priority. This prioritization exercise conducted with the planning committee was a qualitative exercise which takes into consideration the municipality's exposure, potential impacts to people and property, effects on critical infrastructure and FEMA Lifelines, and the needs of socially vulnerable populations.

**Municipal Capabilities**

The LHMP is supported by a range of planning mechanisms, regulatory frameworks, and municipal capacities that guide land use, permitting, floodplain management, infrastructure investment, emergency response, and long-term resilience. These include the Karst Special Planning Area Plan, the Joint Regulation for Permits, the Special Flood Hazard Areas Regulation, the Puerto Rico Building Code, the Stormwater Systems Regulation, the Yabucoa Territorial Plan, and the Yabucoa Emergency

Operation Plan. The municipality also participates in the National Flood Insurance Program and complies with the Clean Water Act's NPDES program. In addition, the plan recognizes the value of green infrastructure and nature-based solutions for stormwater management, while the Four-Year Investment Program (PICA) serves as a tool to align public investment with hazard mitigation priorities.

Yabucoa's technical and administrative capacity is supported by municipal offices with responsibilities related to planning, land use, emergency management, and federal programs. These include a staffed Planning and Land Use Office, Emergency Management Office, and Federal Programs Office, with engineering and specialized technical expertise procured as needed. The municipality's financial capacity is strengthened by positive fund balances and access to federal funding sources, including FEMA's Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Building Resilient Infrastructure and Communities (BRIC), and HUD's CDBG-DR and CDBG-MIT programs.

Public outreach and capacity development are also central components of the LHMP. The municipality uses social media, printed materials, and community meetings to inform residents, gather input, and promote public participation in the mitigation planning process. Capacity-building efforts include staff training and collaboration with academic institutions, supporting the municipality's ability to implement mitigation actions and strengthen institutional knowledge. The plan emphasizes clear, inclusive, and accessible communication to improve hazard awareness, encourage preparedness, and increase community participation.

**Mitigation Action Plan**

The Mitigation Action Plan establishes goals and objectives to reduce hazard impacts, protect life and property, strengthen infrastructure, increase public knowledge, and improve recovery capacity. Its objectives include preventing loss of life and property, improving municipal program implementation, educating residents and businesses about hazard risks, and strengthening emergency response and intergovernmental coordination. Mitigation strategies are organized into categories such as prevention, property protection, natural resource protection, structural mitigation, emergency services, and public awareness and outreach. These strategies include updating land use and emergency management plans, improving stormwater management, conducting hazard drills, supporting infrastructure resilience, and addressing extreme heat through urban greening and response planning among others.

Overall, the 2026 Yabucoa LHMP update integrates hazard assessments, policy frameworks, municipal capabilities, community input, and actionable mitigation strategies into a comprehensive planning tool. Through this integrated approach, the municipality seeks to reduce risk, protect essential services, guide future investments, and strengthen resilience to natural hazards and public health emergencies over the coming years.

# 1. Introduction and Background

The Municipality of Yabucoa and the Puerto Rico Planning Board (PRPB) are dedicated to protecting the well-being of Puerto Ricans by fostering cultural, social, and economic growth while prioritizing public health and safety. In this effort, the Municipality and the PRPB have agreed on a joint effort to update the Municipality's Local Hazard Mitigation Plan (LHMP). The LHMP provides a structured and comprehensive approach to reducing risks associated with natural hazards and strengthening overall community resilience. In recent years, Yabucoa has faced considerable impacts from natural disasters, emphasizing the urgent need for proactive actions to reduce vulnerabilities and safeguard critical infrastructure. These experiences highlight the importance of implementing a coordinated and systematic hazard mitigation strategy that is consistent with federal, state, and local policies.

An LHMP identifies and evaluates potential natural hazards and defines actions designed to reduce or eliminate risks to people, property, and the environment. The plan supports the municipality's land use planning efforts by establishing measures that assist Patillas in achieving its long-term sustainability and resilience objectives.

This LHMP complies with the requirements set forth by the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) and the federal regulations derived from it. Under this legislation, local governments in states and territories are required to develop and formally adopt a hazard mitigation plan as a condition for eligibility to receive certain types of funding administered by the Federal Emergency Management Agency (FEMA).

Risk mitigation plays a critical role in guiding future development and enhancing existing municipal infrastructure. To ensure an effective mitigation strategy, the LHMP is regularly updated to reassess natural hazards that may threaten the lives and property of residents and to incorporate appropriate and responsive mitigation measures.

This document represents the Choose an item. revision of the LHMP for the Municipality of Patillas. The Yabucoa LHMP was approved in 2012. An update for the plan was approved in 2020. This 2026 update reflects evolving conditions and circumstances that have influenced the municipality over the past five years and incorporates newly enacted laws, programs, and regulatory requirements. Through this update, Yabucoa

aims to preserve its eligibility for federal mitigation funding prior to future catastrophic events and to present a strengthened plan aligned with current standards and best practices.

The development of this plan was conducted through a coordinated process that incorporated input from state and local agencies, non-governmental organizations, and the public. The overarching goal is to enhance the municipality's capacity to anticipate, reduce, and effectively respond to natural hazards that may affect its jurisdiction.

The primary objectives of the LHMP are to:

- Identify and evaluate natural hazards that pose risks to the municipality.
- Establish strategies and actions to reduce or eliminate long-term threats to life, property, and critical services.
- Encourage interagency coordination and promote community involvement in disaster preparedness and mitigation initiatives.

## 1.1 Applicable Public Policies

This section outlines the relevant federal and state public policies that guide the development of the 2026 Yabucoa LHMP. The overview provided is not intended to be comprehensive. Additional public policies are referenced throughout the document, particularly in Section 5.1.

### 1.1.1 Federal Policies

#### *1.1.1.1 Federal Laws*

**Stafford Act and Disaster Mitigation Act of 2000**

The Safford Act is primarily aimed at reducing loss of life and property, alleviating human suffering, minimizing economic impacts, and lowering the costs associated with disaster assistance. In 1988, Congress amended the Act to create the Hazard Mitigation Grant Program (HMGP), which became the principal source of federal mitigation funding following a disaster declaration by the President of the United States. Through this program, funds are made available to states and territories to implement cost-effective measures that reduce the risk of damage and losses from

future hazard events.

**Disaster Mitigation Act of 2000**

Enacted on October 30, 2000, the Disaster Mitigation Act of 2000 (DMA 2000) further amended the Stafford Act to enhance disaster planning, response, and recovery at all levels of government. This legislation establishes eligibility requirements for municipalities to access federal mitigation funding, including the preparation and adoption of a Local Hazard Mitigation Plan (LHMP). An LHMP demonstrates a jurisdiction's commitment to reducing risks associated with natural hazards and serves as a decision-making tool for implementing preventive and mitigation actions. It also provides a framework for the State to deliver technical assistance and establish funding priorities.

In accordance with DMA 2000 requirements, this LHMP is comprehensive and coordinated, incorporating the participation of state, local, and regional agencies, non-governmental organizations, and members of the public.

**National Flood Insurance Act**

The National Flood Insurance Act established the National Flood Insurance Program (NFIP) to provide affordable flood insurance coverage to homeowners, businesses, and renters located in flood-prone areas. The program was designed to reduce the financial burden on individuals and the federal government in the aftermath of flood-related disasters.

The Act also encourages participating communities to adopt and enforce minimum floodplain management standards aimed at reducing future flood risks. Communities that comply with these requirements become eligible for NFIP benefits and programs.

Access to flood insurance enables property owners to recover more rapidly following flood events without relying solely on federal disaster assistance. Supporting legislation, such as the Flood Disaster Protection Act of 1973, further requires federally regulated lenders to mandate flood insurance coverage for properties located in high-risk flood zones and financed through federally backed mortgages.

The Federal Emergency Management Agency (FEMA) has recognized the Municipality as part of the region that is within the PRPB's coverage within the National Flood Insurance Program. The municipality can request updates and amendments to flood

hazard maps utilized by the NFIP through the PRPB.

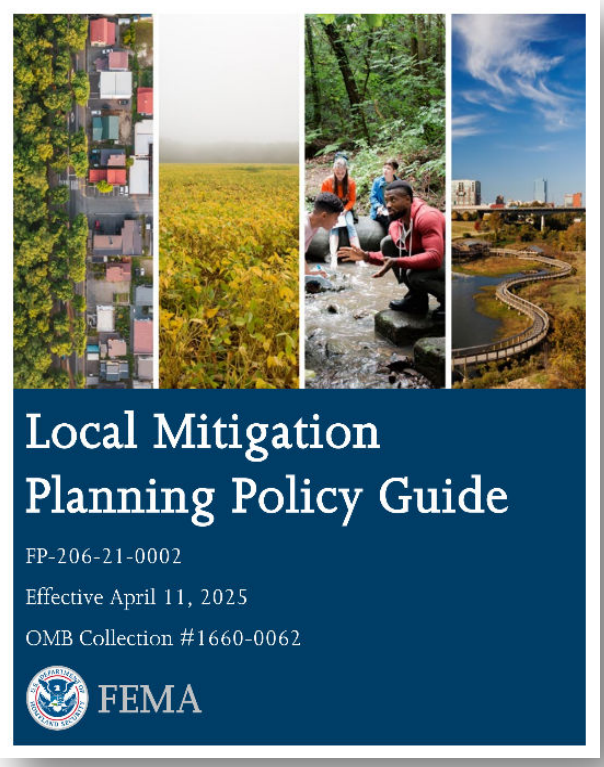
Additionally, through participation in the Flood Mitigation Assistance Program, the municipality has identified specific mitigation strategies to reduce flood-related risks. Funding has also been allocated for the acquisition of structures located in high-risk flood areas as part of ongoing efforts to decrease vulnerability and exposure to future flood events.

### 1.1.1.2 Federal Regulations

Mitigation Planning - 44 CFR Part 201

This section of the Code of Federal Regulations describes the rules and procedures governing hazard mitigation planning as mandated under the Stafford Act. It outlines the requirements for the preparation and adoption of mitigation plans, which serve as the primary tool for reducing risks posed by natural hazards at the local level. Additionally, this section establishes the policies and planning processes that guide hazard mitigation efforts, underscoring the role of mitigation plans in directing the effective allocation of resources for disaster risk reduction.

*Figure 1: Cover of FEMA's Local Mitigation Planning Policy Guide*




FEMA Local Hazard Mitigation Planning Guide

The Local Hazard Mitigation Planning Policy Guide published by FEMA establishes the official framework and guidance that local governments are required to follow when preparing, reviewing, and updating their Local Hazard Mitigation Plans (LHMPs). This guidance is designed to ensure compliance with the requirements set forth in the Code of Federal Regulations (44 CFR Part 201).

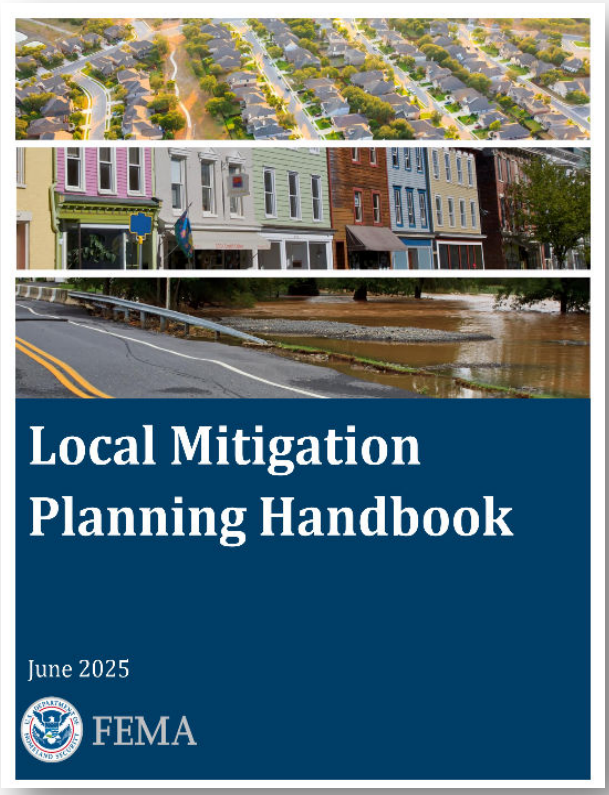
The policy guide emphasizes data-driven planning tailored to local capacities, while prioritizing equity and inclusive stakeholder participation. It encourages communities to integrate hazard mitigation into broader

planning and decision-making processes, thereby strengthening long-term resilience and reducing vulnerability to natural hazards ( (FEMA, Local Mitigation Planning Policy Guide, 2025).

The guide identifies the essential components that every mitigation plan is required to address. In addition, it provides practical resources such as resolution templates, checklists, and plan review criteria to support local governments throughout the planning process. The guide also explains FEMA's plan review and approval process, which may result in full approval, conditional approval pending formal adoption, or return of the plan for revisions and corrections.

**Local Mitigation Planning Handbook**

*Figure 2: Cover of FEMA's Local Mitigation Planning Handbook*



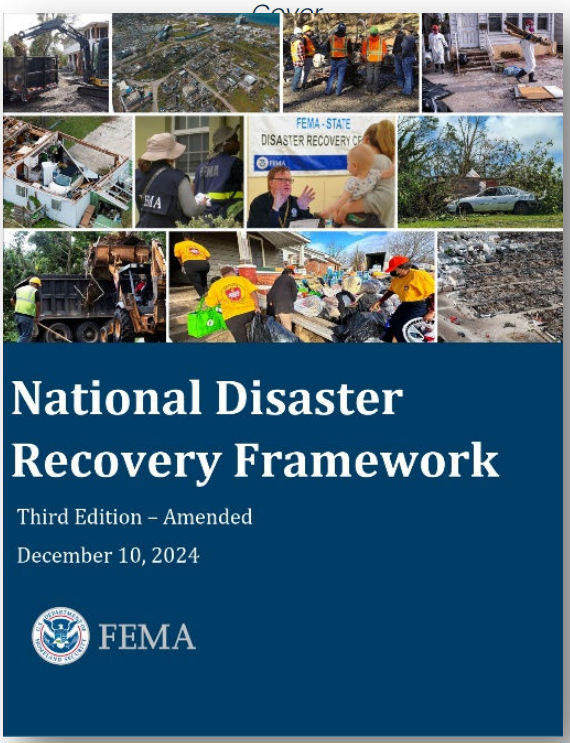

The *Local Mitigation Planning Handbook* is an operational resource developed by FEMA to assist local governments, including municipalities and special districts, in the development or update of their Local Hazard Mitigation Plans. This handbook serves as a companion to FEMA's mitigation planning policy guidance and offers a detailed, step-by-step methodology for complying with the requirements outlined in Title 44 of the Code of Federal Regulations, Part 201.

The primary purpose of the handbook is to support communities in identifying the natural hazards they face, evaluating institutional and administrative capabilities, and formulating effective strategies to reduce disaster-related impacts (FEMA, 2025). Ultimately, the handbook promotes the creation of safer and more resilient communities that are better prepared to anticipate, withstand, and recover from adverse events.

**National Disaster Recovery Framework**

The National Disaster Recovery Framework (NDRF) is a guide created by FEMA in the United States that establishes how recovery should be organized and coordinated after a disaster. Its main objective is to help affected communities rebuild in a stronger, more equitable, and more resilient way, involving all levels of government—local, state, tribal, territorial, and federal—along with private and community organizations.

*Figure 3: National Disaster Recovery Framework Cover*




This framework promotes recovery that not only restores what was lost but also improves pre-disaster conditions. To achieve this, the NDRF defines guiding principles, specific roles for the actors involved, and coordination structures that facilitate collaboration among agencies. It also emphasizes the importance of planning before a disaster occurs and ensuring that recovery goals are defined by the affected communities themselves.

National Flood Insurance Program

The National Flood Insurance Program (NFIP), administered by FEMA, provides affordable flood insurance coverage to property owners, renters, and businesses while encouraging effective floodplain management practices to reduce future flood risks. Established in 1968, the NFIP supports communities in minimizing flood-related losses by requiring the adoption and enforcement of local floodplain management regulations. The program also offers insurance coverage for both structures and their contents in more than 22,000 participating communities nationwide.

Because most standard homeowners' insurance policies do not cover flood damage, the NFIP plays a critical role in protecting lives and property while reducing long-term disaster recovery costs. Additional information regarding the Municipality of Yabucoa's participation in the NFIP is provided in Section 4.2 of this plan.

**National Earthquake Hazards Reduction Program**

The National Earthquake Hazards Reduction Program (NEHRP) was established under the Earthquake Hazards Reduction Act of 1977 to advance the development, dissemination, and application of knowledge, tools, and practices that reduce risks associated with seismic events. This objective is achieved through coordinated, multidisciplinary, and interagency collaboration among NEHRP's participating federal agencies and partners, including local jurisdictions such as the Municipality of Yabucoa

.

The National Institute of Standards and Technology (NIST), within the U.S. Department of Commerce, serves as the lead agency for NEHRP. The program is further supported by three cooperating federal agencies: the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF), and the United States Geological Survey (USGS). Each agency contributes expertise and complementary activities related to research, preparedness, mitigation, and public safety.

**National Incident Management System**

The National Incident Management System (NIMS) is a standardized framework developed by the U.S. Department of Homeland Security and administered by FEMA to guide incident management across the nation. Its purpose is to enable effective coordination and cooperation among governmental agencies, private sector organizations, and community-based entities at all jurisdictional levels during the prevention, preparedness, response, and recovery phases of emergencies and disasters.

NIMS establishes a common organizational structure, terminology, and set of processes to ensure seamless coordination regardless of the incident's type, size, or complexity. Core components of the system include resource management, interoperable communications, ongoing preparedness activities, and the Incident Command System (ICS), which defines clear roles, responsibilities, and command structures during emergency operations.

Implementation of NIMS is also a prerequisite for jurisdictions seeking access to certain federal preparedness and response funding. By adopting NIMS, jurisdictions enhance operational efficiency, reduce duplication of efforts, and promote the effective and coordinated use of available resources.

### 1.1.2 Government of Puerto Rico Policies

#### *1.1.2.1 Puerto Rico Laws*

**Act No. 161-2009, as Amended**

Act No. 161-2009, known as the *Puerto Rico Permits Reform Act*, establishes a modern legal and administrative framework designed to comprehensively restructure the Commonwealth's permitting system. The primary goal of the Act is to create a transparent, efficient, and streamlined process for the submission, evaluation, approval, or denial of permits issued by the Government of Puerto Rico.

To accomplish this objective, the law created the Office of Permits Management (OPM), consolidating permitting responsibilities that were previously distributed across multiple agencies. This centralization reduced procedural delays and improved consistency in the application of permitting standards. The Act also introduced specialized roles—including Authorized Professionals, Permit Managers, Service Representatives, and Permit Officers—each with defined responsibilities intended to expedite reviews and professionalize the permitting process.

A further objective of Act No. 161-2009 is to enhance oversight, accountability, and transparency within the permitting system. By strengthening internal controls and standardizing procedures, the Act seeks to ensure compliance while reducing administrative inefficiencies.

From a public policy perspective, the Act aims to promote economic development while safeguarding environmental protection. Legislative intent emphasizes that an efficient permitting system is essential to attract investment, encourage construction activity, support long-term job creation, and eliminate bureaucratic barriers that previously hindered economic growth. Analyses of the Act also highlight its role in centralizing governmental functions and implementing an Integrated Permitting System to reduce fragmentation, improve interagency coordination, and ensure regulatory uniformity throughout Puerto Rico.

**Act No. 33-2019, as Amended**

Act No. 33-2019 establishes the public policy of the Government of Puerto Rico regarding mitigation, adaptation, and resilience in response to observed variations in temperature and precipitation patterns. The legislation formally recognizes the need

for integrated governmental action, including at the municipal level, to address the impacts of environmental instability.

This Act calls for the incorporation of concrete mitigation, adaptation, and resilience measures into territorial and land use planning instruments. By doing so, it promotes a proactive approach that strengthens communities' capacity to withstand environmental stressors and reduces long-term risks to public safety, infrastructure, and natural resources.

**Act No. 107-2020, as Amended**

Act No. 107-2020, as amended, known as the *Puerto Rico Municipal Code*, significantly expands the authority, responsibilities, and operational autonomy of municipal governments. The Code promotes local self-governance and enhances municipalities' capacity to manage their own affairs, including disaster preparedness and risk reduction.

Among the responsibilities granted to municipalities is the authority to design and implement programs and measures to prevent, respond to, and recover from emergencies, natural disasters, catastrophic accidents, and other hazardous events. This expanded role reinforces the importance of municipal governments in protecting public safety and community well-being.

The Municipal Code also grants municipalities enhanced autonomy over land use regulation within their jurisdictions. This authority includes the application of tools such as the transfer of development rights and the evaluation and issuance of construction permits, enabling municipalities to incorporate hazard mitigation principles directly into development decisions. These powers are essential for reducing exposure to natural hazards and safeguarding lives and property.

Overall, the Municipal Code recognizes territorial planning as a critical instrument for risk mitigation and establishes a legal framework that enables municipalities to take proactive, locally tailored actions to protect their communities from natural hazards and other adverse events.

### 1.1.2.2 Puerto Rico Regulations

**Puerto Rico Land Use Plan (PUT-PR by its Spanish acronym) - 2015**

*Figure 4: PUT-PR Coversheet*




In compliance with Act No. 550-2004, as amended, the Puerto Rico Land Use Plan (PUT, by its Spanish acronym) constitutes the primary territorial planning instrument prepared by the Puerto Rico Planning Board. The Plan is intended to direct land use, development, and conservation activities throughout the island in a coordinated, sustainable, and resilient manner, guided by a long-term planning horizon of ten (10) years (PRPB, 2015).

One of the primary functions of the Puerto Rico Land Use Plan (PUT) is to classify land throughout the Commonwealth into specific land use categories. Land classification serves as a land administration framework that establishes the types of zoning districts and allowable uses that may be applied to individual parcels. Under the PUT, land is classified according to the following scheme:

- Urban Land (SU, by its Spanish acronym): This category includes areas that are already developed and served by the necessary infrastructure and public services.

- Land for Development: This classification applies to land identified as suitable for future development and is subdivided into two categories:
    - Programmed Development Land (SUP, by its Spanish acronym): Land scheduled for development under established programs or plans.
    - Non-Programmed Development Land (SUNP, by its Spanish acronym): Land available for development that has not yet been assigned to a specific development program.

- Rustic Land: Rustic lands are designated for protection, conservation, or limited use due to their environmental, agricultural, or ecological value. This

classification is further subdivided into:

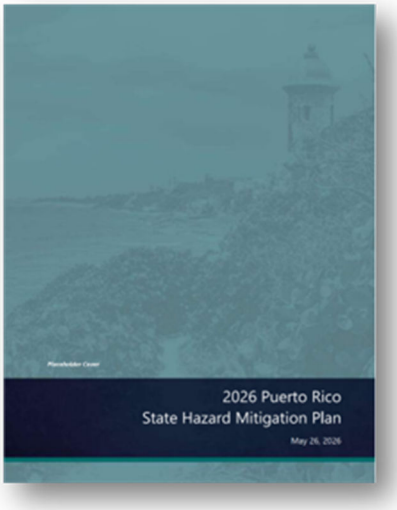
- Common Rustic Land (SRC, by its Spanish acronym): Areas suitable for limited, low-intensity uses.
- Specially Protected Rustic Land (SREP, by its Spanish acronym): Areas subject to heightened protection due to their environmental, natural, or cultural significance.

The PUT-PR aims to coordinate and harmonize land use planning efforts among state agencies and municipalities. It serves as the foundation for the preparation of municipal Land Use Plans (Planes de Ordenación Territorial, POT, by its Spanish acronym), which are adopted for an eight-year planning period (PRPB, 2015).

Currently, the PUT-PR is in the process of being updated for the 2026 -2032 planning cycle. This revision will incorporate robust citizen participation, clearly defined compliance and performance metrics, and an inclusive planning approach that integrates economic development, green infrastructure, sustainable transportation systems, and the conservation of natural resources.

**Puerto Rico State Natural Hazard Mitigation Plan (2026)**

*Figure 5: Puerto Rico SHMP Cover*




Similar to requirements for local jurisdictions, the Stafford Act mandates that states and territories develop a hazard mitigation plan covering their entire jurisdiction. In the case of Puerto Rico, the most recent State Hazard Mitigation Plan was completed in 2026. The Puerto Rico 2026 State Hazard Mitigation Plan outlines long-term strategies to address natural hazards that have the potential to disrupt daily activities, damage property, and threaten human life. These hazards—which in many cases are intensified by changing environmental conditions—can escalate into disasters that affect not only individuals, but entire communities, with wide-ranging impacts on public health, infrastructure, economic stability, and natural ecosystems (NMEAD, 2026)

This plan provides a comprehensive framework for identifying risks and implementing actions aimed at reducing vulnerability to these hazards. Through its emphasis on mitigation, the plan seeks to enhance community resilience, safeguard critical

infrastructure and systems, and promote sustainable development across Puerto Rico.

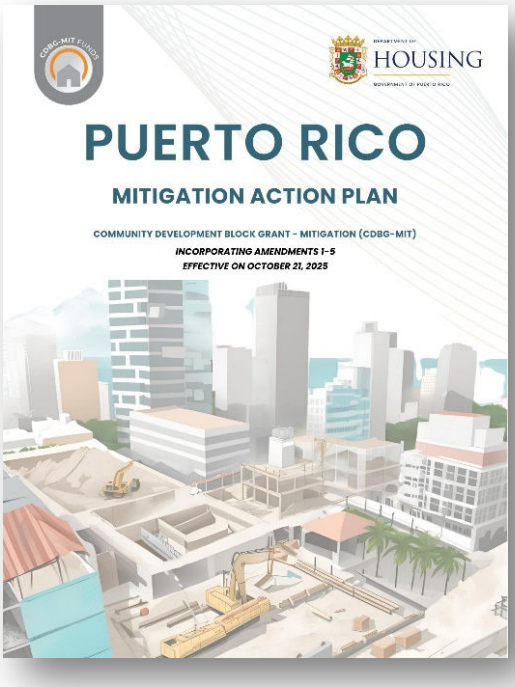
The Municipality of Yabucoa revised Puerto Rico's 2026 State Hazard Mitigation Plan during the preparation of this LHMP update. Risk profiles, state capabilities, mitigation goals, and relevant state actions were considered during the risk assessment, capacity assessment, and development of the municipal mitigation strategy.
.

**Puerto Rico Mitigation Action Plan, CDBG-DR MIT (2021, 2025)**

Originally approved by the U.S. Department of Housing and Urban Development (HUD) in 2021 and subsequently amended in August 2025, the Puerto Rico Mitigation Action Plan for the Community Development Block Grant–Mitigation (CDBG-MIT) Program is a strategic planning document prepared by the Puerto Rico Department of Housing (DV). The plan establishes the framework for the administration and management of federal mitigation funds allocated by HUD under the CDBG-MIT program.

Its primary objective is to reduce risks and vulnerabilities to future disasters by enhancing the resilience of infrastructure, communities, and critical systems. Although these funds were appropriated by Congress to Puerto Rico following Hurricanes Irma and María in 2017, CDBG–MIT funding differs from CDBG–Disaster Recovery (CDBG-DR) in that it is specifically focused on preventing and mitigating future impacts. Accordingly, CDBG-MIT resources are directed toward sustainable, high-impact mitigation projects and are not required to be directly linked to disaster recovery activities associated with those hurricanes (PRDOH, 2025). This plan is designed to reduce exposure to hazards, safeguard lives and property, and enhance emergency response capabilities through targeted investments in infrastructure, housing, and land-use planning (PRDOH, 2025).

*Figure 6: Puerto Rico Mitigation Action Plan Cover*




Other relevant planning regulations will be

discussed as part of subchapter 4.17

### 1.1.3 Municipal Policies

**Yabucoa Local Hazard Mitigation Plan (2020)**

*Figure 7: Yabucoa Hazard Mitigation Plan Cover*




Adopted by the Municipality on 7/24/2020, this is the most recent Hazard Mitigation. The plan was updated in compliance with the federal Disaster Mitigation Act of 2000 and FEMA requirements, which require municipalities to maintain an approved hazard mitigation plan in order to remain eligible for federal mitigation funding. The document explains that the purpose of the LHMP is to reduce future losses of life and property through planning, infrastructure improvements, and other mitigation measures that enhance community resilience.

The plan provides an overview of Yabucoa's demographic and geographic characteristics. Located on the southeastern coast of Puerto Rico, Yabucoa covers approximately 55 square miles and contains ten barrios. Population data show a decline from 37,941 residents in the 2010 Census to an estimated 35,025 residents in 2017, representing a decrease of 7.69 percent. At the same time, the municipality experienced significant growth in its elderly population, while younger age groups declined. These demographic trends are important for understanding the municipality's vulnerability to natural hazards and future planning needs.

Public participation played a significant role in the development of the plan. A multidisciplinary Hazard Mitigation Planning Committee was established, composed of municipal officials, emergency management personnel, community representatives, and other stakeholders. The committee updated critical facility inventories, reviewed previous mitigation actions, assessed new mitigation opportunities, and coordinated outreach activities. Public meetings were held in 2019, notices were published in local newspapers, and draft versions of the plan were made available both online and at municipal offices to encourage community review and feedback.

The risk assessment identified ten natural hazards affecting Yabucoa, including sea level rise, drought, earthquakes, flooding, landslides, strong winds, tsunamis, coastal

erosion, storm surge, and wildfires. Based on technical analyses, community input, and historical experience, the hazards with the highest risk rankings were earthquakes/liquefaction, flooding, and strong winds associated with tropical cyclones. These findings guided the prioritization of mitigation actions, with special emphasis on prevention, property protection, emergency services, public education, and structural projects designed to reduce future losses and improve resilience.
The mitigation strategy and action plan focus on maintaining essential municipal services and strengthening community preparedness. Key actions include implementing the municipal territorial plan, improving inventories of public infrastructure and critical facilities, supporting debris management, enhancing emergency response capacity, reducing flood and coastal risks, improving tsunami preparedness, and expanding public education efforts. The plan also establishes a maintenance process involving annual reviews, continued public participation, periodic evaluations of mitigation progress, and updates following major disasters. FEMA approved the plan on July 30, 2020, making Yabucoa eligible for Hazard Mitigation Assistance programs through July 29, 2025.

**Yabucoa Municipal Recovery Plan**

*Figure 8: Yabucoa Municipal Recovery Plan Cover*




As part of the CDBG-DR funds assigned by Congress to Puerto Rico in the aftermath of hurricanes Irma and María, municipalities were able to develop a recovery plan to guide recovery efforts and resiliency in the event of future stressors. In essence the Municipal Recovery Plans:

Identify local post-disaster needs created or worsened by Irma and María
Establish short-, medium-, and long-term recovery priorities
Integrate resilience and hazard mitigation strategies
Serve as a policy and project roadmap for future funding decisions

Each Municipal Recovery Plan has a list of recovery and resiliency projects that might be considered as new mitigation strategies for the LHMP.

## 1.2 Scope and Previous Versions

### 1.2.1 Primary Objectives

The primary objectives of the LHMP are to:

- Identify and assess natural hazards that pose a risk to the municipality.
- Develop strategies and actions to reduce or eliminate long-term risks to life, property, and essential services.
- Promote interagency coordination and community engagement in disaster preparedness and mitigation efforts.

### 1.2.2 Previous FEMA Comments

This section presented the comments made by FEMA in the 2020 LHMP Review Tool and how they were addressed in the 2026 revision.

**Element B.3**

- Recommendation - Since last revision, FEMA has reconsidered and determined that language regulation allows for some flexibility on reviewing compliance with this element. After further consideration, FEMA agrees that the approach presented in the LHMPs to describe the impact of natural hazards in the Municipality meets minimum requirements for the LHMP Review Guide sub-element B.3. However, FEMA still recommends that for future plan updates, the Municipality uses data available to estimate dollar losses for the natural hazards included in the LHMP to adequately assess the impact of natural hazards on the communities."

- Municipality's Response - Dollar losses have been determined for earthquake, tsunami, flood and tropical cyclone (hurricane). Other hazards have not developed a methodology or there is not enough available data for computation of dollar amount losses.

**Element B.4**

- Recommendation - "The municipality will need to update the RL and SRL, NFIP information as soon as is available as stated in the plan. "The Municipality of Añasco (sic) Mitigation Plan shall be amended to include the required NFIP information once the JP and the Municipality of Añasco (sic) are able to retrieve the data under the insurance referral reporting tool. The NFIP information shall include properties that are covered by the NFIP and that have suffered repeated losses and severe repeated losses because they are in areas identified by the program as flood hazard zones. This information should include the type of structure, i.e., residential, commercial, institutional, and others. This information aids in understanding the vulnerability of flood-affected properties in the jurisdiction and provides greater likelihood of qualifying for flood control or prevention grants through programs such as Flood Mitigation Assistance (FMA), the Hazard Mitigation Grant Program (HMGP), the U.S. Department of Housing and Urban Development (HUD) programs, the Community Development Disaster Recovery Grant Program (CDBG-DR), and others."

- Municipality's Response - NFIP information has been updated with the available information data set as of June 30th, 2026.

**Element D.1**

- Recommendation - "For the next plan update, please provide a more complete description of development changes within hazard prone areas and the effect on vulnerability for all years since the previous Plan approval. The currently submitted Plan discusses the results of the economic recession that started in 2009 and that has severely limited the construction of new developments in the Municipality. In addition, a more detailed accounting of vulnerability changes and new developments is provided based on available data for the years 2015 to 2019. However, the previous plan was approved in 2013. For the next Plan update, please make sure to include in the analysis of new developments those projects that were permitted or constructed for all years since the year of the previous plan approval. This will allow a more comprehensive and representative analysis of what occurred regarding the community's risk and vulnerability to natural hazards. If construction or permit information is not available for all years of that period, then clearly state those facts within the plan."

- Municipality's Response - To better analyze the recent development, the municipality obtained the from the Puerto Rico Planning Board the relevant data regarding constructions permits granted for the period of 2020 – 2026 (until June 30th, 2026. When the data is available there are some hazards that have the permits granted shapefile superimposed on the extent of hazard area shapefile. In those hazards where this does not happen it is either because there is not enough information or the hazards has been evaluated by stochastic methods.

**Element E.1**

- Requirement - The jurisdiction approved the Municipal Ordinance number Resolution Num. 3, Serie 2020-2021 on July 24, 2020. That Municipal Ordinance adopts the Mitigation Plan for Municipality of Yabucoa. Municipal Ordinance should be incorporated into the Plan when final version is submitted to FEMA.

- Municipality's Response - Copy of the Municipal Ordinance was included as part of Appendix A of the 2020 LHMP.

## 1.3 LHMP Organization

Table 1 shows the layout for the 2026 of Yabucoa LHMP. To help LHMP reviewers and the public understand compliance, the table includes a column specifying which FEMA-required element (FEMA, 2025) is addressed by each section.

*Table 1: LHMP Organization*

| Chapter # | Title | Description | Review Tool<br><br>Elements met |
|---|---|---|---|
| N/A | Executive Summary | This section summarizes the most important findings from the planning process and explains how they are addressed in the LHMP. | Local Element |
| Chapter 1: | Introduction | This chapter discusses the planning background for Yabucoa It explains the organization of the LHMP and the most significant changes in the 2026 version compared to the 2020 version. It also addresses the public policies relevant to the update of the LHMP and the planning process followed, including citizen participation and stakeholder involvement. | E2-a, A1-a, A1-b, A4-a, A2-a, A3-a |
| Chapter 2 | Municipal Profile | The municipal profile describes the municipality's relevant characteristics, including physical features, infrastructure, and demographic and socioeconomic traits. | E1-a |
| Chapter 3 | Hazard Profiles and Risk Analysis | This section is the most extensive in the plan. It covers the hazards identified for Yabucoa and examines the risks associated with each one. | B-1a, B-1b, B1-c, B1-d, B-e, B2-a, B2-b, E1-a |
| Chapter 4 | Mitigation Capabilities | This chapter elaborates on the municipality's capabilities to implement the mitigation strategies that will be proposed in Chapter 6. | C1-a, C-1b |
| Chapter 5 | Mitigation Strategies | This chapter establishes the mitigation goals of the Plan and the actions the municipality will take to reduce the risks associated with the identified natural events. It also serves to update the status of the mitigation actions included in the 2020 Plan. | C3-a, C4-a, C4-b, C5-a, C5-b, E2-b |
| Chapter 6 | Plan Maintenance | This chapter addresses the process for evaluating the effectiveness of the plan. It also explains the procedure for making modifications or updates to the plan. | D1-a, D2-a, D2-6, D2-c, E2-c |

| Chapter # | Title | Description | Review Tool<br><br>Elements met |
|---|---|---|---|
| Chapter 7 | Adoption and Approval | This section includes information on the adoption of the plan by the municipality, FEMA's approval, and the expiration date of the 2026 Local Hazard Mitigation Plan. | F1-a, F1-b |
| N/A | References | This section presents the sources used in updating the plan. | A4-a |
| N/A | Appendixes | This section includes all appendices and supplementary information related to the planning process of the Plan. | |

## 1.4 Changes to the Yabucoa LHMP (E2-a)

Table 2 shows the most significant changes that the 2026 version has from the 2020 version.

*Table 2: Changes to the Yabucoa LHMP*

| Element | Justification |
|---|---|
| Plan Language | Following Presidential Executive Order #14224, the 2026 version of Yabucoa LHMP has been originally prepared in English for submission and consideration of FEMA. An official translation of the final draft for public discussion and the final approved LHMP to Spanish will be prepared for the benefit of the population that are not English proficient. |
| Plan organization | The organization and chapters of the document have been modified to follow the template used in local mitigation plans prepared by the Puerto Rico Planning Board. However, this template has been adapted in the current plan to comply with current federal public policy. |
| Discussion of FEMA Lifelines | As per the Local Hazard Mitigation Policy, FEMA Lifelines are discussed as well as the strategies to mitigate hazard impacts on them. |

| Element | Justification |
|---|---|
| Elimination of non-applicable public policy | For clarity and better readability, references to redundant public policy have been removed. |
| Change to the name of extreme winds | The hazard identified in the 2020 Plan as “extreme wind” has been changed to “Tropical Cyclones” to the current HAZUS capability to model tropical cyclones for Puerto Rico. |
| Update of census data | The municipality and PRPB have chosen to use the most recent version of the American Community Survey for evaluating demographic data. In this case it has chosen to evaluate the data sets from the 2024 five-year American community survey. |
| Action Plan | A new strategy ID has been added to help municipalities and commonwealth agencies keep track of status |
| All the LHMP | Attention has been given to ensure that the content of the Plan does not reveal any personally identifiable information (PII). |

# 2. Planning Process

## 2.1 Planning Process Regulation

This LHMP was updated following the above-mentioned applicable public policies and procedures mentioned in Chapter 1.

## 2.2 General Description of the 2026 LHMP

This LHMP seeks to aid municipality in the task of preventing loss of life and property by the effects of natural hazards. Chapter 1 serves as a general introduction, Chapter 2 discusses the planning process followed, as well as stakeholder and public participation involvement. The LHMP identifies a general profile of the municipality using information provided by the US Census, such as population distribution, employment, housing stock, etc. (see Chapter 3 for more information). After describing the Municipalities general profile, the Plan goes on to evaluate all identifiable natural hazards that can affect the municipality and its population, including the effects on lifelines, properties, population exposure, natural resources, etc. (see Chapter 4 for more information).

Chapter 5 defines the capabilities that the municipality has for implementing the LHMP. While Chapter 6, establishes the mitigation actions that the municipality will execute for the next five years. Chapter 7 discusses the provisions for LHMP Maintenance and Chapter 8 discusses the adoption and approval of the LHMP. The various appendixes hold supporting information.

## 2.3 History of the LHMP

An LHMP was approved by FEMA in 2013. a revision was approved in 2020 (Municipality of Yabucoa, 2020). This new 2026 version responds to changes in conditions and circumstances that have affected the municipality over the past five years. It also reflects changs based on updated FEMA Guidelines published in 2025.

## 2.4 Plan Preparation, Revision Schedule and Methodology (A1-A)

Following federal law, Local Hazard Mitigation Plans must be updated every five (5) years in order for the municipality to remain eligible for federal mitigation funding. To prepare for the 2026 LHMP, the Municipality hired AtkinsRéalis Caribe, LLP as an external consultant to provide professional mitigation planning services.

The Municipality and its consultants followed the natural hazard mitigation planning process as established by FEMA in the Local Hazard Mitigation Planning Guide and the Local Hazard Mitigation Planning Handbook, as well as the recommendations provided by the mitigation planning staff of COR3. The Local Mitigation Plan Review Tool provides a summary of FEMA's current minimum standards to comply with mitigation planning requirements and identifies where each requirement is addressed within this Plan.

The planning process for the 2026 update of the Yabucoa LHMP begun officially on with the kick – off meeting between the Municipality's Mayor and the PRPB staff held on December 16, 2025. An official letter of agreement between the municipality and the PRPB was signed on 12/16/2025 . Copy of the letter of agreement can be found in Appendix B. Later a consulting firm, AtkinsRéalis Caribe LLP, was retained by the PRPB to support the mitigation planning efforts.

The revision phase reached completion upon the official delivery of the final draft to the State Hazard Mitigation Officer (SHMO), within the Central Office for Recovery, Reconstruction and Resiliency (COR3), on Click or tap to enter a date.. The revision process lasted ___ days.

## 2.5 Planning Committee (A1-A, A1-B)

To support the revision of the Yabucoa LHMP, a Planning Committee was established, comprised of representatives from several municipal dependencies who were designated to guide the process. The members of the Committee are:

*Table 3: Planning Committe*

| Name | Position |
|---|---|
| Luis G. Rivera | Special Aide to the Mayor |
| Aileen Laboy | Executive Assistant |
| Wanda Castro | Executive Assistant |
| Miguel Flores | Director of the Municipal Office of Emergency Management |

The designation letter for the Planning Committee is included in Appendix B. This appendix also compiles the meeting minutes, documentation of the materials discussed throughout the process, and accompanying photographic evidence.

The purpose of the Planning Committee is to guide the development of the plan by bringing together local officials, stakeholders, and community representatives to identify hazards, assess risks, and develop mitigation strategies. The committee ensures that the planning process incorporates local knowledge, public participation, and coordination among agencies while meeting FEMA requirements. Its primary purpose is to help create a practical, community-supported plan that reduces future disaster risks and strengthens long-term resilience (FEMA, Local Mitigation Planning Policy Guide, 2025).

Appendix D holds the documentation of the planning committee meetings.

## 2.6 Citizen participation (A3-a)

### 2.6.1 Community Outreach and Public Participation Strategies

The public participation approach selected for this LHMP revision incorporated the following activities:

**Holding a first public meeting** that included:

- Distribution of notification letters to agencies, neighboring municipalities,

community leaders, nonprofit organizations, neighborhood associations, business or industrial groups, and other interested stakeholders, informing them that the LHMP revision process had commenced and inviting their input. Documentation of these communications is included in Appendix D.

- Publication of notices on the Municipality's website and official social media platforms to inform the public that the LHMP revision was underway. These postings also provided an email address for submitting comments and made available a virtual survey to gather information regarding the community's experiences with natural hazards. Evidence of these public notices is also included as part of Appendix C

- Convening an initial community meeting to introduce the LHMP revision process. This step involved:

- Issuing a public announcement in a newspaper, on the Municipality's website, and across official social media channels at least 15 days before the meeting.

- Providing notice of an additional 15-day period for the public to submit comments or suggestions via email or in person at a specified location.

**Holding a second community meeting** to discuss the hazard assessment and analysis with the public. This stage included:

- Publishing a newspaper announcement and posting notices on the Municipality's website and official social media outlets at least 15 days before the meeting.

- Confirming in the announcement that the draft plan was available for review in printed and online versions.

- Providing an additional 7-day comment window for the community to offer feedback, either by email or by visiting the designated address.

### 2.6.2 Community Outreach and Public Participation Results

**First Public Meeting Results**

A public meeting notification announcing the initiation of the LHMP update process

was published on 2/17/2026 via El Vocero de Puerto Rico newspaper and via Yabucoa official Facebook. The notification informed the public that the meeting would be held on 3/3/2026 in Yabucoa, Puerto Rico at Activities Room, Parque el Niño at 3:00 PM. During this meeting, participants expressed the following concerns: the identification of natural hazards affecting their communities, and the request to consider the Cancha de Saltillo Bajo as critical infrastructure.

In response, the Municipality took notes of the comments and concerns as input for Plan preparatation. Appendix C includes the notes documented by the planning board staff, along with supporting evidence. All documentation complies with PII protection requirements.

**Second Public Meeting Results**

A public meeting notification to present to present the draft of LHMP was published on Click or tap to enter a date. via _____. The notification informed the public that the meeting would take place on Click or tap to enter a date. in _____ at _____. It also stated that a printed copy of the draft LHMP would be available at _____ during regular work hours. Additionally, the public had the option of accessing the draft LHMP through the webpage _____. Copies of the public notification are included in Appendix C.

During this meeting, participants expressed the following concerns: _____

The Municipality took the following measures to address these concerns: _____. Appendix D includes the notes documented by the planning consulting firm during the activity, along with supporting evidence. All documentation complies with PII protection requirements.

## 2.7 Stakeholder involvement (A2-a)

The Municipality carried out outreach efforts to external stakeholders, including government agencies and neighboring municipalities, through formal

correspondence addressed to agency heads and mayors. Copies of these invitation letters are provided in Appendix D. Stakeholders were encouraged to submit input either via email or by participating in the public involvement process.

Input from internal stakeholders was obtained through the Planning Committee. Appendix D also includes any written responses or correspondence received from stakeholders during this outreach process.

### 2.7.1 Hazard Analysis Data Sources

The following table presents the datasets utilized for the evaluation of each hazard. Table 4 identifies the hazards considered in this LHMP and the corresponding data sources used to support their assessment.

*Table 4: Hazard and Risk Assessment of Data Sources*

| Hazard | Data Sources |
|---|---|
| Earthquake | USGS, FEMA |
| Landslides | USGS |
| Tsunami | NOAA, FEMA |
| Flooding | FEMA |
| Tropical Cyclone/Extreme Winds | FEMA |
| Extreme Heat | NOAA |
| Drought | NDIM |
| Long – Term Coastal Dynamics | NOAA, UPR- COREPI |
| Pandemic/Epidemic | PR Department of Health |

## 2.8 FEMA Lifelines

The Local Mitigation Planning Handbook and the Local Hazard Mitigation Planning Policy Guide highlight the importance of integrating critical lifelines into the hazard mitigation planning process. FEMA defines lifelines as essential services that sustain public safety, economic stability, and the continuity of government and daily life before, during, and after an emergency or disaster. These lifelines serve as a framework for prioritizing resources and actions that are essential to reducing loss of

life and property and supporting efficient and rapid recovery following hazard events (FEMA, 2023).

The Local Mitigation Planning Handbook and the Local Hazard Mitigation Planning Policy Guide highlight the importance of integrating critical lifelines into the hazard mitigation planning process. FEMA defines lifelines as essential services that sustain public safety, economic stability, and the continuity of government and daily life before, during, and after an emergency or disaster. These lifelines serve as a framework for prioritizing resources and actions that are essential to reducing loss of life and property and supporting efficient and rapid recovery following hazard events (FEMA, 2023).

FEMA identifies eight (8) primary lifelines:

- Safety and Security: Includes law enforcement, fire services, search and rescue operations, government services, and community safety functions.
- Food, Hydration, and Shelter: Encompasses food systems, water access, emergency shelter, and agricultural resources.
- Health and Medical: Includes medical care, public health services, patient movement, medical supply chains, and healthcare facility management.
- Energy: Covers the electrical power grid and fuel supply systems.
- Communications: Includes communications infrastructure, responder communications, alert and warning systems, financial services, 911 operations, and emergency dispatch.
- Transportation: Encompasses highways, motor vehicle systems, mass transit, railways, aviation, and maritime transportation.
- Hazardous Materials: Includes facilities and systems associated with hazardous materials, pollutants, and contaminants.
- Water Systems: Includes potable water infrastructure and wastewater collection and treatment systems.

Each of these lifelines is supported by sub-lifelines that allow jurisdictions to more precisely identify vulnerabilities and prioritize recovery actions. Together, they enable emergency managers and decisionmakers to rapidly assess conditions, focus response operations on the most critical needs, and coordinate actions that directly affect human life and community stability.

By monitoring the status and functionality of lifelines, jurisdictions can respond more effectively during emergencies, minimize cascading impacts, and accelerate more

resilient recovery. A detailed discussion of lifelines and their relevance to the Municipality of Yabucoa is provided in Section 3.5.

# 3. Municipal Profile

The Municipality of Yabucoa is a coastal municipality located in southeast Puerto Rico. It borders the following municipalities: to the north, San Lorenzo, Las Piedras and Humacao; to the east, the Vieques Passage; to the south, Maunabo; and to the west, Patillas. Map 1 shows the municipality of Yabucoa and adjacent municipalities. Map 2 shows the wards (barrios) into which Yabucoa is subdivided.

## 3.1 Data Sources for Municipal Profile

The Yabucoa LHMP has been updated using the most current demographic and socioeconomic data available. Municipal profiles and risk assessments rely primarily on the 2020–2024 Five-Year estimates from the American Community Survey (ACS). When specific information is not available through the ACS, alternative data sources are identified and cited in the corresponding footnotes.

In addition, the plan reflects the most up-to-date knowledge on hazards and mitigation practices. References to relevant plans, studies, and technical reports are provided in page-level footnotes and consolidated in the References section.

GIS layers included in Chapter 3 were mostly provided by the PRPB's GIS Office.

## 3.2 Brief Historical Background

Although historians do not fully agree on the exact date, many believe that the town of Yabucoa was founded on October 3, 1793, during the administration of Captain General Francisco Torralbo. One year after the town's founding, construction of the church was completed and dedicated to the Guardian Angels. Over time, additional municipal structures were completed. Gradually, the jail was built, and the cemetery grounds were enclosed.

The land on which the Parish Church of the Saints (1794), the King's House, the Priest's House, the public grounds, and the town square were established, 25 "cuerdas" in total, was donated by Manuel Colón and his wife, Catalina Morales Pacheco.

In its early years, the Municipality of Yabucoa belonged to the District of San Juan, and by 1802 it had been reassigned to the District of Coamo. On January 2, 1816, with the

inclusion of Humacao, Puerto Rico was reorganized into six districts, and Yabucoa became part of the District of Humacao.

A significant event in local history occurred on July 25, 1825, when Hurricane Santa Ana devastated Yabucoa, destroying almost the entire town; only the church remained standing. The town was eventually rebuilt, and three years later the jail was reconstructed, followed shortly by the completion of the first slaughterhouse.

By 1830, the municipality already consisted of eight barrios. Historical records indicate that by 1847, a school existed with twenty students enrolled. In 1928, Hurricane San Felipe struck Puerto Rico, once again severely impacting the local and national economy, including Yabucoa. Despite the destruction caused by natural disasters, Yabucoa repeatedly rebuild itself, demonstrating the town's enduring spirit of renewal, development, and growth.

Yabucoa's territorial organization remained unchanged until 1947, when the Planning Board redefined and expanded the municipality's urban zone, incorporating portions of the rural barrios of Calabazas and Juan Martín (Municipality of Yabucoa, 2020).

## 3.3 Geography

The Municipality of Yabucoa is located at the southeastern tip of Puerto Rico. Yabucoa has a territorial area of 55.25 square miles, equivalent to 143,044,067.01 square meters.

According to the most recent regional delineations established by the Puerto Rico Planning Board, the Island is divided into eleven planning regions. These regions group municipalities based on demographic trends, patterns of human settlement, infrastructure distribution, socioeconomic variables, sociodemographic characteristics, internal cohesion, and the availability and development potential of local resources.

The Humacao Functional Area, to which the Municipality of Yabucoa belongs, is composed of the municipalities of Humacao, Naguabo, Las Piedras, Maunabo, and Yabucoa (Municipality of Yabucoa, 2020).

Map 1 shows the geographic locations of Yabucoa and adjacent municipalities. Map 2 identifies the wards into which the municipality is divided which are; Aguacate, Barrio Pueblo, Camino Nuevo, Calabazas, Guayabota, Jácanas, Juan Martín, Limones, Playa,

and Tejas.

*Map 1: Yabucoa Geographic Area*

# Geographic Area




Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

Municipality of Yabucoa
Neighboring Municipalities



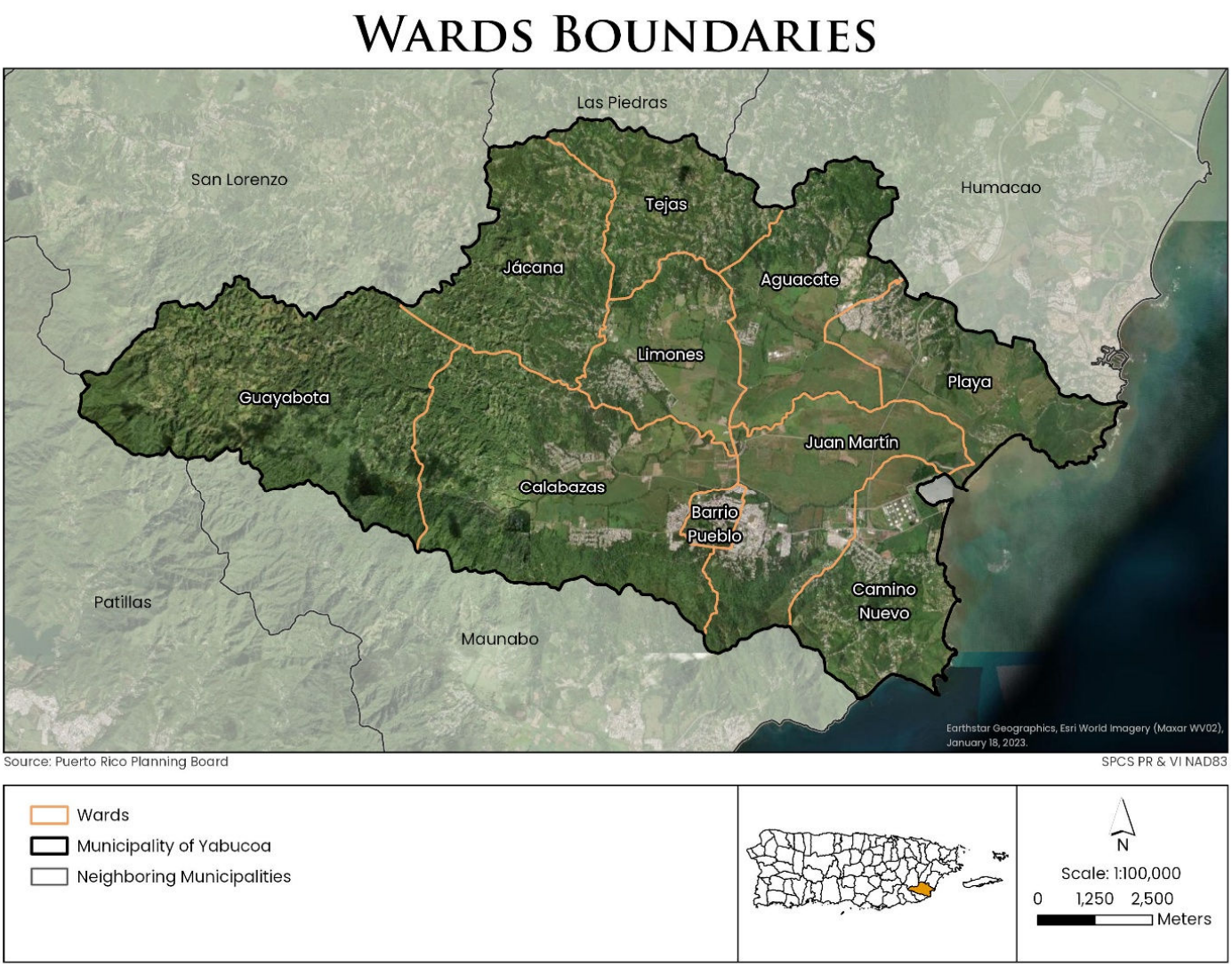
N

Scale: 1:200,000

0 2,500 5,000

Meters

*Map 2: Yabucoa – Wards Subdivision*



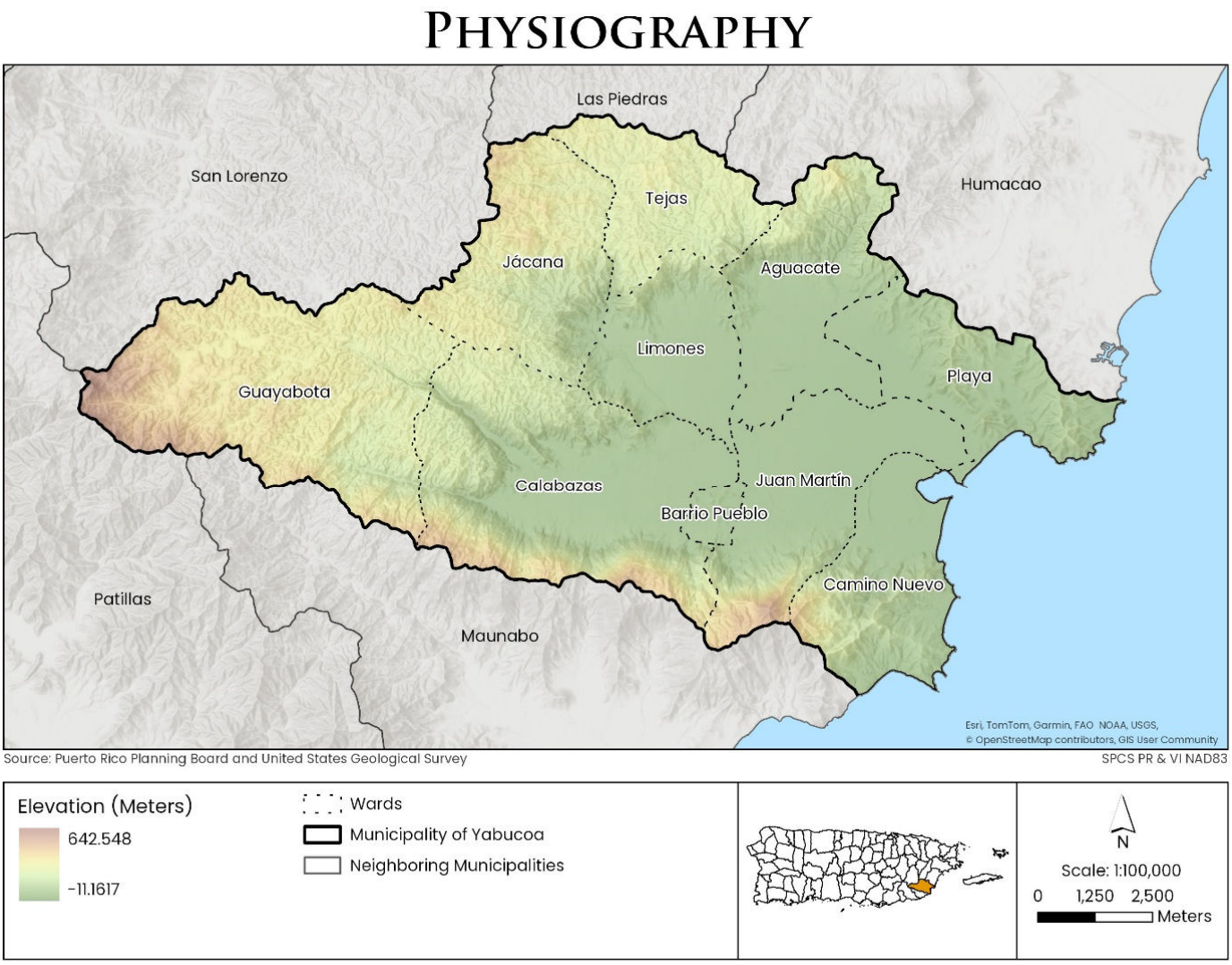

## 3.3.1 PHYSIOGRAPHY

Geographically, Yabucoa belongs to the humid region of the Eastern Coastal Valleys. The Yabucoa Valley is composed of fertile alluvial soils. The terrain and topography are largely flat. Because of its size and territorial boundaries, the surrounding landscape varies, marked by a combination of coastal plains and mountainous sections that define its geographic character.

As part of Puerto Rico's eastern coastal valley region, Yabucoa features several notable coastal formations. From north to south, these include Punta Guayanés, the Port of Yabucoa, Punta Quebrada Honda, and Punta Yeguas.

Toward the south, along the boundary with the municipality of Maunabo, lies the Cuchilla de Panduras, where two prominent hills stand out: Cerro Santa Elena, rising 570 meters (1,870 feet) above sea level in the barrio Juan Martín, and Cerro La Pandura, reaching 516 meters (1,693 feet) in the Calabazas ward. In Candelero Arriba ward, Cerro Candelero reaches an elevation of only 200 meters (656 feet). On its western edge, the terrain transitions into the foothills of the Cayey mountain range (Municipality of Yabucoa, 2020).

*Map 3: Physiography*



### 3.3.2 Geology

The Municipality of Yabucoa is composed primarily of alluvial deposits and granodioritic rocks associated with the San Lorenzo Diorite, commonly referred to as the San Lorenzo Batholith. Alluvial deposits consist of sand, gravel, clay, and silt that have been transported by flowing water and deposited in alluvial fans, floodplains, alluvial channels, and deltaic environments. This geologic material is found predominantly within the Yabucoa Valley, particularly in the central and eastern portions of the municipality.

In contrast, granodiorite formations are intrusive igneous rocks that are formed within the Earth's crust. These formations are primarily located in the mountainous areas of Yabucoa, extending across the northern, western, and southern sectors of the municipality, within the Sierra Pandura (USGS, 2026).

Other geologic formations present within the municipality, though in more limited distribution, include granodiorite from the Punta Guayanés plutonic complex, located in the northern and eastern areas; diorite formations in the southern sector; metavolcanic rocks associated with the Sierra de Cayey in the western portion of the municipality; and beach deposits in the vicinity of the Port of Yabucoa. Metavolcanic rocks are those that have undergone metamorphism through recrystallization, meaning that they were originally of volcanic origin but were altered as a result of pressure, temperature, and other geologic forces (USGS, 2026). Beach deposits, meanwhile, consist of minerals deposited along the coastline by marine processes.

In addition to the characterization of the rock types that form Yabucoa's geologic framework, the presence of geologic faults has also been identified. Faults are defined as fractures or fracture zones along which relative displacement of rock blocks has occurred, either parallel to the fracture or along the fracture surface (Bates & Jackson, 1980). The major fault systems that influence the region and are located closest to the Municipality of Yabucoa include the Anegada Fault, situated in the Caribbean Sea; the Great Northern Puerto Rico Fault, which trends along the northern portion of the island and terminates in the Municipality of Ceiba; and the Great Southern Puerto Rico Fault, extending from Añasco to Guayama. Additionally, minor fault traces traverse the municipal territory, including one that crosses the central portion of Barrio Pueblo (Bonano, 2020).

### 3.3.3 Soils

The predominant soils within the Municipality of Yabucoa belong to the Pandura, Talante, Teja, and Maunabo soil series, which collectively account for approximately 72 percent of the municipal territory. The Pandura series is characterized by shallow, well-drained soils that occur primarily on steep slopes ranging from 20 to 60 percent. These soils are clay in composition and overlie weathered plutonic rock (USDA, 2023). The Talante series consists of sandy clay soils located within floodplains, where slope gradients generally range from 0 to 1 percent (USDA, 2002). Similarly, the Teja series includes shallow, well-drained soils composed of gravel derived from plutonic rocks, predominantly quartz and granodiorite. These soils are typically found on slopes ranging between 12 and 40 percent (USDA, 2004). Finally, the Maunabo series is composed of clayey soils with low permeability that are also situated within floodplain areas, where slopes range from 0 to 1 percent (USDA, 2001).

### 3.3.4 Hydrography

Yabucoa's hydrographic system is composed primarily of the Guayanés River, which originates in the barrio Guayabota and runs approximately 27 kilometers (17 miles) before emptying into the Caribbean Sea at the Port of Yabucoa. The municipality is also crossed by several additional rivers—the Prieto, Arenas, Limones, and Ingenio rivers—all of which serve as tributaries to the Guayanés River, as well as the Santiago Channel. In addition, several streams flow through the area, including Cortadera, Aguacate, Aguas Largas, and Laja (Municipality of Yabucoa, 2020).

Map 4 shows the hydrographic system of the Municipality of Yabucoa. Major rivers and creeks are identified by name. Map 5 shows the present in the municipality, while Map 6 shows the sub-watershed basins.

*Map 4: Hydrography*

# HYDROGRAPHY




Source: Puerto Rico Planning Board and United States Geological Survey

SPCS PR & VI NAD83

Hydrography
Municipality of Yabucoa
Neighboring Municipalities



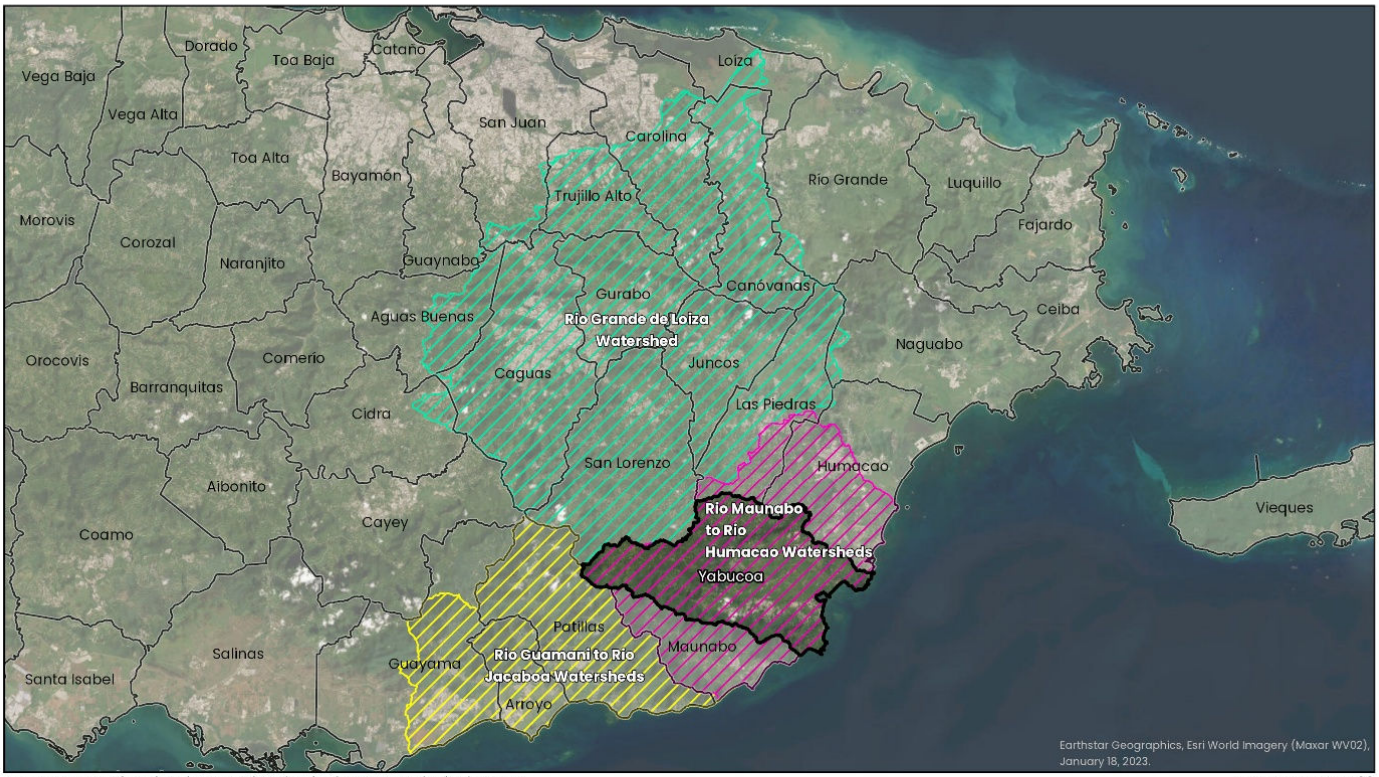
N

Scale: 1:100,000

0 1,250 2,500 Meters

*Map 5 Hydrographic Watershed*

# HYDROGRAPHIC WATERSHEDS




Source: Puerto Rico Planning Board and United States Geological Survey

SPCS PR & VI NAD83

Watersheds

- Rio Grande de Loiza Watershed
- Rio Guamani to Rio Jacaboa Watersheds
- Rio Maunabo to Rio Humacao Watersheds
- Municipality of Yabucoa
- Neighboring Municipalities

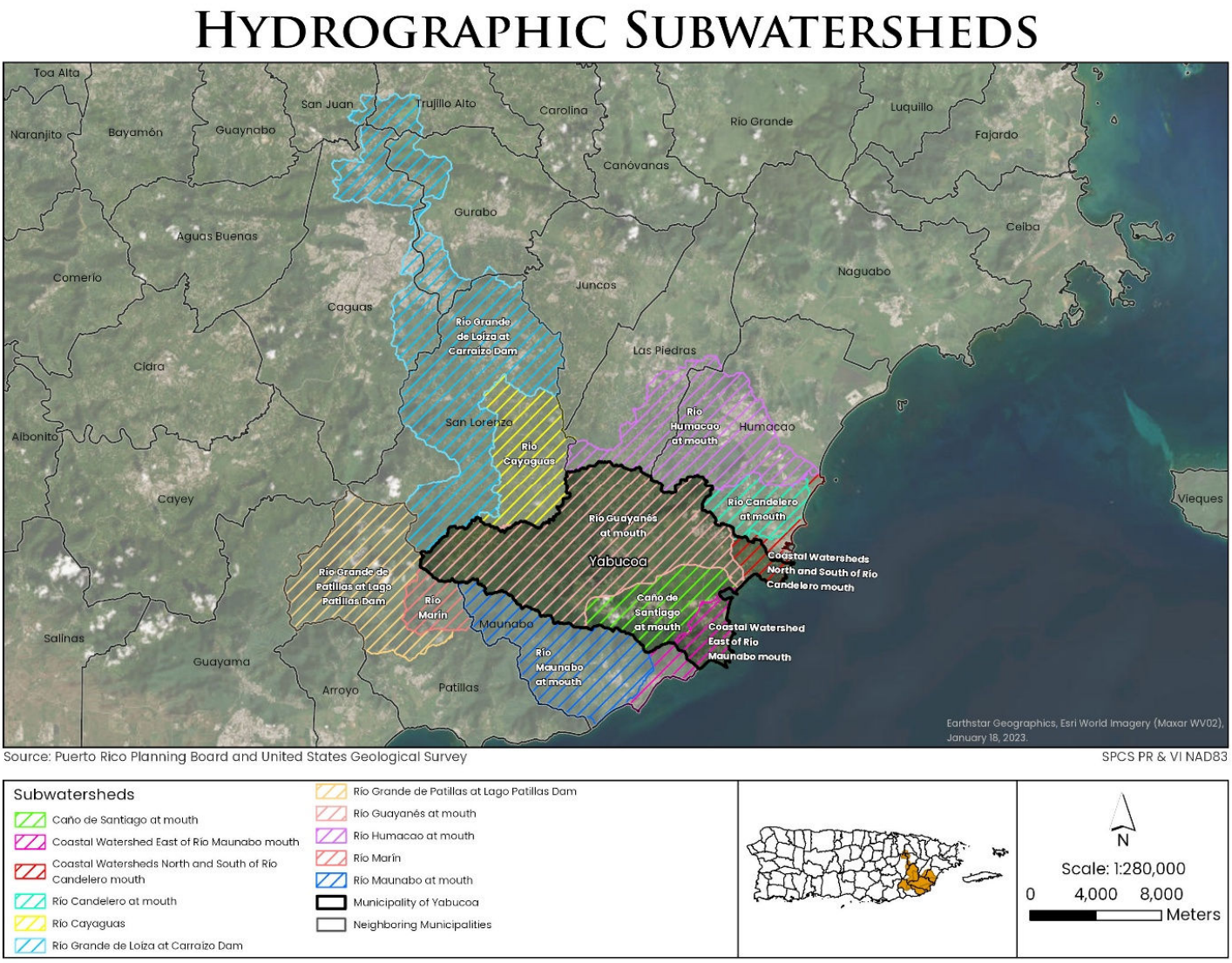


N

Scale: 1:400,000

0 5,000 10,000 Meters

*Map 6: Yabucoa Sub-Watershed*




## 3.3.5 PRECIPITATION

In Puerto Rico, the rainy season begins in August and ends in October. The frequency, amount, and distribution of rainfall are influenced by factors such as topography and the effects of the trade winds. Rainfall distribution across the Island is not uniform. For instance, the Caribbean National Forest (El Yunque) receives significantly more precipitation than the semi-arid areas of the southern coast and certain parts of the southwest coast (Municipality of Yabucoa, 2020).

### 3.3.6 Temperature

Regarding temperature, during the winter season the average daily minimum along Puerto Rico's coastline ranges from 19.9°C to 22°C (67.8°F to 71.6°F). In the mountainous interior, winter minimums fluctuate between 15.5°C and 16.6°C (59.9°F to 61.9°F). Winter maximum temperatures reach about 27.7°C (81.9°F) in coastal areas and between 22°C and 26.6°C (71.6°F to 79.8°F) in the interior highlands.

In summer, the average minimum temperature recorded in the mountainous interior ranges from 18.8°C to 21°C (65.8°F to 69.8°F), while coastal minimums range from 22°C to 24.4°C (71.6°F to 75.9°F). Summer maximum temperatures typically average 26.6°C to 29.4°C (79.8°F to 84.9°F) in higher elevations and about 29.4°C (84.9°F) along the coast (Municipality of Yabucoa, 2020).

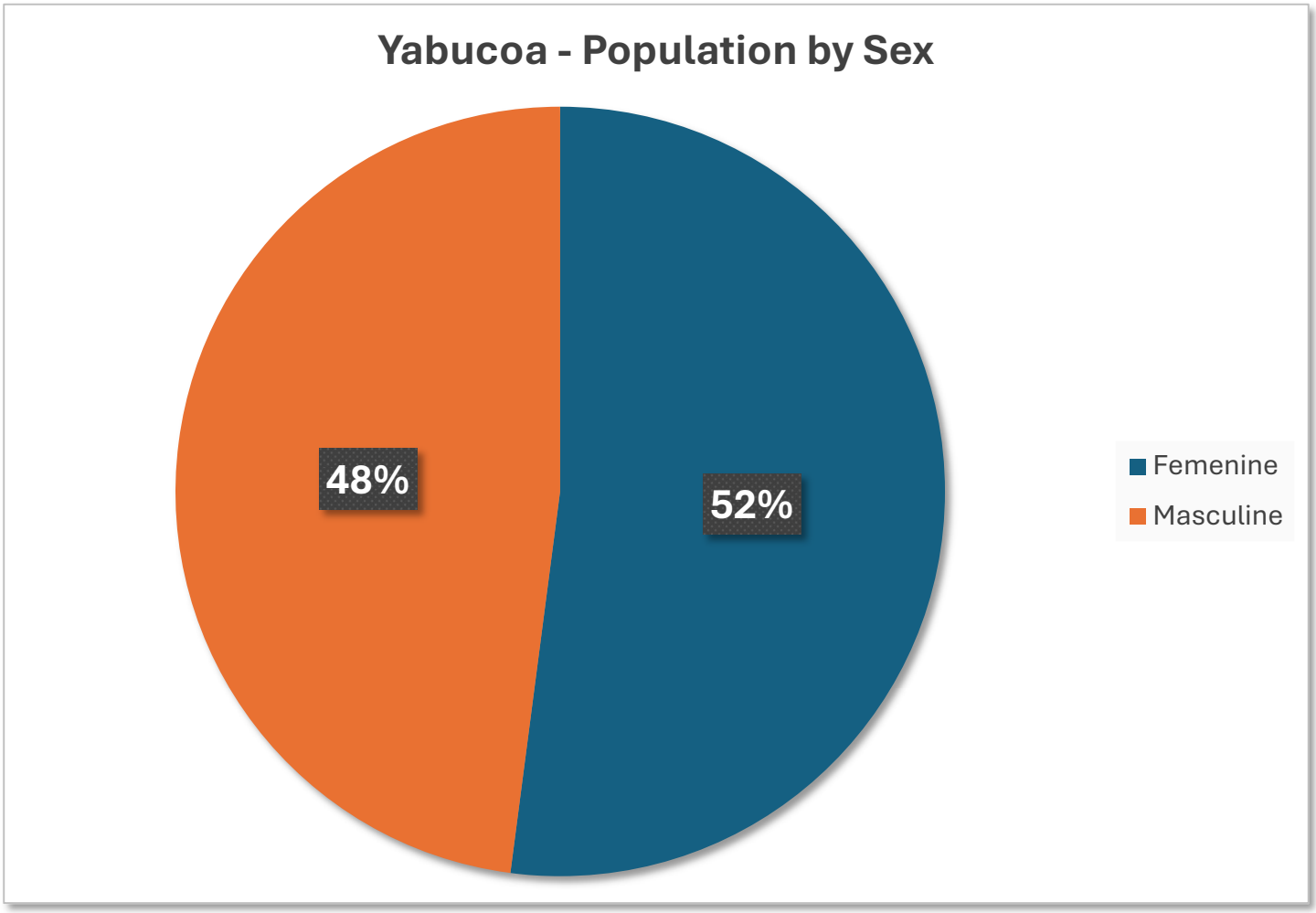
## 3.4 Demographics

### 3.4.1 Current Population

According to the 2020-2024 American Community Five-Year Survey (ACS 2024)[1] the total population of Yabucoa is 29,400. Of these, 14,095 individuals are male and 15,305 are female. The percentage split is 47.92% male, 52.06%female. The sex ratio is of 100.2 males per 109 females (US Census Bureau, 2025). Figure 10 shows the male/female split in pie chart graph.

[1] Unless otherwise stated, all data and analysis are from the 2024Five-Year American Community Survey (ACS) Data Set for Yabucoa.

*Figure 9: Yabucoa Population by Sex (2024 ACS)*




According to the 2024 ACS a total of 7,464 individuals in Yabucoa were 65 or older. This constitutes over a quarter (25.39%) of the total population of Yabucoa. While 3,482 individuals (11.84%) of the population are 75 years old or older.

On the younger age groups, Yabucoa has 5,218 (17.75%) individuals that are 19 years old or younger. Of those 1,846 (6.28%) are 9 years old or younger. This LHMP considers people younger than 19 and older than 65 as vulnerable. As such we find that 12,682 residents of Yabucoa (43.14% of the population) are especially vulnerable to the effects of a natural disaster.

Table 5 distributes the current population of Yabucoa by age groups as established in Table DP05 ACS Demographic and Housing Estimates of five years. Table 5 also compares the data of the 2024 ACS with that of the 2015-2019 ACS (2019 ACS).

*Table 5: Population by Age Group 2024 ACS vs 2019 ACS*

| Age Cohort | Population 2024 | Percentage 2024 | Population 2019 | Percentage 2019 | Net change | Rate of change |
|---|---|---|---|---|---|---|
| Under 5 years | 854 | 2.90% | 1325 | 3.96% | -471 | -35.55% |
| 5 to 9 years | 992 | 3.37% | 1963 | 5.86% | -971 | -49.47% |
| 10 to 14 years | 1,650 | 5.61% | 1860 | 5.55% | -210 | -11.29% |
| 15 to 19 years | 1,722 | 5.86% | 2226 | 6.64% | -504 | -22.64% |
| 20 to 24 years | 1,834 | 6.24% | 2279 | 6.80% | -445 | -19.53% |
| 25 to 29 years | 1,871 | 6.36% | 2111 | 6.30% | -240 | -11.37% |
| 30 to 34 years | 1,708 | 5.81% | 1740 | 5.19% | -32 | -1.84% |
| 35 to 39 years | 1,326 | 4.51% | 1,949 | 5.82% | -623 | -31.97% |
| 40 to 44 years | 1,803 | 6.13% | 2,072 | 6.19% | -269 | -12.98% |
| 45 to 49 years | 1,863 | 6.34% | 2,162 | 6.45% | -299 | -13.83% |
| 50 to 54 years | 1,935 | 6.58% | 2,352 | 7.02% | -417 | -17.73% |
| 55 to 59 years | 2,084 | 7.09% | 2,498 | 7.46% | -414 | -16.57% |
| 60 to 64 years | 2,294 | 7.80% | 2,329 | 6.95% | -35 | -1.50% |
| 65 to 69 years | 1,963 | 6.68% | 2,124 | 6.34% | -161 | -7.58% |
| 70 to 74 years | 2,019 | 6.87% | 1,803 | 5.38% | 216 | 11.98% |
| 75 to 79 years | 1,562 | 5.31% | 1,120 | 3.34% | 442 | 39.46% |
| 80 to 84 years | 1,047 | 3.56% | 803 | 2.40% | 244 | 30.39% |
| 85 years and over | 873 | 2.97% | 783 | 2.34% | 90 | 11.49% |
| Total | 29,400 | | 33,499 | | -4,099 | -12.24% |

*Source: US Census*

Table 5 shows that in Yabucoa the biggest negative rate change in age group has been with the 5 to 9 years (-49.47%), the under 9 years age group (-35.55%) and 35 to

39 year (-31.97%) age groups. While the biggest positive rate change were with the 75 to 79 years (39.46%), the 80 to 84 years (30.39%) and the 85 years and over (11.49%) age groups. Overall, the municipality experience a negative growth of -4,099 people (-12.24%).

*Figure 10: Yabucoa Population by Age Group (ACS 2024)*

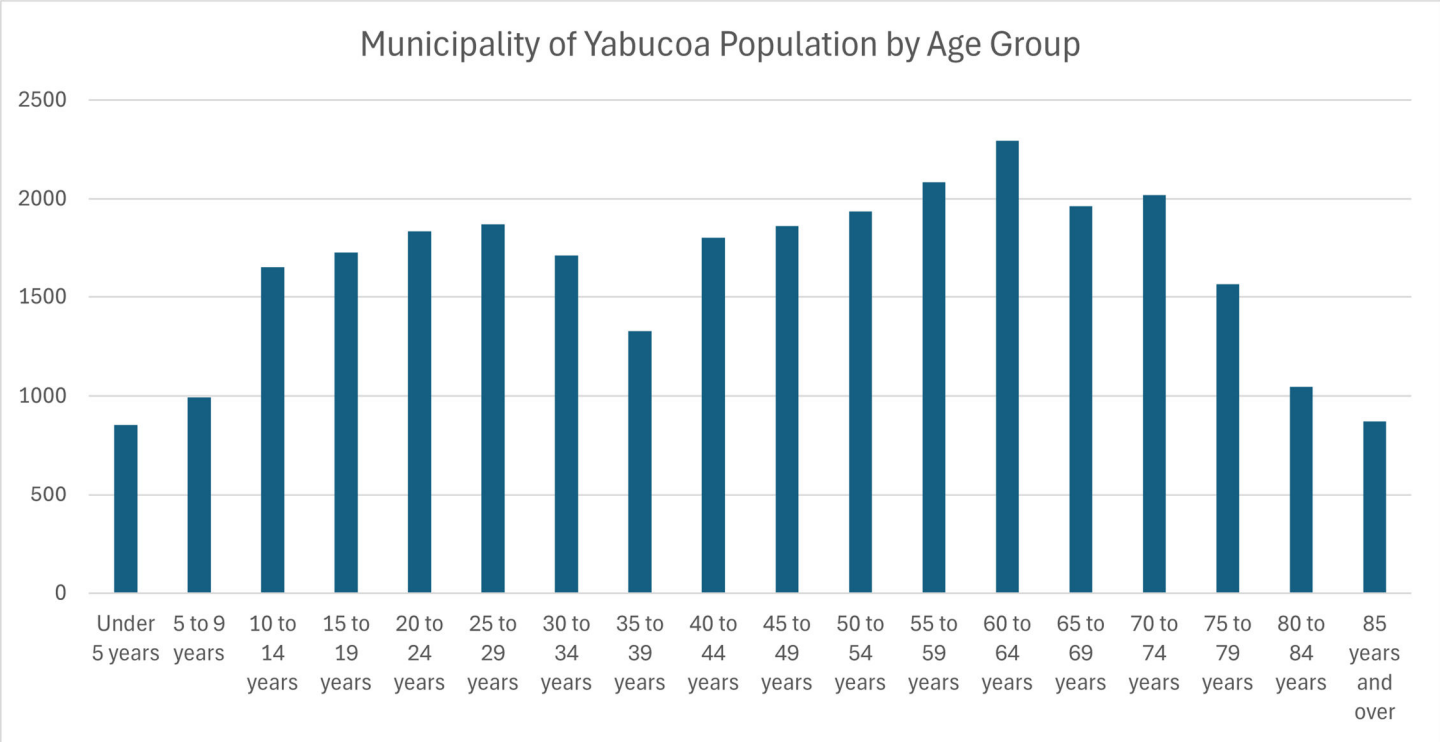
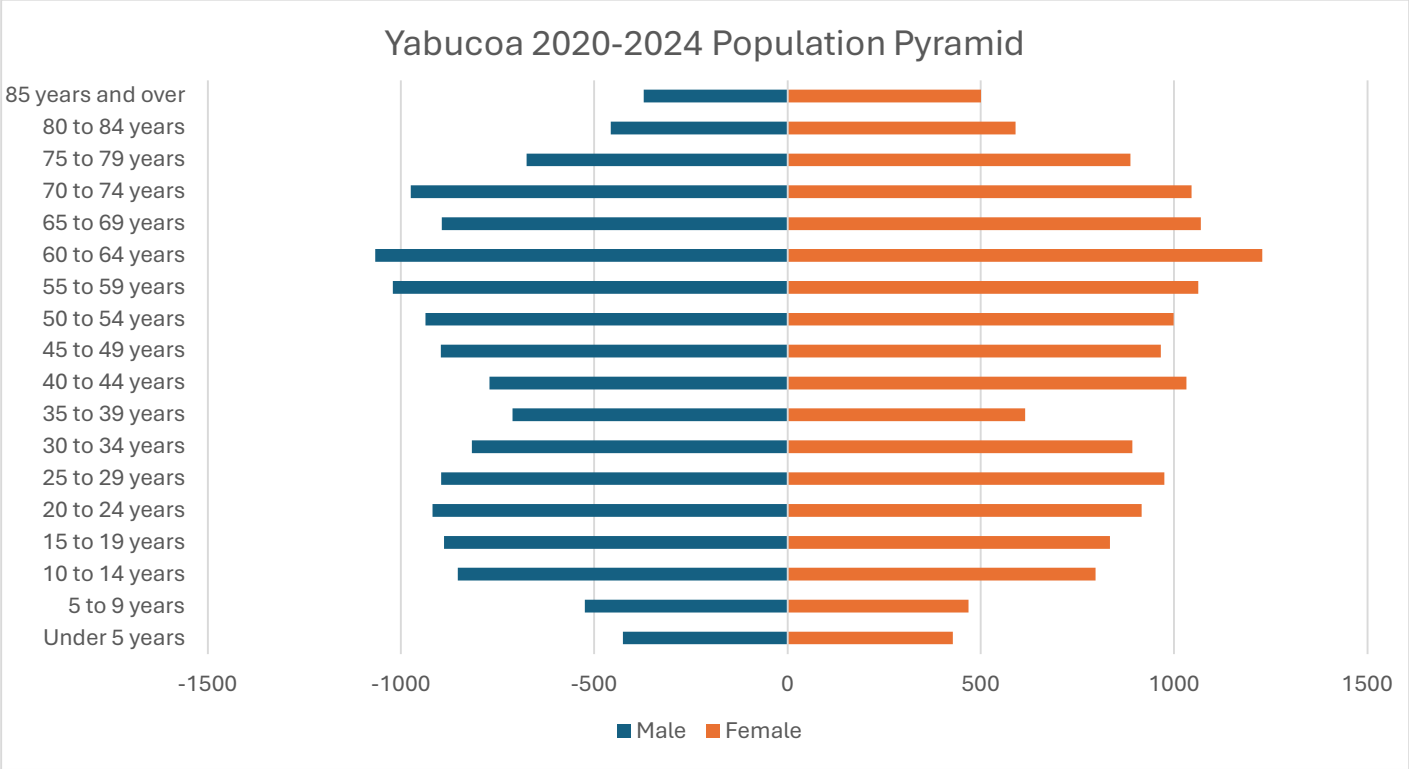



Figure 11: Yabucoa Population Pyramid (2024 ACS)Figure 11 shows the same age group distribution in a bar chart form. Figure 11 shows the population pyramid for Yabucoa. As can be seen in Figure 11 an irregular population pyramid shows the two large trends in the municipality: Low Birth Rates and a larger share of citizens above 65 years.

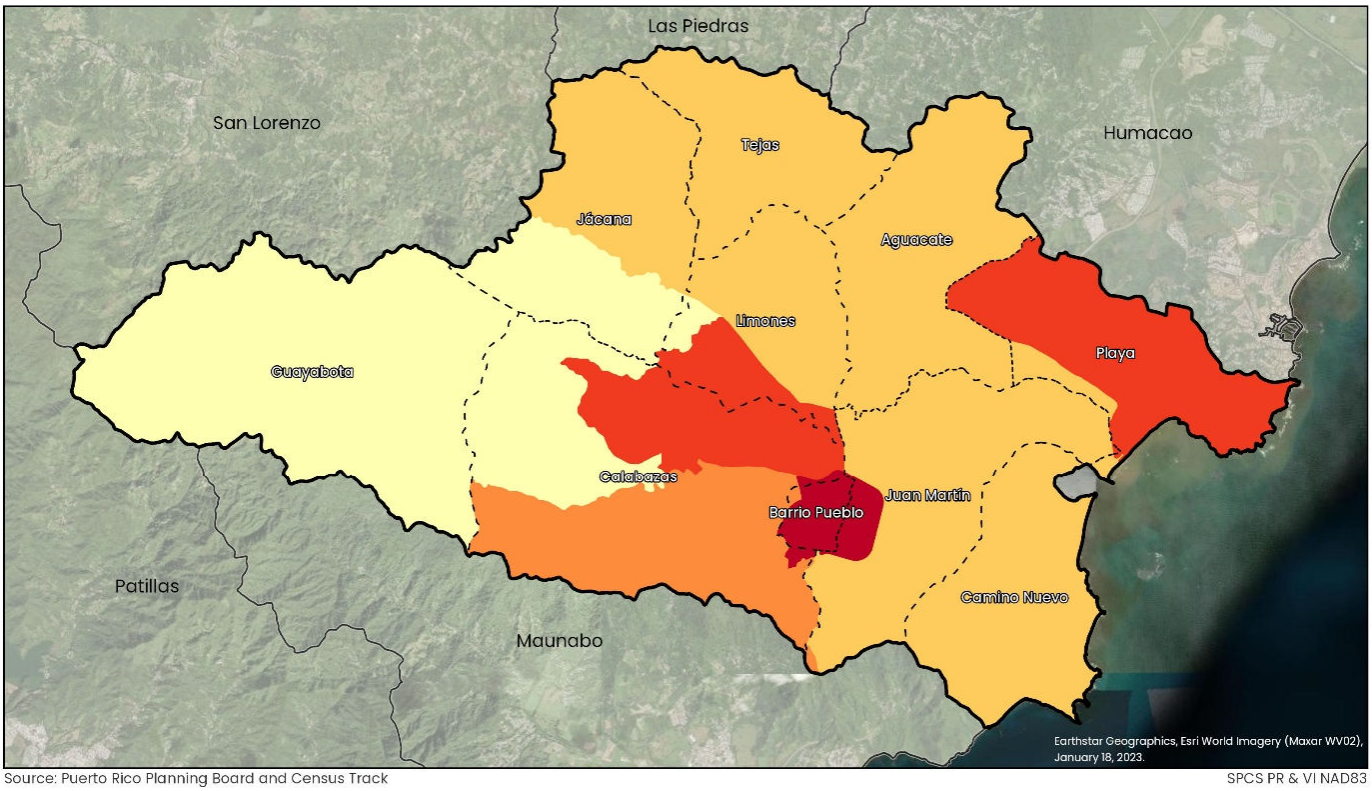
*Figure 11: Yabucoa Population Pyramid (2024 ACS)*




The following map shows the population Yabucoa by census tract. This map shows that the highest population is in the area of the Barrio Pueblo, followed with sections of the Limones and Calabazas wards to the northwest of the Barrio Pueblo. A similar concentration can be found in the Playa ward next to the municipal limit with Humacao. The lowest population density is to the west of the Municipality in the Guayabota wards and parts of Calabazas and Jácana wards.

*Map 7: Population by Census Tract*

## Population Density




Source: Puerto Rico Planning Board and Census Track

SPCS PR & VI NAD83

Population Density
- 107.405827
- 107.405828 - 171.986267
- 171.986268 - 236.032342
- 236.032343 - 364.268865
- 364.268866 - 1601.760158
- Wards
- Municipality of Yabucoa
- Neighboring Municipalities



N

Scale: 1:95,000

0 1,250 2,500

Meters

## 3.4.2 Socio-economic Characteristics

### *3.4.2.1 Employment*

Table 6 shows the employment status for the municipality according to the 2020 - 2024 Five-Year ACS.

*Table 6: Yabucoa - Current Labor Force Statistics*

| Variable | Estimate | Percentage |
|---|---|---|
| Population 16 years and over | 25,507 | |
| In Labor Force | 9,268 | 36.30% |
| Civilian Labor Force | 9,239 | 36.20% |
| Employed | 8,431 | 33.10% |
| Unemployed | 808 | 3.20% |
| Armed Forces | 29 | 0.10% |
| Not in Labor Force | 16,239 | 63.70% |
| Unemployment rate | | 8.70% |

*Source: US Census*

The census data shows that the population in the labor force for Yabucoa is lower than population that is not in the labor force (36.30% in labor force vs 63.70% not in labor force). Compared with the 2015-2019 Five Year ACS, the percentage of population in the labor force decreased (36.30% in 2024 vs 38.70%in 2019). In comparison with the whole Commonwealth of Puerto Rico the municipal population in the labor force is lower (36.30% for Yabucoa vs 46.40% for Puerto Rico)

The 2024 ACS showed an unemployment rate for the municipality of 8.70%. This represents an increase regarding the 2015-2019 Five-Year ACS (8.70% in 2024 vs 7.60% in 2019). In comparison to the whole Commonwealth of Puerto Rico the unemployment rate is lower (8.70% for Yabucoa vs 10.7% for Puerto Rico).

#### *3.4.2.2 Employment by Industry*

The following table presents employment by industry within the municipality, comparing data from the 2020–2024 Five-Year ACS with the 2015-2019 Five-Year ACS. The final column reflects the percentage change in employment by industry between the two survey periods.

*Table 7: Employment by Industry 2024 ACS vs 2019 ACS*

| Industry | ACS 2024 Five Year | Percentage 2024 | ACS 2019 Five Year | Percentage 2019 | Delta between 2024 and 2019[2] |
|---|---|---|---|---|---|
| Agriculture, Forestry, fishing and hunting and mining | 74 | 0.88% | 58 | 0.67% | 27.59% |
| Construction | 840 | 9.96% | 371 | 4.31% | 126.42% |
| Manufacturing | 1,178 | 13.97% | 1,838 | 21.34% | -35.91% |
| Wholesale Trade | 78 | 0.93% | 84 | 0.98% | 3.33% |
| Retail Trade | 1,160 | 13.76% | 959 | 11.14% | 20.96% |
| Transportation and warehousing, and utilities | 261 | 3.10% | 246 | 2.86% | 6.10% |
| Information | 37 | 0.44% | 68 | 0.79% | 17.22% |
| Finance and Insurance, and real estate and rental and leasing | 408 | 4.84% | 422 | 4.90% | -3.32% |
| Professional, scientific, and management, and administrative and waste management services | 777 | 9.22% | 787 | 9.14% | -1.27% |
| Educational services, health care and social assistance | 1,703 | 20.20% | 1,932 | 22.44% | -11.85% |
| Arts, entertainment, recreation, and accommodation and food services | 897 | 10.64% | 768 | 8.92% | 16.80% |
| Other services, except public administration | 454 | 5.38% | 316 | 3.67% | 43.67% |
| Public administration | 564 | 6.69% | 762 | 8.85% | -25.98% |
| Total employee Population 16 years and over | 8,431 | | 8,611 | | -2.09% |

*Source: US Census*

Table 7 shows the following employment characteristics for Yabucoa:

[2] Rate of percentage change is calculated as $Percentage\ Change = \frac{new\ value - original\ value}{original\ value} \times 1$

- The industry with the highest level of employment in Yabucoa in 2024 is the "Educational services, healthcare and social assistance" industry occupying 20.20% of Yabucoa's workforce.

- In comparison with the 2019 survey, we find that "Educational services, health care and social assistance industry" was also the one with the highest share of the municipal workforce. However, this industry had the third highest level of net negative growth among all the industries of Yabucoa, losing an estimated 229 (-11.85%) jobs between 2018 and 2023. The industries with the highest share of the labor force within the municipality are Manufacturing (13.97%), which experienced a -35.91% rate change, and Retail Trade industry (13.76%) had a 20.96% increase in employment share.

- An interesting outlier is the "Construction" industry that had a rate change of 126.42%, with a net increase from 371 positions to 840 positions, or of 469 jobs. This increase means that this industry employs 9.96% of the total population.

- Overall 7 of the 13 industrial categories surveyed by the ACS experienced a reduction in their workforce. These changes represent a net loss of 180 roles within the municipality. The industries that had negative growth between the 2019 and the 2024 surveys are:
    - "Manufacturing" (-660 individuals or a -35.91% rate change).
    - "Public Administration" (-198uih individuals or a -25.98% rate change)
    - "Educational services, health care and social assistance" (-229 individuals or a -11.85% rate change)

- Industries that had a positive percentage change rate are:
    - "Retail Trade" (201 individuals or 20.96% rate of change)
    - "Other services, except public administration" (138 individuals or 43.67% rate of change)
    - "Arts, entertainment, recreation, and accommodation and food services" (129 individuals or 16.80% rate of change)

Overall, the employed population of the municipality decreased by 180 individuals, this represents a rate change of 2.09% between 2019 and 2024.

### 3.4.2.3 Poverty Level

The table below shows the estimated percentage of poverty status for individuals over the past 12 months. This information is used to evaluate the economic well-being of individuals and families. The table is essential for understanding the economic conditions of different groups and for guiding the development and implementation of policies aimed at reducing poverty as well as the vulnerability of the population.

*Table 8: 2024 ACS Poverty Level*

| Total Population | Number of Individual below the poverty level during the last 12 months | Percentage of the Population below the poverty level in the last twelve months |
|---|---|---|
| 29,332 | 14,006 | 47.70% |

*Source: US Census*

### 3.4.2.4 Income

According to the 2024 ACS the median household income for Yabucoa was $18,317, while the mean household income was 29,612. The following table shows the estimated income and benefits for households in the municipality.

*Table 9: 2024 ACS Income and Benefits per Household*

| Category | Number of Households | Percentage |
|---|---|---|
| Less than $10,000 | 2,481 | 20.40% |
| $10,000 to $14,999 | 1,615 | 13.30% |
| $15,000 to $24,999 | 2,490 | 20.50% |
| $25,000 to $34,999 | 1,846 | 15.20% |
| $35,000 to $49,999 | 1,842 | 15.10% |
| $50,000 to $74,999 | 1,301 | 10.70% |
| $75,000 to $99,999 | 398 | 3.30% |
| $100,000 to $149,999 | 124 | 1.00% |

| | | |
|---|---|---|
| $150,000 to $199,999 | 20 | 0.20% |
| $200,000 or more | 50 | 0.40% |
| Total households | 12,167 | 100.00%[3] |

*Source: US Census*

This table shows that slightly less that a fifth of all households (20.40%) in Yabucoa earn less than $10,000 per year. While 54.20% of households earn less than $25,000 per year. In comparison for the 2015-2019 ACS, 31.05% of households earn less than $10,000and 64.86% of households earn less than $25,000.

### *3.4.2.5 Population with disabilities*

Table 10 presents data on individuals living with disabilities based on the 2020–2024 and 2015–2019 Five-Year American Community Survey datasets

*Table 10; Yabucoa Population living with disabilities*

| Age Group | 2024 | 2019 | Net change | Rate of change |
|---|---|---|---|---|
| Under 5 years | 15 | 16 | -1 | -6.25% |
| 5 to 17 years | 42 | 268 | -226 | -84.33% |
| 18 to 34 years | 175 | 400 | -225 | -56.25% |
| 35 to 64 years | 1,129 | 1,425 | -296 | -20.77% |
| 65 to 74 years | 735 | 871 | -136 | -15.61% |
| 75 years and over | 1,652 | 1,374 | 278 | 20.23% |
| Total Population living with a disability | 3,748 | 4,354 | -606 | -13.92% |

*Source: US Census*

Table 10 shows that overall, there was a net reduction of 606 individuals living with a

[3] Sum does not add to 100 due to rounding.

disability in the municipality. Six of the 7 age groups surveyed by the ACS experienced a decrease in population. The only age group to experience an increase in population share was that of the "75 years and over" group, which increased its share by 278 persons. This increase means that this age group has the largest population share of people with disabilities within the municipality. This data is particularly important for the LHMP update as the relevant literature shows that people with disabilities are especially vulnerable to natural hazards events.

#### 3.4.2.6 Population receiving supplemental nutritional support

Table 11 provides information on households in Yabucoa that receive food assistance, based on data from the 2020–2024 and 2015–2019 American Community Survey (US Census Bureau, 2025).

*Table 11: Population receiving food aid*

| Data Set | 2024 | 2019 | Net Change | Rate of Change |
|---|---|---|---|---|
| Total Households in the municipality | 12,167 | 11,541 | 626 | 5.42% |
| Households receiving food assistance | 7,480 | 6,137 | 1,343 | 21.88% |
| Percent of Households receiving food assistance | 61.50% | 53.20% | | |

*Source: US Census*

As shown in this table the number of households in Yabucoa receiving food assistance is 12,167. The total number of households receiving food assistance has increased by 21.88% since 2015 - 2019 ACS. The table shows that 61.50% of households in Yabucoa receive food assistance. Thus, food insecurity is an important consideration for the municipality.

#### 3.4.2.7 Health Insurance Coverage

The next table shows the 2020-2024 ACS health insurance coverage for the municipality

*Table 12: 2024 ACS Health Insurance Data*

| Variable | Estimate | Percentage |
|---|---|---|
| Civilian noninstitutionalized population | 29,321 | |
| With health insurance coverage | 27,857 | 95.00% |
| With private health insurance | 5,920 | 20.20% |
| With public coverage | 22,692 | 77.40% |
| No health insurance coverage | 1,464 | 5.00% |

*Source: US Census*

The data shows that 1,464 people (5.00%) in Yabucoa have no health insurance at all. While more than three quarters (77.39%) depend on public health coverage. This data will be revisited when discussing the hazard of pandemic/epidemic.

### 3.4.3 Housing Stock and Other Related Details

According to 2020 - 2024 ACS Yabucoa had a total of 14,631 housing units. Of those, a total of 2,464 were vacant. This constitutes 16.80% of the total housing stock of the municipality. According to the 2024 ACS of the 14,631 units only 12,167 were occupied. Furthermore, 8,597 units were occupied by owners and 3,570 by renters.

The next table shows the year of construction of the housing units by range.

*Table 13: 2024 ACS - Housing Units Year of Construction*

| Year Structure Built | Housing Units | Percentage |
|---|---|---|
| Built 2020 or later | 9 | 0.06% |
| Built 2010 to 2019 | 367 | 2.51% |
| Built 2000 to 2009 | 1,930 | 13.19% |

| Year Structure Built | Housing Units | Percentage |
|---|---|---|
| Built 1990 to 1999 | 3,290 | 22.49% |
| Built 1980 to 1989 | 2,790 | 19.07% |
| Built 1970 to 1979 | 3,143 | 21.48% |
| Built 1960 to 1969 | 2,040 | 13.94% |
| Built 1950 to 1959 | 641 | 4.38% |
| Built 1940 to 1949 | 283 | 1.93% |
| Built 1939 or earlier | 138 | 0.94% |
| Total | 14,631 | 100% |

*Source: US Census*

The 2020 - 2024 ACS shows that more than half of the housing stock was built between 1970 and 1999. The latest Building Code was adopted by the government of Puerto Rico in 2018, before that the most recent version of the Building Code was adopted in 2011. This means that at least 97.43% of the housing stock was built before the current and immediately previous building code.

Finally, Table 13 shows the vehicle available per occupied housing units.

*Table 14: 2024 ACS - Vehicle per occupied housing unit*

| Variable | Occupied Housing Units | Percentage |
|---|---|---|
| No vehicle available | 1,803 | 14.80% |
| 1 vehicle available | 4,279 | 35.20% |
| 2 vehicles available | 3,820 | 31.40% |
| 3 or more vehicles available | 2,265 | 18.60% |
| Total Occupied Housing Units | 12,167 | |

*Source: US Census*

The 2020 - 2024 ACS shows that there are 1,803 housing units that do not have available vehicles. This represents a critical matter since the development pattern in the municipality is rural and/or suburban, where vehicular transportation is necessary for mobility.

## 3.5 Critical Infrastructure

Infrastructure refers to the essential physical and organizational systems that support the effective functioning of a society or economy. It includes critical networks such as transportation systems (roads, bridges, railways), energy generation and distribution, water supply, telecommunications, and other services that sustain economic activity

and daily life. Collectively, infrastructure serves as the foundational framework that enables communities and economies to operate reliably and efficiently (NIST, n.d.). Infrastructure is commonly classified into two categories: hard infrastructure and soft infrastructure.

Hard infrastructure refers to the physical facilities and networks that underpin the functioning of a modern society and economy. This includes transportation systems such as roads, bridges, railways, and airports, as well as water systems, electrical grids, and telecommunications networks. These tangible assets enable the movement of people and goods, the distribution of energy and water, and the transmission of information.

Soft infrastructure refers to the institutions, services, and systems that support economic stability, public health, social order, and cultural development. This category includes educational institutions, healthcare systems, law enforcement agencies, emergency response services, parks, and recreational facilities. Unlike hard infrastructure, soft infrastructure is characterized by organizational frameworks and human-centered services that contribute to community well-being and effective governance

The discussion below considers the infrastructure assessment in terms of FEMA's Lifeline. As described in Section 2.8, FEMA defines *Community Lifelines* as the most essential services and systems necessary to sustain the uninterrupted operation of critical government and business functions, while also protecting public health, safety, and economic security. These lifelines constitute the fundamental components of a community and once stabilized, enable all other sectors of society to function effectively. During disaster events, any disruption to these lifelines requires immediate and coordinated action to restore stability and reduce cascading impacts.

### 3.5.1 Lifeline: Safety and Security




The purpose of the Safety and Security Lifeline is to protect life and property while maintaining social stability during emergency situations. This lifeline focuses on reducing immediate risks to public safety and personal security through the operation of public safety agencies, controlled access to affected areas, and the prevention of crime, civil unrest, and violence. It also encompasses ensuring safety and security at emergency shelters, distribution centers, and other critical

facilities during disaster response and recovery operations.

FEMA indicates that disruption of this lifeline can result in social disorder and heightened community vulnerability, making rapid restoration a critical priority. Response actions require close coordination among federal, state, and local agencies, the deployment of security personnel, the implementation of traffic control measures, and the protection of critical infrastructure.

Map 8 shows the identified health and medicine facilities according to the latest information provided by the PRPB. As it can be shown in the map the sites related to this lifeline are located in the town center in Barrio Pueblo, specifically along PR-182 (Catalina Morales Pacheco St.).

### 3.5.2 Lifeline: Food, Hydration and Shelter




The Food, Hydration, and Shelter Lifeline is intended to ensure that disaster-affected populations have prompt access to essential necessities, including food, potable water, and safe shelter. This lifeline encompasses the provision of ready-to-eat meals, water distribution, the establishment of temporary shelters, and coordination with governmental and volunteer organizations to meet basic human needs. Disruptions to this lifeline pose an immediate threat to life; therefore, rapid response actions are prioritized to restore food availability and housing stability as quickly as possible.

Map 8 shows the identified health and medicine facilities according to the latest information provided by the PRPB. As it can be shown in the map the sites related to this lifeline are located in the Pueblo, Limones, Camino Nuevo and Playa wards.

### 3.5.3 Lifeline: Health and Medicine




The purpose of this lifeline is to ensure the continuity of essential medical services and the protection of public health during emergencies and disasters. It focuses on stabilizing healthcare delivery, ensuring access to hospitals, clinics, medications, and healthcare personnel, and maintaining the capacity to respond effectively to life-threatening conditions.

FEMA indicates that disruption of this lifeline can have serious consequences;

therefore, priority actions focus on restoring medical facilities, deploying emergency response teams, ensuring the availability of critical medical supplies, and coordinating efforts among federal, state, and local agencies.

Map 8 shows the identified health and medicine facilities according to the latest information provided by the PRPB. As it can be shown in the map, health and medical related facilities are located along PR-901 in the Juan Sanchez Ward, including the Yabucoa Municipal Hospital.

### 3.5.4 Lifeline: Energy




The Energy Lifeline is designed to ensure the reliable and safe delivery of electricity, gas, and essential fuels during emergencies and disaster events. This lifeline is vital to sustaining the operation of critical facilities and services, including hospitals, water and wastewater systems, telecommunications, and other infrastructure that depend on uninterrupted energy supply.

FEMA recognizes that disruptions to energy services pose a direct threat to life safety and community stability. Accordingly, priority response actions include the rapid restoration of the electrical grid, the deployment of generators to critical facilities, coordination with fuel suppliers, and the implementation of temporary measures to maintain service continuity. Map 8 illustrates the location of the Energy related lifelines in the Municipality of Yabucoa. It should be noted that this is a very important lifelines for Yabucoa since the Port of Yabucoa is one of the most important point of entry of fuel for the whole island. This can explain the high concentration of Energy related locations around the port area in Camino Nuevo ward.

### 3.5.5 Lifeline: Communications




The purpose of this lifeline is to ensure the availability and reliability of essential communication systems during emergencies and disaster events. These systems include telephone networks, internet services, radio, television, and public alert and warning platforms, all of which are critical for coordinating response activities, disseminating timely information, and maintaining communication between authorities and the public.

FEMA indicates that disruption of the Communications Lifeline can severely impair life-saving operations and effective resource management. Accordingly, priority actions include the restoration of telecommunications infrastructure, deployment of temporary communication solutions such as satellite systems, ensuring redundancy within critical networks, and maintaining accessible communication channels for the public.

For this LHMP draft a communications shapefile was not able to be identified.

### 3.5.6 Lifeline: Transportation




The purpose of the Transportation Lifeline is to ensure the safe and efficient movement of people, goods, and essential services during emergencies and disaster events. This lifeline supports the continued operation or rapid restoration of land, air, and maritime transportation routes, enabling access to critical resources such as food, potable water, medical care, and emergency response equipment.

FEMA indicates that disruptions to transportation systems directly affect the ability to save lives and distribute essential supplies. Accordingly, priority actions include reopening roadways, repairing damaged bridges, restoring airport and port operations, and coordinating with state and private entities to maintain the logistics chain. Map 9 illustrates the roadway network of the Municipality of Yabucoa. The primary transportation corridors within the municipality are described below.

The Municipality is currently the south terminus of PR-53 (Autopista José Celso Barbosa). This is a controlled access highway that runs through Puerto Rico's east coast. Beginning in Fajardo, this highway runs through Ceiba, Naguabo, Humacao and ends in Yabucoa. The terminus of this highway also provides access to two major petro-chemical facilities to the rest of the Island.

PR-3 runs parallel to PR-53 this is the old connection between Humacao and Yabucoa.

Other major corridors in the municipality are:

- PR-901 which is part of the Luis Muñoz Marín Panoramic Route and connects Yabucoa's town center with the port of Yabucoa. PR-901 also provides access

to the communities in the south part of the municipality to both the Yabucoa Town Center and the Municipality of Maunabo to the west.

- PR-182 which provides connection between the Yabucoa town center and the Municipality of San Lorenzo.

- PR-900 which connects the town center with other rural communities to the west of it (Playita, Guayabota, etc.)

### 3.5.7 Lifeline: Hazardous Materials




The purpose of this lifeline is to prevent hazardous material releases, control spills, and protect communities located near industrial facilities, chemical plants, and hazardous materials transportation corridors.

FEMA indicates that disruption or failure of the Hazardous Materials Lifeline can result in severe consequences, including widespread contamination and the impairment of essential services. Accordingly, priority actions include identifying hazardous materials, activating specialized Hazardous Materials (HazMat) response teams, coordinating with federal and state agencies, and implementing rapid response protocols. Although hazardous materials may be present throughout the municipality, incidents involving hazardous materials are more likely to occur within industrial areas.

Although not identified as Hazardous Materials, the energy related structures in the town center are also considered as hazardous materials, since they store liquid fuel that can create a disaster by anthropogenic genesis.

### 3.5.8 Lifeline: Water Systems

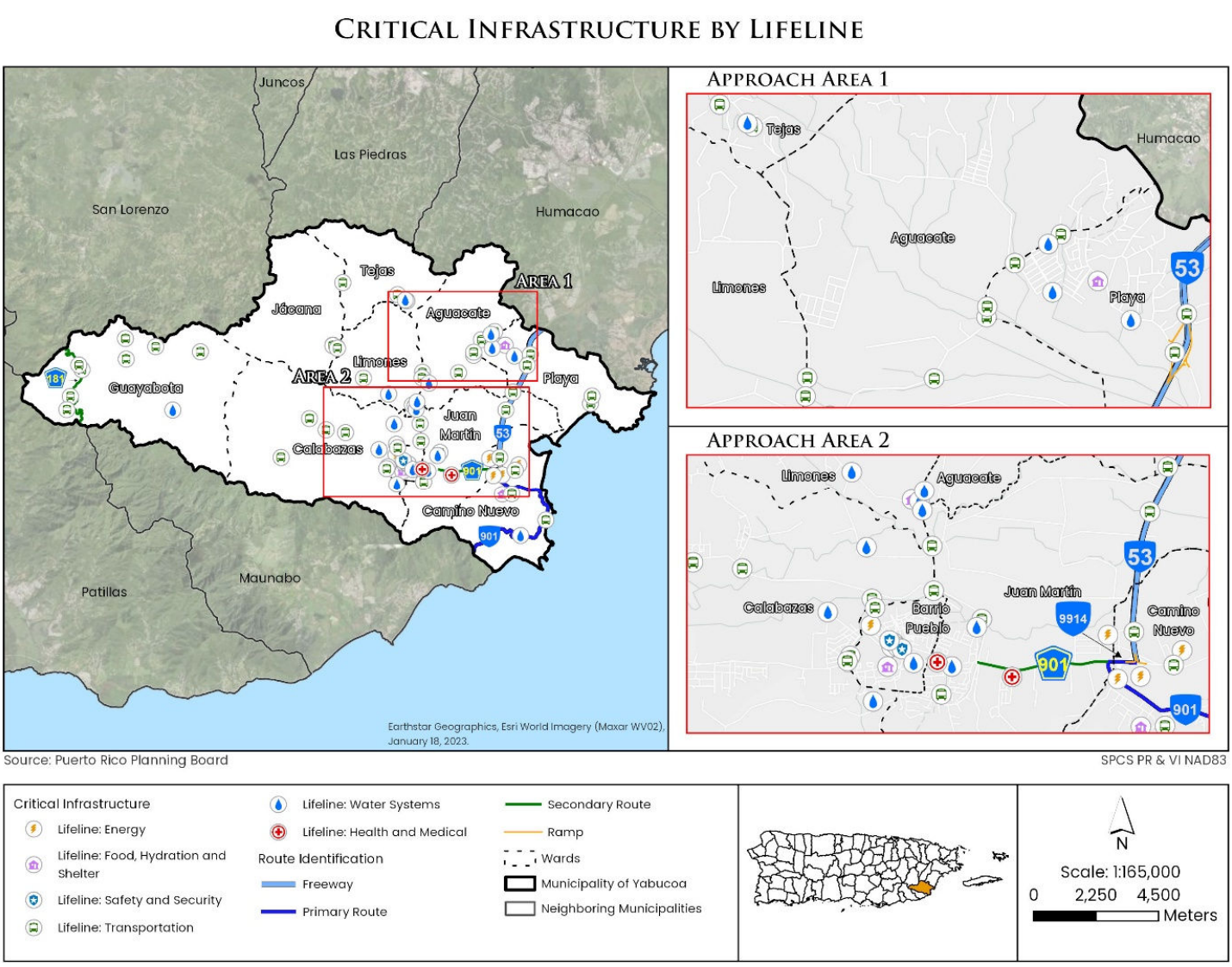



This lifeline highlights the critical role of water infrastructure in disaster response and recovery. Its primary objective is to ensure reliable access to and the timely restoration of drinking water and wastewater services, which are essential to public health, safety, and economic stability. The Water Systems Lifeline is structured around two core components: Potable Water Infrastructure, which includes water intake, treatment, storage, and distribution; and Wastewater

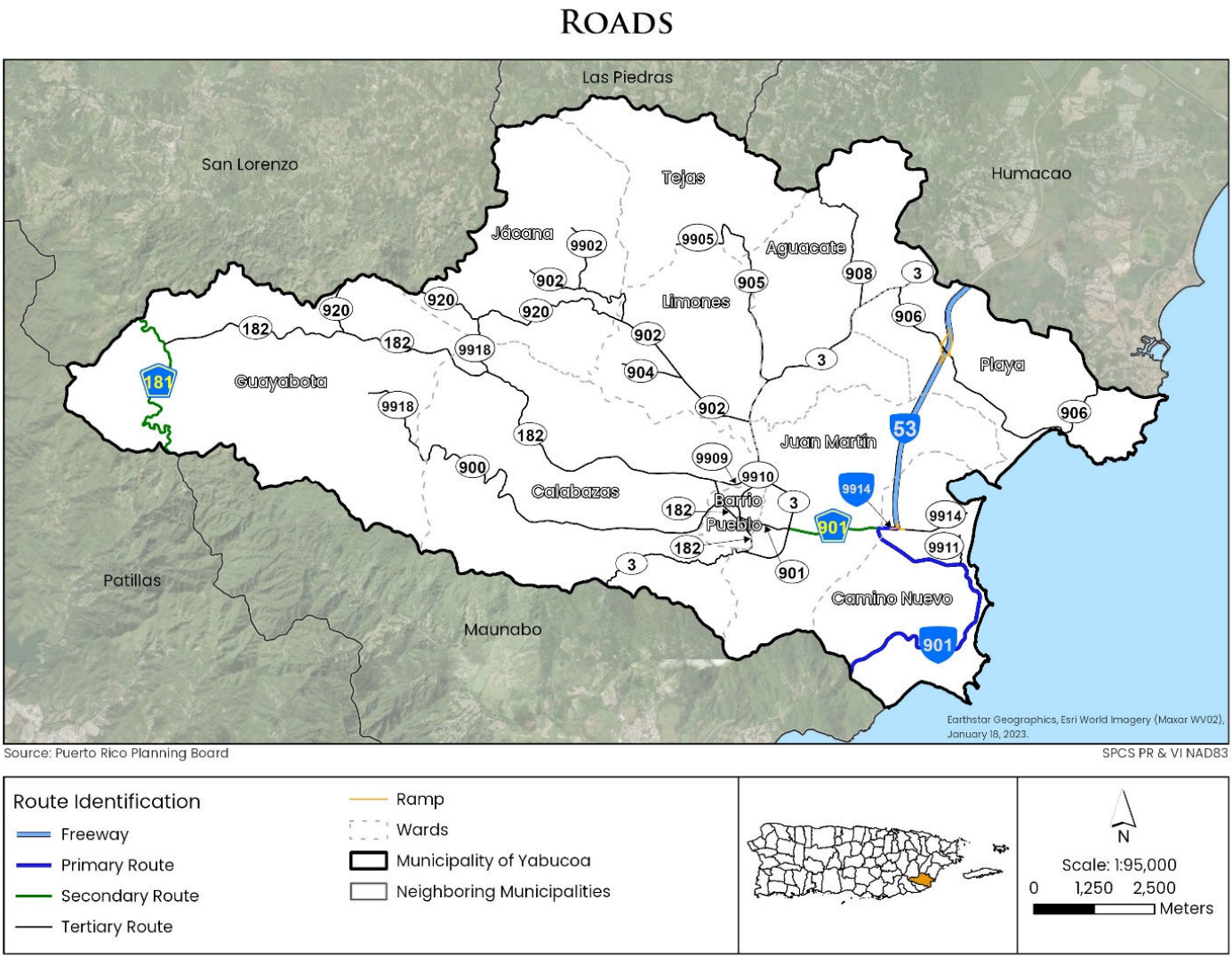
Management, encompassing the collection, storage, treatment, and discharge of wastewater. By prioritizing the protection and functionality of water systems, FEMA seeks to maintain sanitation, support healthcare services, and minimize cascading impacts on food safety and overall community resilience.

Map 8 shows the identified water systems facilities according to the latest information provided by the PRPB. The map shows many water systems related in the area where most of the development has occurred.

*Map 8: Critical Infrastructure by Lifeline*



*Map 9: Roadways*




## 3.6 Recent Development (E1-a)

Hazard mitigation planning must also account for future development conditions. To assess anticipated development trends within the municipality, historical patterns were evaluated using data on construction permits approved between 2020 and 2026. This period begins with the year of approval of the previous hazard mitigation plan. It should be noted that data for 2026 was completed through June 30, 2026.

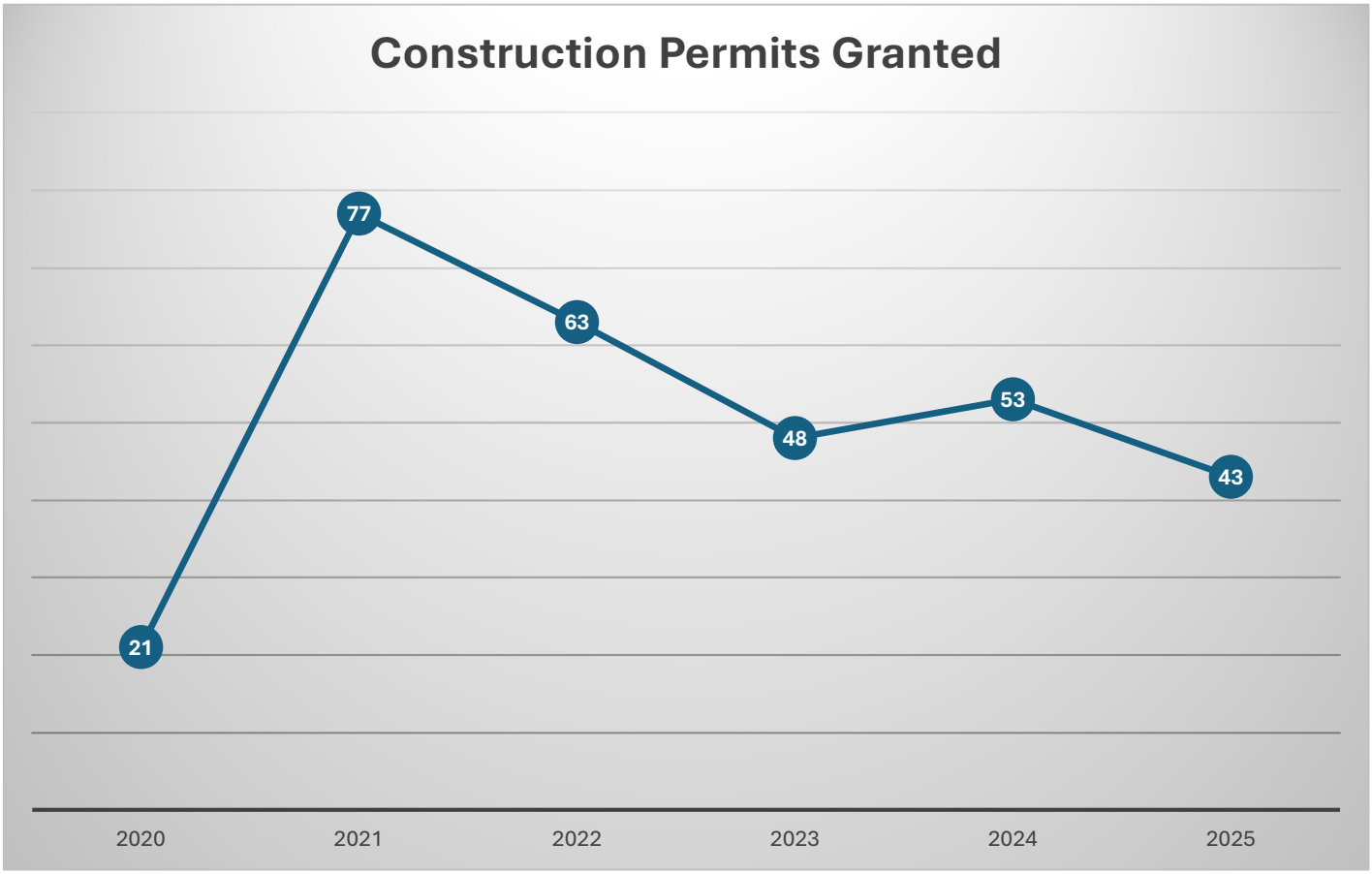
The data indicate that construction permits approval more than tripled between 2020 and 2021. This rise in permit approvals may be associated with the availability of federal stimulus funding provided during that time; however, additional analysis would be required to confirm any direct relationship. Based on the available data, the Municipality of Yabucoa (not including the 2026 data) records an average of 51 permits approved per year. Table 14 and Figure 12 present the number of construction permits approved between 2020 and 2026. Maps 21 and 22 illustrate the spatial distribution of these permits. To enhance legibility, the permits are depicted on two separate maps: one showing permits issued from 2020 to 2022, and another showing permits issued from 2023 to 2025.

*Table 15: Construction Permits Approved*

| Approved Construction Permits 2020-2026 | |
|---|---|
| Year | Permits Approved |
| 2020 | 21 |
| 2021 | 77 |
| 2022 | 63 |
| 2023 | 48 |
| 2024 | 53 |
| 2025 | 43 |
| 2026 | 23 |

*Source: Puerto Rico Planning Board*

*Figure 12: Yabucoa: Approved Construction Permits 2020-2025*[4]

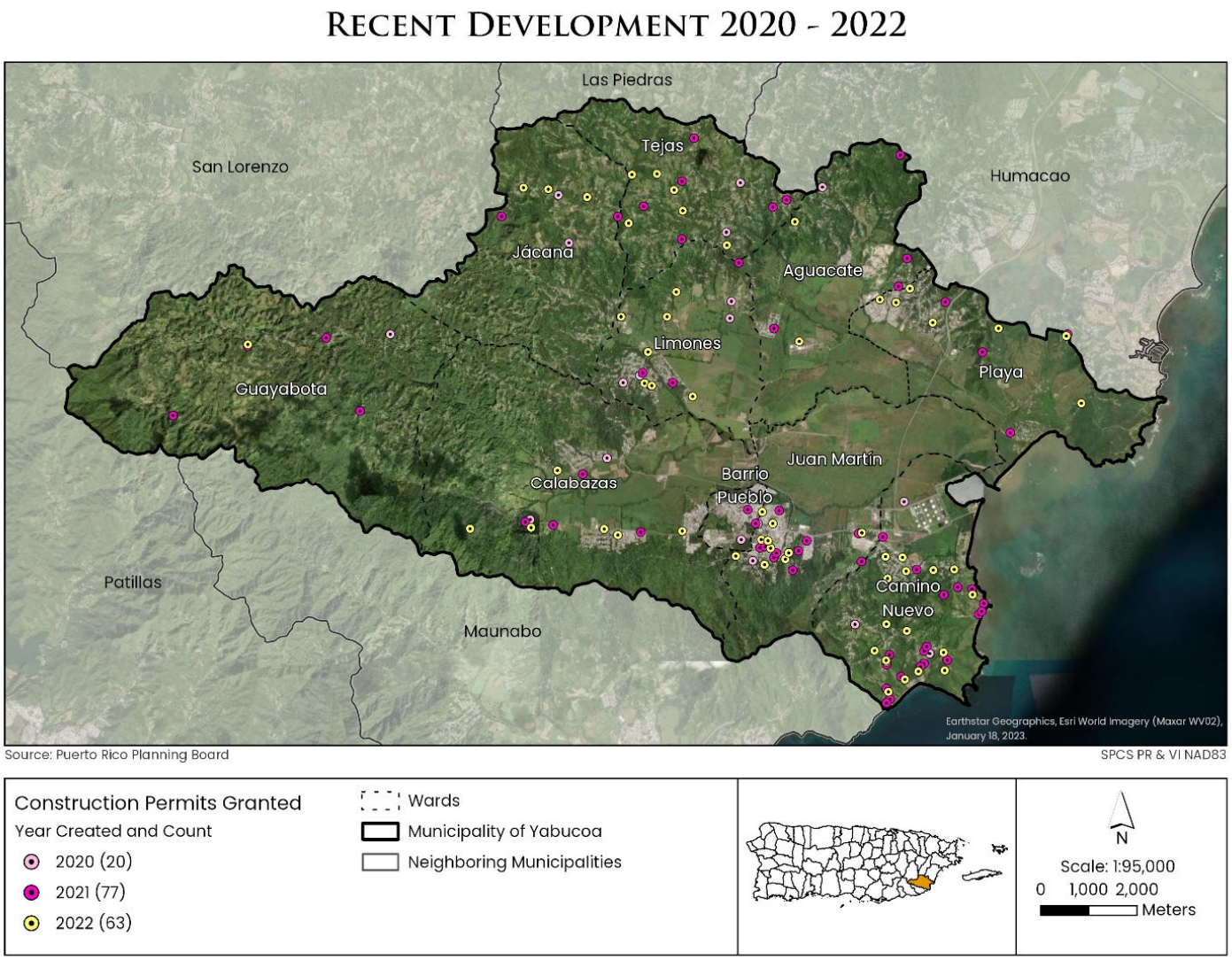



*Source: Puerto Rico Planning Board*

Map 11 shows the location of the approved permits for the period of 2020 – 2022, while Map 11shows the approved permits for the period of 2023 – 2026. These maps show that the areas where the most permits have been issued are in the developed area in Barrio Pueblo. Though a considerable number of construction permits can be seen in the Camino Nuevo ward along the PR-901 (Ruta Panorámica). For the 2023 – 2026 period, it can also be seen that there were a considerable number of permits in the western portion of the Playa ward (Comunas Community, Villas de Buena Ventura, etc.).

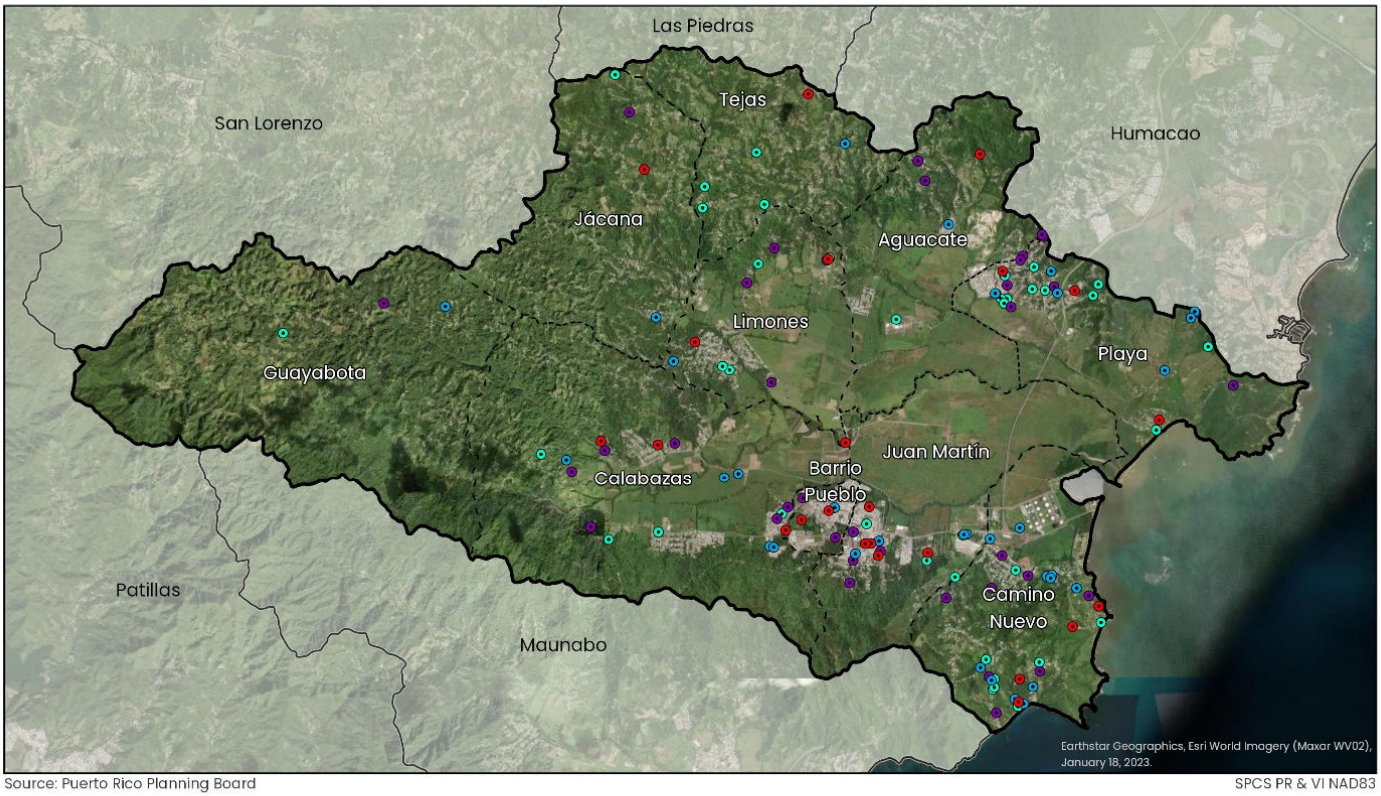
[4] 2026 totals not included as the year has not finalized and it could provide a false trend

*Map 10: Recent Developments 2020 -2022*



*Map 11: Recent Development 2023 - 2026*

## Recent Development 2023 - 2026




Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

Construction Permits Granted
Year Created and Count
- 2023 (47)
- 2024 (52)
- 2025 (43)
- 2026 (23)
- Wards
- Municipality of Yabucoa
- Neighboring Municipalities



N

Scale: 1:95,000

0 1,000 2,000 Meters

# 4. Hazard Profiles and Risk Assessment

## 4.1 Note on the Discussion of Hazards

The 2020 LHMP divided the discussion of the considered hazards in two separate and non-continuous sections. This arrangement made the analysis of the hazard cumbersome since the reader had to go back and forth between two different sections of this large document. In order to improve this, this new LHMP discusses both the profile of the hazard and the risk associated in one single section.

## 4.2 Regulatory Requirements

Federal regulation 44 C.F.R. § 201.6(c)(2) establishes the requirements related to hazard identification and risk assessment for LHMP. The Plan LHMP must include the following:

- An assessment that provides the basis for identifying the proposed activities aimed at reducing losses associated with the identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses related to the identified hazards. The hazard assessment must include:

- A description of the type, location, and extent of all natural hazards that may affect the jurisdiction. It must contain information on previous occurrences of hazard events and the probability of future hazards.

- A description of the jurisdiction's vulnerability to the identified hazards. This description must include a comprehensive summary of each hazard and its impact on the community. This Plan must describe vulnerability in terms of:

    - The number of existing structures, infrastructure, and critical facilities located within identified hazard areas;
    - An estimate of the potential monetary losses to structures identified as vulnerable, along with a description of the methodology used to prepare the estimate; and, lastly,

- A general description of land use and development patterns within the community so that mitigation options can be considered in future land-use decisions.

- A description of all structures insured under the National Flood Insurance Program (NFIP) that have experienced repetitive damage from different flood events. It must explicitly indicate whether the community participates in the NFIP and complies with its regulations. It must also include a table showing repetitive property losses along with a table of NFIP claims and losses.

## 4.3 Hazards that can Affect the Municipality

To determine the hazards to be addressed in this LHMP, the Municipality reviewed and integrated information from the 2021 Puerto Rico State Hazard Mitigation Plan, the 2020 Yabucoa Local Hazard Mitigation Plan, and the latest LHMP's of the municipalities that share a boundary with Yabucoa. The following table summarizes the hazards addressed in these Hazard Mitigation Plans. A check mark indicates that the hazard was included in the corresponding plan, while an "X" denotes that it was not.

*Table 16: Historical Hazard Inventory*

| Hazard | 2026PRSHMP | 2020 Yabucoa LHMP | Neighboring Municipalities |
|---|---|---|---|
| Earthquake/Liquefaction | ✓ | ✓ | ✓ |
| Landslides | ✓ | ✓ | ✓ |
| Tsunami | ✓ | ✓ | ✓ |
| Flooding | ✓ | ✓ | ✓ |
| Storm Surge | ✗ | ✓ | ✓ |
| Coastal Erosion | ✓ | ✓ | ✓ |
| Sea Level Rise | ✗ | ✓ | ✓ |
| Extreme Winds Hazard | ✓ | ✓ | ✓ |
| Extreme Heat | ✓ | ✓ | ✓ |
| Drought | ✓ | ✓ | ✓ |
| Wildfire | ✓ | ✓ | ✓ |
| Pandemic/Epidemic | ✓ | ✗ | ✗ |
| Tropical Cyclones | ✓ | ✓ | ✓ |

After reviewing the hazard profiles contained in these documents, the Municipality of

Yabucoa determined that the following hazards shall be assessed and evaluated as part of the 2026 LHMP:

*Table 17: Hazards to be included in the Yabucoa 2026 LHMP*

| Hazard | Included in Yabucoa 2026 LHMP? | Comments |
|---|---|---|
| Earthquake | Yes | It is included given Puerto Rico's location among major fault lines and the 2020 Seismic activity. |
| Landslides | Yes | It is included given the high propensity for landslides in Yabucoa's territory. |
| Tsunami | Yes | It is included given Puerto Rico's location among major fault lines and the 2020 Seismic activity. |
| Flooding | Yes | It is included given the presence of extensive flood zones in the municipality that host critical infrastructure. |
| Tropical Cyclones/Extreme Winds | Yes | It is included given that the southeastern region of Puerto Rico has been the most recurrent point-of-entry for hurricanes that make landfall in Puerto Rico in recorded history. (National Oceanic and Atmospheric Administration, 2026) |
| Storm Surge | Yes | It is included given the presence of extensive coastal flood plains and critical infrastructure that is exposed to this hazard. |

| Hazard | Included in Yabucoa 2026 LHMP? | Comments |
|---|---|---|
| Long – Term Coastal Modification | Yes | It is included given there is critical infrastructure that is exposed to this hazard. This discussion will include coastal erosion, coastal accretion and changes in the sea base mean level. |
| Tropical Cyclone/Extreme Winds | Yes | Included as part of the discussion on tropical cyclones. |
| Extreme Heat | Yes | A new inclusion, various of Yabucoa neighboring communities included this hazard. The Municipality understands that the inclusion of this hazard in the updated LHMP is warranted. |
| Drought | Yes | It is included given the 2014-2016 droughts and recent periods of moderate drought |
| Wildfire | Yes | Various of Yabucoa neighboring communities included in this hazard. The Municipality understands that the inclusion of this hazard in the updated LHMP is warranted. |
| Pandemic/Epidemic | Yes | The municipality of Yabucoa included this in the previous LHMP. It will be considered by the LHMP update given the COVID -19 emergency declaration of 2020. |

| Hazard | Included in Yabucoa 2026 LHMP? | Comments |
|---|---|---|
| High Hazard Potential Dam | No | This risk was not evaluated in this plan as the municipality has no direct risk exposure within it's territory or from neighboring municipalities. |

For the rest of this document, the hazards shall be evaluated in the following order:

*Table 17: Order of Hazards to be Assessed*

| Classification | Hazard |
|---|---|
| Geological Hazards | Earthquake |
| | Landslides |
| | Tsunami |
| Hydrological Hazards | Flooding |
| Meteorological Hazards | Tropical Cyclone/Extreme Winds |
| | Extreme Heat |
| | Drought |
| Environmental Hazards | Wildfire |
| | Long Term Coastal Modifications |
| Biological Hazards | Pandemic/Epidemic |

## 4.4 Chronology of Events

To prevent duplication of data and for easy reference in the discussion of each hazard profile the reader will find a chronology of events in the discussion of the hazard itself.

## 4.5 Risk Assessment Methodology

This section describes the methodologies employed to evaluate the identified hazards. Given that each hazard presents distinct characteristics, data needs, and levels of uncertainty, multiple analytical approaches were utilized to ensure a thorough, accurate, and comprehensive risk assessment.

#### 4.5.1.1 *HAZUS 6.1*

HAZUS is a Geographic Information System (GIS)–based risk assessment tool developed by FEMA to estimate potential losses associated with natural hazards. The software applies scientific modeling and spatial datasets to evaluate the impacts of events such as earthquakes, floods, hurricanes, and tsunamis on buildings, infrastructure, population, and the local economy. HAZUS generates detailed estimates of physical damage, economic losses, and social consequences, thereby supporting hazard mitigation planning, emergency preparedness, and recovery efforts. By integrating data on hazard intensity, exposure, and vulnerability, HAZUS enables decision-makers to prioritize mitigation strategies and allocate resources effectively. The following hazards were evaluated using the HAZUS 6.1 platform:

- Earthquake
- Tropical Cyclone/Extreme Winds
- Tsunami
- Flooding

#### 4.5.1.2 *Alternative GIS modeling*

Certain hazards are not currently modeled in HAZUS; however, they can be evaluated using alternative GIS-based techniques. ESRI® ArcGIS Pro™ 3.6 was utilized to assess hazard vulnerability by incorporating digital risk datasets and the hazard information database previously described. Using these spatial data layers, vulnerability was estimated by identifying the number of critical facilities and buildings located within hazard-prone areas. It is important to note that this method may overestimate exposure levels. In this LHMP, the following hazards were assessed using this GIS-based approach:

- Landslides
- Storm Surge

#### 4.5.1.3 *Stochastic Risk Assessment*

The stochastic risk assessment methodology was applied to evaluate hazards that are not addressed by existing hazard models or GIS-based analyses. This method is

particularly appropriate for hazards that lack defined geographic boundaries and therefore cannot be reliably examined through spatial analysis. The approach allows for the incorporation of estimated annual losses and impact data; however, the accuracy of the results is highly dependent on the availability and quality of the underlying datasets.

In the case of this LHMP, the hazards evaluated using this methodology are:

- Long Term Coastal Dynamics
- Extreme Heat
- Drought
- Wildfire
- Pandemic/Epidemic

This methodology is particularly appropriate for hazards that lack clearly defined geographic boundaries and therefore cannot be evaluated through GIS-based analysis. It allows for the incorporation of estimated annual losses and impact data; however, the accuracy of the assessment is highly dependent on the availability and quality of the underlying datasets.

## 4.6 Earthquake

### 4.6.1 Description (B1-a)

An earthquake is a sudden movement of the Earth's crust generated by seismic waves that propagate outward in all directions from the focus, or point of origin (FEMA, 1997). The focus is the location within the Earth where the displacement of rocks along a fault initiates, while the epicenter refers to the point on the Earth's surface situated directly above the focus (Puerto Rico Seismic Network, 2019). Earthquakes may occur due to changes in pressure within the Earth's crust, including tectonic plate movement, rock rupture, volcanic activity, landslides, or the collapse of underground cavities.

Most earthquakes result from the release of accumulated stress generated by the displacement of rocks along faults within the Earth's outer crust. These faults are generally located along the boundaries of the planet's major tectonic plates. The highest levels of tectonic instability occur at plate margins where slow, opposing movements create substantial pressure due to plates traveling in different directions

and at varying speeds. This deformation along plate boundaries causes stress to build in the surrounding rock. When the accumulated stress surpasses the strength of the rock, a rupture occurs, releasing stored energy in the form of seismic waves that propagate outward and produce an earthquake (NMEAD, 2021).

Earthquakes can impact extensive geographic areas, causing tens of billions of dollars in property damage, significant loss of life, numerous injuries, and widespread disruption to the social and economic stability of affected communities. Most structural damage and earthquake-related fatalities result from building collapse triggered by ground shaking (NMEAD, 2021). The severity of impacts depends on the amplitude and duration of seismic shaking, which are influenced by factors such as earthquake magnitude, proximity to the fault rupture, and the local and regional geologic conditions (NMEAD, 2021). Additional hazards associated with earthquakes include landslides where soil and rock masses move downslope and liquefaction, a process in which saturated soils lose their rigidity and behave like a fluid. Liquefaction can cause foundations and structures that rely on soil stability to shift, tilt, or collapse.

Puerto Rico is located near the boundary between the North American and Caribbean tectonic plates, within a subduction zone where one plate gradually descends beneath the other. This tectonic environment is characterized by significant seismic activity and lateral displacement. The relative movement between these two plates is approximately 2 centimeters per year (Puerto Rico Seismic Network, 2019). According to the Puerto Rico Seismic Network, seismic activity in the region is concentrated in eight (8) primary zones:

- The Puerto Rico Trench to the North,
- The North and South Slope Faults of Puerto Rico,
- The “Sombrero Zone”, to the Northeast,
- The Mona Passage to the Westa
- The Mona Mona Canyon to the West,
- The Virgin Islands and Anegada depressions to the East,
- The Muertos Trough to the South,
- In the southwest of Puerto Rico

To describe earthquake size, seismology uses three (3) primary terms: intensity, magnitude, and ground acceleration. Intensity measures the level of shaking experienced by structures and the natural environment at a specific location. It varies based on the distance from the earthquake’s focus and the duration of the shaking. Magnitude refers to the amount of energy released during the event, as recorded by

seismometers. Ground acceleration expresses the force of the seismic waves acting on the ground and is commonly used to characterize the severity of an earthquake (PRSN, 2019).

Earthquakes can generate a variety of secondary hazards, including liquefaction, landslides, seismic wave amplification, and tsunamis. For the purposes of this analysis, the primary secondary hazard of concern is earthquake-induced liquefaction, as it is a condition for which mitigation strategies can be effectively developed once susceptible areas are identified and mapped. Liquefaction refers to the process in which certain saturated soils temporarily lose their structural strength and behave like a dense fluid, significantly reducing their load-bearing capacity (PRSN, 2019). Liquefaction typically occurs in areas underlain by medium- to fine-grained sandy soils that are saturated with water and of relatively recent geologic origin. These conditions are most found along river margins and within Quaternary (Q) alluvial deposits. Another secondary hazard associated with earthquakes is the amplification of seismic waves. Seismic wave amplification occurs in thick alluvial deposits where seismic waves decelerate, increasing their oscillation and causing the ground to experience stronger and more prolonged shaking.

#### *4.6.1.1 Affected Area (B1-B)*

The following maps measure the spectral acceleration and spectral displacement in HAZUS run scenarios.

Spectral Acceleration is measure used mainly in earthquake engineering to describe how strongly the ground motion from an earthquake would accelerate a structure with a specific natural period.  This measure answers the question ""If a building (or any structure) vibrates naturally at a certain period, how much acceleration would it experience during an earthquake?" or , How hard the ground is pushing on the building at a specific vibration period? The higher the spectral acceleration, stronger the forces acting on the structure will be, which can cause structural failure if the building isn't designed for it (USGS, 2019).

Spectral Displacement measures how far a structure is expected to move (deform) during an earthquake, based on its natural vibration period and damping. n other words, it answers: "For a building with a given natural period, what is the maximum displacement it would experience during earthquake shaking?" (National Institute of Building Sciences, 2020).

Furthermore, the maps show the Hazus scenario for .03 seconds and 1.0 seconds. The difference relates to how an earthquake impacts different types of structures based on the natural vibration period the building. The maps showing the 0.3-second scenario can affect buildings that are short, stiff structures like 1 or 2-story buildings. These buildings are rigid, so they vibrate quickly when the ground shakes. While the 1.0-second scenario that is more important for buildings are taller, more flexible structures, like mid- to high-rise buildings. These buildings are taller and less stiff and therefore sway more slowly (over a longer period) during an earthquake (FEMA, Hazus Earthquake Model User Guidance, 2024).

As shown on Map 12 spectral acceleration at a 1.0-second period is higher in the northeastern part of the municipality, specifically in Playa ward. The highest spectral acceleration values 0.237683 - 0.251833 g) is concentrated Playa Ward.

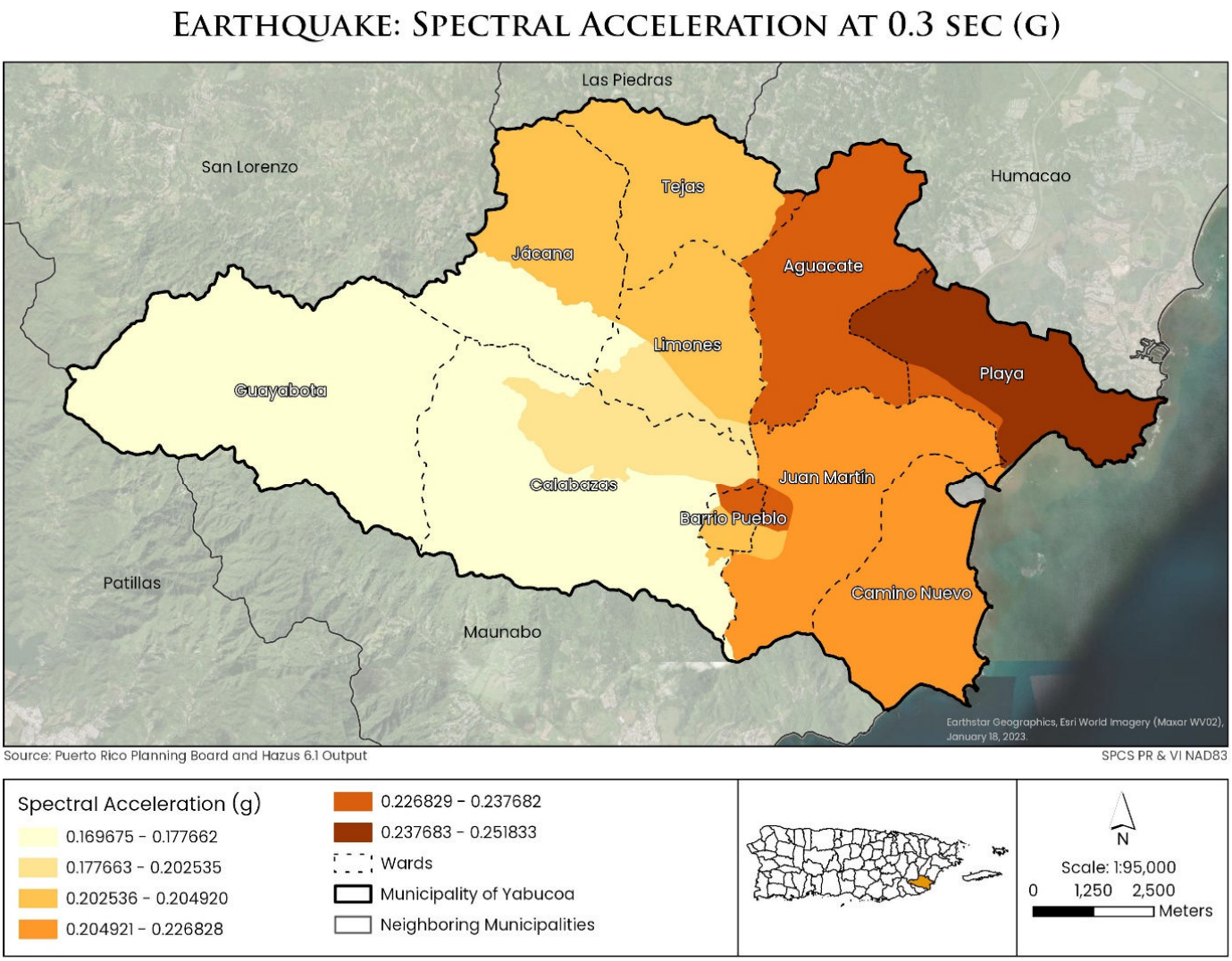
Residential communities located within this zone include Comunas, Playa Guayanés, Villas de Buenaventura. It also includes the facilities of COSEY – *Ciudad Educativa*.

The lowest spectral acceleration is located in Guayabota, most of Calabazas and parts of Limones and Jácana wards in the western section of the municipality.

Map 13 illustrates an additional earthquake scenario based on spectral acceleration at 0.3 seconds. In this scenario, the highest vulnerability again appears in the Playa and Aguacate wards. High to medium high spectral acceleration values are observed in areas Juan Martín and Camino Nuevo wards. Communities and districts within this high-acceleration zone include Playa Guayanés Villa de Buenaventura, Comunas, Sector El Negro, Sector El Cocal among others.

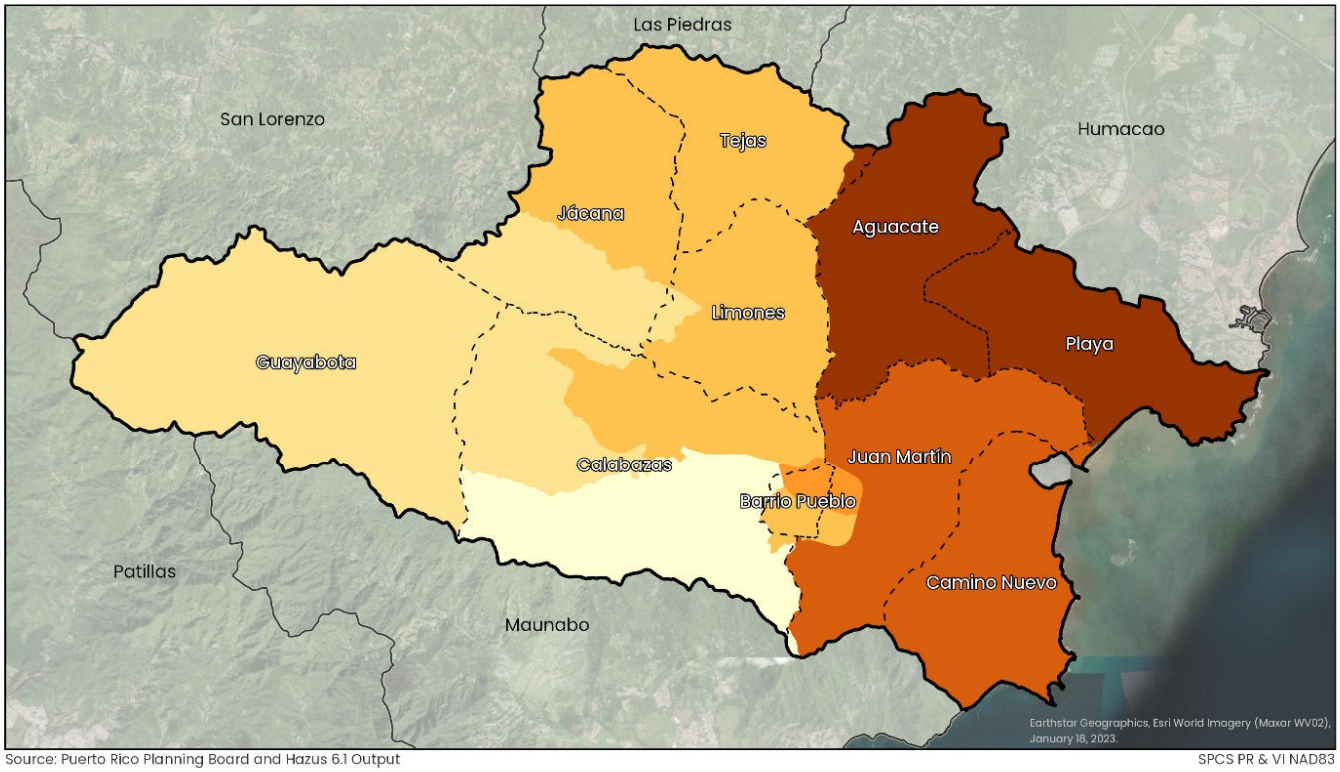
Maps 14 and 15 illustrate the spectral displacement expected during an earthquake, which represents the degree of movement or sway that buildings may experience. The spatial distribution of displacement closely mirrors the patterns observed in spectral acceleration, as higher acceleration levels generally correspond to greater structural sway.

*Map 12: Earthquake: Spectral Acceleration at 0.3 sec*



*Map 13: Earthquake: Spectral Acceleration at 1.0 sec*

## Earthquake: Spectral Acceleration at 1.0 sec (g)




Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Spectral Acceleration (g)
- 0.068609
- 0.068610 - 0.074866
- 0.074867 - 0.087421
- 0.087422 - 0.100914
- 0.100915 - 0.102202
- 0.102203 - 0.109171
- Wards
- Municipality of Yabucoa
- Neighboring Municipalities



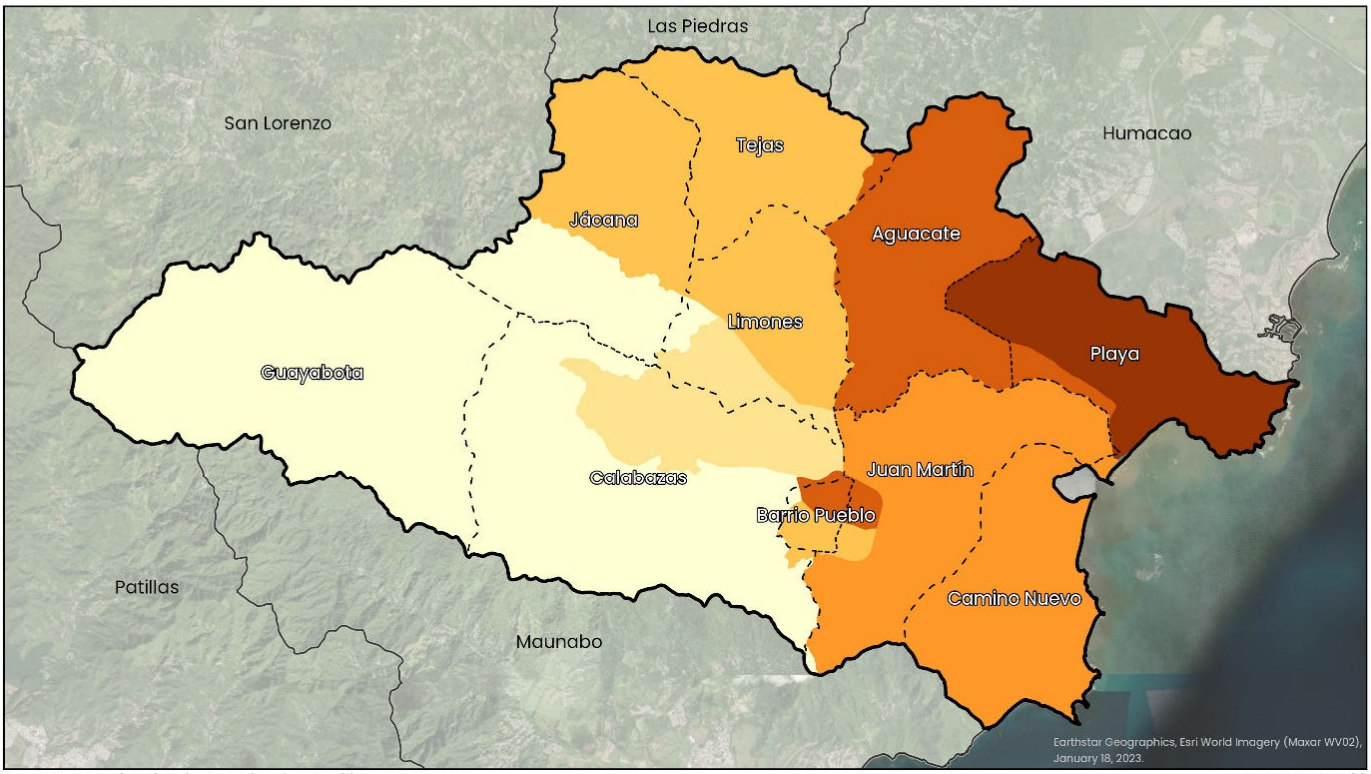
N

Scale: 1:95,000

0 1,250 2,500 Meters

*Map 14: Earthquake Spectral Displacement at 0.3 sec*

## Earthquake: Spectral Displacement at 0.3 sec (in)




Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Spectral Displacement (in)
- 0.149653 - 0.156697
- 0.156698 - 0.178636
- 0.178637 - 0.180739
- 0.180740 - 0.200062
- 0.200063 - 0.209636
- 0.209637 - 0.222117
- Wards
- Municipality of Yabucoa
- Neighboring Municipalities



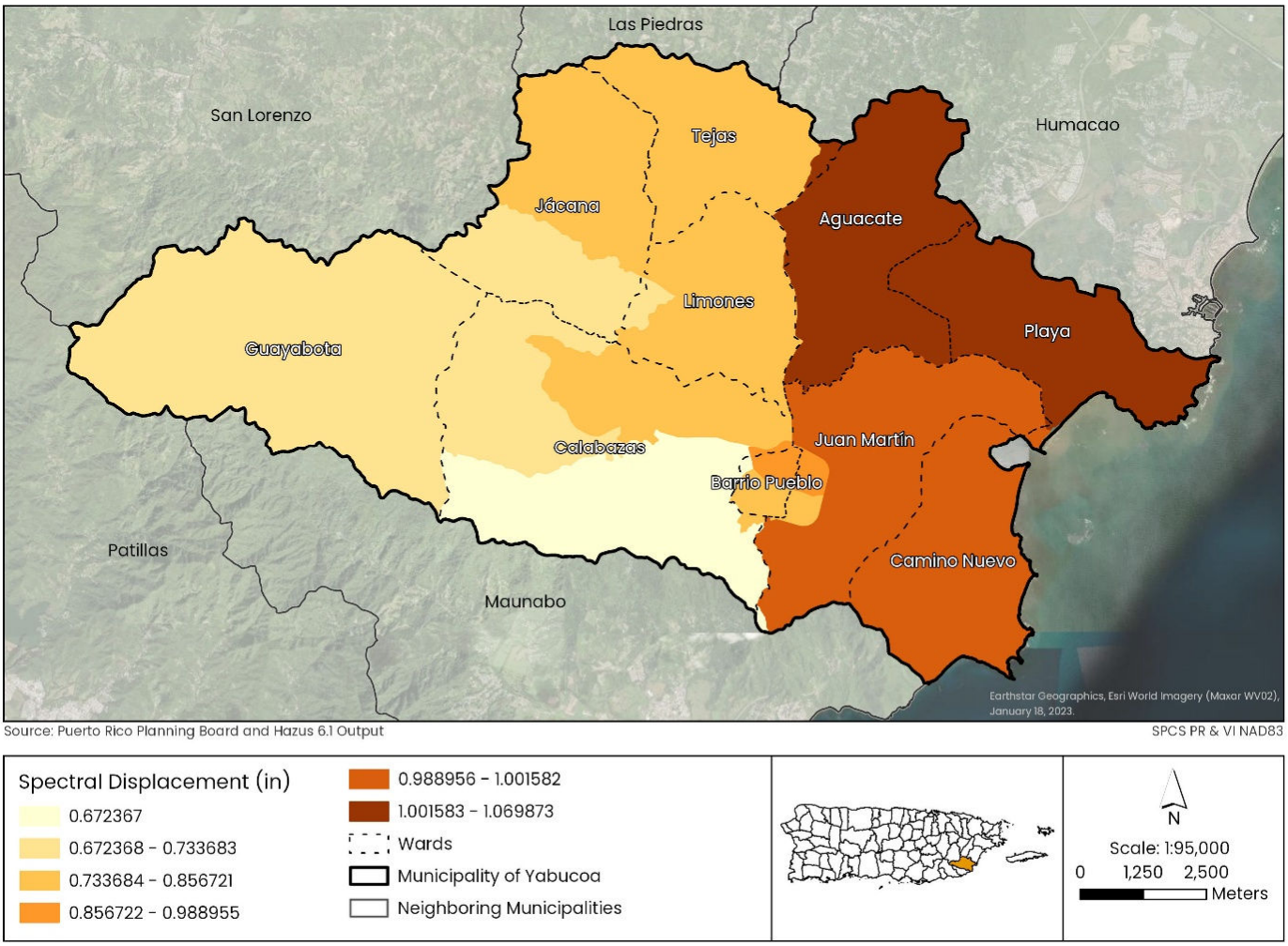
N

Scale: 1:95,000

0 1,250 2,500 Meters

*Map 15 Earthquake - Spatial Displacement t 1.0 sec.*

## Earthquake: Spectral Displacement at 1.0 sec (in)




### *4.6.1.2 Risk Magnitude (B1-C)*

The size of an earthquake, commonly associated with the Richter Scale, is widely recognized but often misunderstood. The concept of a logarithmic magnitude scale was first introduced by Charles Richter in the 1930s to measure earthquakes in Southern California using high-frequency recordings from nearby seismograph stations. This original scale, designated as ML where "L" stands for "local" eventually became known as the Richter magnitude.

As global seismic monitoring networks expanded, it became evident that the Richter method was accurate only within specific frequency and distance ranges. To

accommodate a broader range of seismic signals recorded worldwide, additional magnitude scales were developed as extensions of Richter's original concept, including the body-wave magnitude (Mb) and the surface-wave magnitude (Ms). Each of these scales applies to a particular frequency range and type of seismic waves, and within their respective valid ranges, they provide magnitudes equivalent to the Richter scale. (USGS, 2024)

Due to the limitations of the ML, Mb, and Ms scales, a more universally applicable scale moment magnitude (Mw) was developed. For large-magnitude earthquakes, Mw provides the most accurate and reliable estimate of earthquake size.

Moment is a physical quantity proportional to the amount of slip that occurs along a fault multiplied by the area of the fault surface that undergoes rupture. It reflects the total energy released by an earthquake. Moment can be derived from seismogram data and geodetic measurements and subsequently converted into a magnitude value using a standardized formula. The resulting measure, known as moment magnitude, provides a consistent and comparable estimate of earthquake size across the full range of magnitudes a capability that earlier scales do not offer (USGS, 2024). Table 11 below shows the Moment – Magnitude.

*Table 18: Moment - Magnitude Scale*

| Range | Description |
|---|---|
| Mw < 3.0 | Usually not felt by people. |
| Mw 3.0 – 4.9 | Minor earthquakes, often felt but rarely cause damage. |
| Mw 5.0 – 5.9 | Moderate, can cause slight damage to poorly built structures. |
| Mw 6.0 – 6.9 | Strong, can cause significant damage in populated areas. |
| Mw 7.0-7.9 | Major, serious damage over large areas. |
| Mw ≥ 8.0 | Great earthquakes, catastrophic damage over very large regions. |

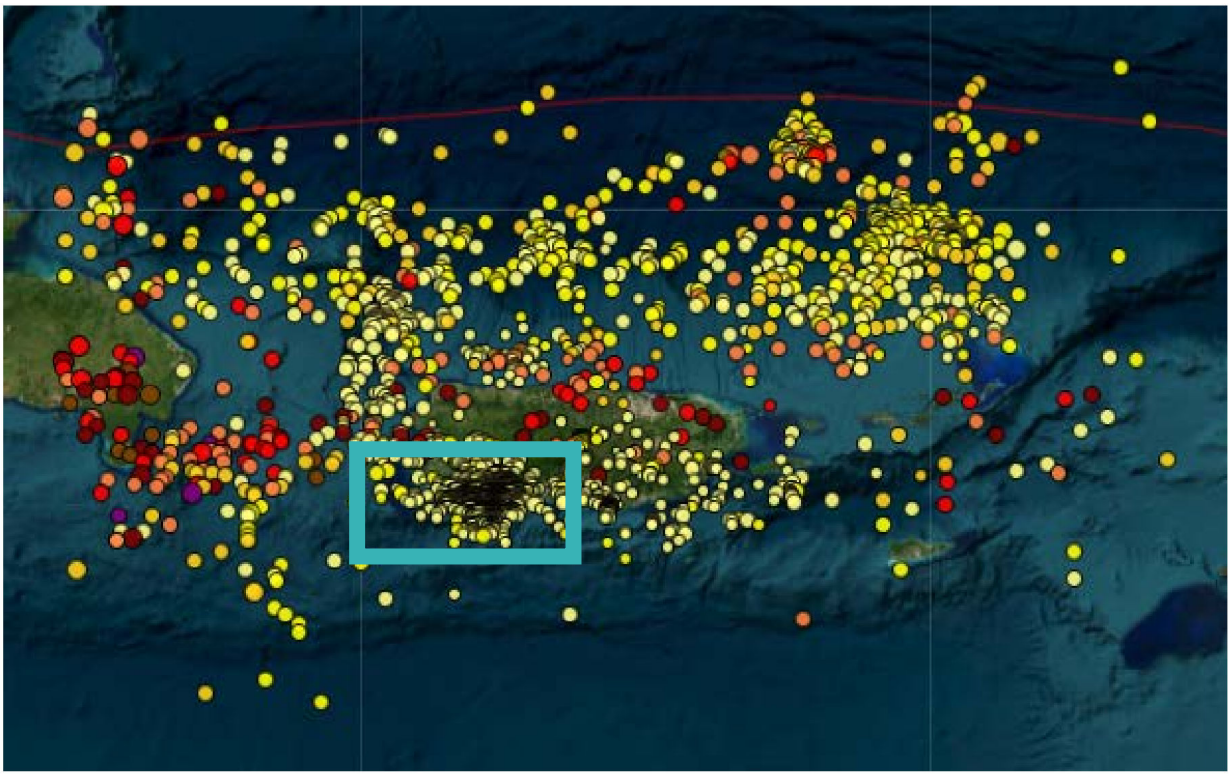
#### *4.6.1.3 Past Events (B1-D)*

Earthquakes occur naturally daily, and their impacts increase significantly with greater magnitude. High-magnitude events can be particularly destructive, causing extensive

property damage, loss of life, and severe disruption to affected regions. Puerto Rico is located near several active seismic zones including the Puerto Rico Trench, the Mona Canyon, the Anegada Trough, the Muertos Trough, and the southern fault system placing the island at heightened risk for seismic events. Seismicity in the southeastern region of Puerto Rico is primarily associated with faults in the Virgin Islands and Anegada depressions. In the southwestern region, activity is influenced by the Punta Montalva fault (Roig Silva, 2010), an area that has experienced a notable increase in seismic activity in recent years (Weilert & Laó-Dávila, 2023).

Figure 13 is a screengrab sourced from a report published by the Puerto Rico Seismic Network. This report illustrates the epicenters of earthquakes recorded in the Puerto Rico and U.S. Virgin Islands region in 2024 (PRSN, 2025). The reddish to brown colors represent the earthquake of higher magnitude; the light yellow are the ones with the lower magnitude. The purpose of this figure is the show the concentration of earquakes in the southwest of Puerto Rico (teal rectangle)

*Figure 13: PRSN - 2024 Earthquakes Epicenter screengrab (PRSN, 2025)*



**Earthquake Chronology**

Table 20 below shows the chronological list of the seismic activity in Puerto Rico for the period of 2012 to 2024 as reported by the PRSN (PRSN, n.d.).

*Table 19: Puerto Ric Seismic Activity 2013-2024*

| Year | Description of seismic events |
|---|---|
| 2024 | The largest earthquake of 2024 occurred on May 14, 2024, at 8:30:11 p.m. (Puerto Rico local time). The magnitude 5.6 Ml earthquake was located 94.3 km north-northwest of Aguadilla (PR) at a depth of 7 km. This moderate earthquake was widely felt throughout Puerto Rico, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in Aguadilla (PR).<br>The largest earthquake of 2024 occurred on May 14, 2024, at 8:30:11 p.m. (Puerto Rico local time). The magnitude 5.6 Ml earthquake was located 94.3 km north-northwest of Aguadilla (PR) at a depth of 7 km. This moderate earthquake was widely felt throughout Puerto Rico, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in Aguadilla (PR).<br><br>During 2024, aftershocks from the South-Southwest Puerto Rico seismic sequence continued. This sequence began on December 28, 2019, with a magnitude 4.7 Ml earthquake. The main event of this sequence occurred on January 7, 2020, in the southern region of Puerto Rico, 12.7 km south of Guayanilla, with a magnitude of 6.4 Mw. This strong earthquake, at a depth of 7 km, had a maximum intensity of VIII in Guánica, Puerto Rico, and caused major damage across the island.<br><br>From the start of the South-Southwest Puerto Rico seismic sequence in 2019 through April 2024, 27,497 earthquakes associated with this sequence have been processed (Figure 2). More than 1,688 felt earthquakes and over 492 significant events with magnitudes greater than 3.5 have been recorded. Of these, 42 earthquakes had magnitudes greater than 4.5. |
| 2023 | The largest earthquake of 2023 occurred on December 9, 2023, at 10:27:22 a.m. (Puerto Rico local time). The magnitude 5.7 Ml earthquake was located 192.28 km east-northeast of San Juan, PR, at a depth of 7 km. This moderate earthquake was widely felt throughout Puerto Rico |

| Year | Description of seismic events |
|---|---|
| | and the Virgin Islands, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in St. Thomas (USVI).<br><br>During 2023, aftershocks from South-Southwest Puerto Rico seismic sequence continued. This sequence began on December 28, 2019, with a magnitude 4.7 Ml earthquake. The main event of this sequence occurred on January 7, 2020, in the southern region of Puerto Rico, 12.7 km south of Guayanilla, with a magnitude of 6.4 Ml. This strong earthquake, at a depth of 7 km, had a maximum intensity of VIII in Guánica, Puerto Rico, and caused major damage across the island. |
| 2022 | The seismic sequence in the South-Southwest region of Puerto Rico, which began on December 28, 2019, continues. From its onset until the March 2022 report by the Puerto Rico Seismic Network, a total of 19,436 earthquakes associated with this sequence had been recorded. In that report, 1,502 events were documented for 2022, of which 30 were reported as felt. The regions with the highest seismic activity during March 2022 were in the southern area of Puerto Rico. |
| 2021 | The largest earthquake of 2021 occurred on January 24, 2021, at 7:21:41 p.m. (Puerto Rico local time). The magnitude 5.4 Ml earthquake was located 44.82 km southeast of Virgin Gorda, BVI, at a depth of 94 km. This moderate earthquake was widely felt throughout Puerto Rico and the Virgin Islands, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in Tortola, British Virgin Islands. |
| 2020 | The year 2020 was marked by significant seismic activity. An earthquake of magnitude 5.8 was recorded on January 6, 2020, followed by another of 6.4 on January 7, 2020, located 8 km from Indios, Puerto Rico. It is important to clarify that, starting from the 4.7 magnitude event recorded on December 28, 2019, up to October 22, 2020, approximately over 1,200 earthquakes of magnitude 2.0+ have been felt on the island.<br>Tectonic activity in Puerto Rico is dominated by the convergence between the North American and Caribbean plates, with the island compressed between the two. To the north of Puerto Rico, the North American plate subducts beneath the Caribbean plate along the Puerto Rico Trench. To the south of the island, and south of the January 7 earthquake, the upper crust of the Caribbean plate subducts beneath Puerto Rico in the Muertos Trough. However, the January 6 |

| Year | Description of seismic events |
|---|---|
| | earthquake and other recent events are occurring in the offshore deformation zone, connected by the Punta Montalva fault on land and the Guayanilla Canyon offshore.<br>Between December 28, 2019, and January 23, 2020, southern Puerto Rico recorded 90 seismic events of magnitude 4.0 or greater, including the 6.5 magnitude earthquake on January 7, 2020, according to the USGS. These seismic movements led state authorities to request a disaster declaration from the President of the United States. This Disaster Declaration was issued on January 16, 2020, under number DR-4473. The Municipality of Choose an item. was not included among those designated to receive Individual Assistance funds from FEMA. |
| 2019 | During 2019, the Puerto Rico Seismic Network (PRSN) located a total of 6,510 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2018 (3,974 earthquakes), the detected and located seismicity in 2019 increased. The year 2019 ended with 2,536 more earthquakes than the previous year. In 2019, the month with the highest activity was December with 1,291 earthquakes, while August had the lowest seismicity with 303 earthquakes.<br>The region with the highest recorded seismicity during 2019 was the Mona Canyon with 1,288 seismic events, followed by the southern region of Puerto Rico with 885 earthquakes (Table 3). Earthquake depths ranged from 1 km to 191 km, and magnitudes varied from 0.34 Md to 6.0 Mw. Of the total earthquakes in 2019, 70 were reported as felt. On December 28, 2019, an active period of seismic activity began, with a 4.7 magnitude earthquake, followed several hours later by another of 5.0 magnitude south of the island. |
| 2018 | During 2018, the Puerto Rico Seismic Network (PRSN) located a total of 3,974 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2017 (3,129 earthquakes), the detected and located seismicity increased by 845 more earthquakes than the previous year. In 2018, the month with the highest activity was December with 549 earthquakes, while February had the lowest seismicity with 227 earthquakes.<br>The region with the highest recorded seismicity during 2018 was the southern region of Puerto Rico with 412 seismic events, followed by the |

| Year | Description of seismic events |
|---|---|
| | 19°N Fault Zone with 349 earthquakes. Earthquake depths ranged from 2 km to 185 km, and magnitudes varied from 0.63 Md to 4.67 Md. Of the total earthquakes in 2018, 29 were reported as felt within our area of responsibility. |
| 2017 | During 2017, the Puerto Rico Seismic Network (PRSN) located a total of 3,129 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2016 (3,948 earthquakes), the detected and located seismicity decreased by 20%, which means 819 fewer earthquakes than the previous year. In 2017, the month with the highest activity was April with 518 earthquakes, while October had the lowest seismicity with 48 seismic events.<br>The region with the highest recorded seismicity during 2017 was the Sombrero Seismic Zone with 856 seismic events, followed by the Virgin Islands Platform with 327 earthquakes. Earthquake depths ranged from 1 km to 180 km, and magnitudes varied from 0.85 Md to 4.8 Mb. Of the total earthquakes in 2017, 24 were reported as felt within our area of responsibility. |
| 2016 | During 2016, the Puerto Rico Seismic Network (PRSN) located a total of 3,947 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2015 (3,235 earthquakes), the detected and located seismicity increased by 22.0%, or 712 more earthquakes than the previous year. In 2016, the month with the highest activity was September with 566 earthquakes, while March had the lowest seismicity with 169 earthquakes.<br>The region with the highest recorded seismicity during 2016 was the Sombrero Seismic Zone with 973 seismic events, followed by the Virgin Islands Platform with 497 earthquakes. Earthquake depths ranged from 1 km to 177 km, and magnitudes varied from 0.76 Md to 4.6 Ml. Of the total earthquakes in 2016, 28 were reported as felt within our area of responsibility. |
| 2015 | During 2015, the Puerto Rico Seismic Network (PRSN) located a total of 3,235 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2014 (3,420 earthquakes), the detected and located seismicity decreased by 5.4%, or 185 fewer |

| Year | Description of seismic events |
|---|---|
| | earthquakes than the previous year. In 2015, the month with the highest activity was July with 473 earthquakes, while April had the lowest seismicity with 157 earthquakes.<br>The region with the highest recorded seismicity during 2015 was the Sombrero Seismic Zone with 588 seismic events, followed by the 19°N Fault Zone with 477 earthquakes. Earthquake depths ranged from 1 km to 211 km, and magnitudes varied from 0.80 Md to 4.80 Md (duration magnitude). Of the total earthquakes in 2015, 23 were reported as felt within the area of responsibility. |
| 2014 | During 2014, the Puerto Rico Seismic Network (PRSN) located a total of 3,420 earthquakes in the area of responsibility (AOR) known as the Puerto Rico and Virgin Islands Region (latitude 17.00˚ to 20.00˚N and longitude 63.50˚ to 69.00˚W). Compared to 2013 (2,293 earthquakes), the detected and located seismicity increased by 49%, which is 1,127 more earthquakes than the previous year. In this year, the month with the highest seismicity was January with 709 earthquakes, and the month with the lowest seismicity was November with 192 earthquakes.<br>Of the total seismicity in 2014, 29 earthquakes (0.85%) were reported as felt, all located within our AOR. The magnitudes (Md) of the seismic events calculated for this year by PRSN ranged from 1.0 to 6.4, although for felt events they ranged from 2.53 Md to 6.4 Mwp. During 2014, depths varied between 1 km and 182 km, while for felt earthquakes they ranged from 6 km to 134 km. Earthquakes with depths of 0 to 25 km were the most frequent with 1,385 events, while those between 175 km and 200 km were the least frequent this year. The region with the highest recorded seismicity during 2014 was the 19°N Fault Zone with 905 seismic events, followed by the Sombrero Seismic Zone with 483 earthquakes. |
| 2013 | During 2013, the Puerto Rico Seismic Network (PRSN) located a total of 2,293 earthquakes in the Puerto Rico and Virgin Islands region (latitude 17.00˚ to 20.00˚N and longitude 63.50˚ to 69.00˚W). Compared to 2012 (2,852 earthquakes), the detected and located seismicity decreased by 20%, which is 559 fewer earthquakes than the previous year. In this year, the month with the highest seismicity was September with 272 earthquakes, and the month with the lowest seismicity was February with 114 earthquakes.<br>Of the total seismicity in 2013, 44 earthquakes (1.92%) were reported as felt, all located within the Puerto Rico and Virgin Islands region. The |

| Year | Description of seismic events |
|---|---|
| | magnitudes of the seismic events calculated for this year by PRSN ranged from 1.0 to 5.12, although for felt events they ranged from 2.36 to 5.12. During 2013, depths varied between 1 km and 182 km, while for earthquakes they ranged from 4 km to 112 km. The region with the highest recorded seismicity during 2013 was the Sombrero Seismic Zone with 504 seismic events, followed by the Virgin Islands Platform with 246 earthquakes. Through its educational program, PRSN reached 14,099 people in Puerto Rico and the U.S. and British Virgin Islands during 2013. |

**2020 Seismic Sequence**

In early January 2020, Puerto Rico experienced a significant seismic sequence that began with a series of foreshocks and culminated in a major earthquake on January 7. The main shock registered a magnitude of 6.4 Mw and struck along the island's southern coast, severely affecting the municipalities of Guayanilla, Ponce, and Yauco. This event was preceded by a magnitude 5.8 Mw earthquake on January 6, which had already caused widespread concern and notable structural damage (USGS, n.d.). The seismic activity was associated with the complex interaction between the Caribbean and North American tectonic plates, a region characterized by active subduction zones and fault systems. The resulting shaking was felt across the island, causing power outages, school closures, and the collapse of numerous structures, including residential and public buildings.

The aftermath of the earthquake resulted in extensive damage to homes and critical infrastructure, displacing thousands of residents and prompting a federal emergency declaration. The southern region experienced prolonged aftershocks—some exceeding magnitude 5.0, which continued for weeks, intensifying public concern and creating sustained disruption. This event underscored Puerto Rico's heightened vulnerability to seismic hazards and highlighted the importance of preparedness measures and resilient construction practices. The incident received a Presidential Disaster Declaration under the Stafford Act (DR-4473-PR) (FEMA, n.d.). Although the Municipality of Yabucoa was not included in the disaster declaration, it recognizes that Puerto Rico's location along active tectonic boundaries place all jurisdictions at risk of seismic events capable of causing millions of dollars in damages and significant disruptions to daily life.

According to the Puerto Rico Seismic Network (PRSN), from the onset of the South–

Southwest Puerto Rico seismic sequence in 2019 through April 2024, a total of 27,497 earthquakes associated with this sequence were recorded and processed. Of these events, more than 1,688 were reported as felt, and over 492 registered magnitudes greater than 3.5. Additionally, 42 earthquakes reached magnitudes exceeding 4.5.

#### 4.6.1.4 Future Event Probabilities (B1-e)

Unlike atmospheric hazards, earthquakes cannot be predicted with current scientific capabilities. However, advances in seismology allow for the development of probabilistic forecasts. Historical records indicate that Puerto Rico has experienced four major destructive earthquakes since 1670—specifically in 1670, 1787, 1867, and 1918. This sequence suggests a recurrence interval ranging from 51 to 117 years, with an average interval of approximately 83 years for significant events. It is important to note, however, that each of these earthquakes originated on different fault systems; therefore, this record alone cannot be used to establish a precise recurrence rate.

For more comprehensive analyses, geologic maps of specific zones are examined to identify active faults and other relevant structural features. These datasets are then correlated with historical earthquake intensity distributions, seismic attenuation models, and statistical records. This integrated approach produces maps of seismically active areas that delineate regions with varying potential for strong earthquake activity. Identifying these high-risk zones is essential for informed land-use planning and effective emergency preparedness.

In the case of Puerto Rico, the PRSN cites a probabilistic seismic hazard study conducted in 1987 by Dr. William McCann, which estimated a 33–50% probability of a strong earthquake (Intensity VII or higher on the Modified Mercalli Scale) occurring in various parts of the island within a 50-year period (PRSN, 2025).

Further research conducted by the U.S. Geological Survey in 2003 identified an area west–southwest of Puerto Rico as the region most likely to experience strong earthquakes on the island (Figure 1). This probabilistic analysis does not account for secondary hazards such as tsunamis, liquefaction, or seismic wave amplification, which predominantly affect low-lying coastal areas and high-elevation zones susceptible to landslides.

### 4.6.2 Risk Analysis (B2-a, B2-b)

#### *4.6.2.1 Estimated Loses*

The Federal Emergency Management Agency's HAZUS Earthquake Analysis provides estimates of Annualized Earthquake Losses defined as the long-term average annual economic impact of earthquakes on the general building stock within a given geographic area as well as annualized estimates of population loss.

The Annualized Earthquake Loss is calculated using the Riemann Sums Method, which averages the annual losses associated with multiple return periods and then multiplies each average loss by its corresponding differential probability to produce a single loss estimate for each Census tract. (FEMA, National Risk Index Data - Technical Documentation, 2025)

Table 20 presents the exposure to earthquake hazards. It is important to note that, although assigning an exact monetary value to human life is inherently complex, FEMA guidance converts population loss into an economic estimate using a "population equivalence" methodology based on the Value of Statistical Life (VSL). Under this approach, each fatality—or the equivalent of ten injuries—is assigned an economic loss value of $1.37 million, reflecting FEMA's inflation-adjusted VSL estimate. All historical loss figures are subsequently adjusted to December 2024 dollars to account for inflation.

The HAZUS 6.1 analysis indicates that the municipality's total exposure to an earthquake event is $356,286,682,00. This estimate includes $3,345,082,000 in building value exposure and $352,941,600,000 in population exposure.

*Table 20: Exposure to Earthquake Hazard*

| Exposure - Impacted Area (sq mi) | Exposure - Building Value | Exposure - Population | Exposure - Population Equivalence | Exposure - Total |
|---|---|---|---|---|
| 55.81 | $3,345,082,000 | 30,426 | $352,941,600,000 | $356,286,682,000 |

The expected annual loss for each Census tract or jurisdiction represents the average yearly economic impact, expressed in dollars, anticipated from natural hazard events. Table 21 presents the expected annual earthquake-related losses for both buildings

and population.

*Table 21: Expected Annual Loss to Earthquake*

| Expected Annual Loss - Building Value | Expected Annual Loss - Population | Expected Annual Loss - Population Equivalence | Expected Annual Loss -Total |
|---|---|---|---|
| $2,041,244.30 | 0.1459 | $1,692,253.11 | $3,733,497.41 |

#### 4.6.2.2 Lifelines and Critical Infrastructure

Earthquakes can affect a community's lifelines in the following ways:

- Safety and Security – An earthquake can cause the structural failure of critical facilities such as police stations and fire stations, generate increased demand for search-and-rescue operations, and result in population displacement requiring emergency sheltering. Such conditions may also create challenges in maintaining public order and ensuring community security.

- Food, Hydration, and Shelter – A seismic event can cause damage to water treatment plants and distribution systems, resulting in contamination or loss of potable water. Disruptions to transportation routes and storage facilities may also interrupt food supply chains. Widespread structural damage can increase the demand for temporary shelters. Additionally, the loss of refrigeration capacity may lead to significant spoilage of perishable goods.

- Health and Medicine - Hospitals and clinics may experience structural damage or a reduction in operational capacity during an earthquake. A surge in injuries requiring emergency medical attention can overwhelm existing healthcare facilities. Disruptions to pharmaceutical supply chains and medical logistics may also occur. Additionally, compromised sanitation conditions in emergency shelters can elevate the risk of disease outbreaks.

- Energy - Damage to power plants, substations, and transmission lines can result in widespread power outages. Ruptures in gas lines may create fire and explosion hazards. Interruptions in the fuel supply chain can also impede the operation of generators and emergency response vehicles.

- Communications - Damage to cell towers, fiber-optic cables, and communication hubs can result in significant loss of connectivity. Emergency call surges may overload telecommunications networks, further degrading service availability. These disruptions can impair coordination among emergency response agencies and hinder the timely dissemination of critical information.

- Transportation - Collapse or severe damage to roads, bridges, and tunnels can significantly restrict mobility. Airports and seaports may become inoperable due to damage to runways or docks. Rail systems, including the Tren Urbano, may also be disrupted because of track deformation or landslides.

- Hazardous Materials – An earthquake may cause spills from industrial facilities, chemical plants, or storage tanks, increasing the risk of environmental contamination affecting air, soil, and water resources. Additionally, damage to sites containing hazardous materials may result in fires or explosions.

- Water Systems - Breakage of water mains and sewer lines can result in localized flooding and contamination. Such damage may also reduce firefighting capacity due to diminished water pressure and lead to long-term disruptions in wastewater collection and sanitation services.

Maps 17 and 18 show the identified critical infrastructure location in respect to the spectral acceleration areas previously identified

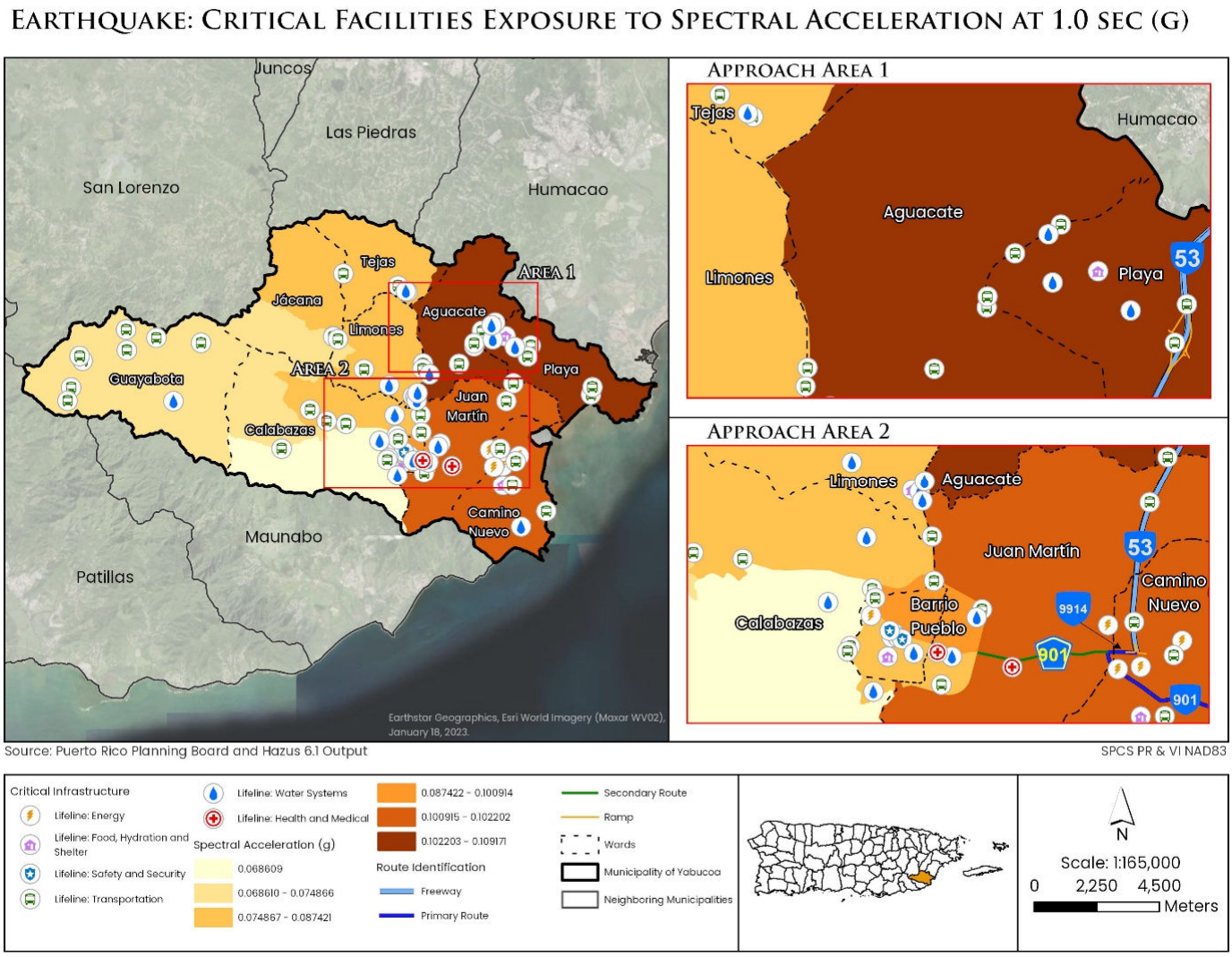
These map shows that critical facilities that are located in the areas of high spectral acceleration are the ones located in the Comunas and nearby development in the western section of Playa Ward.

**Yabucoa Port and Petroleum Storage Facility**

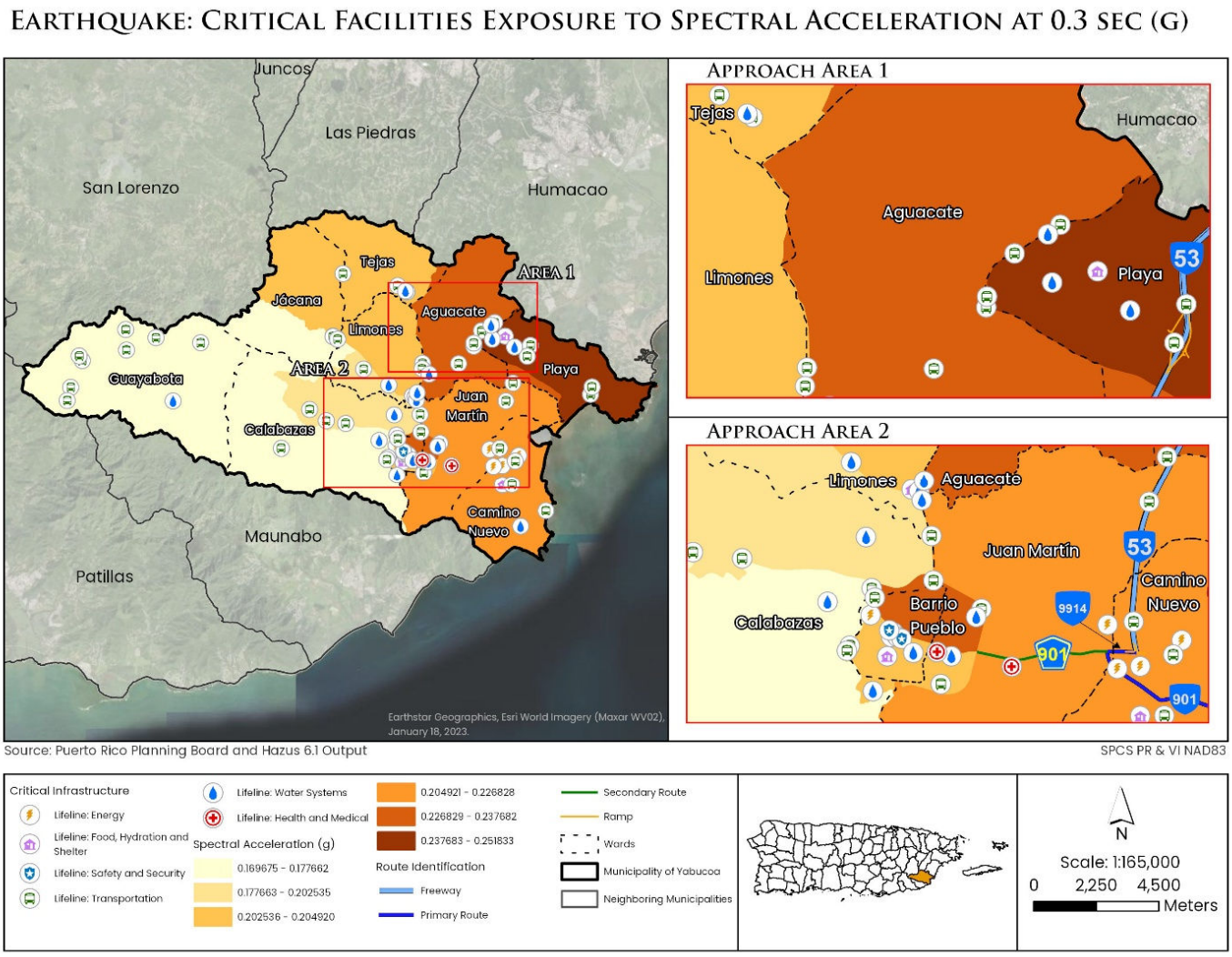
An earthquake could significantly impact the Port of Yabucoa by causing structural damage to docks, pipelines, and loading systems that are essential for fuel transfer operations. Ground shaking may compromise the integrity of oil storage tanks, leading to potential leaks or catastrophic failure, especially if older infrastructure is present. Additionally, soil instability or liquefaction in coastal areas could further damage foundations and disrupt port functionality. Such impacts would interrupt fuel supply chains and create environmental risks due to possible spills.

The port of Yabucoa is in a high to moderate area of spectral acceleration in comparison with the rest of the municipality.

*Map 16: Earthquake Critical Facilities Exposure to Spectral Acceleration at 1.0 sec*



*Map 17: Earthquake - Critical Facilities exposure to spectral acceleration at 0.3 sec*




### *4.6.2.3 Social Vulnerabilities*

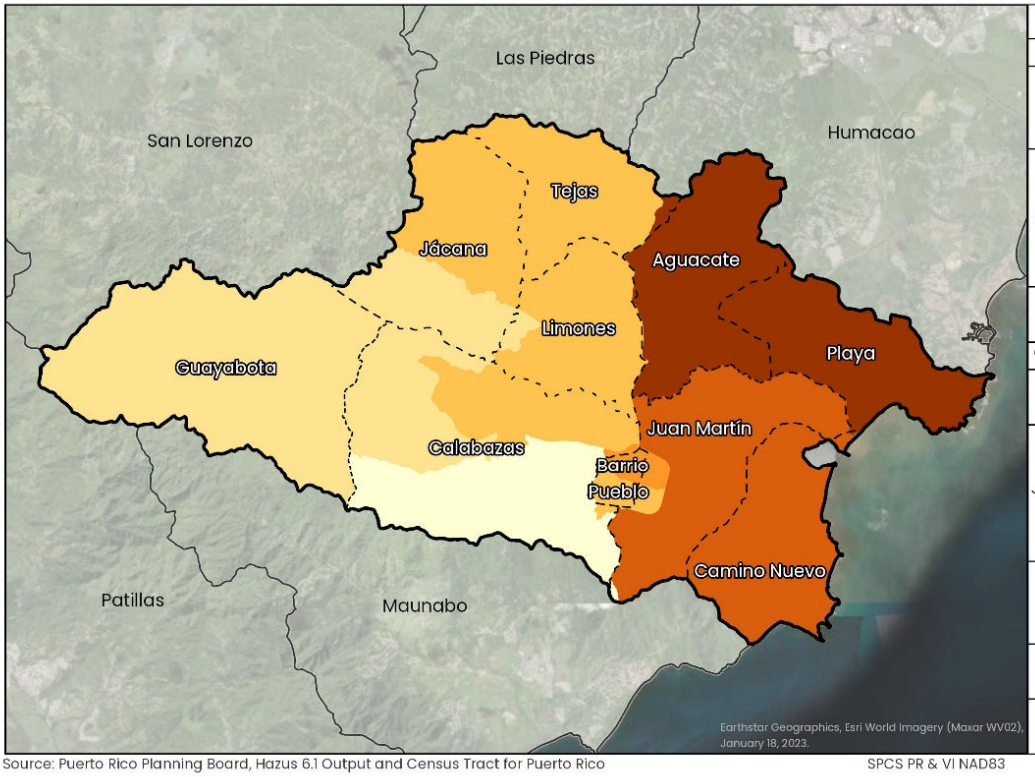
Social vulnerability to earthquakes in Puerto Rico is shaped by high levels of poverty, aging infrastructure, and limited access to essential resources, all of which disproportionately affect the ability of communities to withstand and recover from seismic events. Many residents face compounding disadvantages—such as disability, low educational attainment, and limited vehicle access—that reduce their capacity to evacuate, access information, or secure aid after a damaging earthquake. Research on disaster governance also shows that systemic governmental neglect and energy insecurity intensify the impacts of disasters, leaving communities with fewer resilience

mechanisms in the aftermath of earthquakes.

Puerto Rico's disaster research literature identifies long-standing structural inequities that heighten vulnerability, including political and economic marginalization that limit long-term recovery and exacerbate risk accumulation across hazard types. Federal assessments further find that many census tracts exhibit high social vulnerability scores (US Census Bureau, 2024), (US Census Bureau, 2025), meaning that an earthquake's impacts are likely to intersect with broader socio-economic fragility. Overall, these combined factors demonstrate that earthquakes in Puerto Rico pose not only a physical hazard but also a deep social challenge tied to historical, economic, and infrastructural conditions that shape uneven disaster outcomes. For more details about Social Vulnerabilities see section 3.4.4. Maps 19 and 20 show the population affected by range of spectral acceleration for both a 0.3 and 1.0 sec scenarios.

*Map 18: Earthquake: Population Exposed to Spectral Acceleration at 1.0 (g) sec*

## Earthquake: Population Exposure to Spectral Acceleration at 1.0 sec (g)




| Wards | Risk Category | Population |
|---|---|---|
| Aguacate | Extreme | 2,231 |
| Barrio Pueblo | Very Low | 15 |
| | Very High | 901 |
| | Medium | 1,065 |
| Calabazas | Low | 861 |
| | Very Low | 2,891 |
| | Medium | 2,356 |
| | Very High | 182 |
| | Medium | 199 |
| Camino Nuevo | Very High | 1,656 |
| Guayabota | Low | 2,928 |
| Jácana | Low | 615 |
| | Medium | 1,512 |
| Juan Martín | Extreme | 6 |
| | Very Low | 23 |
| | Very High | 1,938 |
| | High | 819 |
| | Medium | 630 |
| Limones | Extreme | 6 |
| | Low | 56 |
| | Medium | 2,075 |
| Playa | Extreme | 3,843 |
| | Very High | 18 |
| Tejas | Extreme | 47 |
| | Medium | 1,656 |

Source: Puerto Rico Planning Board, Hazus 6.1 Output and Census Tract for Puerto Rico

SPCS PR & VI NAD83

Spectral Acceleration (g)
- 0.068609 (Very Low)
- 0.068610 - 0.074866 (Low)
- 0.074867 - 0.087421 (Medium)
- 0.087422 - 0.100914 (High)
- 0.100915 - 0.102202 (Very High)
- 0.102203 - 0.109171 (Extreme)
- Wards
- Municipality of Yabucoa
- Neighboring Municipalities

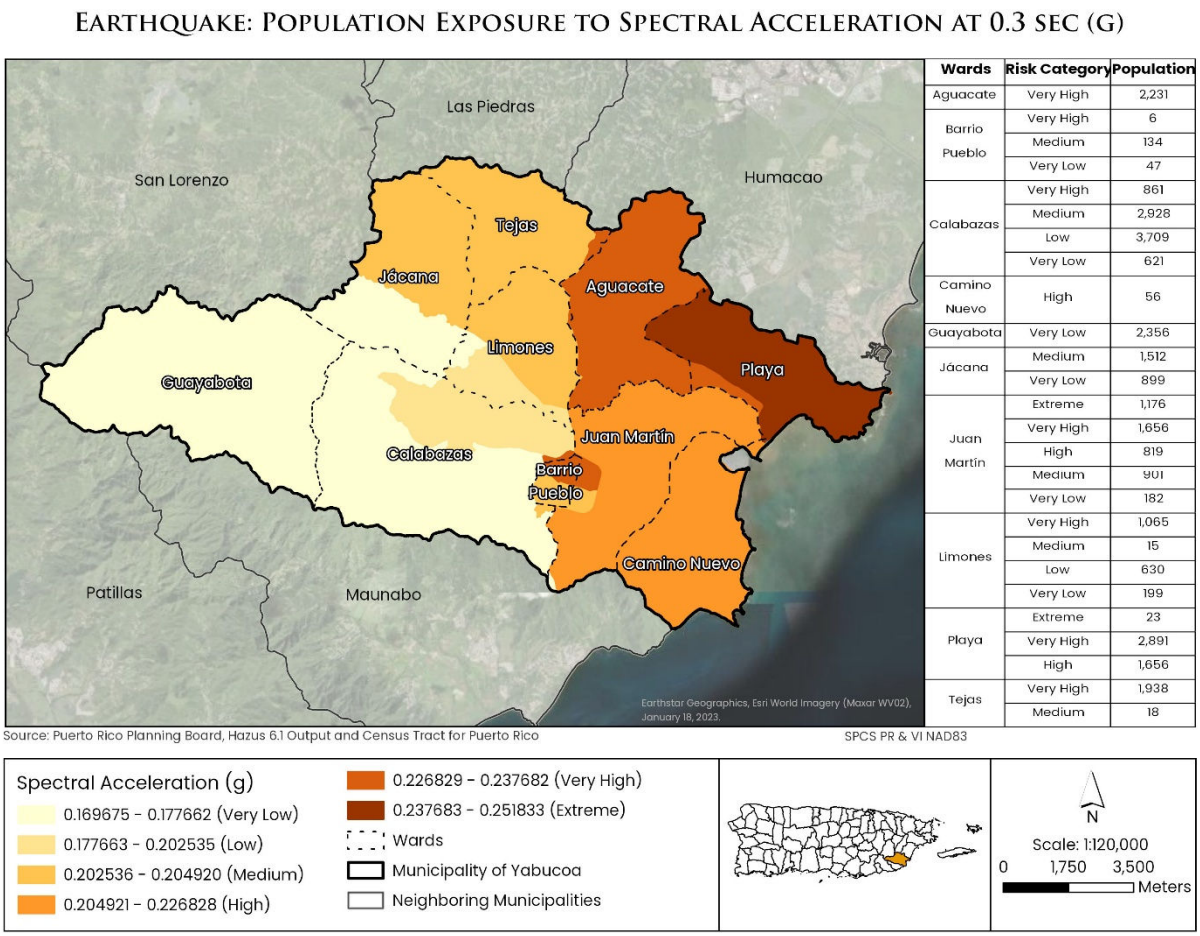


N

Scale: 1:120,000

0 1,750 3,500 Meters

*Map 19 Earthquake: Population Exposure to Spectral Acceleration at 0.3 sec (g)*




| Wards | Risk Category | Population |
|---|---|---|
| Aguacate | Very High | 2,231 |
| Barrio Pueblo | Very High | 6 |
| | Medium | 134 |
| | Very Low | 47 |
| Calabazas | Very High | 861 |
| | Medium | 2,928 |
| | Low | 3,709 |
| | Very Low | 621 |
| Camino Nuevo | High | 56 |
| Guayabota | Very Low | 2,356 |
| Jácana | Medium | 1,512 |
| | Very Low | 899 |
| Juan Martín | Extreme | 1,176 |
| | Very High | 1,656 |
| | High | 819 |
| | Medium | 901 |
| | Very Low | 182 |
| Limones | Very High | 1,065 |
| | Medium | 15 |
| | Low | 630 |
| | Very Low | 199 |
| Playa | Extreme | 23 |
| | Very High | 2,891 |
| | High | 1,656 |
| Tejas | Very High | 1,938 |
| | Medium | 18 |

### 4.6.2.4 Natural and Cultural Resources

Earthquakes can produce a wide range of impacts on natural and cultural resources:

- Landslides and Soil Instability: Seismic activity can trigger landslides, rockfalls, and soil liquefaction, altering natural landforms and damaging ecological habitats.
- Water Quality and Hydrology: Ground shaking may modify river pathways, impair aquifers, and increase sedimentation in water bodies, which can degrade water quality and disrupt aquatic ecosystems.
- Vegetation and Wildlife: Ground deformation and related secondary hazards such as flooding or fires can lead to habitat loss, fragmentation, and adverse

effects on biodiversity.

- Coastal and Marine Environments: Submarine earthquakes may generate tsunamis, resulting in coastal erosion, coral reef degradation, and the deterioration of marine and estuarine ecosystems.

While the following damage can happen to Cultural Resources:

- Seismic forces can cause significant structural damage or the complete collapse of heritage structures, archaeological sites, and monuments.
- Museums and Archives: Earthquakes may lead to the loss, damage, or deterioration of artifacts, archival materials, and collections due to structural failures or insufficient seismic protection.
- Community Identity and Tourism: Damage to culturally important sites can undermine community identity and reduce tourism activity, thereby affecting local economic stability.

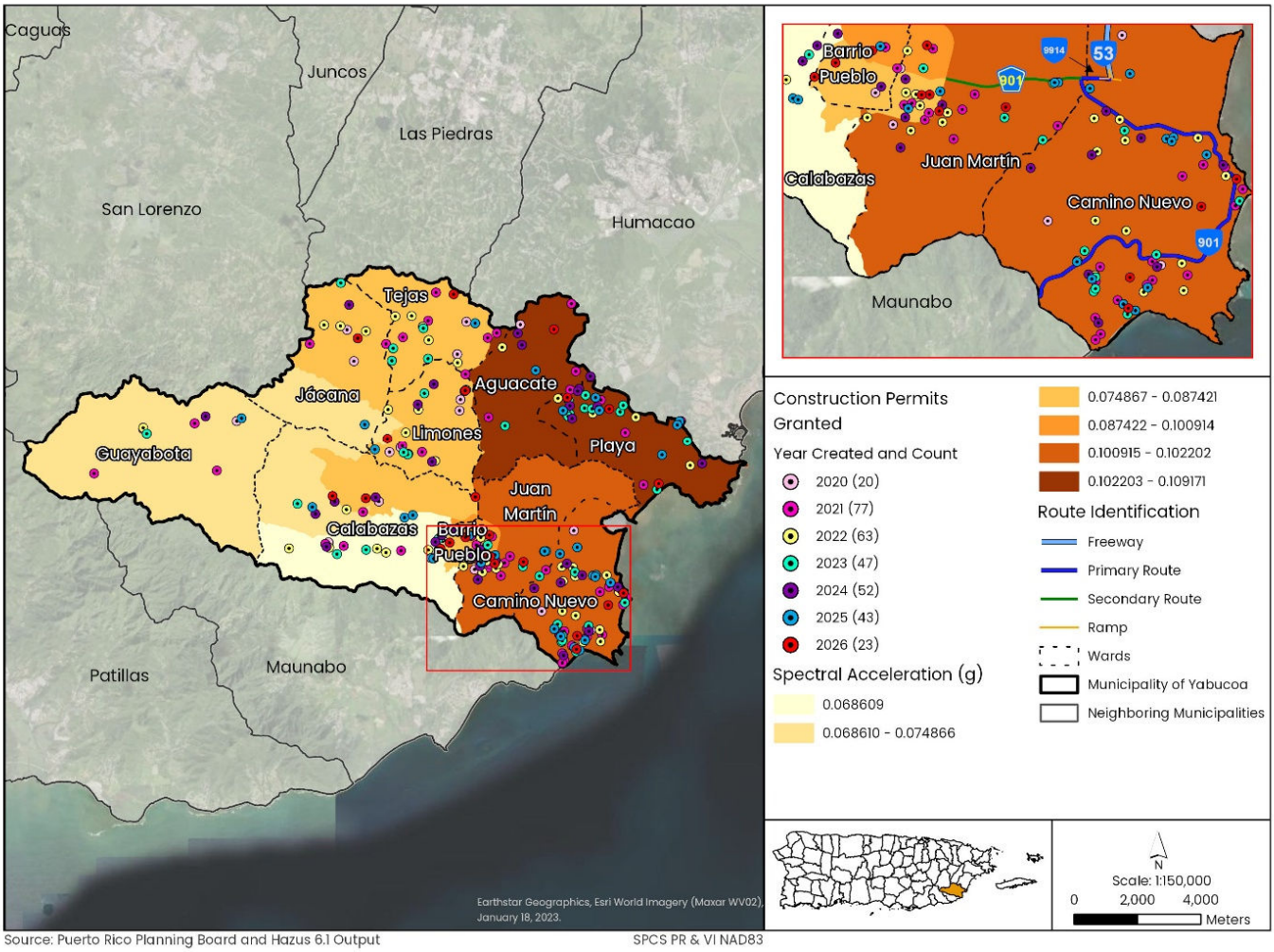
Cultural resources that could be affected by an earthquake include the ruins of the Roig Sugar Mill in the Guayanés River Valley.

#### *4.6.2.5 Future Conditions (E1-a)*

As discussed in Section 3.5, the elevated number of construction permits issued by the Municipality reflects a sustained level of economic activity. To further support this analysis, Maps 21 and 22 highlight the areas with the highest spectral acceleration values at 0.3 and 1.0 seconds alongside the distribution of authorized construction permits. As cab be seen in both maps there has been a large numbers of construction permits granted in the area of Comunas and adjacent development (Playa and Aguacate wards). Taken together, these findings indicate that future exposure to earthquake hazards is unlikely to diminish in the near term, as development continues to expand within zones of elevated seismic vulnerability.

*Map 20: Earthquake: Recent Development Exposure to Spectral Acceleration at 0.3 sec*

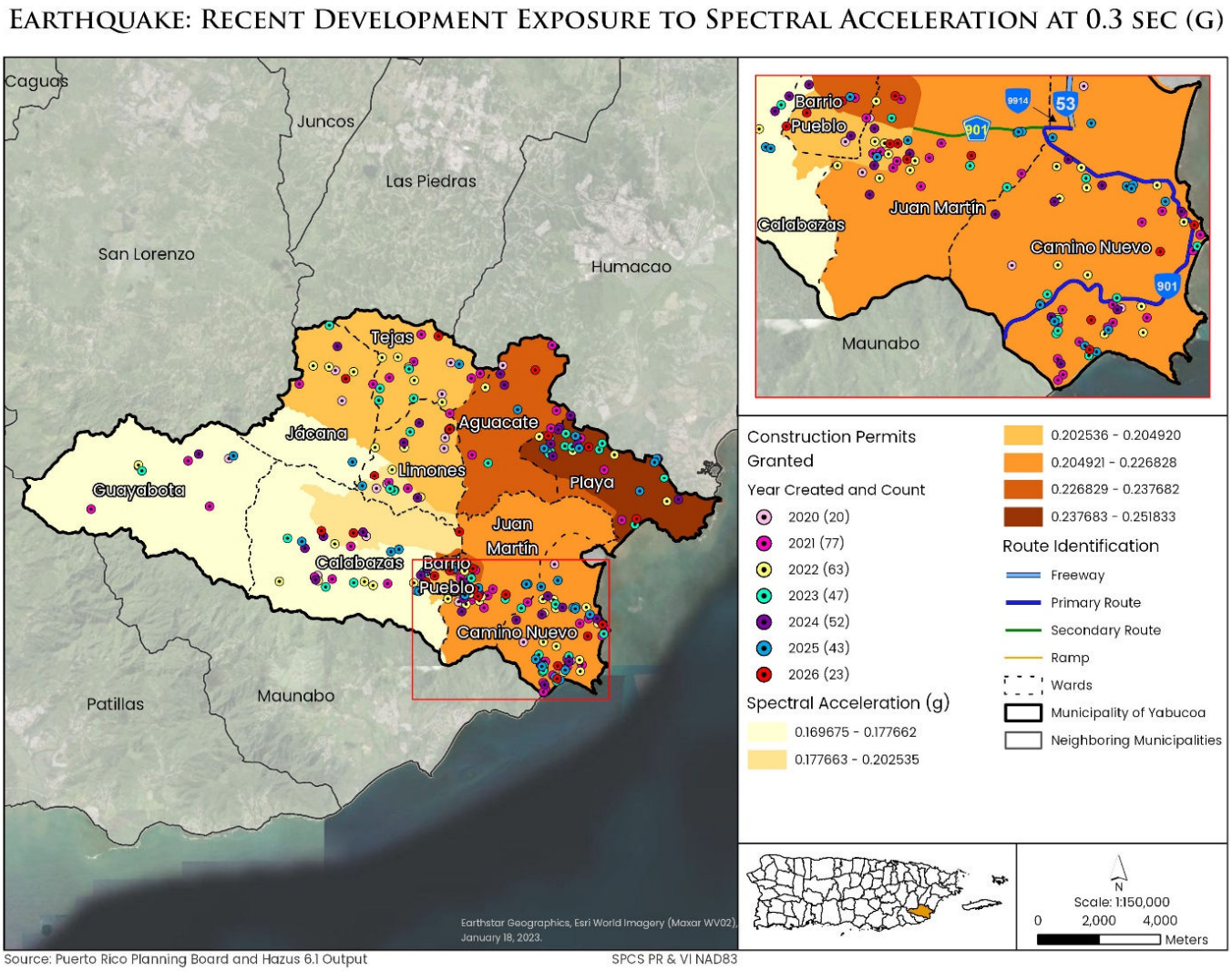
## Earthquake: Recent Development Exposure to Spectral Acceleration at 1.0 sec (g)




Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

*Map 21: Earthquake: Recent Development Exposure to Spectral Acceleration at 0.3 sec (g)*




## 4.7 Landslides

### 4.7.1 Description (B1-a)

Landslides are a natural geomorphological process characterized by the downslope movement of soil, rock, or debris due to terrain instability. These events occur when environmental conditions align such that gravitational forces acting on surface materials exceed their natural resistance. The term landslide encompasses multiple

types of ground displacement including rockfalls, slope failures, and debris flows, all of which pose significant risks to life and property. Such movements can obstruct transportation routes and carry with them vegetation, homes, bridges, vehicles, and other infrastructure, causing extensive disruption and damage (FEMA, 1997).
Prolonged and intense rainfall associated with meteorological systems such as tropical waves, troughs, and tropical cyclones is one of the primary triggers of landslide events. Additionally, population growth and the expansion of informal construction increase the municipality's exposure to landslide hazards. Potable water supply and wastewater systems including sanitary pipes, septic tanks, and storm sewers whether properly authorized or informally installed, can further exacerbate slope instability. The likelihood of landslides rises significantly when these systems leak or are inadequately sited or constructed (USGS, n.d.).

Multiple factors contribute to the development of landslides, including soil type, terrain slope, degree of soil saturation, erosion processes, the presence of depressions or subsurface voids, human activities, and seismic events. The Building Performance Assessment Report (BPAR) prepared after Hurricane Georges warns that "landslides will become a major problem in the future as more houses are built and more development occurs in areas susceptible to these risks." This observation underscores the increasing vulnerability associated with continued development in high-risk zones (FEMA, 1997).

Many landslides in Puerto Rico fall into a specific subtype known as debris flows. These events typically occur in mountainous areas with steep slopes during periods of intense rainfall. As rainwater infiltrates the ground, the soil becomes saturated and the underlying subsurface layer loses its cohesion. This loss of stability causes the material to detach often at the interface where the subsurface meets the bedrock resulting in a rapid downslope flow of soil, rock, and water.

There are many types of landslides; however, those specifically linked to water-saturated soils include the following (PREMB, 2021):

- Slow Landslide: A gradual and sustained downslope movement of soil or rock. These events are often identifiable by displaced tree trunks, distorted or twisted fences and retaining walls, and leaning posts or structures.
- Debris Flow: A rapid mass movement in which loose soil, rocks, and organic material combine with infiltrated water and air to form a dense, viscous flow that travels swiftly down a hillside.
- Debris Avalanche: An extremely rapid or very fast-moving form of debris flow,

characterized by high velocity and significant destructive potential.
- Mudflow: A fast-moving mass composed of water-saturated material containing at least 50 percent sand, silt, and clay particles.

#### 4.7.1.1 Affected Area (B1-B)

The areas most affected by landslides in the Municipality of Yabucoa are primarily located in its mountainous region, which dominates much of the municipal territory. The municipality's topography is divided into two main zones: a mountainous interior, formed by the continuation of the central and eastern mountain ranges, and alluvial valleys, such as the one that hosts the Yabucoa Agricultural Reserve. Because the mountainous terrain occupies a large portion of the land, it significantly increases susceptibility to slope instability and landslide events.

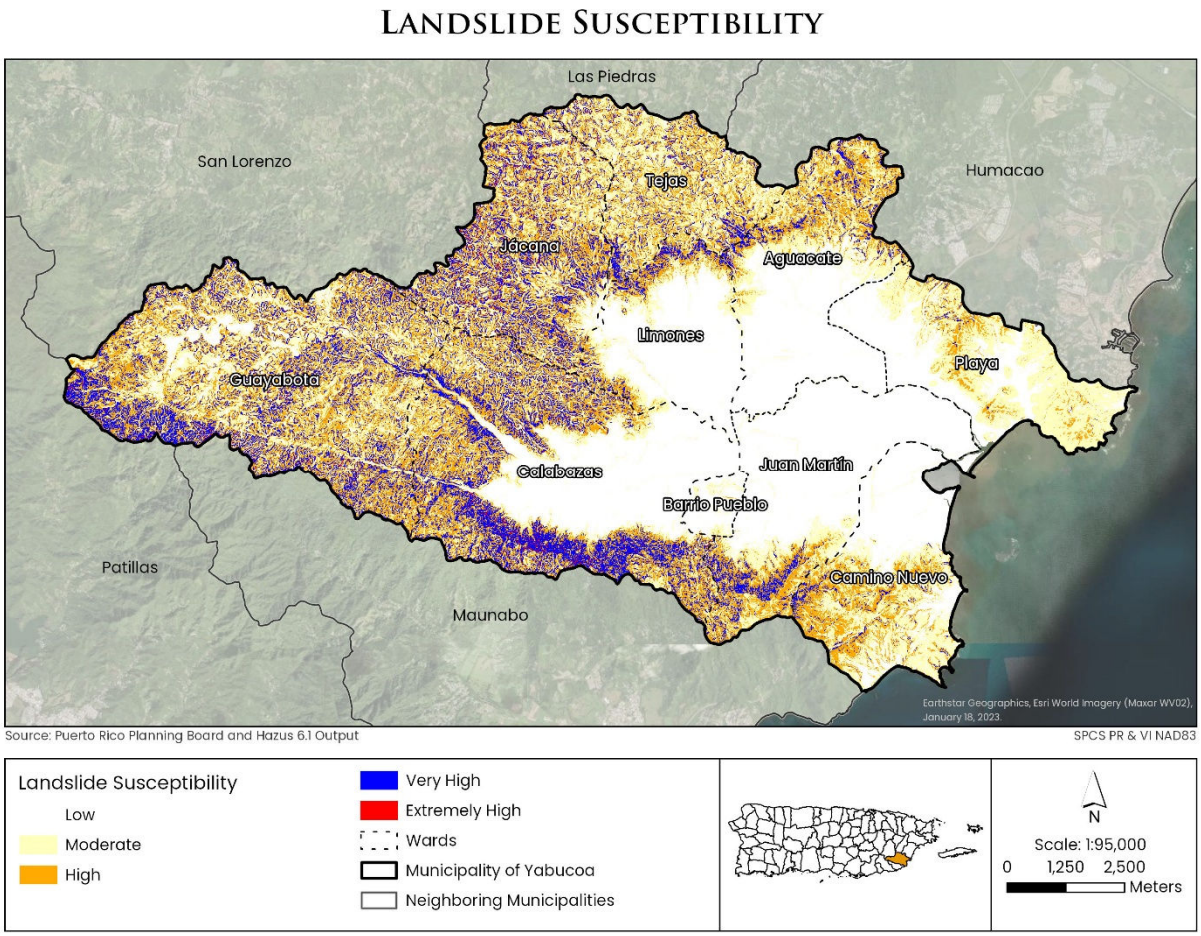
The 2020 Yabucoa Hazard Mitigation Plan indicates that nearly all neighborhoods in Yabucoa, with the exception of Pueblo, contain areas with at least a moderate probability of landslides (PRPB, 2020). This widespread exposure is directly related to the steep slopes, soil composition, and drainage conditions characteristic of the mountainous zone, which make the terrain more vulnerable to mass movement, especially during periods of intense rainfall.

According to USGS data, more than 200 individual landslides were identified in the aftermath of Hurricane María (Hughes, Bayouth García, Martínez Milian, Schulz, & Baum, 2019). Most of these landslides occurred in Guayabota, Jácana, Calabazas, or Tejas neighborhoods. Hurricane María was particularly impactful due to the overwhelming volume of precipitation delivered on site, which exacerbated local conditions such as soil stability, slope gradient and anthropogenic impact. Scientific research points to a strong correlation and causal relationship between the location of a roadway and the occurrence of landslides (Larsen & Park, 1997) (Larsen & Torres-Sanchez, 1998). Most of the landslides that have occurred in the municipality were located near, or adjacent to, roadways.

In summary, landslides in Yabucoa are most prevalent in mountainous area, particularly Guayabota, Jácana, Calabazas, and Tejas, due to steep terrain, soil saturation, and the effects of extreme weather events such as Hurricane María.

As it can be seen from Map 23, particular attention should be paid to the area of the south of Calabazas and Juan Martín wards where the steep formation of the Sierra de la Pandura increases the likelihood of landslides.

*Map 22: Landslide Susceptibility*




### 4.7.1.2 Risk Magnitude (B1-C)

Landslides typically occur in steep, mountainous areas during periods of intense or prolonged rainfall. As water infiltrates the ground, the soil becomes saturated, weakening natural drainage systems and reducing the structural capacity of the terrain, which can ultimately lead to slope failure. Certain areas are inherently more susceptible to landslides than others, particularly those with greater slope gradients. Vegetation plays a critical role in maintaining soil cohesion and reducing surface erosion; therefore, slopes lacking vegetation are generally more prone to instability.

Slope stability is influenced by several factors, including elevation, steepness, vegetative cover, and underlying geology. In general, increases in slope height and inclination correlate with a greater likelihood of terrain instability. Below are key factors

that contribute to the occurrence of landslides:

- The base of inclined slopes
- Areas near small depressions where drainage converges
- The lower portion of slopes is composed of fill - material
- The base or crest of a very steep slope
- Locations with a history of previous landslides
- Hillsides that have been developed and where septic systems are present
- Steep slopes underlain by clay-rich soils
- Hills or slopes with inclinations greater than 12 degrees and elevations exceeding 300 meters

The hazard categories are derived from the USGS classification index, which evaluates slope and soil characteristics as defined by the agency. Table 14 outlines these categories—low, moderate, high, and very high—and describes the corresponding levels of hazard.

*Table 22: Landslide Risk Categories*

| Category | Description |
|---|---|
| Low | Areas with minimal slopes and stable soil; landslides are unlikely except under extreme conditions. |
| Moderate | Areas with some susceptibility; landslides may occur during prolonged or intense rainfall. |
| High | Areas with significant susceptibility; landslides are likely during heavy rain or seismic activity. |
| Very High | Areas extremely prone to landslides; frequent events during storms or earthquakes. |

The municipality incorporates landslide prevention and mitigation measures as an integral component of its earthquake response protocol.

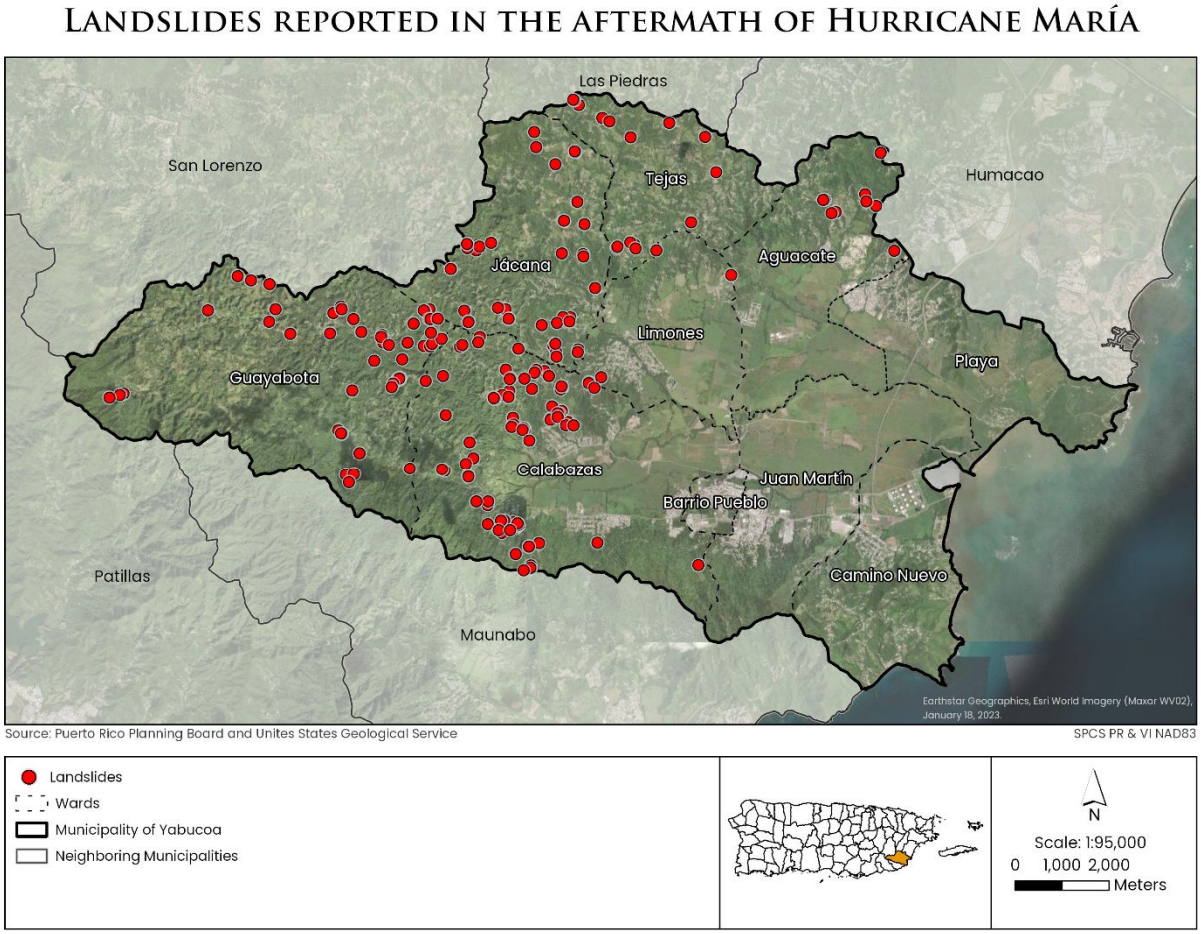
#### *4.7.1.3 Past Events*

As noted earlier, landslides are frequently associated with heavy rainfall events. Map 24 illustrates the landslides reported following Hurricane María in 2017, which align with the areas of greatest susceptibility shown in the map. Landslides are often connected to rain events and the prevalence of roadways (Larsen & Park, 1997) (Larsen & Torres-Sanchez, 1998). According to data from the U.S. Geological Survey (USGS), more than

200 individual landslides were identified following Hurricane María (Hughes, Bayouth García, Martínez Milian, Schulz, & Baum, 2019).

As expected, the more mountainous western half of the municipality experienced the most landslides following the areas of highest susceptibility as shown in section 4.6.1.1.

*Map 23: Landslides Reported in the Aftermath of Hurricane María*

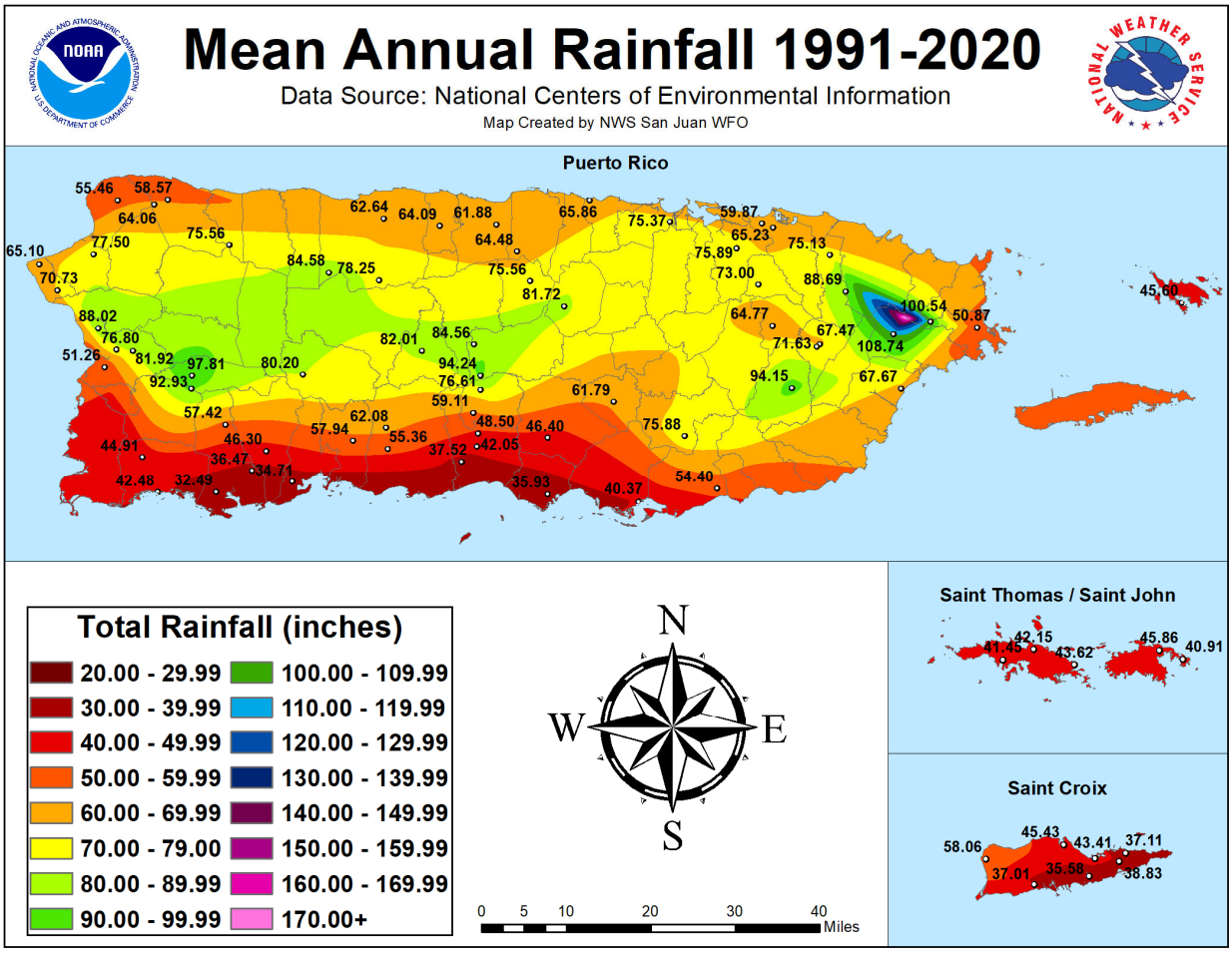



### 4.7.1.4 Future Event Probabilities

Although landslides can also result from earthquakes or human activities, most landslides in Puerto Rico are triggered by rainfall. As previously discussed, these events can occur during any type of rain event. Figure 14 presents the Mean Annual Rainfall for Puerto Rico and the U.S. Virgin Islands from 1991 to 2020. The Municipality of Choose an item. lies entirely within a zone that receives between 70 and 79 inches of rainfall annually. Given these precipitation levels, landslides are expected to continue

occurring in the municipality.

*Figure 14: Mean Annual Rainfall 1991-2020 (PR & USVI)*[5]




## 4.7.2 Risk Analysis

### *4.7.2.1 Estimated Loses*

In the Municipality of Yabucoa , as in many other parts of Puerto Rico, landslides most often occur during or immediately after major storms that produce intense, prolonged rainfall. Rainfall-induced landslides are closely linked to severe weather systems or consecutive rain events that saturate steep and vulnerable soils.

At present, no standardized models exist to quantify structural or content losses

[5] Obtained from https://www.weather.gov/sju/climo_pr_usvi_normals

resulting from landslides or other mass-movement events. Consequently, USGS susceptibility indices were applied empirically using the best available data to estimate potential impacts from these hazards in Choose an item. . These indices classify risk into four levels: low, moderate, high, and very high. Due to data limitations, it is not currently possible to calculate monetary losses associated with building damage.

#### 4.7.2.2 Lifelines and Critical Infrastructure

Landslides can impact FEMA Lifelines in the following ways:

- Safety and Security: Landslides can trap and injure or kill individuals through rapidly moving debris, hinder rescue operations, and create life-safety risks when emergency services become isolated or damaged (Center for Disaster Resilient Communities, n.d.).

- Food, Hydration, and Shelter: Landslides can destroy homes and agricultural areas, resulting in displacement and increased food insecurity. They may also disrupt local water and sanitation systems, heightening contamination risks, especially within temporary shelter environments (IFRC, 2023).

- Health and Medicine: Landslides can cause direct injuries such as trauma or suffocation, while longer-term impacts may include outbreaks of waterborne and vector-borne diseases, as well as psychological distress and trauma among survivors (Center for Disaster Resilient Communities, n.d.).

- Energy: Landslides can severely damage power lines, electrical substations, and fuel supply infrastructure, resulting in widespread power outages that hinder both public services and emergency response operations.

- Communications: Damage to communication cables, fallen utility poles, and restricted access to telecommunications infrastructure can disrupt alert and warning systems, hinder coordination among emergency responders, and impair public information networks.

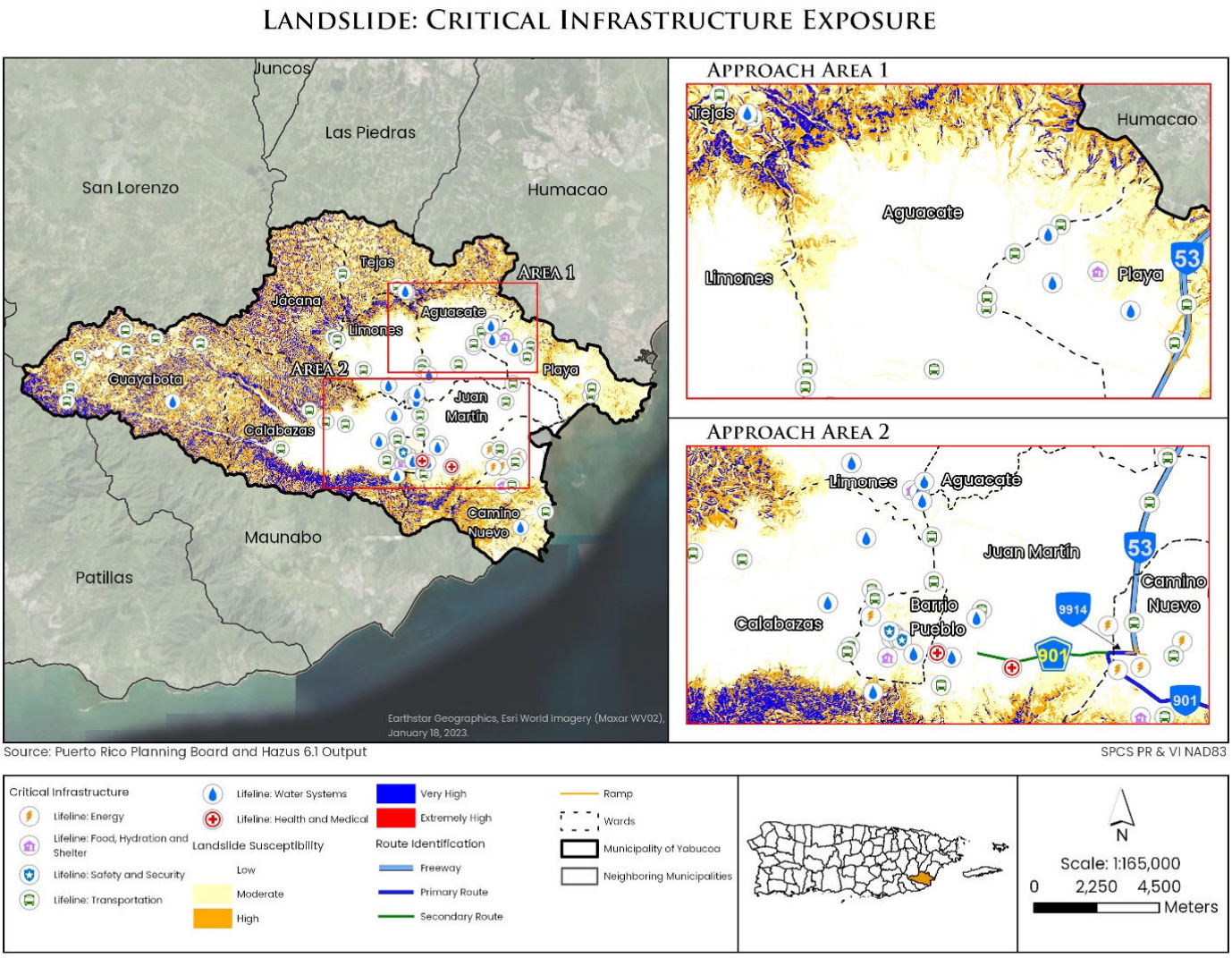
- Transportation: Landslides can render roads, railways, bridges, and tunnels impassable or destroy them entirely as debris obstructs critical routes, severely limiting mobility for the public and restricting access for emergency response services.

- Hazardous Materials: Landslides can rupture containment structures, pipelines, storage tanks, or industrial facilities, leading to the release of hazardous chemicals or pollutants and potentially triggering HAZMAT emergencies (FEMA, 2024).

- Water Systems: Landslides can damage water intakes, treatment plants, distribution lines, and wastewater collection and treatment facilities, leading to contamination, reduced water pressure, and significant service interruptions (IFRC, 2023).

Map 25 shows the identified critical infrastructure that could be affected by Landslides. As this map shows most of the critical infrastructure is not in areas of high susceptibility to landslide.

*Map 24: Landslide: Critical Infrastructure Exposure*




### 4.7.2.3 Social Vulnerabilities

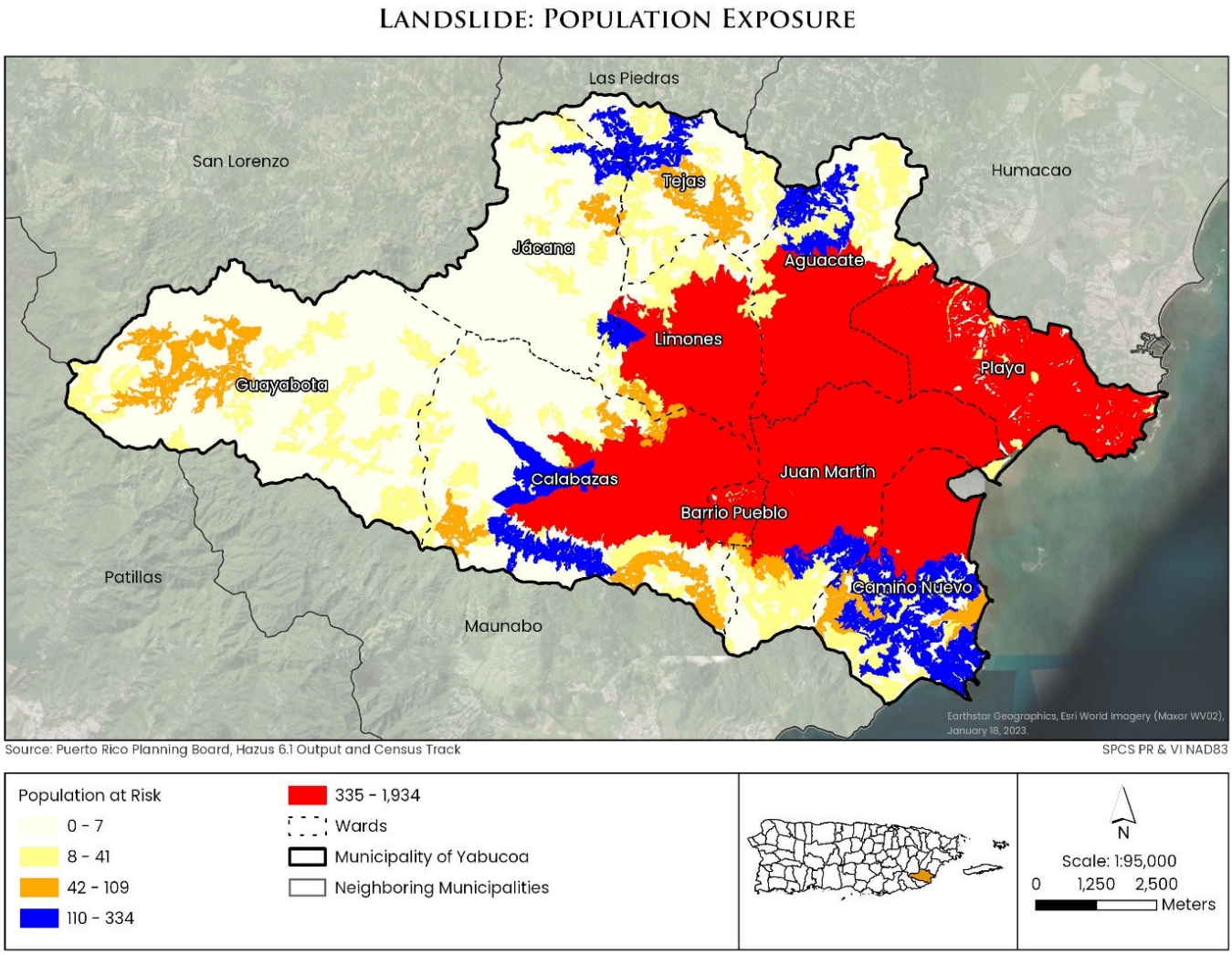
Social vulnerability to landslides in Puerto Rico is the product of topography, poverty, aging populations, fragile infrastructure, and geographic isolation, all of which shape the severity of impacts after major storms or seismic events. Academic and federal analyses consistently show that landslides disproportionately burden communities that already struggle with access to transportation, healthcare, income stability, and emergency response. Addressing these vulnerabilities requires hazard mitigation strategies that integrate geospatial risk analysis, social vulnerability indicators, community-based planning, and infrastructure reinforcement tailored to rural and mountainous municipalities (West, Rodríguez Cruz, & Hughes, 2023).

As discussed earlier, a significant portion of Yabucoa's population is considered vulnerable. Of particular concern, rural residents often depend on a single road that can be destroyed or blocked by slope failures, isolating entire communities. Of particular concern, rural residents often depend on a single road that can be destroyed or blocked by slope failures, isolating entire communities. For example Road PR-182 and PR-900.

Focus groups on the other municipalities highlighted that landslides cut-off access to medical facilities, emergency response, and even water and food, sometimes for months. This situation can also happen in this municipality. This creates immediate life-threatening conditions for people with health conditions, mobility limitations, or emergency medical needs (West, Rodríguez Cruz, & Hughes, 2023).

Map 27 shows the total population exposed to the risk of landslide. It should be noted that the population exposed does not follow necessarily the areas of greater landslide susceptibility as those areas are not as densely populated.

*Map 26: Landslide Population Exposure*




### 4.7.2.4 Natural and Cultural Resources

Landslides are among the most destructive natural hazards, producing impacts that extend far beyond the immediate physical damage they cause (Eliot, Cloyd, & Philbin, 1994). Their effects on natural resources are profound and often irreversible. When a landslide occurs, vast areas of vegetation are uprooted or buried, leading to the loss of critical habitats and a decline in biodiversity. The displacement of soil not only strips away fertile layers essential for agriculture but also introduces large volumes of sediment into rivers and reservoirs. This sedimentation degrades water quality, disrupts aquatic ecosystems, and can compromise drinking water supplies. Furthermore, landslides frequently alter hydrological systems by blocking river

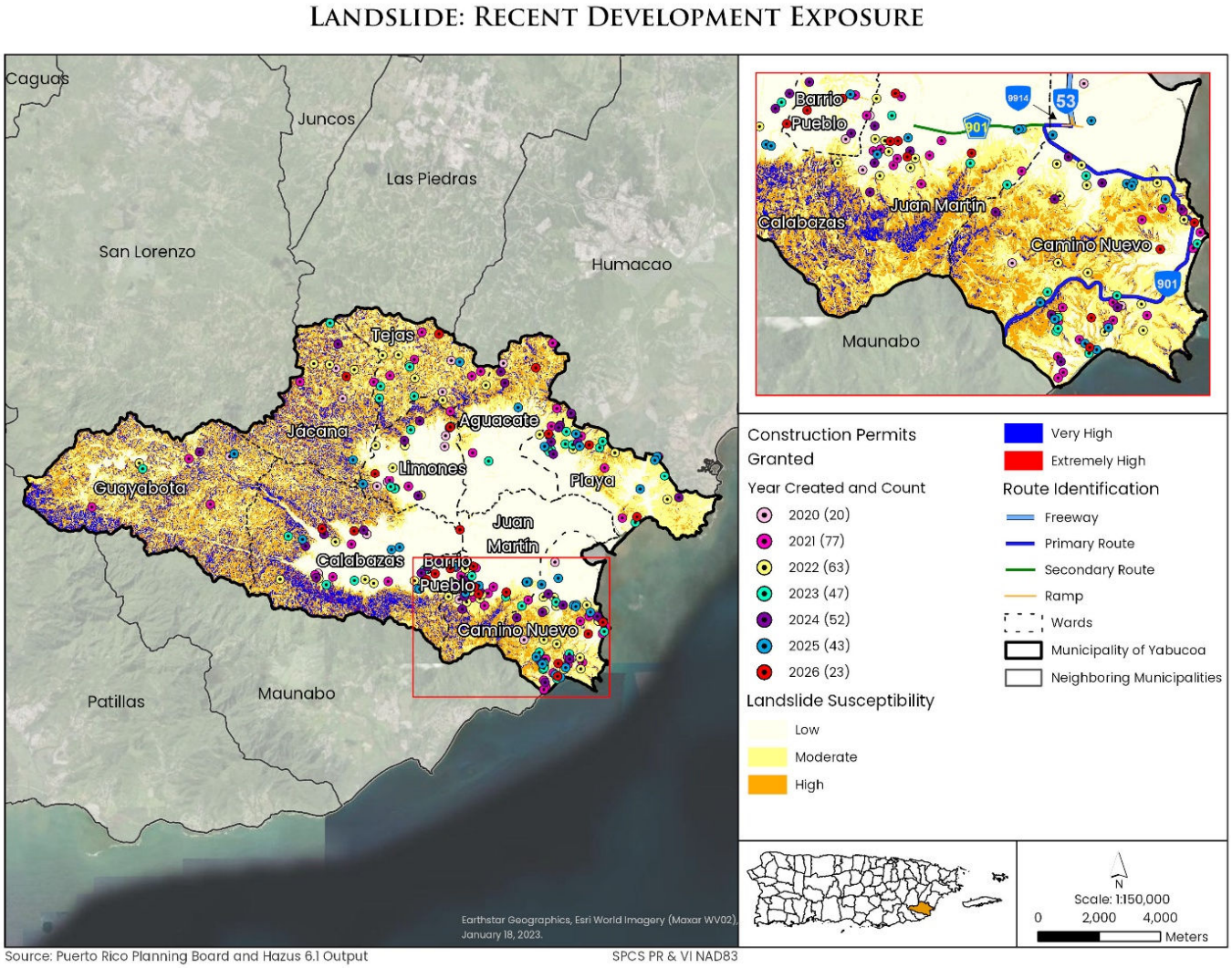
channels, creating temporary dams that increase flood risk and modify groundwater recharge patterns.

The cultural dimension of landslide impacts is equally significant. Archaeological sites, historic monuments, and culturally significant landscapes are highly vulnerable to burial or destruction during such events. These losses are irreplaceable, erasing tangible links to the past and diminishing cultural heritage. In many regions, landslides have damaged centuries-old structures, including churches, colonial buildings, and sacred sites, resulting in costly restoration efforts or permanent loss. Beyond physical damage, the alteration of cultural landscapes such as terraced fields or ceremonial grounds undermines community identity and traditions deeply tied to the land. Economically, these impacts ripple through local economies dependent on cultural tourism, reducing visitor numbers and income for communities that rely on heritage-based activities.

#### *4.7.2.5 Future Conditions (E1-a)*

As map 25 shows, most recent developments in the municipality have not occurred in the area of high susceptibility to landslides. The notable exception is the Camino Nuevo ward south of PR-901.

*Map 25: Landslide Recent Development Exposure*




## 4.8 Tsunami

### 4.8.1 Description (B1-a)

A tsunami, or tidal wave, is a series of waves typically caused by a vertical displacement of the ocean floor resulting from an underwater earthquake. Tsunamis can also be triggered by submarine landslides or volcanic eruptions in a specific region. The characteristics of a tsunami vary depending on whether the wave is moving through deep water or approaching the shore. In deep waters, these waves

can travel at speeds of up to 500 miles per hour and appear as low waves, generally less than one foot above sea level, often unnoticed by vessels at sea. The distance between wave crests is usually very wide. As the waves near coastal areas, their speed decreases significantly while their height increases dramatically because the wave frequency rises as its amplitude diminishes. This phenomenon can produce massive waves, sometimes exceeding 98 feet in height. However, tsunamis are often sudden, large surges in sea level along the coast, resembling a powerful tide rushing inland.

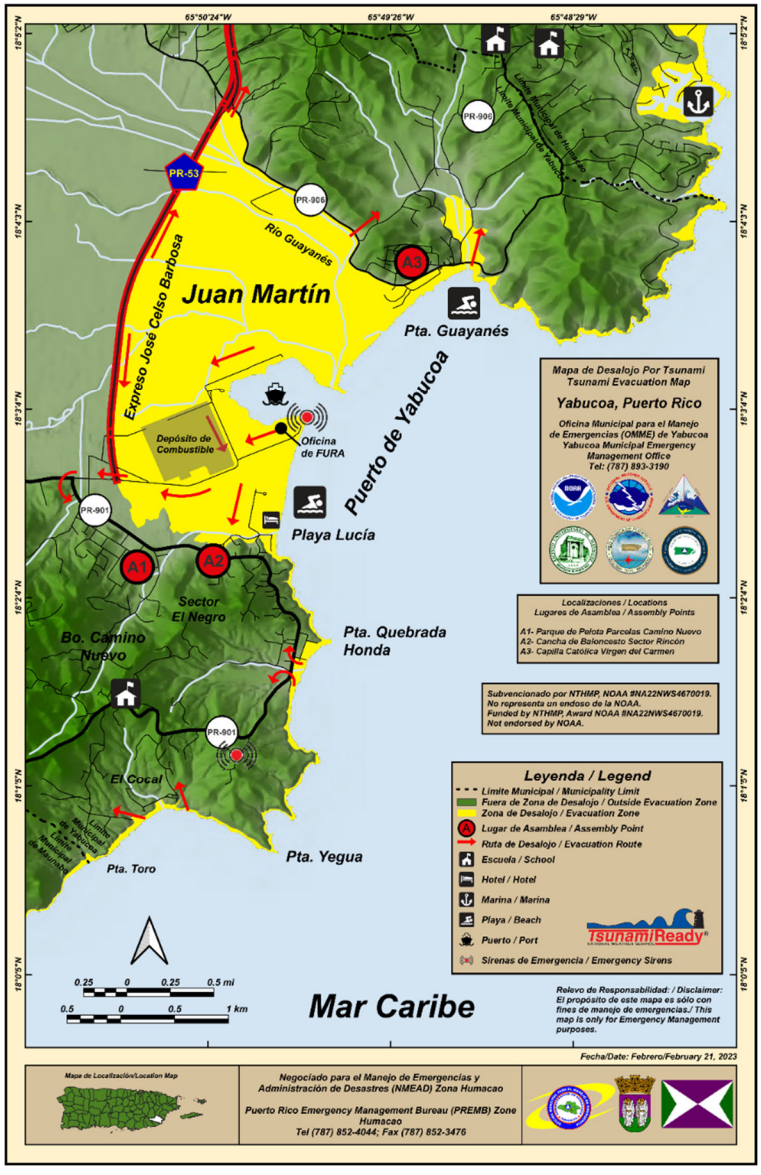
Additional warning signs may precede a tsunami. These include a noticeable retreat of the sea—where water recedes from the shore—or a rapid and excessive rise in coastal sea level. Typically, a loud roar from the ocean can be heard, similar to the sound of a low-flying aircraft. Other noises may occur as powerful waves crash against reefs, rocks, and objects dragged by the current.

Although tsunami hazards cannot be prevented, municipalities can implement mitigation measures through individual and collective preparedness, maintain alert systems to warn vulnerable communities, and ensure an effective response after such an event. In Puerto Rico, efforts have been coordinated under the National Tsunami Hazard Mitigation Program (NTHMP) at the University of Puerto Rico at Mayagüez (UPRM) and by UNESCO's IOCARIBE for regional areas. This program aims to reduce tsunami impacts through disaster assessment, alert messaging guidance, and mitigation strategies. NTHMP develops tsunami inundation maps, disseminates information through media for community drills, and promotes awareness of past events. Mitigation efforts include improving information dissemination, reducing risks, creating evacuation plans, producing educational materials, and implementing NOAA's Tsunami Ready Program, among other initiatives.

### 4.8.1.1 AFFECTED AREA (B1-B)

As Figure 15 shows the Tsunami Evacuation Map developed by PREMB and other partners[6]. In the event of a Tsunami, the areas most impacted will be the Camino Nuevo, Juan Martín and Playa wards. However, depending on the intensity and angle of approach of the Tsunami, the municipality's coastal morphology may act as a funnel, amplifying its impact. Figure 15 also shows the official tsunami evacuation routes.

*Figure 15: Yabucoa Tsunami Evacuation Map*




*Source: Puerto Rico Emergency Bureau*

### 4.8.1.2 RISK MAGNITUDE (B1-C)

Tsunami events rank among the most severe natural disasters. Among the hazards associated with a tsunami event are the following:

- Flooding of low-lying coastal areas: This occurs when tsunami waves penetrate inland, causing property destruction and fatalities due to drowning.
- Damage to coastal properties and buildings: Homes and structures located near the shoreline can suffer severe damage, rendering them uninhabitable. Additionally, these waves cause significant coastal erosion and undermine building foundations by washing away sand and soil, increasing their reach and force.

[6] NOAA, NWS, PRSN and University of Puerto Rico, Mayagüez

- Floating debris and large objects: A tsunami can carry debris or even large vessels inland, creating additional hazards and potentially causing major accidents and further tragedies.

Although this natural phenomenon moves slowly across the ocean, the force of a tsunami's waves can cause thousands of deaths and extensive property damage, including homes, critical facilities, and municipal infrastructure. If the disturbance originates near a coastal area, the tsunami can devastate the community within minutes (NOAA, n.d.). Developing and implementing an early warning system is essential to mitigate or reduce the impacts of such events. Likewise, it is critical that communities vulnerable to tsunamis are prepared to respond promptly and effectively once an alert is issued (NOAA, n.d.).

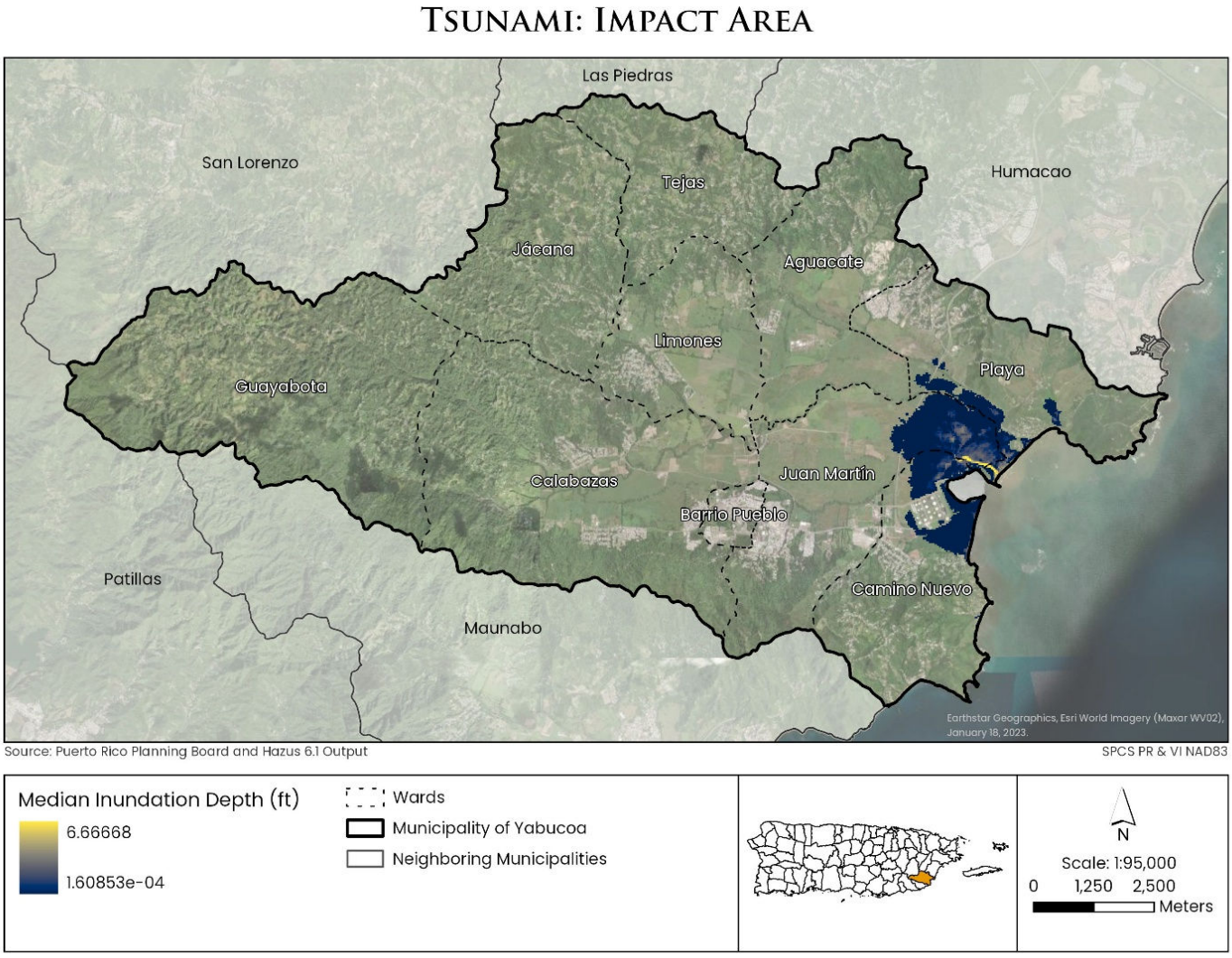
In 1995, the U.S. Congress designated NOAA to lead the National Tsunami Hazard Mitigation Program (NTHMP). This program represents a federal–state partnership that includes NOAA, FEMA, the U.S. Geological Survey, and 28 states and territories. Its primary goal is to reduce tsunami impacts on U.S. coasts through activities such as public education and awareness, community-level planning, risk assessments for specific areas, and guidance on tsunami alerts (NOAA, n.d.).

The TsunamiReady Program, created by NOAA's National Weather Service, aims to minimize loss of life and property from tsunamis and promote preparedness. In Puerto Rico, the Seismic Network (RSPR) manages funds for both the NTHMP and TsunamiReady Program, in coordination with the NWS Forecast Office in San Juan, FEMA, PREMB, Municipal Emergency Management Offices (OMMEs), and local communities.

Currently, 46 municipalities across the island participate in the TsunamiReady Program, including Yabucoa. The municipality of Yabucoa has a tsunami evacuation map and has TsunamiReady certification.

Maps 26 shows the modeled extent of the Tsunami in Yabucoa using HAZUS 6.0. This map shows that the Tsunami impact can be felt from Playa Santa Lucía to the south to Playa Guayanés to the north. According to the modeling the fuel storage at the Port of Yabucoa would be protected from a Tsunami. The map also shows that the Tsunami could reach a section of the bridge of PR-53.

*Map 26: Tsunami Impact Area*




### 4.8.1.3 PAST EVENTS (B1-D)

The following table show the most recent recorded Tsunami Events in Puerto Rico.

*Table 23: Tsunami events in Puerto Rico*

| Tsunami Event | Description |
|---|---|
| 1946 Tsunami | In Puerto Rico, the sea receded at Aguadilla (24 m) and Mayagüez (76 m) before returning as destructive |

| Tsunami Event | Description |
|---|---|
| | waves. The combined earthquake and tsunami resulted in 75 fatalities and left 20,000 people homeless. At San Juan, the tsunami was recorded on a tide gauge 35 minutes after the earthquake, following a second shock (Ms 7.9) nearly as strong as the August 4 quake but located about 100 km to the northwest. The waves were also detected at distant locations, with travel times of 2:02 hours to Bermuda, 4:02 to Daytona Beach, and 4:42 to Atlantic City (Lander, Whiteside, & Lockridge, 2002). |
| 1918 Tsunami | On October 11, 1918, Puerto Rico experienced one of the most powerful earthquakes in its history. Official reports indicate that 116 people lost their lives, and economic losses were estimated at $4 million—twice the island's annual budget at the time. The earthquake generated a tsunami that struck the island's western coast within minutes of the initial shaking. Waves reached heights of up to 20 feet, at the island's northwestern corner, appearing almost immediately after the quake. Approximately 40 of the fatalities were attributed to the tsunami itself (PRSN, 2025).<br><br>In all areas where the wave was observed, witnesses reported that the sea first receded, exposing reefs and sections of the seabed never seen before, even during the lowest tides. The water then surged back, reaching equally high levels. In some locations, |

| Tsunami Event | Description |
|---|---|
| | the large wave was followed by one or two smaller ones, and in enclosed bays, the water remained turbulent for some time. At Punta Borinquen in Aguadilla, the lighthouse keeper noted that the water began to recede during the earthquake and later rose to 15 feet. Near Punta Aguejereada, the wave reached between 18 and 20 feet, arriving 4 to 7 minutes after the quake. In Aguadilla, 32 people drowned, and nearly 300 beachside huts were destroyed. The tsunami reached Mayagüez about 20 minutes after the earthquake, with a height of approximately 5 feet (PRSN, 2025). |
| 1867 Tsunami | On November 18, an earthquake of magnitude 7.3 was felt strongly in the Virgin Islands and the eastern region of Puerto Rico. The epicenter was in the Anegada Passage, between the islands of St. Thomas, St. Croix, and Vieques. The resulting tsunami reached heights of nearly 20 feet in St. Thomas and St. Croix. At San Juan and Arroyo, water levels increased by approximately 0.9 to 1.5 meters, accompanied by significant wave activity near the Vieques Islands. In Fajardo, only a minor wave was documented, whereas in Yabucoa, a pronounced sea withdrawal occurred prior to a return surge that penetrated approximately 137 meters inland (Lander, Whiteside, & Lockridge, 2002). No fatalities were recorded (Castro Rivera, Proyecto 1867, n.d.). |

#### 4.8.1.4 Future event probabilities (B1-e)

The occurrence of a tsunami cannot be predicted, nor can its timing be determined with precision. However, because tsunamis are closely associated with seismic events such as earthquakes, their future likelihood depends on the probability of future seismic activity. Vulnerability studies have estimated a 33% to 50% probability of experiencing strong ground shaking (Modified Mercalli Intensity VII or higher) in different parts of the island within a 50-year period (PRSN, n.d.). Consequently, given that the areas of greatest seismic activity around Puerto Rico are located underwater to the northwest southeast and southwest of the island, it is plausible that the next significant earthquake could generate a tsunami.

Earthquakes and tsunamis are relatively infrequent phenomena, and not all earthquakes generate tsunamis. Nevertheless, when a major earthquake occurs beneath the ocean floor, the likelihood of a tsunami increases substantially. This implies that the probability of a tsunami is directly correlated with the probability of a strong earthquake, particularly in coastal areas. This probability serves as a key parameter for risk classification, based on historical records and contributions from planning committees and existing studies.

### 4.8.2 Risk Analysis (B2-a, B2-b)

#### 4.8.2.1 Estimated Loses

Table 24 presents Yabucoa's exposure to tsunamis, as registered in FEMA National Risk Index.

*Table 24: Tsunami Exposure*

| Exposure - Impacted Area (sq mi) | Exposure - Building Value | Exposure - Population | Exposure - Population Equivalence | Exposure - Total |
|---|---|---|---|---|
| 0.163711 | $ 109,692,370.11 | 250 | $ 2,905,447,087.21 | $3,015,139,457.32 |

The expected annual loss for each Census tract or jurisdiction represents the average yearly economic impact, expressed in dollars, anticipated from natural hazard events. Table 25 presents the expected annual tsunami-related losses for both buildings and

population.

*Table 25: Expected Annual Loss to Tsunami*

| Expected Annual Loss - Building Value | Expected Annual Loss - Population | Expected Annual Loss - Population Equivalence | Expected Annual Loss -Total |
|---|---|---|---|
| $0.00 | 0 | $0.00 | $0.00 |

#### 4.8.2.2 Critical Infrastructure and Lifelines

A tsunami event poses a severe and cascading threat to community functionality due to rapid onset, widespread inundation, strong currents, and extensive debris transport. Tsunamis can significantly disrupt all FEMA Community Lifelines, both immediately and over prolonged recovery periods. Lifeline impacts are often interdependent, creating compounding effects that hinder response, relief, and long-term recovery efforts (FEMA, 2021).

- The Safety and Security lifeline is critically compromised during tsunami events due to sudden flooding, debris, and limited evacuation time. Law enforcement, fire services, and emergency shelters may be damaged or rendered inaccessible by inundation or coastal erosion. Search and rescue operations are often required on a large scale, placing heavy strain on emergency responders while access routes are obstructed by debris, collapsed structures, or washed-out roadways. Additionally, damaged correctional facilities and disrupted communications can elevate secondary public safety risks (NOAA, n.d.).

- Tsunami impacts frequently contaminate potable water systems through saltwater intrusion, chemical releases, and damage to treatment facilities. Food distribution systems may be interrupted due to flooded warehouses, damaged ports, and loss of refrigeration. Housing stock in coastal and low-lying areas is particularly vulnerable; entire neighborhoods may be destroyed or declared uninhabitable due to structural damage or mold contamination. As a result, large, displaced populations require mass care, sheltering, and long-term housing solutions, significantly stressing local and regional resources (FEMA, 2020).

- Healthcare systems face immediate challenges following a tsunami, including physical damage to hospitals and clinics, loss of power, and limited access for patients and staff. Medical surges are common due to drowning, trauma, and exposure-related injuries. Public health risks increase as standing water and debris contribute to disease transmission, while ongoing disruptions to water and sanitation systems exacerbate health vulnerabilities. Long-term mental health impacts are also common among affected populations and first responders (FEMA, 2017; World Health Organization, 2019).

- Electrical substations, fuel storage facilities, and distribution infrastructure located in coastal or low-elevation areas are at high risk of inundation and corrosion damage during tsunami events. Power outages can persist for extended periods, affecting all other lifelines such as water treatment, healthcare delivery, telecommunications, and emergency operations. Fuel supply disruptions may hinder debris removal, emergency response, and generator operations, further delaying restoration efforts (FEMA, 2017).

- Tsunami waves and associated flooding can damage fiber-optic lines, cellular towers, and switching facilities, resulting in widespread loss of voice and data communications. These disruptions impair emergency notifications, situational awareness, interagency coordination, and public information dissemination. Communication outages during evacuation and response phases can significantly increase risk to life and complicate rescue operations (FEMA, 2020).

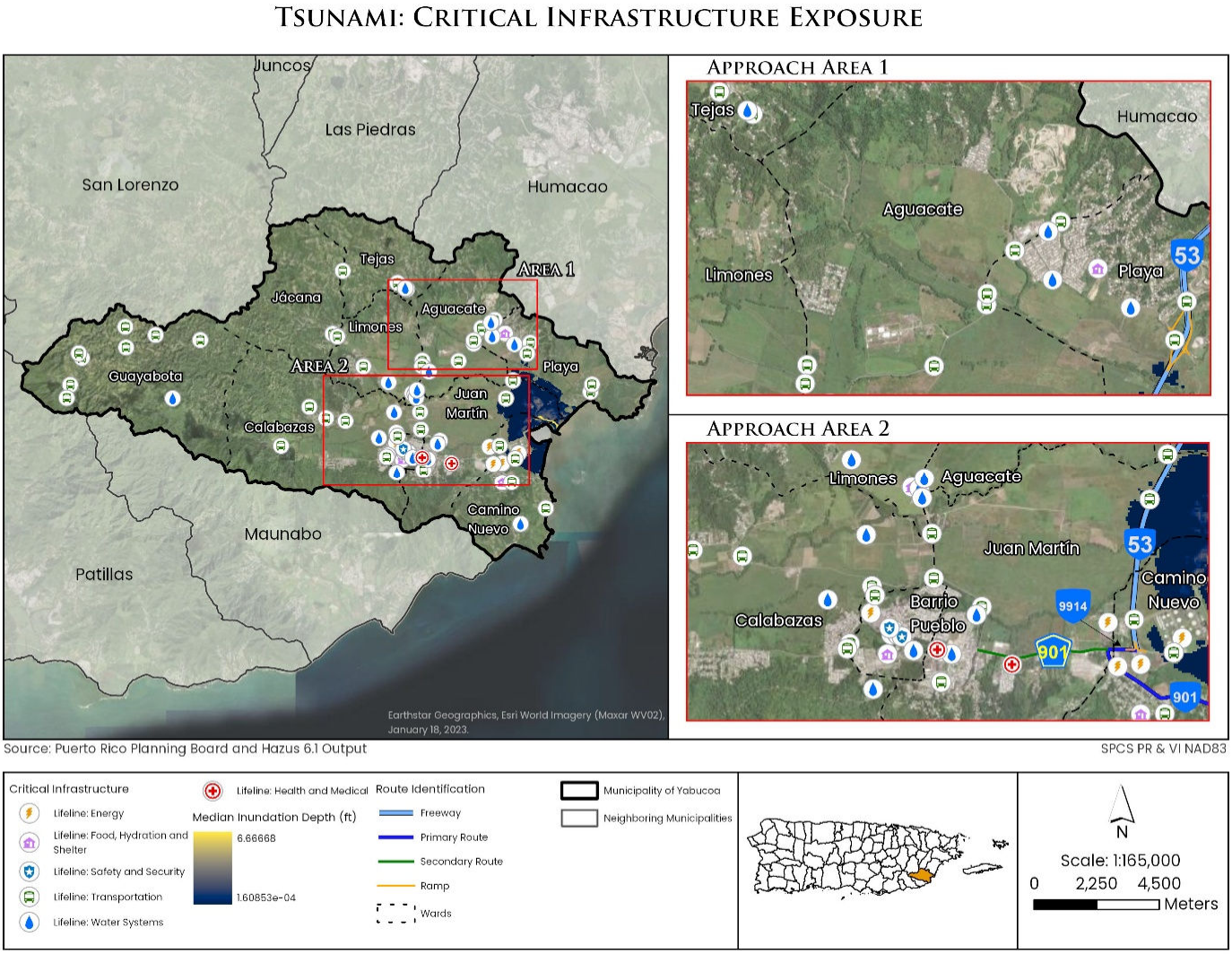
- Transportation systems are among the most heavily impacted lifelines during tsunami events. Roads, bridges, ports, rail lines, and airports may be destroyed, undermined, or obstructed by debris and sediment. Port facilities are particularly vulnerable and may experience prolonged closures, affecting regional supply chains and economic recovery. Impaired transportation networks limit evacuation, emergency access, and delivery of critical supplies during response and recovery operations (NOAA, 2023).

- Water and wastewater infrastructure is highly susceptible to tsunami damage due to inundation, pipeline breaks, pump station failures, and contamination from saltwater and hazardous materials. Wastewater system failures can result in environmental contamination and public health hazards. Restoration of water service is often complex and time-consuming, particularly where underground infrastructure has shifted or corroded due to saltwater exposure

(FEMA, 2017).

With the notable exception of the port facilities of Yabucoa, Map 27 shows that a Tsunami would have very little effect on the critical infrastructure.

*Map 27: Tsunami: Critical Infrastructure Exposure*



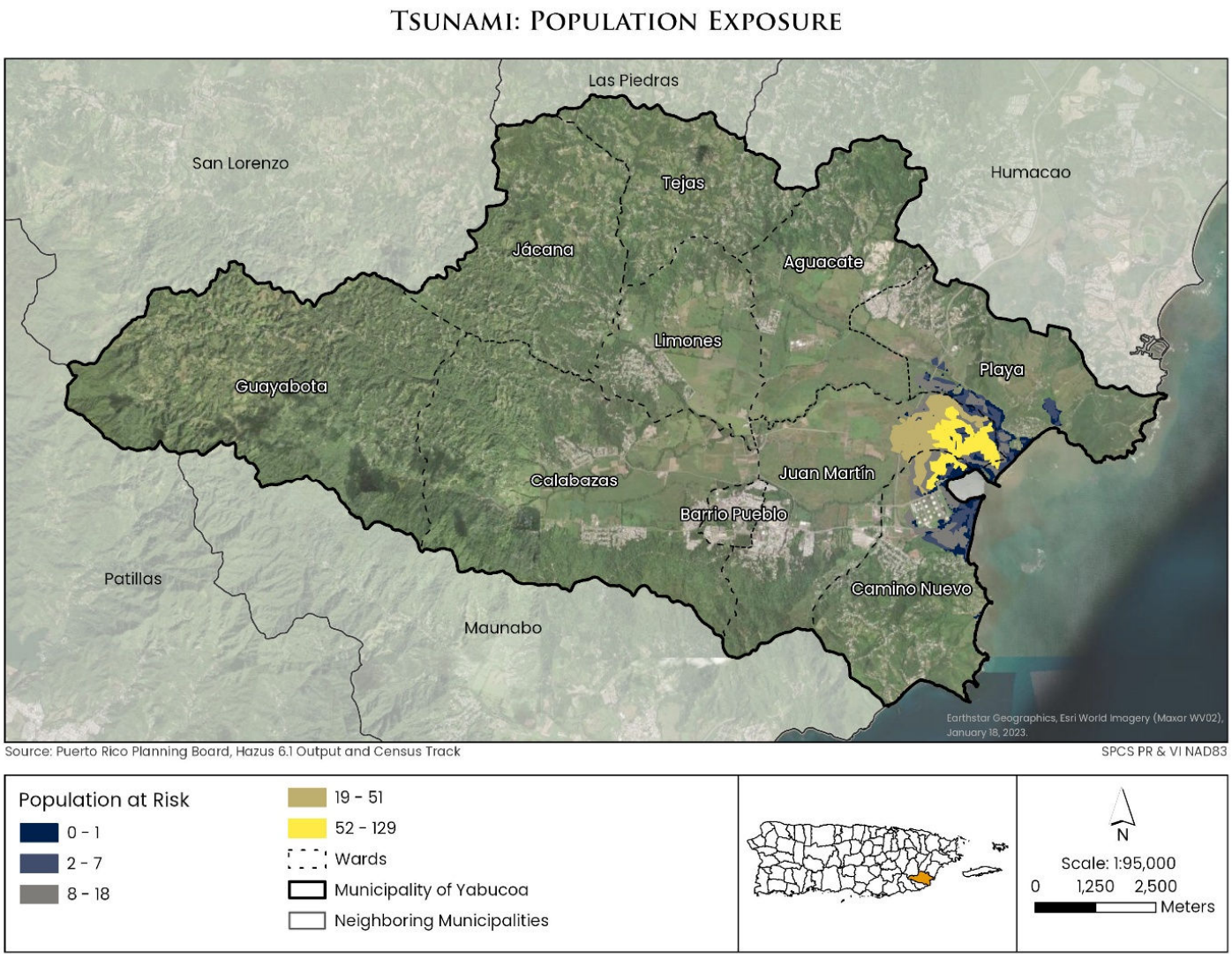

### *4.8.2.3 Social Vulnerabilities*

Social vulnerability during a tsunami event reflects pre-existing social, economic, and

health conditions that influence how individuals and communities prepare for, respond to, and recover from rapid-onset coastal hazards. Research by U.S. scholars demonstrates that populations with lower incomes, limited access to transportation, and residence in hazard-prone coastal zones face disproportionately higher risk during tsunami evacuations (Cutter, Boruff, & Shirley, 2003). Older adults and people with disabilities are particularly vulnerable due to reduced mobility, dependence on medical and social support systems, and challenges accessing timely warnings and evacuation assistance ( (Peek & Stough, 2010)). Studies of community resilience further show that inadequate risk communication, lack of hazard awareness, and weak institutional planning can significantly amplify disaster impacts, even when physical exposure is similar (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007). Language barriers and social isolation may delay protective actions, increasing mortality and injury risk during time-compressed tsunami events. Collectively, these factors produce uneven disaster outcomes and underscore the importance of integrating social vulnerability considerations into tsunami preparedness and emergency planning.

Map 28 shows the population exposure to tsunami. It shows that there is very little population exposure to a tsunami.

*Map 28: Tsunami: Population Exposure*




### 4.8.2.4 Natural and Cultural Resources

A tsunami's waves scour coastal areas, eroding beaches, dunes, and cliffs, and reshaping geomorphology through sediment redistribution. They remove coastal vegetation, including mangroves, saltmarshes, and coastal forests, severely weakening ecological buffers against future events and disrupting habitat for wildlife. Submerged ecosystems, such as coral reefs and seagrass beds, suffer mechanical damage or smothering from debris and sediment, reducing biodiversity and undermining fisheries (Institute for Environmental Research and Education, 2025).

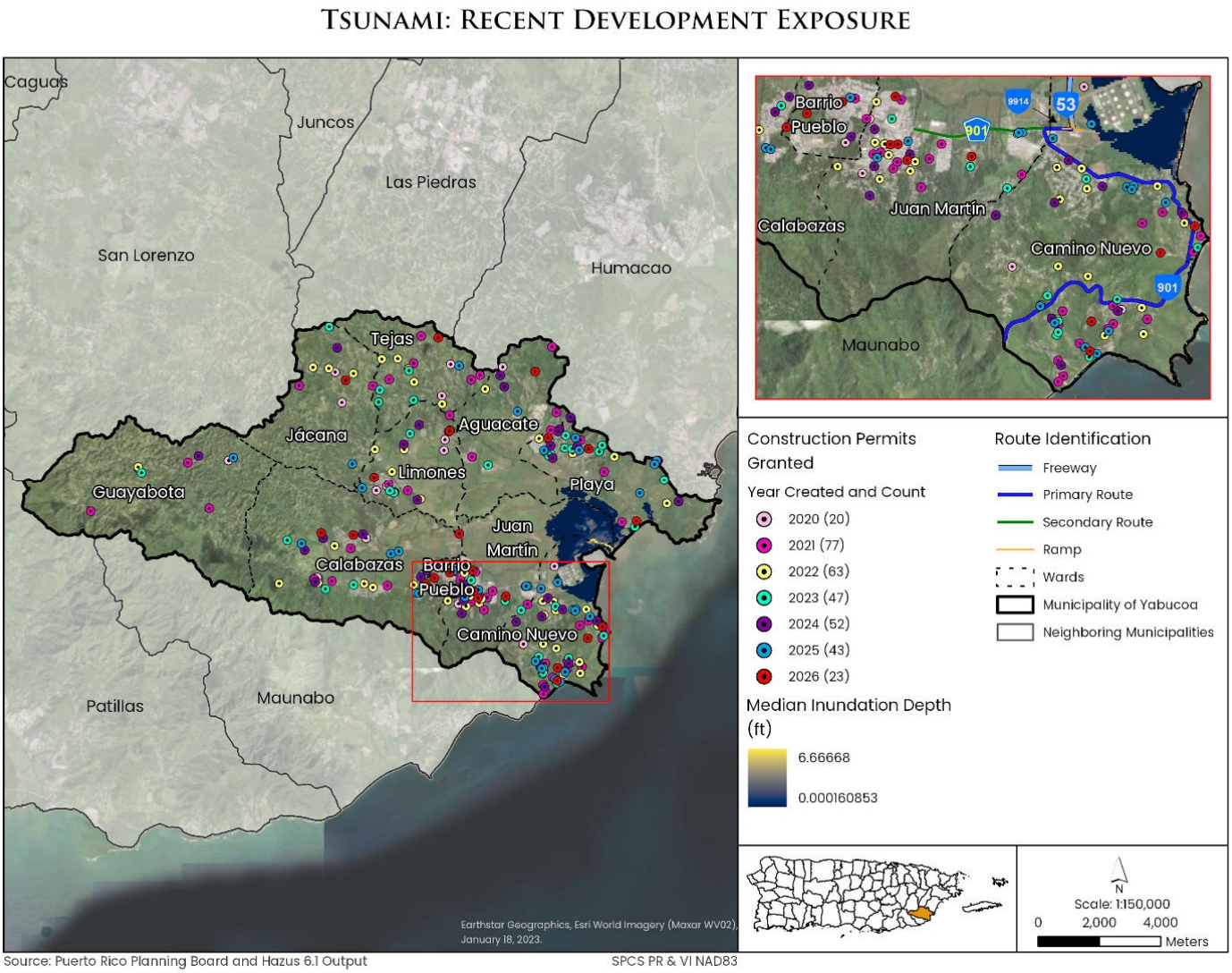
Saltwater intrusion contaminates freshwater ecosystems and aquifers, compromising drinking water and agriculture. Inland, fish and other aquatic organisms are often displaced or perish due to abrupt changes in salinity, wave force, and sedimentation. Studies on the 2011 Tōhoku tsunami showed changes in seafloor sediment structure that affected benthic invertebrate activity over time, highlighting lasting ecological legacies. Overall, these effects can take years or decades to recover from, especially when compounded by diminished habitat complexity and altered physical conditions (Institute for Environmental Research and Education, 2025).

Cultural heritage in coastal regions—including historic towns, monuments, and archaeological sites—is profoundly impacted. Physical destruction often occurs due to wave forces, flooding, debris impact, and prolonged inundation. Buildings and monuments can collapse or suffer structural failure, while artifacts and intangible cultural practices may be irretrievably lost. (Okamura, et al., 2013).

#### 4.8.2.5 Future Conditions (E1-a)

Map 29 shows the approved construction permits in the municipality for the period of 2020 – 2026 layered out on the tsunami impact area. This map shows that almost no permit was granted in the Tsunami impact area.

*Map 29: Tsunami: Recent Development Exposure*




Source: Puerto Rico Planning Board and Hazus 6.1 Output SPCS PR & VI NAD83

## 4.9 FLOODING

### 4.9.1 DESCRIPTION (B1-A)

Floods, generally caused by excessive rainfall (FEMA, 1997), are classified into two main categories: general floods and flash floods.

General floods are long-duration events that can last several days and include riverine, coastal, and urban floods. Coastal floods are associated with storm surges,

waves, and heavy rains generated by hurricanes and tropical storms, while urban floods result from the alteration of natural drainage due to urban development. Riverine floods occur when rivers overflow due to excessive water runoff though rainfall or structural failures, causing water to spill into surrounding land. Flash floods often stem from stationary storms, hurricanes, or dam failures, affecting both mountainous areas and urbanized zones.

Flash floods happen when prolonged rainfall falls over a watershed (water basin). The latter result from intense precipitation over a short period in specific areas. The magnitude of flash floods events depends on factors such as basin topography and physiography, weather patterns, soil saturation, and surface impermeability. Flash floods mainly originate from slow-moving storms over specific areas or from intense rainfall associated with hurricanes and tropical storms (NMEAD, 2021). However, they can also occur after the collapse of dams or levees within minutes or hours, due to extreme rainfall or the sudden release of water from retention basins or other stormwater control facilities. Although more frequent in mountain streams, these events can occur in urban areas where impermeable surfaces limit infiltration.

The periodic flooding of land adjacent to rivers, streams, and coasts—known as floodplains—is a predictable natural phenomenon based on recurrence intervals. These intervals represent the average time, in years, between events of equal or greater magnitude. The longer the recurrence interval, the greater the magnitude of the event, which implies a significant increase in risk and the extent of the affected area. Floodplains flood periodically according to recurrence intervals, defined as the average time between events of equal magnitude. For example, a 100-year flood has a 1% annual probability, while a 500-year flood corresponds to 0.2%. These frequencies are calculated through statistical analysis of historical flow records and extreme events.

Table 26 shows the different flood zone classifications for Puerto Rico adopted by the PRPB (PRPB, 2021).

*Table 26: Puerto Rico Flood Zones*

| Flood Zone | Description |
|---|---|
| Zone A | Special Flood Hazard Area with a recurring period of one hundred (100) years determined by using approximate methodologies with no base flood elevation or Floodway determined. |

| Flood Zone | Description |
|---|---|
| Zone AE | Special Flood Hazard Areas with a recurring period of one hundred (100) years determined by detailed methodologies with base flood elevations indicated. According to the scope of the study, may include the Floodway determination. |
| Zone AO/AH | Shallow Special Flood Hazard Areas with a recurring period of one hundred (100) years with a base flood depth fluctuating between 0.30 meters (one (1) foot) and 0.91 meters (three (3) feet). The average flood depths are obtained from detailed hydraulic analysis. |
| Zone A99 | areas prone to flooding from a flooding event with a one percent (1%) annual chance of occurring. These special areas are within a flood protection or control system where enough progress has been made in its construction, even though it has not been completed, but specific statutory progress has been reached to complete it. This zone does not detail base flood elevations or flooding depths, so it is recommended to use, if required, the previous flood elevation for Zone 99. Mandatory flood insurance purchase requirements apply. |
| Zone D | Flooding area that is not determined but is possible. |
| Zone VE | Coastal high flood hazard area with a recurring period of one hundred (100) years with velocity and energy (storm surge) and a determined base flood elevation. |
| Zone X Shaded | flooding area with 0.2% chance of occurring each year or the one hundred (100) year flood with a water depth of less than 0.3 meters, with drainage areas of less than 2.6 square kilometers or areas protected by levees against the one hundred (100) year flood. |
| Zone X (unshaded) | Area determined to be outside the five hundred (500) year storm flood. |

#### *4.9.1.1 Affected Area*

**Flood Hazard Insurance Map**

Map 30 shows the affected areas by flood in Yabucoa. The areas in orange represent the 500 – year (.02%) flood extent. The extent of flood hazard in Yabucoa is strongly

influenced by the municipality's geomorphology and climatic conditions. Both the 100-year and 500-year flood events cover nearly the entire extent of the municipality's alluvial valleys, demonstrating the high level of exposure present in these low-lying areas. These valleys are generally flat and sit at lower elevations, making them natural zones for water accumulation during heavy rainfall events.

Most of these alluvial valleys are bounded on three sides by steep mountainous terrain. This configuration creates a funneling effect, where runoff generated on the surrounding slopes is rapidly directed toward the valley floor. Due to the steep degree of these slopes, rainwater accelerates quickly as it flows downhill, increasing both the volume and velocity of runoff entering the valleys. As a result, these areas are particularly prone to rapid inundation and flooding.

This condition is further intensified by Yabucoa's location within one of the regions of Puerto Rico that receives some of the highest annual precipitation. Frequent and intense rainfall events lead to soil saturation, significantly reducing the ground's capacity to absorb additional water. Once the soil reaches saturation, infiltration declines and excess rainfall is converted into surface runoff. This increase in runoff contributes to higher flood peaks and expands the extent of inundation during both moderate and extreme storm events.

Together, the combination of low-lying valley topography, steep surrounding slopes, and high rainfall accumulation creates a highly vulnerable flood environment in Yabucoa. These factors explain why both 100-year and 500-year flood scenarios result in widespread coverage of the alluvial valleys and underscore the importance of flood risk management and land use planning in these areas.

Figures 16 to 19 shows various FIRMette that shows specific areas of flooding in the Municipality.

- Figure 16 shows the flood area around Yabucoa's Centro Urbano. This FIRMette shows that the residences and businesses in the axis of PR-182 are affected by an AE Flood Zone. Some areas specifically affected is Plaza Yabucoa Shopping Center as well as the Yabucoa Fire House. This flood may be cause by the Quebrada Aguas Larga and Caño Santiago overflowing their banks. Also, the runoff from the steep hills to the south of the Centro Urbano can also affect the flooding. The map also shows that to the north of the Centro Urbano there is a large AE Flood Zone probably related to flood events from Caño Santiago and the Guayanés River.

- Figure 17 was chosen because it delineates the recurrent flooding exposure to the Jardines de Yabucoa II and Los Angeles subdivisions. Again, the flooding can be related to the Caño Santiago and the Guayanés river and their tributaries. It should be highlighted that in this flood area there is the Yabucoa Water Treatment Plant.
- Figure 18 was chosen because it shows part of the impact of flooding to the chemical tanks that are part of the Port of Yabucoa complex.
- Figure 19 shows the flood zone for the Martorell Community in Limón Ward.

*Map 30: Flood Hazard Zones*

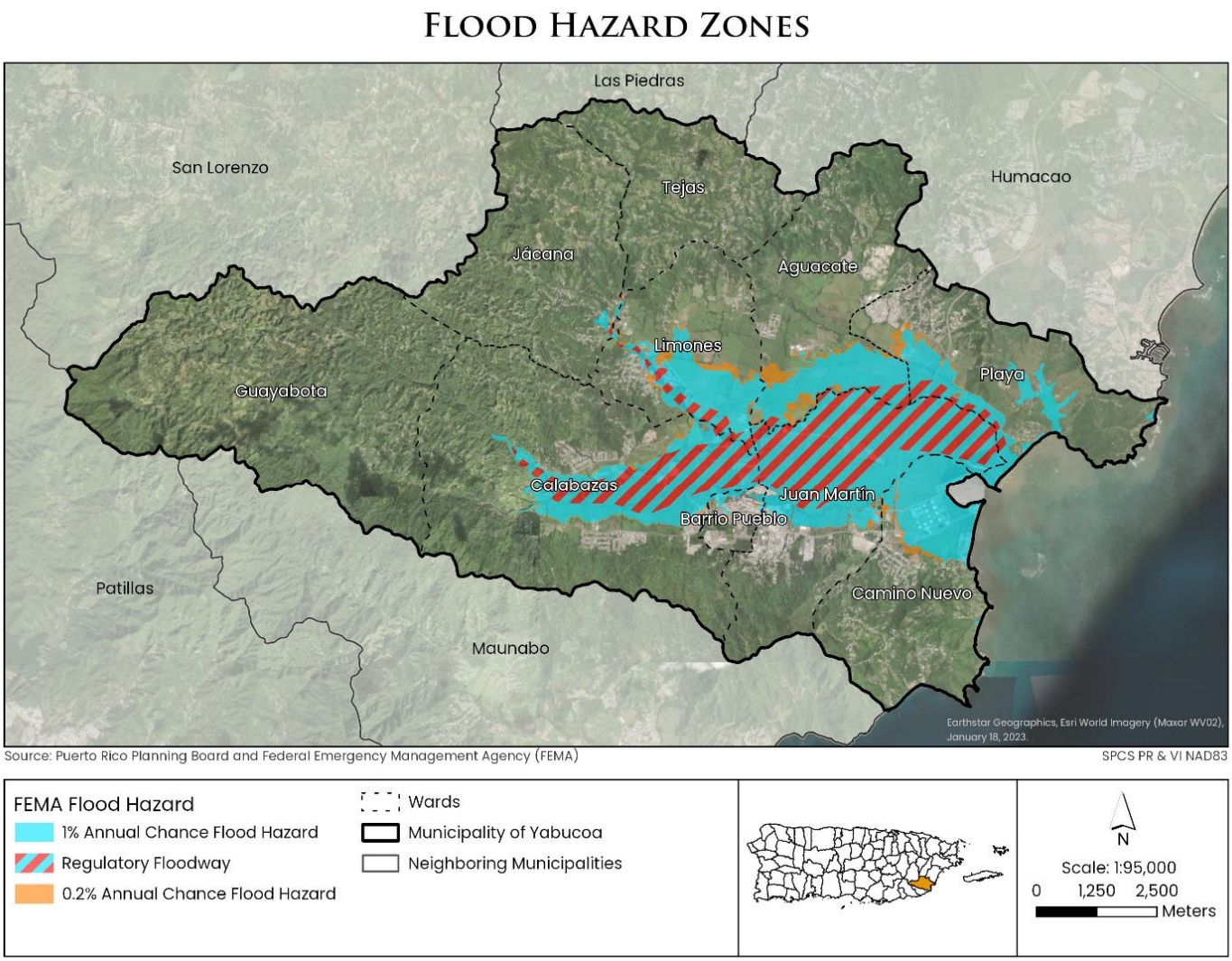


*Figure 16: National Flood Hazard Layer FIRMette (Yabucoa Centro)*

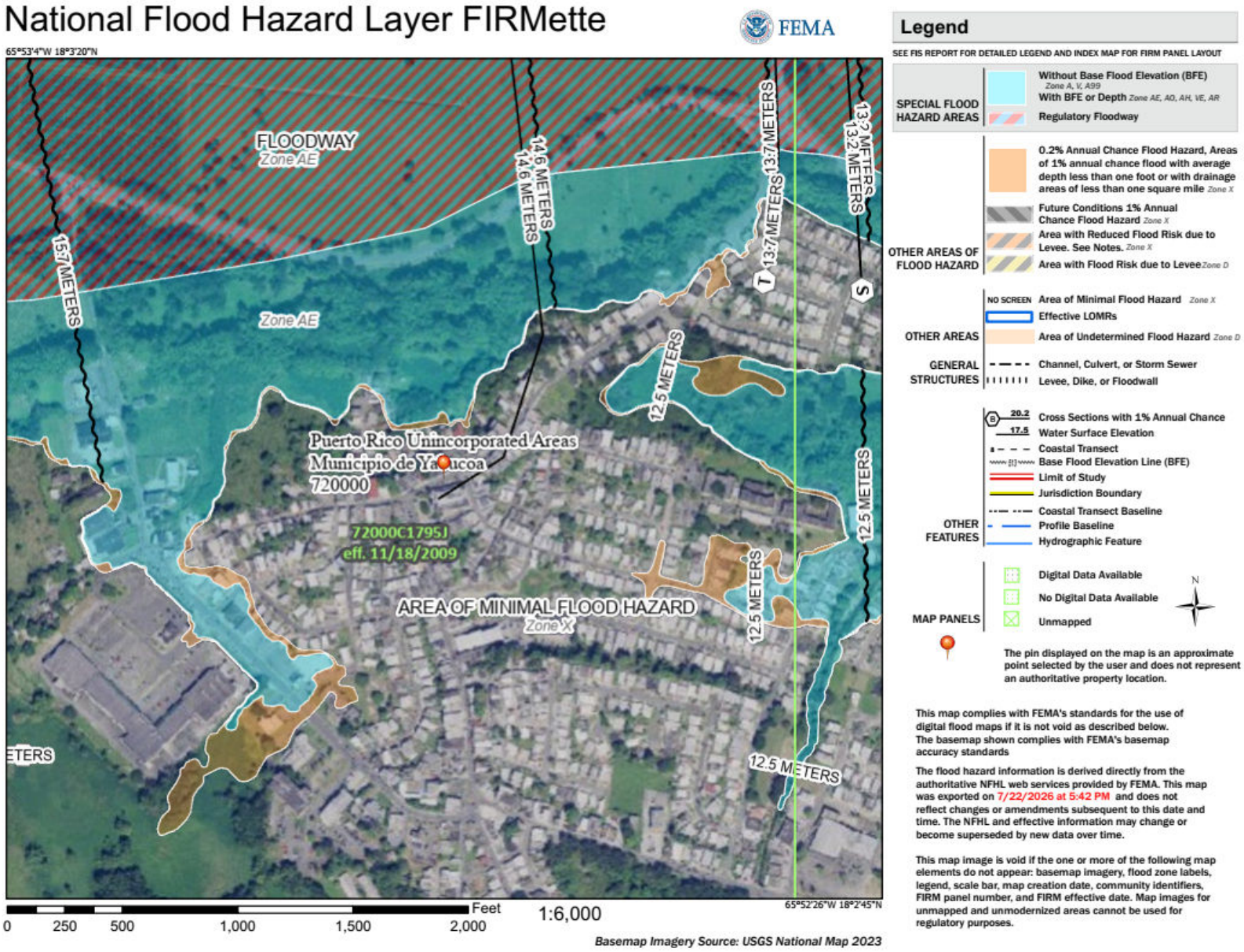


*Figure 17: National Flood Hazard Layer FIRMette (Jardines de Yabucoa)*

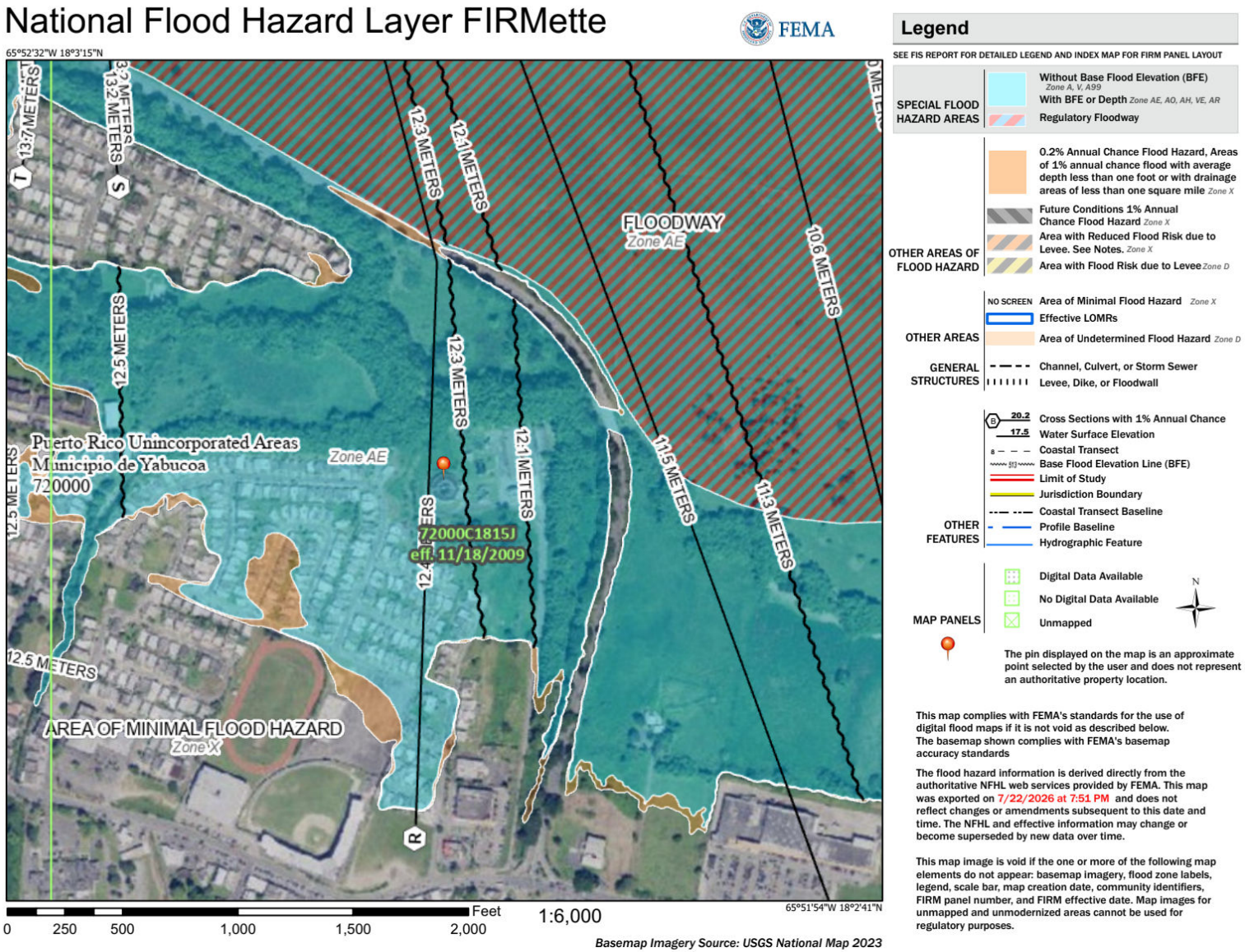


*Figure 18: National Flood Hazard Layer FIRMette (Port of Yabucoa)*

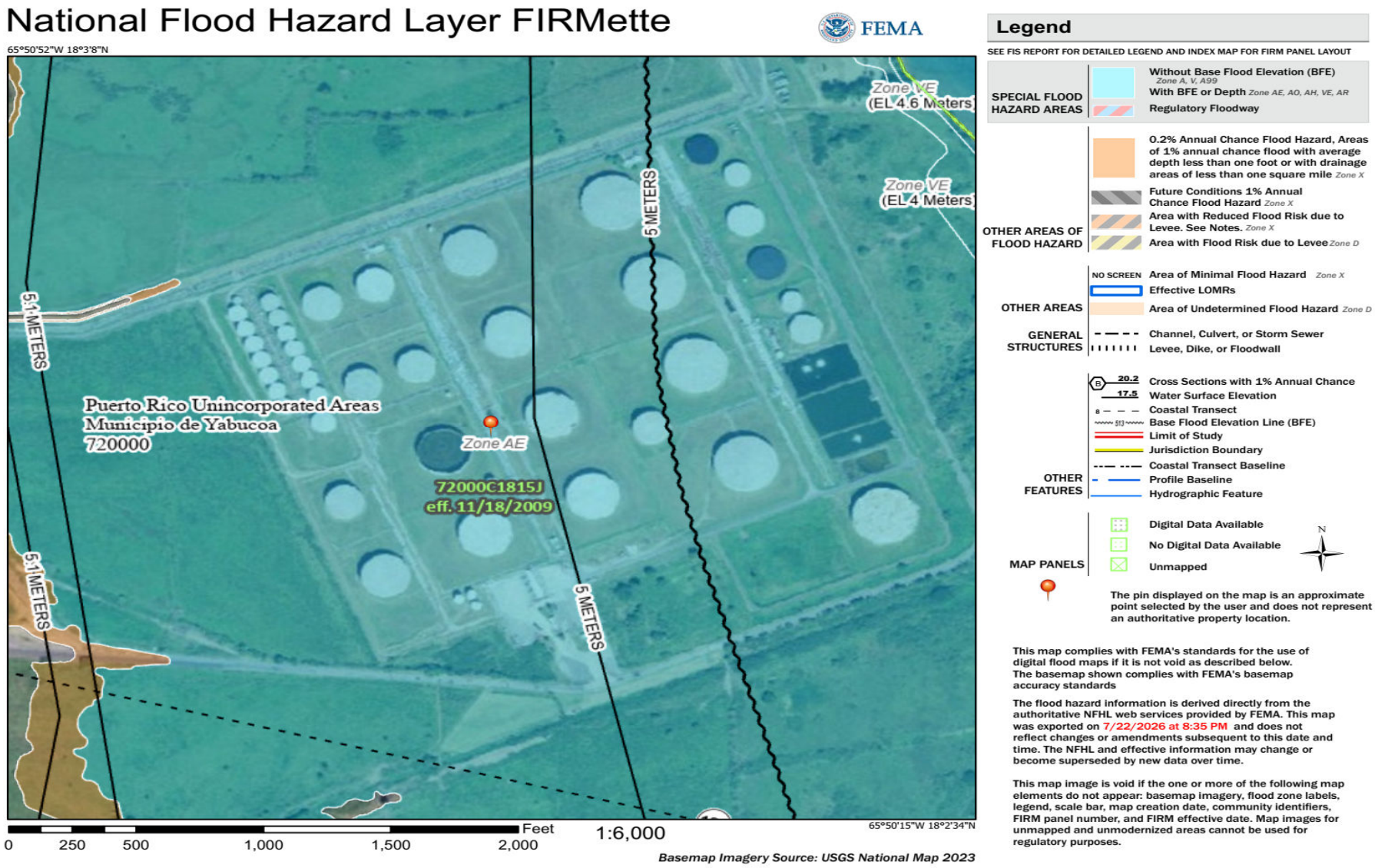
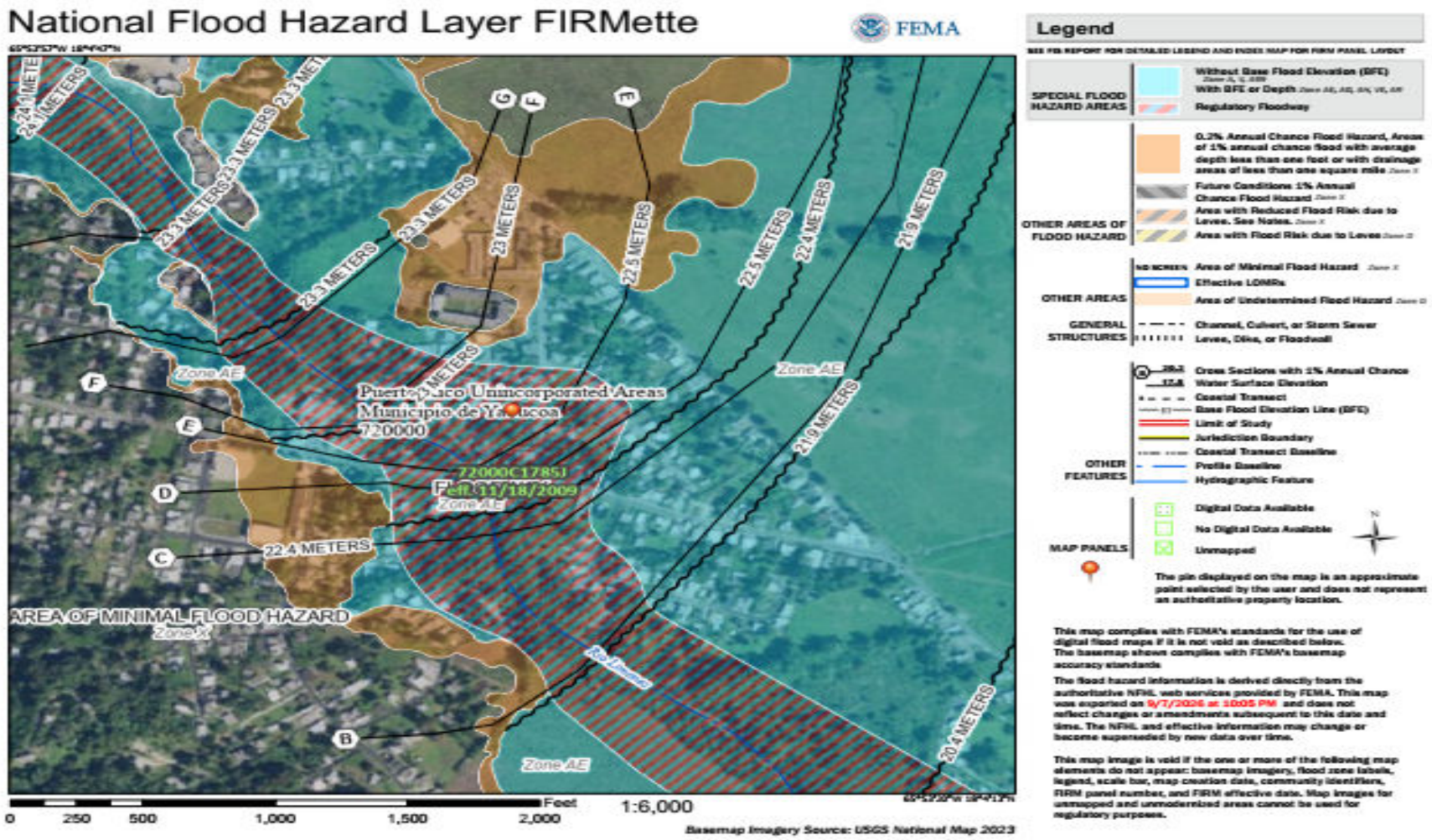


*Figure 19: National Flood Hazard Layer FIRMette Comunidad Martorell)*



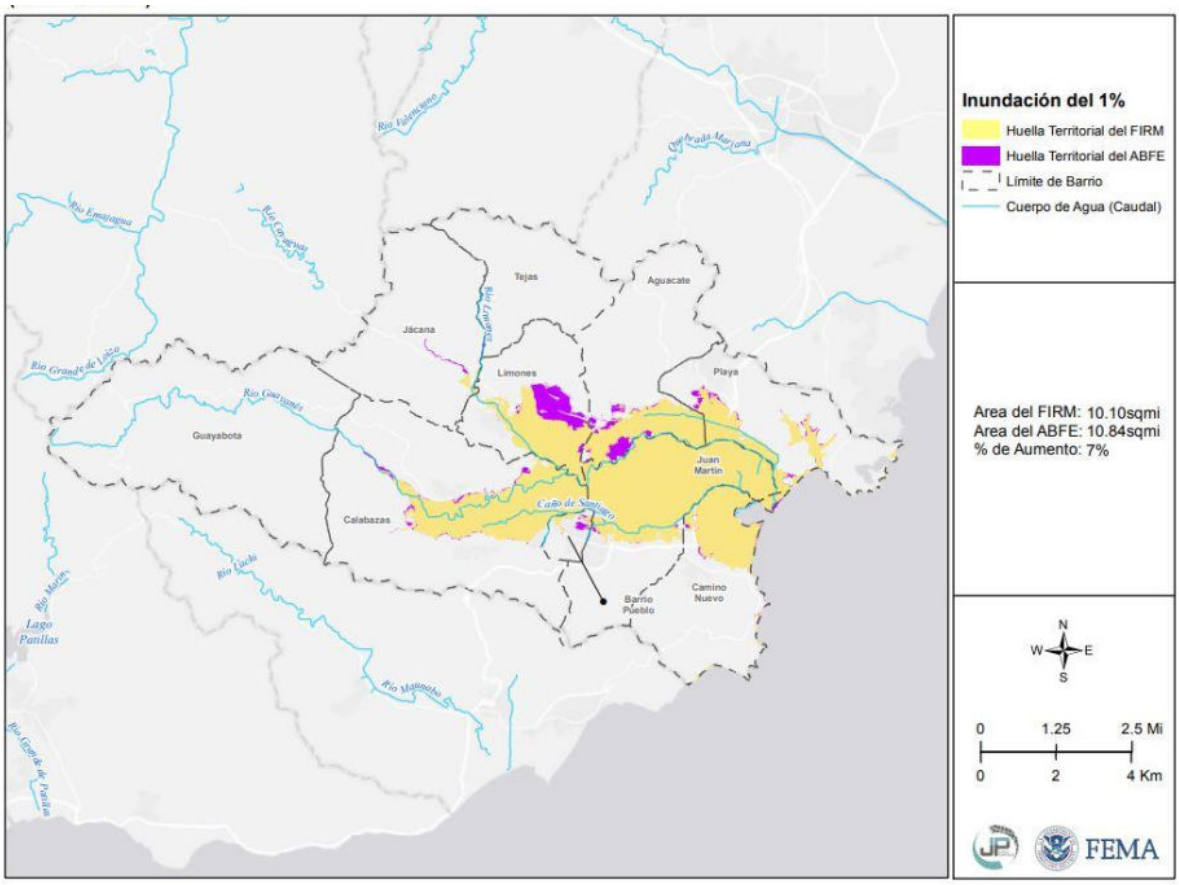
**Advisory Base Flood Elevation (ABFE)**

Likewise, FEMA uses another type of map for the purpose of developing regulations and construction permits known as the Advisory Base Flood Elevation Maps (ABFE). ABFEs are developed after the occurrence of a high-impact atmospheric event, and several factors related to the latest engineering analysis are taken into consideration to determine whether an analysis is necessary. Some of the factors considered in the analysis include the age of the analysis, the territory covered by the analysis, and the engineering models/data used in the analysis. ABFEs have been produced for states such as Mississippi (Hurricane Katrina), New York, and New Jersey (Hurricane Sandy). Following Hurricane María's passage through Puerto Rico in 2017, and due to the availability of better data, FEMA developed ABFEs for Puerto Rico. It should be noted that the Puerto Rico Planning Board adopted the ABFEs on an emergency basis in March 2018. At present, Puerto Rico has two (2) types of flood maps: the FIRMs (2009), which are used solely for flood insurance rates, and the ABFEs (2018), which are used to regulate construction on the Island.

For comparison purposes, this subsection includes the difference in the extent of land affected by flooding based on the FIRMs prior to Hurricane María in September 2017 and the ABFEs developed by FEMA for Puerto Rico. After Hurricane María in 2017, the areas designated as flood-prone throughout the Island increased by 20%. Thus, this reflected an increase of 41%.

The next Figure (in Spanish) shows the difference between the extent of the FIRM maps before Hurricane María and the Advisory Base Flood Elevation (ABFE) for an event of 1% chance (100 years flood) maps after the hurricane. In the Municipality of Yabucoa, the difference represents an increase of approximately 23%, from 5.51 square miles to 6.79 square miles, meaning that the areas exposed to flooding are more extensive than previously determined and greater than those highlighted in the municipality's previous Plan. The new areas include the expansion of previously identified areasin the Limon, Ingenio and Guayanes Rivers.

*Figure 20: FIRM vs ABFE Coverage*




As instructed by PRPB the hazard analysis was made using the ABFE maps and not the FIRM maps.

**HAZUS Modeling**

Flooding source identification and hazard loss estimation were performed using Federal Emergency Management Agency's (FEMA) Hazus platform, a nationally standardized tool for multi-hazard risk assessment. The Hazus flood module was used to delineate streams in areas where no engineering studies have been developed and also used to estimate potential monetary losses associated with structural damage.

Input data included depth grids produced by a Base Level Engineering (BLE) study in 2018 post hurricanes Irma and Maria. This BLE study did not review all potential riverine flooding sources so additional modeling was developed with Hazus hydrology and hydraulics to review other potential losses associated with streams with drainage

areas of one square mile or more.

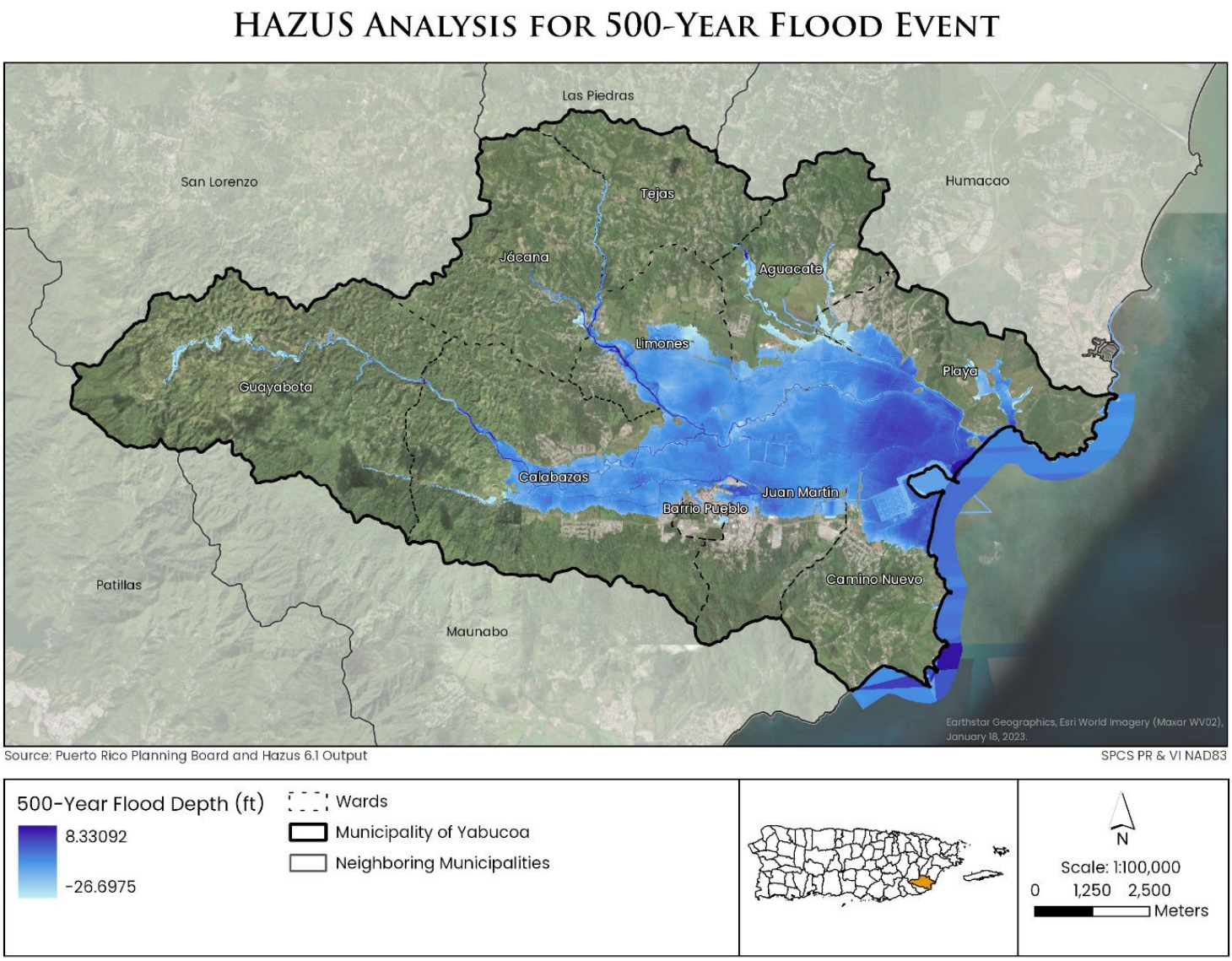
Topographic data used by Hazus for depth calculations and damage estimation was sourced from the USGS 3D Elevation Program (3DEP) seamless 1/3 arc-second Digital Elevation Model (DEM), at an approximate resolution of 10 feet. This dataset provides current coverage of Puerto Rico and its surrounding islands.

The 3DEP seamless DEM for Puerto Rico is derived from two lidar collection efforts: a 2016–2017 USGS lidar survey and a 2018 USGS post-Hurricane Maria lidar survey. The 2018 collection, conducted following the significant coastal geomorphic changes caused by Hurricane Maria, represents the most current available terrain data for the island and forms the primary basis of the 3DEP elevation layer used in this analysis.

The areas documented in the mapincluded within the LHMP may have streamlines represented but with no depth grids associated with them. Due to the inconsistency of available regression equations and other data necessary for computation of flood risk and losses with Hazus's hydrology and hydraulics models, some streams that were delineated were unable to be completed during modeling runs. These stream areas may need to be reviewed for future flood studies and potential flood risk identification but, due to the lack of data, they were unable to be included in the Hazus studies.

The following map shows the result of the Hazus Run. The most up to date Hazus Run shows that flooding may extend beyond what was determined in the 2018 ABFE. It particularly shows that the flooding areas of the Limón, Ingenio, and Guayanés rivers, reaching further north and west of the municipality.

*Map 31: 2026 Hazus Analysis 500 year (0.2%)*




### *4.9.1.2 Risk Magnitude (B1-C)*

Flood events can represent one of the most severe atmospheric threats, as there is no other event worldwide that causes greater loss of life (FEMA, 1997). This is due to the high frequency of such events and the population's lack of awareness regarding the magnitude of the damage they can cause, whether physical harm or property damage. It should be noted that most disaster declarations in the U.S. are related to flood events. The majority of flood-related incidents involve people being swept away

by fast-moving water, along with their vehicles (FEMA, 1997). Each year, the devastation caused by floods results in billions of dollars in asset losses. Highly urbanized areas with dense populations are particularly vulnerable to flash floods, as the construction of buildings, roads, and parking lots create impermeable surfaces, reducing the land's natural ability to absorb water (NSWL, n.d.).

Floods are the most common natural disaster, occurring when water overflows and submerges land that is typically dry. They are often triggered by heavy rainfall, rapid snowmelt, or storm surges from tropical cyclones or tsunamis in coastal regions.

Floods can cause extensive destruction, including loss of life and severe damage to homes, property, and critical public health infrastructure. Between 1998 and 2017, floods impacted more than 2 billion people worldwide. Those living in floodplains, in poorly constructed buildings, or without access to warning systems and hazard awareness are the most vulnerable (WHO, 2025).

Three common types of floods include:

- Flash floods: Result from sudden, intense rainfall that rapidly raises water levels, overwhelming rivers, streams, channels, or roads.
- River floods: Occur when prolonged rainfall or snowmelt causes rivers to exceed their capacity.
- Coastal floods: Caused by storm surges linked to tropical cyclones or tsunamis.

Regarding the impact on life, property, and operations, floods cause loss of life and property damage, including residences, buildings, infrastructure, agriculture, and sanitation and drainage systems. After a flooding event, the aftermath can increase the occurrence of various diseases, such as leptospirosis, and lead to rises in contaminated water (Malilay, 2000).

According to a Congressional Budget Office (CBO) report, "Over the past 10 years, damage from flooding in the United States has averaged $46 billion per year (in 2023 dollars)" (CBO, 2024). This estimate includes costs such as:

- The replacement of residential and commercial property;
- Repairs to or rebuilding of public infrastructure;
- Emergency response measures;
- Costs associated with the continued loss of property use (for example, the

provision of temporary housing);
- Commercial losses resulting from business interruptions; and
- Damage to crops, livestock, and timber" (CBO, 2024).

Although the effectiveness of adaptation projects varies, estimates by the U.S. Army Corps of Engineers indicate that approximately two-thirds of its projects—excluding those in the highest and lowest sixth of benefit–cost ratios—are expected to reduce flood damages by $2 to $6 for every dollar invested over a 50-year project lifespan (CBO, 2024).

#### *4.9.1.3 Past Events (B1-D)*

For the most part, flooding events in Puerto Rico are related to tropical systems (tropical waves, tropical depressions, tropical storms and hurricanes). Consequently, flooding hazards occur most frequently during Atlantic hurricane season, which extends from June 1 through November 30.

However, flooding events can occur outside this window as shown in the case of the April- May 2024 Floods, the February 2022 floods and the Three Kings' Flooding of 1992. The following table summarizes the major flooding events in the period of 2010 – 2025.

*Table 27: Major flooding events in Puerto Rico 2010-2025*

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| Tropical Storm Ernesto | 8/14/2025 – 8/16/2025 | DR-4850- PR | Public Assistance – Yes<br><br>Individual Assistance No | The storm's slow movement and moisture-rich environment contributed to prolonged precipitation, particularly in central and eastern municipalities. Parts of Central Puerto Rico recorded 12–14 inches of rainfall in localized areas.<br>Flash flooding occurred in urban and rural areas, rendering primary and secondary roads impassable.<br>Floodwaters caused structural failures in bridges and washed-out critical road segments, isolating several communities. Stormwater drainage systems in metropolitan areas, were overwhelmed, leading to localized urban flooding.<br>Emergency Response and Disruptions<br>Evacuations were conducted in flood-prone areas such as Toa Baja to mitigate loss of life. |
| Puerto Rico Severe Storms, Flooding, Landslides, and Mudslides | 4/29/2024 – 5/10/2024 | DR-4805-PR | Public Assistance – No<br><br>Individual Assistance - No | In April 2024, Puerto Rico was struck by a series of severe storms that delivered prolonged heavy rainfall—some areas received more than 10 inches—leading to widespread flooding and landslides. |

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| | | | | Floodwater turned streets into torrents, trapping residents on rooftops and prompting emergency evacuations in over 20 municipalities. |
| Hurricane Fiona | 9/17/2025 - 9/21/2022 | DR-4671-PR | Public Assistance – Yes<br><br>Individual Assistance - Yes | Hurricane Fiona struck Puerto Rico in September 2022, unleashing torrential rains—up to 31.22 inches of rainfall over 72 hours in Ponce, nearly matching the accumulation from Hurricane Maria. This deluge led to catastrophic flooding, with 7 to 20 inches common across most of the island and localized spots exceeding 30 inches. |
| Puerto Rico Severe Storm, Flooding and Landslide | 2/4/2022 – 2/6/2022 | DR-4649-PR | Public Assistance: No<br><br>Individual Assistance: No | In February 2022, Puerto Rico experienced a severe storm that brought prolonged heavy rainfall, causing widespread flooding across the island. Rainfall totals ranged from 3 to 10 inches in many areas, with localized peaks reaching up to 16 inches. The intense precipitation overwhelmed drainage systems, leading to urban flooding in coastal towns Rivers swelled beyond their banks, inundating roads and isolating communities, while landslides compounded the damage in mountainous regions. Emergency |

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| | | | | responders issued flash flood warnings and conducted evacuations as homes and businesses were submerged. |
| Puerto Rico Severe Storm and Flooding | 9/13/2020 | DR-4571-PR | Public Assistance: No<br><br>Individual Assistance: No | Puerto Rico was battered by a severe storm and flooding on September 13, 2020, resulting in widespread flood damage and infrastructure disruption. Torrential rains overwhelmed drainage systems and caused rivers to overtop in areas like Arecibo, where one home was destroyed, over 100 suffered major damage, and more than 20 experienced minor flooding. Roads and bridges were submerged or damaged, isolating communities and impeding emergency response efforts. Floodwaters inundated homes and public facilities, prompting evacuation orders and flash flood warnings across several municipalities. |
| Tropical Storm Isaías | 7/29/2020 - 7/30/2020 | DR-4560-PR | Public Assistance: No<br><br>Individual Assistance; No | Although the center of Tropical Storm Isaías did not make landfall on the island, the system left a large amount of rain in its path, causing flooding throughout Puerto Rico. Rainfall accumulation of up to 10 inches was recorded around the island. |
| Hurricane María | 9/20/2017 | DR-4339-PR | Public Assistance – Yes | Widespread flooding severely affected the whole Island. For example, in San |

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| | | | Individual Assistance - Yes | Juan, water levels reached up to 6 feet in some areas and numerous structures losing their roofs. Survivors reported that floodwater rose 6 feet in just 30 minutes, and some areas experienced depths of up to 15 feet (4.6 m). |
| Hurricane Irma | 9/5/2017 | DR-4336-PR | Public Assistance – No<br><br>Individual Assistance - No | On September 5, 2017, Hurricane Irma impacted Puerto Rico; an Emergency Declaration was issued for the Island. On September 6, 2017, a Major Disaster Declaration was issued following Hurricane Irma's passage.<br>Two people died due to torrential rains before the hurricane: Wave heights in Puerto Rico reached 9 meters, and sustained winds of 111 mph were recorded in Culebra. |
| Tropical Storm María[7] | 9/8/2011 – 9/114/2011 | DR-4040-PR | Public Assistance: No<br><br>Individual Assistance: Yes | Tropical Storm Maria formed in early September 2011 and passed near Puerto Rico, bringing significant heavy rainfall and tropical storm conditions to the island. The storm caused widespread flooding that inundated numerous roadways and homes; floodwaters near Patillas destroyed several homes and |

[7] Tropical Storm María was a tropical system that pass to the northeast of Puerto Rico in 2011 and that caused flooding in the Island. Not to be confused with the 2017 Hurricane María. The name "María" was retired from the official Atlantic hurricane season list of names after 2017.

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| | | | | bridges, and approximately 150 houses in Yabucoa were flooded and damaged. |
| Hurricane Irene | 8/22/2011 | DR-4017-PR | Public Assistance: Yes<br><br>Individual Assistance: No | Total rainfall reached 22 inches over three days, with the eastern region being the most affected—the same area that had already received over 6 inches earlier in August during the close passage of Tropical Storm Emily. Record levels were recorded for many rivers. Flooding was severe enough to cause infrastructure stress and dangerous conditions across multiple municipalities. Tragically, there was one direct fatality attributed to Irene, due to drowning. |
| Puerto Rico Severe Storms, Flooding. Mudslides and Landslides | 5/20/2021 – 6/8/2021 | DR-4004-PR | Public Assistance: Yes<br><br>Individual Assistance: No | In May 2021, Puerto Rico experienced a series of intense rainfall events that caused flash flooding, river overflows, mudslides, and landslides, particularly in mountainous and interior regions. Although May is normally one of the wettest months of the year, several storm systems produced short-duration but high-intensity rainfall, overwhelming local drainage systems and destabilizing steep terrain. |
| Sub-Tropical Storm Otto | 10/3/2010 – 10/8/2010 | DR-1946-PR | Public Assistance: Yes | An extensive rain band covered Puerto Rico while Otto moved as a distant |

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| | | | Individual Assistance No | tropical cyclone north of the Island (NOAA). This resulted in heavy and continuous rainfall that caused serious flooding.<br>(Eco Exploratorio). |
| Puerto Rico Severe Storms and Flooding | 5/26/2010 – 5/31/2010 | DR-1919-PR | Public Assistance: No<br><br>Individual Assistance: No | In May 2010, Puerto Rico was hit by a series of severe storms that produced torrential rainfall and widespread flooding across the island. Rainfall exceeded 12 inches in some areas, overwhelming drainage systems and causing rivers to overflow their banks. Low-lying communities and urban centers experienced significant inundation, with roads submerged and bridges damaged, isolating several municipalities. Flash floods swept through residential areas, forcing evacuations and leaving homes and businesses underwater. Landslides triggered by saturated soil compounded the crisis, blocking access routes and delaying emergency response efforts. The event resulted in extensive infrastructure damage and highlighted the island's vulnerability to prolonged heavy rain events during the wet season. |

In summary, between 2010 and 2025 there were a total of 13 major disaster declarations caused by flooding or events that had flood related damage. Of those, the municipality of Yabucoa was declared eligible for either Public Assistance or Individual Assistance in five instances.

#### 4.9.1.4 Special Consideration: Floods by Stormwater Management Deficiencies

Urban drainage systems — whether natural or constructed — are designed to convey surface water runoff to receive water bodies. When storm drains, channels, or swales become obstructed, insufficient or overwhelmed by heavy rainfall and expanding urbanization, they can overflow and flood surrounding areas. As a result, floodwaters may spread beyond FEMA's mapped floodplains, even entering zones typically considered low or moderate risk (e.g., Zones B, C, or X) (FEMA, Reducing Damage from Localized Flooding, 2025).

Puerto Rico's stormwater runoff is conditioned by the island's climate, topography and land cover. Annual rainfall varies from less than 1,000 millimeters (mm) to over 4,000 mm (40 to 157 inches). The island's watersheds are largely mountainous, with steep slopes, and stream valleys are typically narrow and well-incised. Intense but short-duration storms are common, leading to rapid flooding with peak discharges that can be several orders of magnitude higher than base flows. All of Puerto Rico's watersheds have experienced significant alterations. It is estimated that more than 11% of the island is covered by developed surfaces, within areas reaching up to 40% in regions such as the San Juan Metropolitan Area. These changes have significantly modified stormwater drainage patterns and downstream floodwater levels (FEMA, 2024).

Paved surfaces severely limit the infiltration of rainwater, increasing both the volume and velocity of surface runoff. As a result, storm drains can easily become overwhelmed. In addition, runoff from paved surfaces reaches streams and rivers much faster, exceeding their capacity to convey water and causing higher and more frequent flood levels in adjacent areas. Moreover, contaminants from both point and non-point pollution sources are more likely to reach surface water bodies when transported by runoff over paved surfaces instead of being partially or totally degraded by vegetated soils. Higher flows also have a greater capacity to remove and transport soil and other loose materials from streambanks and riverbeds, facilitating erosion and scouring (FEMA, 2024).

Paradoxically, river flow between rain events tend to decrease after urbanization. Paved surfaces act as a barrier that isolates the soil, preventing the infiltration of rainwater that otherwise would have gradually discharged from the ground and into streams days later, a process that is critical for maintaining base flows for riparian fish and wildlife species, but also to sustain public water supply. In response, various hard infrastructure measures (hard infrastructure measures such as flood-control pump stations, concrete trapezoidal channels, and curved side gutters have been widely implemented across Puerto Rico. While effective at quickly conveying runoff, these structures often neglect ecological, social, cultural, and aesthetic considerations. These practices often involve significant operation and maintenance costs and, in many instances, can exacerbate downstream erosion, scouring and water quality problems.

A more sustainable approach would be to take advantage of the ecological services that green areas and other nature-based solutions to manage runoff flows and improve water quality. Such strategies are increasingly critical to protect communities from the growing water-related impacts of climate change in Puerto Rico (FEMA, 2024).

#### 4.9.1.5 Future Event Probabilities (B1-e)

A sustained increase in the frequency of extreme rainfall events has been identified in recent decades. As stated above, the Island of Puerto Rico has had 13 flood – related flood major disaster declaration in the last fifteen years. This means that the average frequency of a flooding event is approximately every 14 months.

Any mitigation action adopted to reduce the effects of flooding in the Municipality of Yabucoa must consider, for example, that 100-year return events or those with a 1% annual probability could become 50-year return events or have a 2% annual probability in the future. This means that flood events of a certain magnitude and impact on the municipality may increase, particularly in high-risk areas. Though there are many floods control projects in Choose an item., the probability of future events is considered high.

### 4.9.2 Risk Analysis (B2-a, B2-b)

#### 4.9.2.1 Estimated Loses

Map 32 shows the estimated building loss by a 500 – year flood in Choose an item., distributed by census tract. The highest risk is concentrated in the census tract related to the Port of Yabucoa, most likely because of the fuel storage facilities. High level of building loss can also be identified in the Juan Martin Wards, most likely due to the flood from el Caño Santiago and its tributaries (Laja and Aguas Largas Creeks among others. Other high areas of building loss can be identified in census tracts with major water features such as the Aguacate Creek, the Ingenio River and the Limones River.

Map 33 shows the expected building loss in a 1.0% chance scenario (100 – years). This scenario shows results similar to Map 32.

The following table shows the municipality exposure to flood.

*Table 28 Flood Exposure*

| Exposure - Impacted Area (sq mi) | Exposure - Building Value | Exposure - Population | Exposure - Population Equivalence | Exposure - Total |
|---|---|---|---|---|
| 7.57 | $424,992,859.06 | 2,072 | $24,032,618,130.19 | $24,457610989.25 |

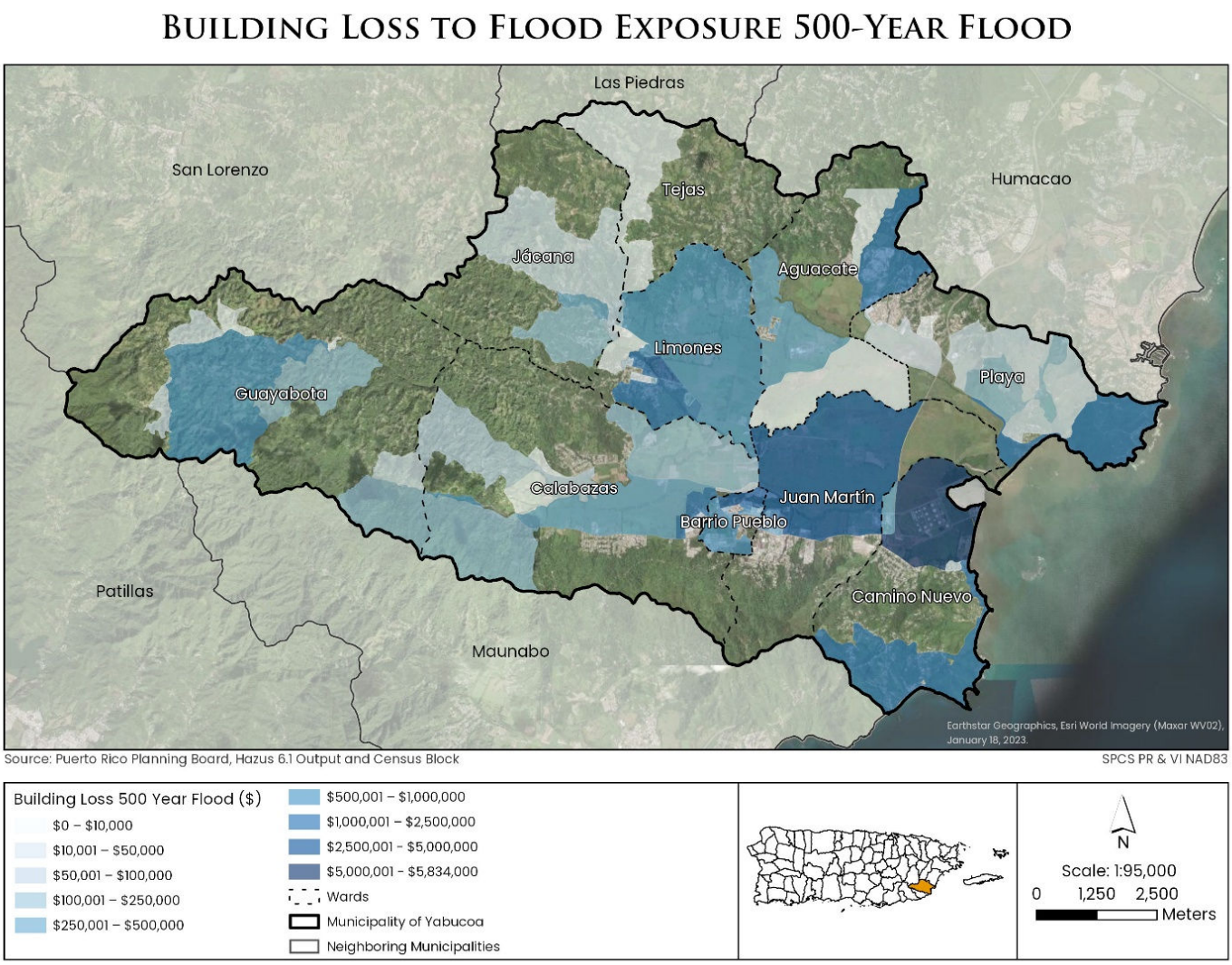
While Table 29 presents the expected annual flood related losses for both buildings and population.

*Table 29:Expected Annual Loss to Flood*

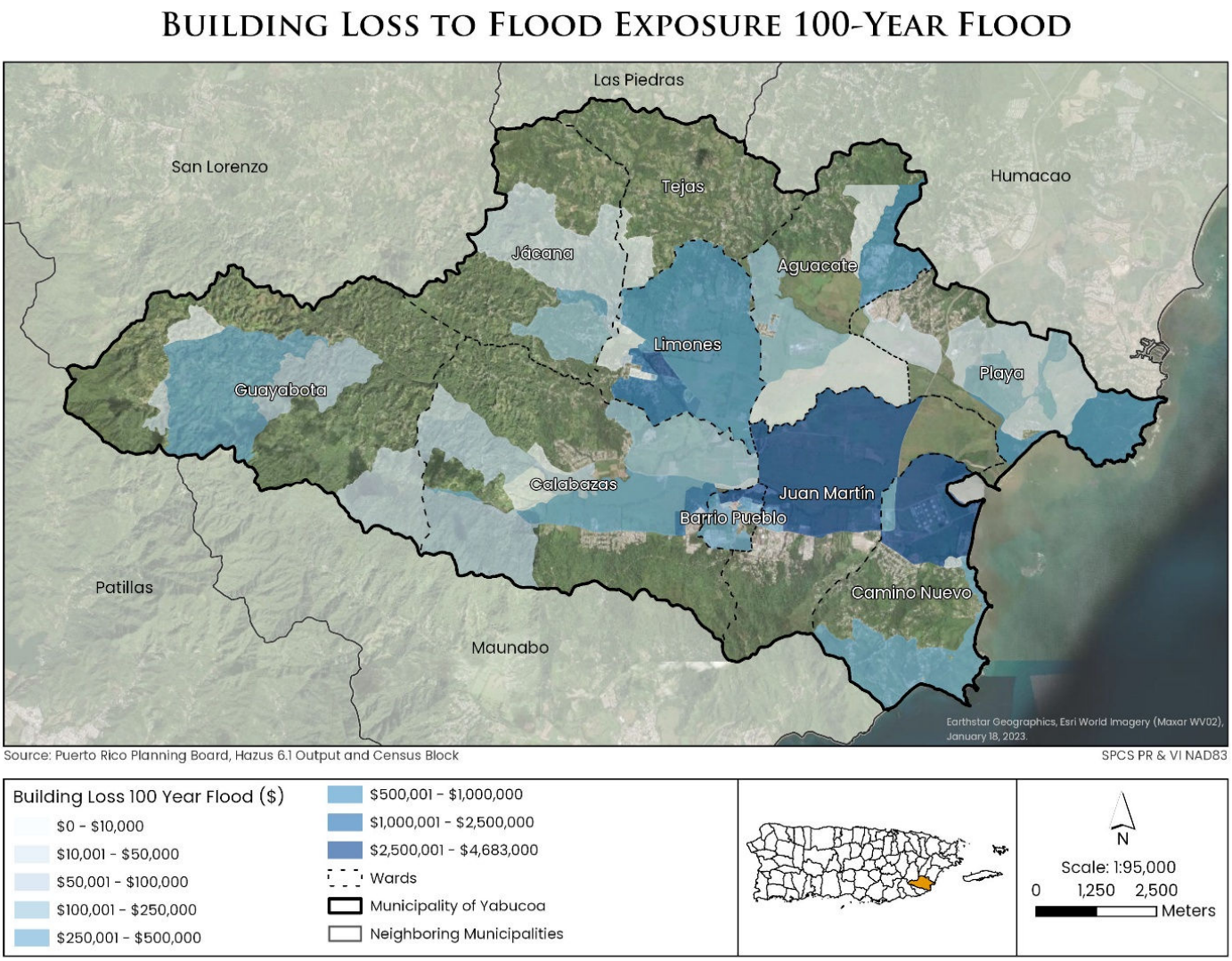
| Expected Annual Loss - Building Value | Expected Annual Loss - Population | Expected Annual Loss - Population Equivalence | Expected Annual Loss -Total |
|---|---|---|---|
| $166,192.38 | 0.75 | $87,053.60 | $253,245.98 |

.

*Map 32: Building Loss to Flood Exposure 500 – year flood*



*Map 33: Flood - Building Loss to Exposure 100 - year Flood*




After running the HAZUS model, the following estimated losses were determined:

- A total of 15,843 structures are expected to sustain losses (see Table 29).
- Total losses are estimated at $47,400,000 for a 100-year (1% annual-chance) event and $56336 for a 500-year (0.2% annual-chance) event (see Table 29).
- Specifically, for nonresidential structures, total losses are estimated at $$8,312,000for a 100-year (1% annual-chance) event and $10,487,000for a 500-year (0.2% annual-chance) event (see Table 30).
- For residential uses, losses are estimated at $$38,137,000for a 100-year (1% annual-chance) event and $45,849,000for a 500-year (0.2% annual-chance) event (see Table 31).

*Table 30: Total de Pérdidas de Estructuras*

| **Estructuras** | |
|---|---|
| No Residenciales | 67 |
| Residenciales | 15,776 |
| Total de estructuras | 15,843 |

*Table 31: Total de Pérdidas de Estructuras*

| Tipo de Uso | Pérdidas en dólares Evento de 1% | Pérdidas en dólares Evento de 0.2% |
|---|---|---|
| No - Residencial | $9,263,000 | $10,487,000 |
| Residencial | $38,137,000 | $45,849,000 |
| **Total** | **$47,400,000** | **$56,336,000** |

*Table 32: Pérdidas No Residenciales Detalladas*

| Tipo de Uso | Pérdidas en dólares Evento de 1% | Pérdidas en dólares Evento de 0.2% |
|---|---|---|
| Comercial | $5,233,000 | $5,612,000 |
| Educación | $3,079,000 | $3,382,000 |
| Gobierno | $277,000 | $797,000 |
| Religioso | $85,000 | $107,000 |
| Agricultura | $0 | $0 |
| Industrial | $589,000 | $589,000 |
| Total | $9,263,000 | $10,487,000 |

*Table 33: Pérdidas Residenciales Detalladas*

| Pérdidas Residenciales Detalladas | Pérdidas en dólares Evento de 1% | Pérdidas en dólares Evento de 0.2% |
|---|---|---|
| Structure | $10,482,000 | $13,001,000 |
| Contents | $5,873,000 | $7,629,000 |
| Relocation | $14,179,000 | $16,287,000 |
| Rental Income | $7,603,000 | $8,932,000 |
| Total | $38,137,000 | $45,849,000 |

#### 4.9.2.2 Lifelines and Critical Infrastructure

Flooding is among the most disruptive natural hazards, affecting all eight FEMA Community Lifelines. These lifelines represent essential services that support public health, safety, and economic stability. Below is an analysis of some of the impacts that flooding can have on lifelines:

- Safety and Security - Flooding can damage emergency services infrastructure such as police stations, fire departments, and emergency operations centers. Blocked evacuation routes and submerged roads hinder rescue efforts, while prolonged outages increase vulnerability to crime and civil unrest.

- Food, Water, Shelter - Floodwaters can contaminate drinking water supplies and damage water treatment facilities. Food supply chains may be severely disrupted when warehouses and grocery stores are flooded. Damage to residential structures can result in displacement, creating urgent demand for temporary shelters.

- Health and Medical - Hospitals and clinics may become inaccessible or experience power outages during flood events. Flood conditions can contribute to increased incidence of waterborne diseases and mold-related illnesses increase significantly. Disruptions to medical supply chains may delay both emergency care and routine treatments.

- Energy (Power and Fuel) - Flooding can submerge electrical substations and transformers, causing widespread outages. Fuel distribution networks may be disrupted due to impassable roads and damaged transportation routes. Prolonged power loss can significantly affect critical facilities such as hospitals and water treatment plants.

- Communications – Flooding can damage cell towers, fiber-optic cables, and emergency communication systems, reducing the capacity to coordinate rescue and recovery operations. This disruption can delay the dissemination of critical information.

- Transportation- Flooding can wash out or undermine roads, bridges, and rail lines, rendering them impassable. Airports and seaports may be forced to suspend operations, delay evacuation and the delivery of emergency supplies. Also, transportation disruptions amplify the overall impact of the disaster.

- Hazardous Materials - Floodwaters can mobilize and disperse hazardous substances from industrial sites, sewage systems, and fuel storage tanks, increasing the risk of environmental contamination. Cleanup efforts can become complex, costly and time-consuming, potentially resulting in long-term public and environmental impacts.

- Water Systems - Floodwaters can contaminate drinking water supplies and damage water treatment facilities. Excessive inflow from floodwaters may overwhelm sewer systems, causing untreated sewage to backflow into streets and homes. Flood conditions can exceed the design capacity of storm drains and retention basins, resulting in urban flooding and infrastructure damage. The accumulation of sediment and debris clog drainage systems, reducing effectiveness and increasing flood risk during subsequent storms events.

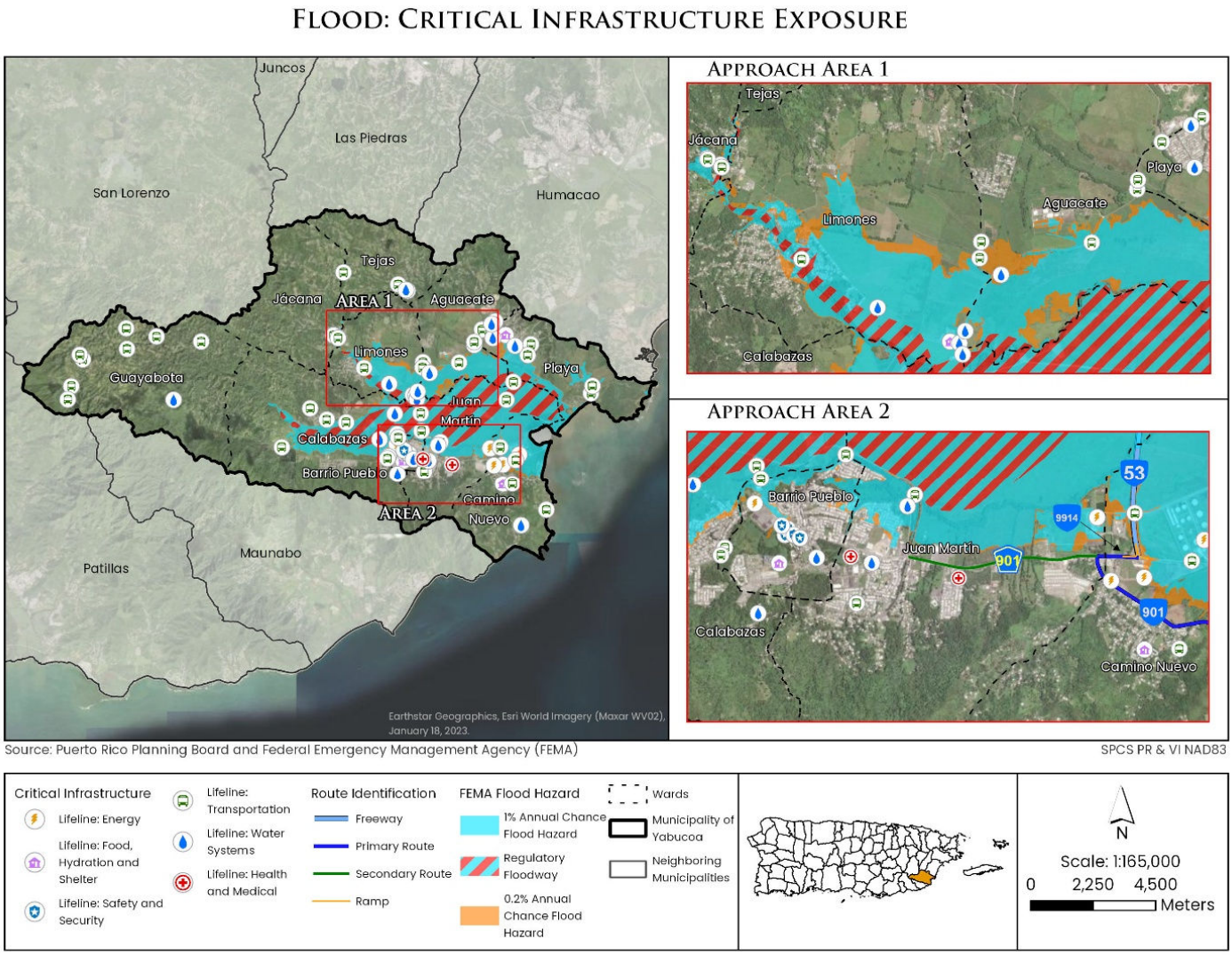
Map 35 shows the location of the critical facilities in relation to a 0.2% Flood event.

The vulnerability of the road system and bridges is mainly associated with soil erosion, flood risk, and obstruction caused by cables, poles, trees, and debris. Of particular note is PR-53, which serves as the main access point to the National Highway System. This roadway crosses throughout the Yabucoa Agricultural Reserve and the areas most prone to sever flooding. The following table, adapted from the previous LHMP, breaks down the calculation of the kilometers of primary and secondary state roads located within flood zone.

Also of concern is the fact that in the flood area there are many water system lifeline facilities affected, a prime example is the Yabucoa Treatment Plant.

.

*Map 34: Flood Critical Facilities Exposure*



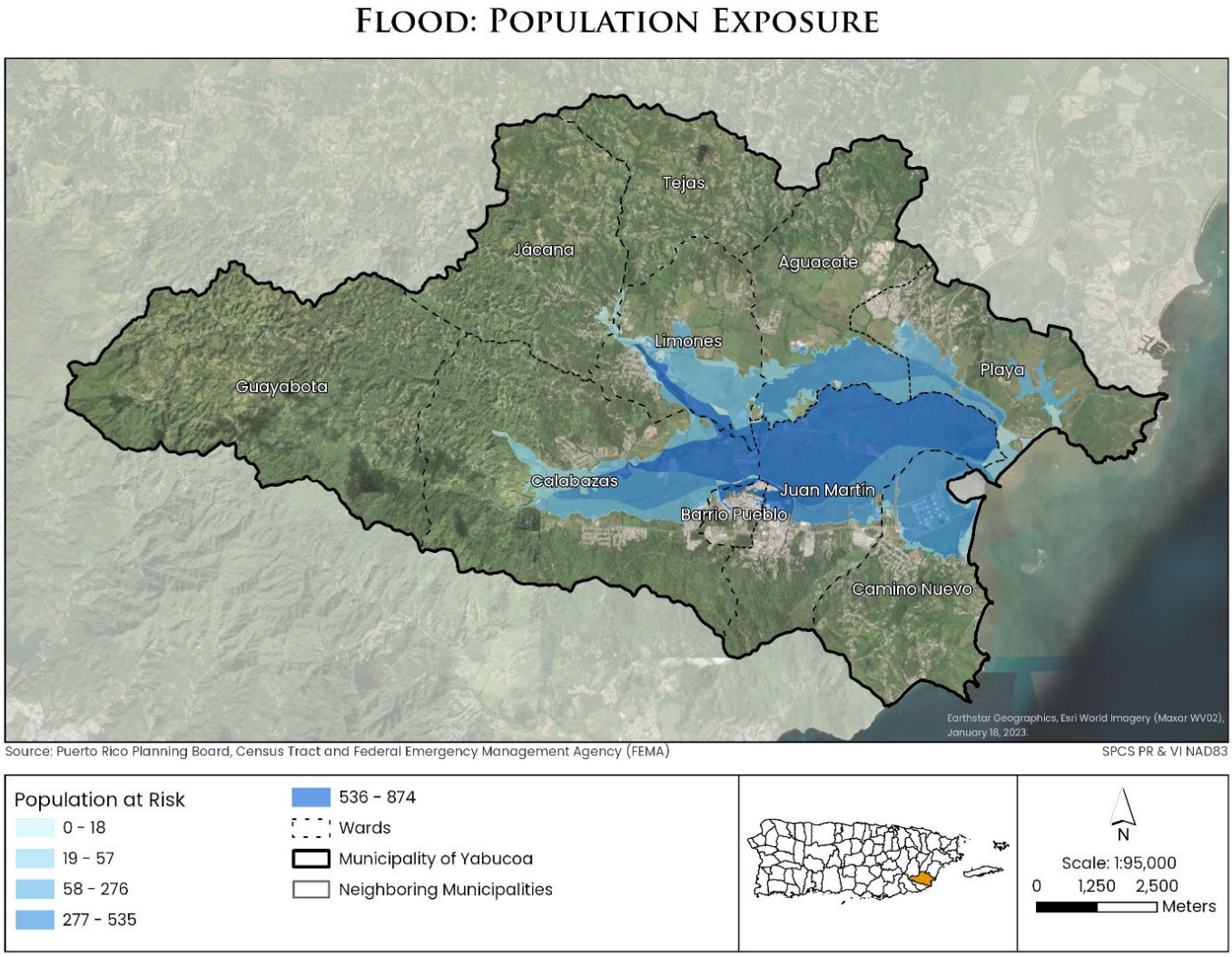
#### 4.9.2.3 Social Vulnerabilities

Map 36 shows the population at risk of displacement I for both a 500-year and 100 – year event.. The highest population exposure is concentrated along the Guayanes River Floodway and that if its tributaries. Some of the communities that are affected are, Jardines de Yabucoa I, Jardines de Yabucoa II, Los Angeles, and Martorell.

As discussed earlier, a significant portion of Yabucoa's population is considered vulnerable. Of particular concern, rural residents often rely on a single access road, which may become impassable due to flooding or landslides caused by erosion and soil saturation during heavy rainfall. One such example is PR-53 which crosses throughout the Yabucoa Agricultural Reserve and the areas most prone to sever flooding.

Research in flood-prone Puerto Rican communities shows that access to economic, material, and social resources strongly influences adaptive capacity, with low-income residents facing significant barriers to elevating homes, purchasing insurance, or relocating away from high-risk zones. These same communities frequently experience "false security" due to structural flood-control measures that reduce perceived risk but do not eliminate underlying exposure, which can worsen long-term vulnerability when residents underestimate future flood potential. Flood impacts also disproportionately affect individuals with limited mobility—including older adults, disabled residents, and those with chronic medical conditions—who may be unable to evacuate rapidly or access emergency shelters during rising waters. The Census Bureau's Community Resilience Estimates indicate that vehicle access, caregiver support, health insurance gaps, and disability prevalence are among the most widespread vulnerability components in the commonwealth, factors that directly shape whether individuals can flee or recover from flooding (US Census Bureau, 2024), (López Marrero, 2010) .

*Map 35: Flood: Population Exposure*




### 4.9.2.4 Natural and Cultural Resources

In most flood events, water resources are exposed to high levels of contaminants associated with rising water, sewage accumulation, and other hazardous or toxic substances left behind by flooding (Malilay, 2000). This contamination can facilitate the spread of diseases in municipal water bodies and adversely affect local flora and fauna, including humans. For example, prolonged stagnant water after a flood can promote diseases such as dengue and leptospirosis. Following Hurricane María, stagnant water contributed to leptospirosis outbreaks and mosquito proliferation. Leptospirosis is a bacterial disease that affects both humans and animals and can spread through urine from infected animals. These contaminated residues often

remain in stagnant water after flooding events.

Floods also lead to the accumulation of debris, including structural remnants, soil, sediments, organic waste, and personal belongings. If not properly managed, this debris can contaminate land and water when burned, abandoned, buried, or dumped into water bodies.

#### 4.9.2.5 Special Consideration: Repetitive Loses and Severe Repetitive Losses

In Yabucoa there are properties insured under the National Flood Insurance Program (NFIP). These properties participate in the NFIP covered by the PRPB. Section 6.5 provides further details on how the municipality can use the NFIP as a mechanism for mitigation planning.

The Municipality has included properties that have experienced repetitive losses and/or severe repetitive losses located in identified flood hazard areas. These properties currently lack descriptions of the type of structures (residential, commercial, institutional, among others). Including this information helps to understand the vulnerability of properties affected by flooding within the jurisdiction and increases the likelihood of qualifying for flood control or prevention grants through programs such as Flood Mitigation Assistance (FMA), Hazard Mitigation Grant Program (HMGP), Housing and Urban Development (HUD), CDBG-DR, and others.

As of May 29, 2026, the information regarding NFIP coverage for Repetitive Loses (RL) and Severe Repetitive Loses (SRL) for the Municipality of Yabucoa are as follow:

*Table 34: NFIP Policies in force and coverage*

| Amount of NFIP Policies | Total Disbursement for both RL and SRL Loses |
|---|---|
| 31 | $301,608 |

Accordingly, the registered RL are as follows:

*Table 35: NFIP Repetitive Loses*

| Structures with Repetitive Loses (RL) | Insured structures (RL) | Total Repetitive Losses (RL) |
|---|---|---|
| 22 | 1 | 47 |

While the data provided show the following information regarding SRL

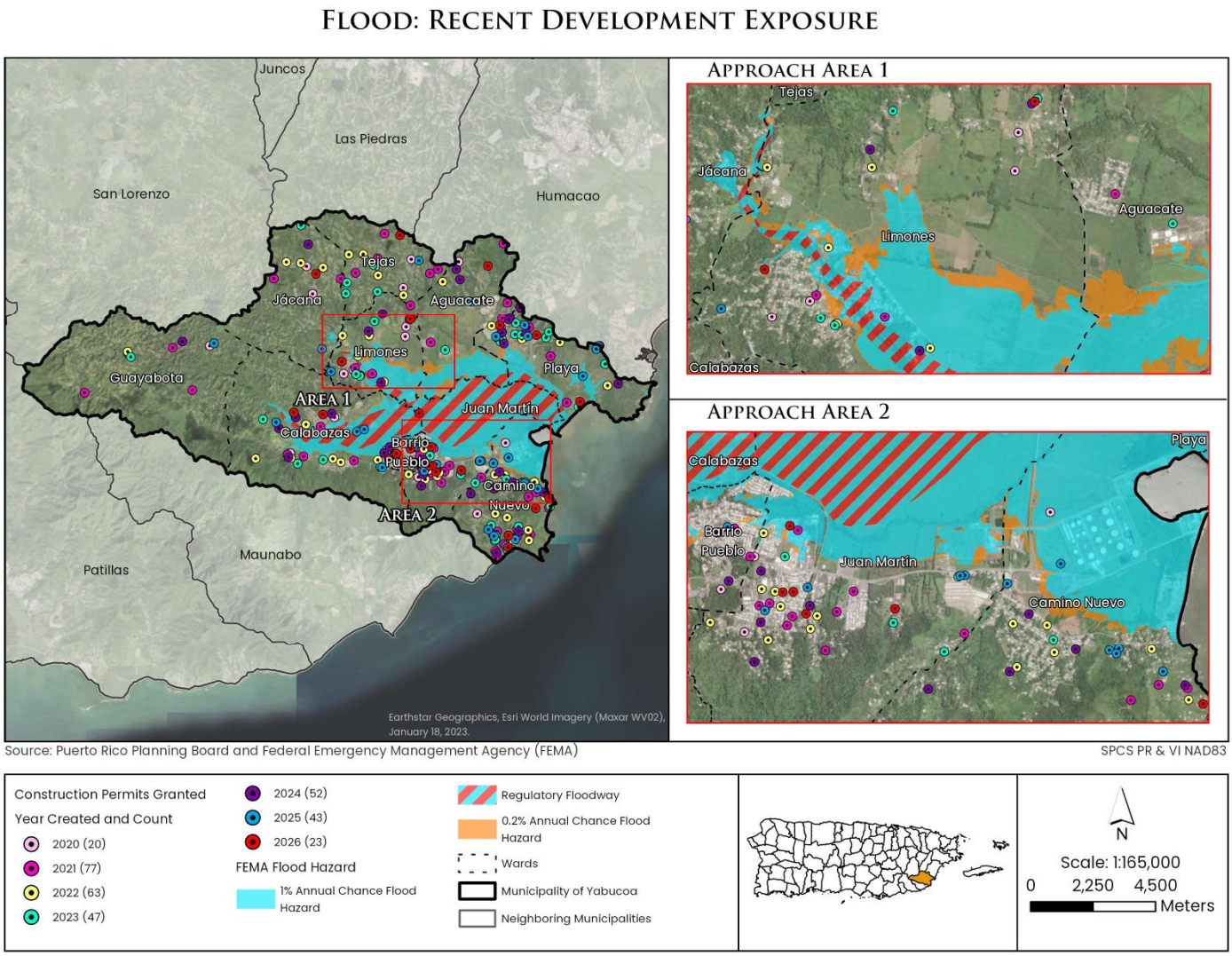
*Table 36: NFIP Severe Repetitive Loses*

| Structures with Severe Repetitive Loses (SRL) | Insured structures S(RL) | Total Repetitive Losses (SRL) |
|---|---|---|
| 0 | 0 | 0 |

#### *4.9.2.6 Future Conditions (E1-A)*

The following map shows the locations of recent construction permits in Yabucoa in relation to known flood areas. This map shows that few permits have been issued in areas identified as flood zone in the FIRM maps.

*Map 36: Flood Recent Development Exposure*




## 4.10 Tropical Cyclones and other Extreme Wind Events

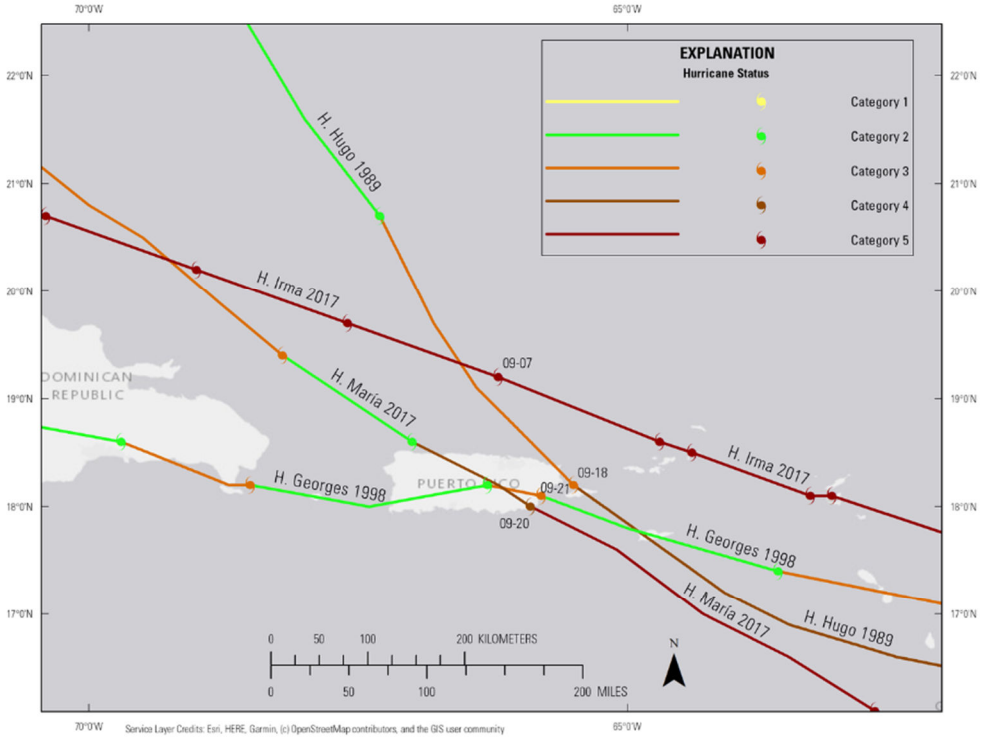
### 4.10.1 Description (B1-a)

Winds consist of air currents generated in the atmosphere due to variations in pressure. Although these currents are constantly present, when their intensity increases, they can become a high-level hazard. For the purposes of this Plan, we will focus on events severe wind events associated with tropical cyclones and their extreme force (Castro Rivera & López Marrero, Cartilla de los Ciclones, 2018).

This sub-chapter is titled Tropical Cyclones in order to include phenomena such as tropical storms and tropical depressions. However, hurricanes pose the greatest threat due to their high destructive potential, wide geographic impact, rapid development, and sometimes unpredictable paths. In addition, hurricanes are often accompanied by high tides, storm surges, and heavy rainfall, which may result in landslides and riverine flooding. Since these accompanying hazards are addressed in separate sections, this section will focus specifically on the impact of wind within the municipality.

Figure 21 shows the path of category 2 – 5 hurricanes that have affected Puerto Rico since 1989.[8]

*Figure 21: Hurricane Tracks 1989-2017 (only Cat 2-5)* [9]




Sources/Usage: Public Domain. View Media Details

***Figure 1.*** *Hurricane tracks for Hugo (1898), Georges (1998), Irma (2017) and Maria (2017). Data provided by NOAA. Base image is intellectual property of Esri and is used herein under license. Copyright Esri and its creator.*

***Figura 1:*** *Trayectorias de los huracanes Hugo (1989), Georges (1998), Irma (2017) y María (2017). Datos provistos por la NOAA. La imagen de base es propiedad intelectual de Esri y se usa aquí bajo licencia. Los derechos de autor y reproducción son propiedad de Esri y sus licenciatarios.*

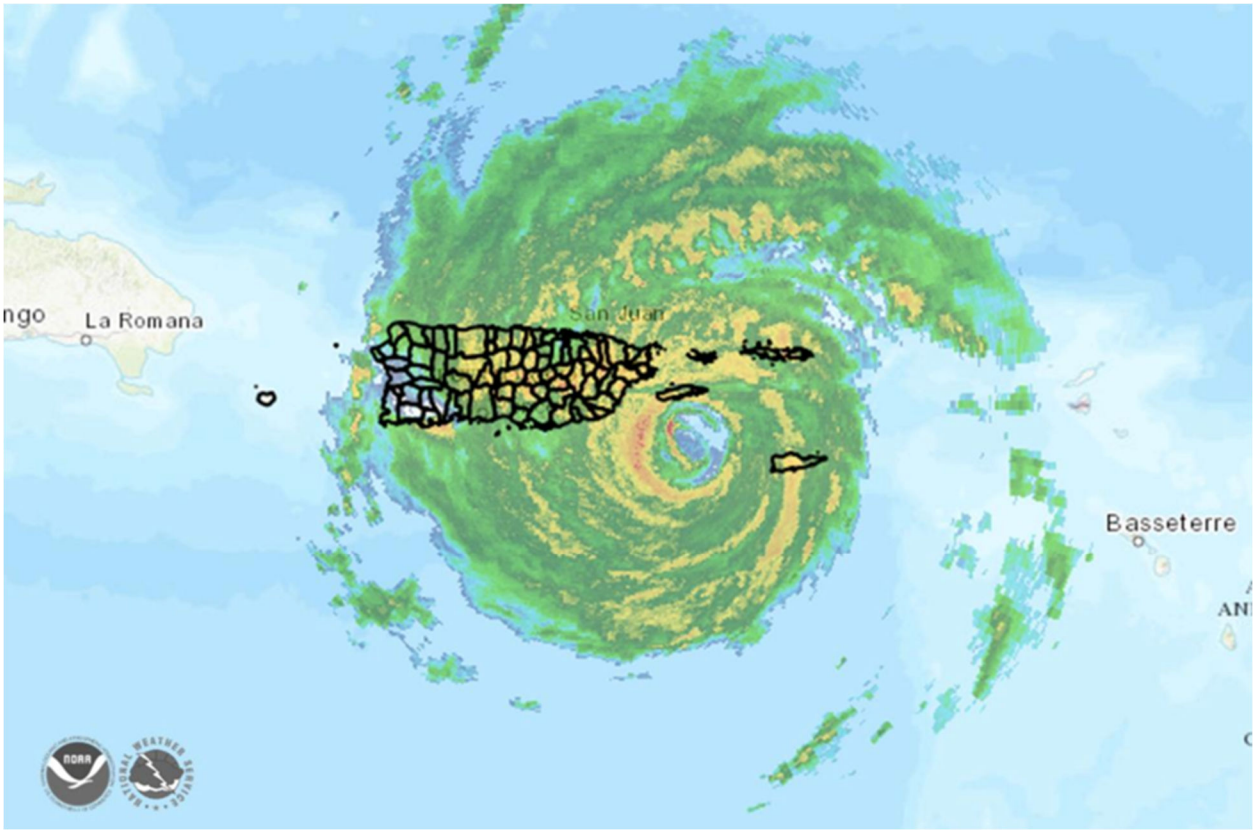
[8] Hortense (1996) and Fiona (2022) are not shown since they were category 1 hurricanes when they hit Puerto Rico.

[9] htt.s://www.usgs/gov/mission-areas/natural-hazards/science/Puerto-rico-natural-hazards-hurricanes-peligros-naturales-de

### 4.10.1.1 Affected Area (B1-b)

Tropical Cyclones are atmospheric systems that can affect the whole island. For example, Figure 22 shows the size of hurricane María (2017) as it approached Puerto Rico.

*Figure 22: Hurricane María (2017) as it approaches Puerto Rico*[10]




### 4.10.1.2 Risk Magnitude (B1-c)

Tropical cyclones are the most frequent natural hazard in Puerto Rico, with hurricanes being the most dangerous. Hurricanes are tropical atmospheric systems characterized by sustained wind speeds exceeding seventy-four (74) miles per hour. They develop over warm ocean waters and result from instability caused by the interaction of warm and cool air masses. Tropical cyclones are classified according to sustained wind intensity as follows:

[10] Obtained from https://www.researchgate.net/figure/Hurricane-Maria-approaching-Puerto-Rico-NWS-2017_fig1_371340603.

Tropical Depression: An organized system of clouds with a defined circulation and maximum sustained winds below 39 mph. This represents the formative stage of a tropical cyclone.
Tropical Storm: An organized system of clouds with a defined circulation and maximum sustained winds ranging from 39 to 73 mph.
Hurricane: The most intense form of a tropical cyclone, with sustained winds of 74 mph or greater. Hurricanes have a well-defined center with very low barometric pressure. They are categorized from one (I) to five (V), and the strongest can reach wind speeds exceeding 155 mph (Castro Rivera & López Marrero, 2018).

Table 37 shows the Saffir - Simpson Scale of hurricanes and gives historical examples of those passing through or near Puerto Rico.

*Table 37: Saffir-Simpson Hurricane Scale*

| Category | Wind Speed | Description | Historical Example |
|---|---|---|---|
| Tropical Storm | 39 – 73 mph | Strong enough to cause tree damage, power outages, and localized flooding, but generally less destructive than a hurricane. | Eloise (1975)<br>Claudette (1979)<br>Frederic (1979)<br>Jeanne (2004)<br>Irene (2011)<br>Isaias (2020)<br>Ernesto (2024) |
| 1 | 74–95 mph | Winds can cause minor damage to roofs, siding, and trees, with potential for power outages. | Santa Clara[11] (1956)<br>Hortense (1996)<br>Fiona (2022) |
| 2 | 96–110 mph | Strong winds can cause extensive damage to roofs and trees, leading to widespread power loss. | Marilyn (1995) |
| 3 | 111–129 mph | Devastating winds can destroy roofs and walls of homes, | Hugo (1989)<br>Georges (1998) |

[11] Officially known as Hurricane Betsy

| | | | |
|---|---|---|---|
| | | uproot trees, and cause prolonged outages. | |
| 4 | 130–156 mph | Catastrophic winds can cause severe structural damage, most trees snapped or uprooted, and power outages lasting weeks. | San Ciriaco (1899)<br>San Ciprian (1932)<br>Donna (1960)<br>David (1979)<br>María (2025) |
| 5 | 157 mph or higher | Catastrophic winds can result in total roof failure and building collapse, rendering areas uninhabitable for weeks or months. | San Felipe II (1928)<br>Irma (2017) |

To assess the vulnerability posed by hurricanes, this LHMP utilizes the 100 – year wind event and 500-year wind event as benchmark design standards. A 100-year wind event refers to a wind speed that has a 1% chance of being equaled or exceeded in any given year. Similarly, a 500-year wind event has a 0.2% annual probability of being equaled or exceeded. These terms describe statistical return periods and do not imply that such events occur only once every 100 or 500 years. Rather, they express the likelihood of occurrence in any single year. Wind return period values are derived through statistical analysis of historical wind speed records using extreme value probability models. These analyses estimate wind intensities associated with specific recurrence intervals and are widely applied in engineering, insurance modeling, and hazard mitigation planning.

These values are critical for structural design standards like the American Society of Civil Engineers Standard 7 (ASCE 7), which specify wind loads for different risk categories, and for insurance companies assessing potential storm damage. For example, typical 3-second gust wind speeds at 33 ft above ground (Exposure Category C) are about 100 mph for a 100-year event and approximately 110–115 mph for a 500-year event. These design speeds ensure safety for buildings, bridges, and critical infrastructure, and help guide emergency planning and financial risk management.

#### *4.10.1.3 Past Events (B1-d)*

The following table shows the extreme wind events that received a declaration of disaster in since 2000. One column identifies whether the Municipality of Yabucoa was

designated for Public Assistance (PA), Individual Assistance (IA), or both under each declaration.

*Table 38: Tropical Cyclone Disaster Declarations since 2000*

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| Tropical Storm Ernesto | 8/14/2024 – 8/16/2024 | DR-4850- PR | Public Assistance – Yes<br><br>Individual Assistance No | The storm's slow movement and moisture-rich environment contributed to prolonged precipitation, particularly in central and eastern municipalities. Parts of Central Puerto Rico recorded 12–14 inches of rainfall in localized areas.<br><br>Flash flooding occurred in urban and rural areas, rendering primary and secondary roads impassable. Floodwater caused structural failures in bridges and washed-out critical road segments, isolating several communities. Stormwater drainage systems in metropolitan areas, were overwhelmed, leading to localized urban flooding. |
| Hurricane Fiona | 9/17/2022 - 9/21/2022 | DR-4671-PR | Public Assistance – Yes<br><br>Individual Assistance - Yes | Hurricane Fiona struck Puerto Rico in September 2022, unleashing torrential rains—up to 31.22 inches of rainfall over 72 hours in Ponce, nearly matching the accumulation from Hurricane Maria. This deluge led to catastrophic flooding, with 7 to 20 inches common across most of the island and localized spots exceeding 30 inches. |

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| Tropical Storm Isaías | 9/29-30/2020 | DR-4560-PR | Public Assistance: No<br><br>Individual Assistance; No | Although the center of Tropical Storm Isaías did not make landfall on the island, the system left a large amount of rain in its path, causing flooding throughout Puerto Rico. Rainfall accumulation of up to 10 inches was recorded around the island. |
| Hurricane María | 9/20/2017 | DR-4339-PR | Public Assistance – Yes<br><br>Individual Assistance - Yes | Widespread flooding severely affected the whole Island. For example, in San Juan, water levels reached up to 6 feet in some areas and numerous structures losing their roofs. Survivors reported that floodwater rose 6 feet in just 30 minutes, and some areas experienced depths of up to 15 feet (4.6 m). |
| Hurricane Irma | 9/5/2017 | DR-4336-PR | Public Assistance – Yes<br><br>Individual Assistance - No | On September 5, 2017, Hurricane Irma impacted Puerto Rico; an Emergency Declaration was issued for the Island. On September 6, 2017, a Major Disaster Declaration was issued following Hurricane Irma's passage.<br><br>Two people died due to torrential rains before the hurricane. |

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| Tropical Storm María[12] | 9/8/2011 – 9/11/2011 | DR-4040-PR | Public Assistance: Yes<br><br>Individual Assistance: No | Tropical Storm (later Hurricane) Maria formed in early September 2011 and passed near Puerto Rico, bringing significant heavy rainfall and tropical storm conditions to the island. The storm caused widespread flooding that inundated numerous roadways and homes; floodwaters near Patillas destroyed several homes and bridges, and approximately 150 houses in Yabucoa were flooded and damaged |
| Hurricane Irene | 8/22/2011 | DR-4017-PR | Public Assistance: No<br><br>Individual Assistance: No | Total rainfall reached 22 inches over three days, with the eastern region being the most affected—the same area that had already received over 6 inches earlier in August during the close passage of Tropical Storm Emily. Record levels were recorded for many rivers. Flooding was severe enough to cause infrastructure stress and dangerous conditions across multiple municipalities. There was one direct fatality attributed to Irene, due to drowning. |

[12] Tropical Storm María was a tropical system that pass to the northeast of Puerto Rico in 2011 and that caused flooding in the Island. Not to be confused with the 2017 Hurricane María. The name "María" was retired from the official Atlantic hurricane season list of names after 2017.

| Event | Date | Disaster Declaration Number | Yabucoa Included? | Description |
|---|---|---|---|---|
| Tropical Storm Jeanne | 9/14/2004 – 9/19/2004 | DR-1152-PR | Public Assistance: Yes<br><br>Individual Assistance Yes | Tropical Storm Jeanne crossed Puerto Rico on September 15, 2004, as a strong tropical storm with maximum sustained winds around 70 mph (110 km/h), producing gusts up to 72 mph (≈116 km/h). The winds caused widespread power and water outages, with numerous reports of structural damage to homes, uprooted trees, fallen utility poles, and significant impacts on infrastructure across the island.<br><br>The storm resulted in eight fatalities in Puerto Rico—four direct and four indirect, including deaths during preparations and carbon monoxide poisoning. Damages were estimated at approximately $169.5 million (2004 USD), making Jeanne the most destructive tropical cyclone to impact Puerto Rico since Hurricane Georges in 1998. |

#### 4.10.1.4 Tornados

No tornado has been registered in Yabucoa according to the NOAA's National Centers for Environmental information (NCEI).

#### 4.10.1.5 Future event probabilities (B1-e)

According to the Colorado State University Tropical Cyclones, Rada, Atmospheric Modeling and Software Team, the following average annual probabilities apply for storms coming ashore or passing within 50 miles of Puerto Rico: (Colorado State University, 2026)

- Average probability of a named storm coming ashore or within 50 miles of Puerto Rico: 40%
- Average probability of a hurricane coming ashore or within 50 miles of Puerto Rico: 24%
- Average probability of a major hurricane coming ashore or within 50 miles of Puerto Rico: 9%

### 4.10.2 Risk Analysis (B2-a, B2-b)

#### 4.10.2.1 Estimated Loses

Table 39 presents the exposure to tsunamis, as registered in FEMA National Risk Index.

*Table 39: Tropical Cyclone Exposure*

| Exposure - Impacted Area (sq mi) | Exposure - Building Value | Exposure - Population | Exposure - Population Equivalence | Exposure - Total |
|---|---|---|---|---|
| 55.809063 | $ 3,344,912,759.59 | 30,394 | $ 352,570,993,315.28 | $ 355,915,906,074.87 |

The expected annual loss represents the average yearly economic impact, expressed in dollars, anticipated from natural hazard events. Table 40 presents the expected annual tsunami-related losses for both buildings and population.

*Table 40: Expected Annual Loss to Tropical Cyclone*

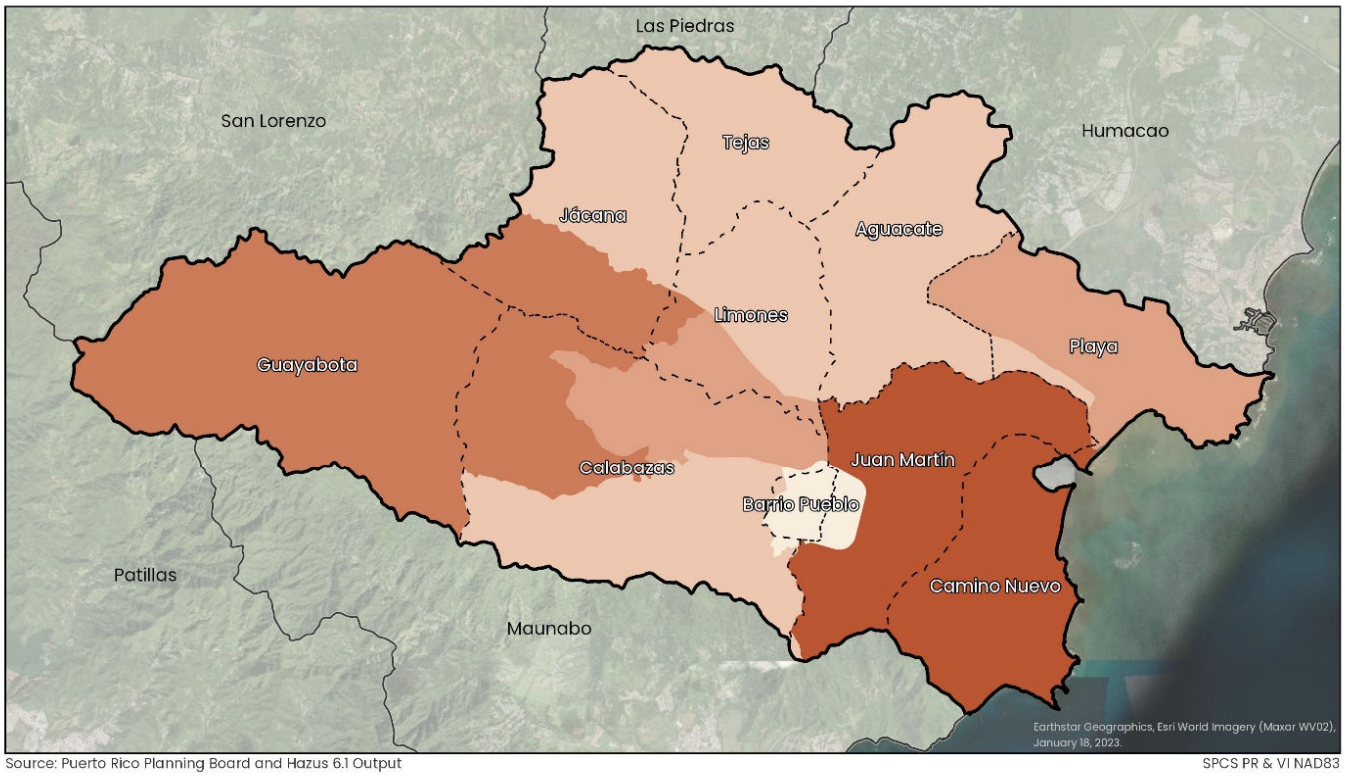
| Expected Annual Loss - Building Value | Expected Annual Loss - Population | Expected Annual Loss - Population Equivalence | Expected Annual Loss -Total |
|---|---|---|---|
| $ 17,077,478.46 | 0.0626 | $ 726,138.44 | $17,803,616.9 |

The following maps show the expected losses resulting from the impact of a hurricane. Map 37 presents the projected total building damage associated with a 100 year wind event. This map shows that the greatest loss of buildings would be in the Guayabota and the mountainous section of Calabazas and Jácana wards. subdivisions. The 500-year event (Map 38) shows similar results to the 100-year event map, though with increased overall loss values due to higher design speeds and greater structural stress.

The higher building damage in the western section of the municipality is largely attributable to topographic influences. Wind speeds are generally stronger over mountainous terrain due to elevation and topographic effects, while the lower, flatter northern areas experience comparatively lower wind intensities.

*Map 37: Tropical Cyclone - Total Damaged Buildings 100 – Year Event*

# Tropical Cyclone: Total Damaged Building 100-Year Event




Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Total Damage Building Count (100yr)
- 241 - 265
- 266 - 365
- 366 - 462
- 463 - 580
- 581 - 892
- Wards
- Municipality of Yabucoa
- Neighboring Municipalities

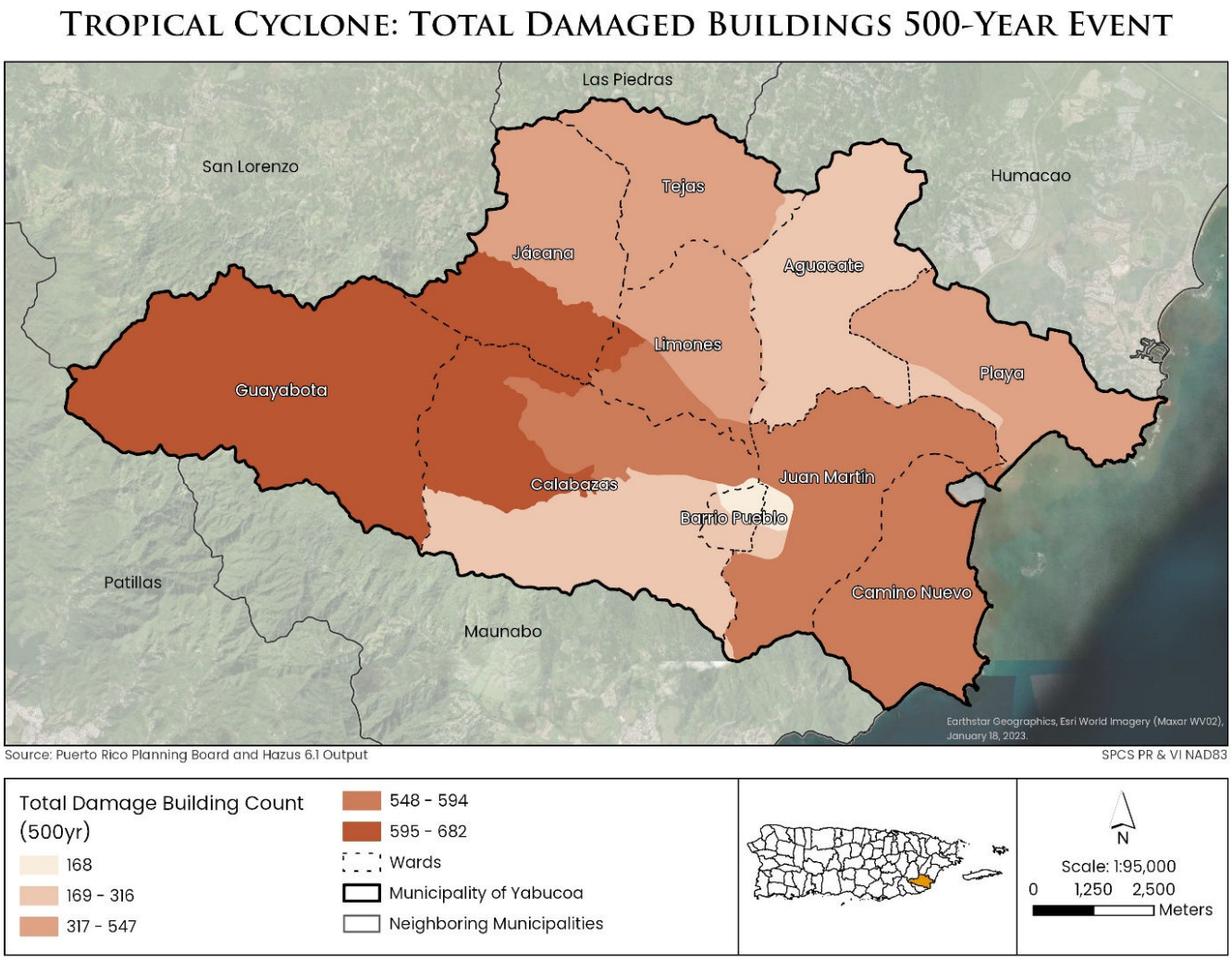


N

Scale: 1:95,000

0 1,250 2,500 Meters

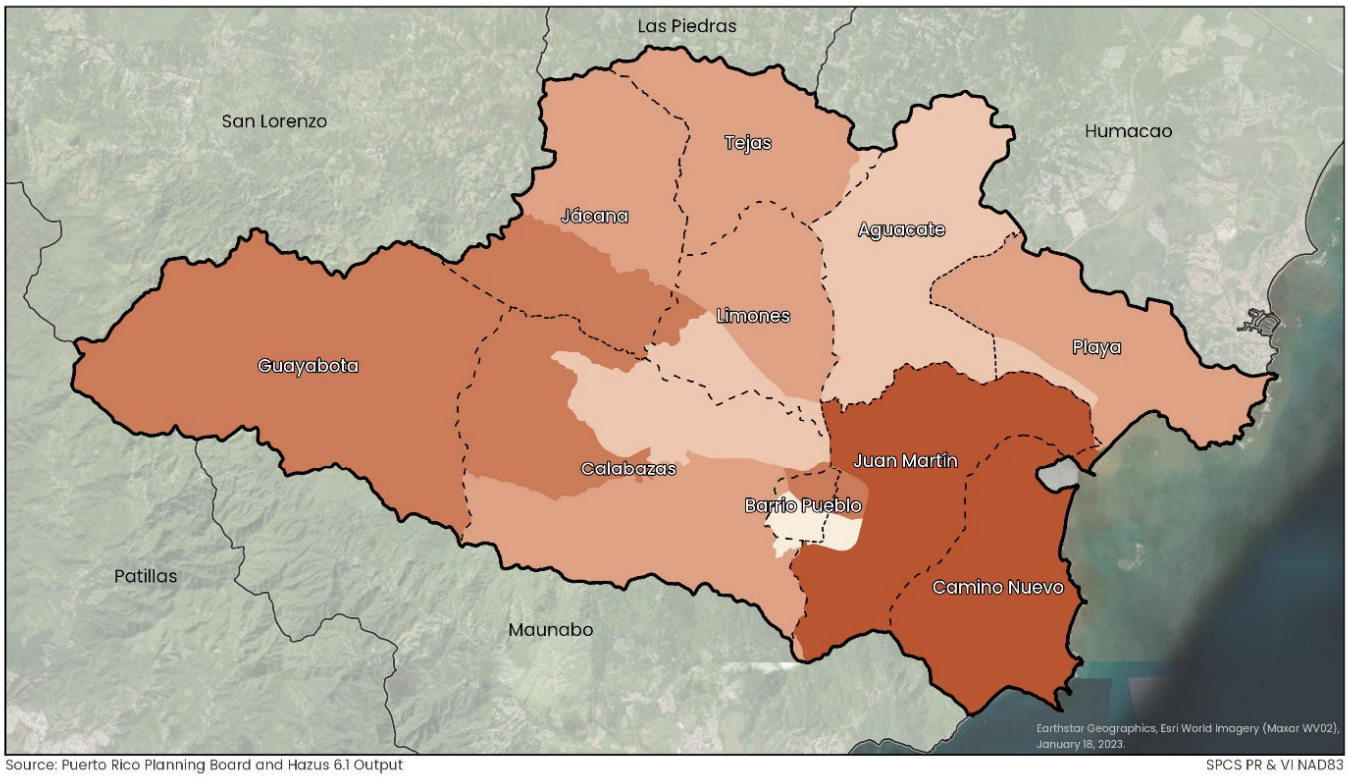
*Map 38: Tropical Cyclone - Total Damaged Building 500 - Year Event*




Map 39 shows the total Economic Loss for a 100 – year event, while Map 40 shows the total Economic Loss for a 500 Year event. Both maps show that the greatest economic loss would be in the Camino Nuevo and Juan Martin wards. This most likely accounts for the industrial infrastructure related to the Port of Yabucoa and the commercial corridor between the PR-901's intersection with PR-53 and the town center.

*Map 39; Tropical Cyclone: Economic Loss 100 year event*

## Tropical Cyclone: Total Economic Loss 100 Year-Event ($K)




Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Total Loss - All - 100 Year Event ($K)

- $54,928.69
- $54,928.70 - $78,151.28
- $78,151.29 - $95,830.14
- $95,830.15 - $128,493.66
- $128,493.67 - $222,543.85
- Wards
- Municipality of Yabucoa
- Neighboring Municipalities

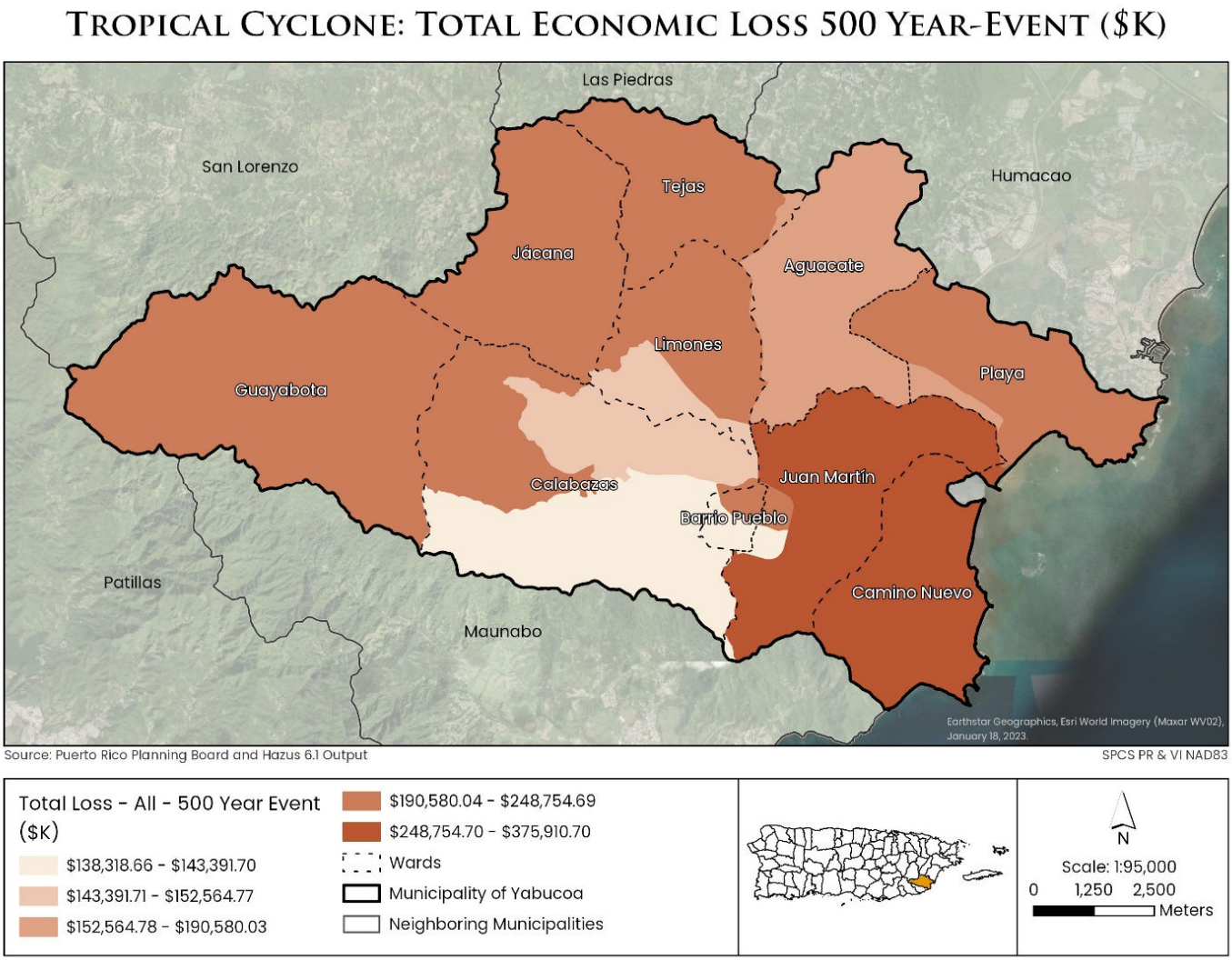


N

Scale: 1:95,000

0 1,250 2,500 Meters

*Map 40: Tropical Cyclone: Economic Loss 500 year event*




### 4.10.2.2 Lifelines and Critical Infrastructure

Hurricane winds have profound effects on all eight FEMA Community Lifelines, disrupting essential services and infrastructure.

- Safety and Security systems are compromised when high winds damage police stations, fire departments, and emergency operations centers, while debris and fallen power lines obstruct emergency routes, delaying rescue efforts.

- Food, Hydration, and Shelter lifelines suffer as winds destroy agricultural fields,

damage food storage facilities, and tear roofs off homes and shelters, leaving communities vulnerable and displacing thousands.

- In the Health and Medicine sector, hospitals and clinics experience roof failures and structural damage, forcing evacuations and interrupting critical care, while pharmacies and supply chains face severe disruptions.

- The Energy lifeline is particularly vulnerable, as hurricane winds topple transmission towers, snap utility poles, and damage substations, causing widespread power outages that cascade into other lifelines.

- Communications systems fail when telecommunication towers and antennas are blown down, severing cellular and internet connectivity and hindering emergency coordination.

- Transportation networks are crippled by blocked roads, damaged bridges, and wind-related destruction at airports and seaports, delaying relief efforts and supply deliveries.

- Facilities handling Hazardous Materials face increased risks when wind-driven debris ruptures tanks or pipelines, creating environmental hazards and complicating cleanup operations.

- Finally, Water Systems are disrupted as treatment plants and pumping stations sustain roof and equipment damage, while elevated storage tanks and distribution infrastructure collapse, interrupting access to clean water for drinking and sanitation. These cascading failures underscore the critical need for wind-resistant design standards and proactive planning to protect lifelines and maintain community resilience during hurricane events.

For planning purposes this LHMP shall assume that all critical infrastructure is equally exposed to this hazard.

**Yabucoa Port and Petroleum Storage Facility**

Tropical cyclones present a multi-hazard threat to the Port of Yabucoa, combining high winds, heavy rainfall, and coastal flooding. Strong winds can damage port structures, cranes, and storage tank components, while intense rainfall may lead to

flooding and operational shutdowns. These storms can also disrupt maritime traffic, delay fuel shipments, and compromise the integrity of oil storage systems. The cumulative effects of wind and water increase the likelihood of infrastructure damage and fuel supply interruptions.

#### 4.10.2.3 Social Vulnerabilities

As discussed before in Section 4.6.1.1 a tropical cyclone can impact the whole island. For this LHMP it is assumed that all the population of Yabucoa is vulnerable to this hazard. For further details on the Municipality's social vulnerability see section 3.4

#### 4.10.2.4 Natural and Cultural Resources

Hurricane winds caused extensive damage to both natural and cultural resources by exerting extreme mechanical forces on landscapes and built environments. In natural settings, strong winds uproot trees, strip foliage, and break branches, leading to deforestation and habitat loss. This disruption affects biodiversity and can alter ecosystem functions for years. Coastal vegetation such as mangroves is particularly vulnerable, as wind-driven forces weaken root systems and reduce their ability to protect shorelines. Agricultural areas also suffer severe losses, with crops flattened or destroyed, impacting food supply and local economies.

Cultural resources, including historic buildings, monuments, and archaeological sites, are equally at risk from hurricane winds. High wind speeds can dislodge roofing materials, collapse walls, and damage structural integrity, especially in older or unreinforced constructions. Museums, archives, and heritage sites may experience irreparable harm if protective measures are inadequate. The loss of these cultural assets not only affects community identity but also has economic implications for tourism and preservation efforts. Understanding wind speed thresholds and incorporating them into design standards and conservation planning is essential to mitigate these risks and safeguard both natural and cultural heritage.

#### 4.10.2.5 Future Conditions (E1-a)

The risk of hurricane is a municipal – wide risk. Every part of the recent development approved by the municipality is equally in risk of being affected by a tropical cyclone.

## 4.11 Storm Surge

### 4.11.1 Description

A storm surge is the inland movement of seawater that occurs when a hurricane makes a direct impact on the coast. These storm surges occur due to an atypical increase in the water levels of water bodies. Primarily, storm surges are produced by an excessive rise in water along coastlines as a consequence of a massive low-pressure system, rainfall, and strong winds, characteristic of a hurricane or tropical storm (Castro Rivera & López Marrero, 2018).

These factors, inherent to a storm surge, create dangerous conditions at sea and cause extensive devastation after passing through coastal areas. Consequently, this type of natural hazard results in loss of life and severe damage to infrastructure and structures located in the affected areas. They are particularly dangerous when they occur during high tide, combined with the effects of swells and wave action. These factors make it difficult to predict this type of event because they depend on the diversity of tropical systems, the geological formations of the impacted area, and meteorological forecasts (FEMA, 1997).

The maximum potential storm surge for a particular location depends on a series of different factors. Storm surge is a very complex phenomenon because it is sensitive to even slight changes in storm intensity, forward speed, size (radius of maximum winds—RMW), angle of approach to the coast, central pressure (which contributes minimally compared to wind), and the shape of coastal features such as bays and estuaries.

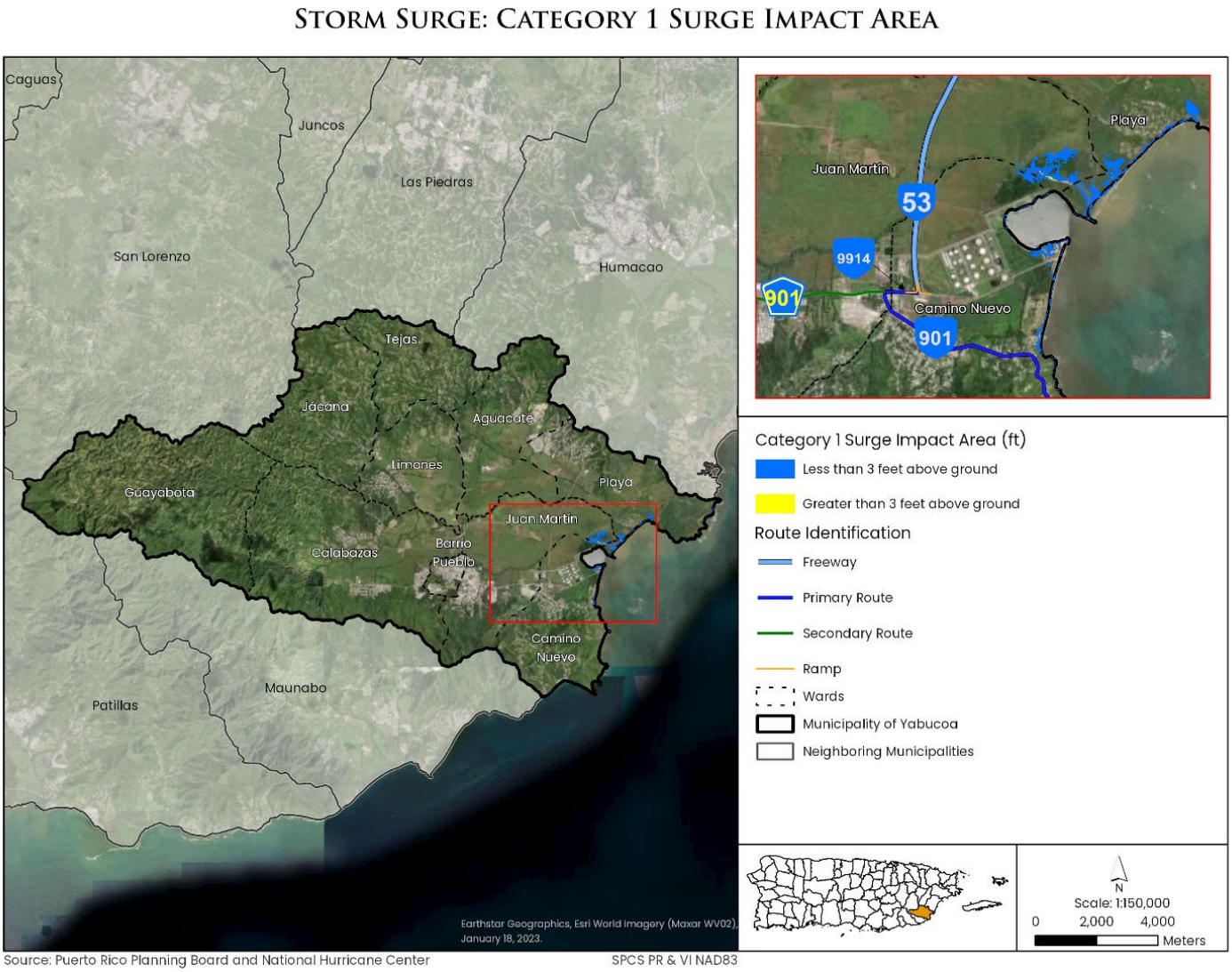
Coastal areas are usually prone to storm surge impacts when an imminent hurricane threat is present. The behavior, magnitude, and impact of storm surge over land vary depending on the hurricane's trajectory. Likewise, the topography and coastal bathymetry of the municipality play an important role in relation to the impact of the surge on affected areas (FEMA, 1997).

In the case of Yabucoa, there is also a heightened chance of storm surge as the tropical cyclones that directly hit the island usually do so from the east coast (ie. María, Georges, Hugo, Santa Clara (Betsy) San Felipe II. etc.)

### 4.11.1.1 Affected Area

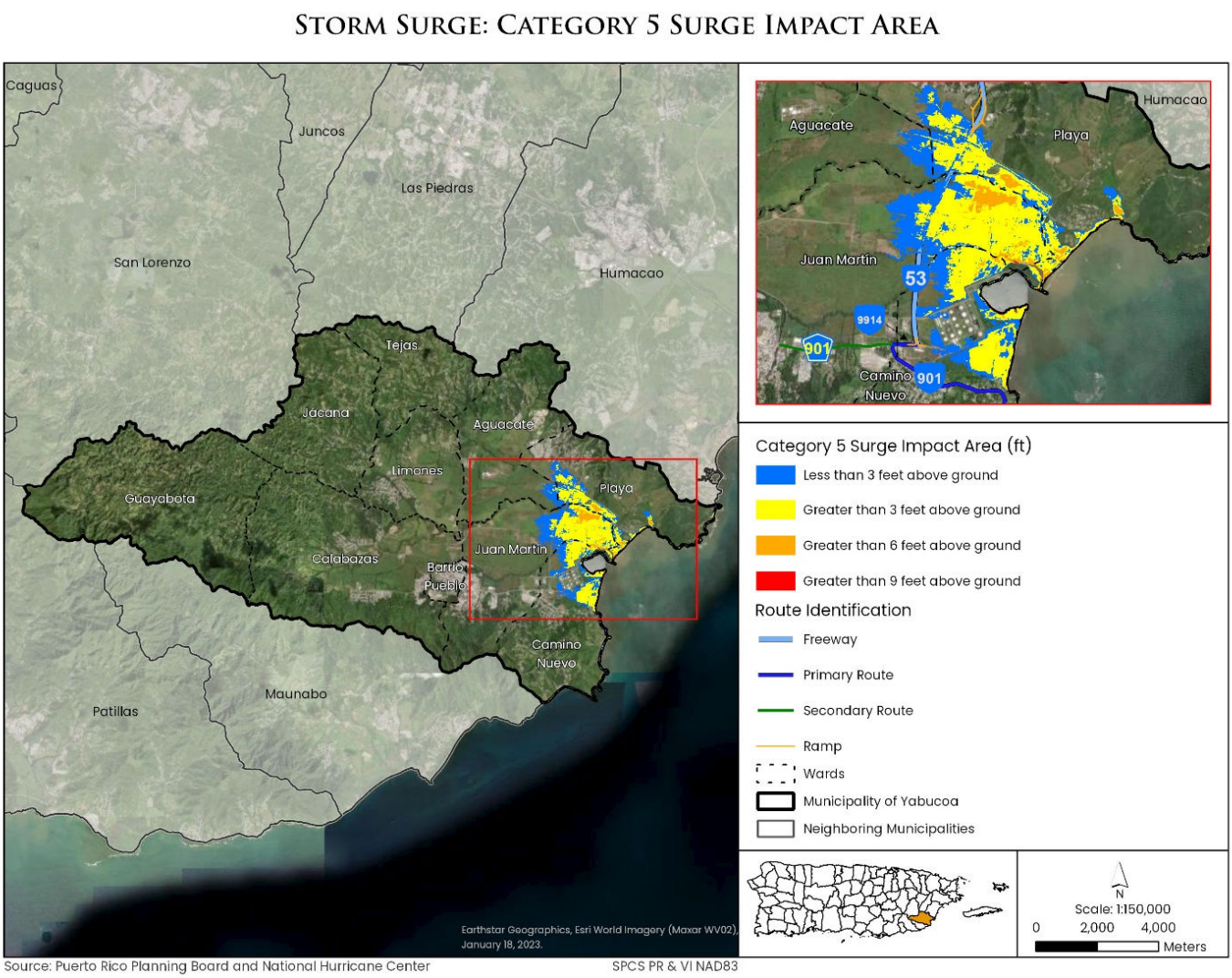
Map 41 and 42 show the areas affected by a storm surged caused by a Category 1 and Category 5 hurricanes Map 41 shows that small section around the Port of Yabucoa would be affected. However, as shown in map 42, a Category 5 induced storm would go inland as far as the PR-53 bridge and the surrounding agricultural areas. The tourist facilities of Playa Lucía to the south of the Port of Yabucoa would also be affected. Importantly the community of Playa Guayanés also has exposed areas to storm surge.

*Map 41: Category 1 Storm Surge Impact Area*




Source: Puerto Rico Planning Board and National Hurricane Center SPCS PR & VI NAD83

*Map 42: Category 5 Storm Surge Impact Area*




### *4.11.1.2 Risk Magnitude*

Each of the storm surge maps shows the depth of flooding that would be expected at a given location based on the category of the storm. Flood depth represents the severity/magnitude of the storm surge risk; therefore, when describing this severity/magnitude, it could be expressed in a manner such as, "the greatest flood depth that a community could experience as a result of storm surge with a specific height measure." The building table can be used to determine a rough estimate of the maximum potential flood depth.

The maps included in the previous section, with reference to the geographic areas

affected by this natural hazard, show the impact of this event based on flood depth and according to the occurrence of Category 1 and Category 5 hurricane events. In summary, flood depth represents the severity or magnitude of the storm surge risk. As shown, there is a correlation between the magnitude of the storm event and the depth of flooding and the extent of land area that will be affected. That is, in most instances, as a storm escalates to higher-magnitude categories, a greater number of neighborhoods and sectors may be impacted by flooding events of greater depth.

Similar to other coastal hazards, storm surges have the potential to expose the population and infrastructure supporting lifelines. Likewise, areas within the municipality that are already prone to flooding may be more severely affected by flooding resulting from storm surge events.

#### *4.11.1.3 Past Events*

Hurricane Maria (2017) generated measurable storm surge and storm tide impacts along Puerto Rico's southeastern and eastern coasts. Post-storm field investigations conducted by the U.S. Geological Survey (USGS) documented storm-tide inundation heights generally ranging from approximately 6 to 9 feet above ground level in coastal municipalities including Humacao, Naguabo, and Ceiba (Byrne, 2019). Lower storm surge levels, typically between 1 and 4 feet, were observed along portions of the northern and western coasts. Although the most catastrophic impacts of Hurricane Maria were driven by extreme rainfall and inland flooding, storm surge contributed to coastal flooding, shoreline erosion, and damage to marinas and port facilities, particularly along exposed eastern shorelines (Byrne, 2019) (Pasch, Penny, & Berg, Hurricane Maria, 2023).

Hurricane Georges (1998) generated storm surge impacts along the southern and eastern coasts, exacerbating coastal inundation and contributing to damage in low-lying coastal communities (Guiney, 1999). More recently, Hurricane Fiona (2022) caused storm surge and wave-driven coastal flooding along Puerto Rico's southern coast, particularly in municipalities facing the Caribbean Sea, despite making landfall as a hurricane of relatively lower wind intensity (Pasch, Reinhart, & Alaka, Hurricane Fiona, 2023).

#### 4.11.1.4 Future Events Probability

NOAA defines the term storm surge as the rise in ocean level resulting from the effects of wind and the drop in atmospheric pressure associated with hurricanes and other storms. In other words, storm surge is caused primarily by the strong winds of a hurricane or tropical storm; therefore, the probability of occurrence of a storm surge event in the municipality is directly associated with—and increases following—events of strong winds such as hurricanes and will increase or may intensify as such events occur.

To this end, the Sea, Lake, and Overland Surges from Hurricanes model (known as SLOSH, by its English acronym) is a computerized model used by NOAA for the assessment of coastal flooding risk and the operational prediction of storm surge.

According to FEMA, coastal flood risk areas are determined through a statistical analysis of records of riverine flow or currents, storm tides, and rainfall; information obtained through consultations with the community; and a hydrologic and hydraulic analysis. Coastal flood risk areas are delineated or defined in the Flood Insurance Rate Maps (FIRM). These maps also communicate two regulatory flood mapping elements: the extent of land at risk of base flooding (1% annual probability) and the related flood levels in these areas, known as Base Flood Elevations (BFE).

### 4.11.2 Risk Analysis

#### 4.11.2.1 Estimated Loses

For the FEMA National Risk Index (NRI), storm surge losses are generally represented under the Coastal Flooding hazard category. FEMA does not report a separate "storm surge" Expected Annual Loss (EAL) value for Yabucoa (FEMA, 2026). To prevent duplication of the data presented in the flood risk analysis, this LHMP will not consider it, as it cannot separate damages created by storm surge or other types of coastal floods.

#### 4.11.2.2 Lifelines and Critical Infrastructure

Storm surges pose a significant threat to FEMA-defined community lifelines by inundating critical infrastructure located in coastal and low-lying areas. Transportation lifelines are frequently disrupted when roads, bridges, ports, and

evacuation routes are flooded or damaged, restricting evacuation, emergency response, and supply chain movement. Energy lifelines, including power plants, substations, and fuel distribution systems, are highly vulnerable to saltwater intrusion and flooding, which can result in equipment failure and prolonged power outages. Communications lifelines may also be compromised when cell towers, fiber-optic networks, 911 systems, and backup power supplies are damaged or inaccessible due to storm surge flooding. These cascading failures reduce situational awareness and hinder coordination among emergency responders and government agencies. Collectively, impacts on these lifelines significantly reduce a community's ability to protect lives and property during storm surge events. (NOAA, n.d)

Storm surges also have severe consequences for FEMA's health and medical lifeline by flooding hospitals, clinics, long-term care facilities, and pharmaceutical supply chains, sometimes requiring evacuations or service closures. Damage to water and wastewater infrastructure threatens the food, water, and shelter lifeline by limiting access to safe drinking water and sanitation services. Flooded treatment plants and damaged pipelines can lead to water contamination, boil-water advisories, and increased public health risks. Safety and security lifelines are further strained when police, fire, and emergency medical service facilities are damaged or when flooded roadways limit response times. Prolonged disruption of these lifelines slows community recovery and exacerbates social, economic, and health vulnerabilities. These impacts underscore FEMA's emphasis on hazard mitigation, lifeline stabilization, and resilience planning to reduce storm surge.

Storm surge in Yabucoa would have cascading impacts across multiple FEMA lifelines, severely disrupting Energy, Transportation, Communications, and Food, Water, and Shelter systems. Within the Energy lifeline, flooding of the Yabucoa petroleum terminal could damage storage tanks, pipelines, pumping systems, and electrical controls, significantly interrupting fuel imports, storage, and distribution. This would directly limit the availability of gasoline, diesel, and other fuels needed for power generation and transportation, potentially leading to widespread power shortages and delayed recovery operations. Transportation systems would also be affected, as inundation of port facilities and coastal roadways would restrict the movement of goods and emergency services, while impacts to communications infrastructure could hinder coordination and response efforts. The Food lifeline would be particularly vulnerable, as low-lying agricultural lands could be flooded, resulting in crop loss and destruction of farmland. In addition, saltwater deposited by storm surge can degrade soil quality, reducing its fertility and long-term agricultural productivity. Disruptions to fuel supply and transportation would further limit food distribution across the island. In a worst-

case scenario, catastrophic failure of oil storage tanks could result in a large-scale petroleum release, triggering a major environmental disaster that contaminates water resources, damages ecosystems, and compounds impacts on food systems, public health, and overall economic stability.

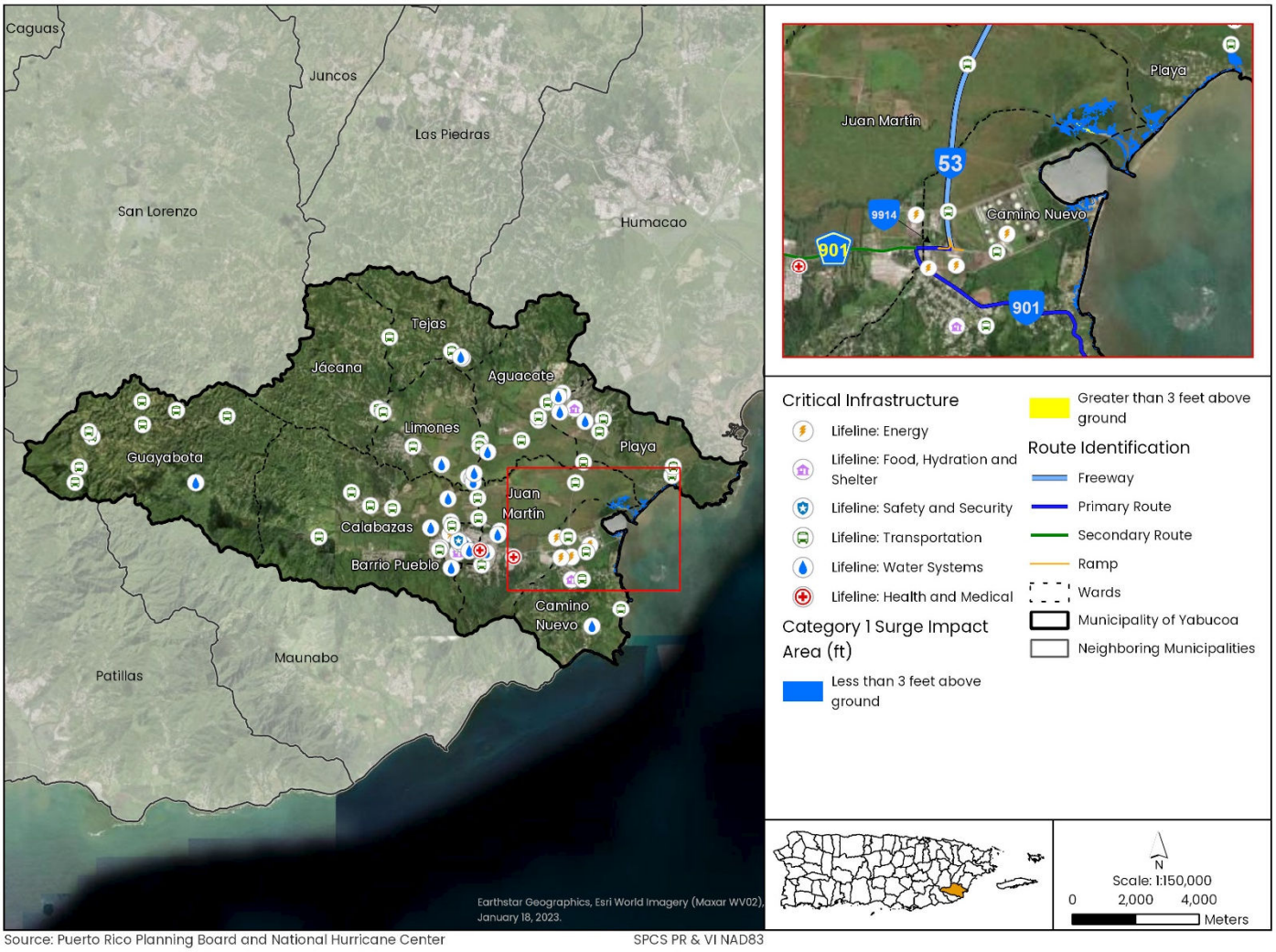
**Yabucoa Port and Petroleum Storage Facility**

Storm surge represents one of the most significant hazards to the port and oil storage facilities due to the potential for extensive coastal inundation. Elevated water levels can flood docks, pipelines, and storage areas, potentially leading to corrosion, mechanical failure, or displacement of equipment. Storage tanks exposed to surge conditions may experience structural damage or buoyancy-related instability, increasing the risk of petroleum spills. These impacts could result in widespread operational disruption and environmental contamination.

Map 43 shows the critical infrastructure that would be affected by a storm surge caused by a category 1 hurricane, while Map 44 shows the same but for a category 5 hurricane.

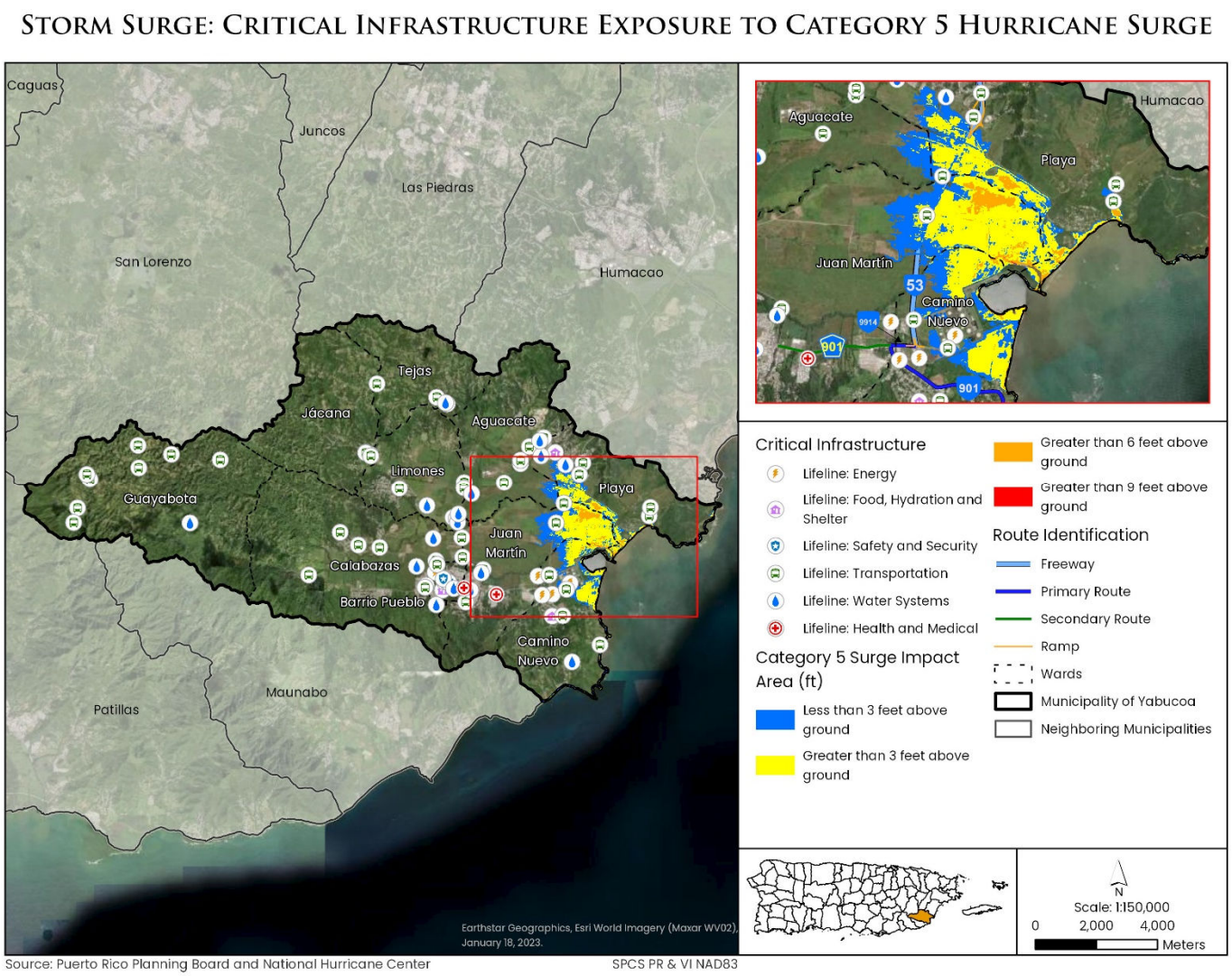
*Map 43: Critical Infrastructure exposure to Category 1 Hurricane Surge*

## Storm Surge: Critical Infrastructure Exposure to Category 1 Hurricane Surge




Source: Puerto Rico Planning Board and National Hurricane Center SPCS PR & VI NAD83

*Map 44: Storm Surge: Critical Infrastructure exposure to Category 5 Hurricane Surge*




Source: Puerto Rico Planning Board and National Hurricane Center SPCS PR & VI NAD83

### *4.11.2.3 Social Vulnerabilities*

Storm surge events represent a significant social hazard for Puerto Rico due to the Island's extensive coastline, high population density in coastal municipalities, and legacy socioeconomic vulnerabilities. Storm surge–related flooding frequently results in displacement, housing damage, and prolonged interruption of essential services, particularly in low-lying coastal communities and estuarine areas. Studies of hurricanes impacting Puerto Rico, including Hurricane Maria, have shown that flood exposure and displacement are disproportionately concentrated among low-income households, older adults, and communities with limited access to transportation, healthcare, and economic resources, which delays recovery and increases long-term

vulnerability. FEMA and NOAA analyses further indicate that socially vulnerable populations are more likely to reside in surge-prone areas and experience compounded impacts when storm surge coincides with power outages, roadway flooding, and disruptions to water and medical services. (Chowdhury, et al., 2025)

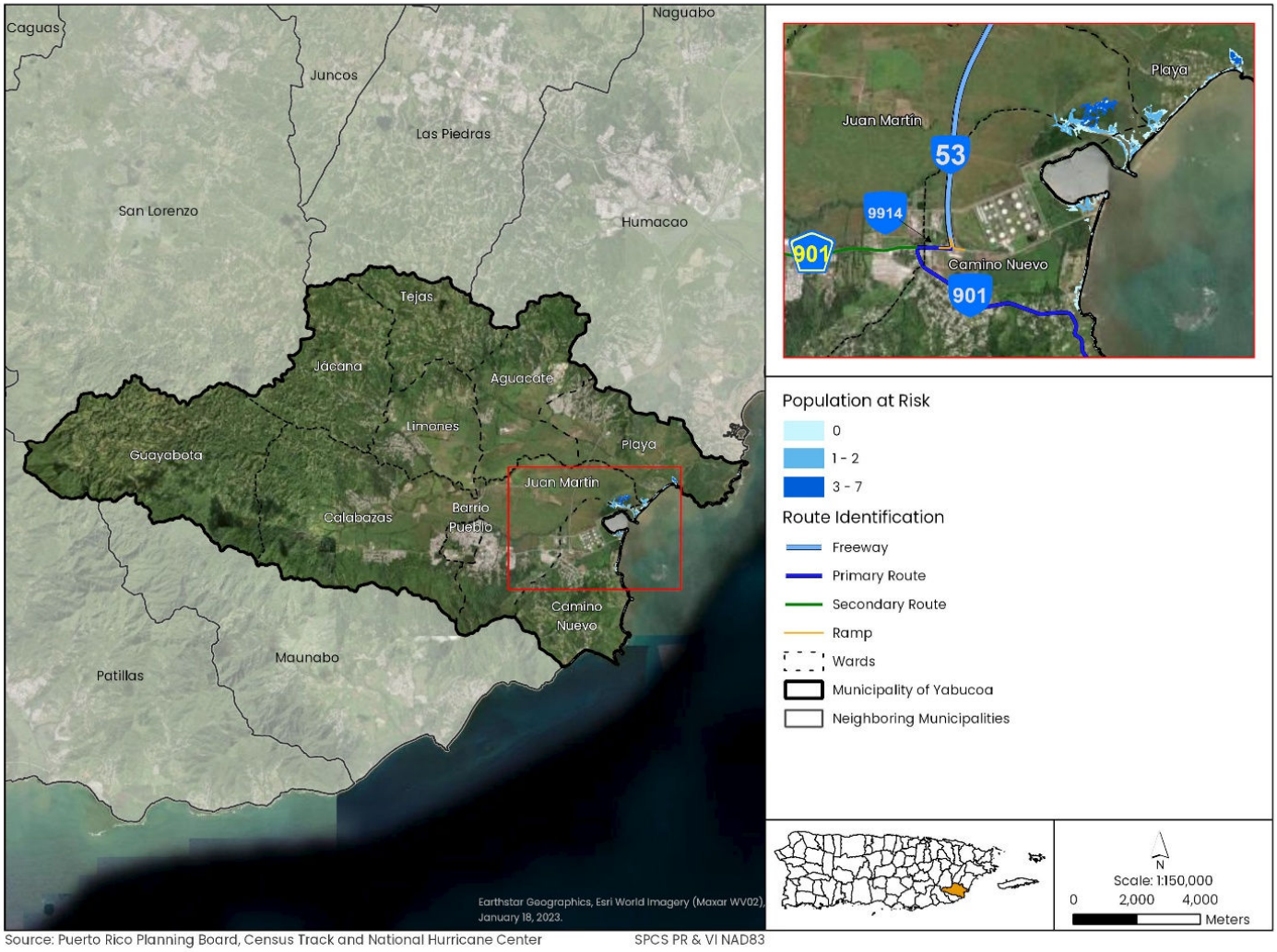
Storm surge flooding also poses serious public health, economic, and equity challenges for Puerto Rico. Flooding of homes, healthcare facilities, and water and wastewater systems increases risks of injury, water contamination, and adverse mental health outcomes, particularly in communities that experience extended power outages and limited access to medical care. Economic impacts are often prolonged, as small businesses, informal workers, and coastal livelihoods face income losses and slower recovery due to limited insurance coverage and financial capacity. Research and federal reviews of disaster recovery programs highlight that inequities in disaster assistance and rebuilding resources can exacerbate social and wealth disparities on the Island, reinforcing the need for mitigation actions that integrate social vulnerability, equitable recovery, and community resilience into storm surge planning. (Chowdhury, et al., 2025)

Storm surge impacts in Yabucoa would disproportionately affect vulnerable populations, which make up a large portion of the Municipality (see section 3.4). Residents living in low-lying, flood-prone areas where housing and resources are limited, increasing their exposure to displacement, service disruptions, and health risks. Damage to energy, transportation, and food systems would further restrict access to essential services, prolong recovery, and intensify existing social and economic challenges.

Maps 46 and 47 show the population by census tract that could be affected by the possible effects of a Category 1 and Category 5 induced storm surge. Both maps show that there are very few people that would be directly affected by a storm surge

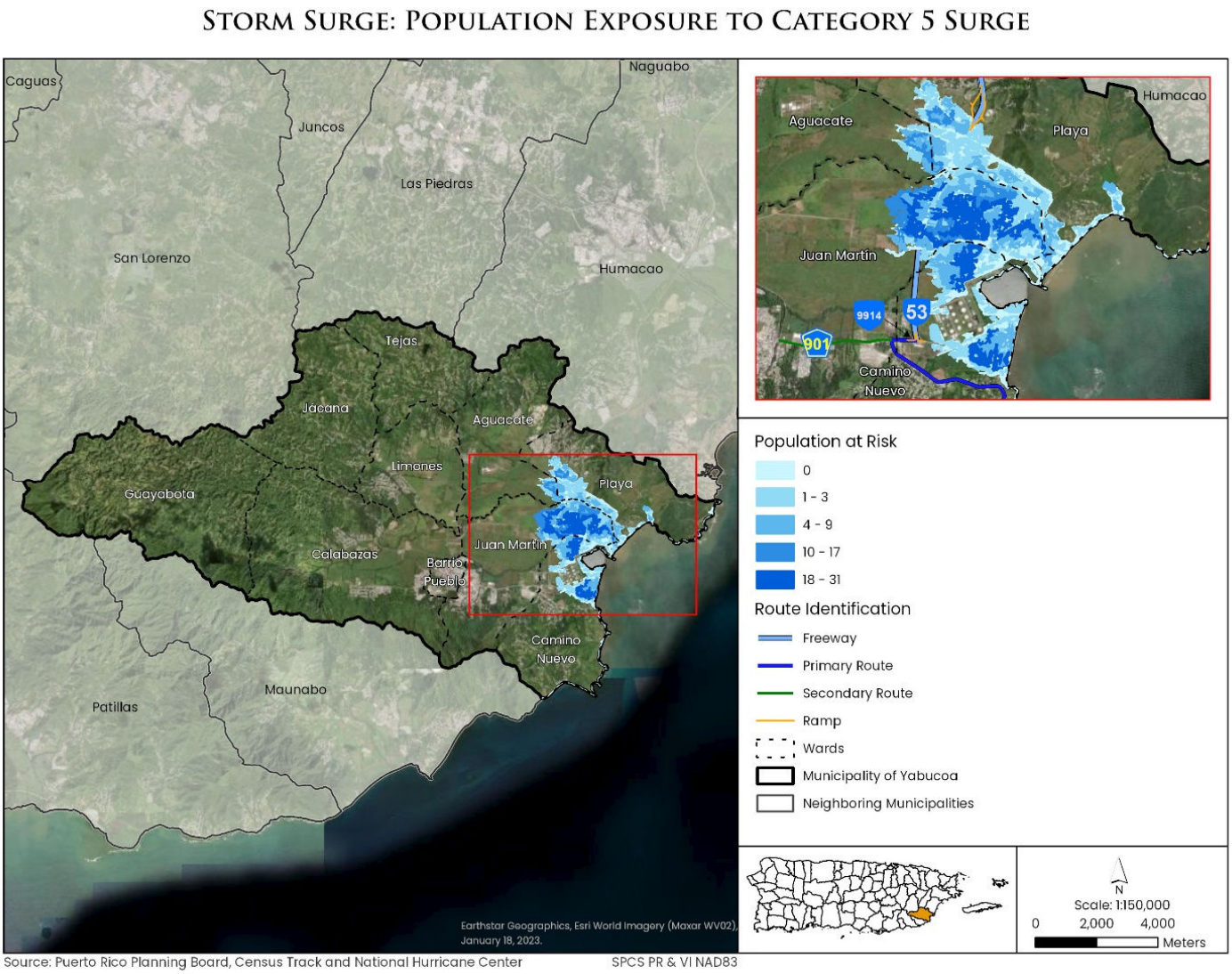
*Map 45: Storm Surge: Population Exposure to Category 1 Surge*

## Storm Surge: Population Exposure to Category 1 Surge




Source: Puerto Rico Planning Board, Census Track and National Hurricane Center SPCS PR & VI NAD83

*Map 46: Strom Surge: Population Exposure to Category 5 Surge*




### *4.11.2.4 Natural and Cultural Resources*

Storm surge poses a significant natural hazard to Puerto Rico's coastal and near-coastal environments due to the Island's extensive shoreline, low-lying coastal plains, and concentration of sensitive ecosystems. Surge-driven flooding and wave action can cause severe erosion, saltwater intrusion, and habitat degradation in mangroves, coastal wetlands, estuaries, seagrass beds, and coral reef systems that are critical to biodiversity, fisheries, and natural coastal protection. These ecosystems can experience vegetation die-off, sediment redistribution, and long-term loss of

ecological functions such as flood attenuation and water filtration following storm surge events. Repeated storm surge exposure can permanently alter coastal geomorphology and reduce the buffering capacity of natural systems, increasing vulnerability of inland areas and amplifying future flood risk across Puerto Rico's coastal municipalities (Ganz, Duan, & Ji, 2023).

Storm surge also presents substantial risks to Puerto Rico's cultural and historic resources, many of which are concentrated in coastal zones and historic town centers. Flooding and erosion associated with storm surge events can damage or destroy historic buildings, archaeological sites, cemeteries, and cultural landscapes, including Spanish-era structures and Indigenous archaeological resources located near the coast. In addition to physical damage, storm surge–related displacement can disrupt traditional cultural practices and undermine community identity tied to historic places and coastal livelihoods. FEMA and its federal partners recognize the vulnerability of cultural resources to coastal flooding and support mitigation, documentation, and recovery efforts through programs such as the Heritage Emergency National Task Force, emphasizing the importance of incorporating cultural resource protection into hazard mitigation planning for Puerto Rico.

Storm surge impacts in Yabucoa could cause significant damage to both environmental and cultural resources, particularly if coastal erosion, habitat loss, and failures at the petroleum storage facility occur simultaneously. Flooding and wave action could erode beaches and destroy coastal habitats such as wetlands and mangroves, which serve as critical ecosystems for wildlife and natural buffers against flooding. Saltwater intrusion and contamination from potential oil spills could further degrade these environments, affecting marine life, fisheries, and water quality. From a cultural perspective, coastal communities, recreational areas, and sites of local significance could be damaged or lost, disrupting community identity and heritage. A catastrophic failure of the oil reservoirs would amplify these impacts by releasing hazardous materials into coastal and inland areas, leading to long-term ecological damage, loss of natural resources, and lasting effects on both the environment and the cultural landscape of Yabucoa.

#### 4.11.2.5 Future Conditions (E1-a)

This hazard poses a direct threat to coastal infrastructure, shoreline businesses, the agricultural sector, and the oil and maritime industry within Yabucoa harbor. Storm surge, in particular, can significantly intensify these impacts by causing sudden and severe coastal flooding that extends inland beyond typical tidal limits.

During a storm surge event, elevated sea levels combined with powerful wave action can inundate low-lying coastal areas, including port facilities, fuel storage infrastructure, and nearby communities. In Yabucoa, where critical assets such as docks, pipelines, and storage tanks are located near sea level, storm surge can lead to physical damage, corrosion, and system failures. Floodwaters can disrupt port operations, damage loading and unloading systems, and temporarily halt maritime activity. This directly affects the oil and maritime industries by interrupting fuel imports, storage, and distribution.

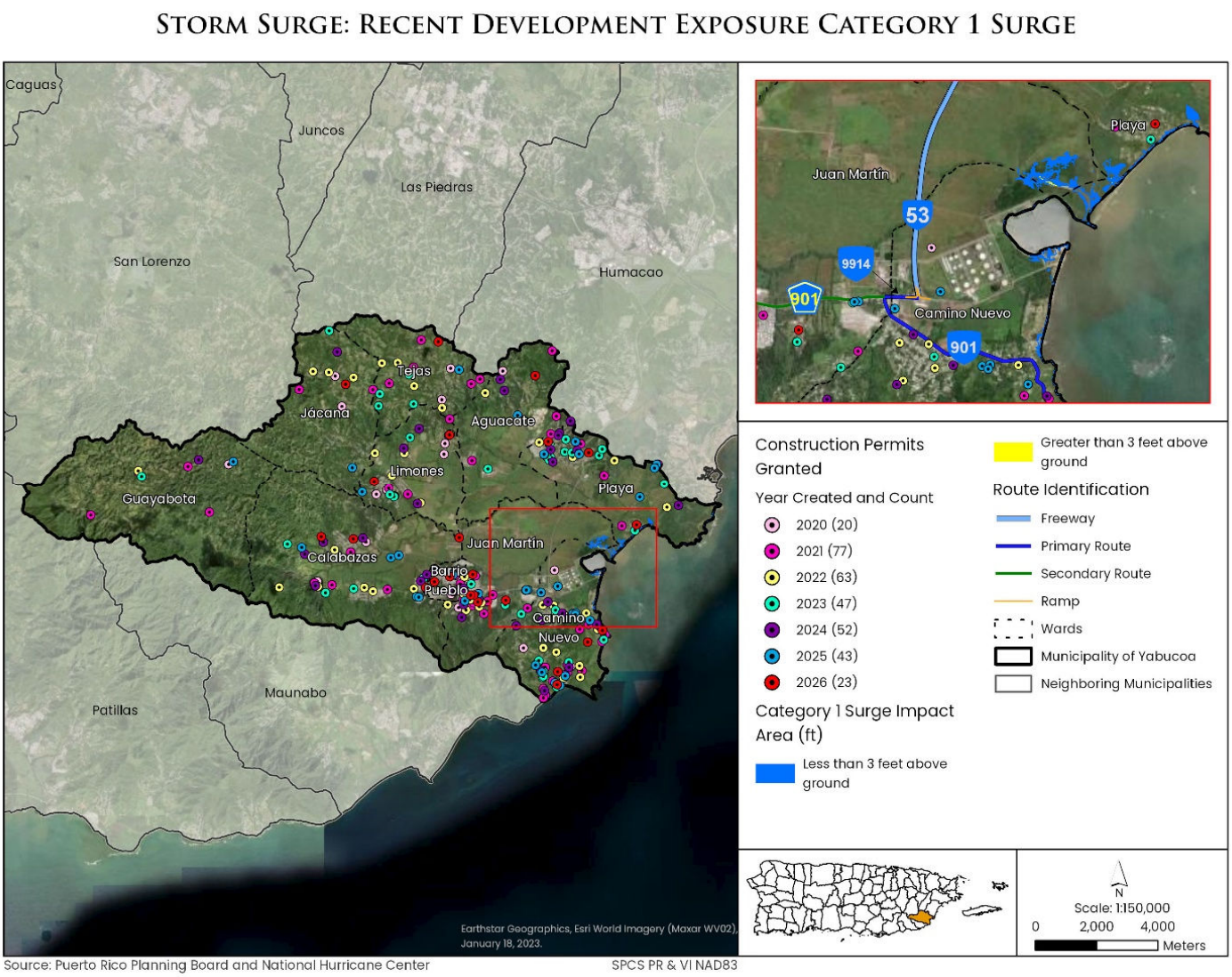
In addition, shoreline businesses and coastal infrastructure are highly susceptible to structural damage and economic losses due to prolonged inundation and debris carried by surge waters. The agricultural industry, particularly in low-lying alluvial valleys near the coast, can experience crop loss, soil salinization, and long-term land degradation as saltwater penetrates farmland and irrigation systems.

Storm surge also increases the risk of hazardous material releases. Flooding of the petroleum terminal could lead to spills or leaks from storage tanks and pipelines, resulting in contamination of coastal waters, wetlands, and adjacent ecosystems. This creates compounding environmental impacts, including harm to marine habitats and fisheries, as well as costly and complex cleanup operations.

Furthermore, storm surge can overwhelm drainage systems already stressed by heavy rainfall, worsening inland flooding and delaying recovery efforts. Given the concentration of critical infrastructure in vulnerable coastal zones, storm surge represents a multi-dimensional threat that affects economic activity, environmental quality, and public safety in Yabucoa.

Maps 47 shows the construction permits approved for the period of 2019 -2026. And the impact areas of a Category 1 induced storm surge. It shows that very few new developments would be affected by a Category 1 induced storm surge. Map 48 does the same for a Category 5 induces surge. Both maps show that very few constructions permits have been issued in storm surge impact areas.

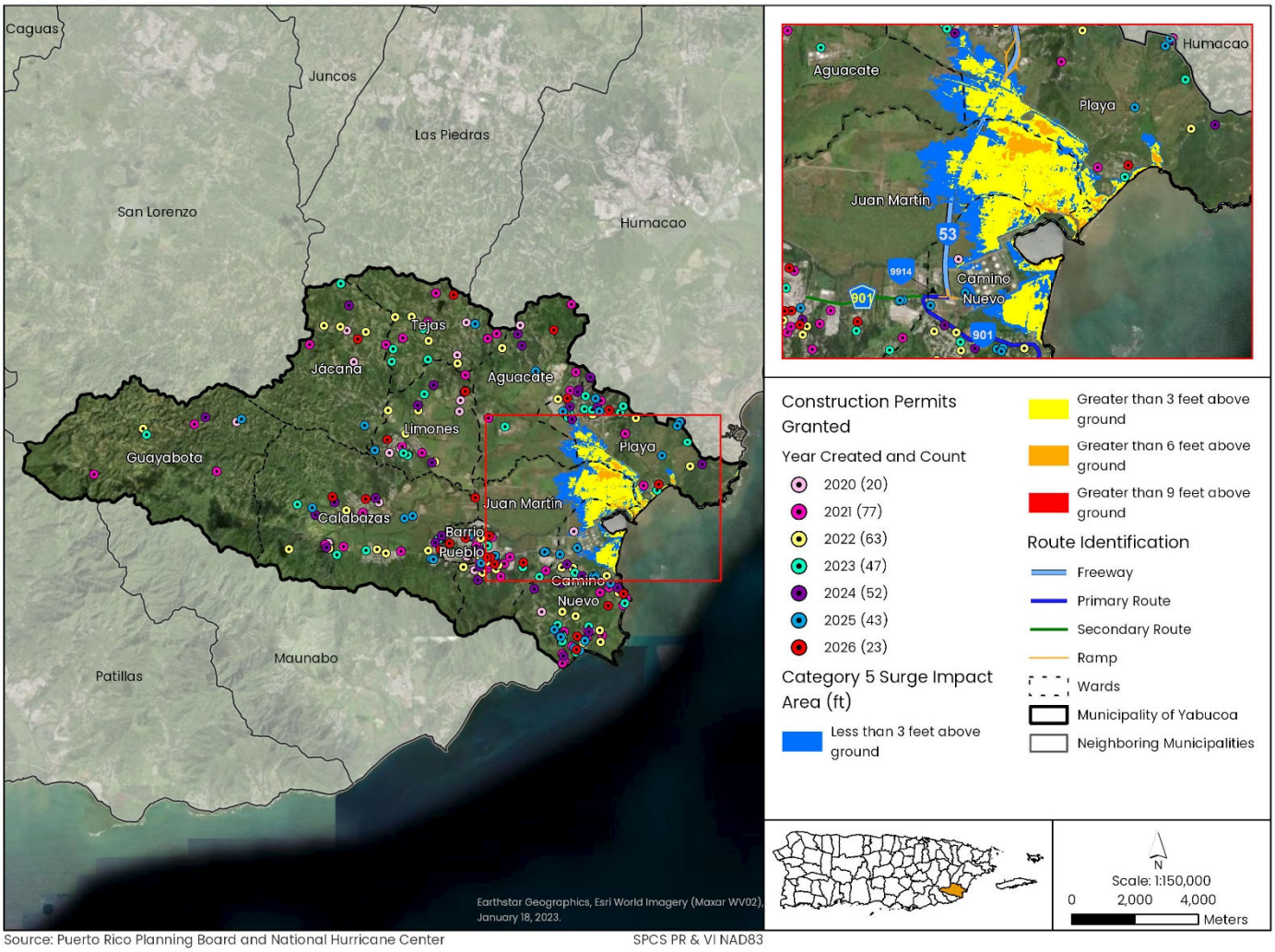
*Map 47: Recent Development and Category 1 Storm Surge Impact*




Source: Puerto Rico Planning Board and National Hurricane Center SPCS PR & VI NAD83

*Map 48: Storm Surge: Recent Development Exposure Category 5 Surge*

## Storm Surge: Recent Development Exposure Category 5 Surge




Source: Puerto Rico Planning Board and National Hurricane Center SPCS PR & VI NAD83

## 4.12 Extreme Heat

### 4.12.1 Description (B1-a)

There is no universally accepted definition for extreme heat or heat waves. For the purposes of this Plan, the definition adopted by the Department of Homeland Security (DHS) is used. It is defined as a prolonged period of 48 to 72 hours of intense heat and humidity, with temperatures above 90 °F. Under these conditions, evaporation is reduced and the body is forced to make a significant effort to maintain its normal temperature, which has caused the death of many people in attempts to stabilize physically. In general, extreme heat represents the highest rate of deaths among weather-related hazards.

A study titled Heat Risk Perception and Vulnerability in Puerto Rico: Insights for Climate Adaptation in the Caribbean, published in the academic journal International Journal of Environmental Research and Public Health, analyzes how Puerto Rico residents perceive health risks associated with extreme heat and how these perceptions relate to vulnerability and protective behaviors during extreme heat events that occurred in the summer of 2020 (Guzmán-Colon, Guido, Amaya-Ardilla, Cabrera-Rivera, & Méndez-Lázaro, 2025). The research was conducted through a cross-sectional telephone survey of 500 adults in metropolitan and non-metropolitan areas. This study defined the metropolitan area as the municipalities of Bayamón, Carolina, Cataño, Toa Baja, and Trujillo Alto. The non-metropolitan zone consists of the remaining municipalities of Puerto Rico.

The questionnaire included sociodemographic variables, health status, prior heat exposure, risk perception, and mitigation strategies. Statistical analysis employed chi-square tests and multinomial and logistic regression models.

The results reveal that, although most participants expressed concern about climate change and high temperatures, less than half perceived heat as a high health risk, and only one-fourth considered it likely to suffer a heat-related illness in the next five years. Risk perception was significantly higher among men, people aged 50 to 64, the unemployed, individuals with fair health, multiple chronic conditions, and those who had experienced heat-related symptoms. In contrast, older adults (65+) reported low levels of risk perception despite their high vulnerability.

Forty-four percent (44%) of respondents indicated having suffered heat-related

symptoms during the summer, and 68% reported nighttime thermal discomfort, a factor closely linked to health problems. The most common strategies to mitigate heat were the use of fans (84%) and air conditioning (64%), although economic limitations and instability of the electrical system reduced their effectiveness. Regional differences were also notable: residents in non-metropolitan areas showed greater risk perception than those in metropolitan zones.

The study concludes that there is a significant gap between actual vulnerability and risk perception, especially among older adults. It recommends strengthening risk communication targeted at vulnerable groups, addressing nighttime heat exposure, and improving electrical infrastructure to ensure equitable access to cooling systems. Proposed solutions include decentralized energy systems, cooling centers with backup power, and passive designs that reduce electrical dependence, thus contributing to community resilience in the face of increasing extreme heat events.

#### *4.12.1.1 Affected Area (B1-B)*

Extreme heat events can impact the entire municipality, particularly in urbanized areas where the heat island effect may occur. Based on previously presented information, adverse climate effects have been observed, including severe droughts, increased frequency of strong wind events and flooding, higher heat index levels, among others. Due to the municipality's geography and location, the entire region is highly susceptible to extreme heat conditions.

Urban heat islands refer to urbanized areas where structures such as buildings, roads, and other infrastructure absorb and emit the sun's heat more than natural landscapes such as forests and water bodies. Daytime temperatures in urban areas are about 1–7 °F higher than temperatures in outlying areas; nighttime temperatures are about 2–5 °F higher (EPA, 2025).

Heat islands develop due to a combination of factors:

- Loss of Natural Landscapes – Urban areas often replace trees, vegetation, and water bodies—natural elements that cool the air through shade, transpiration, and evaporation—with hard, dry surfaces like roads, rooftops, and parking lots. These surfaces provide little shade or moisture, leading to higher temperatures.
- Properties of Urban Materials – Common construction materials such as asphalt and concrete absorb and retain more heat than natural surfaces. They

reflect less solar energy and release heat slowly, causing temperatures to remain elevated, especially after sunset.

- Urban Design and Geometry – The layout of buildings affects airflow and heat retention. Dense developments with narrow streets and tall structures create "urban canyons" that trap heat and block cooling winds, turning buildings into thermal masses that release heat gradually.
- Human-Generated Heat – Activities such as transportation, industrial operations, and air conditioning add waste heat to the environment, intensifying the heat island effect.
- Weather and Geographic Conditions – Clear, calm weather amplifies heat islands by maximizing solar energy absorption and limiting heat dispersion. Conversely, wind and cloud cover help reduce the effect. Geographic features like mountains can also influence wind patterns, either blocking cooling breezes or channeling heat through urban areas (EPA, 2025).

According to Yabucoa's Land Use Plan (Municipality of Yabucoa, 2023), only 6.06% of the municipality's territory was classified as Urban Land (Suelo Urbano) when the document was initially developed. Overall, this means that only a small percentage of the municipality's territory is exposed to this phenomenon. However, due to the complex interdependence of variables, detailed urban-scale analysis is required to understand how extreme heat might impact urban space and vulnerable populations within the municipality.

#### *4.12.1.2 Risk Magnitude (B1-C)*

Local NWS offices often work with community agencies to decide when heat alerts should be issued. Because the United States is so geographically and culturally diverse, heat tolerance varies by region. For example, residents of Puerto Rico are generally more accustomed to temperatures above 90°F than those living in Alaska.

Nevertheless, the NWS uses the following standard alerts (NWS, n.d.):

- Excessive Heat Warning – Issued 12 hours before dangerous heat conditions are expected. This occurs when the heat index is forecast to reach 105°F or higher for more than three hours over two consecutive days, or 115°F or higher for any period of time.
- Excessive Heat Watch – Issued when an extreme heat event is possible within the next 24 to 72 hours.
- Heat Advisory – Issued 12 hours before conditions where the heat index is at

least 105°F but less than 115°F for three consecutive days.

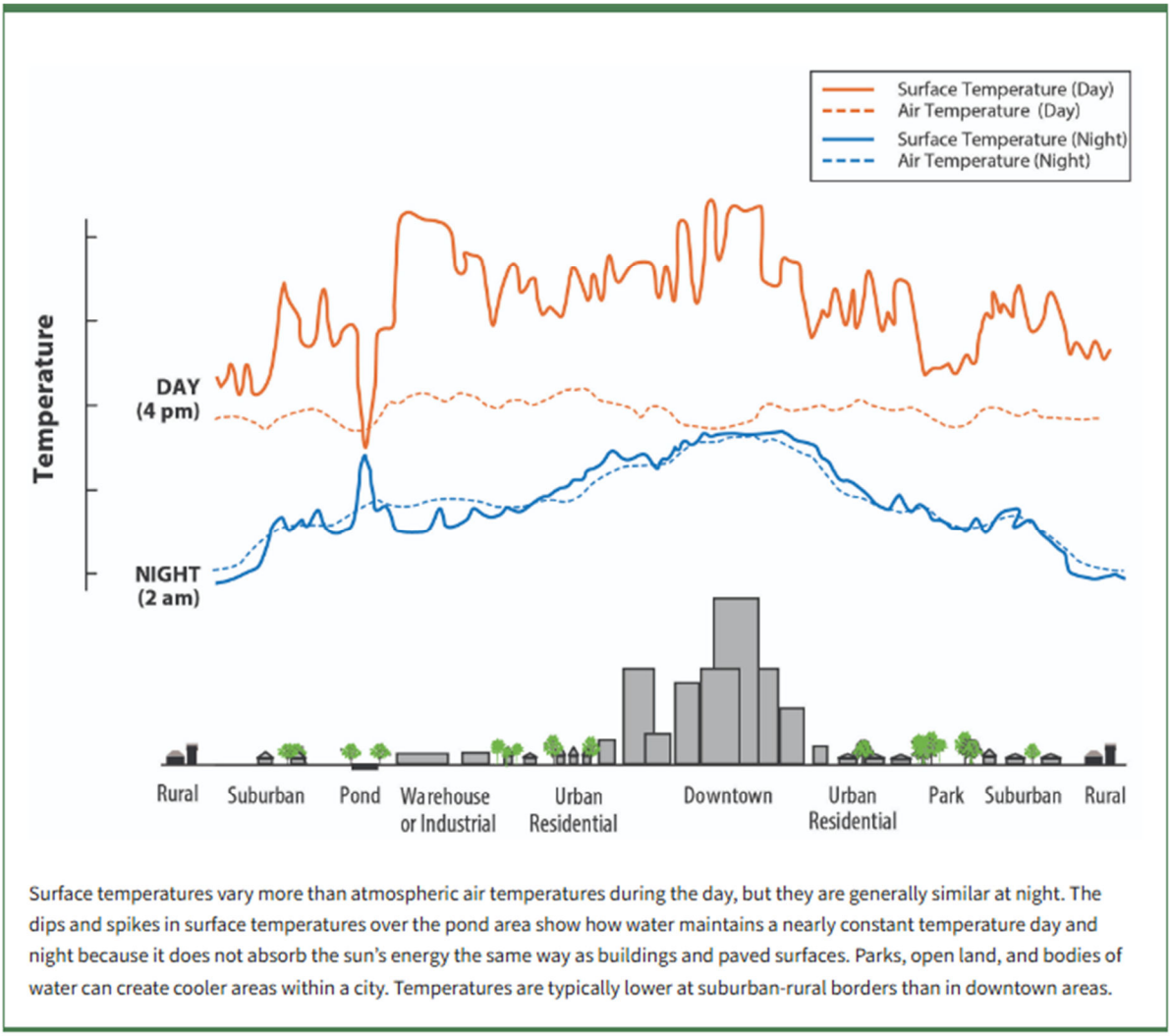
- Extreme Heat Outlook – Issued when there is potential for extreme heat within the next three to seven days, providing advance notice for those who need extra time to prepare.

It must be emphasized that Urban Heat islands (UHI) phenomena can occur regardless of whether there is an extreme heat warning event. UHI is a relative temperature difference between urban and surrounding rural areas caused by factors like heat-absorbing surfaces, lack of vegetation, and human activities. It exists year-round, even during mild or cool weather, because cities consistently retain more heat than natural landscapes. Extreme heat events can amplify UHI, making UHI effects more dangerous, but UHI does not require extreme heat to form—it simply means urban areas are warmer than their surroundings under similar conditions.

UHIs are typically assessed by comparing temperatures in urban areas to those in surrounding regions. Even within a city, temperatures can vary significantly. Some neighborhoods are hotter due to dense concentrations of heat-absorbing surfaces like buildings and pavements, while areas with trees and greenery remain cooler. These variations create what are known as intra-urban heat islands. In diagrams illustrating this effect, urban parks, ponds, and residential zones generally appear cooler than central downtown districts.

The following diagram, taken from an EPA website, shows a diagram of how a heat island effect behaves in temperature.

*Figure 23: Heat Island Effect Diagram (EPA, 2025)*




*Source: EPA*

### *4.12.1.3 Past Events (B1-D)*

Méndez Lázaro et al. (2015) identified several years in which extreme heat temperatures were recorded in the San Juan metropolitan area. According to their findings, periods of extreme heat occurred in 1983, 1995, 2012, and 2013. According to Méndez Lazaro et. all, the summer of 2012 was the hottest in a century, with 42 days of extreme temperature values. During June, July, and August, of that year, the maximum heat index reached 98.06° F, 98.96° F, and 102.02° F, respectively (Méndez Lázaro et al., 2015).

For this LHMP it was sought to have more direct information regarding official temperature readings for this municipality. Unfortunately, the closed NOAA weather station that recorded temperature is in Guayama and it only shows data until 2020.

#### *4.12.1.4 Future event probabilities (B1-e)*

Official NOAA assessments in the 2018 Puerto Rico and U.S. Virgin Islands State Climate Summary report an increase in both average temperature (≈1.5°F since 1950) and the frequency of extreme heat events (NOAA, 2022). Additionally, climate projections from CMIP6 (via the World Bank's Climate Change Knowledge Portal) show steady rises in summer and annual maximum temperatures for Puerto Rico, further indicating elevated future risk for heat waves (World Bank, n.d.).

### 4.12.2 Risk Analysis (B2-a, B2-b)

#### *4.12.2.1 Estimated Loses*

Extreme Heat primarily causes material and system stress rather than immediate structural failure. For example:

- Roads and Pavements: Asphalt can soften and deform under prolonged high temperatures, leading to rutting and surface damage (Highways Industry, n.d.) (EPA, 2012).
- Rail Systems: Steel tracks expand in extreme heat, which can cause buckling and derailment risks (USDOT - FRA, 2013).
- Power Infrastructure: Electrical grids experience higher loads from air conditioning demand, and transformers or cables can overheat, reducing efficiency or causing outages.
- Building Materials: Expansion and contraction of concrete, steel, and glass can lead to cracks or joint failures over time. Roofing materials may degrade faster under intense heat.
- Cooling Systems: HVAC systems work harder, increasing energy consumption and risk of failure, which can compromise indoor comfort and safety.

While heat waves rarely cause buildings to collapse, they accelerate wear and tear, increase maintenance costs, and can lead to system failures that disrupt essential

services. As of now the municipality does not have a method to calculate losses from extreme heat events.

#### 4.12.2.2 Lifelines and Critical Infrastructure

Extreme heat poses systemic risks across energy, transportation, and communications systems, creating compound failures precisely when demand for services peaks. In Energy Lifeline, high temperatures drive sharp increases in electricity demand for cooling while simultaneously decreasing generation and delivery efficiency. Thermoelectric plants may be forced to curtail output when cooling water is too warm, solar panels produce less electricity at elevated module temperatures, and transmission lines lose carrying capacity as conductors heat and sag—conditions that heighten the likelihood of voltage drops and blackouts during heat waves (Jessen, 2025). The combination of record cooling loads and diminished supply underscores a growing "peak risk" problem for grids that were not designed for today's heat extremes (Jessen, 2025) (American Society of Civil Engineers, 2024).

Similarly, the Transportation Lifeline is similarly vulnerable. Prolonged high surface temperatures soften asphalt, accelerating rutting and deformation; steel rails thermally expand and can buckle, prompting heat-related slow orders that disrupt service; and catenary or other overhead lines can sag in the heat, further constraining operations. Airports face dual constraints: runway pavements can deform under extreme heat, and reduced air density on hot days impairs aircraft performance, affecting takeoff weight and scheduling. These effects are now commonly observed across U.S. systems during sustained heat events, requiring operational restrictions and emergency maintenance that ripple through supply chains and passenger mobility (American Society of Civil Engineers, 2024)

Communication Lifeline also faces mounting heat stress. Data centers, switching facilities, and network nodes rely on continuous cooling; overheating elevates outage risks and can degrade equipment lifespans. Heat-related disruptions to power supply and localized microclimate conditions compound these risks, with cascading impacts across other lifeline sectors that depend on connectivity for operations and emergency response. Federal assessments underscore that extreme weather—including extreme heat—can interrupt fiber networks, degrade wireless performance, and limit access to data centers, affecting each of the other critical infrastructure sectors and complicating disaster response coordination (Public-Private Analytic Exchange Program, 2025).

Overall, extreme heat acts as a stress multiplier: it pushes materials beyond design thresholds, reduces equipment efficiency, and narrows operational safety margins, all while increasing demand for services. The evidence from engineering organizations and energy market observers indicates that without targeted adaptation—such as heat-resilient design standards, strategic grid reinforcement, enhanced thermal management for digital infrastructure, and heat-aware operations—systems will face more frequent service disruptions and higher lifecycle costs as heat events intensify (American Society of Civil Engineers, 2024).

#### 4.12.2.3 Social Vulnerabilities

A recent academic study examines the relationship between heat stress and mortality in Puerto Rico (Méndez - Lázaro, et al., 2025). Researchers analyzed hourly 2-meter air temperature data from ERA5 reanalysis for 2015–2020 and derived daily minimum, maximum, and mean values to calculate two heat stress indices: the Heat Index (HI) and the Universal Thermal Climate Index (UTCI). Findings show that extreme heat conditions are common for eight months of the year, with August and September being the hottest months, and that urban heat island effects exacerbate exposure in metropolitan areas. (Méndez - Lázaro, et al., 2025) Mortality risk increased significantly on days with high heat stress: deaths were 23% higher in the highest HI tertile and 47% higher in the highest UTCI tertile compared to the lowest. Cardiovascular and cerebrovascular diseases, heart failure, and respiratory conditions were among the leading causes of death associated with heat stress. The study highlights Puerto Rico's socio-economic vulnerabilities, aging population, and limited infrastructure amplifying health risks during extreme heat events (Méndez - Lázaro, et al., 2025). Considering Yabucoa's high number of vulnerable  of residents, extreme heat poses a significant threat to its constituents.

Further information about social vulnerabilities can be found in section 3.4.

#### 4.12.2.4 Natural and Cultural Resources

Extreme heat, specifically Urban Heat Islands can pose the following impacts on the natural resources:

- Increased Energy Consumption – Heat islands increase electricity demand for air conditioning and peak energy demand. Increased electricity demand for

air conditioning ranges from 1–9% for each 2ºF increase in temperature, with the highest increase in countries where most buildings have air conditioning, such as the United States.[3] This increased demand contributes to higher electricity expenses. Peak demand generally occurs on exceptionally hot afternoons, when offices and homes are running air-conditioning systems, lights, and appliances. This increased demand can overload systems and require a utility to institute controlled brownouts or blackouts to avoid power outages.

- Elevated Emissions of Air Pollutants – To meet electricity needs, utility companies typically rely on fossil fuel power plants as a power source. Increased use of fossil fuels increases emissions of air-borne pollutants, such as carbon dioxide, which can have health concerns, especially in people living with respiratory diseases.

- Compromised Human Health and Comfort – Hot weather events contribute to heat-related deaths and heat-related illnesses. Areas experiencing heat islands further contribute to higher daytime temperatures and reduced nighttime cooling. Heat is of greatest concern for groups such as older adults, young children, populations with low-income, people who work outdoors, and people with chronic health conditions, disabilities, mobility constraints, or taking certain medications. From 2004 to 2018 the Centers for Disease Control and Prevention recorded an average of 702 heat deaths per year.

- Impaired Water Quality – High temperatures of pavement and rooftop surfaces can heat stormwater runoff, which drains into storm sewers. This runoff raises water temperatures as it is released into streams, rivers, ponds, and lakes. Water temperature affects the metabolism and reproduction of many aquatic species.

- Rapid temperature changes can also be stressful, and even fatal, to aquatic life. One study found that urban streams have more frequent temperature surges than streams in forested areas. Temperature surges in urban streams were as much as 18ºF higher due to heated runoff from urban areas, higher discharge volumes due to impervious surfaces, and warmer baseline stream temperatures (EPA, 2025).

#### 4.12.2.5 Future Conditions (E1-a)

The approved construction permits map (Map 10) shows that many of the recent developments in Yabucoa are in the already built-up area of the city. This means that the possibility of urban heat island effect will continue to be present in the municipality in the near future.

Most of Yabucoa's settlements, being a predominantly rural municipality, are spread-out throughout existing, or past, agrarian communities. While the potential for UHI is relatively low when compared to larger, denser, urban developments, design decisions regarding the materials, design, placement and orientation of buildings can create or exacerbate extreme heat conditions in individual buildings.

## 4.13 Drought

### 4.13.1 Description (B1-a)

Drought is described as a temporary irregularity in rainfall or natural water flow, where a prolonged lack of precipitation leads to a significant hydrological imbalance. This condition may or may not result in interruptions to regular drinking water service, crop failures, and adverse effects on wildlife and vegetation. The severity of a drought is determined by the level of moisture deficiency, its duration, and the geographic extent of the affected area (Colón, 2009).

Drought represents one of the most complex climatological risks and one of the most severe events (DRNA, 2016). Drought is the result of a natural reduction in the expected amount of precipitation over a prolonged period, usually a season or longer. High temperatures, strong winds, and low humidity levels can exacerbate the effects of drought in areas where they are already prevalent. Likewise, drought can lead to severe wildfires (FEMA, 1997). Human actions and the demands they place on water resources can accelerate drought-related impacts. Droughts occur in different forms across the island, meaning that some regions may experience greater impact while others remain normal.

According to FEMA there are four types of droughts (FEMA, 1997):

*Table 41: Types of Droughts*

| | |
|---|---|
| Meteorological Drought | A period characterized by a significant deficiency in precipitation compared to normal conditions over a specific timeframe (e.g., monthly, seasonal, yearly) |
| Agricultural Drought | Occurs when soil moisture becomes insufficient to support crops or livestock needs, typically following meteorological drought. |
| Hydrological Drought | Defined by reduced water levels in streams, rivers, reservoirs, and groundwater systems, often lagging behind meteorological drought |
| Socioeconomic Drought | Reflects the impact on human systems and the economy, arising when water supply shortages—due to any form of drought—fail to meet societal demand for water and other resources |

In 1999, the Federal Drought Monitor program was implemented. This program is a tool that publishes data and maps on drought conditions in the United States, including Puerto Rico and Hawaii. This system integrates information from various agencies, such as NOAA, the United States Department of Agriculture (USDA), and the National Drought Mitigation Center at the University of Nebraska-Lincoln. In addition, the monitor has developed standardized indicators that allow drought categories to be classified at the national level, providing a uniform reference for risk assessment and management.

The short-term drought indicator focuses on precipitation over 1–3 months. The long-term drought indicator focuses on a period of 6–60 months. Additional indices used, especially during the growing season, include the "USDA/NASS Topsoil Moisture," the Keetch-Byram Drought Index (KBDI), and NOAA/NESDIS satellite vegetation health indices. Other indicators include groundwater levels, reservoir capacity, and pasture conditions.

In Puerto Rico, the Puerto Rico Aqueduct and Sewer Authority (PRASA), the Puerto Rico Electric Power Authority (PREPA), and the Department of Natural and Environmental Resources (DNER) are responsible for constantly monitoring the dams and reservoirs used for potable water supply. Once critical levels are reached, the first strategy adopted at the supply system level is reducing water pressure. If adequate levels are not restored, water rationing begins. This is implemented in phases lasting 12 hours

and, in extreme cases, up to 48 hours. The affected area is divided into sectors, and the different rationing phases of a given duration are initially implemented locally, usually in municipalities with the highest consumption. In extreme circumstances, several municipalities and entire regions may be affected.

#### 4.13.1.1 Affected Area

Yabucoa's administrative boundary is uniquely influenced by its topography, as it largely coincides with the natural limits of the watersheds formed by the surrounding mountainous terrain. The municipality's steep ridges and enclosed valleys define drainage patterns in such a way that most surface water flow originates and remains within its own territory, rather than receiving significant inflows from external watersheds. While this configuration helps contain runoff during rainfall events, it also creates heightened vulnerability during periods of drought. Because Yabucoa depends primarily on the precipitation that falls within its boundaries, prolonged dry conditions can significantly reduce water availability, with limited opportunity to offset shortages through inflows from neighboring regions. This makes localized droughts particularly critical, as water supply becomes directly tied to internal climatic conditions and the capacity of local watersheds to sustain demand.

#### 4.13.1.2 Risk Magnitude (B1-C)

Drought is a slow-onset hazard, but over time, it can have highly detrimental effects on crops, municipal water supplies, recreational uses, and wildlife. If drought conditions persist for several years, the direct and indirect economic impact can be significant. Drought can also potentially provide favorable conditions for another hazard to occur, wildfire.

The National Drought Monitoring Center uses the following categories to describe the magnitude of drought conditions (US Drought Monitor, 2025).

*Table 42: US Drought Monitor Categories*

| Category | Description | Typical Impacts |
|---|---|---|
| None | Normal/Wet Conditions | No drought impacts |
| D0 - Abnormally Dry | Early signs of dryness may slow planting, affect surface water | Short-term dryness; minor stress |

| | | |
|---|---|---|
| D1 - Moderate Drought | Noticeable soil moisture depletion; low water; voluntary restrictions | Crop stress; reduced streamflow |
| D2 - Severe Drought | Common water shortages; likely crop/pasture losses | Mandatory restrictions possible |
| D3 - Extreme Drought | Major crop/pasture losses; widespread restrictions | Fire bans; severe water stress |
| D4 - Exceptional Drought | Exceptional and widespread losses; water emergencies | Emergency measures; critical impacts |

#### *4.13.1.3 Past Events (B1-D)*

Puerto Rico has a humid tropical climate characterized by two well-defined seasons: a rainy season, which extends from May to November, and a dry season, which runs from December to April. The eastern and western interior regions record the highest annual rainfall, while the northern zone receives significantly more rain than the south.

USGS identified that major drought conditions have occur in 1967 – 1969, 1974, 1994, 1994, 1997, 2001-2002 and 2013 -2016 (USGS, 2014), (DNER, 2016). According to historical records the federal government has activated its resources to deal with drought conditions;

- Puerto Rico Extreme Drought Conditions (DR-170-PR) – Date of Declaration May 26, 1964
- Puerto Rico Impact of Drought (EM-3002-PR) - Date of Declaration August 29, 1974

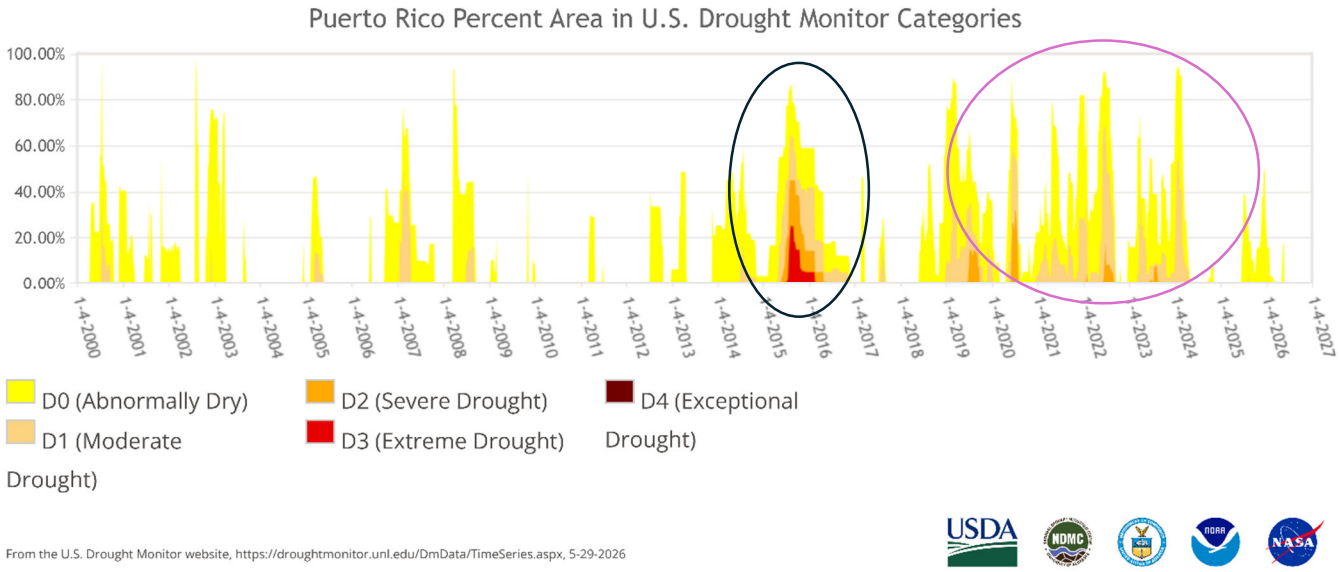
During the rainy season, precipitation mainly comes from local convection processes, orographic effects, tropical waves, and cyclones. In contrast, rainfall during the dry season is mostly associated with the influence of cold fronts and troughs (CEACC, 2024).

Figure 24 shows the data captured by US Drought Monitor Categories for the period of January 2020 to January 2026 (US Drought Monitor, 2025) for Puerto Rico's entire territory. The graph measures the occurrence, duration, territorial extent and intensity

of droughts in Puerto Rico. Intensity is measured with a color gradient ranging between yellow (D0 (abnormally Dry in the legend) as being the lowest intensity and the dark red (D4 Exceptional Drought) representing the highest level of drought. Duration is measured through the width of the data, expressed along the lower axis of the graph. Territorial extent is represented on the horizontal axis of the graph, the higher an event reaches the more of Puerto Rico's territory it covers. Occurrence is measured by combining all of the other variables and locating them within the graph.

Figure 24 also shows that the occurrences of D1 – Moderate Drought has become more recent in Yabucoa since 2019 (see purple oval in figure 24)

*Figure 24 Puerto Rico Percent Area in U.S. Drought Monitor Categories*

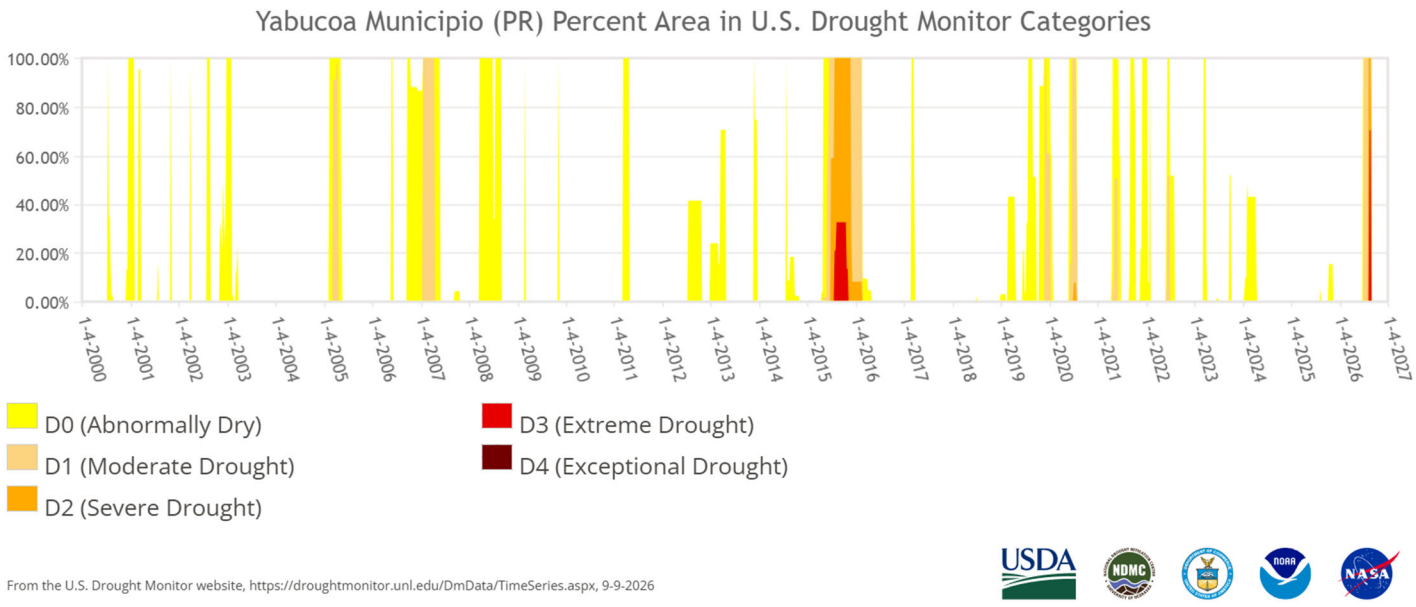



From the graph we may appreciate a sustained trend of increased occurrence, duration and intensity of droughts in Puerto Rico that began as early as 2010 and solidified by 2014. Between 2015-2017, Puerto Rico experienced the most intense period of drought in recent years, with more than 80% of the Island's territory experiencing at least Abnormally Dry levels while at least 20% of the territory experienced Extreme Drought. The 2017 Hurricane season brough historic volume of precipitation, which explains the brief reduction in drought between 2017-2019. From 2017-2024, Puerto Rico experienced an extended period of drought in the vast majority of its territory.

The Drought Monitor also provides information at the municipal level. Figure 26 shows that part of the municipality was in extreme drought during the 2015 -2016 Drought. It also that there were moderate to severe drought conditions for all of the municipality during the same period. At the extreme right of the figure we can see the current drought conditions (2026)

Figure 25 shows the occurrence of drought in Yabucoa since 2000. This map shows that during the island-wide drought of 2015-2016, Yabucoa had areas with conditions of extreme drought. However, the municipality has experience less frequency of drought when compared with the whole Island. As of September 8, 2026, the municipality was experiencing severe and extreme drought conditions.

*Figure 25: Yabucoa US Percent Area in Drought Category*




*Source: Us Drought Index*

### *4.13.1.4 Future event probabilities (B1-E)*

USGS reports that in Puerto Rico, drought has an occurrence of 15 of 18 years (USGS, 2016), (USGS, 2014). Recent scientific data shows that the Caribbean region faces increased vulnerability to drought hazards. (USGCRP, 2018). The probability of drought occurrence is difficult to forecast or foresee in a long-term perspective. Though as figure 23 shows, moderate droughts periods have become more prevalent since 2018.

While most of Yabucoa's territory is considered to be at a moderate-to-low risk for drought, long-term trends in rain patterns, such as those caused by fluctuations in the El Niño–Southern Oscillation (ENSO), may result in prolonged periods of below-average precipitation (CCOF, 2026) and reduced groundwater recharge. When combined with rising temperatures, these conditions increase evapotranspiration rates and accelerate soil moisture loss, intensifying water scarcity. As a result, areas that have not historically experienced significant drought impacts may become increasingly vulnerable under changing climate conditions.

### 4.13.2 Risk Analysis (B2-a, B2-b)

If drought results in potable water rationing, the municipality could experience economic losses to the extent that services are immediately affected by the partial or total closure of schools, businesses, industrial areas, and public and private offices.

The potential economic impact of a prolonged drought would arise from the need to mobilize the municipality to meet the basic needs of its population during the emergency period. This cost is associated with mobilizing resources such as personnel and equipment for the distribution of water to communities and municipal facilities. However, the municipality has not been able to quantify the economic impact of this expense, nor the impact on agriculture, due to a lack of information. Since drought is a hazard that does not directly affect structures, no dollar estimate of structural losses is generated.

Drought conditions in Yabucoa can significantly impact the agricultural industry by reducing water availability for irrigation and stressing crops during critical growing periods. Prolonged dry conditions can quickly lead to soil moisture deficits, lower crop yields, and in severe cases, total crop failure. In addition, reduced water supply can affect livestock and increase production costs, as farmers may need to rely on alternative water sources. These combined effects threaten the economic stability of agricultural operations and the overall food supply within the municipality.

#### *4.13.2.1 Estimated Loses*

Documenting the fiscal impact of a drought is a complex process due to the wide range of ways this climate event affects society (DNER, 2015). One way to calculate losses caused by drought periods is by looking at the impact on the agricultural sector.

The Puerto Rico Department of Agriculture reported that the 2015 drought had a net cost of $14,000,000.00 impact on the agricultural sectors.

#### 4.13.2.2 Lifelines Critical and Infrastructure

Drought can place significant strain on critical infrastructure by reducing water availability for municipal systems, often leading to rationing measures and service interruptions. Extended water shortages can disrupt essential operations in schools, hospitals, and businesses, resulting in economic losses and reduced access to public services. Energy infrastructure may also be affected, particularly where hydroelectric generation declines due to low reservoir levels, increasing reliance on more expensive or less sustainable energy sources. Transportation systems can experience indirect impacts, such as road damage caused by soil shrinkage and heightened wildfire risk along highways. Emergency response and communication services may face additional challenges when limited water supplies constrain cooling systems and firefighting capabilities. Collectively, drought conditions can trigger cascading impacts across interconnected infrastructure systems, increasing vulnerabilities and underscoring the need for coordinated mitigation and response strategies.

As noted above, drought events that require potable water rationing can lead to economic losses for the municipality by disrupting normal government operations. Partial or complete closures of schools, businesses, industrial zones, and public or private offices may occur when water availability is reduced. These impacts primarily affect the day-to-day functioning of municipal assets, as the services they provide are directly limited by water shortages or service interruptions. As droughts become more frequent or prolonged, their cumulative effects on operations are likely to intensify. However, while drought significantly affects service delivery and operational capacity, it does not directly damage the municipality's critical facilities and physical assets.

#### 4.13.2.3 Social Vulnerabilities

As mentioned in Section 3.4 Yabucoa has a sizable vulnerable population (See Section 3.4). If the pattern that began in 2019 continues, the vulnerable population of Yabucoa will continue to face major challenges regarding access to potable water. Communities will experience a decrease in water availability, which is essential for industrial and agricultural production, as well as for personal use by residents. It can also affect public health. This results in a reduction in quality of life, mental and

physical stress, and social discomfort, with potential risks of malnutrition, dehydration, and disease. Since the effects of a drought period can have effects on the whole population (even drought periods that do not directly affect the municipality's territory, it is recommendable for the municipal administration to consider the whole population of Yabucoa as exposed to this hazard.

#### 4.13.2.4 Natural and Cultural Resources

When a region experiences prolonged and cumulative periods of little or no rainfall, a drought begins. This natural hazard has adverse effects on biodiversity and water supplies. For instance, a precipitation deficit lowers water levels in bodies of water, including mangroves, impacting the region's flora and fauna. Damage to vegetation directly affects animal habitats, creating an imbalance in food availability for wildlife.

Agriculture in the area is also severely affected due to the lack of water. When rainfall is significantly below normal levels, it causes severe hydrological imbalances that negatively affect land productivity systems. Similarly, crop growth and harvests decline, along with the availability and quality of drinking water. Drought can also lead to ecosystem degradation, loss of biodiversity and species, wind erosion, and increased wildfire risk.

#### 4.13.2.5 Future Event Probabilities

Over the long term, drought-related challenges are expected to intensify as rainfall patterns continue to vary. These variations may result in droughts that are more severe, longer in duration, and wider in geographic extent than those experienced historically, thereby increasing vulnerability among affected populations.

Overall population trends in the Municipality of Yabucoa indicate a general decline at the neighborhood level. However, the population aged 65 and older has increased (see Section 3.4), representing a particularly vulnerable segment of the community. The growing proportion of older adults requires special consideration in drought planning due to heightened sensitivity to water shortages, health impacts, and service disruptions.

Future land development also plays a critical role in drought vulnerability. Approving projects near sinkholes or developments that rely on septic systems increases the risk of groundwater contamination, which becomes especially problematic during drought conditions when alternative water sources are limited. Additionally, soil

surface impermeabilization and the obstruction or filling of sinkholes reduce natural aquifer recharge by increasing surface runoff. These factors further diminish groundwater availability, limiting its viability as a supplemental water source during drought events.

## 4.14 Wildfire (E1-a)

### 4.14.1 Description (B1-a)

Wildfires are uncontrolled fires that spread through vegetation, posing serious threats to structures, human health, and natural ecosystems. These events often begin unnoticed and can spread rapidly, producing dense smoke that affects nearby communities. While wildfires may occur at any time of year, they are most common during periods of low rainfall, when grasses, leaves, and other fine fuels become dry and highly combustible.

In 2021, the Puerto Rico Department of Natural and Environmental Resources (DNER) published its Forest Action Plan (DNER, 2021). The Plan discusses overall trends, issues and objectives for the management of forest resources. Wildfires are among the challenges discussed in the document. The Plan argues that wildfire management is a pressing issue at both local and global levels due to the complex interactions among human activity, fire dynamics, and natural landscapes. While research has established that fire influences ecosystem structure and function, its effects on ecosystem services remain uncertain because of interrelated factors such as land cover changes, invasive species, and climate change (Gould, 2008).

A clear understanding of the ecological and social impacts of wildfires in Puerto Rico's natural ecosystems is essential for guiding effective conservation and management strategies. Prevention efforts must extend to private forest owners and the general public, as most fires on the island are human-caused (Gould, 2008). Historically, fire monitoring and research in the region have received limited attention. Currently, fires occur predominantly in dry forest zones, where the risk is highest. However, climate change, prolonged droughts, and human-induced landscape fragmentation could expand fire-prone conditions into moist and wet tropical forests, as well as into areas traditionally unaffected by fire (Gould, 2008).

Increasing temperatures, more frequent droughts, and the spread of invasive species

are making forests more susceptible to wildfires. This shift is already evident in Puerto Rico, where fires are becoming more frequent and occurring in areas with no prior history of such events (Robbins, Eckelmann, & Quiñones, 2009).

.

#### 4.14.1.1 Risk Magnitude

The United States Forest Service main classification for fire types (USFS, n.d.) are;

- Ground Fire - Fire that burns within the organic material below the litter layer, mostly by smoldering combustion. It typically occurs in duff, peat, dead moss and lichens, and punky wood are typically ground fire. Ground fires mainly growing vegetation such as grasslands, shrubs, and tree bases. Depending on environmental factors (vegetation composition and density, slope orientation and steepness, wind speed, among others), these fires can vary in intensity but generally release less thermal energy than fires that spread through tree canopies.
- Crown Fires – A fire that burns in the crowns of trees and shrubs usually ignited by a surface fire. Crown fires are common in coniferous forests and chaparral-type shrublands. In these types of fires, flames climb through lower branches until reaching the tree canopy. However, in some cases, its spread remains primarily surface-based, often because trees are sparse and their canopies are too far apart.
- Surface Fire – A fire that burns through leaf litter and other live or dead fuels located at or just above the ground, mostly by flaming combustion.

While FEMA follows a four-classification typology (FEMA, 1997):

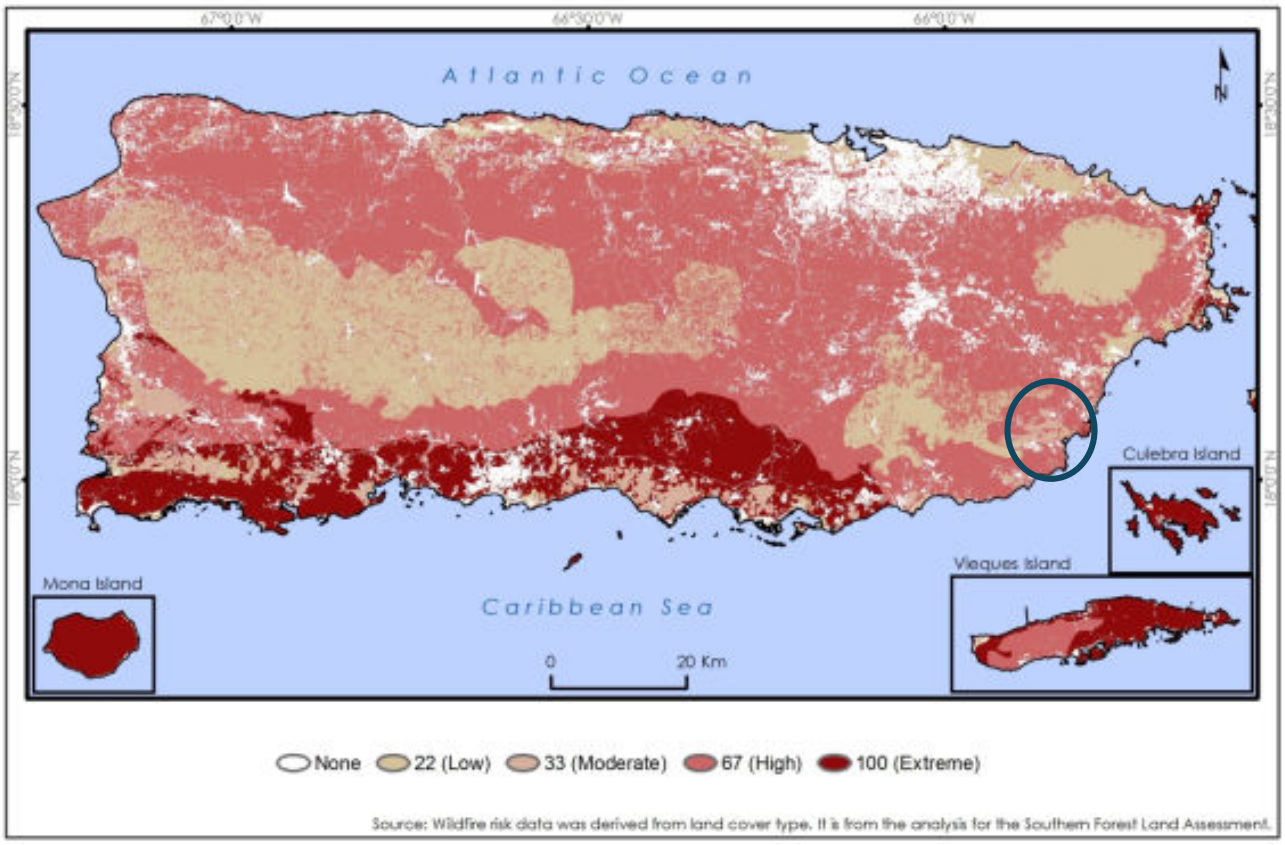
- Wildfires – Fueled almost exclusively by natural vegetation. They typically occur in forests and national parks, where federal agencies are responsible for fire management and suppression.
- Interface or Intermixed Fires – Fires that occur in urban and/or wildland areas where vegetation and integrated surroundings provide the fuel.
- Firestorms – Events of such extreme intensity that effective suppression is virtually impossible. Firestorms occur under severe weather conditions and generally burn until conditions change, or available fuel is exhausted.
- Intentional and Prescribed Burns – Fires caused by human intervention and natural fires intentionally allowed to burn vegetation for management purposes.

Another typology is the distinction between wildfires and wildland-urban interface (WUI) fires. Wildfires occur in areas with minimal development, except for infrastructure such as roads or power lines. WUI fires, on the other hand, involve situations when fire spreads into areas with structures or other human developments. In WUI fires, flames feed on both vegetation and structural elements of urban areas. The US Fire Administration defines WUI as the zone or area where human structures and developments meet or intermingle with wildland vegetation and fuels (US Fire Administation, 2025).

#### *4.14.1.2 Affected Area (B1-b)*

Figure 26 (DNER, 2021) provides an overview of areas in Puerto Rico, Vieques, and Culebra under varying levels of wildfire incidence, as defined by Southern Federal Land Assessment (SFLA). This information provides the state of knowledge of what is known as fire-prone landscapes. The combination of human presence, dry fuels, and climatic conditions accounts for the high number of fires in the southern coastal plain. Yabucoa's territory (blue circle) is characterized by High risk in the mountainous area and a moderate risk in the valleys to wildfires.

*Figure 26: Overview of areas of Puerto Rico, Vieques and Culebra under different levels of wildlife incidence accounting to SFLA*




### *4.14.1.3 Risk Magnitude (B1-C)*

Wildfires tend to be associated with template climate areas, like California or Canada. However, the recent experience in the State of Hawai'i showed that rapid and deadly wildfire can occur even in tropical humid locations. The catastrophic Lahaina Fire of August 2023 sent swift, devastating flames through densely built neighborhoods, revealing severe vulnerabilities in early warning systems, evacuation planning, and community preparedness. Fueled by dry vegetation, strong winds, and record-setting drought conditions, the blaze rapidly ignited structures and overwhelmed emergency response efforts. Independent investigation by the Fire Safety Research Institute highlights that inadequate infrastructure resilience, insufficient communication networks, and a lack of coordinated interagency planning significantly amplified the disaster's impact.

As Puerto Rico faces similar wildfire threats, especially in southern coastal plains, this

tragedy underscores the need to strengthen detection systems, bolster community evacuation routes, and elevate public education about fire safety. Building codes that emphasize fire-resistant materials and defensible space strategies around homes and critical facilities can reduce structural losses under extreme wildfire conditions.

The importance of integrated land management also emerges, encouraging Puerto Rico to limit development in WUI zones and maintain vegetation buffers. The Lahaina Fire in Hawai'I highlight that rapid, well-coordinated suppression and resilient communications systems are vital to curbing wildfire escalation. Investing in cross-agency collaboration and emergency training at the local level will help Puerto Rican municipalities respond more effectively. Ultimately, Lahaina serves as a stark wake-up call, emphasizing that proactive planning, robust infrastructure, and community resilience are essential to preventing a similar wildfire catastrophe in Puerto Rico.

#### *4.14.1.4 Past Events (B1-D)*

Citing data from the Puerto Rico Firefighters Bureau (PRFB), The Puerto Rico Forest Action Plan states that a total of 7,099 wildland fires were reported across Puerto Rico between 2018 and 2020. The highest number of incidents occurred in 2020, with 5,077 recorded fires. The regions most affected were Ponce, Guayama, and Mayagüez (DNER, 2021).

Within the Department of Natural and Environmental Resources (DNER) Protected Natural Areas, fire incidence increased in 2019 compared to 2018. Notable affected sites included Guánica State Forest, Boquerón Wildlife Refuge, Punta Cuchara Natural Reserve, Caño Tiburones Natural Reserve, and Tortuguero Lagoon Natural Reserve. Most of these fires were linked to human activities, such as unattended campfires, discarded cigarettes, intentional burning, improper waste burning, and poorly managed prescribed burns in pasturelands (DNER, 2021).

The high frequency of wildfires in Puerto Rico highlights the urgent need for targeted education and public outreach efforts to raise awareness. When combined with active land management and a landscape-scale conservation approach, these initiatives can help reduce the occurrence of fires and mitigate additional pressures on forest ecosystems.

During 2024 (which is the most recent available data) a total of 14 forest fires were reported by the Puerto Rico Fire Bureau. The following table shows the details of the wildfires reported in that year.

*Table 43: Registered Wildfires*

| CASE NUMBER | DISCOVERY DATE | CONTAINMENT DATE | LATITUDE & LONGITUDE |
|---|---|---|---|
| BPR012324-570 | 2024-01-23 12:01:06.255000 | 2024-01-23 15:56:41.639000 | -65.897, 18.0728 |
| BPR012224-1257 | 2024-01-22 21:43:53.137000 | 2024-01-22 22:24:45.870000 | -65.897, 18.0728 |
| BPR021124-392 | 2024-02-11 11:22:38.302000 | 2024-02-11 11:50:05.898000 | -65.897, 18.0728 |
| PR021424-965 | 2024-02-14 18:27:47.303000 | 2024-02-14 19:41:21.957000 | -65.85746, 18.0192 |
| PR022424-489 | 2024-02-24 11:49:03.532000 | 2024-02-24 13:28:54.969000 | -65.86305, 18.0986 |
| PR022424-803 | 2024-02-24 16:46:16.217000 | 2024-02-24 19:30:03.346000 | -65.93647, 18.0601 |
| BPR022524-162 | 2024-02-25 05:21:43.404000 | 2024-02-25 09:28:10.925000 | -65.897, 18.0728 |
| BPR030524-442 | 2024-03-05 11:23:13.091000 | 2024-03-05 12:15:50.564000 | -65.897, 18.0728 |
| BPR031224-394 | 2024-03-12 10:41:13.874000 | 2024-03-12 11:36:46.037000 | -65.897, 18.0728 |
| PR033024-717 | 2024-03-30 16:48:55.733000 | 2024-03-30 18:43:02.547000 | -65.98549, 18.078 |
| PR040924-1027 | 2024-04-09 21:26:58.418000 | 2024-04-09 22:25:45.967000 | -65.86848, 18.0257 |
| PR081124-389 | 2024-08-11 11:50:08.512000 | 2024-08-11 14:43:57.513000 | -65.82277, 18.0609 |
| PR092724-326 | 2024-09-27 09:12:03.918000 | 2024-09-27 10:39:04.820000 | 0.0, 0.0 |
| PR100824-702 | 2024-10-08 14:14:49.570000 | 2024-10-08 15:16:58.077000 | -65.93654, 18.0821 |

#### 4.14.1.5 Future Event Probability (B1-e)

Long-term trends in rain patterns, such as those caused by fluctuations in the El Niño–Southern Oscillation (ENSO), may lead to extended dry periods (CCOF, 2026), reduced soil moisture, and increased vegetation stress. When combined with rising temperatures, these conditions accelerate evapotranspiration and further dry out fuels, significantly increasing the likelihood of ignition and fire spread. As a result, areas that have not historically been prone to wildfires may become increasingly susceptible under these changing climate conditions.

## 4.14.2 Risk Analysis (B2-a, B2-b)

### *4.14.2.1 Estimated Loses*

Wildfires can result from both natural conditions, such as the presence of flammable vegetation, and human activities, including the intentional use of fire. These factors strongly influence the potential scale and intensity of wildfire events. The level of potential loss increases with higher population concentrations, greater numbers of structures, and sensitive ecosystems located within the affected area. Climatic conditions, combined with patterns of human activity, largely determine the extent and severity of wildfire impacts.

At present, there is insufficient information to quantify monetary losses related to building damage from this hazard. Additionally, at the time of this Plan update, no official damage estimates were available for the municipality. To address this gap, the municipality will take a proactive approach by incorporating updated damage information in future Plan revisions as data become available.

### *4.14.2.2 Lifelines and Critical Infrastructure*

Wildfires pose a significant threat to critical infrastructure, creating cascading impacts across power systems, communications, water supply, transportation, and the built environment. The electric grid is particularly vulnerable. Research from Sandia National Laboratories (Sandia National Laboratories, n.d.) and other institutions shows that wildfires can both damage grid components and be ignited by them, as seen in the 2018 Camp Fire, which caused $9.3 billion in damages. To address this, the U.S. Department of Energy has invested $3.46 billion through its Grid Resilience and Innovation Partnerships program (DOE, 2023), funding projects that include undergrounding power lines, installing fire-resistant poles, and deploying advanced sensors.

Communications infrastructure faces similar risks. A study by the University of Wisconsin – Madison faculty found that while cell towers often survive fires physically, power outages lead to widespread service disruptions (Anderson, Barford, & Barford, 2020). Water systems and watersheds are also heavily impacted. Post-fire conditions—such as vegetation loss and soil hydrophobicity—can trigger flooding and debris flows, introducing sediment, nutrients, and metals into water supplies.

Transportation networks suffer both direct and indirect damage. Roads, bridges, and drainage systems are often compromised by post-fire floods and debris flows buildings and other structures in the wildland–urban interface is increasingly at risk due to climate change and urban expansion.

In summary, wildfire creates complex, interconnected risks for critical infrastructure, requiring a combination of engineering solutions, advanced modeling, policy reforms, and community engagement. Official and academic sources consistently call for proactive measures—such as infrastructure hardening, improved land management, and resilience planning—to reduce exposure and enhance recovery.

Wildfire occurs regularly during periods of drought, primarily in the southern region of Puerto Rico. These events have significant social and economic impacts, mainly due to structural and property damage or loss caused by the fires. If the affected area served as an employment or industrial hub, many individuals could face unemployment. Additionally, insurance premiums tend to rise because of increased demand for coverage to mitigate economic losses associated with wildfire hazards. Collectively, these factors negatively affect the region's economy, wildlife, vegetation, and contribute to broader social decline.

Wildfires in Yabucoa can significantly impact both the agricultural and oil industries by damaging land, infrastructure, and critical resources. In the agricultural sector, fires can destroy crops, pastureland, and irrigation systems, leading to immediate production losses and long-term soil degradation due to the loss of organic matter and increased erosion. For the oil industry, wildfires pose a serious risk to facilities such as storage tanks, pipelines, and support infrastructure, where high heat exposure could lead to structural damage or even trigger hazardous incidents such as explosions or fuel releases. Additionally, smoke and reduced air quality can disrupt operations and pose health risks to workers in both sectors. Overall, wildfires represent a multi-dimensional threat that can interrupt production, damage critical assets, and create environmental and economic consequences for the municipality.

#### *4.14.2.3 Social Vulnerability*

Social vulnerability plays a critical role in shaping how communities experience and recover from wildfire events. Research consistently shows that populations with higher levels of poverty, older adults, individuals with disabilities, limited English proficiency, and households without reliable transportation face greater challenges preparing for, evacuating from, and recovering after wildfires. The CDC/ATSDR Social Vulnerability

Index (SVI) identifies these demographic and socioeconomic conditions as key factors that increase susceptibility to disaster impacts, including wildfires, by constraining a community's adaptive and coping capacity before, during, and after an event. National-scale studies further demonstrate that U.S. communities experiencing wildfire occurrence or exposure tend to have systematically higher levels of social vulnerability, including higher unemployment, lower educational attainment, and greater concentrations of medically or socially dependent populations (Schumann, III, et al., 2024).

Wildfires also exacerbate existing inequalities through indirect impacts such as prolonged displacement, loss of livelihoods, and health effects from smoke exposure. Peer-reviewed studies show that socially vulnerable populations experience disproportionate health burdens from wildfire smoke, including higher rates of respiratory and cardiovascular illness and increased mortality risk, due to pre-existing health conditions and limited access to medical care. FEMA and the U.S. Fire Administration emphasize that older adults, low-income households, people living in mobile homes, and individuals without access to private vehicles face heightened risk of injury or death during wildfire evacuations, underscoring the importance of incorporating social vulnerability into wildfire mitigation, evacuation planning, and recovery strategies. (Dennin, Nock, Muller, Akindele, & Adams, 2025) (Dennin, Nock, Muller, Akindele, & Adams, 2025). A significant portion of Yabucoa's population is considered vulnerable, and increased wildfire risk may disproportionately impact these residents by threatening homes, limiting access to essential services, and exacerbating health risks associated with heat and smoke exposure.

#### *4.14.2.4 Natural and Cultural Resources*

The severity, scale, and consequences of wildfire can be grouped into the following categories:

- Impact on Landscape - The most visible effect after a wildfire is the loss of scenic quality caused by the destruction of vegetation cover and its regression to earlier ecological stages.
- Impact on Wildlife - Wildfires have both immediate and long-term effects on fauna. In the short term, fires can cause direct mortality, particularly among invertebrates, small vertebrates, and young animals with limited mobility, as well as larger herbivores and carnivores that may be trapped by flames or barriers such as fencing. In the longer term, habitat loss, reduction of forage, and ecosystem disruption can force wildlife migration and threaten

vulnerable or endangered species.

- Impact on Soil - Wildfires significantly alter soil structure and increase its susceptibility to erosion. The combustion of organic matter destabilizes soil aggregates, causing progressive disintegration. As a result, solid particles are then removed by rain or wind erosion. Fire often creates hydrophobic (water-repellent) layers to the deposition of organic compounds and changes in mineral composition, which reduce water infiltration and further accelerate surface runoff and erosion. Significant losses of soil and organic matter reduce nutrient levels, lowering fertility. In addition, heat also kills many organisms, reducing biological activity and disrupting biogeochemical cycles. However, not all effects are negative. Naturally occurring fires (now increasingly rare) can benefit forest health by mobilizing nutrients and controlling pests. Low-intensity fires help retain carbon in the soil, preventing its release as carbon dioxide.
- Alteration of the Water Cycle - Wildfire-induced soil degradation can significantly disrupt the hydrological cycle. Reduced infiltration lowers groundwater reserves that feed aquifers essential for agriculture and urban use. At the same time, increased surface runoff accelerates soil erosion, transports sediment into water bodies, and heightens the risk of flash flooding following intense rainfall events.
- Increase in Carbon Emissions – The combustion of biomass during wildfires releases substantial quantities of carbon dioxide ($CO_2$), methane ($CH_4$), and suspended particles. These emissions cause significant environmental damage and negatively affect people with respiratory illness (Asthma, COPD, etc.).

Wildfires can lead to numerous environmental consequences, including the destruction of vegetation cover, the death or displacement of wildlife, the loss of fertile soil, and an increase in erosion events. They can also cause significant loss of life and property, resulting in substantial economic costs associated with firefighting and recovery efforts.

As for cultural resources, wildfires pose a serious threat to cultural resources, including historic buildings, and archaeological sites. Intense heat and flames can destroy irreplaceable structures, artifacts, and archives, erasing centuries of heritage in a matter of hours. In addition, smoke, soot, and water used during firefighting operations can further damage delicate materials. Post-fire effects such as erosion and flooding after fires may expose or wash away archaeological remains.

Beyond physical damage, the loss of cultural landmarks disrupts can community identity and traditions, while also affecting tourism and local economies. Protecting these resources requires proactive planning, fire-resistant measures, and collaboration between emergency agencies and cultural preservation experts.

#### 4.14.2.5 Future Conditions (E1-a)

Puerto Rico already experiences a high annual probability of wildfire-supporting conditions. According to the World Bank–supported ThinkHazard! platform, Puerto Rico's wildfire hazard is classified as High, meaning there is a greater than 50% probability in any given year of weather conditions capable of supporting a significant wildfire that could cause impacts to life or property. This assessment incorporates historical fire occurrence, climate variables, vegetation type, and drought conditions and is widely used in infrastructure and hazard mitigation planning worldwide (World Bank, n.d.).

Taken together, the best available scientific evidence indicates that Puerto Rico currently faces a probability exceeding 50% annually of wildfire-supportive weather conditions, with future probability and severity expected to increase due to rising temperatures, expanded drylands, and longer seasonal droughts. While precise ignition probability percentages cannot be reliably projected at the municipal scale, confidence is high that wildfire occurrence, fire weather days, and burned area will increase by mid-century, particularly in southern, western, and interior regions of the island (World Bank, n.d.).

## 4.15 Long term Coastal Dynamics

### 4.15.1 Description

Long-term coastal dynamics refer to the gradual, persistent processes that shape coastlines over extended periods of time, including shoreline movement, sediment transport, erosion, accretion, and changes in coastal water levels, which together influence coastal form, stability, and hazard exposure (USGS, 2018) (Mentaschi, Vousdoukas, Pekel, Voukouvalas, & Feyen, 2018). These dynamics differ from short-term storm impacts in that they reflect persistent, incremental change rather than episodic disturbance. For Local Hazard Mitigation Plans, understanding

long-term coastal dynamics is critical because such changes influence shoreline position, coastal stability, and long-term exposure to coastal hazards (USGS, 2018).

Long-term coastal dynamics are primarily driven by the interaction of coastal erosion, coastal accretion, and changes in the mean (base) sea level, all of which influence sediment distribution, natural protective features, and flood exposure along coastal areas (Bird, 2008; Davidson-Arnott, 2010).

Coastal Erosion

Coastal erosion is the long-term landward movement of the shoreline resulting from a net loss of sediment from beaches, dunes, bluffs, or nearshore environments. While erosion may occur rapidly during storm events, long-term erosion reflects sustained sediment imbalance operating over decades (Komar, 1998).

From a hazard mitigation perspective, chronic coastal erosion is important because it gradually reduces beach width and elevation, weakens dune systems, and exposes inland areas to increased wave action and flooding. Long-term erosion is commonly measured as average annual shoreline retreat, integrating multiple historical shoreline positions and providing an indicator of sustained vulnerability rather than isolated event-driven damage (Allan et al., 2003; USGS, 2018).

Coastal Accretion

Coastal accretion refers to the long-term accumulation of sediment that results in shoreline advancement or increases in beach width and elevation. Accretion can enhance coastal resilience by reinforcing natural protective features; however, it is often spatially variable and dependent on sediment availability and transport pathways (Davidson-Arnott, 2010).

In many coastal systems, accretion in one location corresponds to erosion elsewhere, reflecting sediment redistribution rather than net sediment gain. As a result, accretion may be temporary and insufficient to offset long-term erosional trends at a regional scale (Bird, 2008; Mentaschi et al., 2018).

Variations in Mean (Base) Sea Level

Mean sea level, often referenced using tidal datums such as mean sea level (MSL) or mean higher high water (MHHW), serves as a controlling baseline for coastal

processes. Long-term changes in mean sea level influence the elevation at which waves interact with the shoreline, the frequency of tidal inundation, and the position of the coastal profile (USGS, 2018).

Gradual changes in mean sea level contribute to long-term coastal dynamics by promoting landward adjustment of beaches and dunes, increasing inundation during routine tides, and enhancing erosion during moderate storm conditions. These impacts occur incrementally and contribute to persistent shoreline retreat over time (Bird, 2008; Mentaschi et al., 2018).

Long-term coastal dynamics emerge from the interaction of erosion, accretion, and mean sea-level position rather than from any single process acting independently. Coastal systems tend to adjust toward equilibrium conditions, which may involve shoreline migration, redistribution of sediment, and progressive loss of natural buffering capacity (Davidson-Arnott, 2010).

As a result, localized accretion may slow erosion but may not reverse long-term shoreline retreat where underlying sediment deficits or water-level changes persist. These interactions explain why many coastlines experience sustained landward movement despite episodic periods of beach recovery (Komar, 1998; Allan et al., 2003).

For Local Hazard Mitigation Plans, long-term coastal dynamics are a key consideration because they contribute to the gradual expansion of coastal hazard exposure beyond areas affected by single storm events. Persistent erosion, shifting shorelines, and changing base water levels can increase the vulnerability of infrastructure, reduce the effectiveness of fixed shoreline protection measures, and influence long-term land-use suitability (USGS, 2018).

Incorporating long-term coastal dynamics into hazard mitigation planning supports proactive decision-making related to land use, infrastructure siting, and mitigation strategy development by addressing the underlying physical processes shaping coastal risk.

Long-term coastal dynamics, including ongoing erosion, accretion, and changes in mean sea level, contribute to gradual shoreline adjustment and increased exposure to coastal hazards over time. These processes represent a persistent source of coastal risk that should be considered in land-use planning, infrastructure investment, and hazard mitigation strategies (Bird, 2008; USGS, 2018).

#### 4.15.1.1 Affected Area

Yabucoa's coastline extends approximately 19.5 kilometers. Based on 2018 data, beaches accounted for 44% of the shoreline, with widths ranging from 3 to 68 meters. The remaining coastline consisted primarily of rocky shores (39%), followed by vegetated shoreline (2%) and areas protected or modified by coastal structures (5%).

Under HMGP FEMA-4339-DR-PR Subgrantee Number 4339-0007P, a comprehensive post-event coastal assessment was conducted to evaluate the geomorphic condition of Puerto Rico's beaches following Hurricane María (September 2017) and their subsequent recovery. This study was conducted by the University of Puerto Rico, Río Piedras' Coastal Research and Planning Institute of Puerto Rico (COREPI-PR).

The assessment analyzed beach conditions immediately after the hurricane and approximately ten months later (July 2018), covering a representative group of coastal municipalities across the north, west, east, and south coasts including Aguada, Aguadilla, Añasco, Arecibo, Arroyo, Barceloneta, Humacao, Loíza, Rincón, and San Juan (COREPI-PR, 2020).

The study found that as of September 2017, most of Yabucoa's beaches—approximately 71%—showed sediment accretion. The greatest sediment gains were documented at Icacos, Guayanés, and Lucía Beaches. However, coastal erosion occurred at Teresa, El Negro, and El Cocal Beaches, as well as along a beach segment near Hotel Lucía, following Hurricane María (COREPI-PR, 2020).

Ten months after Hurricane María, erosion had intensified along the sandy shoreline at Guayanés Beach and in portions of Lucía and Teresa Beaches. In contrast, El Cocal Beach experienced sand accumulation by July 2018. (COREPI-PR, 2020).

By July 2018, approximately 1.84 kilometers of Yabucoa's shoreline showed landward migration of the waterline. Affected areas included shoreline segments near Villa Pesquera, Guayanés Beach, the mouth of the Guayanés River, Yabucoa Beach, the vicinity of Cueva de Las Cabras, El Negro Beach, and Punta Yeguas. In addition, approximately 1.65 kilometers of beach shoreline migrated inland, primarily along Yabucoa and Lucía Beaches (COREPI-PR, 2020).

The next figures show the results of the State of the Beach study for the municipality of Yabucoa Figure 27 (shows the type of coast (beach, rocky, human-made). This figure also shows the difference of percentages between beaches that were in erosion

versus those that were in accretion in the direct aftermath of Hurricane Maria (September 2017) and ten months after Hurricane Maria (July 2018) as shown in figure 28. Figure 29 shows the sections of the coast that showed changes in the state of the beach (erosion vs accretion) in September 2017 (immediately after Maria), and Julio 2018 (10 months after Maria). Please note that these figures are screengrabs of a website and that the hazard mitigation planners preparing this LHMP were not able to locate an English version (COREPI-PR, 2020).

*Figure 27: Yabucoa State of the Coast Study (in Spanish)*

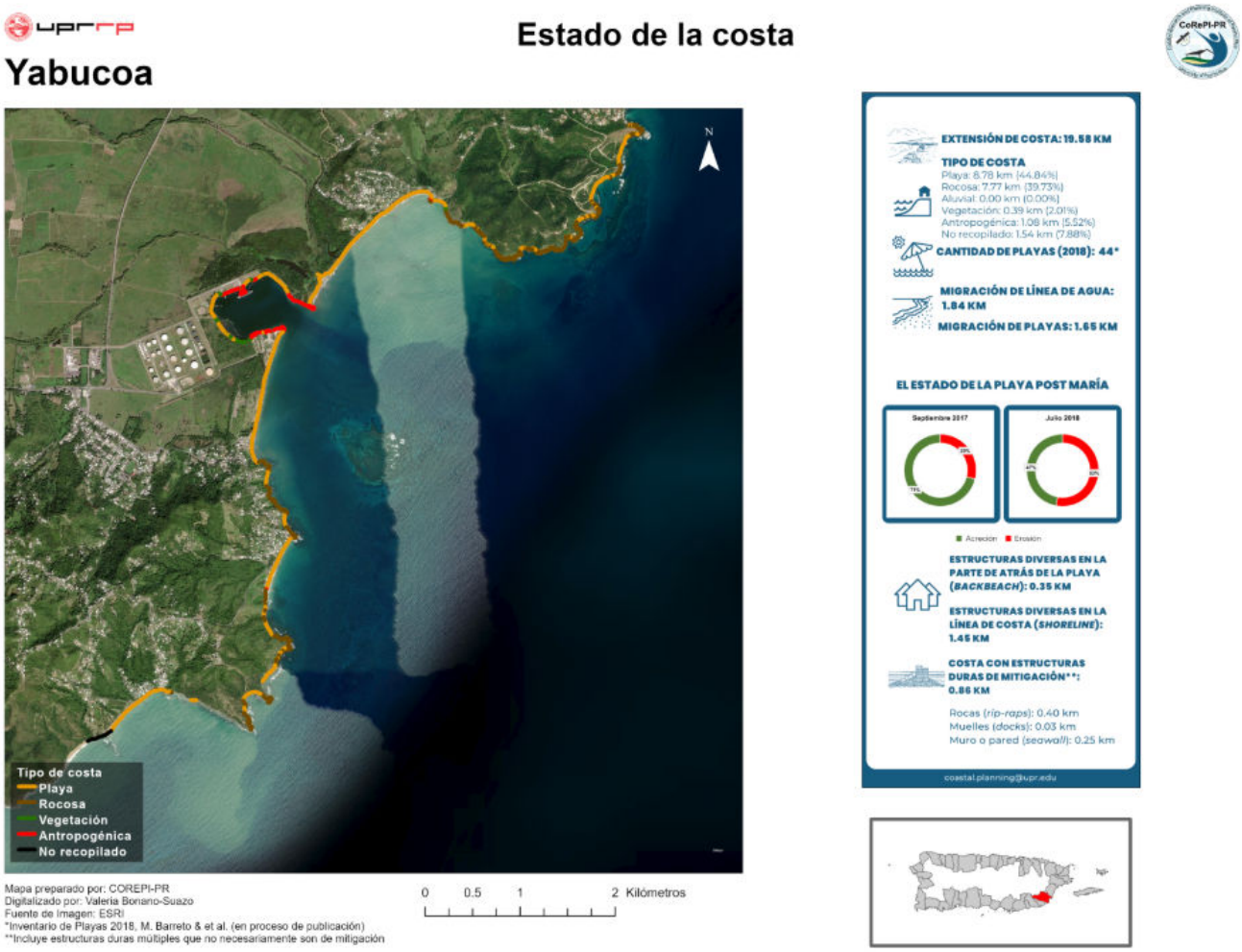


*Figure 28: State of the Beach September 2017 vs. July 2018 (in Spanish)*

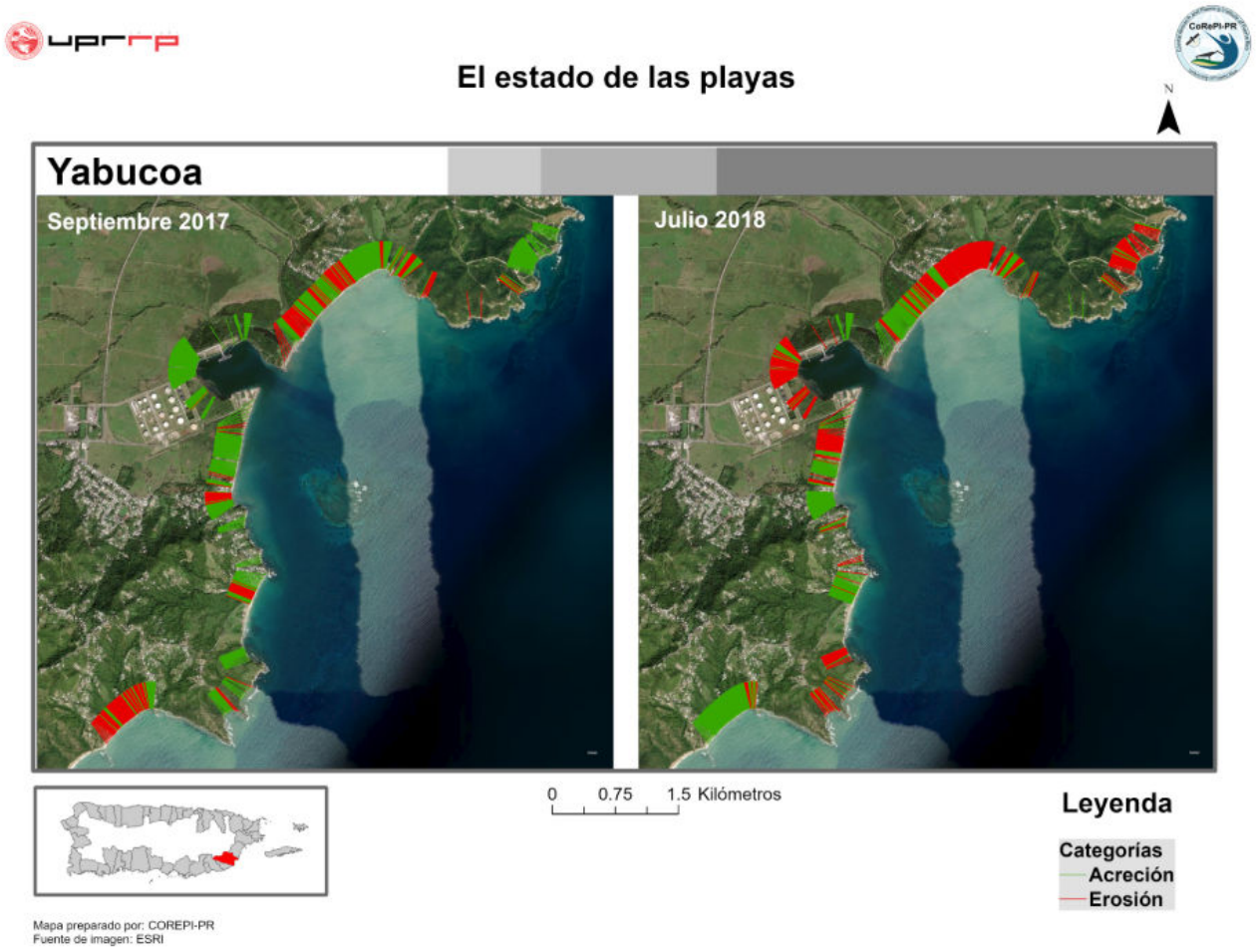
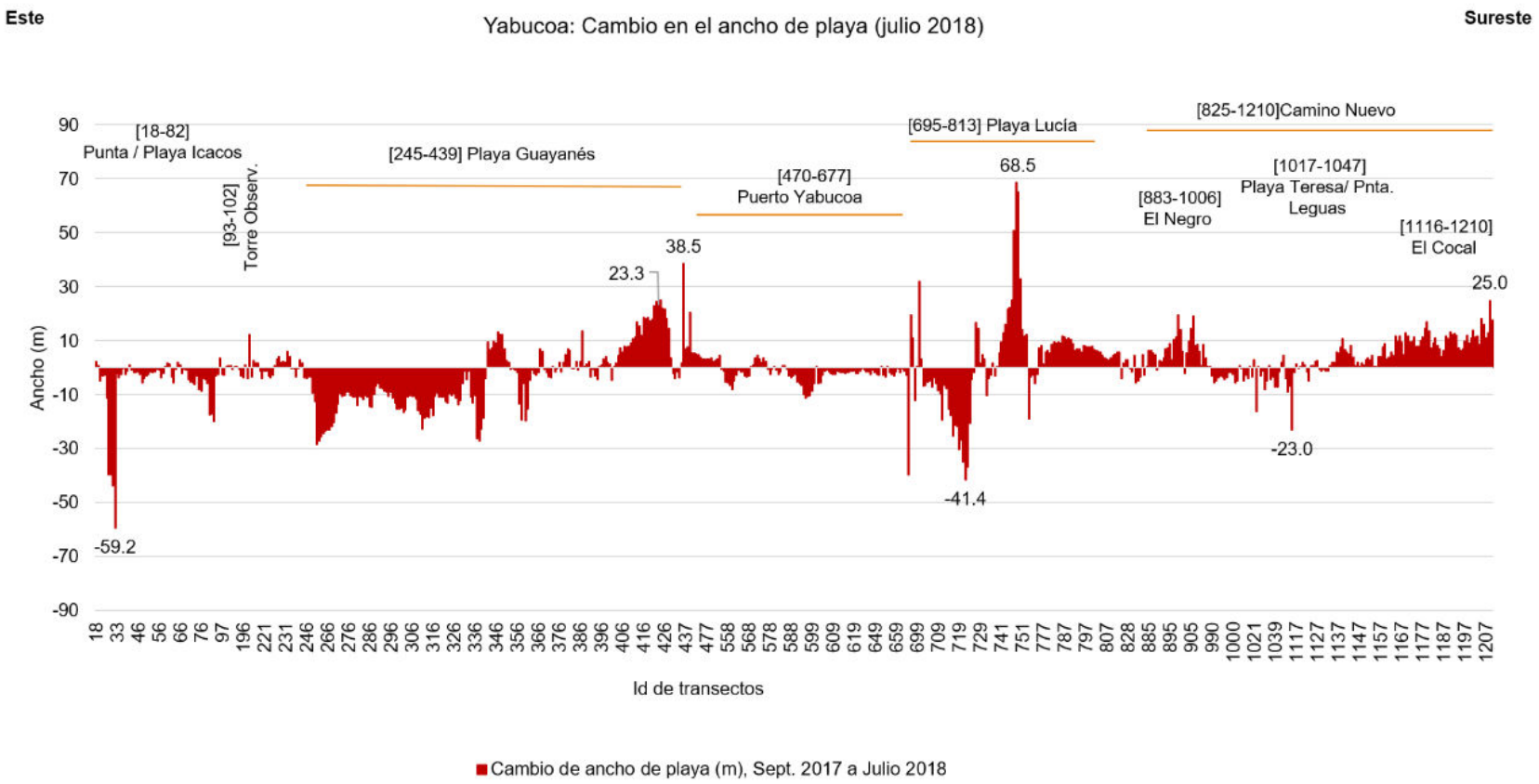


*Figure 30: Yabucoa Changes to Width of the Beach 9/2017 - 7/20218*



### 4.15.1.2 Risk Magnitude

**Coastal Erosion**

Erosion is the process by which major storms, flooding, strong wave action, rising sea levels, and human activities wear away beaches and cliffs along coastlines (FEMA, 1997). Beaches are affected by storms and other natural events that cause coastal erosion; however, the extent and severity of the problem are not uniform, as they vary by location. Consequently, there is no single solution for mitigating erosion. Erosion processes and their impacts may be episodic or long-term. These two (2) descriptors assign an important temporal component to erosion processes and their consequences.

Episodic erosion, also known as storm-induced erosion, primarily consists of the cross-shore movement of sand and sediments resulting from high-intensity weather events and ocean storms. This type of response leads to coastal adjustment and occurs during a single storm or a sequence of storm events within a season. Changes in beach and shoreline profiles during intense storms may result in dramatic erosion of beaches and dunes, including the reduction or removal of coastal dunes, as well as the retreat and collapse of coastal cliff formations. The consequences of this type of erosion may include increased inland wave penetration and ocean flooding in areas that were previously not exposed to water inundation.

Long-term or chronic erosion, on the other hand, is associated with slower processes such as gradual shoreline change linked to:

- Increases in sea level,
- Land subsidence,
- Changes in sediment supply due to watershed modifications,
- Impacts on coral reefs resulting from rising water temperatures and ocean acidification,
- Coastal structures and development, and
- Decadal adjustments in rainfall, wind, and climate associated with global warming.

Erosion may also be caused by anthropogenic forces (Romeu-Cotchett, 2012), including:

- Removal of coastal sediments, resulting in area erosion and the loss of dunes and beaches;

- Construction of developments, roadways, or agricultural activities, which increase sediment deposition and contamination in coastal waters, causing adverse effects on coral reefs. It should be noted that reefs function as natural barriers that protect beaches from wave impacts and, consequently, from erosion;
- Dam systems constructed to reduce the normal flow of sand delivered to the ocean by rivers; and
- Construction close to beaches, which allows the sea to advance further inland, thereby increasing erosion processes.

**Costal Accretion**

Coastal accretion is a fundamental component of long-term coastal dynamics and represents the process by which sediment is deposited along the shoreline, resulting in the widening, elevation, or seaward movement of beaches, dunes, and other coastal landforms. Accretion occurs when sediment inputs exceed sediment losses over time and plays a critical role in shaping shoreline configuration and influencing coastal hazard exposure (USGS, 2018).

For Mitigation planning coastal accretion is significant because it affects the capacity of beaches and dunes to function as natural protective features that reduce wave energy, coastal flooding, and erosion impacts. However, accretion is neither uniform nor permanent and must be evaluated in terms of its duration, spatial extent, and relationship to broader coastal processes (Bird, 2008).

Episodic coastal accretion refers to short-term sediment deposition that occurs following discrete events or over limited periods, such as between storm seasons. This form of accretion is typically associated with the return of sediment from offshore bars or adjacent shoreline segments to the beach through cross-shore or alongshore transport processes (Davidson-Arnott, 2010).

Episodic accretion may result in temporary increases in:

- Beach width,
- Beach elevation, and
- Dune volume following storm-related erosion.

These changes may occur rapidly, sometimes within weeks or months; however, episodic accretion represents temporary profile adjustment rather than sustained

shoreline stabilization. Subsequent storms or shifts in hydrodynamic conditions may quickly redistribute or remove accreted sediments (Komar, 1998).

From a hazard mitigation perspective, episodic accretion may reduce short-term exposure to wave action or tidal inundation but should not be assumed to provide long-term protection unless supported by evidence of persistent sediment supply.

Long-term coastal accretion occurs when sediment deposition persists over years to decades, resulting in stable or progressively advancing shorelines. This form of accretion reflects a positive sediment budget within the coastal system, often supported by consistent sediment delivery and favorable transport conditions (USGS, 2018).

Long-term accretion is commonly associated with:

- Sustained sediment input from rivers or coastal ecosystems,
- Alongshore sediment transport that concentrates material in specific shoreline segments,
- Nearshore bathymetry that favors sediment retention, and
- Relatively stable mean sea-level conditions relative to land elevation (Bird, 2008).

While long-term accretion can enhance coastal resilience by reinforcing beaches and dunes, it is often spatially limited and may occur concurrently with erosion in adjacent areas. In many cases, accretion reflects sediment redistribution rather than net sediment gain across a regional coastline (Mentaschi et al., 2018).

Human activities can influence coastal accretion both directly and indirectly. In some cases, engineered interventions such as beach nourishment or coastal structures may promote localized sediment accumulation. In other cases, development and infrastructure interfere with natural sediment pathways, limiting accretion potential elsewhere (Komar, 1998).

Anthropogenic factors affecting accretion include:

- Beach nourishment and sediment placement projects,
- Coastal structures that trap sediment locally,
- Alterations to river systems that modify sediment delivery, and
- Shoreline development that restricts natural shoreline adjustment (NOAA,

2020).

While engineered accretion may provide short- to medium-term protective benefits, it typically requires long-term maintenance and should be evaluated within the context of sustained coastal dynamics.

**Change in Base Sea Level Mean**

Changes in the mean (base) sea level, commonly referenced using tidal datums such as mean sea level (MSL) or mean higher high water (MHHW), represent an important component of long-term coastal dynamics and influence the frequency and extent of coastal inundation. Mean sea level serves as a baseline against which shoreline position, wave interaction, and tidal flooding are measured, and gradual shifts in this baseline affect how coastal systems respond over time (NOAA, 2026). Sustained increases in mean sea level relative to the land surface allow wave energy to act on higher portions of the coastal profile, increasing the frequency of tidal flooding and accelerating shoreline adjustment processes. These incremental changes can lead to landward migration of beaches and dunes, greater exposure of low-lying areas to coastal flooding, and reduced effectiveness of natural and engineered protective features, even in the absence of major storm events. From a hazard mitigation planning perspective, changes in mean sea level contribute to long-term increases in coastal hazard exposure and should be considered when evaluating future risk, land-use suitability, and infrastructure resilience along the coast (USGS, 2018) (NOAA, 2026).

Sea level fluctuates over both short- and long-term timeframes as a result of multiple interacting factors. Short-term variations typically occur on daily to event-based timescales and are influenced by processes such as waves, tides, and discrete flooding events, including those associated with seasonal snowmelt, hurricanes, or other coastal storms. In contrast, long-term sea-level variations occur over extended periods ranging from months to multiple years and may manifest as recurring cycles, gradual trends, or episodic departures from typical conditions. These longer-term changes are influenced by a combination of factors, including seasonal atmospheric patterns, variations in the Earth's declination, changes in coastal and ocean circulation, human activities such as dredging, vertical land motion, and large-scale climate–ocean oscillations such as the El Niño–Southern Oscillation.

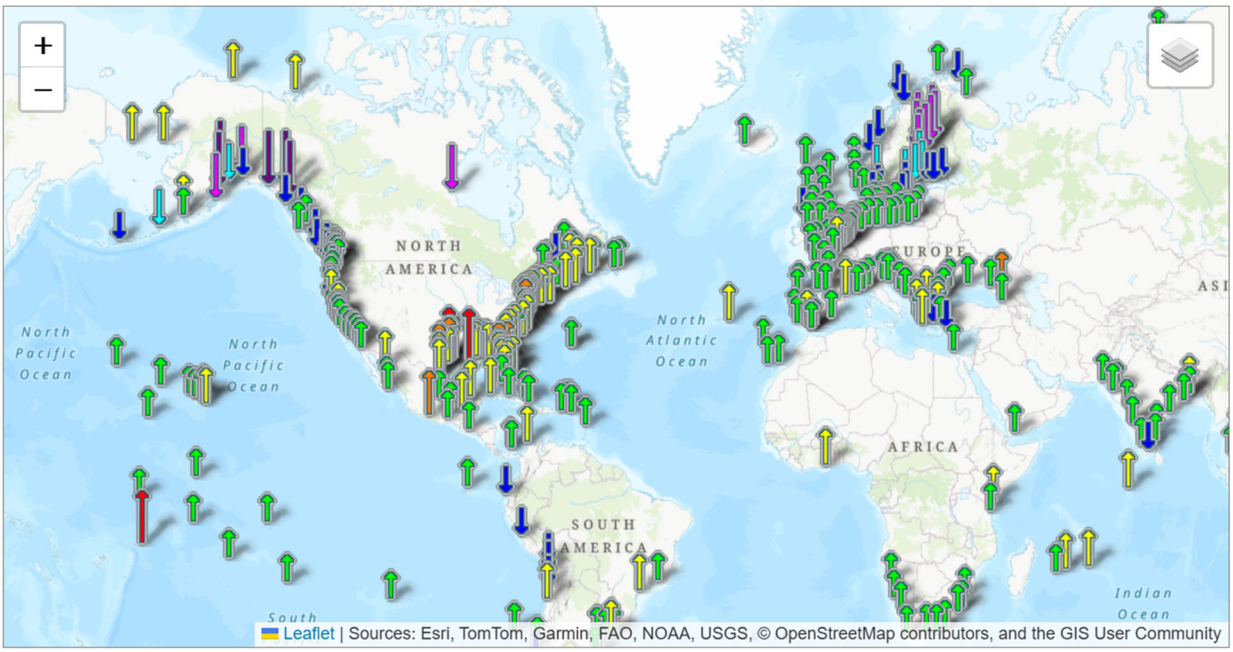
When evaluating long-term sea-level trends, a minimum observational record of 30 years is commonly used to capture these underlying variations and minimize

uncertainty associated with shorter-term fluctuations in monthly mean sea level. Accounting for predictable and repeatable processes—such as tidal cycles, seasonal variability, and interannual oscillations—allows for a more accurate representation of long-term sea-level behavior (NOAA, 2026).

NOAA's Relative Sea Level Trends website provides the up to date trends for sea levels at a global scale. The global sea-level trend has been measured using satellite altimetry since 1992, and the most recent global estimates, along with maps showing regional variations, are available from NOAA's Laboratory for Satellite Altimetry. The screen shot below shows the map provided by NOAA as of 4/29/2026 (NOAA, 2026).

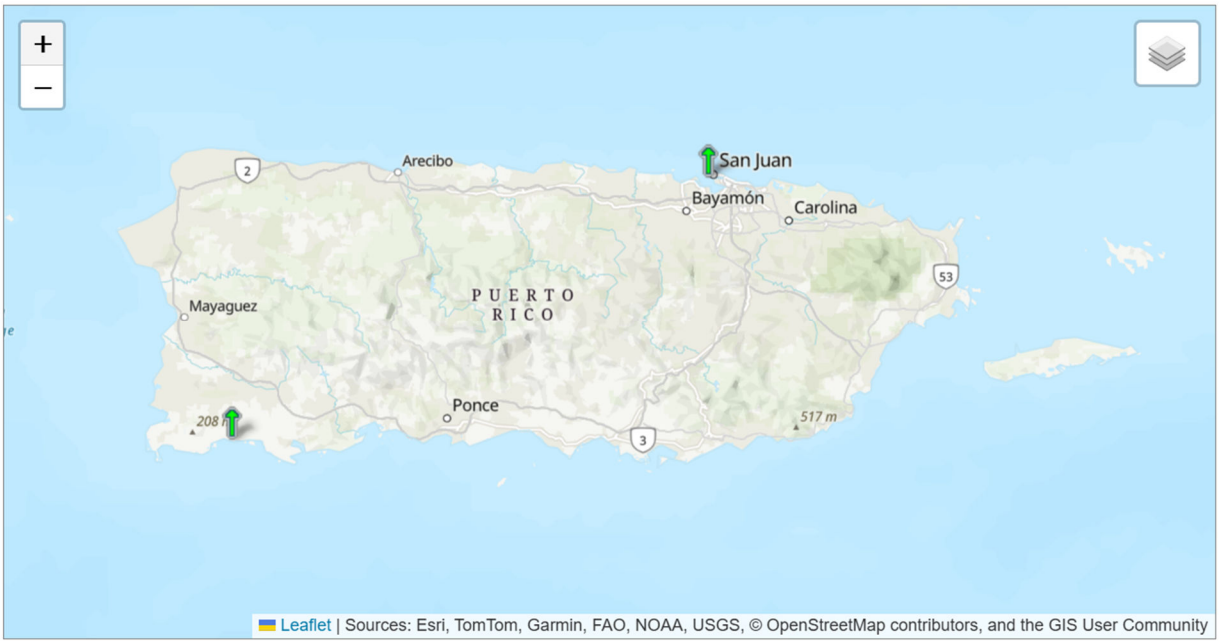
As figure 30 show, although there are various places where the sea level has decreased (specially to the south of Alaska, the west of British Columbia, Hudson Bay, the Nordic countries and among some parts of the South American western coast (Ecuador, Peru and northern Chile) the general trend is for increasing sea level in varying degrees.

*Figure 30: NOAA's Relative Sea Level Trend Map*




In the case of Puerto Rico, according to this map there has been observed an increase in base sea levels.

*Figure 31: NOAA's Relative Sea Level Trend Map (Zoom to Puerto Rico)*




The gauges shown in the map present the following data:

*Table 44: Sea Base Mean Level Readings in Puerto Rico*

| Gauge Name | Trend | Period | Commentary |
|---|---|---|---|
| Magueyes Island, PR 9759110 | + 2.06/year | 1955 - 2025 | The relative sea level trend is 2.06 mm/year with a 95% confidence interval of +/- 0.27 mm/year based on monthly mean sea level data from 1955 to 2025 which is equivalent to a change of 0.68 feet in 100 years. |
| San Juan, PR 9755371 | +2.16/year | 1962 - 2025 | The relative sea level trend is 2.16 mm/year with a 95% confidence interval of +/- 0.32 mm/year based on monthly mean sea level data from 1962 to 2025 which is equivalent to a change of 0.71 feet in 100 years. |

Figures 32 and 33 are screen grabs from the Relative Sea Level Website. They show the trend for the Magueyes Island and San Juan gauges.

*Figure 32: Relative Sea Level Trend 9759110 Magueyes Island, PR*

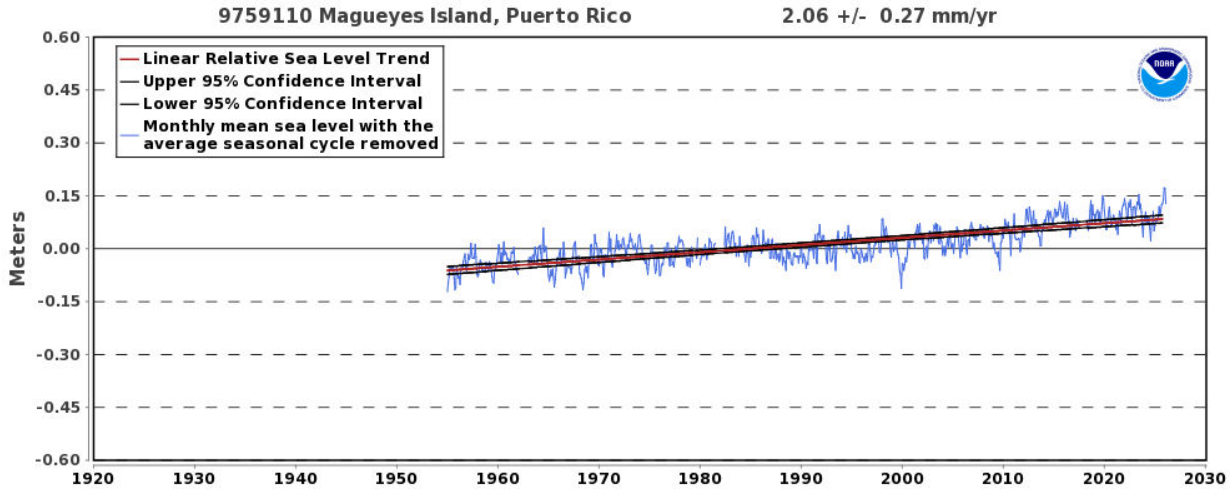
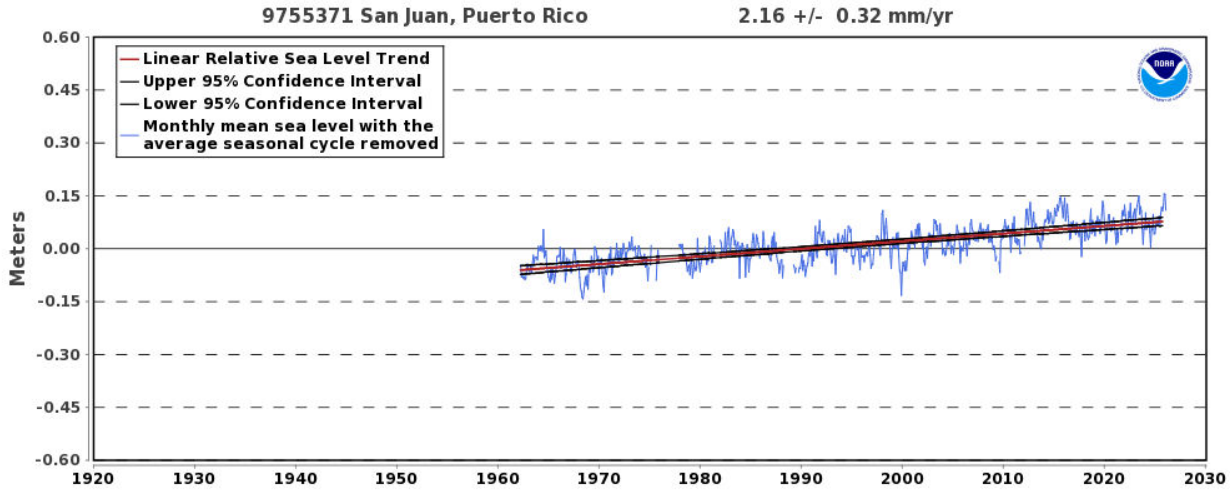



*Figure 33: Relative Sea Level Trend 9755371 San Juan, PR*




#### 4.15.1.3 Past Events

Section 4.14.1.1 above details the changes in beach erosion or accretion for the coast in Yabucoa in the aftermath of Hurricane Maria as detailed in the COREPI-PR study.

This study brought forth the following key findings (COREPI-PR, 2020):

- Widespread Coastal Erosion: Significant erosion occurred along multiple

beach segments following Hurricane María, particularly in Arroyo, Humacao, and Barceloneta, reducing beach width and elevation and increasing exposure to storm surge and flooding.[13]

- Partial Natural Recovery: Ten months after the hurricane, many beaches exhibited sediment accretion and partial recovery; however, recovery was uneven and site-specific, with some areas remaining highly vulnerable to future events.

- Beach Migration: The study documented permanent inland migration of beaches in several municipalities, including Añasco, Humacao, Arecibo, Aguada, and Rincón. This indicates a long-term shift of the shoreline landward, increasing risk to inland infrastructure and properties.

- Influence of Built Infrastructure: Erosion was frequently observed adjacent to rigid shoreline structures (e.g., seawalls, rip-rap, coastal development), suggesting that hardened shorelines may exacerbate erosion processes and reduce natural beach resilience.

- Loss of Protective Function: In several locations, the reduction of beach width and loss of sandbars diminished the beach's capacity to function as a natural protective barrier, resulting in greater susceptibility to storm surge damage during subsequent events (e.g., 2018 extra-tropical storms).

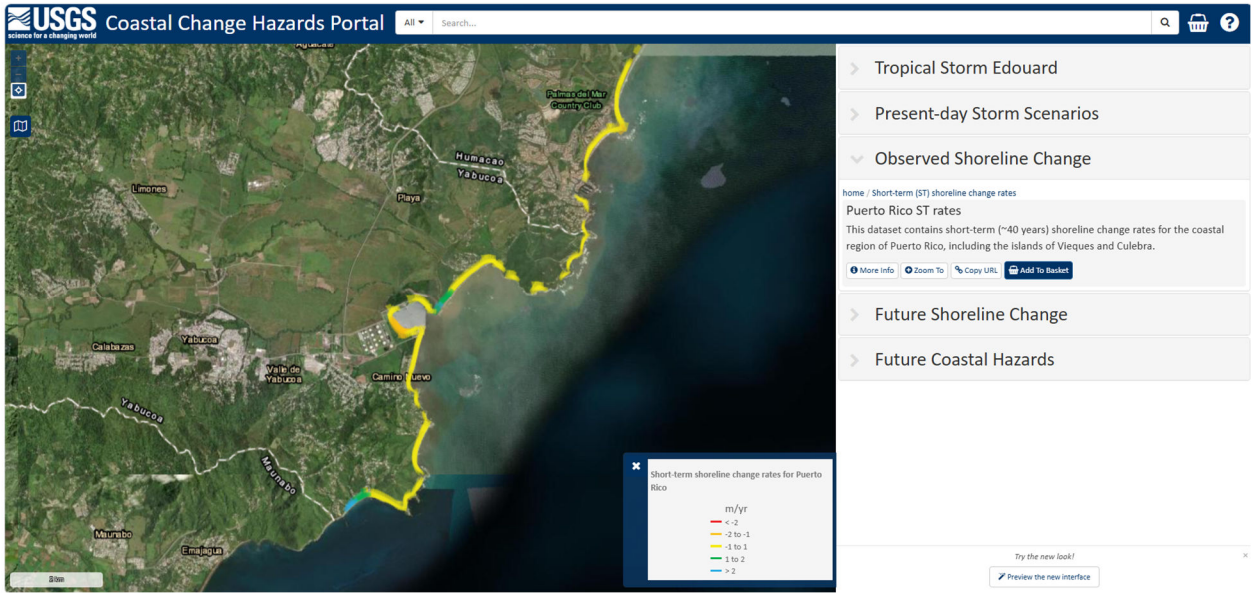
The findings of this study are important for hazard mitigation planning since beaches are a critical natural infrastructure that provide coastal protection by dissipating wave energy, reducing flooding extent, and protecting inland development. The documented erosion, beach migration, and reduced protective capacity highlight increased vulnerability to; coastal flooding, storm surge, wave action and progressive shoreline retreat.

These findings support the integration of coastal erosion monitoring, nature-based solutions, land-use planning controls, and adaptive shoreline management strategies into local and regional hazard mitigation efforts. The assessment also provides a baseline for prioritizing mitigation projects and for validating requests for local, state, and federal mitigation funding.

[13] https://storymaps.arcgis.com/stories/ac6e366a14d840e88a266d23b440ab0c

Figure 31 is a screengrab from the USGS Coastal Change Hazards Portal that shows the changes in the Yabucoa coastline from the 1970's to 2018. This portal show that overall the shoreline change for Yabucoa has been from -1 to 1 meter per year. It also shows that a section of the coast right to the north of the Port of Yabucoa entrance has increased by 1 to 2 meters per year. This could be an effect of the construction of the Yabucoa Port itself as it is manmade. There are some positive changes in shorelone also in the southeast of the Municipality (Cocal Beach).

*Figure 31: Short – Term shoreline change rates*




### 4.15.1.4 Future Events Probability

The USGS has created a Coastal Change Likelihood assessment that "combines over twenty coastal data sources that describe the landscape and the hazards that act on it to determine the future likelihood of change on the coast on a decadal scale (USGS, 2026). Unfortunately, this tool is not yet available for Puerto Rico.

However given the higher probability of storms and rough seas reaching Yabucoa and anthropogenic changes to the coast, it is highly likely this hazard will continue to affect the municipality.

## 4.15.2 Risk Analysis

### *4.15.2.1 Estimated Loses*

Currently there are no standard way to estimate loses due to long-term coastal erosion. This is due to the unpredictability of this particular hazard.

### *4.15.2.2 Lifelines and Critical Infrastructure*

**Coastal Erosion and Accretion**

- Coastal erosion is a long-term, progressive hazard that results in the loss of shoreline, land instability, and the degradation of natural protective features such as beaches, dunes, and wetlands. This hazard is driven by wave action, coastal storms, flooding, and long-term shoreline change processes, and it poses increasing risks to developed coastal areas and supporting infrastructure. In coastal communities, erosion directly affects the Community Lifelines that are essential to public safety, economic stability, and effective emergency response (FEMA, 2024).

- Safety and Security Lifeline is particularly vulnerable to coastal erosion. Law enforcement facilities, fire stations, emergency operations centers, and evacuation routes located near the shoreline may experience increasing exposure as erosion undermines foundations, access roads, and protective buffers. Roadway narrowing or collapse caused by shoreline retreat can reduce emergency response times and limit evacuation capacity during hazard events, placing residents and responders at greater risk (FEMA, 2021)

- The Food, Water, and Shelter Lifeline is also impacted as erosion threatens utility infrastructure and housing stock. Water distribution lines, wastewater systems, and stormwater infrastructure may become exposed or damaged as coastal land erodes, increasing the risk of service disruptions and water quality concerns. In areas where erosion leads to the loss of residential structures, displaced households may require emergency shelter and housing assistance. Additionally, erosion affecting ports, coastal roads, and access points can disrupt food supply chains and the delivery of essential goods, particularly in geographically isolated or island communities (FEMA, 2024).

- Coastal erosion can adversely affect the Health and Medical Lifeline by limiting access to healthcare facilities and emergency medical services. Hospitals, clinics, and pharmacies located in erosion-prone areas may face increased structural risk or reduced accessibility. Transportation disruptions caused by erosion can delay emergency medical response and impede the delivery of medical supplies. Secondary public health concerns may arise when erosion damages water and wastewater infrastructure, potentially increasing exposure to contaminants or unsanitary conditions (USGS, 2025); (FEMA, 2021).

- The Energy Lifeline, including power generation, transmission, and fuel systems, is highly susceptible to erosion-related impacts. As shorelines retreat, erosion can expose underground electrical lines, pipelines, substations, and fuel storage facilities that were previously protected by coastal landforms. Damage to this infrastructure can result in power outages or fuel shortages, affecting residents, critical facilities, and emergency response operations that rely on consistent energy supply (USACE, 2013); (FEMA, 2021)

- Erosion also threatens the Communications Lifeline by damaging or destabilizing physical infrastructure such as cell towers, fiber-optic cables, and communications hubs located in coastal areas. Loss of communications systems can impair emergency notification, 911 services, and coordination among response agencies. Reduced system redundancy along eroding shorelines increases the likelihood that communications outages will occur during coastal hazard events (FEMA, 2024).

- The Transportation Lifeline experiences direct and cascading impacts from coastal erosion. Roads, bridges, ports, ferry terminals, and coastal airports may be undermined or rendered inoperable as erosion progresses. Transportation disruptions limit evacuation routes, restrict access for emergency responders, slow the delivery of supplies, and delay recovery operations. These impacts can have significant economic consequences and prolong community recovery following disaster events (USGS, 2023).

- Finally, coastal erosion may affect the Hazardous Materials Lifeline by exposing buried fuel tanks, contaminated soils, or legacy industrial sites located near the coast. Erosion can increase the risk of hazardous material releases, threatening environmental quality and public health, and complicating emergency response and cleanup efforts. Facilities handling hazardous materials lose natural protective buffers as shorelines retreat, increasing the

likelihood of cascading impacts during severe weather events (USGS, 2023); (FEMA, 2021).

Overall, coastal erosion represents a chronic hazard with the potential to destabilize multiple Community Lifelines simultaneously. Because these lifelines are interdependent, erosion-related impacts can cascade across sectors, magnifying community vulnerability. Incorporating coastal erosion considerations into land-use planning, infrastructure investment, and mitigation strategies is critical to reducing long-term risk, maintaining essential services, and enhancing overall community resilience.

**Variations in Mean Base Sea-Level**

Sea level rise is a chronic and progressive coastal hazard that increases the frequency, depth, and duration of coastal flooding while accelerating erosion and shoreline instability. As relative sea levels rise, coastal communities experience more frequent high-tide flooding, expanded floodplains, and greater storm surge impacts. These changes place increasing stress on the y Lifelines that support public safety, economic stability, and emergency response, even in the absence of major storm events (FEMA, 2024).

The Safety and Security Lifeline is affected as sea level rise increases the exposure of emergency facilities and evacuation routes to recurrent flooding. Police stations, fire stations, and emergency operations centers located in low-lying coastal areas may experience reduced functionality or loss of access due to chronic inundation. Rising seas can also compromise evacuation routes, bridges, and ingress/egress corridors, limiting the ability to conduct timely evacuations and delaying emergency response during hazard events (FEMA, 2021); (USGS, 2025).

- Sea level rise presents significant challenges to the Food, Water, and Shelter Lifeline. Potable water systems, wastewater treatment plants, and stormwater infrastructure are increasingly vulnerable to tidal flooding and saltwater intrusion as sea levels rise. These impacts can disrupt service delivery, degrade water quality, and increase maintenance and operational costs. In addition, repetitive flooding can damage residential structures, reduce housing availability, and increase demand for emergency shelter and long-term housing assistance, particularly in socially vulnerable communities (USGS, 2025).

- The Health and Medical Lifeline is impacted through both direct and indirect effects. Healthcare facilities located in flood-prone coastal zones may experience operational disruptions, equipment damage, or access constraints due to flood-impacted transportation networks. Frequent flooding can hinder patient movement, delay emergency medical services, and disrupt supply chains for pharmaceuticals and medical equipment. Public health concerns may also increase as rising groundwater and flooded sanitation systems elevate the risk of contamination and disease exposure (USGS, 2025; FEMA, 2024).

- Sea level rise also threatens the Energy Lifeline by increasing flood risk to power generation facilities, substations, fuel terminals, and transmission infrastructure located near the coast. Even minor but repeated flooding events can degrade electrical components and reduce system reliability, leading to power outages that affect residences, businesses, and critical facilities. Fuel distribution systems and ports may also experience operational interruptions, limiting fuel availability for generators, emergency vehicles, and recovery operations (FEMA, 2024).

- The Communications Lifeline is vulnerable as increase in base sea level potentiates exposure of communications infrastructure, including cell towers, fiber-optic networks, and data facilities, to chronic flooding and corrosion. Disruptions to communications systems can impair emergency notification, 911 services, and interagency coordination. Repeated flood exposure without permanent mitigation measures may result in cumulative damage and decreased system reliability over time (FEMA, 2024).

- Transportation systems associated with the Transportation Lifeline are particularly sensitive to increase in base sea levels. Roads, bridges, ports, ferries, and coastal airports may experience more frequent closures or long-term service reductions due to flooding and infrastructure degradation. Transportation disruptions can isolate communities, delay emergency response, limit evacuation options, and impede the movement of goods, services, and recovery resources (USGS, 2025).

- Finally, increase in the mean base sea level can affect the Hazardous Materials Lifeline by increasing exposure of industrial sites, fuel storage areas, landfills, and wastewater facilities to flooding. Inundation of these sites raises the potential for releases of hazardous substances, posing risks to human health,

ecosystems, and drinking water supplies. Managing these risks becomes more complex as flood frequencies increase and protective buffers are lost (FEMA, 2021); (USGS, 2025).

#### 4.15.2.3 Social Vulnerabilities

Long-term coastal dynamics can be not only a physical hazard but also a social stressor that disproportionately affects certain populations due to preexisting social, economic, and environmental conditions.

Low-income households are among the most socially vulnerable to long-term coastal dynamics. These populations are more likely to reside in older or lower-cost housing located in high-risk coastal areas and may lack the financial resources needed to invest in mitigation measures, such as structural reinforcement or relocation. As erosion or inward changes in shoreline progresses, declining property values can further reduce household wealth and limit access to insurance, credit, and recovery assistance, thereby prolonging vulnerability and recovery timelines (FEMA, 2023).

Housing insecurity is a significant concern associated with long-term coastal dynamics. Gradual land loss can render homes unsafe or uninhabitable, leading to chronic displacement rather than sudden disaster-related relocation. Renters are particularly vulnerable, as they often have limited control over mitigation decisions and may be displaced without sufficient notice or long-term relocation support. In communities with limited affordable housing options, erosion-related housing loss can increase overcrowding, homelessness, or permanent out-migration (FEMA, 2023).

Elderly individuals, people with disabilities, and those with chronic health conditions face heightened risks as coastal erosion disrupts access to essential services and infrastructure. Eroded or flooded roadways and transportation networks can isolate neighborhoods from healthcare facilities, pharmacies, grocery stores, and social services. These populations may also experience limited mobility or depend on in-home medical equipment, increasing their sensitivity to infrastructure disruptions associated with erosion (FEMA, 2023).

Communities that rely on coastal and marine resources for their livelihoods are also socially vulnerable to erosion. Fishing communities, small tourism-dependent businesses, and subsistence users may experience economic losses as shorelines retreat, beaches narrow, and access to coastal infrastructure is reduced. These

impacts can lead to job loss, reduced household income, and community-wide economic stress, particularly in rural and island settings where economic diversification is limited (USGS, 2023).

#### 4.15.2.4 Natural and Cultural Resources

Long-term coastal dynamics rise can significantly impact natural resources by altering shorelines, degrading habitats, and disrupting ecological processes. As beaches, dunes, wetlands, and mangroves erode or become permanently inundated, the natural systems that provide storm protection, water filtration, and wildlife habitats are reduced or lost. These changes can lead to declines in biodiversity as plant and animal species lose critical breeding, feeding, and nesting areas. Saltwater intrusion caused by rising sea levels can also degrade freshwater ecosystems, affecting groundwater, estuaries, and coastal forests. Increased erosion can mobilize sediments and pollutants, diminish water quality and harming coral reefs and seagrass beds. Over time, the loss of natural coastal features reduces ecosystem resilience and increases inland exposure to flooding and storm impacts. (USGS, 2023)

Long-term coastal dynamics can also pose serious threats to cultural resources, particularly those located near shorelines. Historic buildings, archaeological sites, cemeteries, and cultural landscapes may be damaged or permanently lost as shorelines retreat and soils are destabilized. Gradual erosion can undermine foundations and expose artifacts, making sites vulnerable to destruction, looting, or environmental decay. As these resources are often irreplaceable, coastal erosion and sea level rise represent not only physical loss but also the loss of cultural memory and heritage passed through generations (USGS, 2023).

#### 4.15.2.5 Future Conditions (E1-a)

As discussed in section 4.11.1 long-term coastal dynamics are understood to contribute to loss of shoreline, either due to coastal erosion or increases in mean base sea level. Specific mitigation actions to deal with expected future conditions will be included as part of Section 6.5.

## 4.16 Pandemic/Epidemic

### 4.16.1 Description (B1-a)

An epidemic occurs when the incidence of a disease or health-related event rises suddenly and significantly above what is expected in a specific community or region. According to the CDC, an epidemic represents a sudden increase in cases over the normal baseline in a population, and outbreaks—often used interchangeably—refer to such events in more limited geographic areas (CDC, 2012).

A pandemic is essentially an epidemic that has expanded to span multiple countries or continents, affecting a large portion of the global population. The CDC describes it as an epidemic with broad geographic spread, while the World Health Organization defines it as the worldwide transmission of a new disease to which people generally have little or no immunity (CDC, 2012).

These terms emphasize both the magnitude of cases and their geographical distribution: an epidemic is localized, but a pandemic reaches across international borders and impacts global public health systems. Consequently, emergency response strategies must escalate accordingly—from targeted regional interventions during epidemics to coordinated global action in pandemics.

#### *4.16.1.1 Affected Area (B1-b)*

This LHMP considers that all areas of the municipality are equally vulnerable to the Epidemic/Pandemic Hazard.

#### *4.16.1.2 Risk Magnitude (B1-c)*

Although all these events can result in loss of life and economic disruption, to distinguish between the following terms:

- Epidemic: refers to a sudden increase in the number of disease cases beyond what is normally expected within a specific population and geographic area.
- Outbreak: shares the same definition as epidemic but is typically used for a more localized area.
- Cluster: describes a grouping of cases in a particular place and time that appears to exceed the expected number, even if that expected number is unknown.
- Pandemic: refers to an epidemic that has spread across multiple countries or

continents, usually affecting a large population (CDC, 2012).

#### 4.16.1.3 Past Events (B1-D)

The following table listing epidemics and pandemics in Puerto Rico has been collected from various sources. This list does not intend to be exhaustive:

*Table 45: Pandemics and Epidemic in Puerto Rico 1855 - 2020*

| Disease | Date | Classification | Description |
|---|---|---|---|
| Cholera Epidemic | 1855 - 1856 | Epidemic | Between 1855 and 1856, Puerto Rico suffered a major cholera outbreak that claimed over 25,820 lives, representing approximately 4–10% of the island's population at the time. (Vega Lugo, 2021) |
| Measles and Malnutrition | 1917 - 1918 | Epidemic | A severe measles outbreak occurred between 1917 and 1918, resulting in nearly 9,000 cases and approximately 2,000 deaths. High infant mortality—59% of deaths within six months were in children under two—was driven by malnutrition and poor living conditions (Rigau-Pérez & Vallejo - Calzada, 2020). |
| Spanish Flu (A/H1N1 influenza pandemic) | 1918 - 1919 | Pandemic | Puerto Rico was affected by the global A/H1N1 influenza pandemic, also known as the Spanish flu. Beginning around June 1918, community spread produced as many as 1,000 cases in four days in areas like Puerta de Tierra. Misdiagnosis as dengue initially obscured |

| Disease | Date | Classification | Description |
|---|---|---|---|
| | | | the true impact (Rosario Urrutia, 2021). |
| Poliomyelitis | 1960 | Epidemic | The 1960 polio epidemic in Puerto Rico was the most severe paralytic polio outbreak in the Western Hemisphere at the time. It impacted 68 of 76 municipalities, causing 495 cases of paralysis, predominantly among school-age children (Timothee, Morris, Filiberti, & Mainardi, 1963). |
| Dengue | 2013, 2024 | Outbreak | Dengue is endemic in Puerto Rico, with significant outbreaks occurring in 2013 and again in 2024. The 2024 outbreak triggered a public health emergency, with 6,291 confirmed cases, a 4.2% rate of severe dengue, and 11 deaths reported (Rodríguez, et al., 2024) (Ware-Gilmore, et al., 2025) |
| Chikungunya | 2014 | Epidemic | The first locally acquired chikungunya case in Puerto Rico was confirmed on May 5, 2014, triggering expanded surveillance efforts using Puerto Rico's dengue infrastructure. Between May 5 and August 12 of that year, 10,201 suspected cases (approximately 282 per 100,000 residents) were reported, of which 1,975 (68%) were laboratory-confirmed. During this period, four deaths were |

| Disease | Date | Classification | Description |
|---|---|---|---|
| | | | also recorded. (Sharp, et al., 2014) |
| Zika | 2015 - 2016 | Epidemic | The first locally transmitted Zika case in Puerto Rico was reported in December 2015. By April 2016, over 6,000 suspected cases had been evaluated, with 683 confirmed cases. Pregnant women and related neurological issues (e.g., Guillain-Barré syndrome) were of particular concern. (Thomas, et al., 2016) (Dirlikov, et al., 2016) |
| COVID - 19 | 2020 - 2022 | Pandemic | See narrative below |

**COVID – 19 Pandemic**

Puerto Rico confirmed its first COVID-19 case—a European tourist—on March 8, 2020, leading the governor to declare an emergency on March 12 and implement early measures including airport screening and mandatory isolation, as outlined in the Puerto Rico Department of Health's epidemic situation reports (PRDH, 2022), (COR3, n.d.). By April 6, 2022, official data reported 270,485 confirmed cases and 4,171 deaths due to COVID-19 in Puerto Rico, according to detailed government spreadsheets and dashboards maintained by the Puerto Rico Health Department (PRDH, 2022), (COR3, n.d.).

The municipality experienced significant economic and social disruptions. A Bayesian analysis revealed a clear causal relationship between rising COVID-19 infections and increased unemployment, and engineering studies from the University of Puerto Rico–Mayagüez estimated that unemployment soared above 17%, also noting elevated operating costs for businesses due to personal protective equipment (PPE) and safety measures (Hernández - Padilla & Méndez-Piñero, 2020).

Subsequent public health research revealed widespread mental health consequences. One study found that 31% of healthcare workers scored in the range of depressive symptomatology following combined stress from prior disasters (e.g.,

hurricanes) and the pandemic; another identified high levels of anxiety (26.9%) and stress (69.9%) among physicians during the second COVID-19 wave (Hernández - Torres, et al., 2023), (Sánchez - Plazas, García - De Jesús, Martínez - González, Amaya - Ardila, & Almodóvar - Rivera, 2024).

#### *4.16.1.4 Future Events Probability (B1-e)*

Puerto Rico's susceptibility to future pandemics or epidemics is underscored by its subtropical climate, population distribution, and healthcare infrastructure. A university-developed emergency preparedness model—commissioned by Puerto Rico's Department of Health—simulated influenza pandemics and demonstrated how variations in disease transmissibility, healthcare capacity, and mitigation efforts can significantly influence outbreak trajectories and the likelihood of healthcare system overload. Furthermore, the U.S. Department of Health and Human Services' Hospital Preparedness Program (HPP) in Puerto Rico operates under the Assistant Secretary for Preparedness and Response, with coordinated health care coalitions and special pathogen systems explicitly designed to reduce pandemic risk by strengthening surge capacity and infection-control readiness. These combined efforts reflect a data-driven recognition that, without sustained investment in public health infrastructure and preparedness modeling, Puerto Rico remains at an elevated probability for experiencing another epidemic or pandemic (Hirsh & Centeno - Marín, 2015), (ASPR, n.d.)

### 4.16.2 Risk Assessment (B2-a, B2-b)

#### *4.16.2.1 Estimated Loses*

The COVID-19 pandemic resulted in significant mortality across Puerto Rico, underscoring the importance of public health hazards in local mitigation planning. Official data from the Puerto Rico Department of Health indicate that COVID-19 mortality is tracked through an epidemiological surveillance system that compiles death certificate data and case investigations and is made publicly available through government data portals. At the territorial level, thousands of deaths have been attributed to COVID-19 since 2020, as reported in official datasets and federal summaries. However, cumulative mortality totals for individual municipalities, including Yabucoa, were not consistently published as single static figures in official reports. Instead, municipality-level death counts must be obtained by querying downloadable datasets provided by the Puerto Rico Department of Health, which

allow users to filter results by municipality.

These datasets are considered provisional and subject to due to reporting delays and ongoing validation of death records, as acknowledged by public health authorities. Consequently, while Yabucoa-specific COVID-19 mortality was not recorded as fixed published figure. Based on the currently available data, the total number of COVID-19-related deaths in Yabucoa cannot be reliably determined.

#### 4.16.2.2 Critical Infrastructure and Lifelines

In the event of a pandemic or epidemic, the most significantly affected lifeline is typically the healthcare and medicine lifeline. During widespread disease outbreaks, hospitals, clinics, and other healthcare facilities often face overwhelming demand for services. Surges in patient volume can exceed system capacity, leading to shortages of personal protective equipment (PPE), critical medical devices (such as ventilators during COVID-19), hospital beds, and qualified medical personnel. As resources are redirected to address the immediate public health emergency, non-urgent and even some essential non-related medical services may be postponed or delayed. Additionally, mortality management systems—including morgues, funeral services, and vital records processing—may experience severe strain during periods of elevated death rates.

However other lifelines can be affected such as the Food, Hydration and Shelter Lifeline, due to increase food insecurity from unemployment and economic shutdowns ort closed or reduced shelters due to infection control requirements. The Safety and Security Lifelines can be affected by high absenteeism due to illness, quarantine or caregiving responsibilities and increase levels of stress and burnout among first responders and law enforcement officers.

Other lifelines and critical infrastructures can be affected by increased demand, like increased residential water demand) or the lack of trained personnel to maintain existing operations.

#### 4.16.2.3 Social Vulnerability

For this hazard, the whole population of Choose an item. is considered equally vulnerable. Nonetheless besides factors of age and poverty, the 2019 - 2023 ACS shows that a total of 1,464 people in Yabucoa did not have health insurance coverage (US

Census Bureau, 2025). This means that 6.7% of the total population of Choose an item. is uninsured.

Of those most of the uninsured group belonged to the 26-to-34-year cohort (3,319 persons) followed by the cohort of 19 to 25 years (2,336 persons).[14] The results given by the ACS show that the young adult population is the most vulnerable in terms of uninsured in the face of a pandemic or epidemic.

Table 32 shows the breakdown of uninsured people in Choose an item. according to the 2019 - 2023 ACS.

*Table 46: Number of People in Choose an item. without Healthcare Coverage*

| Age Cohort | Number of people uninsured |
|---|---|
| Under 6 years | 36 |
| 6 to 18 years | 78 |
| 19 to 25 years | 234 |
| 26 to 34 years | 194 |
| 35 to 44 years | 207 |
| 45 to 54 years | 438 |
| 55 to 64 years | 271 |
| 65 to 75 years | 6 |
| 75 years or older | 0 |

This would be considered population at risk in case of a pandemic or epidemic. Further information regarding social vulnerability can be found in Section 3.4.

#### 4.16.2.4 Natural and Cultural Resources

The scientific literature shows that the COVID-19 Pandemic produced mixed environmental outcomes. While temporary lockdowns initially led to short-term improvements in air quality and reductions in greenhouse gas emissions in many regions, broader evidence suggests that the pandemic also generated significant negative environmental impacts.

These impacts included increased pollution from the widespread use of personal

[14] US Census 2019 - 2023 ACS Table S2701

protective equipment, deforestation, illegal poaching and logging, overfishing, and disruptions to conservation programs and projects. The findings also note that the spread of pandemics may be intensified by environmental pollution and rapid global population growth (Muche, Yemata, Molla, Muasya, & Tsegay, 2022) (Guo & Lee, 2021).

At the same time, despite these adverse impacts, the period of reduced human activity—often referred to as the *anthropause*—also produced several positive effects on natural resources. These included short-term reductions in indoor and outdoor air pollutants including $PM_{2.5}$, $PM_{10}$, $NO_2$, $SO_2$, CO, and $CO_2$, as well as a decrease in noise pollution from ships, boats, vehicles, and aircraft. Collectively, these changes benefited aquatic ecosystems and water quality, influenced bird behavior, supported wildlife biodiversity, and contributed to temporary ecosystem recovery (Muche, Yemata, Molla, Muasya, & Tsegay, 2022).

When it comes to cultural and heritage sites, a report from UNESCO notes that the crisis has produced both negative and positive effects across different types of World Heritage properties (UNESCO, 2021). The sudden cessation of travel and tourism disrupted visitor flows and eliminated a critical source of revenue for many sites, where tourism income is essential to supporting conservation activities, routine maintenance, and staff salaries. Local communities surrounding these properties were similarly affected, with widespread loss of employment and income.

Conversely, in some cases, the reduced level of human activity enabled rehabilitation and restoration efforts to proceed more efficiently, while anthropogenic pressures were temporarily reduced across many natural areas. This contrast highlights the diverse and uneven impacts of the crisis on World Heritage properties. At the same time, it highlights opportunities to build upon the environmental benefits observed during reduced activity periods, while advancing targeted research, sustainable tourism strategies, and long-term recovery planning (Guo & Lee, 2021) (Guibert & Hyde, 2021), (UNESCO, 2021).

#### 4.16.2.5 Future Conditions (E1-a)

Puerto Rico faces structural and environmental conditions that elevate its exposure and vulnerability to future pandemics relative to many mainland U.S. locations. As a tropical island with high population density in urban corridors, frequent international travel, and climatic conditions favorable to vectors and pathogens, Puerto Rico is particularly susceptible to emerging and re-emerging infectious diseases, especially those with zoonotic or vector-borne origins. The CDC and peer-reviewed research

document ongoing transmission of diseases such as dengue and previous outbreaks of Zika and Chikungunya, demonstrating the island's continued exposure to pathogens with outbreak and epidemic potential. This exposure holds regardless of the development pattern of the municipality.

## 4.17 Planning Mechanism

Understanding and recognizing regulatory and planning capacities enables more effective management of land use and economic growth. These capacities consist of the legal frameworks and public policy provisions that influence land use to guide sustainable development, while also supporting actions that mitigate the vulnerability of communities and their resources to natural hazards.

Besides the Public Policies already discussed in Section 1.1, what follows is a list in chronological order of the regulatory and planning mechanisms available to the municipality for the implementation of this LHMP.

### 4.17.1 Joint Regulation for the Evaluation and Issuance of Permits Related to Development, Land Use, and Business Operations (2023)

The Joint Regulation for the Evaluation and Issuance of Permits Related to Development, Land Use, and Business Operations (*Reglamento Conjunto* in Spanish) is a regulatory instrument created by the Planning Board in compliance with Act No. 161, as amended. Its main purpose is to regulate land use, territorial planning, and the granting of permits related to development, construction, and business operations within a uniform and centralized framework. The Joint Regulation aims to harmonize public policy on land use planning with the principles of sustainable development, seeking a balance between economic growth, environmental protection, and social well-being. This regulation establishes the rules to classify land, define zoning districts, regulate zoning, and determine

*Figure 35: Joint Regulation Cover*



the permitted uses in each category. Additionally, it sets the procedures to evaluate projects, issue permits, and monitor compliance with the applicable provisions. Its purpose is to provide a uniform regulatory framework for the evaluation and issuance of permits, ensure the proper use of land, protect natural resources, and facilitate economic development under criteria of competitiveness and sustainability, integrating planning with permit management.

Of particular importance in the Joint Regulation is the zoning district *Distrito de Riesgo para Espacios Abiertos* – Open Space (RE-A).[15] The RE-A zoning district is established to identify lands designated as open space in accordance with federal regulations (44 CFR Part 80) or another federal program, due to the presence of a risk condition resulting from a natural event. These spaces may include, but are not limited to, severe flooding and landslides. There are conditions in these areas that are unfavorable or harmful to health, safety, or general welfare, and there may be a risk of loss of life and property. Land within this district may be susceptible to one or more of the identified hazards.

The purpose of the district is to preserve the open space condition established in perpetuity by federal regulation, which the government or the community must uphold, with the objective of protecting health, life, and property; preventing severe losses and repetitive use of affected properties; reducing the investment of public and federal funds in mitigation; and limiting rescue efforts, among other goals.

### 4.17.2 Special Flood Hazards Areas Regulation (2021)

The 2021 regulation was adopted by the Puerto Rico Planning Board under its authority from Public Law No. 75 of 1975 and Public Law No. 3 of 1961 to control development in flood-prone zones. It aligns Puerto Rico's floodplain management requirements with the minimum standards of the National Flood Insurance Program (NFIP), administered by FEMA. The regulation establishes updated criteria for construction, land use, and development within Special Flood Hazard Areas (SFHAs), including requirements such as elevating structures above Base Flood Elevation and submitting technical certifications. It applies to new construction, substantial improvements, and land-use changes across designated flood zones such as AE and VE, using FEMA Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FIS) for zone identification.

[15] Joint Regulation Rule 6.1.30

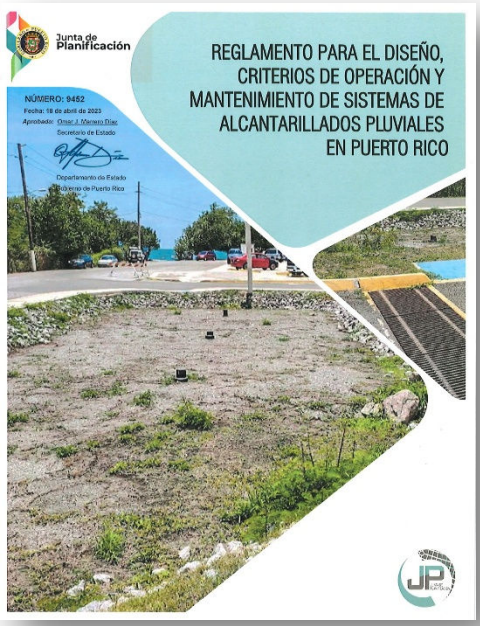
The revision clarifies and expands regulatory provisions to enhance public safety and prevent harmful development in high-risk areas.

### 4.17.3 Puerto Rico Building Code

The Puerto Rico Building Code sets minimum requirements for the design, construction, modification, and upkeep of buildings to ensure the safety, health, and well-being of the public. It is derived from nationally and internationally recognized model codes and is updated periodically to incorporate improvements in construction practices and lessons learned from past hazard events. The code includes provisions addressing structural safety, fire protection, accessibility, energy conservation, and resistance to natural hazards such as earthquakes, hurricanes, floods, and strong winds. Adherence to the Building Code is mandatory for all new construction and substantial renovations throughout Puerto Rico. Enforcement is carried out through local permitting, planning review, and inspection processes to verify compliance with established standards. Overall, the Puerto Rico Building Code is a key instrument for advancing resilient, safe, and sustainable development across the island.

### 4.17.4 Regulation for the Design, Operation Criteria and Maintenance of Stormwater Systems in Puerto Rico

*Figure 326: Regulation 40 Cover*




Adopted in 2023 as Planning Regulation No. 40, this regulation updates and replaces the island's outdated 1975 standards to address current engineering practices, environmental considerations, and increased flood risk. The regulation is designed to provide developers, engineers, contractors, and municipalities with modern technical criteria for designing, operating, and maintaining public and private stormwater systems, incorporating updated scientific knowledge and methodologies necessary for managing stormwater infrastructure under present-day conditions. Its objectives include minimizing flood-related damage, improving the capture and management of runoff, reducing impacts to water resources and ecosystems, and supporting safer, more resilient community

development. The regulation integrates risk management principles and aligns with Puerto Rico's climate adaptation policies, requiring consideration of urban flooding, karst hydrology, low-impact development practices, and stormwater control structures such as retention and detention systems. It also establishes minimum design considerations for all land development projects and provides a comprehensive framework for planning, monitoring, and maintaining stormwater systems across the island.

### 4.17.5 Yabucoa Land Use Plan (2025)

As per the Municipal Code, the Municipality of Yabucoa is in the process of updating their Territorial Plan. The Territorial Plan (PT, by its Spanish acronym) is a strategic and comprehensive tool for organizing land use within a municipality. This plan covers, at a minimum, the entire municipal area and aims to define the essential elements of such organization, as well as establish a program for its development and implementation, including its validity period

*Figure 337: Yabucoa Land Draft Land Use Plan Cover Page*




The 2023 version of Yabucoa's PT was updated to:

- Incorporate policies, strategies, and recommendations from land-use planning instruments approved by the Planning Board (JP) after the last review of the PT.
- Include provisions from recently approved or amended statutes.
- Review the municipal socioeconomic context based on recent population trends.
- Integrate information on policy and plan changes resulting from Hurricanes Irma and María in Puerto Rico.
- Include topics of mitigation, adaptation, and climate change resilience in public policy and state, sectoral, and municipal planning.
- Reflect the vision of the municipal administration and its citizens regarding the physical and socioeconomic development of Yabucoa.
- Adjust local land uses according to current and future context and needs.

### 4.17.6 Yabucoa Emergency Operation Plan

This Emergency Operation Plan (EOP) describes how emergency operations are structured through the Incident Command System, enabling unified command and efficient allocation of resources. It details the activation levels of the Municipal Emergency Operations Center, which escalates from routine monitoring to full 24/7 multi-agency disaster response. The municipality highlights the importance of interagency collaboration, including coordination with state and federal agencies when local capabilities are exceeded. Community involvement, public information, and support for vulnerable populations—such as individuals with disabilities, children, and the elderly—are essential components woven into all phases of emergency management. Additionally, the plan incorporates long-term recovery strategies, emphasizing damage assessments, restoration of critical services, and alignment with federal assistance processes. Ultimately, it presents a structured, community-centered approach to ensure Yabucoa can respond to, withstand, and recover from a wide range of emergencies.

### 4.17.7 National Flood Insurance Program

The National Flood Insurance Program falls within the category of planning mechanisms, as it imposes certain floodplain management requirements. FEMA provides flood insurance to communities that are following the NFIP criteria. This includes adopting and enforcing floodplain management practices that promote appropriate development in these flood-prone areas.

The National Flood Insurance Program of the Federal Emergency Management Agency allows homeowners, business owners, and renters in participating NFIP communities to purchase federally backed flood insurance. This insurance provides assistance to help cover the costs of repairing damage caused by flooding to buildings and their contents. This is an insurance program established to help property owners, renters, and businesses recover more easily and at a lower cost. Likewise, the program aims to reduce the impact of flooding on both public and private structures. These efforts help mitigate the effects of flooding on new and improved structures within each community.

The NFIP has several components, including:

- Floodplain management — for which the community must adopt and enforce measures for managing flood-prone lands in accordance with NFIP regulations;
- The preparation of Flood Insurance Rate Maps (FIRMs); and
- Flood insurance.

The Puerto Rico Planning Board has a collection of FIRM maps that can be consulted to determine whether your property is in a high-risk area or in a low- to moderate-risk zone. FIRMs refer to the official map developed and approved by FEMA and adopted by the Puerto Rico Planning Board to designate areas at risk of a 100-year flood (or a 1% annual chance of occurrence). In addition, these maps serve as a tool for managing special areas due to their susceptibility to flooding events.

While the Write Your Own Program (WYO) began in 1983 as a partnership between insurance companies and FEMA. This arrangement allows property and casualty insurance companies to underwrite and service federal flood insurance policies in their own company name. A key feature of this type of policy is that all companies participating in the WYO program provide the same coverage, and their rates must comply with NFIP rules and regulations.

Communities, for their part, adopt and require compliance with the NFIP's minimum standards for construction and development in designated Special Flood Hazard Areas. However, many communities seek to achieve a higher level of safety and protection for their residents beyond the NFIP minimum standards. For this purpose, communities have the option of participating in the NFIP's Community Rating System (CRS), which allows them to obtain reductions in flood insurance premiums.

This is because the CRS recognizes additional community efforts to: 1) Reduce flood damage to insurable property; 2) strengthen and support NFIP insurance provisions; and 3) encourage a comprehensive approach to floodplain management. These additional efforts provide residents with greater safety, reduce property damage, enhance community resilience, and promote a better quality of life. The municipality's participation in the NFIP will be discussed in Section 6.6

### 4.17.8 National Pollutant Discharge Elimination System (NPDES)

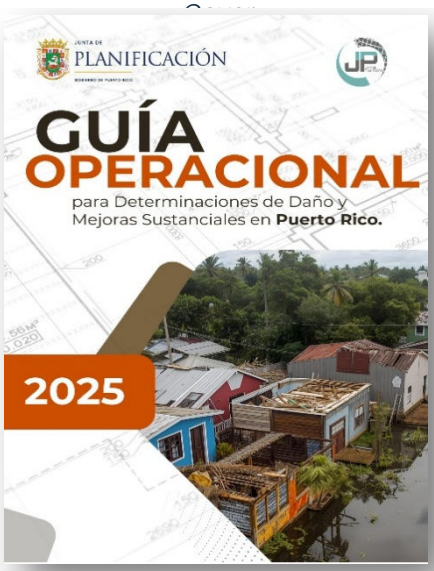
The NPDES is a program authorized under the United States Clean Water Act and administered by the Environmental Protection Agency (EPA). This program requires Municipal Separate Storm Sewer Systems (MS4s) to obtain a permit for the discharge

of stormwater into water bodies. In the case of Puerto Rico, the EPA issued a general permit in 2016, under which municipalities can obtain coverage by submitting a Notice of Intent (NOI) and adopting a Stormwater Management Program (SWMP). If any of the mitigation measures listed in Section 6.5 modify the NOI or the SWMP, they will be properly amended.

### 4.17.9 Operational Guidelines for Determining Damages and Substantial Improvements in Puerto Rico (2025)

The Floodplain Administrator or the Participating Community may review, require, and audit permits in accordance with the provisions of Act No. 3 of September 27, 1961, known as the "Floodplain Building Control Act"; Act No. 75, the "Puerto Rico Planning Board Organic Act"; Act No. 161 of December 1, 2009, as amended, the "Puerto Rico Permit Process Reform Act"; and Act No. 38 of June 30, 2017, the "Uniform Administrative Procedure Act of the Government," as amended, and in compliance with the regulations of the National Flood Insurance Program (NFIP) of the Federal Emergency Management Agency (FEMA), Title 44 of the Code of Federal Regulations (CFR), Part 60.3 [d, e, and Subpart B], and its related sections.

*Figure 38 Operational Guidelines*




As of the effective date of this guidance, an evaluation of substantial damage or substantial improvement will be required as part of the permitting requirements in Special Flood Hazard Areas. The Floodplain Administrator will require that both new structures and substantial improvements be constructed in a manner that minimizes or prevents damage during a regulatory flood.

### 4.17.10 Green Infrastructure and Nature Based Solutions

Section 502 of the United States Clean Water Act defines green infrastructure as the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvesting and reuse, or landscaping to store, infiltrate, or evapotranspiration stormwater and reduce flows to sewer systems or surface waters.

Green infrastructure is a cost-effective and resilient approach to managing wet weather impacts that provide many benefits to the community. While conventional single-purpose gray stormwater infrastructure (such as pipe drainage and water treatment systems) is designed to move urban stormwater away from the built environment, green infrastructure reduces and treats stormwater at its source while providing environmental, social, and economic benefits.

Stormwater runoff is a major cause of water pollution in urban areas. When it rains on rooftops, streets, and parking lots in cities and suburbs, the water cannot soak into the ground as naturally would. Instead, stormwater drains through gutters, storm sewers, and other collection systems and is discharged into nearby water bodies. This runoff carries trash, bacteria, heavy metals, and other pollutants from the urban landscape. Higher flows resulting from heavy rainfall can also cause erosion and flooding in urban streams, damaging the environment, property, and infrastructure.

When rain falls in undeveloped natural areas, the water is absorbed and filtered by soil and vegetation. Stormwater runoff is cleaner and less problematic. Green infrastructure uses vegetation, soils, and other elements and practices to restore some of the natural processes needed to manage water and create healthier urban environments. At the municipal scale, green infrastructure is a network of natural areas that provide habitat, flood protection, cleaner air, and cleaner water. At the neighborhood, development, or sector scale, managing stormwater systems in a way that mimics natural processes help absorb and store runoff that can otherwise cause localized flooding (EPA, 2019).

Some green infrastructure measures that may be considered to mitigate flooding problems include:

- Rainwater harvesting
- Rain gardens (bio-retention/bio-infiltration)
- Urban rain gardens (“planter boxes”)
- Bioswales
- Porous pavements
- Green streets
- Green parking lots
- Green roofs
- Land conservation
- Creation or maintenance of urban tree canopy

- Wetland restoration
- Riparian area rehabilitation
- Sand dune restoration, among others.

The Municipality will consider green infrastructures measures when developing or championing flood control measures with the state or the federal government. In addition to flood control, green infrastructure provides benefits such as improved water quality, enhanced water supply, reduced stormwater management costs (public and private), improved habitat quality, increased spaces for recreation and physical activity, job creation in the maintenance of natural areas, and increased property values (EPA, 2019).

### 4.17.11 Four – Year Investment Program

The Four-Year Investment Program 2022–2023 to 2025–2026 (hereinafter, the PICA) is a short- and medium-term planning instrument designed to guide, coordinate, and direct public investments during the period it covers. Through this instrument, the Planning Board integrates the efforts of various government entities aimed at improving the quality of life of the people of Puerto Rico, in line with established public policies.

The Framework of Reference for the Four-Year Investment Program for the period 2022–2023 to 2025–2026 guides agencies and public corporations in preparing their investment and capital improvement programs. The framework includes a demographic and socioeconomic profile of Puerto Rico as a whole and by regional organization, a diagnosis of the recent performance of the economy, and information on development patterns and priority projects for the competitive Puerto Rico to which all aspire.

The full PICA document for the 2022–2023 to 2025–2026 period incorporates all information on capital improvement projects to be carried out by government entities. It includes a detailed analysis of the distribution of recommended resources by program areas and the origin of those resources. This analysis is the result of an integration process designed to guide budget recommendations formulated by the Office of Management and Budget regarding the Annual Capital Improvements Program included in Puerto Rico's budget.

This program serves as a short- and medium-term planning tool to guide, coordinate, and direct public investments during its period of effectiveness. It uses Puerto Rico's demographic and socioeconomic profile, along with a regional analysis as established by the Planning Board (JP, 2022).
With respect to the municipality's Hazard Mitigation Plan, the PICA is used to integrate information on the current performance of Puerto Rico's economy, including data on public debt and development trends, as well as projects designated as priorities for implementation on the Island. Within this framework, the PICA provides municipalities with information from government entities regarding funding allocations and investments in improvements they are responsible for implementing, which contribute to municipal efforts to mitigate natural hazards.

As part of the projects influencing all Functional Areas of Puerto Rico, the review of municipal Mitigation Plans is included. The Planning Board was designated by the Government Authorized Representative (GAR) as the agency responsible for reviewing and developing Hazard Mitigation Plans in coordination with the 78 municipalities[16].

[16] GAR function is currently held by COR3

# 5. Municipal Capacities

## 5.1 Regulatory and Planning Mechanism (C1-a)

These capabilities refer to the legal provisions that influence land use to manage economic growth and that could support the municipality in its efforts to mitigate the vulnerability of its communities and resources to natural hazards. The municipality identified existing regulations and planning documents that could support its actions, as well as opportunities to promote the development of studies or plans for the same purpose of advancing its mitigation goals. These regulatory and planning tools are described in Section 4.17

## 5.2 Technical and Administrative Capacities (C1-a)

The Municipality of Yabucoa is well staffed to implement this LHMP. The Municipality has fully staffed office of . Copy of this organigram can be found as part of Appendix E.

Table 47 shows the Municipality's Technical and Administrative Capacity

*Table 47: Municipal Technical and Administrative Human Resources*

| Personnel Team / Resources | Yes | No | Future Positions | Department or Agency | Opportunities to Integrate into LHMP | Comments |
|---|---|---|---|---|---|---|
| Planners with experience in land use and mitigation | | X | Through contract services if needed | N/A | N/A | Currently the municipality does not have a planning department. Any planning related issue is worked through the mayor's office, or subcontracted staff. |
| Engineers or professionals trained in construction practices related to buildings and infrastructure | | X | Through contract services if needed | N/A | N/A | Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services. |

| Personnel Team / Resources | Yes | No | Future Positions | Department or Agency | Opportunities to Integrate into LHMP | Comments |
|---|---|---|---|---|---|---|
| Planners or engineers with a broad understanding of natural hazards | | X | Through contract services if needed | N/A | N/A | Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services. |
| Emergency Manager | X | | Director of the Municipal Emergency Management Office | Municipal Emergency Management Office, Department of Public Safety | The LHMP may be used to update the EOP | None |
| Scientist familiar with natural hazards | | X | Through contract services if needed | University of Puerto Rico, Puerto Rico Seismic Network, other universities in Puerto Rico | | Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services. |
| Personnel with expertise or education regarding the vulnerabilities and natural hazards affecting the community | | X | Community Representative | N/A | N/A | Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services. |
| Resource development staff or grant writers | | X | Director of Municipal Federal Programs | Municipal Federal Programs Office | This staff may write and administer grants to cover the mitigation strategies mentioned below. | N/A |

## 5.3 Financial Capacity (C1-a)

The Municipality has a successful track record administrating federal funds from various funding streams and has a dedicated office to administer and supervise the use of federal funds, and when any finding has been identified by grant – providers it has been addressed and corrected.

### 5.3.1 FEMA Funding Streams

For hazard mitigation projects the municipality has identified the following FEMA – administered possible funding streams which it could draw from.

**Stafford Act - Section 404**

Section 404 refers to Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, which authorizes the Hazard Mitigation Grant Program (HMGP), administered by FEMA. Its primary purpose is to reduce future disaster losses by funding long-term mitigation projects after a major disaster is declared.

Under Section 404, funding is made available to states, territories, tribes, and local governments to implement mitigation measures that lessen the impacts of future hazards such as floods, earthquakes, hurricanes, wildfires, and droughts. Unlike Section 406, Section 404 projects do not have to be tied to facilities that were damaged by the declared disaster. This allows communities to take a proactive approach by investing in mitigation actions that address known risks before damage occurs.
Eligible projects under Section 404 may include activities such as elevation or acquisition of flood-prone structures, drainage improvements, seismic retrofits, safe rooms, wildfire mitigation measures, and hazard mitigation planning. Projects must be cost-effective, technically feasible, and consistent with an approved Hazard Mitigation Plan. The program typically provides up to 75 percent federal funding, with the remaining share provided by non-federal sources.

Under Section 404 is also the Hazard Mitigation Grant Program (HMGP) that can support plan development, data collection, risk assessments, and engagement activities required to maintain FEMA approval following a presidential disaster declaration.

**Stafford Act – Section 406**

Section 406 of the Stafford Act supports mitigation projects by allowing hazard-mitigation measures to be incorporated directly into the repair or replacement of public facilities damaged during a declared disaster. This provision enables communities to strengthen damaged infrastructure against future hazards, such as elevating flood-damaged buildings, reinforcing structures to withstand high winds, or improving drainage systems during repairs. Mitigation measures funded under Section 406 must be cost-effective and directly related to the damaged facility. By integrating mitigation into recovery activities, Section 406 helps reduce the likelihood of repetitive damage and future repair costs. Overall, it ensures that rebuilding efforts contribute to long-term resilience rather than simply restoring pre-disaster conditions.

**Stafford Act - Section 428**

Section 428 of the Stafford Act can support mitigation projects by allowing communities to integrate hazard-resilient and risk-reduction measures directly into disaster recovery projects funded through FEMA's Public Assistance Program. Through its alternative procedures, Section 428 enables flexible project design, fixed-cost funding, and consolidation of damaged facilities, making it easier to incorporate mitigation improvements such as relocation, elevation, floodproofing, or structural hardening. Applicants may also reinvest cost savings from efficiently managed projects into additional mitigation features, as long as project objectives are met. By emphasizing outcomes rather than strict cost reimbursement, Section 428 encourages rebuilding that reduces future risk rather than simply restoring pre-disaster conditions. This approach allows mitigation to become an integral part of recovery, strengthening resilience and reducing the likelihood of repetitive losses.

**Flood Mitigation Assistance Program**

The Flood Mitigation Assistance (FMA) Program reduces flood hazards by providing funding to help communities identify and implement measures that lessen long-term flood risk to National Flood Insurance Program (NFIP)insured properties. The program focuses on projects such as elevating, acquiring, relocating, or floodproofing flood-prone structures, with particular priority given to repetitive loss and severe repetitive loss properties. By mitigating flood damage before disasters occur, FMA helps protect lives and property, reduces future flood insurance claims, and lowers the overall cost of disaster assistance. The program encourages proactive risk reduction

by aligning mitigation investments with floodplain management and local hazard mitigation planning.

**Stafford Act – Section 203 (BRIC)**

The Building Resilient Infrastructure and Communities (BRIC) program supports mitigation projects by providing pre-disaster funding to help communities reduce risks from natural hazards before disasters occur. Administered by FEMA, BRIC focuses on long-term, cost-effective investments that enhance the resilience of critical infrastructure, lifelines, and communities. The program funds activities such as infrastructure retrofits, flood control projects, seismic upgrades, and nature-based solutions, as well as hazard mitigation planning and capacity building. BRIC emphasizes innovative, large-scale projects that address multiple hazards and provide measurable community benefits. By investing in mitigation prior to disasters, the BRIC program helps protect lives and property, reduce future disaster costs, and support more resilient and sustainable development.

### 5.3.2 Non-FEMA Federal Funding Streams

Non-FEMA federal Funding Streams can include:[17]

**CDBG-DR**

The Department of Housing and Urban Development's Community Development Block Grant–Disaster Recovery (CDBG-DR) program can fund hazard mitigation planning and projects by supporting activities that reduce long-term disaster risk and address unmet recovery needs following a major disaster. CDBG-DR funds may be used to develop or update hazard mitigation plans, conduct risk assessments, and support resilience and mitigation planning efforts that guide future investments. In addition, the program can finance mitigation projects such as drainage improvements, flood control infrastructure, elevation or acquisition of flood-prone properties, utility hardening, and other measures that reduce vulnerability to natural hazards. Unlike some recovery programs, CDBG-DR allows communities to target mitigation actions even if facilities were not damaged in the most recent disaster, as long as the activities address identified risks.

[17] Please note that the following list is not intended to be exhaustive.

**CDBG-MIT**

The Department of Housing and Urban Development's Community Development Block Grant–Mitigation (CDBG-MIT) program supports hazard mitigation planning and projects by providing federal funding specifically dedicated to reducing future disaster risks in communities that have experienced major disasters. CDBG-MIT funds can be used for mitigation planning activities such as risk assessments, data analysis, and development of strategies that guide long-term resilience investments. The program also finances a wide range of mitigation projects, including flood risk reduction, stormwater management, wildfire mitigation, resilient infrastructure upgrades, and nature-based solutions. CDBG-MIT emphasizes addressing identified vulnerabilities and repetitive loss areas, even if they were not directly damaged in a recent disaster. By focusing on forward-looking risk reduction, the program helps communities proactively adapt to climate impacts and future hazards. Overall, CDBG-MIT integrates mitigation into long-term recovery and development efforts, strengthening community resilience and reducing future disaster losses.

It should be noted that CDBG-DR and CDBG-MIT differ primarily in their purpose and how they support hazard mitigation planning and projects. CDBG-DR focuses on post-disaster recovery, with mitigation activities integrated into rebuilding efforts to address unmet needs and reduce future risk as communities recover. Under CDBG-DR, mitigation planning and projects must be closely tied to disaster recovery goals and justified by disaster impacts or recovery assessments. In contrast, CDBG-MIT is specifically dedicated to hazard mitigation and long-term risk reduction, allowing communities to fund mitigation planning and projects even if areas or facilities were not damaged in the most recent disaster.

**Resilience and Emergency Relief Programs**

The Federal Highway Administration (FHWA) Resilience and Emergency Relief Programs support Hazard Mitigation Plans by promoting the identification and reduction of risks to transportation infrastructure from natural hazards. Through the Emergency Relief Program, FHWA allows mitigation and resilience measures—such as improved drainage, roadway elevation, and bridge reinforcement—to be incorporated into post-disaster repairs. FHWA resilience initiatives also encourage vulnerability assessments and risk-based planning that align with the risk assessment and mitigation strategy components of FEMA-approved HMPs. By integrating hazard mitigation and climate resilience into transportation planning, these programs help ensure that roads and bridges are addressed as critical lifelines. Overall, FHWA

programs complement Hazard Mitigation Plans by supporting transportation-focused mitigation actions that reduce future disruption and repair costs.

**National Resource Conservation Service**

The Environmental Quality Incentives Program (EQIP) and the Watershed and Flood Prevention Operations (WFPO) program support hazard mitigation projects by addressing risks at the landscape and watershed scale through conservation and infrastructure improvements. EQIP, administered by the USDA Natural Resources Conservation Service (NRCS), provides financial and technical assistance to landowners to implement conservation practices that reduce erosion, manage runoff, improve soil health, and mitigate risks from flooding, drought, and wildfires. These practices—such as vegetation management, streambank stabilization, and water retention—help lessen downstream flood impacts and enhance resilience to climate variability. The Watershed and Flood Prevention Operations program support larger-scale mitigation through structural and non-structural measures, including small dams, floodwater retarding structures, channel improvements, and watershed planning. Together, these programs reduce hazard exposure upstream, protect communities and infrastructure downstream, and integrating natural resource management into long-term flood and drought mitigation strategies.

### 5.3.3 Local Funds

Yabucoa like other municipalities in Puerto Rico, receives revenue from the Municipal Revenue Collection Center (MRCC). Other funding sources include revenue from the Sales and Use Tax (IVU, by its Spanish acronym), legislative funds that might be assigned from time to time and other sources. Depending on the state of municipal finances, the municipality might determine that there are some funds that can be used to pay for or cover local funds match for mitigation projects.

However, most major capital improvement projects depend on federal funds transfers. The use of federal funds varies widely from year to year. In some cases, these funds are used to cover costs associated with the creation and monitoring of specific programs (for example, Section 8 or housing programs). In other cases, the funds are used to finance major capital improvement projects.

## 5.4 Outreach and Communications Capacity (C1-a)

Building robust outreach and communication capacity is essential to the successful implementation of a Hazard Mitigation Plan, as effective risk communication enables residents to recognize their risks, actively participate in planning processes, and make informed decisions to reduce potential impacts. FEMA guidance underscores the importance of early and thoughtfully designed engagement strategies to ensure that key stakeholders exchange information at the right time, promoting shared awareness of hazards and broad support for mitigation actions. Communication is a fundamental preparedness capability because it provides timely, practical information that helps individuals and communities act to limit harm. Research further demonstrates that outreach efforts are most successful when messages are clearly defined, customized for specific audiences, and conveyed through trusted sources. Communities that prioritize outreach—by collaborating with local leaders, leveraging a variety of communication channels, and tailoring messages to different population groups—tend to achieve higher public involvement and more effectively incorporate community feedback into hazard mitigation planning. These practices ultimately contribute to more effective plans and more resilient communities (FEMA, 2025).

The Municipality demonstrates adequate capacity to conduct effective outreach and communication activities. The Office of the Mayor is responsible for coordinating these efforts. The Municipality utilizes both social media platforms for real-time communication and traditional methods to disseminate information to the public. In addition, the Planning Office administers the Community Board responsible for land-use decisions, which is largely composed of municipal residents. This board serves as an important forum for public engagement and provides an opportunity to further expand and strengthen the Municipality's outreach and communication capacity.

Table 48 details the communication tools available to the municipality.

*Table 48: Outreach and Communications Tools*

| Tool or resource | Present or not present | Description | Agency in Charge |
|---|---|---|---|
| Municipal Social Media | Present | Facebook Page | Mayor's Office |
| Planning Board Print Material | Present | Print Material regarding hazard | Puerto Rico Planning Board |

| Tool or resource | Present or not present | Description | Agency in Charge |
|---|---|---|---|
| | | mitigation, focused on flood hazard | |
| Community Meetings | Present | Community Outreach Meeting to reach people that do not have access to social media | Various |

## 5.5 Capacity Development (C1-b)

Strengthening institutional and technical capacity is vital to the successful implementation of a Hazard Mitigation Plan, as communities must have the expertise, resources, and organizational frameworks needed to move from planning to sustained risk-reduction actions. FEMA guidance stresses that effective mitigation planning relies on well-coordinated teams, access to reliable technical data, and the ability to collaborate across agencies and stakeholders—all of which directly affect the execution of mitigation strategies. National evaluations have shown that local and state governments often face challenges in implementing mitigation projects not due to a lack of commitment, but because of limited technical assistance, constrained administrative capacity, and insufficient engagement with federal support programs. Studies focused on low-capacity communities further demonstrate that gaps in technical knowledge, training, and leadership involvement can significantly hinder mitigation outcomes. These findings highlight the importance of strengthening workforce skills, enhancing guidance and tools, and reinforcing institutional support to achieve long-term resilience.

The Municipality continues to enhance its mitigation capacity by retaining qualified professionals as staff or contractors as needs arise. It also actively participates in training and continuing education opportunities offered through Commonwealth agencies and academic institutions to build and maintain the technical and institutional expertise necessary to support hazard mitigation efforts.

# 6. Mitigation Strategies

The goals, objectives, and mitigation actions outlined in this Plan are based on discussions held by the designated Mitigation Plan Committee, as well as the public-participation activities conducted to date.

## 6.1 Mitigation Strategies Requirements

Federal regulation 44 C.F.R. § 201.6(c)(3) establishes the requirements related to the mitigation strategy for local mitigation plans.
The Plan must include the following:

- A mitigation strategy that provides the jurisdiction with a framework to reduce potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, along with its capacity to expand and improve existing tools.

This section must include:

- A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
- A section identifying and analyzing a comprehensive range of specific mitigation actions and projects is being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings, as well as infrastructure.
- A description of the jurisdiction's participation in the NFIP (National Flood Insurance Program) and compliance with NFIP requirements, as appropriate; and finally,
- An action plan describing how the identified actions will be prioritized, implemented, and administered by the local jurisdiction. The prioritization must include a special emphasis on how benefits are maximized, based on a cost-benefit review of the proposed projects, along with their associated costs.

## 6.2 Mitigation Goals (C3-a)

### 6.2.1 Municipal Goals and Objectives

**Goal 1** - Have updated Emergency Management Plans to be implemented by the municipal administration for the different natural disaster events that are likely to occur.

*Objectives*

- Update the Emergency Management Plans focused on each area of vulnerability in the municipality, considering new events that may be studied and determined to potentially occur in Yabucoa.
- Establish, for each community, the most appropriate, safe, and effective primary and alternate road routes that will allow us to respond to an emergency.
- Have trained personnel to implement the Emergency Management Plans.
- Avoid improvisation in the Emergency Management process.

**Goal 2** - Prepare society for the imminence of a disaster.

*Objectives*

- Prepare training workshops for the community on what to do before, during, and after a natural disaster. Provide clear, specific, and easy-to-understand literature with the steps to follow and where to obtain assistance.
- Establish partnerships with the central government and the private sector to respond to the needs of communities if basic water, energy, communications, and health services are unavailable during an emergency.
- Make safe and accessible locations available to citizens for use as shelters.

**Goal 3 -** Educate the population so they can properly prepare to face a natural disaster based on the resources available to the administration.

*Objective*

- Educate the community about the services provided by the administration and the central government during the different stages of a natural disaster.

- Create partnerships with institutions such as the College of Engineers and the Puerto Rico Seismic Network to share useful information to orient and train citizens about the consequences of a natural disaster and the precautionary measures to implement.

**Goal 4** - Build partnerships between the government and communities to establish mitigation strategies.

*Objective*

- Hold meetings with each community, discuss the problems that affect them and make them vulnerable to disasters, share information about new events and/or new damages, and include them in the formulation of solutions.

**Goal 5** - Promote adequate planning for land use and the management of land and its resources.

*Objective*

- Make the Mitigation Process an integral part of planning and decision-making processes in the Municipality.
- Incorporate the Hazard Mitigation Plan into land-use planning processes, such as Territorial Plans, Area Plans, and Expansion Plans.

**Goal 6** - Promote sustainable development.

*Objective*

- Determine the best land use for areas identified as high risk, in order to align current uses with vulnerability.
- Ensure that new developments carried out within the jurisdiction make it resilient to natural disasters and do not worsen current vulnerability.
- Contribute to the creation of sustainable communities.
- Prevent sedimentation of bodies of water that supply water resources for both the municipality and surrounding regions.

**Goal 7** - Have trained personnel to efficiently assess damage caused by the impact of a natural event.

*Objectives*

- Train municipal personnel in assessing damage caused by the impact of natural events, in order to quantify and document them as quickly as possible.
- Train citizens on the regulations and/or requirements needed to be eligible to claim damages to their property and to properly assess such damages.

**Goal 8** - Achieve higher levels of understanding regarding what affects the development of each community in the municipality and makes it vulnerable to disasters.

*Objectives*

- Have an inventory of all municipal structures and public works to expedite their assessment after a natural disaster occurs.
- Conduct assessments of structures and public works after a natural disaster occurs to determine their condition associated with the event and document their vulnerability.
- Create an inventory of all bodies of water existing in the municipality, expanding the available database to include streams, creeks, and waterways that are not registered and that, in some way, affect public works and private property during rainfall events.

**Goal 9** - Ensure that existing public works are reliable and disaster-resistant, minimizing damage caused by natural disasters and reducing their vulnerability.

*Objectives*

- Make improvements to public works that have shown repetitive damage during past events, ensuring that they meet current use levels and applicable codes and regulations so they remain available during the impact of a natural disaster.
- Reduce the vulnerability of public works located in areas identified as high risk.

**Goal 10** - Minimize losses in existing and future public works in areas identified as potential hazards.

*Objective*

- Have an inventory of all public property.
- Ensure that the Territorial Plan considers the municipality's vulnerability in decision-making regarding public works to be developed within the jurisdiction.

**Goal 11** - Ensure that residents of the jurisdiction of Yabucoa can rely on essential basic services during the impact of a natural disaster.

*Objective*

- Make improvements to public works classified as critical facilities to ensure they remain available during the impact of a natural disaster.

**Goal 12** - Have a housing inventory that makes it possible to ensure that every family in Yabucoa lives in safe housing.

*Objective*

- Promote the creation of new housing projects to relocate communities identified in high-risk areas.
- Bring existing housing units into compliance with current Building Codes to ensure their safety during events such as strong winds, floods, and earthquakes.
- Determine the number of housing units located in identified high-risk areas and establish the particular vulnerability of each unit to such events, taking into consideration their socioeconomic characteristics.
- Prepare educational workshops for the community on the importance of complying with current construction codes and regulations and the aspects necessary to ensure safe housing.

**Goal 13** - Have better analysis tools, resources, and information to evaluate the municipality's vulnerability to natural disasters.

*Objectives*

- Obtain the information needed to establish the characteristics of the natural disasters that affect the jurisdiction, which was not available for the preparation of the Hazard Mitigation Plan, in order to improve risk analysis.
- Develop an inventory of structures located in areas where repeated flooding has occurred, together with information on past insurance claims, to improve the analysis of structural damage caused by flood events.
- Identify the type and number of future buildings, infrastructure, and critical facilities to be located in areas identified as potential hazards in order to establish their vulnerability.
- Obtain the information needed to establish potential losses for each potential hazard identified for the municipality.
- Have information related to new development trends and changes in land-use density to achieve a better vulnerability analysis in the municipality.
- Actively participate in and become knowledgeable about the various projects and programs being carried out to study natural and anthropogenic impacts on the municipality's coasts, such as projects with the Sea Grant Program at UPRM and the Coastal Zone Management Program of the DNER.

**Goal 14** - Prevent sedimentation and contamination of bodies of water, including rivers and streams.

*Objectives*

- Carry out projects aimed at stormwater runoff collection to prevent erosion of the surface layers of soil from reaching the coasts and depositing sediments and contaminants there, which affect the natural barriers of mangroves and reefs that protect the coast from wave impact and, therefore, from coastal erosion.
- Carry out projects aimed at stormwater runoff collection in the Yabucoa Agricultural Reserve and its surrounding areas to prevent such runoff from flooding nearby residential areas.

### 6.2.2 National Mitigation Investment Strategy

The Municipality also adopts the National Mitigation Investment Strategy and the following goals.

- Goal 1: Show How Mitigation Investments Reduce Risk - The whole community will build a shared understanding of mitigation investment and its value. Specifically, the whole community will understand how effective mitigation investments can protect people, homes, neighborhoods, cultural and historic resources, ecosystems and lifelines (for example, communications, energy, transportation and water). The federal government and its non-federal partners will create a shared vocabulary and common measures to communicate information about risk and find opportunities to educate, hire, train and develop a base of qualified mitigation professionals.
- Goal 2: Coordinate Mitigation Investments to Reduce Risk - The whole community will coordinate mitigation investments through shared risk information, reinforced strategies for risk reduction, and easier access to existing funding. Such coordination will help the whole community justify mitigation investments and choose the most cost-effective and reasonable actions.
- Goal 3: Make Mitigation Investment Standard Practice The whole community will factor mitigation into investment decisions, especially for buildings and infrastructure. The federal government and its non-federal partners will use and expand financial products and approaches for mitigation investment, including funding, incentives and financial risk transfer opportunities. The federal government and its non-federal partners also will make mitigation standard professional practice critical to safeguarding lifelines, services, and national safety and security.

## 6.3 Mitigation Strategy Selection Criteria

The following methodologies were used to select the mitigation actions:

- The Planning Committee reviewed mitigation actions from the previous Mitigation Plan.
- The Committee evaluated those actions and determined which ones were appropriate to include in the current Plan. Actions were excluded if:
- The measure had already been implemented during the previous plan's period and was not a recurring or ongoing action.
- The measure was no longer necessary or useful based on new information. This applies to mitigation actions linked to identified hazards, risks, and vulnerabilities.

- Committee members evaluated and added new measures. These new actions were proposed based on the Committee members' professional experience and suggestions received from community members.
- The Committee reviewed Puerto Rico's 2026 State Hazard Mitigation Plan during the preparation of this LHMP update. Risk profiles, state capabilities, mitigation goals, and relevant state actions were considered during the risk assessment, capacity assessment, and development of the municipal mitigation strategy

The mitigation strategies of the Municipality of Yabucoa were evaluated by the Committee using the STAPLEE methodology. This methodology was considered in the selection of the strategies included in Section 6.5. This methodology has seven evaluation criteria:

S – Social: The proposed action must be socially acceptable.
T – Technical: The proposed action must be technically feasible.
A – Administrative: The community must have the capacity to implement the action (for example, determining whether the responsible agency is capable of supervising the mitigation project).
P – Political: Mitigation actions must be politically acceptable.
L – Legal: The community must have the authority to implement the proposed action.
E – Economic: Economic considerations must include the current economic base, projected growth, and opportunity costs.
E – Environmental: The environmental impact must be considered, given statutory requirements and the public's interest in maintaining sustainable and environmentally healthy communities.

## 6.4 Mitigation Strategy Categorization

To further understand the chosen mitigation strategies, this LHMP classifies said strategies in five broad categories as shown below.

Prevention (Local Policy and Regulation) - Prevention activities aim to keep hazards from creating or worsening problems. These actions are typically carried out through government programs or regulatory measures that guide land-use development and building practices. Prevention is especially effective for reducing future vulnerability in areas that have not yet been developed. Examples include:

- Planning and zoning
- Building codes

- Open-space preservation
- Floodplain regulations
- Stormwater management regulations
- Maintenance of drainage systems
- Capital improvement programming
- Riverbank realignment
- Projects addressing fault zones

Structure and Infrastructure Projects – This LHMP subdivides this category into two subcategories.

- Property Protection – measures involve modifying existing buildings and structures so they can withstand natural hazards, or removing structures located in high-risk areas. Examples include:
    - Acquisition of properties
    - Relocation
    - Elevating structures
    - Protection of critical facilities
    - Structural retrofits (wind protection, floodproofing, seismic techniques)
    - Safe rooms, shutters, impact-resistant windows
    - Insurance policies

- Structural Projects – Projects aim to reduce the impact of disasters by controlling or altering the natural flow of hazard events through engineered construction. These projects are usually designed by engineers and maintained by public works teams. Examples include:
    - Reservoirs
    - Dams, levees, and retaining walls
    - Diversion, detention, and retention systems
    - Channel modifications
    - Stormwater drainage systems
    - Installation of storm drains and related infrastructure

Natural Resource Protection – activities reduce the impact of natural disasters by preserving or restoring natural areas that offer protective benefits. These areas include flood plains, wetlands, steep slopes, and sand dunes. Parks, recreational agencies, and conservation organizations commonly implement measures such as:

- Flood protection
- Watershed management

- Riparian buffers
- Forest and vegetation management (including wildfire and fuel-load control)
- Erosion and sediment control
- Wetland preservation and restoration
- Habitat preservation
- Slope stabilization

Emergency Services - Although not typically classified as mitigation, emergency management measures reduce the human and property impacts of natural hazards. These actions occur immediately before, during, or after a disaster. Examples include:

- Warning systems
- Evacuation management and planning
- Emergency response drills and training
- Flood-fighting measures
- Installation of shutters

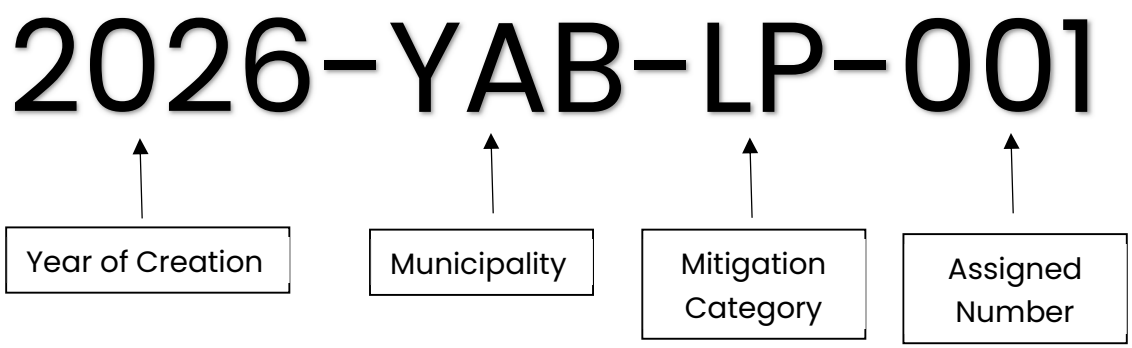
Public awareness and outreach - Efforts to help inform residents, elected officials, business owners, homebuyers, and visitors about hazard-prone areas and mitigation techniques they can use to protect themselves and their property. Examples include:

- Outreach projects
- Demonstration events and guest presentations
- Hazard information materials
- Property-specific risk information
- Library materials
- Educational programs for children
- Exposure to risk-related information

## 6.5 Mitigation Strategies (C4-a, C4-b, C5-a, C5-b, E2.b)

To improve tracking and updating, each mitigation strategy has been giving a unique identification number. The following figure shows the meaning of the nomenclature.

*Figure 34: New ID Nomenclature*




Each identified mitigation strategy shall include:

- Assigned category,
- Hazard(s) Mitigated
- Priority
- Responsible entity
- Founding source
- Estimated cost (when available)
- Qualitative Benefit
- Time Horizon
- Status
- Location in 2020 LHMP (if applicable)

*Table 49: Mitigation Strategies – Prevention (Local Regulations and Policies)*

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Possible Funding Sources | Budget | Implementation Horizon | Current Status and Expected Benefits |
|---|---|---|---|---|---|---|---|---|---|---|
| 2026-YAB-LP-001 | P-1 | Land Use Planning and Permits, together with the Municipal Emergency Management Office, will be responsible for implementing and executing the 2026 Plan.<br>Under the direction of Mayor's Office, actions that can be implemented immediately will be defined, as well as those requiring studies, designs, permits, and proposal development to obtain funds for the municipality to carry them out. The priority or potential execution will depend on the immediate impact on risk to life and property, considering economic, administrative, social, technical, legal, and environmental feasibility. | All | High | N/A | Planning Office<br><br>Municipal Emergency Management Office | Municipality of Yabucoa, Federal Proposals, Ordinary Funds, Legislative Appropriations | $40,000.00 | Immediate | Current Status: Continuous execution – This plan is currently in execution and allow to zone land according to it productive value and protect natural resources, it is also a tool to organize development in safe areas.<br><br>This plan allows to have a clear panorama of those areas that are susceptible to natural hazards and in which areas can construction and economic activity can be allowed and encouraged. The Land Use plan is currently in its first revision. |
| 2026-YAB-LP-002 | P-2 | Develop an action plan to address residences located in areas of high hazard | All | High | All | Planning Office | Federal Proposals, Ordinary Funds, Legislative Appropriations | $90,000.00 | Long - Term | Current status – Financing = Though the municipality currently does not have the funds for this task, it is decided that it this strategy should be kept. The municipality does have various community resiliency plans that could serve to develop a more comprehensive plan. |
| 2026-YAB-LP-003 | P-3 | Improve the inventory system for public property | Tropical Cyclone and Extreme Winds | High | Food, Hydration and Shelter | Municipal Recovery Office | Office of Economic Development, Planning Area | $150,000.00 | Immediate | Continuous execution -<br>Work is being carried out on the implementation of construction, rehabilitation, and maintenance projects for public facilities to ensure they are more resilient to the impacts of various climate-related events and other emergency situations that may arise. |
| 2026-YAB-LP-004 | P-4 | Removal of public nuisances. | All | Medium | Food, Hydration and Shelter | Office of the Mayor | Ordinary Budget (By Administration) | $10,000,000.00 | Immediate | Continuous execution -<br>This strategy helps provide safety and well-being to communities. In addition, abandoned properties are repurposed for residential and commercial uses, generating socioeconomic benefits for the community. |
| 2026-YAB-LP-005 | P-5 | Increase in Emergency Mitigation personnel. | All | High | Safety and Security | Municipal Emergency Management Office<br><br>Municipal Budget and Finance Office | Ordinary Funds, Legislative Appropriation | $1,500,000.00 | Immediate | In continuous execution: There is a continuous effort to maintain a workforce trained in various emergency management and mitigation situations. This enables a rapid and effective response to help prevent property damage and loss of life. |
| 2026-YAB-LP-006 | P-6 | Community Rating System Program. | Flooding | | Communications | Federal Programs Office | Federal Proposals, Ordinary Funds | $60,000.00 | Immediate | Continuous Execution: This program is constantly being updated. |

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Possible Funding Sources | Budget | Implementation Horizon | Current Status and Expected Benefits |
|---|---|---|---|---|---|---|---|---|---|---|
| 2026-YAB-LP-007 | P-7 | Prevention of Reconstruction in Risk Areas. | All | High | All Water Systems | Planning Office | Ordinary Funds, Federal Proposals | Agreement with the Planning Board | Immediate | This is currently addressed by the land use plan. It will continue to be updated as needed. |
| 2026-YAB-LP-008 | P-8 | General Improvements to the Stormwater System. | Flooding | High | Water System | Municipal Recovery Office | HMGP<br>PDM<br>FMA<br>USACE | Not Determined | Long - Term | In Financing: The Municipality is seeking funds for this work under FEMA 428 program. |
| 2026-YAB-LP-009 | P-9 | Installation and Maintenance of Tsunami Warning System | Tsunami | High | Safety and Security | Municipal Emergency Management Office | HMGP<br>PDM | N/A | Immediate | Completed. This strategy will be removed in the next LHMP update. |
| 2026-YAB-LP-010 | P-10 | Installation of a water tank and pumping system at the Nursing Home (YA-040). | All | Low | Food, Hydration and Shelter | Municipal Public Works | HMGP<br>PDM<br>CBDG-DR | N/A | Immediate | Completed. This strategy will be removed in the next LHMP update |

*Table 50: Mitigation Strategies – Property Protection*

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Potential Funding Sources | Budget / Cost | Implementation Term | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| 2026-YAB-PP-001 | PP-1 | Flood control for La Comuna Community. | Flooding | High | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loans, legislative allocations, state agency allocations | $25,000.00 | Short Term | Current Status: Ongoing implementation – Maintenance work is carried out periodically in the water body area to prevent flooding that may affect lives and property. These works require permits from state agencies. |
| 2026-YAB-PP-002 | PP-2 | Flood control for Terralinda Community. | Flooding | High | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $25,000.00 | Short Term | Current Status: Ongoing implementation – Maintenance work is carried out periodically in the water body area to prevent flooding that may affect lives and property. These works require permits from state agencies. |
| 2026-YAB-PP-003 | PP-3 | Flood control for El Ingenio Community. | Flooding | Low | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $25,000.00 | Short Term | Current Status: Ongoing implementation – Maintenance work is carried out periodically in the water body area to prevent flooding that may affect lives and property. These works require permits from state agencies. |
| 2026-YAB-PP-004 | PP-4 | Flood control for Martorell Community. | Flooding | High | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $25,000.00 | Short Term | Current Status: Ongoing implementation – Maintenance work is carried out periodically in the water body area to prevent flooding that may affect lives and property. These works require permits from state agencies. |
| 2026-YAB-PP-005 | PP-5 | Flood control for PR-3 Road, PR-9909 Road intersection. | Flooding | High | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $25,000.00 | Short Term | Current Status: Ongoing implementation – Green areas and nearby farms are being cleaned so that water may flow freely. |
| 2026-YAB-PP-006 | PP-6 | Flood control for Los Millanes Community. | Flooding | High | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $25,000.00 | Short Term | Current Status: Ongoing implementation – Green areas and nearby farms are being cleaned so that water may flow freely. |
| 2026-YAB-PP-007 | PP-7 | Project: Flood control for Rosa Sánchez Community. | Flooding | High | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $25,000.00 | Short Term | Current Status: Choose an item. – Green areas and nearby farms are being cleaned so that water may flow freely. |

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Potential Funding Sources | Budget / Cost | Implementation Term | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| 2026-YAB-PP-008 | PP-8 | Improvements to the stormwater runoff collection system in Playita Community. | Flooding | Medium | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $5,000.00 | Medium Term | Current Status: In Progress – Culverts are being evaluated to allow the free flow of water. |
| 2026-YAB-PP-009 | PP-9 | Flood control for Jaime C. Rodríguez Community. | Flooding | High | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $25,000.00 | Short Term | Current Status: Ongoing implementation – Maintenance work is carried out periodically in the water body area to prevent flooding that may affect lives and property. These works require permits from state agencies. |
| 2026-YAB-PP-010 | PP-10 | Flood control for Jardines de Yabucoa, Jardines de Yabucoa Extension, and Yabucoa Real Communities. | Flooding | High | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $25,000.00 | Short Term | Current Status: Ongoing implementation – Maintenance work is carried out periodically in the water body area to prevent flooding that may affect lives and property. These works require permits from state agencies. |
| 2026-YAB-PP-011 | PP-11 | Improvements to the stormwater runoff collection system in Valles de Yabucoa Community. | Flooding and Landslides | Medium | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $5,000.00 | Short Term | Current Status: Ongoing implementation – Nearby streams and culverts are inspected to prevent flooding. |
| 2026-YAB-PP-012 | PP-11 | Improvements to the stormwater runoff collection system in Valles de Yabucoa Community. | Flooding and Landslides | Medium | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $10,000.00 | Short Term | Current Status: Ongoing implementation – Constant monitoring of the water body that flows through the community and maintenance of the drainage systems located along PR-901. |
| 2026-YAB-PP-013 | PP-12 | Housing rehabilitation to ensure an inventory of affordable, safe, decent, and sanitary housing. | N/A | N/A | N/A | N/A | N/A | N/A | N/A | Current Status: Withdrawn – Previously identified funding steam is being directed exclusively for new housing not rehabilitation. |
| 2026-YAB-PP-014 | PP-13 | Installation of steel storm shutter systems to reinforce critical facilities or other municipal assets. | Tropical Cyclone | High | Safety and Security | Construction and Rehabilitation | HMGP; PDM; Municipal; Legislative | $1,260,000.00 | Immediate | Current Status: Completed – Work was completed. These buildings also received improvements as part of FEMA allocations. |
| 2026-YAB-PP-015 | PP-14 | Maintenance and installation of gabions in the stream at Las Parcelas Comunas. | Flooding | Medium | Water Systems | Municipal Public Works | HMGP; PDM; USDA | $3,290,643.00 | Short Term | Current Status: Funding – Project with obligated funds. |
| 2026-YAB-PP-016 | PP-15 | Terrain stabilization on PR-900. | Landslides | Medium | Water Systems | Municipal Public Works | HMGP; PDM; USDA | $200,000.00 | Medium Term | Current Status: In Design – Work is expected to be completed within 12 to 18 months. |
| 2026-YAB-PP-017 | PP-16 | Terrain stabilization in areas identified by the Municipality with recurring landslides. | Landslides | Medium | Water Systems | Municipal Recovery Office | HMGP; PDM; USDA | $15,000,000.00 | Short Term | Current Status: In Progress – Some projects are in design, and others are under construction through the bidding processes. |
| 2026-YAB-PP-001 | PP-17 | Design and construction of a 150-linear-meter concrete channel near Los Nazario Creek. | Flooding | Medium | Water Systems | Municipal Recovery Office | HMGP; PDM; FMA | $596,000.00 | Medium Term | Current Status: In Design |

*Table 51: Mitigation Strategies Structural Projects*

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Potential Funding Sources | Budget / Cost | Implementation Term | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| 2026-YAB-SP-001 | SP-1 | Develop a comprehensive Plan to bring public works that affect water bodies and are part of the Municipal Road Network into compliance. | Flooding, Earthquakes, and Landslides | Medium | Water Systems | Municipal Public Works; Municipal Emergency Management Office | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $20,000.00 | Short Term | Current Status: Ongoing implementation – This plan is carried out every year at the beginning of the tropical cyclone activity season, from June 1 to November 30. |
| 2026-YAB-SP-002 | SP-2 | Flood Control Project in Jaime C. Rodríguez Urbanization on PR-900 Road in Calabazas Ward, Yabucoa. | Flooding | Medium | Water Systems | Public Works Office | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $40,000.00 | Immediate | Current Status: Completed – This project receives continuous maintenance and is carried out in coordination with the state. It is reconceptualized to include the continuous maintenance work |
| 2026-YAB-SP-003 | SP-3 | Flood control at the intersection of PR-182 and PR-900 Roads, known as Cuesta del Caño. | Flooding, Landslides, and Earthquakes | Medium | Water Systems | Municipal Recovery Office | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | Not estimated | Long Term | Current Status: Funding – This project is awaiting funding. |
| 2026-YAB-SP-004 | SP-4 | River Stream Canalization or other flood to protect various residential areas and critical infrastructure (Los Ángeles, Villa Recreo, Jardines de Yabucoa Urbanizations, section of PR-901 Road in front of Méndez Urbanization, Wastewater Treatment Plant, and PR-3 Road in front of Víctor Berrios Public Housing Complex) | Flooding | Low | Water Systems | Municipal Public Works | Federal proposals, ordinary funds, loan, legislative allocations, state agency allocations | $697,000.00 | Immediate | Current Status: Completed – This project is partially completed, since the PR-901 Road area was channelized; however, the PR-3 Road section has not been executed. |
| 2026-YAB-SP-005 | SP-5 | Elevation of a section of PR-3 Road, from the intersection with PR-9901 to the bridge on that road at the entrance to the former Central, and replacement of the bridge over PR-3. | Flooding and Earthquakes | Not applicable | Not applicable | Not applicable | Not applicable | Not applicable | Not applicable | Current Status: Withdrawn – An attempt was made to carry out the project using CDBG-DR funds, but the funds were not approved. This strategy will be suppressed in the next LHMP revision. |
| 2026-YAB-SP-006 | SP-6 | River Stream Canalization to protect the Martorell Community in Limones Ward. | Flooding | Not applicable | Not applicable | Not applicable | Not applicable | Not applicable | Not applicable | Current Status: Withdrawn. The Municipality funds not identified. This strategy will be suppressed in the next LHMP revision. |
| 2026-YAB-SP-007 | SP-7 | Installation of 200 meters of rock barrier or riprap along the coast, beginning at the entrance to the bay. | Coastal Modification | Low | Water Systems | Ports Authority | HMGP; PDM; USACE; CDBG-DR | $3,000,000.00 | Long Term | Current Status: In Permitting – This is a state project that we presume is in the permitting stage. This project would include dredging the channel. |
| 2026-YAB-SP-008 | SP-8 | Cleaning, maintenance, and expansion of the stormwater collection capacity of streams identified by the Municipality. | Flooding | High | Water Systems | Municipal Public Works | HMGP; PDM; DNER | $10,000,000.00 | Medium Term | Current Status: Funding – Awaiting obligation of funds. |
| 2026-YAB-SP-009 | SP-9 | Support the installation of 200 meters of “rip-rap” beginning at the entrance of the Port of Yabucoa | Long Term Coastal Modification | Medium | Water System | Municipal Public Works in support of the PR Port Authority | HMGP<br>PDM<br>USACE<br>CDBG-DR | $3,000,000.00 | Long Term | Current Status: Permitting – This is a state project; it will include dredging of the channel. |

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Potential Funding Sources | Budget / Cost | Implementation Term | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| 2026-YAB-SP-010 | SP-10 | Cleaning, maintenance, and expansion of the stormwater conveyance capacity of drainage channels identified by the Municipality. | Flooding | Medium | Water Systems | Municipal Public Works | HMGP<br>PDM<br>DRNA | $10,000,000.00 | Medium Term | Current Status – Financing- Waiting for obligation of funds |

*Table 52: Mitigation Strategies - Emergency Services*

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Possible Funding Sources | Budget / Cost | Implementation Term | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| 2026-YAB-SE-001 | SE-1 | Emergency Response Roadway Plan. | All | Low | Transportation | Planning Office | Federal proposals, ordinary funds, loans, legislative appropriations, allocations from state agencies | $150,000.00 | Medium Term | Current Status: Financing – This plan does not have a budget at this time. |
| 2026-YAB-SE-002 | SE-2 | Protection of critical facilities. | All | Medium | Safety and Security | Municipal Police; Security Services | Federal proposals, ordinary funds, loans, legislative appropriations, allocations from state agencies | $200,000.00 | Immediate | Current Status: Ongoing implementation – Security for critical facilities is continuous and part of the Municipal Police work plan. |
| 2026-YAB-SE-003 | SE-3 | Preparation of Community Centers as temporary long-term shelters for communities. | All | Low | Food, Hydration, and Shelter | Office of Community Partnerships | Federal proposals, ordinary funds, loans, legislative appropriations, allocations from state agencies | $8,000,000.00 | Short Term | Current Status: Ongoing implementation – A Community Leaders School has been created, integrating community kitchen programs. Solar panels and water cisterns have been installed in several Community Center facilities to fulfill this function. In addition, Head Start Centers have been built for these purposes, especially for the bedridden patient population. |
| 2026-YAB-SE-004 | SE-4 | Emergency Management Plans. | All | Low | Safety and Security | Office of Emergency Management | Federal proposals, ordinary funds, loans, legislative appropriations, allocations | $100,000.00 | Immediate | Current Status: Completed – This strategy (brief status explanation. We suggest no more than 140 characters. This strategy will provide the following qualitative benefits. |

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Possible Funding Sources | Budget / Cost | Implementation Term | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | from state agencies | | | |
| 2026-YAB-SE-005 | SE-5 | Purchase of emergency generators. | All | Medium | Energy | Office of Rehabilitation and Construction; Municipal Public Works | Federal proposals, ordinary funds, loans, legislative appropriations | $4,000,000.00 | Immediate | Current Status: Completed – After Hurricane María, more than a dozen electric generators were acquired for the municipality's critical facilities. |
| 2026-YAB-SE-006 | SE-6 | Identification of citizens with essential service's needs. | All | High | All | Municipal Office of Emergency Management; Office of Emergency Medical Services | Federal proposals, ordinary funds, loans, legislative appropriations | $60,000.00 | Immediate | Current Status: Ongoing implementation – Through the Office of Emergency Management and Emergency Medical Services, people with vulnerable health conditions, especially bedridden individuals, are identified and a census is conducted to implement the emergency plan during emergencies. |
| 2026-YAB-SE-007 | SE-7 | Acquisition and installation of an emergency electric generator for several municipal assets. | All | High | All | Office of Rehabilitation and Construction; Office of Public Works | HMGP; PDM; CDBG-DR; Municipal funds | $249,000.00 | Immediate | Current Status: Completed – This strategy (brief status explanation. We suggest no more than 140 characters). |
| 2026-YAB-SE-008 | SE-8 | Acquisition, installation, and maintenance of a solar energy system for several municipal assets. | All | High | All | Community Partnerships | HMGP; PDM; CDBG-DR; Municipal funds | $1,080,000.00 | Immediate | Current Status: Completed – This initiative was achieved with the support of community entities that donated photovoltaic systems for community centers, the nursing home, and the Citizen Assistance Office. |
| 2026-YAB-SE-009 | SE-9 | Build structures or identify existing structures that can serve as vertical evacuation shelters for tsunamis. These structures must be elevated above tsunami flood levels and built to withstand the effects of an earthquake, waves, or other loads associated with a tsunami. | Tsunami | Medium | Food, Hydration, and Shelter | Municipal Office of Emergency Management | HMGP; PDM; CDBG-DR; Municipal funds | $10,086,000.00 | Medium Term | Current Status: Financing – This strategy is awaiting funding approval. |
| 2026-YAB-SE-010 | SE-10 | Convert structures identified by the Municipality to implement distribution centers and/or safe rooms and/or Emergency Operations Centers (ECC/EOC) throughout the municipality to store non-perishable supplies, including, but not limited to, food, basic necessities, medicine, medical equipment, communication equipment, among others. These centers are key for disaster planning, response, and recovery, as well | All | Medium | Food, Hydration, and Shelter | Lead; Support | HMGP; PDM; CDBG-DR; Municipal funds | $5,000,000.00 | Medium Term | Current Status: Financing – This strategy is awaiting funding approval. At this time, work is being carried out through community groups and community centers in the different sectors. |

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Possible Funding Sources | Budget / Cost | Implementation Term | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| | | as for safeguarding life and property in the municipality. | | | | | | | | |

*Table 53: Mitigation Strategies - Education and Outreach*

| 2026 ID | 2020 ID | Description | Hazard | Priority | Lifeline | Municipal Office in Charge | Possible Funding Sources | Budget / Cost | Implementation Term | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| 2026-YAB-EO-001 | PEA-1 | Community orientation and education program. | All | High | Communications | Office of Community Alliances | Federal proposals, Section 8 Program, Housing Rehabilitation Program, Ordinary Funds | $35,000.00 | Immediate | Current Status: Under continuous implementation – High-impact projects are open to citizen transparency processes, such as public hearings, bid board sessions and the Municipal Legislature, as well as community visits to discuss their scope. |
| 2026-YAB-EO-002 | PEA-2 | Research to obtain information and acquire additional tools for evaluating vulnerability to hazards in the Municipality of Yabucoa. | All | Low | Communications | Office of Federal Programs | Federal proposals, Section 8 Program, Housing Rehabilitation Program, Ordinary Funds | $30,000.00 | Immediate | Current Status: Under continuous implementation – Different alternatives are being explored to improve processes and the quality of life of citizens. This includes the implementation of the Municipal Recovery, Territorial Planning, and Risk Mitigation Plans. All of these include citizen participation. |

## 6.6 Participation in the NFIP

Covered under the PRPB, the Municipality maintains continuous participation in the National Flood Insurance Program (NFIP) and remains committed to meeting all program requirements to reduce flood risk and protect life and property. Ongoing participation in the NFIP enables residents and businesses to access federally backed flood insurance while promoting sound floodplain management practices. The PRPB, on the municipality's behalf, enforces floodplain management regulations consistent with FEMA requirements, including the adoption and use of Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FIS) for development decisions. Local permitting, inspection, and enforcement activities help ensure that new construction and substantial improvements in Special Flood Hazard Areas comply with applicable elevation and floodproofing standards. The Municipality also supports public awareness and education activities related to flood risk, insurance requirements, and mitigation measures. Continued compliance with the NFIP strengthens eligibility for federal hazard mitigation funding and supports the long-term reduction of flood-related damages.

# 7. Plan Maintenance

This chapter describes the procedures and actions necessary to ensure that the Plan is effectively implemented, regularly reviewed, and maintained in alignment with the established mitigation goals and Objectives. In some instances, Plan updates may require adjustments to proposed mitigation actions to reflect changes in on-site conditions that could either increase or reduce the level of risk affecting certain areas.

In accordance with federal requirements, the Local Hazard Mitigation Plan (LHMP) review process must include the following elements:

A description of the methods and schedule for monitoring, evaluating, and updating the Mitigation Plan within a five-year period.
A process for integrating the Mitigation Plan's requirements into other applicable local planning mechanisms, such as comprehensive plans or capital improvement plans.
A description of how the community will continue to participate in the Plan's review and maintenance process.

## 7.1 Point of Contact

The designated point of contact responsible for the monitoring, revision, and update of the Yabucoa LHMP is as follows:

- Name: Luis G. Rivera
- Position: Special Aide to the Mayor
- Office: Office of the Mayor
- Telephone: (787) 893-3000
- Email: lgriveramedina@live.com

## 7.2 Continuous Public Participation (D1-a)

The Municipality of Yabucoa is committed to ensuring ongoing public participation by implementing the following engagement methods:

- Public education and awareness initiatives
- Surveys

- Community workshops and meetings held throughout the municipality

Consistent with this commitment, public participation and community education are integral components of several mitigation strategies included in this Plan. Residents are encouraged to submit comments and participate in LHMP updates at any time, including requesting copies of the Plan during its development, monitoring, and maintenance phases.

Each time a progress report is completed, it will be made available for public review. Plan progress will also be discussed periodically during public meetings and shared through social media and other communication platforms. Public participation notices will be distributed throughout all monitoring and oversight stages of the Plan.

Additionally, the Municipality will continue providing presentations to community groups regarding the LHMP and the status of mitigation strategy implementation. These groups may include elected officials, schools, and other community organizations. The Municipality will also promote civic engagement and preparedness education by offering training courses and workshops—such as Community Emergency Response Team (CERT) programs—and by informing residents about the National Flood Insurance Program (NFIP) and other relevant initiatives.

Mitigation efforts will be tailored to address the specific vulnerabilities and needs of individual communities, supporting the development of a more informed, prepared, and resilient population. This approach underlines the Municipality's commitment to sustained community engagement throughout the Plan's effective period, updating cycles, and post-adoption activities.

## 7.3 LHMP Oversight (D2-a)

The Municipality's strategy for Plan implementation, monitoring, and evaluation establishes a framework that promotes collaboration, information sharing, and innovation. Through its Planning Committee, composed of representatives from various municipal agencies and departments, the Municipality will work with partners and residents to apply a localized and coordinated approach to hazard mitigation. This collaborative strategy is intended to reduce losses, address community needs, and strengthen the Municipality's capacity to withstand future hazard events.

The Plan will be monitored to assure:

- Current and accurate hazard and risk information is properly mantained
- Ensure mitigation strategies reflect community and stakeholder priorities
- Comply with federal and Commonwealth LHMP requirements
- Maintain This strategy will be suppressed in the next LHMP revision. eligibility for mitigation funding
- Ensure consistency with other local and regional planning efforts

To support effective implementation, the Municipality will leverage existing resources and infrastructure planning processes. Mitigation actions identified as immediate or short-term will be pursued over the next five (5) years, subject to available funding and resources.

## 7.4 LHMP Evaluation and Monitoring

Evaluation of the LHMP will be an ongoing process. In addition to FEMA's required five-year review, the Municipality will conduct annual evaluations, or more frequently if conditions warrant. Following each annual review, the Planning Committee will meet to approve a yearly progress report documenting updates, accomplishments, and progress toward mitigation goals and objectives. This report will be submitted to the Office of the Mayor and made available to the public.

A preliminary schedule for Planning Committee meetings is outlined below:

*Table 54: Preliminary Planning Committee Meeting Schedule*

| Time Period | Participants | Purpose of the Meeting |
|---|---|---|
| Annual Meeting (2027) | Planning Committee (Can be open to the public if deemed necessary) | The Committee will identify funding needs, reassess hazard priorities, develop strategies for grant applications, and conduct site visits to high-risk areas to monitor progress and engage directly with communities. |
| Annual Meeting (2028) | Planning Committee (Can be open to the public if deemed necessary) | The Committee will review mitigation implementation status, identify emerging risks, and evaluate |

| | | |
|---|---|---|
| | | community needs. Site visits will be conducted as necessary. |
| Annual Meeting (2029) | Planning Committee (Can be open to the public if deemed necessary) | The Committee will confirm progress on mitigation actions and assess the need for additional funding. |
| Annual Meeting (2030) | Planning Committee (Can be open to the public if deemed necessary) | The Committee will hold its final meeting prior to the next LHMP update to verify mitigation implementation status, which will be documented in the updated Plan. |

## 7.5 LHMP Update and Revision (D2-c, D3-a)

### 7.5.1 Revision Following a Major Disaster

If a major emergency or disaster declaration affecting the Municipality occurs during the Plan's five-year term, the Planning Committee—along with stakeholders, community representatives, and nonprofit organizations—will convene to identify newly affected areas, revise mitigation priorities, and incorporate lessons learned. This meeting will replace the annual review scheduled for that year.

### 7.5.2 Five-Year Comprehensive Update

In accordance with federal guidance, the LHMP will be comprehensively updated five (5) years after approval and submitted to the State Hazard Mitigation Officer and FEMA for review and approval. Approximately eighteen (18) months prior to the Plan's expiration, the review process will begin, including a full evaluation of the municipal profile, risk assessment, and mitigation strategies, with attention to updated guidance and requirements.

## 7.6 Integration with Other Planning Mechanisms (D3-a)

The following public policies and planning documents were considered in the

development of this LHMP:

**Commonwealth Level:**

- Puerto Rico Land Use Plan (PUT-PR)
- Yabucoa Territorial Plan (PT)
- Karst Special Planning Area Plan and Regulation
- Joint Regulation for the Evaluation and Issuance of Permits
- Special Flood Hazard Areas Regulation (2021)
- Stormwater System Design, Operation, and Maintenance Regulation.

At the **Municipal Level** the documents considered were

- Yabucoa Emergency Operations Plan
- Yabucoa Land Use Plan

Following adoption, the LHMP will guide updates to the Land Use Plan, special area plans, and urban expansion plans, and will inform municipal budget priorities. Once FEMA approval is received, a digital copy of the Plan will be submitted to the Puerto Rico Planning Board to support updates to the PUT-PR and other relevant Commonwealth planning documents.

# 8. Adoption and Approval (F1-a, F1-b)

## 8.1 LHMP Adoption

Federal policy establishes LHMPs must include "Documentation that the LHMP has been formally adopted by the governing body of the jurisdiction requesting approval of the Plan. The municipality has one (1) year to adopt the Plan once it receives an *Approval Pending Adoption (APA)."*[18]

This LHMP was adopted by the Municipality of Yabucoa on **XXXXXX**. A copy of **Resolution**, titled *"To Adopt the 2026 Natural Hazard Mitigation Plan of the Municipality of* Choose an item., *and for Other Related Purposes,"* is included as part of **Appendix A**.

## 8.2 LHMP Approval

This LHMP was approved by FEMA and the SHMO on **XXXXX**. A copy of the Approval Letter, titled *"Approval of the Local Hazard Mitigation Plan, Municipality of* Choose an item.*,"* is included in **Appendix A**. FEMA's approval of the Plan is valid for a period of **five (5) years**, through **XXXXXX**

[18] 44 C.F.R. §201.6(c)(5)

# References


American Society of Civil Engineers. (2024, August 20). *Civil Engineering Source*. Retrieved December 17, 2025, from Rising heat is scorching Americans - and our infrastructure: https://www.asce.org/publications-and-news/civil-engineering-source/article/2024/08/20/rising-heat-is-scorching-americans-and-our-infrastructure

Anderson, S., Barford, C., & Barford, P. (2020). *Five Alarms: Assessing the Vulnerabilities of US Cellular Communication Infrastructure to Wildfires*. Association for Computing Machinery.

Aqilah, S., Karmilla, K., Tamanna, K., Ali, Z., & Mat, N. (2024). Assesing Socio-Economic and Environmental Losses of Dam Failure Flood Risk: A Review on Sustainable Framework. *Journal of Sustainability Sceince and Management, 19*(1), 171 - 195.

ASDSO. (2022). *Dam Safety Performance Report 2022*. Lexington, KY. Retrieved January 4, 2026, from https://damsafety-dev.s3.amazonaws.com/s3fs-public/files/Puerto%20Rico%20Dam%20Safety%20Performance%20Report%202022.pdf

ASPR. (n.d.). *ASPR Health Care Readiness State Highlights*. Retrieved January 5, 2026, from https://aspr.hhs.gov/HealthCareReadiness/HealthCareReadinessNearYou/Pages/Puerto-Rico.aspx

AtkinsRéalis. (2024). *Hazard Mitigation Plan: Dam Annex Template for Puerto Rico*.

Autonomous Municipality of Bayamón. (2018). *Plan de Mitigación Multi-Riesgos 2018 (All Hazard Local Mitigation Plan*. Bayamón, PR: Oficina de Planificación y Ordenamiento Territorial.

Autonomous Municipality of Bayamón. (2024). *Plan Territorial Municipio, Fase 1 - Enunciacion de Metas y Objetivos, Plan de Trabajo, Memorial y Programa (Borrador)*. Oficina de Planificación.

Autonomous Municipality of Bayamón. (2025). *Emergency Operation Plan*. Bayamón PR: Municipal Agency for Emergency Mangement and Disaster Administration.

Baker, C., Cohen, S., Coulson, G., Durden, S., & Rossman, E. (n.d.). *Identification and Engagement of Socially Vulnerable Populations in the USACE Decision Making Process*. The Institute for Water Resources.

Bates, R., & Jackson, J. A. (1980). In *Glossary of geology*. Falls Church, Va.: American Geological Institute.

Benitez-Jaime, CPA-PSC. (2025). *SINGLE AUDIT REPORT-Independent Auditors' Report on Basic Financial Statements and Supplementary Schedule of* .

Bonano, V. e. (2020). *Perfil de Riesgo: Fallas y Fisuras*. Retrieved from https://storymaps.arcgis.com/stories/142062e6d5ec4bfca832c1a7f97dfa3f

Buckeye Partners, L.P. . (2010). *BUCKEYE PARTNERS, L.P. ANNOUNCES AGREEMENT TO PURCHASE REFINED PETROLEUM PRODUCTS TERMINAL IN PUERTO RICO*. Retrieved from https://www.buckeye.com/wp-content/uploads/2021/08/Yabucoa-Agreement-Announcement-FINAL.pdf

Byrne, M. (2019). *Monitoring Storm Tide, Flooding, and Precipitation from Hurricane Maria in Puerto Rico and the U.S. Virgin Islands, September 2017*. USGS.

Caricoos. (n.d.). *Marejada Ciclónica*. Retrieved Noviembre 18, 2025, from http://www.caricoos.org/mao/strorm-surge

Castro Rivera, A. (n.d.). *Proyecto 1867*. Retrieved December 27, 2025, from La triple condena de 1867: https://www.proyecto1867.com/la-triple-condena-de-1867.html

Castro Rivera, A., & López Marrero, T. (2018). *Cartilla de los Ciclones*. Mayagüez, PR: Sea Grant - Universidad de Puerto Rico, Mayagüez.

CBO. (2024). *Federal Spending for Flood Adaptations*. Retrieved from www.cbo.gov/publication/59971

CCOF. (2026, March). *Caribbean Climate Outlook Newsletter - April to June 2026*. Caribbean Institute for Meteorology and Hydrology. Caribbean Climate Outlook Forum. Retrieved from https://rcc.cimh.edu.bb/files/2026/03/caricofamjjas.pdf

CDC. (2012, May 18). *CDC Archive*. Retrieved December 29, 2025, from https://archive.cdc.gov/www_cdc_gov/csels/dsepd/ss1978/lesson1/section11.html

CDC. (2014, December 5). *Morbidity and Mortality Weekly Report*. Retrieved December 29, 2025, from Chikungunya Cases Identified Through Passie Surveillance and Household Investigations - Puerto Rico, May 5 - August 12, 2014: https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6348a1.htm

CDC. (2024, Junio 25). *Heat Health*. Retrieved Noviembre 12, 2025, from Heat and Older Adults (Aged 65+): https://www.cdc.gov/heat-health/risk-factors/heat-and-older-adults-aged-65.html

CEACC. (2024). *Borrador del plan de mitigación, adaptación y resilencia al cambio climático en Puerto Rico*. San Juan, PR: Gobierno de Puerto Rico.

Center for Disaster Resilient Communities. (n.d.). *The Health Effects of Landslides*. Retrieved December 28, 2025, from https://edge.deohs.washington.edu/sites/edge/files/2025-07/Landslides%20Fact%20Sheet.pdf

Chowdhury, A., Zzaman, R. U., Hasan, H., Tarin, N. J., Islam, S., Ansenk, O., . . . Leya, R. (2025). Interacting Social and Environmental drivers of gendered resilience to storm surge disasters. *Discover Geoscience, 3*(190). doi:https://doi.org/10.1007/s44288-025-00297-1

Colón, J. A. (2009). *Climatología*. San Juan, PR: La Editorial Universidad de Puerto Rico.

Colorado State University. (2026). *Tropical Cyclones, Radar, Atmospheric Modeling, and Software Team*. Retrieved April 28, 2026, from CSU Tropical Cyclone Impact Probabilities: https://tropical.colostate.edu/TC_impact.html

Columbia University/Mailman School of Public Health. (2021, February 19). *Epidemic, Endemic, Pandemic: What are the Differences?* Retrieved from https://www.publichealth.columbia.edu/news/epidemic-endemic-pandemic-what-are-differences

COR3. (n.d.). *Coronavirus (COVID-19*. Retrieved January 4, 2026, from https://recovery.pr.gov/en/coronavirus

COREPI-PR. (2020). *The State of the beaches of Puerto Rico post Maria (G-1) ArcGIS Story Maps*. Retrieved April 29, 2026, from https://storymaps.arcgis.com/stories/ac6e366a14d840e88a266d23b440ab0c

Cutter, S., Boruff, B., & Shirley, W. (2003). Social Vulnerability to Envirnmental Hazards. *Social Science Quaterly, 84*(2), 244 - 261.

Cutter, S., Emrich, C., Morath, D., & Dunning, C. (2013). Integrating Social Vulnerability into Federal Flood Risk Management Planning. *Journal of Flood RIsk Management, 6*, 332 - 344.

Dennin, L., Nock, D., Muller, N., Akindele, M., & Adams, P. (2025). Social Vulnerable Communities Face Disproportionate Exposure and Suceptibility to US wildfire and prescribed burn smoke. *Communications Earth & Environment, 6*(190). doi:https://doi.org/10.1038/s43247-025-02100-y

DHS. (n.d.). *Ready.gov*. Retrieved enero 16, 2020, from https://www.ready.gov/heat

Dirlikov, E., Ryff, K. R., Torres -Aponte, J., Thomas, D. L., Pérez - Padilla, J., Muñoz-Jordán, J., . . . Rivera - García, B. (2016, May 6). Update: Ongoing Zika Virus Transmission - Puerto Rico, November 1, 2015 - April 14, 2016. *Morbidity and Mortality Weekly Report, 65*(17), 451-455. Retrieved December 29, 2025, from https://www.cdc.gov/mmwr/volumes/65/wr/pdfs/mm6517.pdf

DNER. (2006, Marzo). Incendios Forestales en Puerto Rico. *Hojas de Nuesto Ambiente*, pp. 1 - 2.

DNER. (2015). *Informe sobre la sequía de 2014-2016 en Puerto Rico*. San Juan, PR: Division de Monitoreo del Plan de Aguas.

DNER. (2016). *Informe sobre la sequía 2014 - 16 en Puerto Rico*. San Juan, PR: Departamento de Recursos Naturales y Ambientales.
DNER. (2021). *Puerto Rico Forest Action Plan, 2021*. San Juan, PR: DNER.
DNER. (2021). *The Puerto Rico Forest Action Plan*. The Puerto Rico Department of Natural and Environmental Resources. Retrieved from https://www.drna.pr.gov/documentos/planes-de-manejo/puerto-rico-forest-action-plan-2021/
DOE. (2023, October 25). *Protecting our Electric Grid from Wildfire*. Retrieved December 16, 2025, from https://www.energy.gov/gdo/articles/protecting-our-electric-grid-wildfire
Ecoexploratorio. (2000). *¿Qué son las inundaciones?*
Eliot, J. W., Cloyd, T. E., & Philbin, M. (1994). Impacts of Landslides on an Ecosystem. *ASAE International Winter Meeting*. Atlanta, GA.
EPA. (2012). Cool Pavements. In *Reducing Urban Heat Islands: Compendium of Strategies*.
EPA. (2025, September 2). *Heat Island*. Retrieved December 17, 2025, from What are Heat Islands?: https://www.epa.gov/heatislands/what-are-heat-islands
EPA. (2026). *Hazardous Waste Cleanup: Buckeye Caribbean Terminals Incorporated in Yabucoa, Puerto Rico*. Environmental Protection Agency. Retrieved from https://www.epa.gov/hwcorrectiveactioncleanups/hazardous-waste-cleanup-buckeye-caribbean-terminals-incorporated-yabucoa
FBI & DHS. (2023). *Strategic Intelligences Assessment and Data on Domestic Terrorism*.
FEMA. (1997). *Multi - Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy*. Federal Emergency Management Administration.
FEMA. (1997). *Multi- Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy*.
FEMA. (1997). *Multi-Hazard Identification and RIsk Assessment: A Cornerstone of the National Mitigation Strategy*.
FEMA. (2013). *Federal Guidelines for Inundation Mapping of Floood Risk Associated with Dam Incidents and Failures - FEMA P-946*.
FEMA. (2018). *Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR) Guide*.
FEMA. (2021). *Coastal Flood Risk*. Retrieved April 28, 2026, from https://www.fema.gov/flood-maps/coastal
FEMA. (2021). *National Incident Management System*.
FEMA. (2023, July). *fema.gov*. Retrieved November 24, 2025, from Community Lifelines Implementation Toolkit: https://www.fema.gov/sites/default/files/documents/fema_lifelines-toolkit-v2.1_2023.pdf
FEMA. (2024, February 20). *2.7 Community Lifelines: The HAZMAT Lifeline*. Retrieved December 28, 2025, from https://www.fema.gov/oet-tools/chemical-incident-consequence-management/2/7
FEMA. (2024). *Federal Guidelines for Dam Safety*. DHS.
FEMA. (2024). *Hazus Earthquake Model User Guidance*.
FEMA. (2024). *Natural and Nature-based Solutions Job Aid for Stormwater Management in Puerto Rico*.
FEMA. (2025). *Local Mitigation Planning Handbook*.
FEMA. (2025). *Local Mitigation Planning Policy Guide*.
FEMA. (2025, May 9). *National Dam Safety Program*. Retrieved April 20, 2026, from Resources for the General Public: https://www.fema.gov/grants/mitigation/learn/dam-safety/resources-general-public
FEMA. (2025). *National Risk Index Data - Technical Documentation*.

FEMA. (2025). *Reducing Damage from Localized Flooding*.
FEMA. (2026, January 7). *National Risk Index for Natural Hazards*. Retrieved June 17, 2026, from https://www.fema.gov/flood-maps/products-tools/national-risk-index
FEMA. (n.d.). *Puerto Rico Earthquakes DR-4473-PR*. Retrieved December 15, 2025, from https://www.fema.gov/disaster/4473
Fox, S., Agyemang, F., Hawker, L., & Neal, J. (2024). Integrating social vulnerability into high-resolution global flood risk mapping. *Nature Communication, 15*. doi:ttps://doi.org/10.1038/s41467-024-47394-2
Ganz, S., Duan, C., & Ji, C. (2023). Socioeconomic Vulnerability and Differential Impact of Severe Weather - Induced Power Outages. *PNAS NEXUS, 2*, 1-10. doi:https://doi.org/10.1093/pnasnexus/pgad295
Gill, J. C., & Malamud, B. D. (2017). Anthropogenic processes, natural hazards, and interactions in a multi-hazard framework. *Earth-Science Reviews*, 246 - 269.
Gould, W. (2008). Editorial. *AMBIO: A Journal of the Human Environment 37(7)*, 521. doi:https://doi.org/10.1579/0044-7447-37.7.521
Guibert, G., & Hyde, I. (2021). *Analysis: COVID-19's impact on Arts and Culture*. Argone National Laboratory.
Guiney, J. (1999). *Preliminary Report Hurricane Georges 15 September - 01 October 1998*. NHC.
Guo, Q., & Lee, D. C. (2021). The Ecology of COVID-19 and Related Environmental and Sustainability Issues. *Ambio*.
Guzmán-Colon, B., Guido, Z., Amaya-Ardilla, C. P., Cabrera-Rivera, L. T., & Méndez-Lázaro, P. A. (2025). Heat Risk Perception and Vulnerability in Puerto Rico: Insights for Climate Adaptation in the Caribbean. *International Journal of Environmental Research and Public Health, 22*(1197). doi:https://doi.org/10.3390/ijerph22081197
Hernández - Padilla, J. A., & Méndez-Piñero, M. I. (2020). Economic Impact of the COVID-19 Pandemic in Puerto Rico. *Proceedings of the 9th Annual World Conference of the Society for Industrial and Systems Engineering 2020 SISE Virtual Conference*, (pp. 90-95). Retrieved January 5, 2026, from https://ieworldconference.org/content/SISE2020/Papers/Hernandez-Padilla.pdf
Hernández - Torres, R., Martínez - Lozano, M., Torres, I., Rosario - Hernández, E., Ramos - Pibernus, A., Soto, A., . . . Rivera - Segarra, E. (2023). The impact of the Covid-19 pandemic and previous natural disasters on the mental health of healthcare workers in Puerto Rico. *PLOS Global Public Health, 3*(5). Retrieved January 5, 2026, from file:///C:/Users/PITR4955/Downloads/journal.pgph.0001784.pdf
Highland, L. M., & Bobrowsky, P. (2008). *The Lanslide Handbook - A Guide to Understanding Landslides*. Reston, VA: USGS.
Highways Industry. (n.d.). *Highways Industry.com*. Retrieved January 2, 2026, from https://www.highwaysindustry.com/impact-extreme-heat-roads/
Hirsh, G. B., & Centeno - Marín, H. (2015). The Puerto Rico Emergency Prepara=edness Model. *Proceedings of the System Dymanics Society*. Retrieved January 4, 2026, from https://proceedings.systemdynamics.org/2015/papers/P1186.pdf
Hughes, K., Bayouth García, D., Martínez Milian, G., Schulz, W., & Baum, R. (2019). *Map of slope-failure locations in Puerto Rico after Hurricane María: U.S. Geological Survey data release*. doi:https://doi.org/10.5066/P9BVMD74
IFRC. (2023, August 8). *Landslides*. Retrieved December 28, 2025, from https://epidemics.ifrc.org/manager/disaster/landslides

Institute for Environmental Research and Education. (2025). *How Do Tsunamis Impact the Environment*. Retrieved December 28, 2025, from https://iere.org/how-do-tsunamis-impact-the-environment/

Jessen, J. (2025, June 30). *Energy Digital*. Retrieved December 17, 2025, from https://energydigital.com/news/climate-change-how-heatwaves-are-affecting-power-grids

Kerber, S., & Alkoins, D. (2024). *Lahaina Fire Incident Analysis Report*. Columbia, MD: Fire Safery Research Institute.

Lander, J. F., Whiteside, L. S., & Lockridge, P. A. (2002). A Brief History of Tsunamis in the Caribbean Sea. *Science of Tsunami Hazards, 20*(1). Retrieved December 27, 2025, from https://www.proyecto1867.com/uploads/8/6/3/9/86396506/lander_et_al.__2002_.pdf

Larsen , M., & Torres-Sanchez, A. (1998). The frequency and distribution of recent landslides in three montane tropical regions of Puerto Rico. *Geomorphology*, 309-331.

Larsen, M., & Park, J. (1997). How wide is a road? The association of roads and mass-wasting in a forested montane environment. *Earth Surface Processes and Landforms*, 835-848.

López Marrero, T. (2010, June). An Integrative Approach to Study and Promote Natural Ahzards Adaptive Capacity: A Case Study of Two Flood-Prone Communities in Puerto Rico. *The Geograhical Journal, 176*(2), 150-163.

López-Vega, CPA, PSC. (2024). *Report on the Audit of the Financial Statements of the Autonomous Municipality of Yabucoa*.

Lugo, A. E., Miranda Castro, L., Abel, V., López, T., Hernández Prieto, E., García Martinó, A., . . . Helmer, E. (2021). *Puerto Rican Karst - A Vital Resource*. Forest Service, United States Department of Agriculture. USFS.

Méndez - Lázaro, P. A., Di Napoli, C., Rivas - Tumanyan, S., Pérez Ríos, N., González Sepulveda, L., Rodríguez, E., . . . Milán, L. (2025). Too hot and too humid in the Caribbean: Impacts of extreme heat events and non-accidental mortality in the tropical island of Puerto Rico. *The Journal of CLimate and Healt*.

Mentaschi, L., Vousdoukas, M., Pekel, J.-F., Voukouvalas, E., & Feyen, L. (2018). Global - long-Term Observations of Coastal Erosion and Accretion. *Scientific Reports, 8*(12876), Scientific Reports. doi:10.1038/s41598-018-30904-w

Muche, M., Yemata, G., Molla, E., Muasya, A., & Tsegay, B. (2022). COVID-19 Lockdown and Natural Resources: A Global Assessment on the Cahllenges, Opportunities and the Way Forward. *Bulleting of the National Research Centre, 46*(20).

Municipality of Barranquitas. (2011). *Territorial Plan for the Municipality of Barranquitas*. Retrieved from https://docs.pr.gov/files/JP-Junta%20de%20Planificacion/Planes%20Territoriales/Barranquitas/Barranquitas-PT-Memorial-2011.pdf

Municipality of Bayamón. (2018). *Plan de Mitigación Multi-Riesgos 2018 (All Hazard Local Mitigation Plan*. Bayamón, PR: Oficina de Planificación y Ordenamiento Territorial.

Municipality of Bayamón. (2025). *Emergency Operation Plan*. Bayamón PR: Municipal Agency for Emergency Mangement and Disaster Administration.

Municipality of Yabucoa. (2020). Retrieved from https://docs.pr.gov/files/JP-Junta%20de%20Planificacion/Planes%20de%20Mitigaci%C3%B3n%20Aprobados/Resumen%20Ejecutivo/Yabu-Approved-HMP-1.pdf

Municipality of Yabucoa. (2020). *Hazard Mitigation Plan, Yabucoa Municipality.* Puerto Rico Planning Board.

Municipality of Yabucoa. (2023). *Land Management Plan for the Municipality of Yabucoa*. Retrieved from https://docs.pr.gov/files/JP-

Junta%20de%20Planificacion/Planificaci%C3%B3n%20F%C3%ADsica/Planes%20Territoriales1/Yabucoa/JP-PT-75-01-Plan_Redacted.pdf
Municipio de Adjuntas. (2011). *Plan de Ordenación Territorial*. Adjuntas, PR: Municipio de Adjuntas.
Municipio de Adjuntas. (2020). *Plan de Mitigación Contra Peligros Naturales*. Adjuntas, PR: Municipio de Adjuntas.
National Institute of Building Sciences. (2020). *2020 NEHRP Recommended Seismic Provisions: Design Examples, Training Materials; and Design Flow Chart*. FEMA. Retrieved April 28, 2026, from https://www.fema.gov/sites/default/files/documents/fema_nehrp_design-examples-training-materials_volume-1.pdf
National Integrated Heat Health Information System. (n.d.). *Heat.gov*. Retrieved noviembre 12, 2025, from Urban Heat Islands: https://heat.gov/urban-heat-islands/
National Oceanic and Atmospheric Administration. (2026). *Historical Hurricane Tracks*. Retrieved from https://coast.noaa.gov/hurricanes/#map=8.57/18.2704/-66.2032&search=eyJzZWFyY2hTdHJpbmciOiJQdWVydG8gUmljbywgVVNBIiwic2VhcmNoVHlwZSI6Imdlb2NvZGVkIiwib3NtSUQiOiI0NDIyNjA0IiwiY2F0ZWdvcmllcyI6WyJlNSIsIkg0IiwiSDMiLCJIMiIsIkgxIiwiVFMiLCJURCIsIkVUIl0sInllYXJzIjp
NIST. (n.d.). Retrieved November 26, 2024, from Infrastructure: https://www.nist.gov/infrastructure
NMEAD. (2021). *Plan Estatal de Mitigación de Peligros Naturales de Puerto Rico*. San Juan, PR: Negociado de Manejo de Emergencias y Administracion de Desastres.
NOAA. (2022). *Centers for Environmental Information*. Retrieved January 2, 2026, from State Climate Summaries: Puerto Rico and the US Virgin Islands: https://statesummaries.ncics.org/chapter/pr/
NOAA. (2025). *National Centers for Environmental Information*. Retrieved December 28, 2025, from https://www.ncei.noaa.gov/stormevents/choosedates.jsp?statefips=99%2CPUERTO+RICO
NOAA. (2026). *Relative Sea Level Trends*. Retrieved April 28, 2026, from https://tidesandcurrents.noaa.gov/sltrends/
NOAA. (n.d). *National Hurricane Center and Central Pacific Hurricane Center*. Retrieved April 20, 2026, from Storm Surge Overview: https://www.nhc.noaa.gov/surge/
NOAA. (n.d.). *NCEI*. Retrieved May 27, 2026, from Tsunamis: https://www.ncei.noaa.gov/products/natural-hazards/tsunamis-earthquakes-volcanoes/tsunamis
Norris, F., Stevens, S., Pfefferbaum, B., Wyche, K., & Pfefferbaum, R. (2007). Community Resilience as a Methaphor, Theory, Set of Capabilities and Strategy for Disaster Readiness. *American Jounral of Community Psychology, 47*, 127 - 150. Retrieved April 28, 2026, from https://www.researchgate.net/publication/5691020_Community_Resilience_as_a_Metaphor_Theory_Set_of_Capacities_and_Strategy_for_Disaster_Readiness
Okamura, K., Fujisawa, A., Kondo, Y., Fujimoto, Y., Uozu, T., Kaner, S., & Mizoguchi, K. (2013). The Great East Japan Earthquake and cultural heritage: towards an archeology of disaster. *Antiquity, 87*, 258-269.
Pasch, R., Penny, A., & Berg, R. (2023). *Hurricane Maria*. NHC. Retrieved April 28, 2024, from https://www.nhc.noaa.gov/data/tcr/AL152017_Maria.pdf
Pasch, R., Reinhart, B., & Alaka, L. (2023). *Hurricane Fiona*. NHC.
Peek, L., & Stough, L. (2010). Children with Disabilities in the Context of Disaster: A Social Vulnerability Perspective. *Child Development, 81*(4), 1260 - 1270. Retrieved April 20, 2026, from https://hazards.colorado.edu/uploads/publications/36_2010_Peek_Stough.pdf
PRDH. (2022). *Resumen ejecutivo: Situación de la epidemia del COVID-19 en Puerto Rico año 2021*. Retrieved January 5, 2026, from https://www.salud.pr.gov/CMS/DOWNLOAD/8708

PRDOH. (2025). *Puerto RIco Mitigation Action Plan, CDBG-MIT*. San Juan, PR: Puerto Rico Department of Housing.
PREMB. (2021). *2021 Puerto RIco State Natural Hazards Mitigation Plan*.
PRPB. (2014). *Plan de Manejo del Area de Planificación Especial del Carso*.
PRPB. (2015). *Plan de Uso de Terrenos, Guías de Ordenación del Territorio*. San Juan, PR: Junta de Planificación.
PRPB. (2020). *Hazard Mitigation Plan agains Natural Hazards - Municipality of Yabucoa*. Puerto Rico Planning Board. Retrieved from https://docs.pr.gov/files/JP-Junta%20de%20Planificacion/Planes%20de%20Mitigaci%C3%B3n%20Aprobados/Resumen%20Ejecutivo/Yabu-Approved-HMP-1.pdf
PRPB. (2020). *Hazard Mitigation Plan against Natural Hazards - Muicipality of Jayuya*. Puerto Rico Planning Board. Retrieved from https://docs.pr.gov/files/JP-Junta%20de%20Planificacion/Planes%20de%20Mitigaci%C3%B3n%20Aprobados/Actualizados%20por%20los%20municipios/Jayuya-Approved-HMP-200622.pdf
PRPB. (2021). *Special Flood Hazard Areas Regulation*.
PRPB. (2023). *Reglamento para la evaluación y expedición de permisos relacionados al desarrollo, uso de terrenos y operación de permisos*. San Juan, PR: Junta de Planificación.
PRSN. (n.d.). Retrieved December 27, 2025, from http://www.prsn.uprm.edu/Spanish/tsunami/historia.php
PRSN. (2019). *Red Sísmica de Puerto Rico*. Retrieved enero 13, 2020, from http://redsismica.uprm.edu/Spanish/educacion/terremotos/
PRSN. (2025). *Puerto Rico Seismic Network*. Retrieved December 15, 2025, from https://redsismica.uprm.edu/english/education/prediction.php
PRSN. (2025). *Red Sísmica de Puerto Rico*. Retrieved December 15, 2025, from Resumen Preliminar de actividad sísmica anual para el 2024: https://redsismica.uprm.edu/spanish/sismicidad/reportes/anuales/Informe_Anual_2024.pdf
PRSN. (2025). *Seismic Information*. Retrieved December 26, 2025, from Earthquake of 1918: http://www.prsn.uprm.edu/English/information/quake1918.php
PRSN. (n.d.). *Red Sísmica de Puerto Rico*. Retrieved December 15, 2025, from Reporte de Sismicidad: https://redsismica.uprm.edu/spanish/sismicidad/reportes/
Public-Private Analytic Exchange Program. (2025). *Implications of Extreme Weather Events on U.S. Telecommunications Infrastructure*. DHS.
Rigau-Pérez, J., & Vallejo - Calzada, E. D. (2020, march). Measles, Malnutrition and Mortality. *Puerto Rico Health Science Journal, 39*(1), 20 - 27. Retrieved December 29, 2025, from https://issuu.com/coleccionpuertorriquena/docs/rigau__vallejo_measles_in_pr_1917-1918_prhsj_2020
Robbins, A., Eckelmann, C., & Quiñones, M. (2009). Forest Fires in the Insular. *Ambio: A Journal of the Human Environment*, 37:528-534.
Rodríguez, D. M., Madwell, Z. J., Torres, J. M., Rivera, A., Wong, J. M., Santiago, G. A., . . . Adams, L. E. (2024, December 12). Epidemiology of Dengue - Puerto RIco, 2010 - 2024. *Morbidity and Mortality Weekly Report*. Retrieved December 29, 2025, from https://www.cdc.gov/mmwr/volumes/73/wr/pdfs/mm7349a1-H.pdf
Rosario Urrutia, M. (2021, February 12). *Puerto Rican Endowment for the Humanities - Encyclopedia of Puerto Rico*. Retrieved December 29, 2025, from From the forgotten Flu Pandemic in Puerto Rico, 1918-1919, to the beginning of Covid-19 in 2020: https://en.enciclopediapr.org/content/from-flu-pandemic-1918-to-covid19-puerto-rico/

Sánchez - Plazas, L. C., García - De Jesús, R., Martínez - González, K. G., Amaya - Ardila, C. P., & Almodóvar - Rivera, I. A. (2024). The psychological impact of the COVID-19 pandemic on physicians in Puerto Rico: a cross-sectional study after the second wave in 2021. *Psychiatry, 14*. Retrieved January 5, 2026

Sandia National Laboratories. (n.d.). *Wildfire Electric Grid Resilience*. Retrieved December 16, 2025, from https://energy.sandia.gov/programs/electric-grid/wildfire-electric-grid-resilience/

Schumann, III, R., Emrich, C., Bustic, V., Mockrin, M., Zhou, Y., Johnson - Gaither, C., . . . Aksha, S. (2024). The Geography of Social Vulnerability and Wildfire Ocurrebce (1984 - 2018) in the Contermonous USA. *Natural Hazards, 120*, 4297 - 4327. doi:https://doi.org/10.1007/s11069-023-06367-2

Seadex. (n.d.). *Yabucoa Port (Small) — Puerto Rico Maritime Hub*. Retrieved from https://seadex.ai/en/port/pryab

Sharp, T. M., Roth, N. M., Torres, J., Ryff, K., Pérez Rodríguez, N., Mercado, C., . . . Rivera García, B. (2014, December 5). Chikungunya Cases Identified Through Passive Surveillance and Household. *Morbidity and Mortality Weekly Report*. Retrieved December 29, 2025, from https://www.cdc.gov/mmwr/pdf/wk/mm6348.pdf

Shipnext. (Accessed 2026). *Yabucoa, Puerto Rico (PRYAB)*. Retrieved from https://shipnext.com/port/yabucoa-pryab-pri

SNOFLO. (2026). *Carite Dam Report*. Retrieved January 4, 2026

SNOFLO. (2026). *Cidra Dam Reservoir Report*. Retrieved January 2, 2026, from https://snoflo.org/reservoir/puerto-rico/pr00020-cidra-dam

Soler - López, L. R. (2010). *Sedimentation Survey of Lago de Cidra, Puerto Rico*. Retrieved January 2, 2026, from https://pubs.usgs.gov/sim/3118/

Stein, S. M., Comas, S. J., Menakis, J. P., Carr, M. A., Steward, S. I., Cleveland, H., . . . Radeloff, V. (2013). *Wildfire, Wildlands and People: Undertaking and preparing for Wildfire in the Wildland-Urban Interface - a Forest on the Edge Report*. Fort Collins, CO: US Department of Agriculture - Forest Service, Rocky Mountain Resewarch Station.

Thomas, D. L., Sharp, T. M., Torres, J., Armstrong, P. A., Muñoz-Jordán, J., Ryff, K. R., . . . Rivera - García, B. (2016, February 19). Local Transmission of Zika Virus — Puerto Rico,. *Morbidity and Mortality Weekly Report, 65*(6). Retrieved December 29, 2025, from https://www.cdc.gov/mmwr/volumes/65/wr/pdfs/mm6506e2.pdf

Timothee, R. A., Morris, L., Filiberti, M., & Mainardi, L. E. (1963). Epidemic of Poliomyelitis in Puerto Rico, 1960. *Public Health Reports, 78*(1), 65 - 76.

UNESCO. (2021). *World Heritage in the Face of COVID-19*.

US Census Bureau. (2024, September 26). *Resource Library*. Retrieved February 10, 2025, from Tools for Vulnerable Populations in Puerto Rico: https://www.census.gov/library/stories/2024/09/cre-pr-tools.html

US Census Bureau. (2025). *Census Data*. Retrieved November 21, 2025, from https://data.census.gov/table/ACSST5Y2023.S1701?g=050XX00US72021

US Census Bureau. (2025). *Census Data*. Retrieved November 21, 2025, from https://data.census.gov/table/ACSST5Y2023.S0101?g=050XX00US72021

US Census Bureau. (2025). *Census Data*. Retrieved November 30 30, 2025, from S1810 Disability Characteristics: https://data.census.gov/table/ACSST5Y2023.S1810?g=050XX00US72021

US Census Bureau. (2025). *Data Census*. Retrieved November 21, 2025, from https://data.census.gov/table?g=050XX00US72021

US Census Bureau. (2025). *Data Census*. Retrieved November 30, 2025, from S1810 Disability Characteristics: https://data.census.gov/table/ACSST5Y2018.S1810?g=050XX00US72021

US Census Bureau. (2025). *Data.Census*. Retrieved November 30, 2025, from S2201: Food Stamps/Supplemental Nutrition Assistance Program: https://data.census.gov/table/ACSST5Y2023.S2201?g=050XX00US72021

US Drought Monitor. (2025). *Data*. Retrieved December 16, 2025, from Time Series: https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx

US Fire Administation. (2025, December 16). *What is the WUI?* Retrieved from https://www.usfa.fema.gov/wui/what-is-the-wui/

USACE. (2013). *Coastal Risk Reduction and Resiliency: Using the Full Array of Measures*. Retrieved April 28, 2026, from https://cdm16021.contentdm.oclc.org/utils/getfile/collection/p266001coll1/id/5270

USACE. (2019). *LifeSim: Flood life-loss estimation model - Technical reference manual*.

USACE. (2020). *Safety of Dams- Policy and Procedures* .

USACE. (2021). *HEC-RAS river analysis system user's manual*.

USACE. (2022, May 11). *National Inventory of Dams*. Retrieved January 4, 2026, from Cidra Dam: https://nid.sec.usace.army.mil/nid/#/dams/system/PR00020/inspections

USACE. (2022, May 11). *National Inventory of Dams*. Retrieved January 4, 2026, from Carite Dam: https://nid.sec.usace.army.mil/nid/#/dams/system/PR00021/inspections

USACE. (2022, May 11). *National Inventory of Dams*. Retrieved January 4, 2026, from https://nid.sec.usace.army.mil/nid/#/dams/system/PR00018/inspections

USACE. (2022, May 11). *National Inventory of Dams*. Retrieved January 4, 2026, from https://nid.sec.usace.army.mil/nid/#/dams/system/PR00019/summary

USACE. (2023, May). *Congresional Fact Sheets 2025*. Retrieved December 29, 2025, from Guajataca Dam Repairs: https://www.saj.usace.army.mil/About/Congressional-Fact-Sheets-2025/Guajataca-Dam-Repairs-PR-C/

USACE. (2024). *Public Notice Archive*. Retrieved from SAJ-1987-01095(SP-CGR): https://www.saj.usace.army.mil/Missions/Regulatory/Public-Notices/Article/3875333/saj-1987-01095sp-cgr/

USACE. (n.d.). *Publications*. Retrieved April 20, 2026, from Risk - Informed safety Program: https://www.publications.usace.army.mil/Portals/76/Publications/EngineerPamphlets/EP_360-1-31.pdf

USACE. (n.d.). *Value to the Nation*. Retrieved December 22, 2025, from Flood Risk Mgmt: Ecomomic Impaxct: https://www.iwr.usace.army.mil/Missions/Value-to-the-Nation/Flood-Risk-Mgmt/Flood-Risk-Economic-Impact/

USDA. (2001, 07). *MAUNABO SERIES*. Retrieved from Soil Series: https://soilseries.sc.egov.usda.gov/OSD_Docs/M/MAUNABO.html

USDA. (2002, 06). *TALANTE SERIES*. Retrieved from Soil Series: https://soilseries.sc.egov.usda.gov/OSD_Docs/T/TALANTE.html

USDA. (2004, 06). *TEJA SERIES*. Retrieved from Soil Series: https://soilseries.sc.egov.usda.gov/OSD_Docs/T/TEJA.html

USDA. (2023, 10). *PANDURA SERIES*. Retrieved from SoilSeries: https://soilseries.sc.egov.usda.gov/OSD_Docs/P/PANDURA.html

USDOT - FRA. (2013). *Track Buckling Prevention: Theory, Safety Concepts, and Applications*. Washington DC: Office of Research and Development.

USFS. (n.d.). *Fire Effects Information System*. Retrieved December 16, 2025, from https://www.fs.usda.gov/database/feis/glossary.html#SCATTER-HOARD:

USGS. (2014). *Puerto Rico's Rainfall Deficit Indicates Drought*. Retrieved December 23, 2025, from https://www.usgs.gov/news/state-news-release/puerto-ricos-rainfall-deficit-indicates-drought

USGS. (2016). *Caribbean - Florida Water Science Center*. Retrieved December 23, 2025, from Drought Conditions in Puerto Rico: https://www.usgs.gov/centers/caribbean-florida-water-science-center-%28cfwsc%29/science/drought-conditions-puerto-rico

USGS. (2018). *Long-Term Coastal Change*. Retrieved April 28, 2026, from https://www.usgs.gov/programs/cmhrp/science/long-term-coastal-change#overview

USGS. (2019, August 6). *Earthquake Hazards 201 Technical Q&A*. Retrieved April 28, 2026, from https://www.usgs.gov/programs/earthquake-hazards/science/earthquake-hazards-201-technical-qa

USGS. (2020). *La duración potencial de las réplicas del terremoto 2020 del suroeste de Puerto Rico*. Reston Virginia: Servicio Geológico de EE. UU.

USGS. (2023). *Coastal Hazards and Resilience*. Retrieved April 28, 2026, from https://www.usgs.gov/science/science-explorer/coasts/coastal-hazards-and-resilience

USGS. (2024, September 10). Retrieved December 15, 2025, from Moment magnitude, Richter scale-what are the different magnitudes scales, and why are there so many?: https://www.usgs.gov/faqs/moment-magnitude-richter-scale-what-are-different-magnitude-scales-and-why-are-there-so-many

USGS. (2025). *Deep Dive: Protecting Critical Infrastructure*. Retrieved April 29, 2026, from https://www.usgs.gov/programs/climate-adaptation-science-centers/science/deep-dive-protecting-critical-infrastructure

USGS. (2026). *Granodiorite–Quartz Diorite of San Lorenzo, Puerto Rico (Geologic Unit Ksl). Mineral Resources Online Spatial Data*. Retrieved from https://mrdata.usgs.gov/geology/pr/prgeo-unit.php?unit=Ksl

USGS. (2026). *Granodiorite–Quartz Diorite of San Lorenzo, Puerto Rico (Geologic Unit Ksl). Mineral Resources Online Spatial Data*. Retrieved from https://mrdata.usgs.gov/geology/pr/prgeo-unit.php?unit=Ksl

USGS. (2026). *State Geologic Map Compilation (SGMC) Lithology Classification—Metavolcanic Rock (Lithology Code 5.3). Mineral Resources Online Spatial Data*. Retrieved from Available at: https://mrdata.usgs.gov/geology/state/sgmc-lith.php?code=5.3

USGS. (n.d.). *Earthquake Hazard Program*. Retrieved December 15, 2025, from Earthquake Hazards ProgramM 6.4 - 4 km SSE of Indios, Puerto Rico: https://earthquake.usgs.gov/earthquakes/eventpage/us70006vll/executive#d

USGS. (n.d.). *Topoview*. Retrieved Noviembre 12, 2025, from http://ngmdb.usgs.gov/topoview/#13/18.3925/-661240

Vega Lugo, R. (2021, February 21). *Enciclopedia de Puerto Rico*. Retrieved December 29, 2025, from El cólera morno en Puerto Rico, 1855 a 1856: https://enciclopediapr.org/content/el-colera-morbo-en-puerto-rico-1855-a-1856/

Ware-Gilmore, F., Rodríguez, D. M., Ryff, K., Torres, J. M., Pérez Vélez, M., Torres - Toro, C. T., . . . Marzán-Rodríguez, M. (2025, February 20). Dengue Outbreak and Response — Puerto Rico, 2024. *Morbidity and Mortality Weekly Report, 74*(5). Retrieved December 29, 2025, from https://www.cdc.gov/mmwr/volumes/74/wr/pdfs/mm7405-H.pdf

Weilert, L., & Laó-Dávila, D. (2023, August). Fault structure and segmentation of the Punta Moltalva Fault in sourhwestern Puerto Rico using high-resolution digital elevantion models. *Tectonophysics*.

West, J., Rodríguez Cruz, L. A., & Hughes, K. (2023). Assessing Social Vulnerability to Landslides in Rural Puerto Rico. *Natural Hazards Center Public Health Disaster Research Report Series*. Retrieved February 10, 2025, from https://hazards.colorado.edu/public-health-disaster-research/steep-risks

WHO. (2025). *Floods*. Retrieved December 22, 2025, from https://www.who.int/health-topics/floods/#tab=tab_1

World Bank. (n.d.). *Climate Knowledge Portal*.

World Bank. (n.d.). *Think Hazard*. Retrieved from https://www.thinkhazard.org/en/report/200-puerto-rico-u-s/WF

Zhang, R., Ji, H., Pang, Y., & Suo, L. (2022). The Impact of COVID-19 on Cultural Industries: An Empirical Research Based on Stock Market Returns. *Frontiers in Public Health*.

# Appendix A: Adoption and Approval

## Adoption

# Approval by FEMA

# FEMA APA Letter

# FEMA Review Tool

# Appendix B: Planning Committee

## Agreement Letter Between the Municipality and the Puerto Rico Planning Board

JUNTA DE
PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

### Carta de Compromiso sobre el Plan de Mitigación Municipal

El Municipio de Yabucoa, representado en este acto por su alcalde, Hon. Rafael Surillo Ruíz, mediante el presente documento denominado carta de compromiso se compromete en conjunto con la Junta de Planificación de Puerto Rico (JPPR) trabajar en la revisión y actualización del plan de mitigación contra peligros naturales municipal (Plan). El mismo tiene el objetivo de identificar actividades y medidas dirigidas a la mitigación de peligros naturales tales como huracanes, inundaciones, sequías, terremotos, deslizamientos, tsunami entre otros que apliquen. El Plan tiene dentro de sus prioridades la reducción de pérdidas de vida y propiedad asociado a los diferentes peligros naturales e identificar medidas para atender las necesidades del municipio y sus residentes de manera planificada y ordenada, promoviendo así el desarrollo sostenido mediante la preservación de la función natural y los beneficios de la conservación de los recursos naturales y la infraestructura.

Observando los planes que se han vencido, y están próximos a vencer, la *Oficina Central de Recuperación, Reconstrucción y Resiliencia* (COR3 por sus siglas en inglés) procedió asignar presupuesto a la JPPR para atender la revisión y actualización de los Planes de Mitigación Contra Peligros Naturales de los municipios. Es importante destacar que los planes de mitigación deberán estar aprobados por la Agencia Federal para el Manejo de Emergencias (FEMA por sus siglas en inglés) para evitar que los municipios pierdan los fondos asignados para la ejecución de los proyectos. Por lo tanto, recae sobre el municipio la responsabilidad de gestionar adecuadamente su plan, ya que la falta de vigencia conllevaría la pérdida de dichos fondos.

La JPPR está facultada para asistir a los municipios, conforme a la Ley Orgánica de la Junta de Planificación de Puerto Rico, Ley Núm. 75 del 24 de junio de 1975, según enmendada, 23 LPRA., sección 62 (k). Asimismo, la JPPR podrá hacer uso de recursos externos para la elaboración del plan de mitigación.

A su vez el Municipio está facultado a realizar acuerdos con cualquier agencia del Gobierno Central para que este desarrolle o lleve a cabo, en beneficio del Municipio, cualquier estudio, trabajo, obra o mejora pública municipal conforme a lo establecido en la ley Código Municipal de Puerto Rico, Ley Núm. 107 del 13 de agosto de 2020, según enmendada.

Es esencial que este plan cumpla con los requisitos del Acta de Mitigación de Desastre, la cual establece que los gobiernos municipales y estatales que hayan adoptado sus planes de mitigación contra peligros naturales serán elegibles para fondos de mitigación pre-desastre (Pre-disaster Mitigation Act) y post desastre a través del Programa de Subvención para la Mitigación de Riesgos (HMGP), el Predisaster Mitigation (PDM) y el Flood Mitigation Assistance Program (FMAP).

Por lo tanto, el municipio reconoce que la JPPR se comprometerá a coordinar junto al municipio la aprobación del Plan; coordinar la evaluación del Plan por parte del COR3 y FEMA; y efectuar la entrega del Plan aprobado por COR3 y FEMA al municipio.

P.O. Box 41119, San Juan PR, 00940-1119 • 787.723.6200 • jp.pr.gov

El Municipio asignará una persona contacto o empleado municipal designado por el alcalde que será el contacto oficial (POC) del municipio para la coordinación, ejecución y la elaboración de la actualización del plan de mitigación. Esta persona trabajará directamente con el personal designado por la Junta de Planificación en este proyecto.

Asimismo, el Municipio agilizará y tramitará la adopción del plan mediante Orden Ejecutiva o a través de la Legislatura Municipal mediante Ordenanza Municipal. También coordinará en conjunto con la JPPR o el personal autorizado, el proceso de participación ciudadana.

Se coordinará por parte del municipio la recopilación de información necesaria que sea requerida, incluyendo:

- Identificación de todos los Riesgos locales – Descripción de los diferentes eventos ocurridos en el Municipio y los impactos que han tenido en la comunidad.
- Identificación de inventario de activos del Municipio, de considerarse el activo como uno crítico favor de identificar el mismo como activo-crítico.
- Información necesaria para complementar la Tabla de análisis de capacidad.
- Identificación e Implantación de las Medidas / actividades de Mitigación: Lista de proyectos y Plan de Acción describiendo cómo los proyectos serán implantados por prioridades, cómo serán administrados, si son costo-beneficiosos.
- Evaluación del Plan Preliminar.
- Evaluación del Borrador del Plan.
- Evaluación del Borrador Final del Plan.
- Implementación del Plan de Mitigación - Monitoreo, Evaluación y Actualización.
- Realizar los esfuerzos educativos y comunicación necesarios a los diferentes sectores de la ciudadanía de este proceso de actualización del plan.
- La JPPR coordinará con el municipio respecto a cualquier otra información que se requiera.

Este compromiso no implica la erogación de fondos públicos por parte del municipio ni de la JPPR. A su vez, podrá ser terminado por la JPPR o por el Municipio, mediante comunicación escrita dirigida al presidente de la JPPR o al alcalde, según corresponda.

Por lo que, de acuerdo con este compromiso, yo, Rafael Surillo Ruíz lo firmo conforme a los mejores intereses del pueblo de Yabucoa.

En San Juan, Puerto Rico, hoy 16 de diciembre de 2025.

Alcalde

# Planning Committee Appointments

**Municipio Autónomo de Yabucoa**
Oficina del Alcalde

**NOTIFICACIÓN DE DESIGNACIÓN**
**Comité de Planificación del Municipio de Yabucoa**

Yo, Hon. Rafael Surillo Ruiz, alcalde del Municipio de Yabucoa, designo a los siguientes funcionarios y representantes como integrantes del ***Comité de Planificación para la actualización del Plan de Mitigación contra Peligros Naturales del Municipio de Yabucoa***, con el deber de apoyar, asesorar, coordinar y evaluar los trabajos de revisión, actualización, implementación y monitoreo del Plan mencionado.

| Nombre | Puesto y Oficina | Correo electrónico | Teléfono (Ext.) |
|---|---|---|---|
| Luis G. Rivera | Ayudante Especial | lgriveramedina@live.com | 787-209-1255 |
| Aileen Laboy | Ayudante Ejecutiva | laboyaileen@gmail.com | 787-206-0288 |
| Wanda Castro | Ayudante Ejecutiva | castro.wanda@gmail.com | 787-407-9036 |
| Miguel Flores | Director OMME | mflores117.omme@gmail.com | 787-914-6397 |

**Funciones principales del Comité:**

- Coordinar con los trabajos relacionados con la actualización del Plan de Mitigación.
- Participar de talleres, presentaciones y reuniones sobre la actualización del Plan de Mitigación de Riesgos
- Proporcionar información, y datos sobre la evaluación de los riesgos y vulnerabilidades del municipio, así como las capacidades y los proyectos prioritarios de mitigación.
- Asegurar el cumplimiento con los requisitos estatales y federales para la elegibilidad de fondos de mitigación.
- Ayudar a diseñar y proponer acciones y proyectos de mitigación al municipio para fortalecer la resiliencia y reducir los riesgos de desastres.
- Mantener comunicación con la ciudadanía y promover la participación comunitaria en el proceso de mitigación.
- Apoyar la adopción e implantación del Plan de Mitigación.

Esta designación tendrá vigencia inmediata y se mantendrá en efecto hasta que se notifique lo contrario.

Firmada hoy, lunes, 26 de enero de 2026, en Yabucoa, Puerto Rico.

Rafael Surillo Ruiz
Alcalde Municipio de Yabucoa

**Dirección:** Apartado 97 Yabucoa, Puerto Rico 00767 • **Tel:** (787) 893-3000 • **Email:** oficinadelcaldeyabucoa@gmail.com
@municipioyabucoa • Autorizado por la Oficina del Contralor Electoral OCE-SA-2024-03679

JUNTA DE
# PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

## FORMULARIO PARA DESIGNAR PERSONA(S) CONTACTO(S)
## PLAN DE MITIGACIÓN CONTRA PELIGROS NATURALES

Municipio: Yabucoa

| | Nombre | Teléfono | Correo electrónico |
|---|---|---|---|
| Personal Designado | Luis G. Rivera | 787-209-1255 | lgriveramedina@live.com |
| Personal Alterno | Wanda Castro | 787-407-9036 | Castro.wanda@gmail.com |
| Dir. OMME | Miguel Flores | 787-914-6397 | mflores117.ommе@gmail.com |
| | | | |
| | | | |

Rafael Surillo Ruiz
Nombre (letra de molde)
Alcalde

Firma
Alcalde

Fecha: 16 - diciembre - 2025

# First Planning Committee Meeting

## Presentation

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

# Plan Local de Mitigación Ante Peligros Naturales

Actualización 2026

2 de febrero de 2026

AtkinsRéalis



1

## AGENDA

01 Presentación del equipo

02 Base Legal y Regulatoria

03 Requerimientos de contenido del Plan

04 Elementos Nuevos

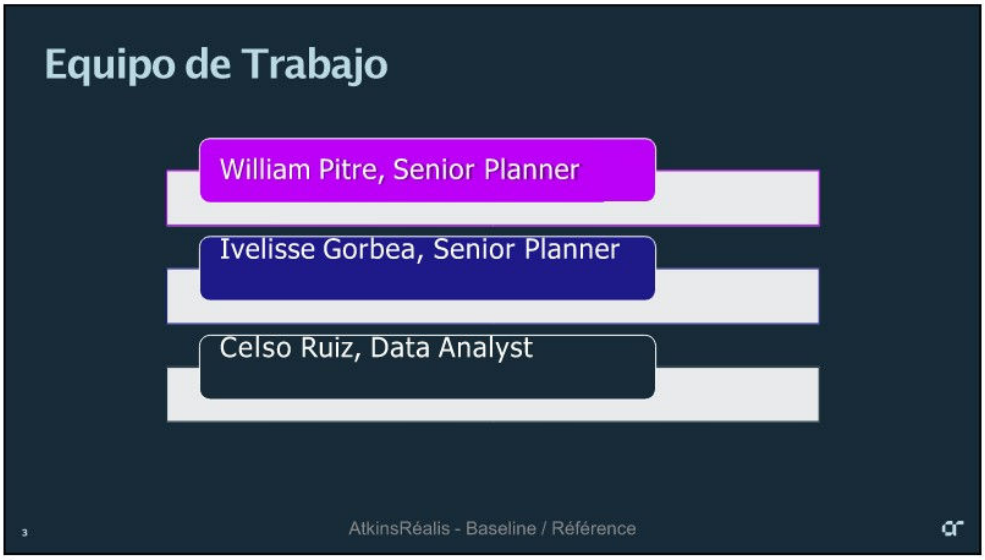
05 Plan de Trabajo

06 Próximos Pasos

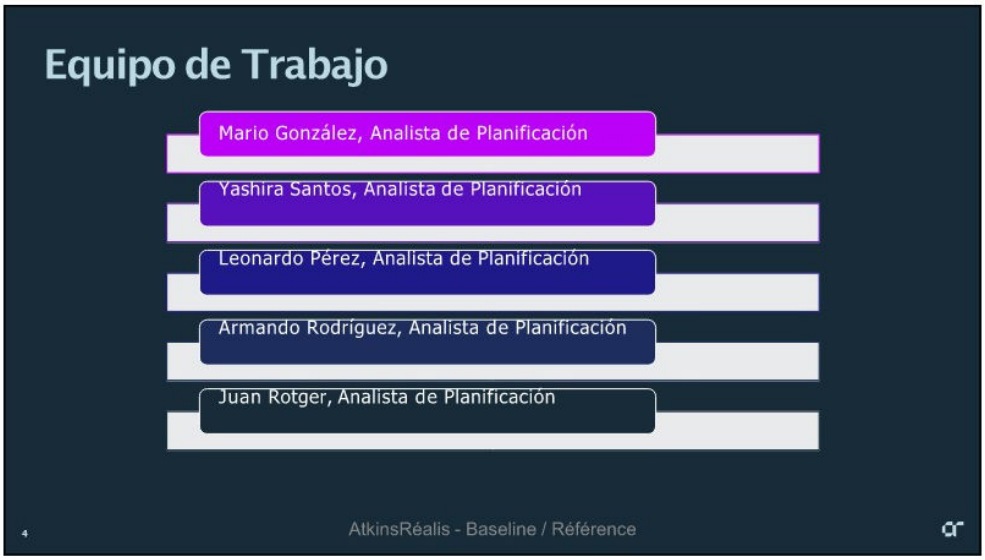


2

1


Equipo de Trabajo
William Pitre, Senior Planner
Ivelisse Gorbea, Senior Planner
Celso Ruiz, Data Analyst
3
AtkinsRéalis - Baseline / Référence

3


Equipo de Trabajo
Mario González, Analista de Planificación
Yashira Santos, Analista de Planificación
Leonardo Pérez, Analista de Planificación
Armando Rodríguez, Analista de Planificación
Juan Rotger, Analista de Planificación
4
AtkinsRéalis - Baseline / Référence

4

2

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

# HOJA DE ASISTENCIA

Fecha: 5 de febrero de 2026 Hora: 9:00am Asunto: 1era Reunión –Revisión Plan de Mitigación contra Peligros Naturales

| Nombre y dos apellidos | Teléfono | Municipio | Firma | Correo Electrónico |
|---|---|---|---|---|
| Luis Rivera Medina | 787 209-1255 | Yabucoa | | Blocked for PII Protection |
| Gilberto Lebrón Rodríguez | 787 [illegible] | Yabucoa | | |
| Rafael Castillo Ruiz | 787 312-7143 | Yabucoa | | |
| Miguel A. Flores Figueroa | 787 316-8313 | Yabucoa | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |




Mapa del Inventario de Activos Municipales Yabucoa

# MINUTA

| | | | |
|---|---|---|---|
| **PROYECTO:** | PRPB 25 LHMP Update | | |
| **TITULO:** | First Committee Meeting | | |
| **LUGAR DE LA REUNIÓN:** | Junta de Planificación Salón B | **# REUNIÓN:** | 1 |
| **FECHA Y HORA:** | 2/5/2026 @ 9:00am | **MINUTA POR:** | Leonardo Pérez García |

## Lista de Asistencia:

| NOMBRE | INICIALES | COMPAÑÍA / AGENCIA |
|---|---|---|
| Luis Rivera | LR | Municipio de Yabucoa |
| Rafael Surillo Ruiz | RSR | Municipio de Yabucoa |
| Leonardo Pérez | LPG | AtkinsRéalis |

## Asuntos Discutidos:

| ID | ASUNTOS DISCUTIDOS |
|---|---|
| AD-1 | Aprobación de Minuta Reunión Anterior:<br>• N/A |
| AD-2 | Asunto Relacionado con Alcance de Servicio Contratado y Entregables<br>• N/A |
| AD-3 | Plan de Trabajo Propuesto (Two Weeks Ahead / Four Week Ahead)<br>• N/A |
| AD-4 | Asuntos Nuevos<br>• Se comenzó la reunión con una presentación que brindó el planificador William Pitre, de AtkinsRéalis, explicando en que consiste el proyecto, actividades, requisitos y como la Junta de Planificación y AtkinsRéalis van a estar preparando el Plan de Mitigación para los municipios.<br>• Luego de la presentación, se inició la mesa de trabajo con el municipio de Yabucoa<br>• L. Pérez se presentó y brindó un breve trasfondo de su experiencia como ingeniero. |

**NOTA A LOS DESTINATARIOS:**
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

| ID | ASUNTOS DISCUTIDOS |
|---|---|
| | • L. Pérez solicitó que el municipio confirmara el Punto de Contacto (POC),a lo cual R. Surillo indicó que el mismo fue designado como POC.<br>• Se repasó parcialmente la lista del "Local Hazard Mitigation Plan" (LHMP) anterior, para que el municipio identificará las acciones de esos proyectos en que estatus estaban actualmente. Para las acciones de mitigación algunas de ellas se encuentran en los siguientes estados:<br>o La acción PEA-1, R. Surillo comentó que se está implementando constantemente<br>o La acción SE-10, R. Surillo comentó que ya está actividad ya se realizó.<br>o La acción SP-10, R. Surillo comentó que esta actividad se realiza de manera anual.<br>o La acción PRN-3, R. Surillo indicó que requiere coordinación con el "Army Corps of Engineers".<br>o La acción PP-17, R. Surillo indicó que ya están asignado los fondos para el proyecto.<br>o La acción PP-10, R. Surillo indicó que ya se instaló el sistema de bombeo.<br>• L. Pérez realizó una dinámica con el municipio en la cual se identificaron nuevas acciones que les gustaría incluir dentro del Plan de Mitigación. Las acciones propuestas fueron:<br>o Mitigación para la erosión costera.<br>o Canalización de la Quebrada Jardines.<br>o Elevación de PR-2 entre urb. Los Ángeles y Central Rois.<br>• L. Pérez realizó una dinámica con el municipio llamada "Planning Poker".<br>o Se le preguntó al municipio que, si recibieran fondos ilimitados para realizar un solo proyecto de mitigación, cuál sería y por qué.<br>▪ De las dos (2) personas participantes surgieron los siguientes proyectos:<br>- Planta de agua potable en la parte alta de Yabucoa y distribuir por gravedad a todas las comunidades.<br>- Proyecto para la creación rompeolas.<br>- Creación de lagos artificiales.<br>• L. Pérez dio por culminada la dinámica e indicó que el correo electrónico para enviar o solicitar información es prpb.lhmp@atkinsrealis.com. También informó que, cada vez que envíen un correo electrónico, el título comience con el nombre del municipio, en este caso Las Marías, seguido de una breve descripción del contenido, con el fin de archivar y atender las comunicaciones de manera más eficiente.<br>• L. Pérez recalcó lo mencionado previamente por el Sr. William Pitre sobre el envío del municipio.<br>• R. Surillo indicó que, de manera tentativa, se seleccionó el día de 3 de marzo de 2026 para la reunión con la comunidad, y que estarán enviando un correo electrónico para confirmar la fecha, hora y lugar. |
| AD-5 | Discusión de Acciones por Tomar<br>• Tabla Inferior |
| AD-6 | Coordinación Próxima Reunión<br>• TBD |

**NOTA A LOS DESTINATARIOS:**
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

## Acciones Por Tomar:

| ID | ACCIONES POR TOMAR | FECHA LÍMITE | ENTIDAD RESPONSABLE |
|---|---|---|---|
| AT-1 | Confirmación de Fecha, hora y lugar para reunión comunitaria. | 2/6/2026 | Mun. Yabucoa |
| AT-2 | Envío de Logo el municipio. | 2/6/2026 | Mun. Yabucoa |
| AT-3 | Enviar lista de estrategias y/o acciones nuevas para el Plan de Mitigación. | TBD | Mun. Yabucoa |
| AT-4 | Enviar Lista de infraestructura crítica de Las Marías con Coordenadas. | TBD | Mun. Yabucoa |

## Acuerdos/Aclaraciones:

| ID | DESCRIPCIÓN |
|---|---|
| AC-1 | N/A |

## Anejos:

| ID | DESCRIPCIÓN ANEJO | NÚMERO DE PÁGINAS |
|---|---|---|
| AN-1 | N/A | |

| | | | |
|---|---|---|---|
| **PRÓXIMA REUNIÓN:** | TBD | | |
| **MEDIO DE DISTRIBUCIÓN:** | Email | | |
| **FECHA DISTRIBUCIÓN:** | 02/06/2026 | **ARCHIVO DE REFERENCIA:** | N/A |

**NOTA A LOS DESTINATARIOS:**
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

# Second Planning Committee Meeting

## Presentation

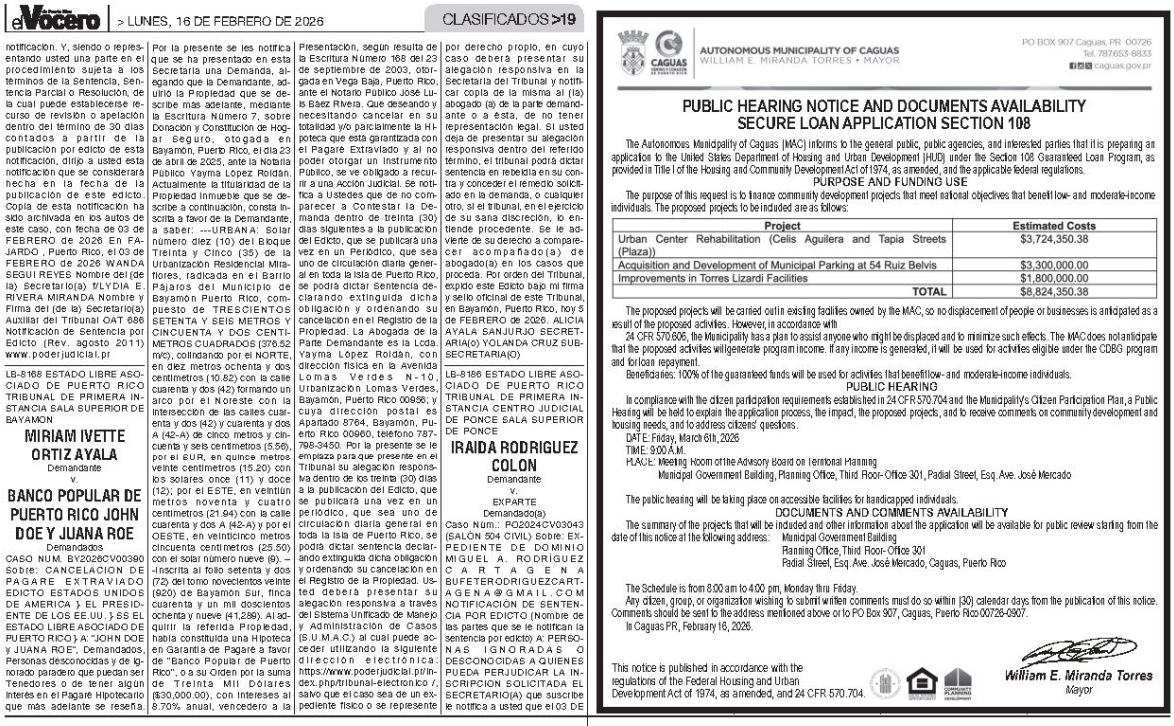
This section will be completed with the final submittal of the LHMP to COR3

### 9.3.3 Documentation

This section will be completed with the final submittal of the LHMP to COR3

# Appendix C – Public Participation and Outreach

## First Public Meeting Notification



eVocero > LUNES, 16 DE FEBRERO DE 2026 CLASIFICADOS >19

notificación. Y, siendo o representando usted una parte en el procedimiento sujeta a los términos de la Sentencia, Sentencia Parcial o Resolución, de la cual puede establecerse recurso de revisión o apelación dentro del término de 30 días contados a partir de la publicación por edicto de esta notificación, dirijo a usted esta notificación que se considerará hecha en la fecha de la publicación de este edicto. Copia de esta notificación ha sido archivada en los autos de este caso, con fecha de 03 de FEBRERO de 2026 En FAJARDO , Puerto Rico, el 03 de FEBRERO de 2026 WANDA SEGUI REYES Nombre del (de la) Secretario(a) f/LYDIA E. RIVERA MIRANDA Nombre y Firma del (de la) Secretario(a) Auxiliar del Tribunal OAT 686 Notificación de Sentencia por Edicto (Rev. agosto 2011) www.poderjudicial.pr

LB-8168 ESTADO LIBRE ASOCIADO DE PUERTO RICO TRIBUNAL DE PRIMERA INSTANCIA SALA SUPERIOR DE BAYAMON

**MIRIAM IVETTE ORTIZ AYALA**
Demandante
v.
**BANCO POPULAR DE PUERTO RICO JOHN DOE Y JUANA ROE**
Demandados

CASO NUM. BY2026CV00380 Sobre: CANCELACION DE PAGARE EXTRAVIADO EDICTO ESTADOS UNIDOS DE AMERICA } EL PRESIDENTE DE LOS EE.UU. } SS EL ESTADO LIBRE ASOCIADO DE PUERTO RICO } A: "JOHN DOE y JUANA ROE", Demandados, Personas desconocidas y de ignorado paradero que puedan ser Tenedores o de tener algún interés en el Pagaré Hipotecario que más adelante se reseña.

Por la presente se les notifica que se ha presentado en esta Secretaría una Demanda, alegando que la Demandante, adquirió la Propiedad que se describe más adelante, mediante la Escritura Número 7, sobre Donación y Constitución de Hogar Seguro, otogada en Bayamón, Puerto Rico, el día 23 de abril de 2025, ante la Notaría Público Yayma López Roldán. Actualmente la titularidad de la Propiedad Inmueble que se describe a continuación, consta inscrita a favor de la Demandante, a saber: ---URBANA: Solar número diez (10) del Bloque Treinta y Cinco (35) de la Urbanización Residencial Miraflores, radicada en el Barrio Pajaros del Municipio de Bayamón Puerto Rico, compuesto de TRESCIENTOS SETENTA Y SEIS METROS Y CINCUENTA Y DOS CENTIMETROS CUADRADOS (376.52 mc), colindando por el NORTE, en diez metros ochenta y dos centímetros (10.82) con la calle cuarenta y dos (42) formando un arco por el Noreste con la intersección de las calles cuarenta y dos (42) y cuarenta y dos A (42-A) de cinco metros y cincuenta y seis centímetros (5.56), por el SUR, en quince metros veinte centímetros (15.20) con los solares once (11) y doce (12); por el ESTE, en veintiún metros noventa y cuatro centímetros (21.94) con la calle cuarenta y dos A (42-A) y por el OESTE, en veinticinco metros cincuenta centímetros (25.50) con el solar número nueve (9). --Inscrita al folio setenta y dos (72) del tomo novecientos veinte (920) de Bayamón Sur, finca cuarenta y un mil doscientos ochenta y nueve (41,289). Al adquirir la referida Propiedad, había constituida una Hipoteca en Garantía de Pagaré a favor de "Banco Popular de Puerto Rico", o a su Orden por la suma de Treinta Mil Dólares ($30,000.00), con intereses al 8.70% anual, vencedero a la Presentación, según resulta de la Escritura Número 168 del 23 de septiembre de 2003, otorgada en Vega Baja, Puerto Rico, ante el Notario Público José Luis Baez Rivera. Que deseando y necesitando cancelar en su totalidad y/o parcialmente la Hipoteca que está garantizada con el Pagaré Extraviado y al no poder otorgar un instrumento Público, se ve obligado a recurrir a una Acción Judicial. Se notifica a Ustedes que de no comparecer a Contestar la Demanda dentro de treinta (30) días siguientes a la publicación del Edicto, que se publicará una vez en un Periódico, que sea uno de circulación diaria general en toda la Isla de Puerto Rico, se podrá dictar Sentencia declarando extinguida dicha obligación y ordenando su cancelación en el Registro de la Propiedad. La Abogada de la Parte Demandante es la Lcda. Yayma López Roldán, con dirección física en la Avenida Lomas Verdes N-10, Urbanización Lomas Verdes, Bayamón, Puerto Rico 00956; y cuya dirección postal es Apartado 8764, Bayamón, Puerto Rico 00960, teléfono 787-798-3450. Por la presente se le emplaza para que presente en el Tribunal su alegación responsiva dentro de los treinta (30) días a la publicación del Edicto, que se publicará una vez en un periódico, que sea uno de circulación diaria general en toda la Isla de Puerto Rico, se podrá dictar sentencia declarando extinguida dicha obligación y ordenando su cancelación en el Registro de la Propiedad. Usted deberá presentar su alegación responsiva a través del Sistema Unificado de Manejo y Administración de Casos (S.U.M.A.C.) al cual puede acceder utilizando la siguiente dirección electrónica: https://www.poderjudicial.pr/index.php/tribunal-electronico /, salvo que el caso sea de un expediente físico o se represente por derecho propio, en cuyo caso deberá presentar su alegación responsiva en la Secretaría del Tribunal y notificar copia de la misma al (la) abogado (a) de la parte demandante o a ésta, de no tener representación legal. Si usted deja de presentar su alegación responsiva dentro del referido término, el tribunal podrá dictar sentencia en rebeldía en su contra y conceder el remedio solicitado en la demanda, o cualquier otro, si el tribunal, en el ejercicio de su sana discreción, lo entiende procedente. Se le advierte de su derecho a comparecer acompañado(a) de abogado(a) en los casos que proceda. Por orden del Tribunal, expido este Edicto bajo mi firma y sello oficinal de este Tribunal, en Bayamón, Puerto Rico, hoy 5 de FEBRERO de 2026. ALICIA AYALA SANJURJO SECRETARIA(O) YOLANDA CRUZ SUBSECRETARIA(O)

LB-8186 ESTADO LIBRE ASOCIADO DE PUERTO RICO TRIBUNAL DE PRIMERA INSTANCIA CENTRO JUDICIAL DE PONCE SALA SUPERIOR DE PONCE

**IRAIDA RODRIGUEZ COLON**
Demandante
v.
EXPARTE
Demandado(a)

Caso Núm.: PO2024CV03043 (SALÓN 504 CIVIL) Sobre: EXPEDIENTE DE DOMINIO MIGUEL A. RODRÍGUEZ CARTAGENA BUFETERODRIGUEZCARTAGENA@GMAIL.COM NOTIFICACIÓN DE SENTENCIA POR EDICTO (Nombre de las partes que se le notifican la sentencia por edicto) A: PERSONAS IGNORADAS O DESCONOCIDAS A QUIENES PUEDA PERJUDICAR LA INSCRIPCION SOLICITADA EL SECRETARIO(A) que suscribe le notifica a usted que el 03 DE

---

AUTONOMOUS MUNICIPALITY OF CAGUAS
WILLIAM E. MIRANDA TORRES • MAYOR

PO BOX 907 Caguas, PR 00726
Tel. 787-653-8833
caguas.gov.pr

### PUBLIC HEARING NOTICE AND DOCUMENTS AVAILABILITY SECURE LOAN APPLICATION SECTION 108

The Autonomous Municipality of Caguas (MAC) informs to the general public, public agencies, and interested parties that it is preparing an application to the United States Department of Housing and Urban Development (HUD) under the Section 108 Guaranteed Loan Program, as provided in Title I of the Housing and Community Development Act of 1974, as amended, and the applicable federal regulations.

PURPOSE AND FUNDING USE

The purpose of this request is to finance community development projects that meet national objectives that benefit low- and moderate-income individuals. The proposed projects to be included are as follows:

| Project | Estimated Costs |
|---|---|
| Urban Center Rehabilitation (Celis Aguilera and Tapia Streets (Plaza)) | $3,724,350.38 |
| Acquisition and Development of Municipal Parking at 54 Ruiz Belvis | $3,300,000.00 |
| Improvements in Torres Lizardi Facilities | $1,800,000.00 |
| TOTAL | $8,824,350.38 |

The proposed projects will be carried out in existing facilities owned by the MAC, so no displacement of people or businesses is anticipated as a result of the proposed activities. However, in accordance with 24 CFR 570.606, the Municipality has a plan to assist anyone who might be displaced and to minimize such effects. The MAC does not anticipate that the proposed activities will generate program income. If any income is generated, it will be used for activities eligible under the CDBG program and for loan repayment.

Beneficiaries: 100% of the guaranteed funds will be used for activities that benefit low- and moderate-income individuals.

PUBLIC HEARING

In compliance with the citizen participation requirements established in 24 CFR 570.704 and the Municipality's Citizen Participation Plan, a Public Hearing will be held to explain the application process, the impact, the proposed projects, and to receive comments on community development and housing needs, and to address citizens' questions.

DATE: Friday, March 6th, 2026
TIME: 9:00 A.M.
PLACE: Meeting Room of the Advisory Board on Territorial Planning
Municipal Government Building, Planning Office, Third Floor- Office 301, Padial Street, Esq. Ave. José Mercado

The public hearing will be taking place on accessible facilities for handicapped individuals.

DOCUMENTS AND COMMENTS AVAILABILITY

The summary of the projects that will be included and other information about the application will be available for public review starting from the date of this notice at the following address: Municipal Government Building
Planning Office, Third Floor- Office 301
Padial Street, Esq. Ave. José Mercado, Caguas, Puerto Rico

The Schedule is from 8:00 am to 4:00 pm, Monday thru Friday.

Any citizen, group, or organization wishing to submit written comments must do so within (30) calendar days from the publication of this notice. Comments should be sent to the address mentioned above or to PO Box 907, Caguas, Puerto Rico 00726-0907.

In Caguas PR, February 16, 2026.

This notice is published in accordance with the regulations of the Federal Housing and Urban Development Act of 1974, as amended, and 24 CFR 570.704.

*William E. Miranda Torres*
Mayor

---

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

AVISO PÚBLICO

PRIMERA REUNIÓN DE PLANIFICACIÓN CON LA COMUNIDAD

La Junta de Planificación, junto al Municipio de Yabucoa, invitan a los organismos gubernamentales, entidades privadas, dueños de negocios, líderes comunitarios y ciudadanía en general a participar de la 1ra reunión de Planificación con la Comunidad para la revisión del Plan de Mitigación contra Peligros Naturales.

Los peligros naturales pueden causar la pérdida de vida y propiedad y tener consecuencias nefastas. La mitigación de riesgos es el esfuerzo de nuestra comunidad por reducir los daños o riesgos ocasionados por peligros naturales mediante el diseño de medidas que reduzcan su impacto.

El Plan de Mitigación contra Peligros Naturales para el Municipio de Yabucoa tiene el propósito de guiar al gobierno municipal en el desarrollo y adopción de estrategias dirigidas al manejo de peligros, tales como inundaciones, huracanes, sequías, deslizamientos, terremotos y otros.

**FECHA:** 3 DE MARZO DE 2026
**HORA:** 3:00 PM
**LUGAR:** SALÓN DE ACTIVIDADES, PARQUE DEL NIÑO DE YABUCOA, BO. JUAN MARTÍN, PR-901, KM 2.6 YABUCOA, PR

PLANES DE MITIGACIÓN CONTRA PELIGROS NATURALES
Planificar para proteger

**YABUCOA**

PARA MÁS INFORMACIÓN, ACCEDA: **JP.PR.GOV**

---

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

AVISO PÚBLICO

PRIMERA REUNIÓN DE PLANIFICACIÓN CON LA COMUNIDAD

La Junta de Planificación, junto al Municipio de Patillas, invitan a los organismos gubernamentales, entidades privadas, dueños de negocios, líderes comunitarios y ciudadanía en general a participar de la 1ra reunión de Planificación con la Comunidad para la revisión del Plan de Mitigación contra Peligros Naturales.

Los peligros naturales pueden causar la pérdida de vida y propiedad y tener consecuencias nefastas. La mitigación de riesgos es el esfuerzo de nuestra comunidad por reducir los daños o riesgos ocasionados por peligros naturales mediante el diseño de medidas que reduzcan su impacto.

El Plan de Mitigación contra Peligros Naturales para el Municipio de Patillas tiene el propósito de guiar al gobierno municipal en el desarrollo y adopción de estrategias dirigidas al manejo de peligros, tales como inundaciones, huracanes, sequías, deslizamientos, terremotos y otros.

**FECHA:** 4 DE MARZO DE 2026
**HORA:** 5:00 PM
**LUGAR:** TERMINAL DE CARROS PÚBLICOS, CALLE TERMINAL, BO. PUEBLO, PATILLAS, PR

PLANES DE MITIGACIÓN CONTRA PELIGROS NATURALES
Planificar para proteger

**PATILLAS**

PARA MÁS INFORMACIÓN, ACCEDA: **JP.PR.GOV**


https://www.facebook.com/photo.php?fbid=1211188937841261&set=pb.100068504987186.-2207520000&type=3
Chat
AtkinsRéalis
United States of A...
PRPB 25 LHMP Up...
Bayamon Mitigatio...
PRHTA Strategic Pl...
ADP
Concur Expense
oneERP | Facturati...
JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO
AVISO PÚBLICO
PRIMERA REUNIÓN DE PLANIFICACIÓN CON LA COMUNIDAD
La Junta de Planificación, junto al Municipio de Yabucoa, invitan a los organismos gubernamentales, entidades privadas, dueños de negocios, líderes comunitarios y ciudadanía en general a participar de la 1ra reunión de Planificación con la Comunidad para la revisión del Plan de Mitigación contra Peligros Naturales.
Los peligros naturales pueden causar la pérdida de vida y propiedad y tener consecuencias nefastas. La mitigación de riesgos es el esfuerzo de nuestra comunidad por reducir los daños o riesgos ocasionados por peligros naturales mediante el diseño de medidas que reduzcan su impacto.
El Plan de Mitigación contra Peligros Naturales para el Municipio de Yabucoa tiene el propósito de guiar al gobierno municipal en el desarrollo y adopción de estrategias dirigidas al manejo de peligros, tales como inundaciones, huracanes, sequías, deslizamientos, terremotos y otros.
FECHA: 3 DE MARZO DE 2026
HORA: 3:00 PM
LUGAR: SALÓN DE ACTIVIDADES, PARQUE DEL NIÑO
DE YABUCOA, BO. JUAN MARTÍN, PR-901, KM 2.6
YABUCOA, PR
YABUCOA
PLANES DE MITIGACIÓN
CONTRA PELIGROS NATURALES
Planificar para proteger
Municipio Autónomo de Yabucoa
February 27 ·
La Junta de Planificación, junto al Municipio de Yabucoa, invita a la ciudadanía a participar de la Reunión de Comunidad sobre el Plan de Mitigación de Riesgos del Municipio de Yabucoa.
Fecha: martes, 3 de marzo de 2026
Hora: 3:00 p.m.
Lugar: Salón de Actividades del Parque del Niño
Esta reunión forma parte del proceso de revisión del Plan de Mitigación contra Peligros Naturales, el cual atiende riesgos como inundaciones, huracanes, sequías, deslizamientos y terremoto...
See more
12
4
9
Like
Comment
Most relevant
Arocho Diaz

# 9.4 Documentation

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

PLANES DE MITIGACIÓN
CONTRA PELIGROS NATURALES
Planificar para proteger

**HOJA DE ASISTENCIA**

Asunto: 1era Reunión de Planificación con la Comunidad- Municipio de Adjuntas — Fecha: 9 de marzo de 2026

Lugar: Coliseo Rafael Llull Pérez, Calle D, Barrio Juan González — Hora: 10:00 am

| Nombre completo (en letra de molde) | Municipio/Barrio/ Comunidad | Teléfono | Correo electrónico | Firma |
|---|---|---|---|---|
| Waleska Alvarado Feliciano | Municipio Adjuntas | Restricted to Protect PII | | |
| Onix F. Concepción | Junta de Planificación | | | |
| Luis Mercado Torres | Municipio Adjuntas | | | |
| Edgardo J. Ramos Escobales | ramosee34.prop@gmail.com | | | |
| Norberto Roman | Yahuecas, Adjuntas | | | |
| Estefanía Rivera Abreu | Municipio de Adjuntas | | | |
| Efrén Abáez | muni Adjuntas | | | |
| Jose H. Soto Rivera | Municipio Adjuntas | | | |
| Nick Vargas | Adjuntas | | | |
| Juan C. Negrón | Adjuntas | | | |

# Appendix D – Stakeholder Involvement

Evidence of Stakeholder Involvement shall be included with the final draft.

# 11. Appendix E – OrgChart

**Año Fiscal 2023-2024**

Administración Municipal de Yabucoa

***ORGANIGRAMA***

