LRTP
2045

2045 Aguadilla TMA
Long Range Multimodal Transportation Plan

Puerto Rico Highways and

Transportation Authority (PRHTA)

Final Report   December 2018

Highway and Transportation Authority

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Department of Transportation
and Public Works

Long Range Transportation Plan for Puerto Rico

APPOVED BY PUERTO RICO METROPOLITAN PLANNING ORGANIZATION

December 12, 2018

The Puerto Rico Department of Transportation and Public Works and the Puerto Rico Highway and Transportation Authority after a 45-day public comment period for revision and comments, has presented and approved this Plan by the Puerto Rico Metropolitan Planning Organization Policy Board Committees.

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Carlos M. Contreras Aponte
President, PR Metropolitan Planning Organization

December, 20, 2018
Date

Prepared by:
Strategic Planning Office
Puerto Rico Highway and Transportation Authority
Department of Transportation and Public Works

2045 Aguadilla TMA Long Range Multimodal Transportation Plan

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1 CHAPTER 1 INTRODUCTION

This report presents the 2045 LRTP for the Aguadilla Transportation Management Area (Aguadilla TMA). This chapter is divided into 3 sections:

1. Background;
2. Plan Context and Importance; and
3. Report Organization.

The Puerto Rico Department of Transportation and Public Works (DTPW) and the Puerto Rico Highway and Transportation Authority (PRHTA) acting as the Puerto Rico Metropolitan Planning Organization (MPO) elaborated the 2045 Long Range Multimodal Transportation Plans (LRTP) consisting of two documents for the Transportation Management Areas (TMAs) for San Juan and Aguadilla, one for the Island-wide Transportation Plan, and one for the Transportation Plan for other urbanized Regions of less than 200,000 inhabitants (includes five transportation planning Regions) as required by federal regulations (23 U.S.C 134 and 135; 42 U.S.C. 7410 et seq.; 49 U. S. C. 5303 and 5304). This document represents the Aguadilla TMA 2045 LRTP.

Aguadilla TMA is the regional core of economic activity in western Island where around 8.5% of the Island's population lives and works in the island. The Region had experienced a significant decrease in population (an overall decrease of 2.6% from 2000 to 2010 and 8.7% from 2010 to 2016) and in employment (5.0% from 2010 to 2016) bur less than the 7.1% overall lost in Puerto Rico.

This 2045 LRTP updating process had been characterized by important challenges conforming the transportation infrastructure and its vision of developing livable and economic competitive Island. The PR MPO and its transportation agencies considered the Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA), a 2016 federal law that established an oversight board, and procedures for approving critical infrastructure projects to improve the Puerto Rican government-debt crisis. As a result, the certified Fiscal Plan for the PRHTA was considered as the financial basis of this analysis. The investment plan for infrastructure in this 2045 LRTP is thus fiscally constraint to current Puerto Rico financial and fiscal conditions.

On the other hand, the Island experienced hurricanes Irma and María impacting significantly the road infrastructure around the Island in August 2017. The 2045 Plan included a component of vulnerability analysis for resilient infrastructure integrated to assess risk of the transportation system's conditions during and after extreme weather events. Although the specific project investment for resilient conditions needs further analysis, the 2045 Plan establishes a policy to

prioritize these efforts toward reducing vulnerability in all Regions including in Aguadilla TMA Region.

This document reports the planning process in the following steps as set out in Figure 1.1.

Figure 1.1: Planning Steps

Source: SDG and PRHTA

Public participation is fundamental throughout the whole process in defining the vision and reviewing the order of importance of the goals and objectives for participants. The goals and objectives allowed to define the key performance indicators and weights to prioritize and establish a ranking for the list of requested projects. The representation of the extended stakeholders was done throughout pre-defined Committees.

The 2045 LRTP for Aguadilla TMA presents challenges and opportunities in infrastructure investment along a long-range period. This 2045 LRTP follows a performance-based planning process according to federal regulations with an average annual investment of $341M in Puerto Rico from Fiscal Year (FY)2020 until FY2045 with a firm commitment with national goals of reducing fatalities, an unprecedent emphasis on pavement and bridges preservation and rehabilitation in order to upgrade its conditions, improve freight mobility, as well as reduce congestion.

BACKGROUND

Since Congress's passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, and through to the Fixing America's Surface Transportation (FAST) Act, the planning process in Puerto Rico has strived to be a comprehensive framework for making transportation investment decisions in the TMAs and Island-wide. The DTPW is the designated MPO for all urbanized areas and Island-wide. As such, it is ultimately responsible for and compliance with the US Department of Transportation (DOT) statutory requirements under the FAST-Act, and with the Rule Makings and Policy Guidance of the Federal Highway Administration (FHWA) and the Federal Transit

Administration (FTA). The DTPW carries out its responsibilities as a MPO[1] through Public Policy Committees whose members are the Mayors of the municipalities under the planning designation, as well as the heads of all agencies that have transportation, land use and planning tasks:

- Planning Board (PB);
- Department of Environmental and Natural Resources (DENR);
- Environmental Quality Board (EQB);
- Puerto Rico Integrated Transit Authority (PRITA);
- Public Service Commission (PSC);
- Metropolitan Bus Authority (AMA);
- Puerto Rico Highway and Transportation Authority (PRHTA);
- Ports Authority (PA);
- Maritime Transportation Authority (MTA); and
- Permissions Management Office (PMO).

Additionally, the MPO encompasses Technical Committees that develop and manage federal and local programs, plans and certifications that are ultimately considered for approval by the Public Policy Committees and adopted by the MPO.

Under this institutional framework, the PRHTA staff carries out the day-to-day workings of the MPO including the oversight of the timely preparation of the LRTP. The 2040 LRTP is valid until December 2018, when an updated 2045 LRTP will be required. The 2045 LRTP must be approved in order to set out the planning framework for all transportation projects (including all modes) for Puerto Rico considering the two-large population TMAs: San Juan and Aguadilla; and the five smaller population TPRs comprising nine other Urbanized Areas; as set out here:

- Aguadilla Transportation Management Area (TMA)
- San Juan Transportation Management Area (TMA); and
- Transportation Planning Regions:
  - East Region:
    - Fajardo Urbanized Area;
  - North Region:
    - Arecibo Urbanized Area; and
    - Florida- Barceloneta Urbanized Area.
  - Southeast Region:
    - Guayama Urbanized Area.
  - South Region:
    - Ponce Urbanized Area;
    - Juana Díaz Urbanized; and
    - Yauco Urbanized Area.
  - Southwest Region:
    - Mayagüez Urbanized Area; and
    - San Germán-Cabo Rojo Urbanized Area.

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[1] Metropolitan Planning Organization means the policy board of an organization created and designated to carry out the metropolitan transportation planning process, according to regulations (23 CFR §450.104).

The 2040 plan considered the planning factors required by MAP-21 (the previous federal surface transportation funding and authorization legal framework). It recognized the "Planes de Ordenamiento Territorial" (POTs), local Environmental Laws, addressed the principles of environmental justice, and considered ongoing capital plans and projects, among many other elements, to propose, evaluate and identify future investments in mobility systems in a multimodal approach. It also considered Performance-based Planning and Programming (PBPP). Significant Island-wide projects related to highways, non-motorized facilities, ports and airports are considered in the 2040 LRTP.

The updated 2045 LRTP considered these aspects and additional key issues as set out by the new federal legislation (FAST-Act) and the local public policy (Law 201 of 2010[2] , Law 74 of 1965 as amended by Law 97 of 2012[3] and Law 22[4]) including a wider emphasis on non-motorized modes, complete streets, freight mobility, livability, resilience infrastructure, reliability, environment, energy, tourism considerations, and principles of sustainability and smart growth. The new plan must also involve stakeholders and residents seeking social consensus through a communications strategy that aligns aspirations and policies with realistic opportunities for investment and improvements. In order to successfully have the insight from community stakeholders, the plan included comprehensive Public Involvement Process (PIP) including open houses with a more dynamic approach of going to where the people are, committee's meetings, surveys and social media.

Considering the economic situation in Puerto Rico and the fact that the Island is facing an aging population trend, the new Plan and model paid closer attention to system preservation (considering the Asset Management Plan), the integration of alternative transportation modes and their infrastructure requirements including public transit, non-motorized modes facilities and an overall Complete Streets approach (considering the local public policy).

In the same context, the continuation of migration patterns exacerbated by the hurricanes Irma and María, that affected the local area in September 2017, required a strong socio-economic forecasting team that was able to rigorously-model, thoroughly thought-out scenarios to set the basis for the modeling strategy based on a well informed and researched approach in order to ensure local and federal approval of the employment and population projections.

Through the LRTP planning process, the mission, vision and development of transportation system in Puerto Rico was updated and reevaluated for the next 27 years (2045). This updated 2045 LRTP performed studies regarding to journeys and travel patterns to the whole Island in order to assess infrastructure needs, define projects to invest for construction and development over a planning period of 5 years.

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[2] Law 201, 2010 to declare the public policy regarding the adoption of the concept of Complete Streets.

[3] Law 74 of the 23 of June 1965, PRHTA Law ("Ley de la Autoridad de Carreteras y Transportación de Puerto Rico") amended by Law 97 in 2012 to include a disposition of adding a fence to all bridges with pedestrian facilities.

[4] Vehicle and Traffic Law of Puerto Rico, as amended by Law 132 of June 3, 2004 which includes the Charter of rights and obligations of cyclists and drivers.

The multimodal transportation system in Puerto Rico encompasses highway and roadways networks, airports, ferry systems and seaports. These facilities provide travel options for people and freight movement.

The proper calibration of a model representing this system is highly dependent on the availability of data used as inputs to the model. The modelling approach took advantage of the wealth of travel pattern information available from cell phone and Global Positioning System (GPS) sources.

The vision, goals, objectives and priorities of the LRTP influence different planning efforts and programs. The basis for the definition of these was the 2040 document, strengthened by more in-depth consideration of resilience, alternative modes of transportation, freight, intermodal improvement opportunities, and Intelligent Transportation System (ITS) technologies. Additional scope in the planning effort is to support the economic vitality of the Regions, increase safety, and promote the effective use of existing infrastructure.

The development of the LRTP followed well-established regulations and guidelines from both the Federal and the Commonwealth Governments and their agencies (FHWA, FTA, PRHTA and others). The Plan development is viewed as a continuing, cooperative and comprehensive process involving on-going communications with the public, stakeholders and responsible government officials.

PLAN CONTEXT AND IMPORTANCE

In order to fulfill main elements of a performance-based transportation plan the following were considered throughout the 2045 LRTP development process:

- Performance measures, targets, system performance reports, and investment strategies;
- Public, stakeholder, and agency engagement role;
- Supporting materials and baseline information, which includes a description of the multimodal transportation system, existing system performance, anticipated challenges, and revenue forecasts;
- Strategic elements of the transportation plan: Strategic Vision, Goals and Objectives;
- Performance measures such as national measures established by US DOT, as well as community-driven measures; and target-setting methods based on factors such as available resources, trend analysis, and data;
- Existing performance of the transportation system, State or Region, regarding established performance measures and targets;
- Identification of investment needs to meet desired performance outcomes, screen strategies, projects concepts, and estimate costs;
- Scenario analysis and approaches for evaluating and choosing investment priorities in the transportation plan based on performance information; and

- Discussion about the transportation plan being translated into programming decisions that reflect priorities recognized over the planning process[5].

Some of the resources supporting a long-range statewide transportation plan includes:

- 23 CFR 450 - Planning Assistance and Standards: are federal transportation planning regulations which announce that each state implements long range statewide transportation plan and Statewide Transportation Improvement Program (STIP);
- FAST-Act Fact Sheet: Metropolitan, Statewide, and Non-Metropolitan Planning: is a program that offers funding and technical requirements for transportation planning which results in short-range and long-range plans programs of transportation investment priorities;
- FHWA FAST-Act Fact Sheet; Metropolitan Planning: is a program that give continuity to the Metropolitan Planning Program; and
- U.S. Code Title 49, Chapter 53 - Transit: is a section of US Code regarding the transit. Includes:
    - The Metropolitan Transportation Planning statute (Section 5303);
    - Statewide Transportation Planning (Section 5304);
    - Planning Programs (Section 5305); and
    - The Metro and Statewide Planning sections (23 U.S.C. 134 and 135)[6].

According with the US Census Bureau 2010, Puerto Rico is an Island with a land area of 3,423.78 square miles where the 93.8% of its population lives in urban areas. An analysis of World Bank Data showed that Puerto Rico's population grew at a rate of 0.7% a year from 1985 to 2004. Thereafter, a significant reversal has occurred, culminating in annual decreases of over 1% a year since 2011.

In 2013, the Puerto Rico government approved five executive orders to begin executing his environmental policy, beginning with a guideline for the Land Use Plan, which will establish the parameters to achieve the Island's economic development in a manner consistent with the protection of the environment:

- OE-2013-019: To order the Department of Natural and Environmental Resources to carry out the National Demarcation of the Maritime Terrestrial Zone;
- OE-2013-018: It orders the quantification of emissions of greenhouse gases in Puerto Rico and the elaboration of a plan for the reduction of these emissions in order to get closer to the carbon neutral goal;
- OE-2013-017: It orders the creation of the Action Council for the Sustainability of Puerto Rico;

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[5] US DOT FHWA, Model Long - Range Transportation Plans: A Guide for Incorporating Performance-Based Planning, 2014

[6] https://www.transit.dot.gov/regulations-and-guidance/transportation-planning/long-range-statewide-transportation-plan.

- OE-2013-016: It orders the development of a study on the vulnerability of public infrastructure to climate changes and the adoption of adaptation plans to confront the findings of the study; and
- OE-2013-015: Orders the Planning Board to finalize and adopt the Land Use Plan of Puerto Rico.

In 2015 the Puerto Rico Planning Board approved unanimously the Land Use Plan (*Plan de Uso de Suelos PUT*), this document defines its main goals as:

1. Concentrate development and redevelopment in communities where infrastructure already exists and development is planned;
2. Preserve and protect natural, archaeological or agricultural resources, rural soils and environmentally sensitive ones from the adverse effects of uncontrolled construction; and
3. Ensure a desirable quality of life in cities, communities and neighborhoods in a sustainable and fair manner.

Plans Considered as Part of the LRTP

The 2045 LRTP is based on federal and local policies regarded sustainable development and resilience. There are several planning documents that are part of the LRTP as appendices and have been considered in the development of the documents; these are:

- Puerto Rico Complete Streets Plan and Design Guidelines;
- Comprehensive Bicycle and Pedestrian Plan;
- Puerto Rico Strategic Highway Safety Plan (SHSP); and
- The PR Asset Management Plan.

In 2016, PRHTA developed, and the PR-MPO adopted on September 2018 the Puerto Rico Complete Streets Plan and Design Guidelines and the Comprehensive Bicycle and Pedestrian Plan.

The main objectives of the Puerto Rico Complete Streets Plan and Design Guidelines are:

- "To guide state and local efforts to improve access and mobility conditions and develop new facilities to improve the quality of life of Puerto Rico communities;
- To improve and/or provide pedestrian and bicycle access to the transit system and the public spaces; and
- To provide safe and affordable access for people of all ages and abilities in accordance with the FHWA's Livability Initiative, the American with Disabilities Act of 1990, the goals set forth by the Puerto Rico Law 207 of August 25, 2000 for the development along the Tren Urbano Corridor, as well as by the Puerto Rico Law 201 of December 16, 2010 for Complete Streets"[7].

The main objectives of the Comprehensive Bicycle and Pedestrian Plan are:

- "Promote and increase the use of cycling and walking as alternative modes of transportation;

[7] PRHTA, Puerto Rico Complete Streets Plan and Design Guidelines, 2016.

- Foment the physical integration of urban centers thru a cyclist and pedestrian network that improves accessibility to different land uses;
- Incorporate the development of projects and bicycle/pedestrian facilities to Statewide and Municipal Transportations Plans;
- Provide cycling and walking infrastructure to improve mobility, accessibility, and safety for all users of our public roads; and
- Develop Educational Programs for all users to share the public roads in a safely manner"[8].

The SHSP states that the overall objective and public policy adopted by the Commonwealth of Puerto Rico is to reduce the number of annual traffic fatalities to less than 300 fatalities by 2018, the lowest level ever recorded. This translates to approximately a 13% annual reduction in the number of fatalities and serious injuries on the highways of Puerto Rico between 2013 and 2018[9]. The main objectives of the Plan include:

- "Reduce the average time for crash data entry from 775 days to 400 days;
- Decrease the Puerto Rico EMS Annual Average Response Time to Crash Scene to less than 11.50 min by 2018;
- Reduce the 5-year moving average of unrestrained occupant fatalities from 124 to 118 by 2018;
- Reduce the 5-year moving average of speeding related fatalities from 144 to 129 by 2018;
- Reduce the 5-year moving average of young driver serious injuries (15-20 years) from 378 to 327 by 2018;
- Reduce the 5-year moving average of serious injuries involving vulnerable users, from 758 to 554, by 2018;
- Reduce fatalities involving roadway departure using 5-year moving average from 134 to 124 by 2018; and
- Reduce fatalities occurring at intersections using 5-year moving average from 47 to 42 by 2018"[10].

2017 Context

The plan update kicked off in August 2017; Hurricane María struck and affected Puerto Rico on September 20, 2017. This powerful Category 4 hurricane with 150 mph winds bisected the entire Island having catastrophic effects. This event had a direct effect on this Plan including:

- The data collection process was not possible considering that mobility patterns were affected by the climatic effect as the infrastructure was affected for over 8 months after the hurricane:
  - As a result, calibration of the model was made using 2016 year;

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[8] PRHTA, Comprehensive Bicycle and Pedestrian Plan, 2016.

[9] 2014-2018 PR Strategic Highway Safety Plan; 2014; http://carreterasegurapr.com/Content/docs/Puerto_Rico_SHSP_2014-2018_English.pdf.

[10] 2014-2018 PR Strategic Highway Safety Plan; 2014; http://carreterasegurapr.com/Content/docs/Puerto_Rico_SHSP_2014-2018_English.pdf.

- Major source of data related impacts of major climatic event on everyday life and mobility:
  - Therefore, resiliency analysis was completed based on evidence; and
  - Household surveys and public involvement was tailored to gather this data.

Further Analysis in Appendix A.

REPORT ORGANIZATION

This report will be divided in 7 main chapters:

- Chapter 1 Introduction;
- Chapter 2 Context Current Situation Assessment;
- Chapter 3 Transportation Planning Process for The Future;
- Chapter 4 Planning Process, Public Involvement, And Needs Assessment For The 2045 Plan;
- Chapter 5 Finance;
- Chapter 6 2045 Plan; and
- Chapter 7 Policy Guidelines Toward the Transportation Infrastructure.

2 CHAPTER 2 CONTEXT CURRENT SITUATION ASSESSMENT

This chapter presents an overview of the local context in terms of planning, demographics and transportation infrastructure; it also presents the forecasts demographics and public policy towards the 2045 horizon. This chapter is divided into 4 sections:

1. The Region in Brief;
2. Land Use;
3. Demographics; and
4. Transportation .

THE REGION IN BRIEF

As shown in Figure 2.1, there are seven planning transportation Regions defined under the Puerto Rico Metropolitan Planning Organization (MPO), which includes:

- Aguadilla TMA;
- San Juan TMA;
- North;
- South;
- East;
- Southeast; and
- Southwest.

This document specifically analyses the Aguadilla Transportation Management Area[11] (TMA); which represents the second TMA within the Island with some 288,777 inhabitants distributed within 9 municipalities. This Region has experienced recent economic development specially within the Aguadilla municipality with the airport experiencing an increase in passenger traffic as well as growth of industries within the area; conversation with freight movement industries

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[11] According to regulations, *Transportation Management Area* (TMA) means an urbanized area with a population over 200,000, as defined by the Bureau of the Census and designated by the Secretary of Transportation, or any additional area where TMA designation is requested by the Governor and the MPO and designated by the Secretary of Transportation (23 CFR §450.104.

identified Aguadilla as one of the top 3 (the other 2 are San Juan and Ponce) distribution center in the Island.

Figure 2.1: Seven MPO Regions in Puerto Rico
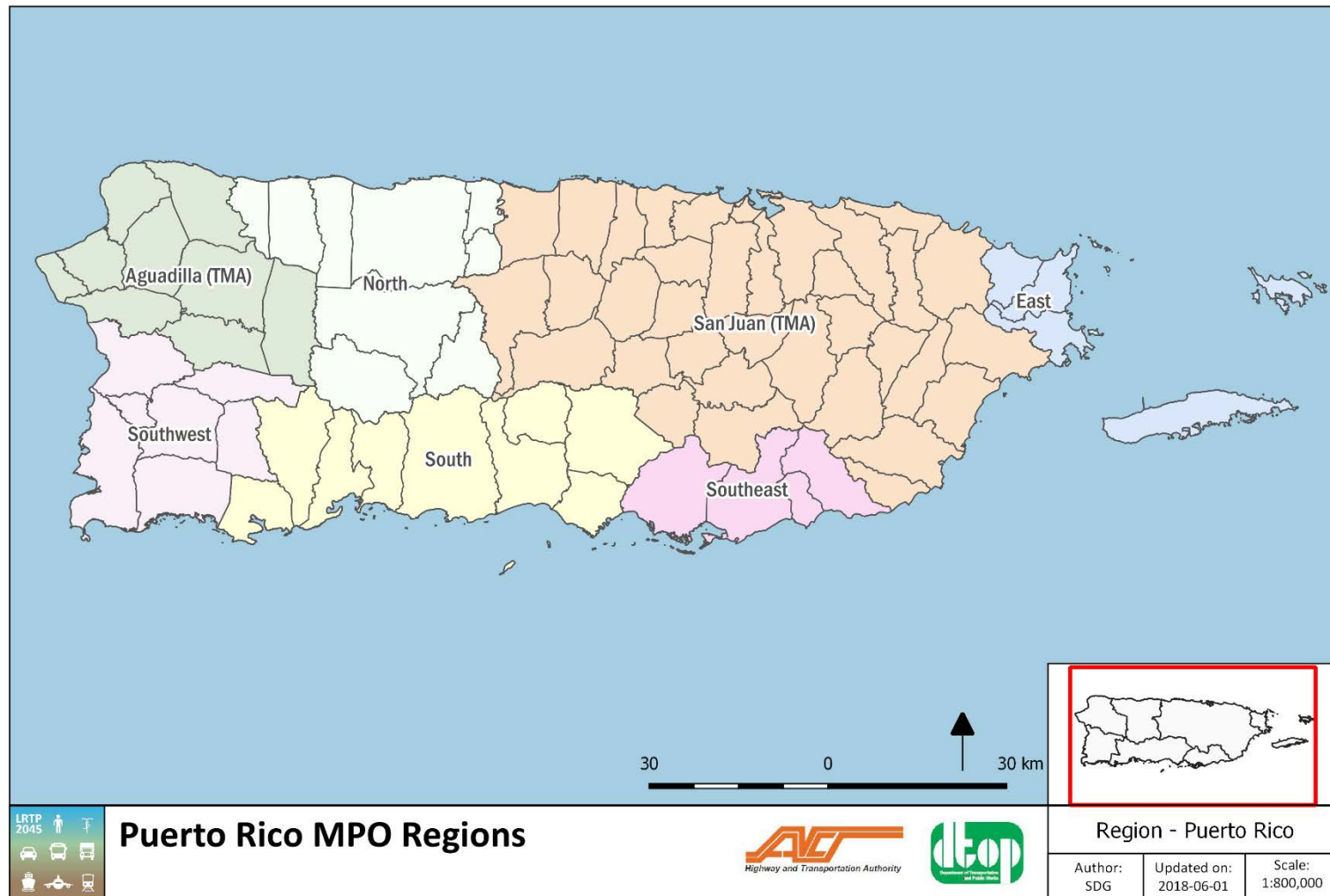
Source: The P.R. MPO Regions layer was created based on the information obtained from the Department of Transporatation and Public Works (DTOP) Public Involvement Plan found at http://www.dtop.gov.pr/fotos/coordinacionfederal/2015-july29-publicinvolvementplan.pdf

Aguadilla is one of the TMAs defined by the Puerto Rico MPO framework. The Aguadilla TMA is the 4th largest Region of Puerto Rico, covering around 11.0% of the land area. Its residents represent 8.5% of the Island total population. Just over 8% of Puerto Rico employment exists in Aguadilla, making it the third largest employment Region behind the San Juan and South Regions.

This Region is bounded to the East by the North MPO Region and to the South by the Southwest MPO Region, as can also be seen in Figure 2.1. A total of nine (9) municipalities make part of the Aguadilla TMA, as shown in Figure 2.2:

- Aguada;
- Isabela;
- Moca;
- Aguadilla;
- Lares;
- Rincón;
- Añasco;
- Las Marías; and
- San Sebastián.

Further details about Barrios in Appendix M.

Figure 2.2: Aguadilla TMA
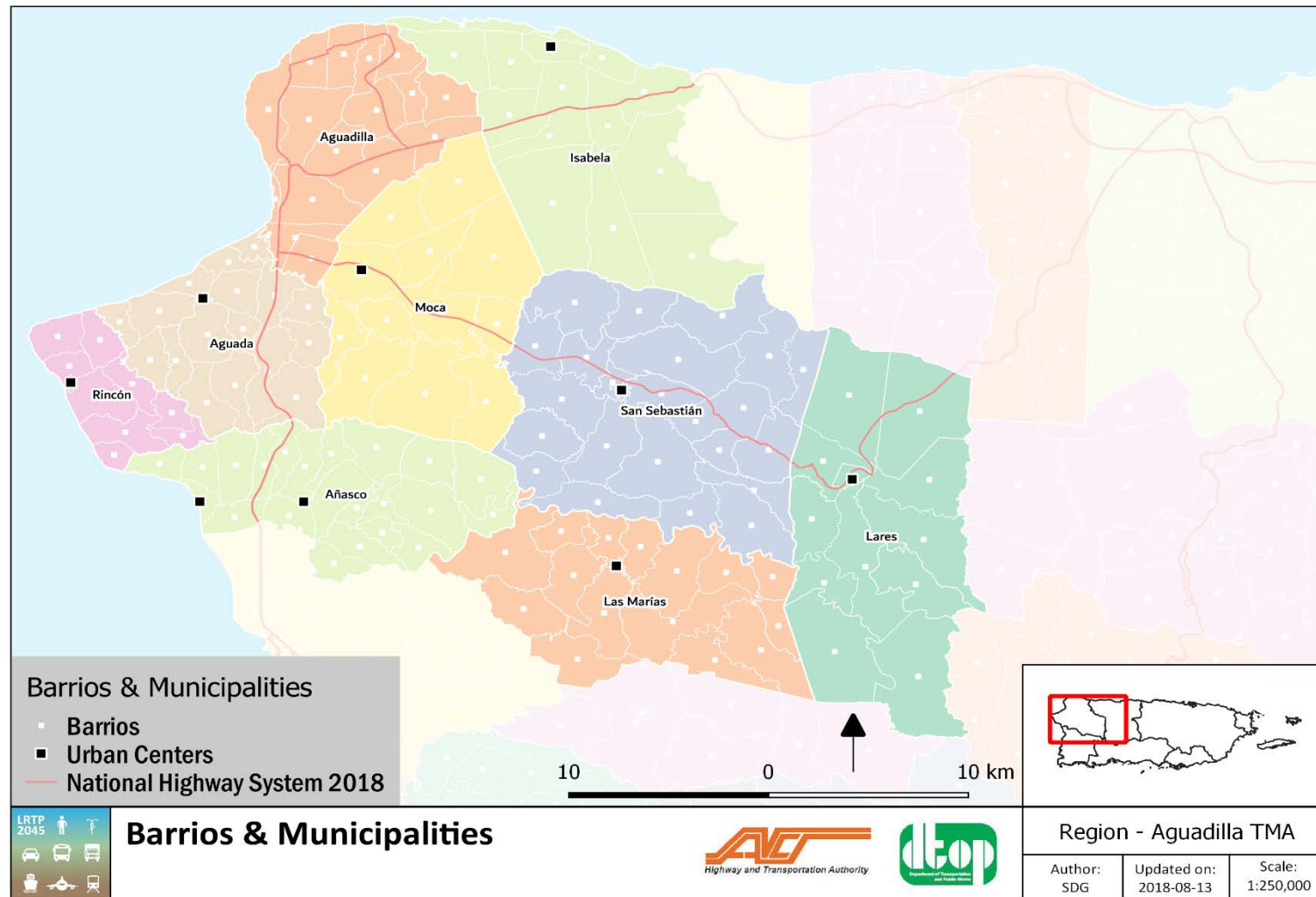
Source: The Municipios and Barrios Shapefile Layers were obtained from the Puerto Rico Planning Board Web Feature Service on March 2018

LAND USE

Development and Urbanization

The Aguadilla TMA experienced a significant urbanization growth by the 2000 decade. Since that period the Region has shown a moderate growth, with the exception of Añasco that revealed a slightly decrease.

Recent years, 2010-2016, show moderate development changes (construction of buildings, urbanizations, shopping malls and many other developments), a period of economic recession, an increasing rate of out-migration to the United States, a decline in fertility and in manufacturing employment.

Figure 2.3 to Figure 2.5 show the urbanized areas in Aguadilla TMA for each decade between 1990 to 2016[12].

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[12] The 2010 Census Urban Area delineation remains the same for 2016, for this reason a 2010 Census Urban Area Map was not included.

Figure 2.3: Aguadilla TMA Urbanized Areas, 1990
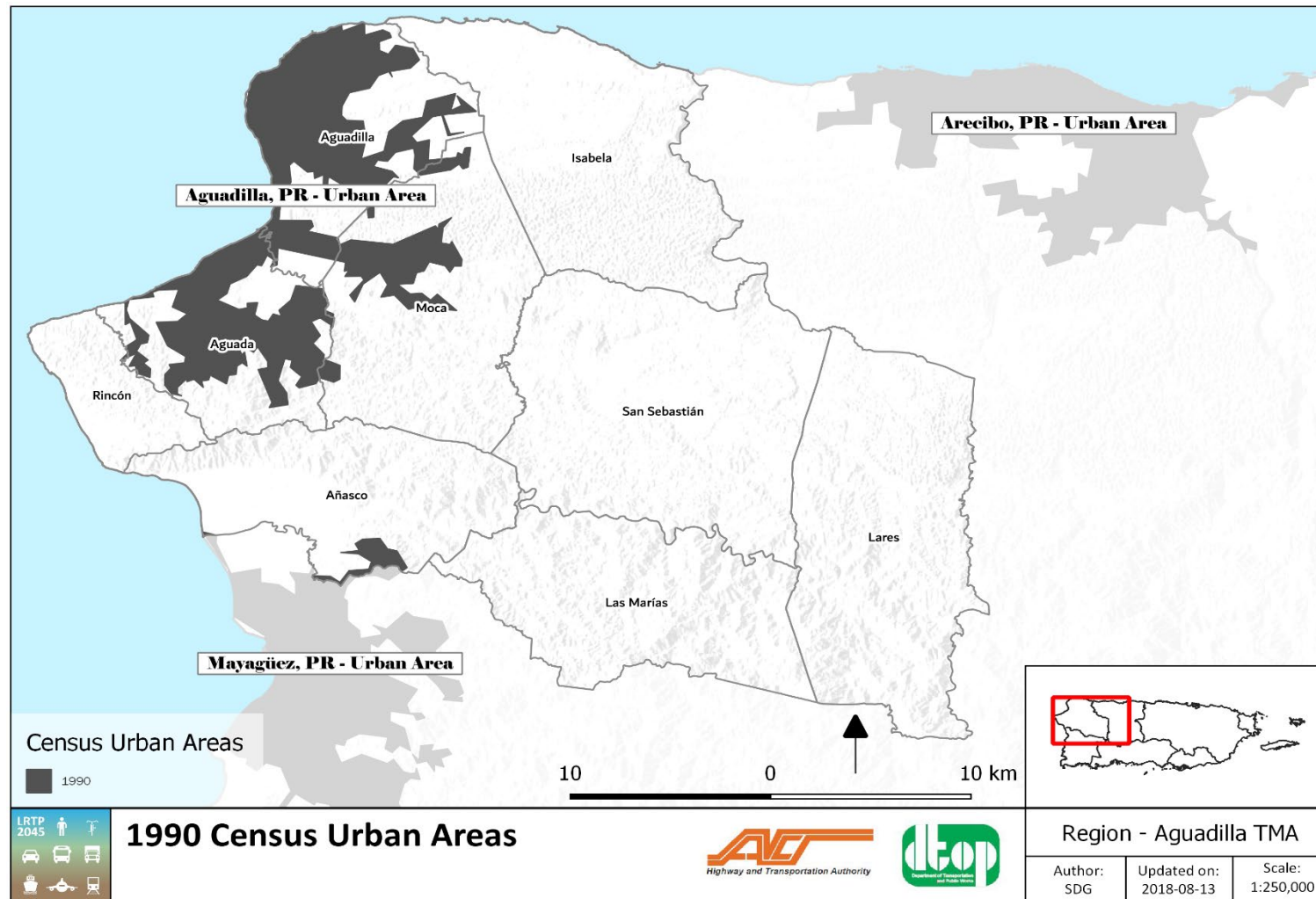
Source: Census Urban Areas for the year 1990 were acquired on March 2018 from the Puerto Rico Planning Board Web Feature Service at: http://geoserver.gis.pr.gov/geoserver/wfs

Figure 2.4: Aguadilla TMA Urbanized Areas, 2000
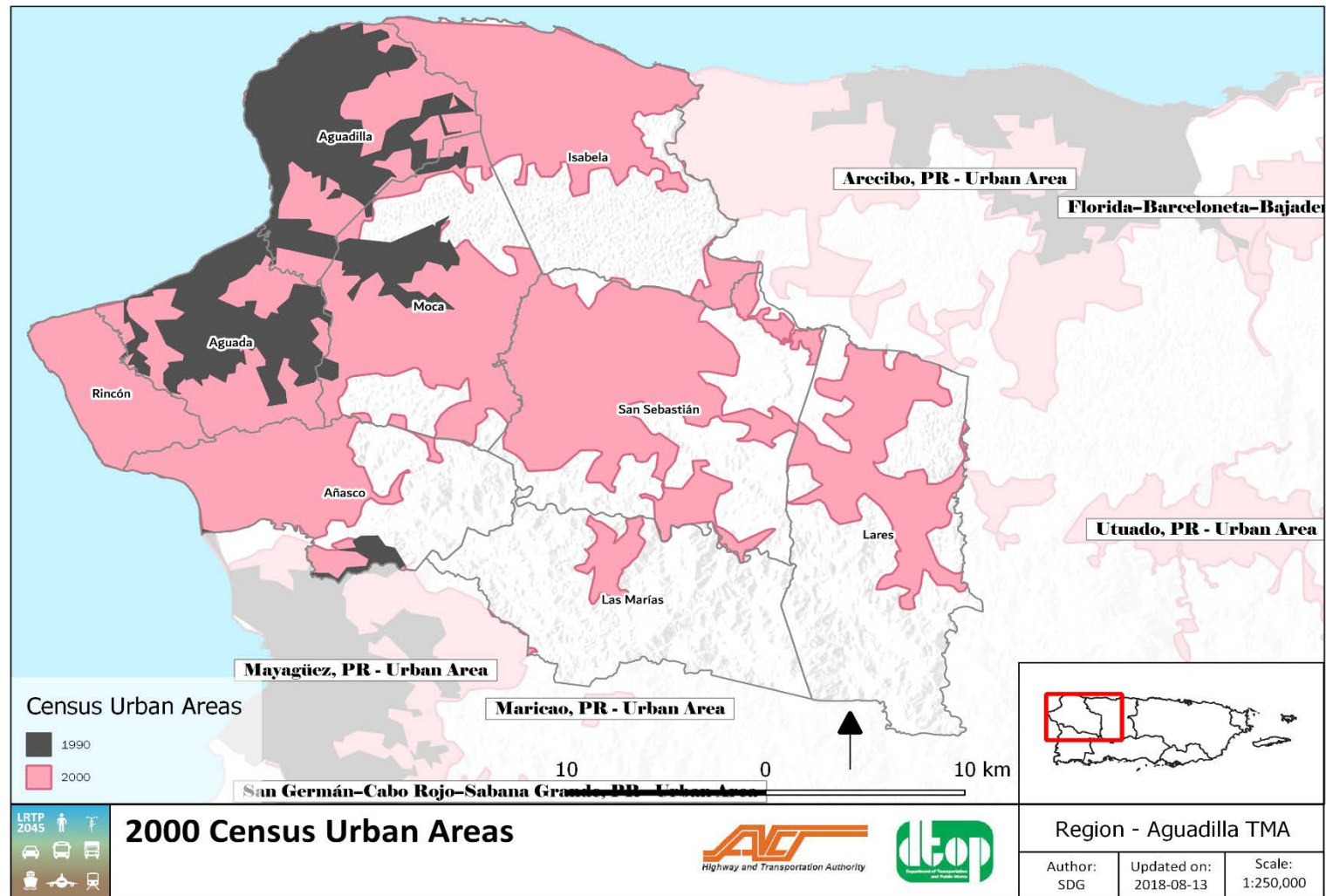
Source: Census Urban Areas for the year 2000 were acquired on March 2018 from the U.S. Census website: https://www2.census.gov/geo/tiger/PREVGENZ/ua/ua00shp/

Figure 2.5: Aguadilla TMA Urbanized Areas, 2016
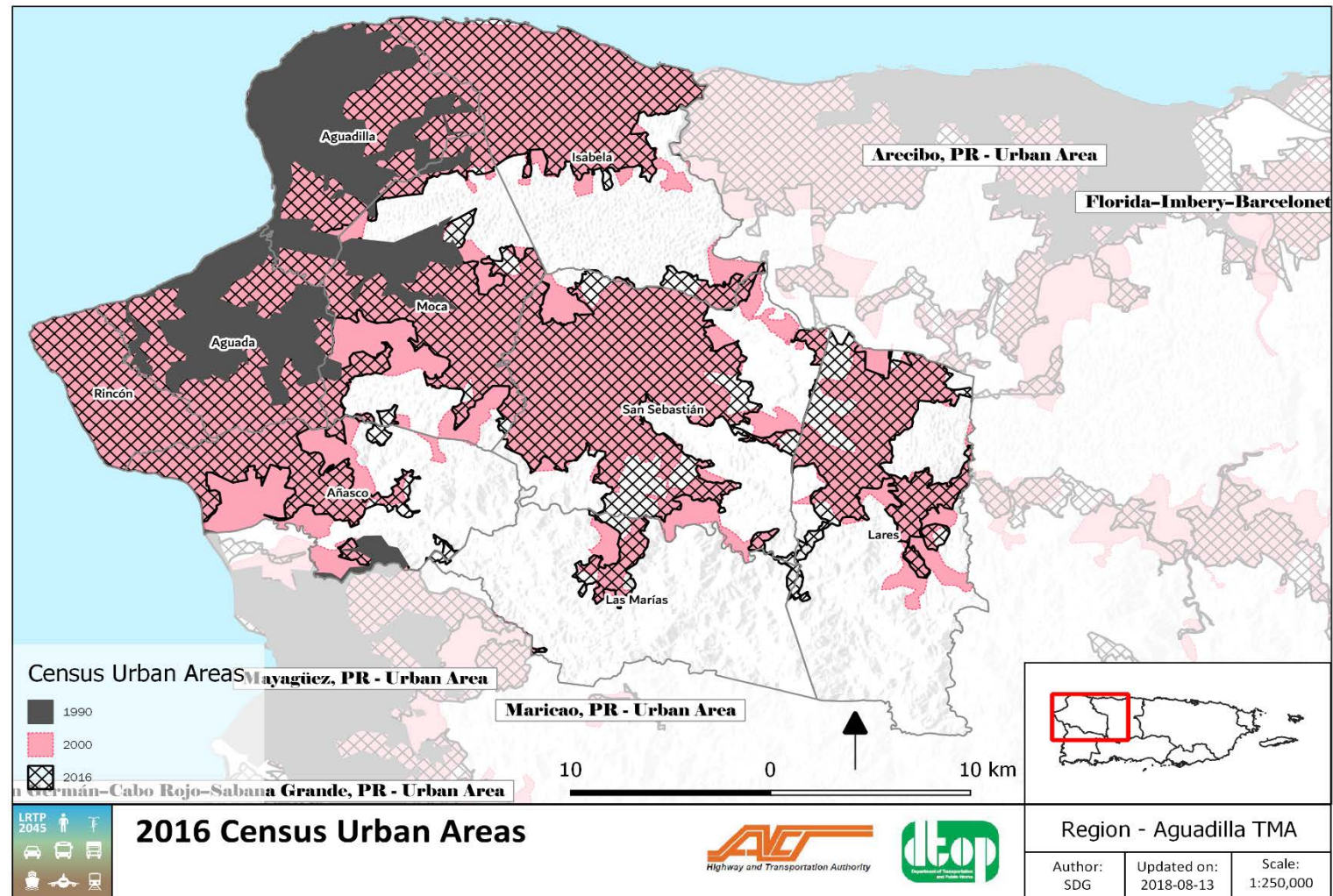
Source: The 2016 Census Urban Area shapefile was acquired on March 2018 from the U.S. Census Website at: https://www2.census.gov/geo/tiger/GENZ2016/shp/

Land Use Patterns

Growth and urban development resulted historically in urban sprawl in the region and across the island. At first, the town centers were developed to concentrate housing, jobs, businesses and services for its population. But over the years, urban centers developments have been changed to suburban developments. This has made a significant impact into the land covering over the years.

Aguadilla TMA grew significantly until the decade of 2000 in line with economic prosperity. Following decades are showing a moderate growth mostly due to recession, out-migration to the United States and other variables.

The natural environment contributes and guides the urban development. Aguadilla TMA has a special planning area: the karstic zone. Puerto Rico's karstic zone constitute the largest recharge system in Puerto Rico for the supply of underground water bodies or aquifers, as well as their emanation on the surface in the form of springs, lagoons, streams and rivers. This zone is divided into two special planning areas: (1) Area of the special planning karstic zone and (2) Area of special planning of the restricted karstic zone.

The referred special planning areas are in effect since July 2014. This planning instrument is aiming to promote a harmonious balance between conservation and sustainable development. Its principal objective has been to orient the use and development of the protected land considering its ecological, social, economic and regulatory reality.

Aguadilla TMA shows a significant portion of its territory classified as protected rural land for agriculture. Beyond that, the Region has an agricultural reserve designated by the Puerto Rico Planning Board. The referred Board define agricultural reserve as (1) an agricultural land or one that can become agricultural and can include (2) land used for non-agricultural purposes whose development is controlled with the goal of avoiding adverse effects on the agricultural land. The agricultural reserve is located in the municipalities of Añasco and Mayagüez.

The Region has two areas designated by the Puerto Rico Planning Board as zones of tourist interest. These can be defined as any area in the Puerto Rico's geographical demarcation in which natural and/or artificial attractions are currently developed for tourism or that have tourism potential. Rincón-Añasco and Aguadilla-Isabela show this condition within the Region.

The Land Use Plan established a new territorial regional structure based on functional areas. This structure intents to understand and attend how the municipalities are interconnected considering its interrelation, mobility, dependencies, complementarity and influences among social, economic and industrial aspects, apart from the shared geographical characteristics.

The functional area of Aguadilla is composed by the following municipalities:

- Aguada;
- Aguadilla;
- Isabela;
- Moca; and
- San Sebastián.

The municipalities of Rincón, Añasco and Las Marías are part of the functional area of Mayagüez. Lares is part of the functional area of Arecibo.

Aguadilla TMA is composed by nine municipalities. This Region shows a moderate urban development growth and a variety of land uses and community types but in a smaller scale compare with the San Juan TMA (Figure 2.6 shows the different land use patterns (classifications) for Aguadilla TMA). It includes a corridor of urbanized areas composed mainly by: Isabela, Aguadilla, Aguada and Moca. These municipalities concentrate 60.0% of the total population of the Region, according to the facts provided by the American Community Survey 2016 – US Census Bureau.

The Aguadilla TMA also has important commercial activity, infrastructure and facilities which contribute to the economic development and better quality of life. Municipalities like Aguadilla, Moca, Aguada and Isabela are the ones that carry the most significant impact in the Region. Rafael Hernández International Airport, one of the most important airports in the Island, is located in the municipality of Aguadilla. Numerous health service locations, hospitals like Buen Samaritano, shopping centers, government offices, legal courts comprehended in the Aguadilla judicial Region, the University of Puerto Rico, Aguadilla campus, and industrial zones are also located within this management area.

It is important to mention that the Puerto Rico Planning Board approved the first Land Use Plan for Puerto Rico in 2015 with the objective of establishing the public policy on the management of land use that allows to maximize the potential of the Puerto Rican soil within a framework that guarantees the protection of natural resources and sustainable development. It is the framework that guides the public policy on land use for Puerto Rico.

The Land Use Plan for Puerto Rico in 2015 was a collaborative process where the Municipal land use plans or already autonomous municipalities and its Territorial Plans (Plan de Ordenamiento Territorial), were considered or integrated since the Planning Board regulates and approves the Territorial Plan process for the municipalities. This is required so that all municipalities move towards achieving the goals of: "(1) development and redevelopment in communities where infrastructure already exist, (2) preserve and protect the natural, archeological, agricultural, rural soils, and sensitivity environments to the adverse effects of uncontrolled construction, and (3) ensuring a desirable quality of life within cities, communities and neighborhoods in a fair and sustainable way"[13].

The Comprehensive Bicycle and Pedestrian Plan and the Complete Street Plan and Design Guidelines adopted in September 2018 will also foster a positive impact on the land use patterns. Both documents aim to encourage a physical integration of urban centers by providing alternatives modes of transportation.

[13] Quoted from the Puerto Rico Land Use Plan approved November 19, 2015.

Figure 2.6: Aguadilla TMA Land Uses

Land Use

■	VIAL - Road System
■	AGUA - Body of Water
■	SU - Urban Land
■	SURP - Planned Development
■	SURNP - Unplanned Developable Urban Land
■	SRC - Rustic Common Soil
■	SREP - Specially Protected Rustic Common Soil
■	SREP-H - Specially Protected Rural Land - Hydrology
■	SREP-P - Specially Protected Rustic Common Soil - Landscape
■	SREP-A - Specially Protected Rural Land - Agriculture
■	SREP-AE - Specially Protected Rural Land - Agriculture and Ecology
■	SREP-AP - Specially Protected Rural Land - Agriculture and Landscape
■	SREP-AH - Specially Protected Rural Land - Agriculture and Hydrology
■	SREP-E - Specially Protected Rural Land - Ecology
■	SREP-EA - Specially Protected Rural Land - Ecology and Agriculture
■	SREP-EH - Specially Protected Rural Land - Ecology and Hydrology
■	SREP-EP - Specially Protected Rural Land - Ecology and Landscape

Land Use

Region - Aguadilla TMA

Author:	Updated on:	Scale:
SDG	2018-09-26	1:250000

Source: Land Use layer provided by Puerto Rico Highway and Transportation Authority (ACT by its spanish acronym), the shapefile layer was created by the Puerto Rico Planning Board and was adopted on November 19, 2015.

Environmental Resources

Puerto Rico, even though having a small territorial extension, possesses a diversity of natural resources and ecosystems, which are the result of its geological evolution across the ages. These features are a direct consequence of the abrupt difference in ground elevations observed between the coastal plains and the central mountainous part of the Island. This variability in the topography, results in rainfall patterns of orographic nature between the different Regions, which in turn provide adequate conditions for biodiversity as well as different landscapes. Therefore, it is possible to observe a high degree of variability in the environmental settings as a function of the location within the Region, ranging from the coastal plains and mountainous parts of the Aguadilla TMA.

The northern parts of the Aguadilla TMA are characterized by low elevations while the highest ones are located toward the southern part of the Region which happens to coincide with the center part of the Island. This area is located within the Cordillera Central mountainous system. These higher elevation grounds also lie within what has been designated as a kart Region resulting from its geologic characteristics. Karst or karstic formations such as haystack hills (commonly referred to as mogotes) refer to the portions of the earth's surface made up mainly of limestone, which contains calcium carbonate (CaCO3) and dissolves due to acidic water eroding and breaking the rock down. About a third of the Puerto Rico surface area is known to be of karstic nature. Carbonate rocks were formed from the skeletal remains of marine organisms deposited on the bed of shallow seas (continental and Island shelves) millions of years ago. Most of these organisms are comprised of coral reefs and accumulations of coral colonies that contain the bones of fish, conch shells, urchins and other marine organisms that consolidated over time. Posterior geological movements pushed the seabed up, resulting in the formation of the limestone mountains. This process took place during the mid-tertiary period of the Cenozoic era, after which the constant movement of the earth's surface during the course of millions of years resulted in the formation of the faults and fractures presently observed in these limestone rocks. The largest one of these Regions is constituted by the northern parts of the Island located between the municipalities of Aguadilla and Loíza. The Guajataca Natural Reserve constitutes the most important forest resource located within this Region. Studies performed in these areas have disclosed the fact that the greatest diversity of native trees (49.0%) has been found in this humid karst Region (Figueroa Colón, J.C.; Gómez, G.; Ortiz, P.; Lapin, B. (1984), Informe de Progreso, Departamento de Recursos Naturales y Ambientales, San Juan, Puerto Rico). These areas also constitute the habitat for many protected fauna species (birds, reptiles and terrestrial mammals).

As previously indicated, the most important forest system located within this Region is the Guajataca Forest, which is bounded to the north by the municipalities of Aguadilla and Isabela. The biggest portion of this forest is located within the geographic boundaries of the municipalities of San Sebastián and Moca. In addition, two (2) relatively important agricultural valleys are observed in this Region: the Aguada and the Añasco agricultural valleys. Both of them are located nearby the coastal plains along the west shores of this Region and were utilized in the past mostly for sugar cane plantation.

In terms of hydrologic features, an extensive network of creeks, rivers and streams are observed approximately across the lower two thirds parts of this TMA, as a function of its topography which

provides adequate conditions of relatively frequent rain events. Some wetland systems are observed toward the west side of the Region, in the municipalities of Aguada, Añasco and Rincón. It is also important to note that area's hydrologic features have provided adequate environmental conditions for the establishment of populations of critical, endangered and threatened species mostly within the range of Guajataca Forest. The Guajataca lake, which is located to the south of this forest, constitutes a vital component of the water supply infrastructure for the Island, in particular for the municipalities of Isabela and Aguadilla, which lack the presence of superficial bodies of water and/or groundwater resources with adequate capacities to supply water for the needs of the population of this area. Raw water is transported to the mentioned municipalities through a system of tunnels and concrete lined channels which upon reaching their destination is treated at filtration plants owned by the Puerto Rico Aqueduct and Sewer Authority (PRASA). This distribution system was built around 1927 as a source of irrigation water for agricultural purposes as well as to provide a source of water to the hydroelectric power plants in the municipalities of Isabela and Aguadilla.

Land uses within the TMA show the presence of concentrated patches of urban areas localized mostly around the town centers of each one of the municipalities comprising this Region, while a significant part of the soils has been dedicated to agricultural uses. This land use pattern may be result of a combination of conditions such as the elevation of the terrain a well as the type of soils. It is a historic fact, that early in the 20th century up to the 1960's and 70's, sugar cane plantations constituted the most significant agricultural product observed along the coastal plains and valleys within the Region, while at the higher grounds of the Region significant agricultural products were constituted by coffee, tobacco, citrus and dairy farms. Currently, the center parts of this Regions agricultural production are related to coffee, citrus and dairy farms since sugar cane and tobacco no longer constitute products in demand. Based on current as well as projected development trends for the area, present land use patterns are expected to remain. Some light industrial uses related to the aeronautic industry are observed near the Ramey base Airfield area, while some pharmaceutical uses are observed in the municipality of Añasco. Tourism industry related land uses are mostly concentrated near the municipality of Rincón.

Improvements of existing roadways as well as the construction of new transportation related infrastructure requires the sensible consideration of the natural resources present at each discrete location, to minimize potential direct and indirect impacts to their integrity and to foster their preservation and functionality for future generations. In pursuing this goal, many environmental laws and regulations have been approved and are currently in place to facilitate in complying with this goal. The National Environmental Policy Act (NEPA) of 1970, and the Environmental Policy Law (Law #416 of September 20014) enforced by the Puerto Rico Environmental Quality Board (EQB) are examples of laws that have established the procedural scheme that requires to address the environmental impacts associated with the construction of transportation projects, and requires their avoidance, minimization and mitigation as the last resort. This process requires the coordination of many local and federal environmental agencies. The MPO fully supports and promotes this coordination between local and federal agencies.

Figure 2.7 through Figure 2.9 illustrate the main environmental features of the Aguadilla TMA.

Further details about Protected Forests and Reserves in Appendix M.

Figure 2.7: Environmentally Sensitive Areas
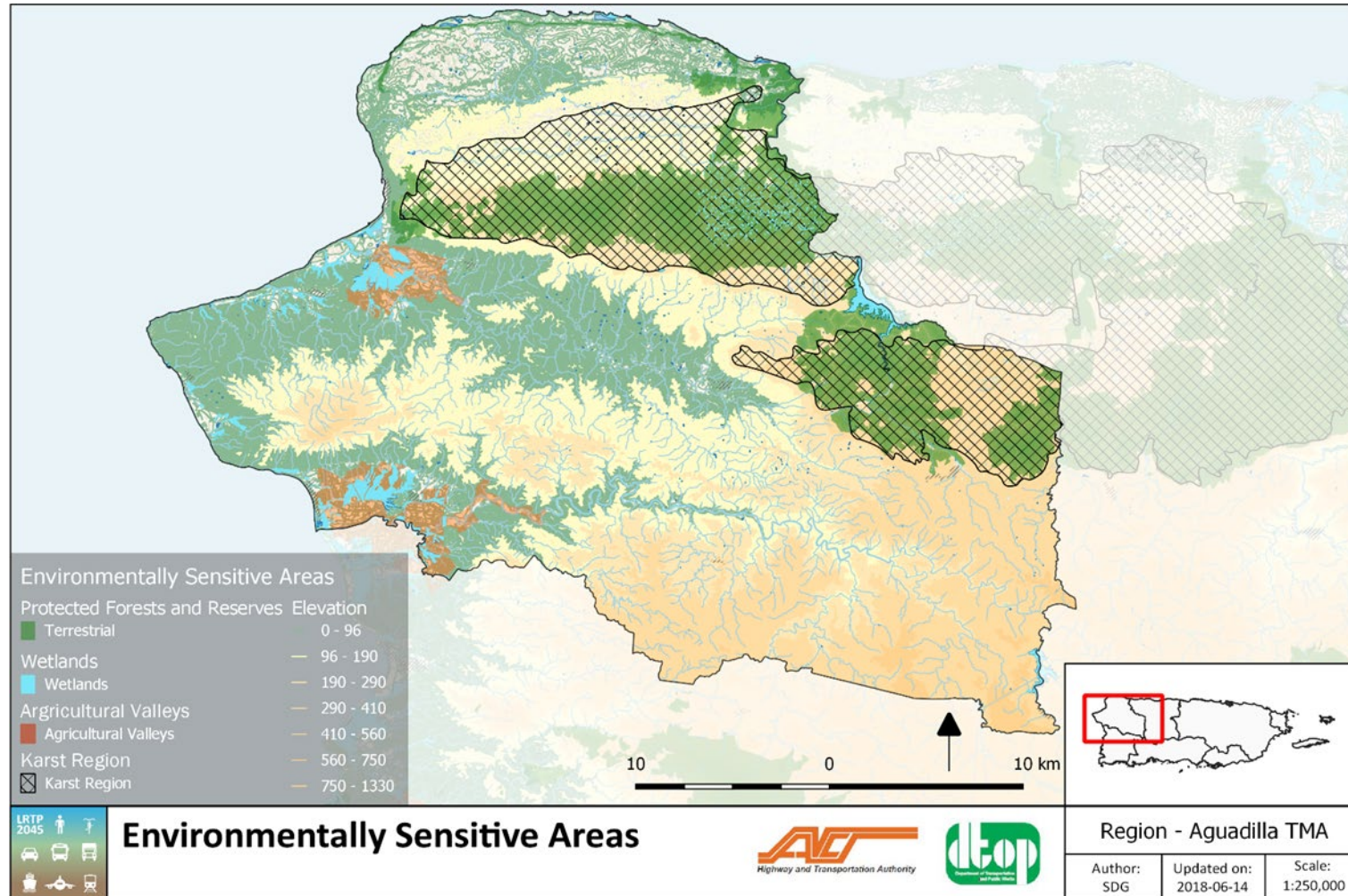
Source: The Environmentally Sensitive Areas Map was created using information layers from various government agencies listed as follows: Wetlands • https://www.fws.gov/wetlands/data/Mapper.html | Elevation: • Puerto Rico Planning Board Web Feature Service: http://geoserver.gis.pr.gov:80/geoserver/wfs? | Agricultural Valleys: • Puerto Rico Planning Board: http://www2.pr.gov/agencias/gis/descargaGeodatos/Desarrollo_Economico/Pages/Agricultura.aspx | Protected Forests and Reserves • https://www.fs.usda.gov/detail/iitf/research/?cid=fseprd528757

Figure 2.8: Protected Forests and Reserves
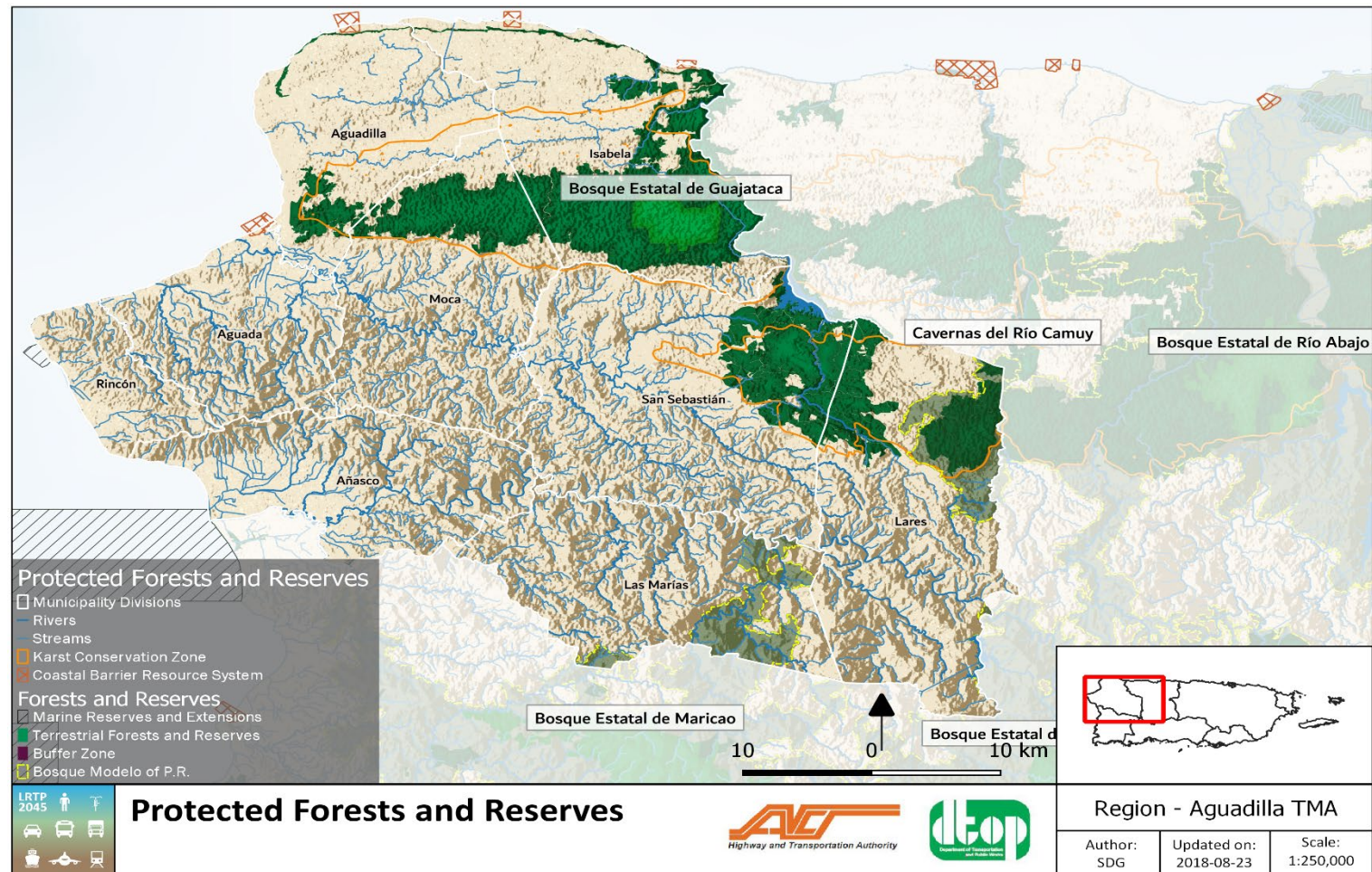
Source: The Protected Areas and Reserves layer represents the latest compilation (as of Dec.2016) of protected areas and reserves, the shapefile is the product of a collaborative effort by the Caribbean Landscape Conservation Cooperative (CLCC) Protected Areas Conservation Action Team (PA-CAT), which aims to compile, analyze and improve protected areas data for Puerto Rico and US Virgin Islands. The Bosque Modelo of P.R. information layer was acquired from the Puerto Rico planning board on 2018. Boundaries of the John H. Chafee Coastal Barrier Resources System (CBRS) shown on this map were acquired from the FWS website at: https://www.fws.gov/gis/data/national/. The official CBRS maps are enacted by Congress via the Coastal Barrier Resources Act, as amended, and are maintained by the U.S. Fish and Wildlife Service. The official CBRS maps are available for download at http://www.fws.gov/CBRA.

Figure 2.9: Coverage of Environmental Features
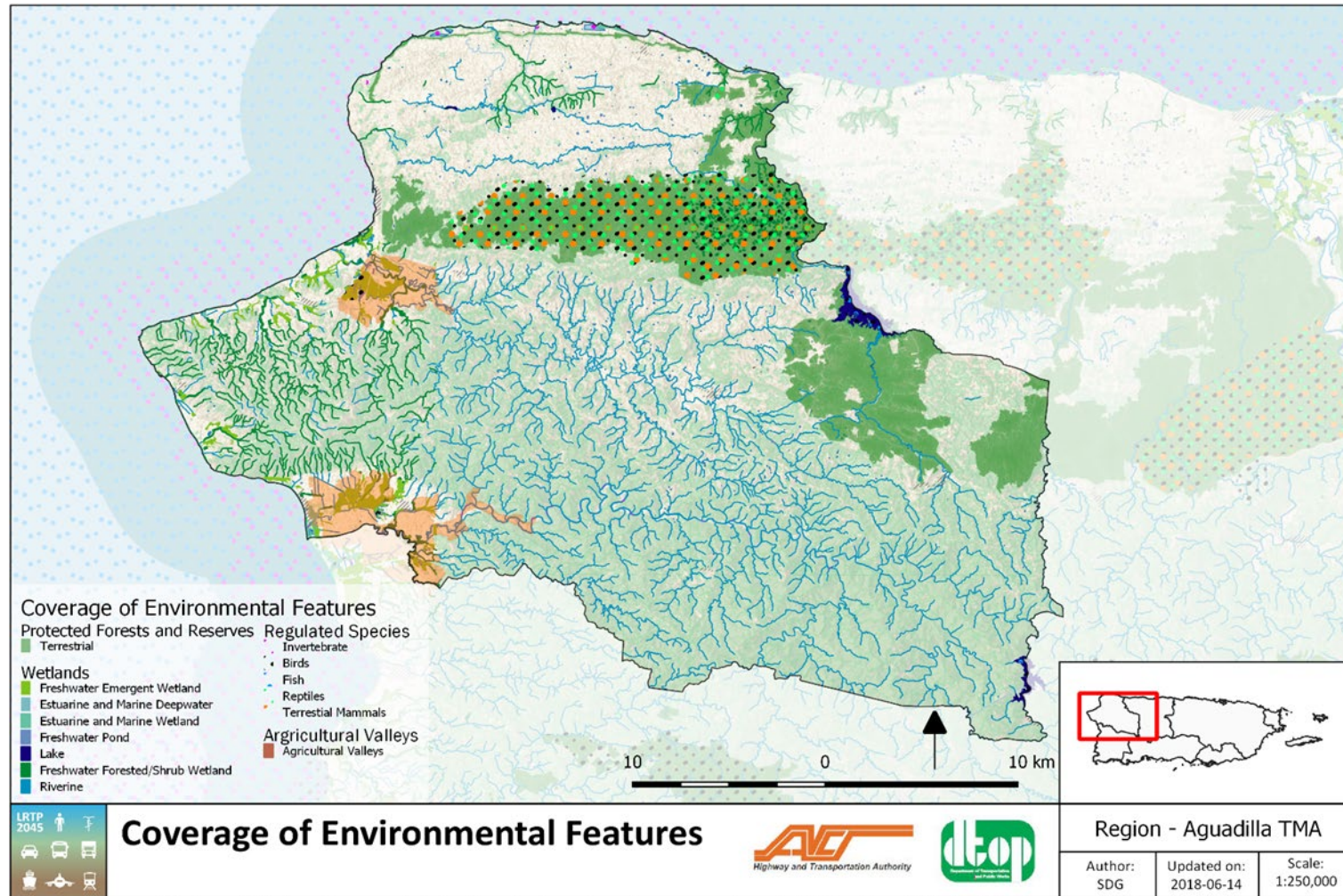
Source: The Coverage of Environmental Features Map was created using information layers from various government agencies listed as follows: Wetlands • https://www.fws.gov/wetlands/data/Mapper.html | Regulated Species: • Puerto Rico Planning Board Web Feature Service: http://geoserver.gis.pr.gov:80/geoserver/wfs? | Agricultural Valleys: • Puerto Rico Planning Board: http://www2.pr.gov/agencias/gis/descargaGeodatos/ Desarrollo Economico/Pages/Agricultura.aspx | Protected Forests and Reserves • https://www.fs.usda.gov/detail/iitf/research/?cid=fseprd528757

DEMOGRAPHICS

Population

The population growth trend is fundamental in estimating travel patterns and its impact on the operation performance in terms of congestion and reliability of the transportation system. The Population in Puerto Rico had experienced a decreasing trend since 2005 when the Island started to register an economic recession along with other countries and the United States. This trend on population had continued from an annual trend of 0.5% between 2005 and 2010 to over 1% after 2010 as shown in Figure 2.10.

According to the US Census Bureau and the Puerto Rico Statistic Institute, the population of Puerto Rico is projected to be less than three million people (2,980,532 people) by the year 2025. In its previous projection, this happened for the year 2050. For the year 2050, the new projection is only two million people (2,089,492 people) in Puerto Rico[14].

Between 2010 and 2016, the Aguadilla TMA's population declined 8.7% from 316,173 to 288,777, a loss of 27,396 people, as can be seen in Figure 2.11.

Figure 2.10: Puerto Rico Historic Population
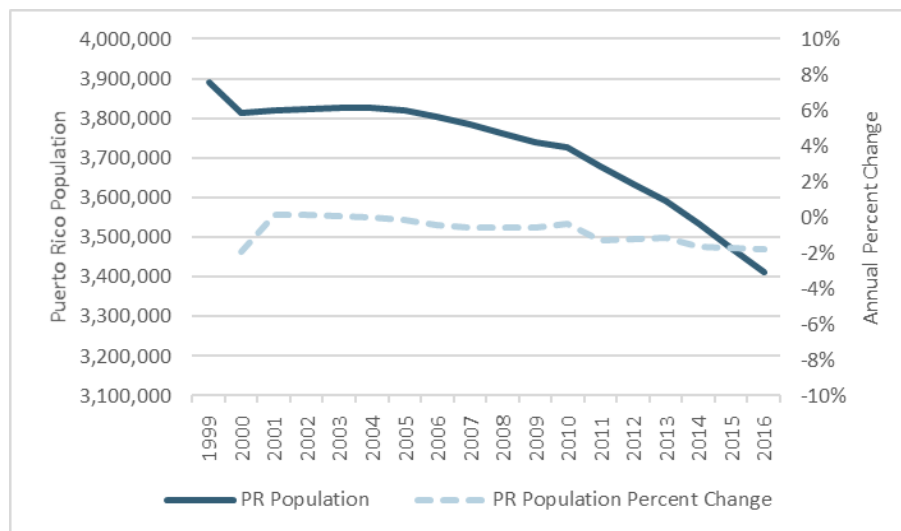
Source: SDG analysis of US Census Data

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[14] U.S. Census Bureau projects population in Puerto Rico will be below 3 million inhabitants in just 8 years (2025). (September 2017) Press Release. Red State Data Center of Puerto Rico (SDC-PR). https://censo.estadisticas.pr/Comunicado-de-prensa/2017-09-17t125335.

Figure 2.11: Comparison Puerto Rico vs Aguadilla TMA – Population
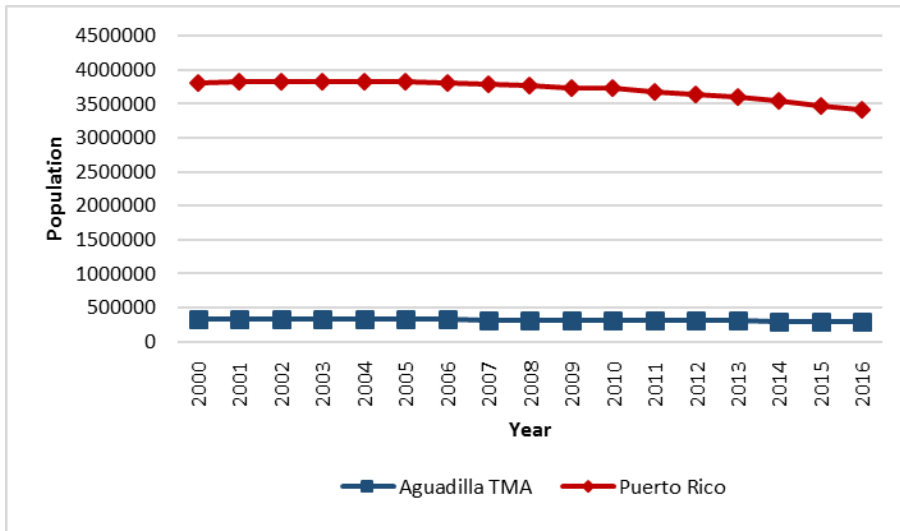
Source: SDG analysis of US Census Bureau Estimates

Aguadilla TMA (288,777) represented 8.5% of the Island total population (3,411,307) in 2016. The population in the Aguadilla TMA has been decreasing since 2000 with an overall decrease of 2.6% from 2000 to 2010 and a more severe 8.7% from 2010 and 2016.

As shown in Figure 2.12, the most populated municipalities within the Aguadilla TMA are Aguadilla, followed by Isabela, Aguada, San Sebastián and Moca. From 2000 to 2010 there was a mix of population losses and gains within the Aguadilla TMA municipalities with 5 of the 9 losing population between -0.7% in Aguada to -10.8% in Lares. Increases in population were observed in the remaining 4 municipalities from 0.9% in Moca to as high as 3.0% in Rincon.

Between 2010 and 2016, Lares exhibited the largest reduction in population (13.4%); followed by Las Marías (12.5%). Population changes are shown in Table 2.1.

Figure 2.12: Aguadilla TMA Population 2016

Source: Population Estimates from U.S. Census Bureau

CHAPTER 2 CONTEXT CURRENT SITUATION ASSESSMENT
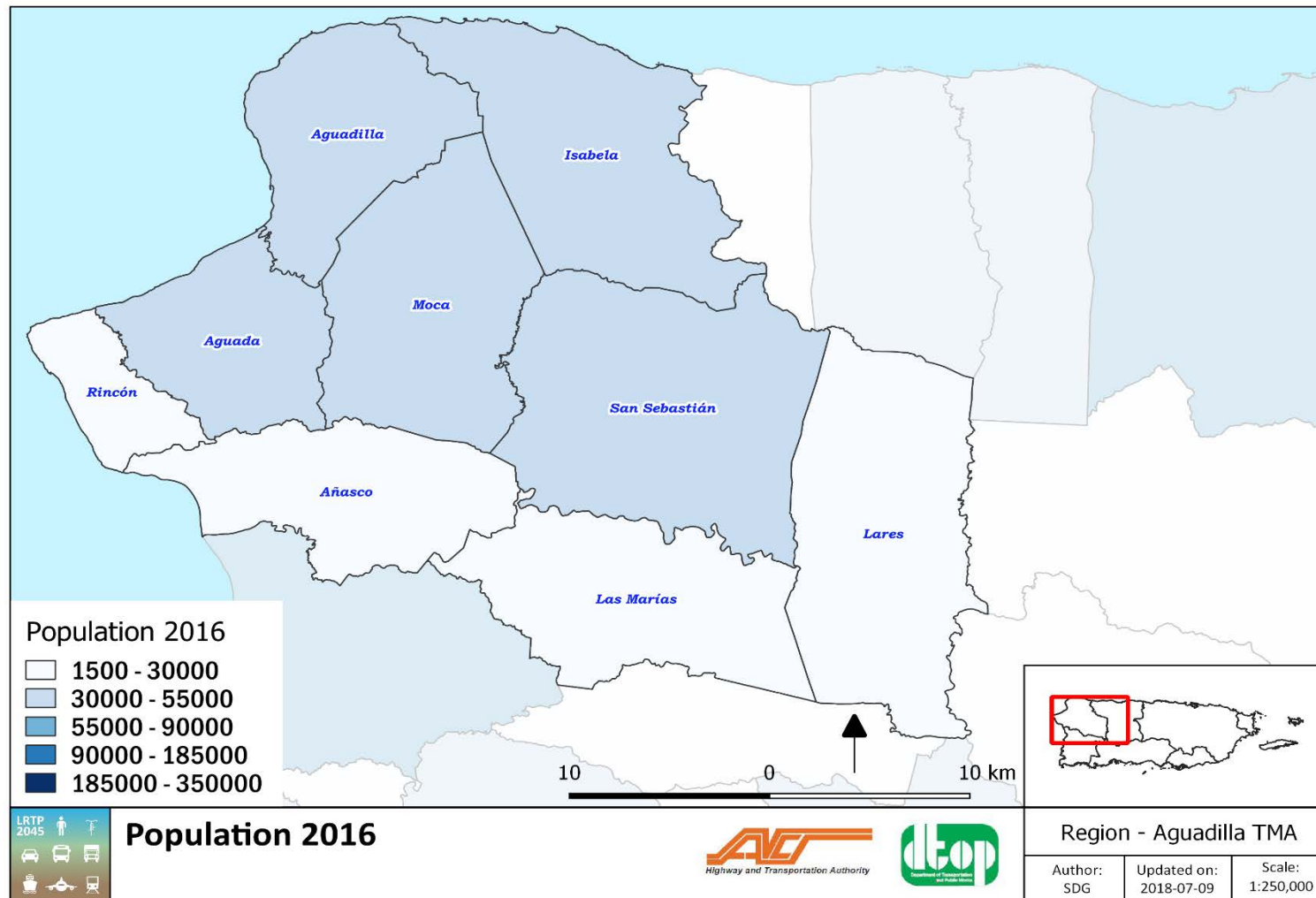
Table 2.1: Aguadilla TMA Population 2010-2016

Municipality	2000	2010	2000-2010 % Change	2016	2010-2016 % of Change
Aguada	42,262	41,959	(0.7%)	38,938	(7.20%)
Aguadilla	64,879	60,949	(6.1%)	54,582	(10.45%)
Añasco	28,505	29,261	(2.7%)	27,540	(5.88%)
Isabela	44,604	45,631	(2.3%)	42,744	(6.33%)
Lares	34,493	30,753	(10.8%)	26,629	(13.41%)
Las Marías	11,051	9,881	(10.6%)	8,645	(12.51%)
Moca	39,770	40,109	(0.9%)	37,117	(7.46%)
Rincón	14,756	15,200	(3.0%)	14,380	(5.39%)
San Sebastián	44,243	42,430	(4.1%)	38,202	(9.96%)
Total	**324,563**	**316,173**	**(2.6%)**	**288,777**	**(8.66%)**

Source: US Census Bureau Estimates 2010-2016

Employment[15]

In 2016, the Aguadilla TMA contained 81,952 jobs counting for 8.3% of total formal and informal employment in Puerto Rico[16]. Aguadilla municipality accounts for most of the employment in the Region with 19.4%, followed by Isabela, San Sebastián, Moca, and Aguada at 14.2%, 14.0%, 13.7% and 12.2% respectively, as shown in Figure 2.14.

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[15] Employment Data used to graph trends in this section showing intermediate years between 2010 to 2016 is by Place of Residence and covers all employment sectors including agricultural employment and the self-employed. In employment tables showing just the years 2010 and 2016, employment is by place of work, and covers all the employment sectors noted above. The sourcing under each table or graph, and it will be noted whether the data is by Place of Residence or Place of Work.

[16] This data is obtained from the Bureau of Labor Statistics Local Area Unemployment Statistics (LAUS) program. This program relies heavily on the Current Population Survey (CPS); a monthly survey consisting of in-person and telephone visits to a rotating sample of the population. Because the CPS occurs at individuals home locations, it is adept at capturing both formal and informal employment. The definition of employment by the BLS is:

> "All persons who, during the reference week, (a) did any work at all (at least 1 hour) as paid employees, worked in their own business, profession, or on their own farm, or worked 15 hours or more as unpaid workers in an enterprise operated by a member of the family, and (b) all those who were not working but who had jobs or businesses from which they were temporarily absent because of vacation, illness, bad weather, childcare problems, maternity or paternity leave, labor-management dispute, job training, or other family or personal reasons, whether or not they were paid for the time off or were seeking other jobs".

Quoted from Bureau of Labor Statistics, U.S. Department of Labor, Household Data, Current Population Survey, on the Internet at https://www.bls.gov/cps/eetech_methods.pdf (visited May 29, 2018).

Puerto Rico lost 7.1% of its employment between 2010 and 2016, which amounts to 74,905 jobs and a Compound Annual Growth Rate (CAGR) of -1.2%. In the same 6-year period, the Aguadilla TMA lost 5.0% of its employment, which amounts to 4,274 jobs and a CAGR of -0.8%. Figure 2.13, showing employment by place of residence, helps depict this trend[17].

Figure 2.13: Comparison Puerto Rico vs Aguadilla TMA – Employment
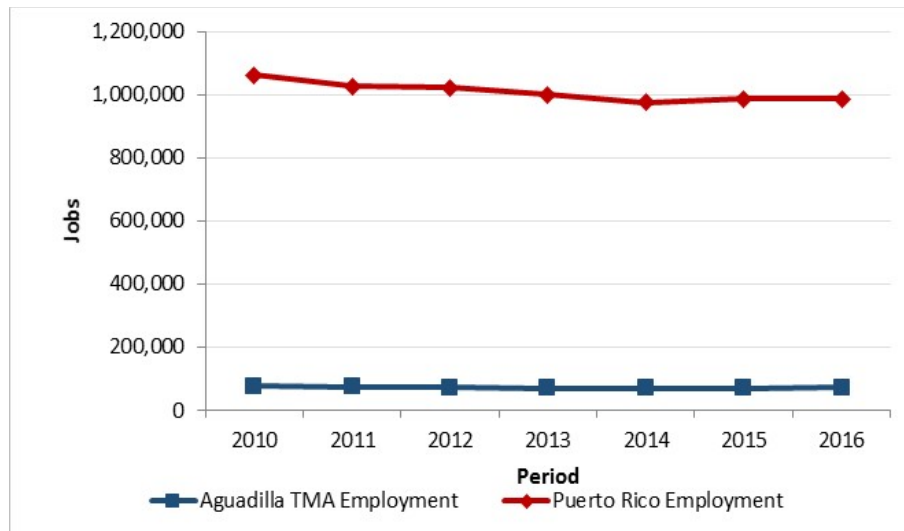
Source: SDG analysis of Bureau of Labor Statistics (BSL) Local Area Unemployment Statistics (LAUS) by Place of Residence

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[17] As employment was only transformed from Place of Residence to Place of Work for the spot years 2010 and 2016. Employment data by Place of Residence has been utilized to depict historical trends over time.

Figure 2.14: Aguadilla TMA Employment 2016
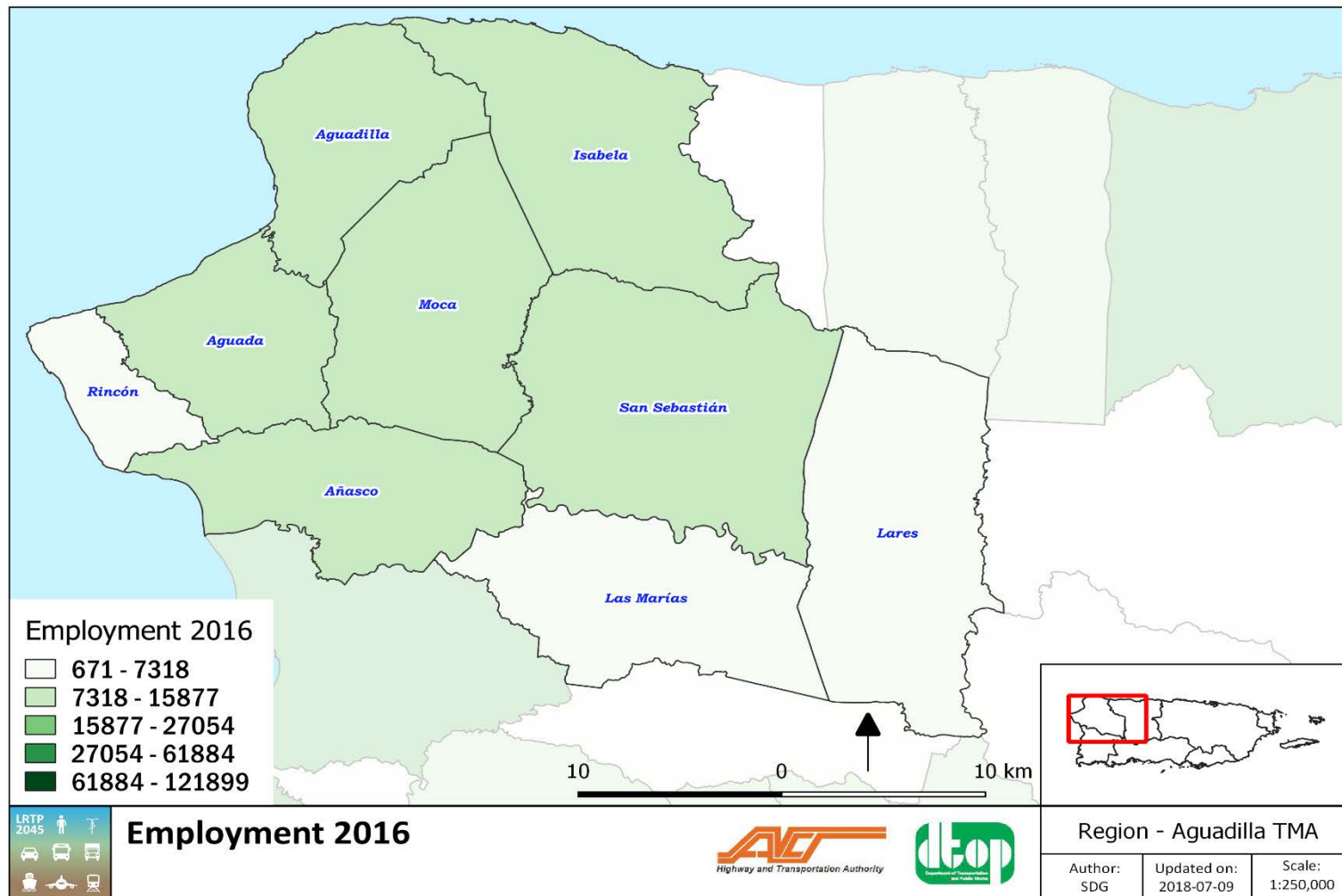
Source: Employment Data from the BLS LAUS, transformed to present employment by place of work.

Between 2010 and 2016, notable employment increases were noted in Rincon (8.9%) and San Sebastián (1.0%). Las Marías exhibited the largest reduction (-26.6%), followed by Lares (-19.1%), as shown in Table 2.2.

Table 2.2: Aguadilla TMA Employment by Place of Work 2010-2016

Municipalities of Aguadilla	2010	2016	Percent Change
Aguada	11,648	10,027	(13.92%)
Aguadilla	16,033	15,877	(0.98%)
Añasco	7,957	7,641	(3.98%)
Isabela	11,690	11,648	(0.36%)
Lares	8,743	7,077	(19.06%)
Las Marías	3,339	2,450	(26.63%)
Moca	11,257	11,191	(0.59%)
Rincón	4,176	4,549	(8.92%)
San Sebastián	11,382	11,494	(0.98%)
Aguadilla TMA Total	**86,227**	**81,952**	**(4.96%)**
Puerto Rico	**1,061,056**	**986,151**	**(7.06%)**

Source: 2010-2040 LRTP and 2016- 2045 LRTP Analysis of Bureau of Labor Statistics Local Area Unemployment Statistics, adjusted to be by Place of Work

In 2016, Puerto Rico and Aguadilla TMA unemployment rates, 13.4% and 15.5% respectively, have decreased from 2010 to 2015, as shown in Figure 2.15 and Figure 2.16.

Figure 2.15: Comparison Puerto Rico vs. Aguadilla TMA – Unemployment Rate
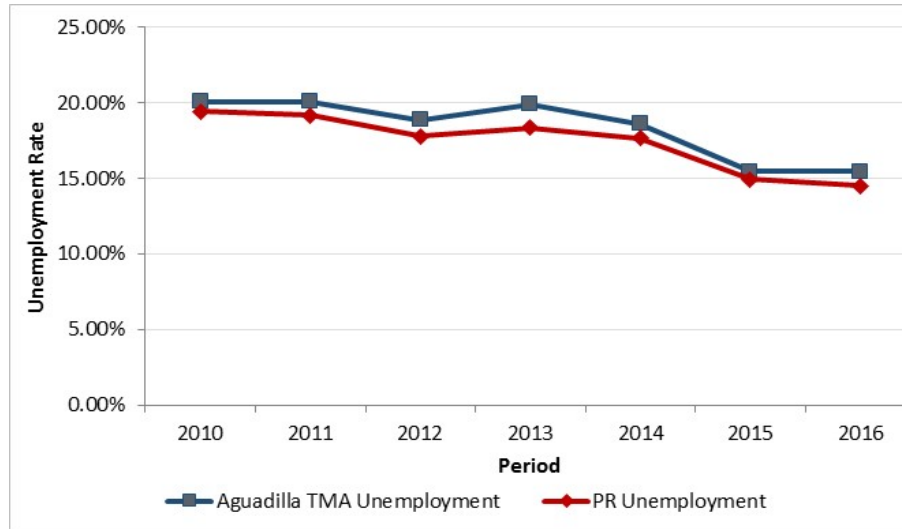
Source: SDG analysis of Bureau of Bureau of Labor Statistics Local Area Unemployment Statistics by Place of Residence

Figure 2.16: Aguadilla TMA Unemployment Rate 2016

Source: Bureau of Labor Statistics, Local Area Unemployment Statistics - https://www.bls.gov/lau/
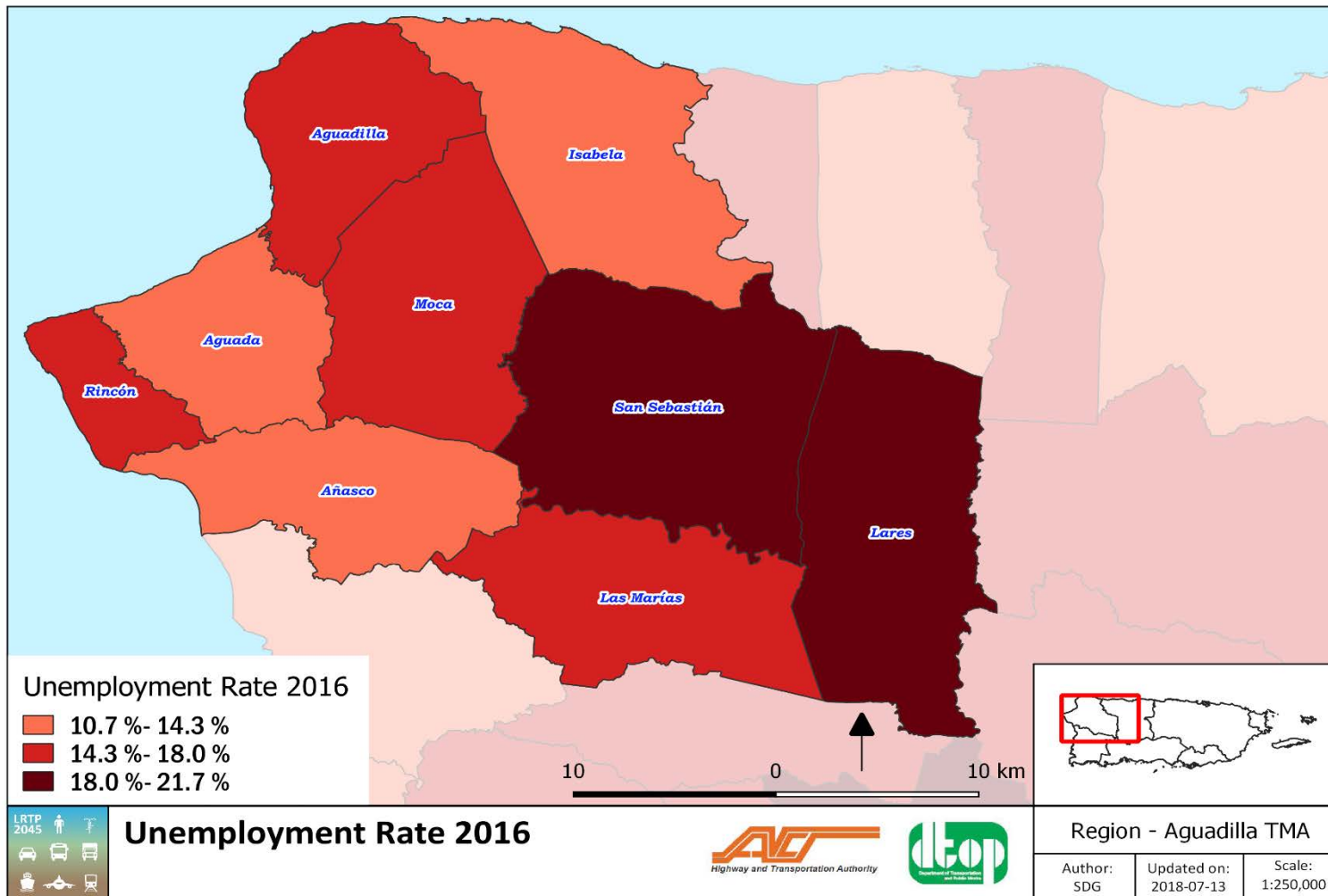
Table 2.3 and Figure 2.17 display the unemployed population by municipality per years. Aguadilla TMA represents a 10.0% of the unemployed (in labor force) population in Puerto Rico, where Aguadilla Municipality contributes with a 17.0%. Figure 2.16 shows that Lares has the highest unemployment rate, at 19.3%. The three largest municipalities in terms of labor force, Aguadilla, Isabela, and Aguada all have unemployment rates below 15%.

Figure 2.17: Unemployed (In Labor Force) Population
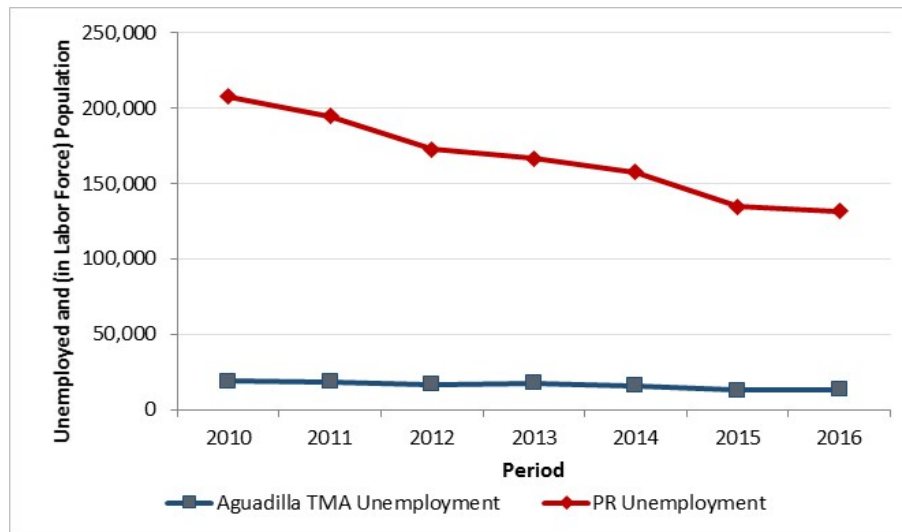
Source: SDG analysis of Bureau of Bureau of Labor Statistics Local Area Unemployment Statistics by Place of Residence

The LAUS survey does not distinguish between informal and formal employment, as questions of taxation or method of payment do not determine whether someone is counted as employed.

Unemployment has declined as employment declined because population and the labor force decreased at a faster rate than employment losses. This is highly related to the migration of individuals in the labor force out of the Island and the effect of low birth rates over the past 20 years starting to affect the workforce. Aguadilla's participation rate, calculated as labor force as a portion of population over 16 years old, and shown in Figure 2.18, has consistently been lower than Puerto Rico as a whole around 30%.

Figure 2.18: Participation Rate in Labor Force
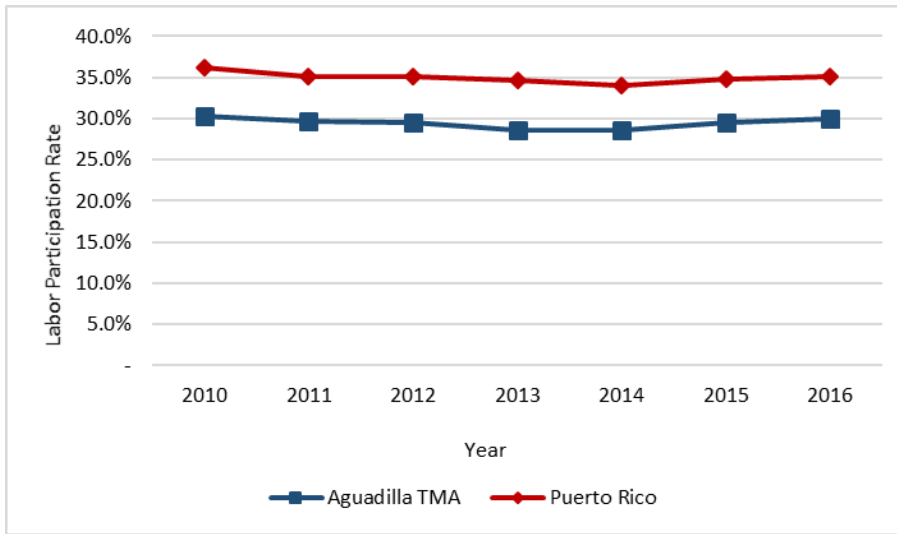
Source: SDG analysis of ACS population estimates and BLS LAUS employment data

Table 2.3: Unemployed (In Labor Force) Population by Municipality

Municipality	2010	2011	2012	2013	2014	2015	2016
Aguada	2,626	2,602	2,329	2,284	2,070	1,659	1,667
Aguadilla	3,556	3,310	3,013	2,689	2,470	2,081	2,223
Añasco	1,933	1,780	1,590	1,705	1,475	1,159	1,147
Isabela	2,679	2,532	2,295	2,104	1,886	1,559	1,783
Lares	1,606	1,642	1,511	2,004	1,774	1,503	1,435
Las Marías	673	659	601	749	736	487	427
Moca	2,453	2,392	2,202	2,199	1,990	1,665	1,677
Rincón	920	965	899	976	941	768	725
San Sebastián	2,637	2,670	2,504	2,709	2,566	2,129	2,033
Total	**19,083**	**18,552**	**16,944**	**17,419**	**15,908**	**13,010**	**13,117**

Source: Bureau of Bureau of Labor Statistics Local Area Unemployment Statistics by Place of Residence

In Puerto Rico, in recent history, overall the number of people employed has decreased while employment rates have increased, as shown in Table 2.4. This is due to population losses, which occur at a faster rate than employment. All Regions have lost over 10% of their labor forces between 2010 and 2016, while the Aguadilla TMA Region lost 10.6% of their labor force with employment declined by 5.5%.

Table 2.4: Aguadilla TMA and Puerto Rico Employment (2010 and 2016)

MPO Name	2010 - Labor Force	2010 - Employment	2010 - Employment Rate	2016 - Labor Force	2016 - Employment	2016 Employment Rate	% Change in Labor Force	% Change in Employment
Aguadilla	94,929	75,846	80%	84,823	71,706	85%	(10.6%)	(5.5%)
Puerto Rico	1,268,673	1,061,056	84%	1,117,928	986,151	88%	(11.9%)	(7.1%)

Source: Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics (LAUS) by Place of Residence

Age

In 2010 Puerto Rico had an elderly population, individual 65 years and older, 541,998 people, representing the 14.6% of the Island inhabitants. By the year 2016, the population of individuals 65 years and over was estimated at 645,887 people, which represents 18.9% of the total residents. Puerto Rico's elderly population holds a more significant share of total population, 18.9% compared to the young segment (under 15 years) who made up 16.3% of the population in 2016, as shown in Figure 2.19.

Figure 2.19: Age Distribution for Puerto Rico
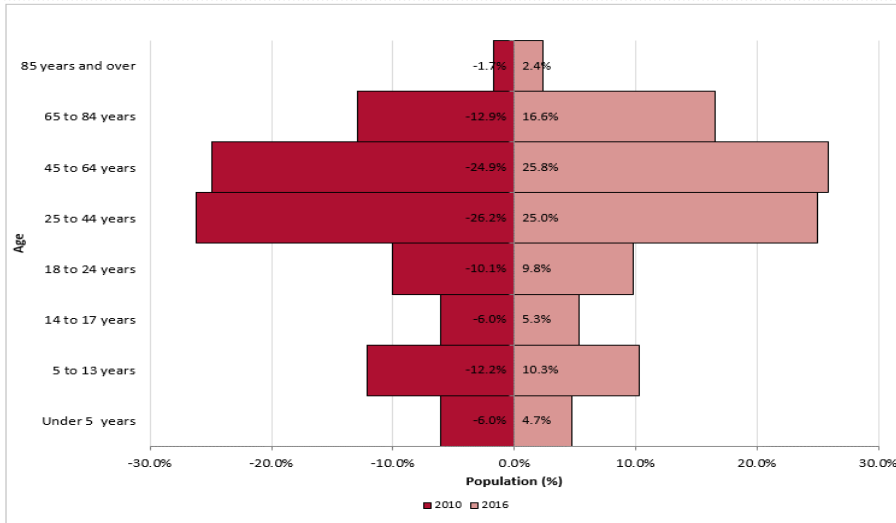
Source: SDG analysis of US Census Bureau Estimates 2010-2016

In 2010, the elderly population in Aguadilla TMA reached 45,880 people, representing 1.2% of the Island population. By the year 2016, the population of individuals 65 years and over was estimated at 55,290 which represents a 1.6% share of the Puerto Rico population. Between 2010 and 2016, population share of individuals under 15 years decreased from 1.7% to 1.4%. Therefore, the Aguadilla TMA's elder population holds a more significant share of total population (1.6%) compared to the young segment (1.4% under 15 years) in 2016.

Figure 2.20: Comparison Aguadilla TMA population Older vs. Younger. Figure 2.20 shows that the share of the elderly population grew larger than the share of youths starting in 2014, with the gap continuing to widen. The proportion of the population aged between 20 and 59 years has been maintained, changing slightly from 4.4% to 4.3% during the period 2010-2016.

Figure 2.20: Comparison Aguadilla TMA population Older vs. Younger
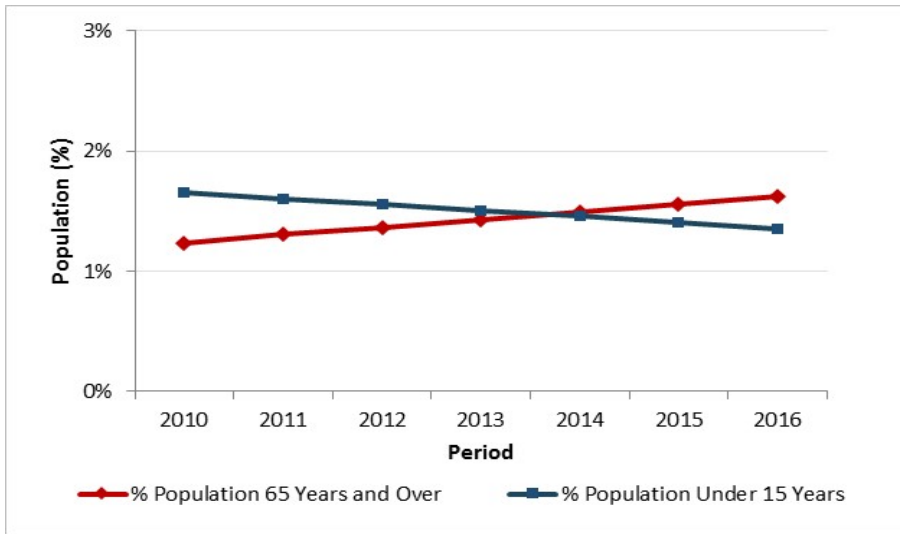
Source: SDG analysis of US Census Bureau Estimates 2010-2016

Figure 2.21 shows the trend of the Aguadilla TMA's Aging Index[18] since 2010. In July 2016, in the Aguadilla TMA, the index was above 100 representing more senior than youth inhabitants in eight (8) of nine (9) municipalities, as seen in Figure 2.22.

Figure 2.21: Aguadilla TMA Aging Index 2010-2016
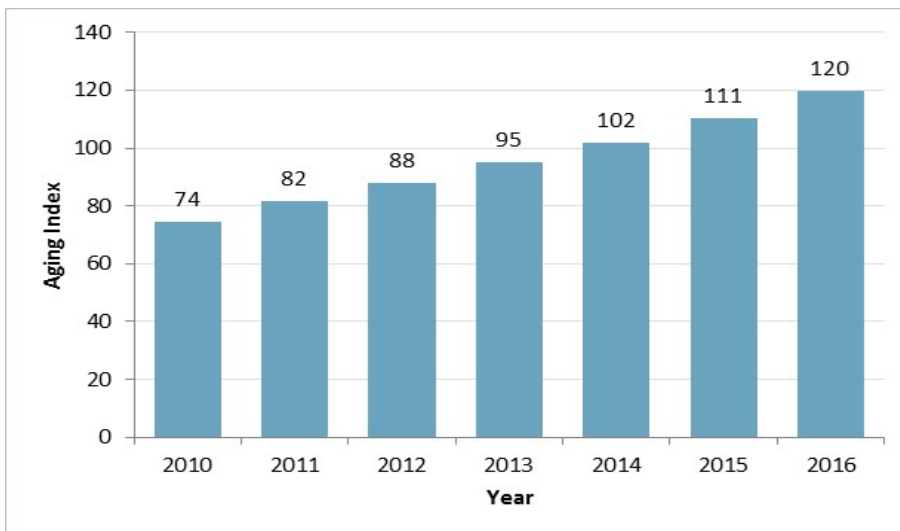
Source: SDG analysis of US Census Bureau Estimates 2010-2016

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[18] Aging Index: "relates the most dynamic groups of population and that most influence the structure and evolution of a population. This index relates the old population, which can be 60 years or more (P_{60+}) or 65 years or more (P_{65+}) with the population of minors that is generally below the age of 15 years (P_{0-14}) in order to see if the oldest population of a particular place is more, equal or less than the youngest population. The utility of the Aging Index is to observe the amount of old population per 100 young, that is, try to measure the weight that one sector falls on another sector". http://demografia.rcm.upr.edu/index.php/indicadores-en-demografia/i-composicion/i-viejos.

Figure 2.22: Aging Index by Municipality 2016
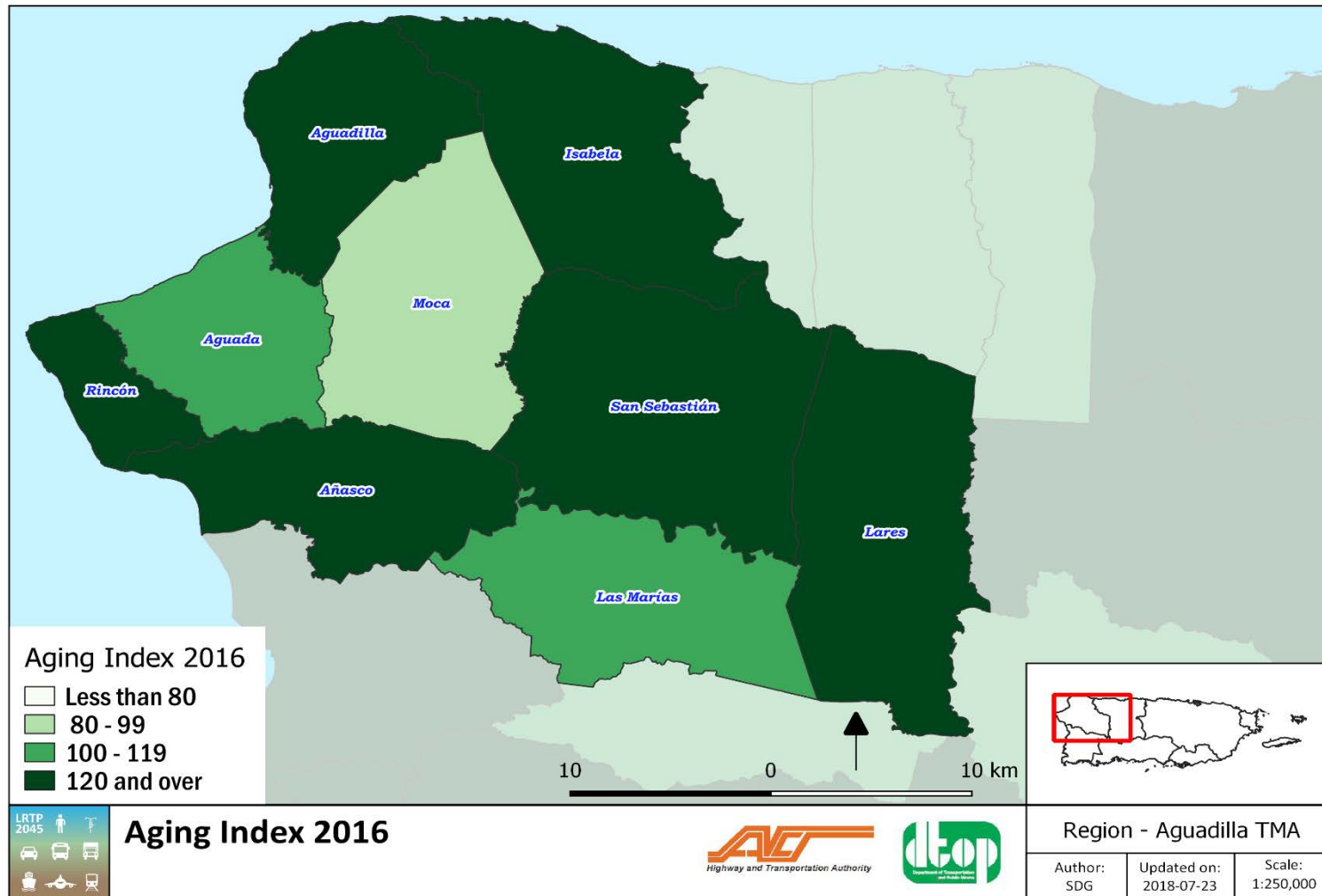
Source: Age Statistics obtained from the U.S. Census Bureau

In the Aguadilla TMA, the five (5) highest ranking municipalities in terms of aging index are shown in Table 2.5.

Table 2.5: Highest Aging Index in Aguadilla TMA 2016

Municipality	Aging Index
Rincón	159
San Sebastián	133
Aguadilla	125
Añasco	124
Isabela	120

Source: SDG analysis of US Census Bureau Estimates 2010-2016

The four (4) lowest ranking municipalities in terms of aging index are shown in Table 2.6.

Table 2.6: Lowest Aging Index in PR 2016

Municipality	Aging Index
Moca	93
Las Marías	110
Aguada	112
Lares	119

Source: SDG analysis of US Census Bureau Estimates 2010-2016

Regarding the median age, the Aguadilla TMA's population (41.90 years) continued to have a median age higher than the one in Puerto Rico (40.80 years) in 2016, as shown in Figure 2.23.

Figure 2.23: Median Age in Aguadilla TMA
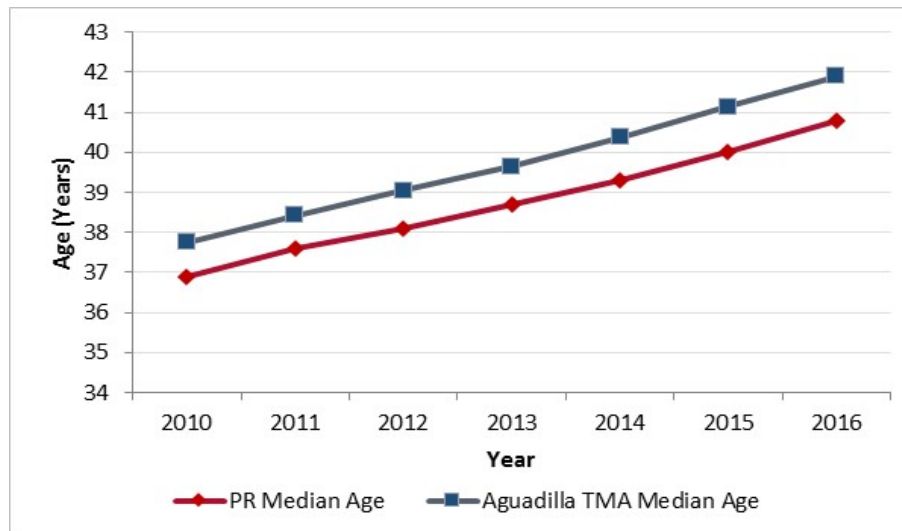
Source: SDG analysis of US Census Bureau Estimates 2010-2016

Regarding the median age by gender, the Aguadilla TMA's female population (43.22 years) continued to have a median age higher than the male population (40.53 years). The 2016 median

age for females was 43 years while the median age for males was around 41 years, as shown in Figure 2.24.

Figure 2.24: Median Age by Gender
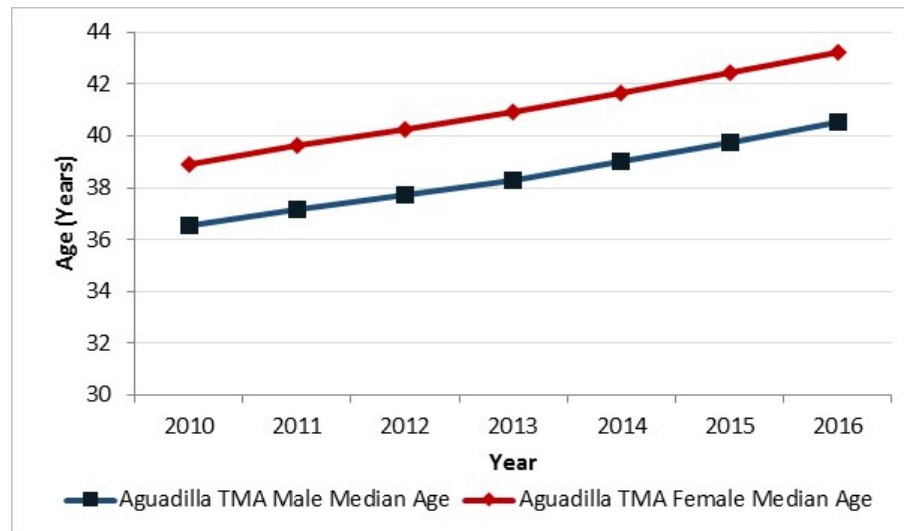
Source: SDG analysis of US Census Bureau Estimates 2010-2016

Within the Region, eight (8) municipalities showed a median age of 40 years and over in their population, highlighted in Figure 2.25. Table 2.7 and Table 2.8 show top the top municipalities within the Aguadilla TMA with the highest and lowest median age populations in 2016 respectively.

Table 2**.7: Highest Median Age in Aguadilla TMA - 2016**

Municipality	Median Age
Rincón	45.5
San Sebastián	43.0
Añasco	42.0
Aguada	41.9
Isabela	41.7

Source: SDG analysis of US Census Bureau Estimates 2010-2016

Table 2.8: Lowest Median Age in Aguadilla TMA - 2016

Municipality	Median Age
Moca	39.1
Las Marías	41.0
Lares	41.4
Aguadilla	41.5

Source: SDG analysis of US Census Bureau Estimates 2010-2016

Figure 2.25: Aguadilla TMA Median Age 2016
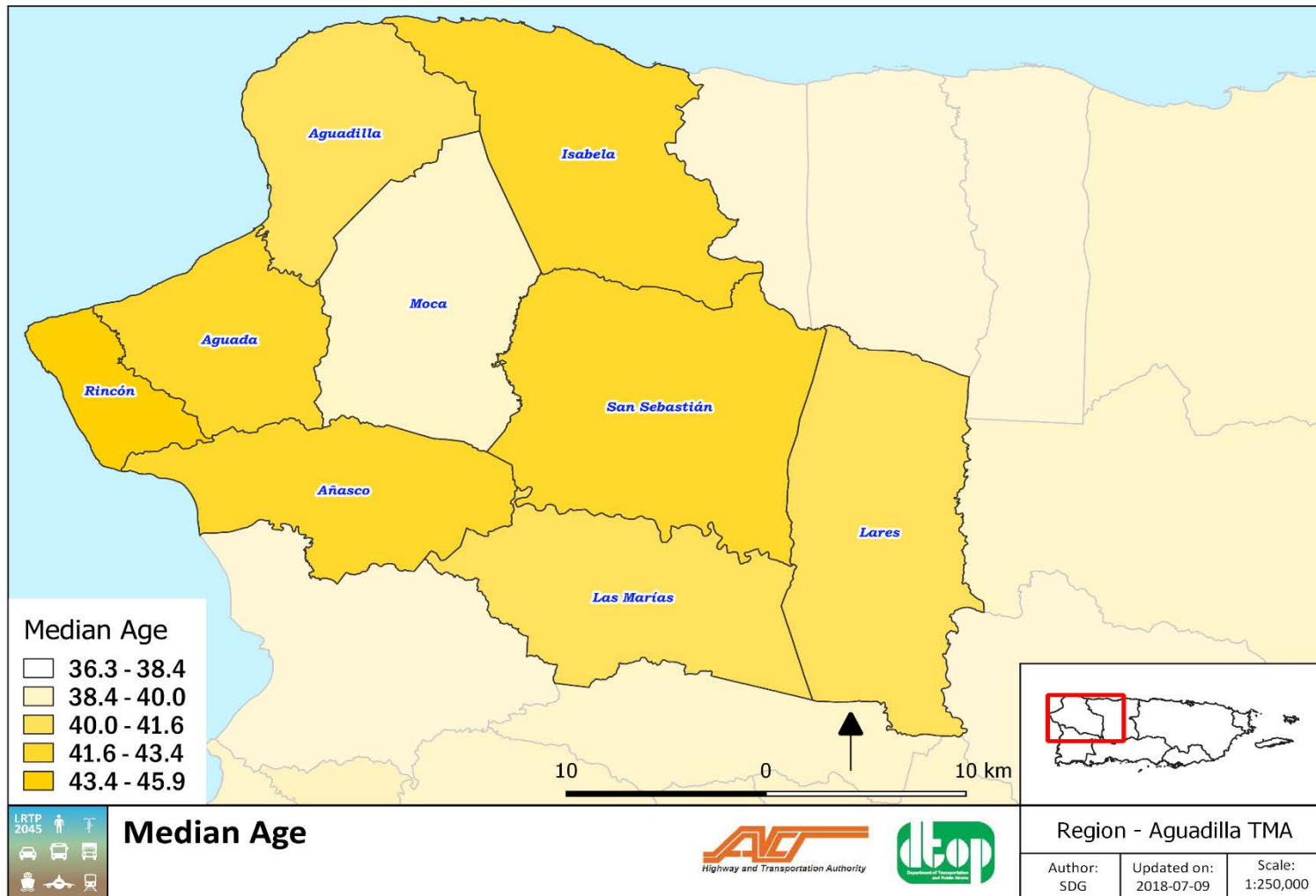
Source: Median Age Statistics obtained from the U.S. Census Bureau

Housing Type and Household Size

For the analysis of household type and size, U.S. Census estimates from 2016 indicated there were 1,237,180 households in Puerto Rico, and households in Aguadilla TMA represented an 8.3% (103,195) of the total Island, as shown in Figure 2.26.

Figure 2.26: Comparison PR vs. Aguadilla TMA – Total Households
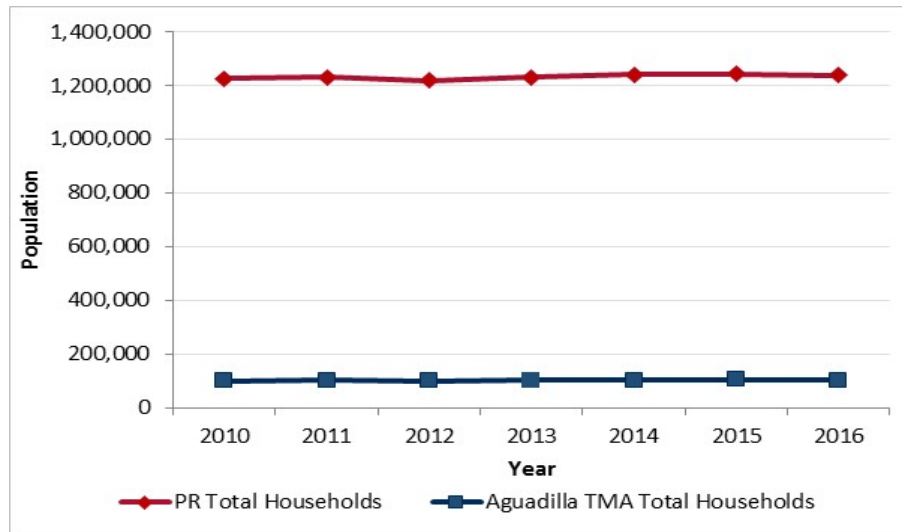
Source: SDG analysis of ACS 5-Year Estimates (2012-2016)

In 2016 the Aguadilla TMA had 136,722 housing units. Of these, 66.5% (68,586) owned their homes, 33.5% (34,609) were renters and mostly (73.7%) are 1-unit detached structures[19]. This information is shown in Figure 2.27 to Figure 2.29.

In the Aguadilla TMA, the percentage of household owners (homeownership rate) decreased from 73.3% to 66.5% between 2010 and 2016 and an increase in the corresponding rate for the households that are rented (26.7% to 33.5%) was observed. Within these 6 years, the number of housing units increased by 8.8%.

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[19] Definition by U.S. Census Bureau: "This is a 1-unit structure detached from any other house; that is, with open space on all four sides".

Figure 2.27: Comparison PR vs. Aguadilla TMA – Owner-Occupied
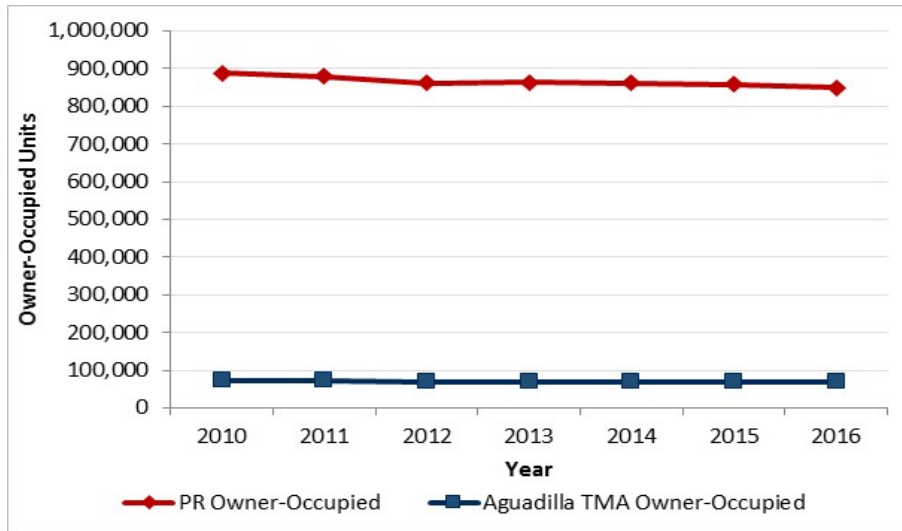
Source: SDG analysis of ACS 5-Year Estimates (2012-2016)

Figure 2.28: Comparison PR vs. Aguadilla TMA – Renter-Occupied
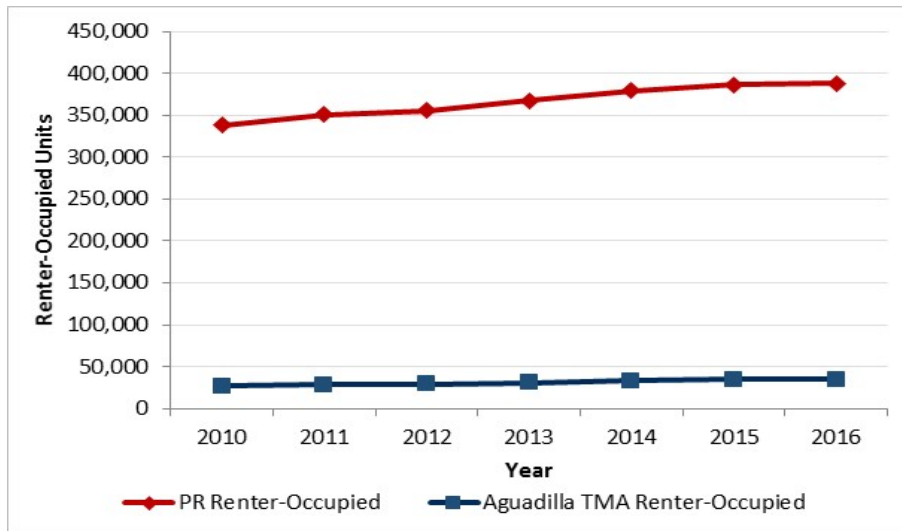
Source: SDG analysis of ACS 5-Year Estimates (2012-2016)

Figure 2.29: Comparison PR vs. Aguadilla TMA – 1-Unit, Detached
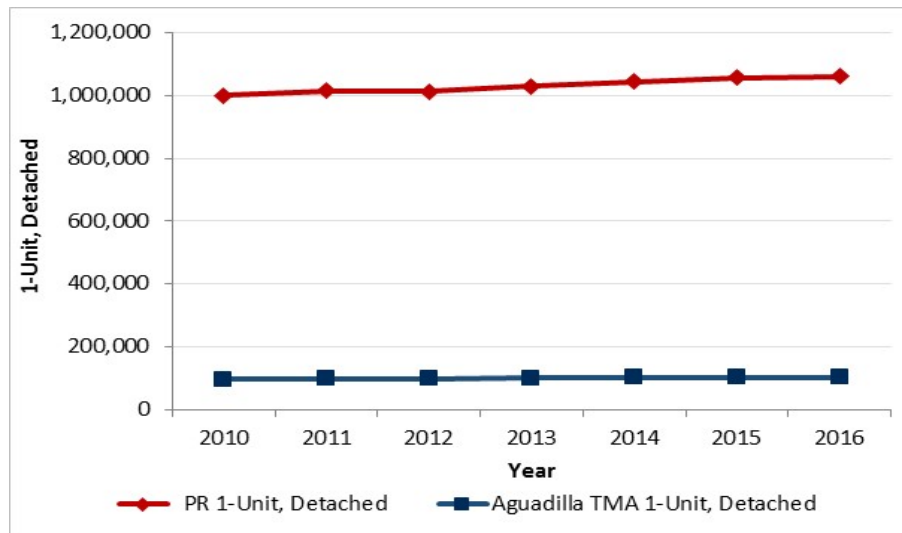
Source: SDG analysis of ACS 5-Year Estimates (2012-2016)

In 2016, the Aguadilla TMA's average household size was 2.64 people. This Region presents larger values compared with the average household size of Puerto Rico (2.61 people), as shown in Figure 2.30. However, there is a decreasing trend not only in Puerto Rico but also in the Region, with the average falling from 2.84 in 2010 to 2.64 in 2016.

Figure 2.30: Comparison PR vs. Aguadilla TMA – Average Household Size
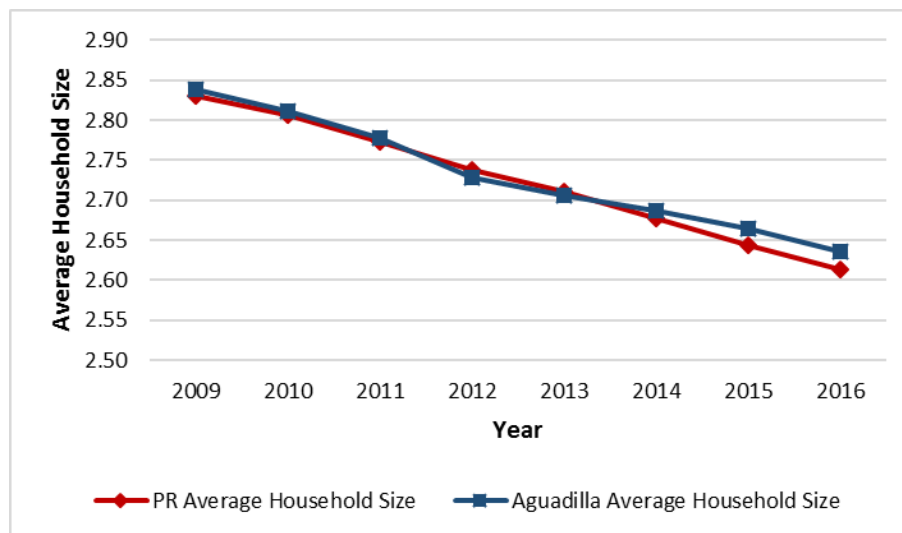
Source: SDG analysis of ACS 5-Year Estimates (2012-2016)

In 2016, Aguadilla was the municipality with the largest shares of households (20.4%), total housing units (20.0%) and occupied housing units (20.4%) in the Region. On the other hand, Moca and Añasco have average household sizes of 2.73 and 2.70 people per household respectively, the largest of the Region. Table 2.9 shows the household characteristics for each municipality.

Table 2.9: Aguadilla TMA – Total and Occupied Housing Units and Average Household Size

Municipality	Total Housing Units 2016	Occupied Housing Units 2016	Average Household Size 2016
Aguada	17,508	12,934	2.65
Aguadilla	27,365	20,999	2.56
Añasco	12,448	9,373	2.70
Isabela	20,417	15,084	2.63
Lares	12,263	10,148	2.68
Las Marías	3,932	3,104	2.61
Moca	15,632	12,473	2.73
Rincón	9,462	5,210	2.55
San Sebastián	17,695	13,870	2.63
Total	**136,722**	**103,195**	**2.64**

Source: SDG analysis of ACS 5-Year Estimates (2012-2016) [20]

Puerto Rico Household Travel Survey (PRHTS)

Household surveys were completed as part of the 2045 PRLRTP; (please, see details included in Appendix L). Overall, sample size was 2,784 households participating in the survey; resulting in 341 households for the Aguadilla TMA included in this section.

Weighted survey results from the PRHTS are displayed with real 2016 data, but are not meant for direct comparison, as the survey results were weighted to 2015 household and population levels; this provides a check, looking for general proximity, to support the claim that the survey sampling distribution was representative of the population.

The weighted survey results of the PRHTS, which were weighted using 2015 US Census data, showed that Aguadilla had 277,224 inhabitants, representing 7.9% of the island population. In 2016, the U.S. Census showed that Aguadilla TMA (288,777) represented 8.5% of the Island total population (3,411,307). Figure 2.31 shows the distribution by gender, where just over 46% were female and 51% were male.

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[20] ACS household data provides percentage of households that are 1-person, 2-person, 3-person, and 4-person plus. Using an assumed average value of 5 people for the 4-person plus households. SDG Team produced Weighted averages of household size by municipality. were produced. Because household data comes from the 5-year estimated dataset while population is from 2016 data only along with the weighted average calculation, multiplying number of households by the household size in table 3.11 will not be exactly equal to municipality population.

Figure 2.31: Aguadilla TMA Population Distribution by Gender
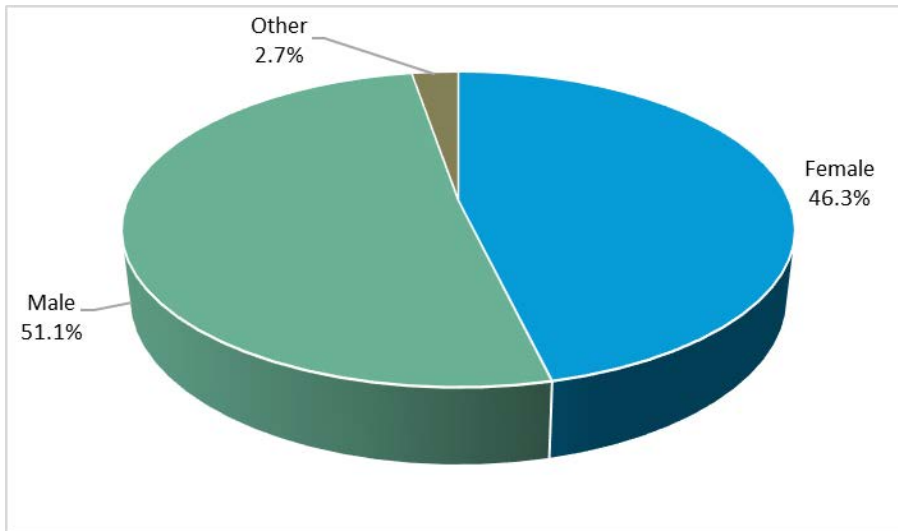
Source: SDG – Using Weighted Survey Results

The weighted survey results showed that in 2015 for Aguadilla TMA, 22.5% of the population fall under the age of 20, 43.3% are between 20 and 49 years of age, and 32.1% are older than 50. The population of individuals 65 years and over was 37,644, which represents 13.6% of the total Aguadilla population, as described in Figure 2.32. In 2016, the U.S. Census shows that the population of individuals 65 years and over was estimated at 55,290 which represents a 19.1% share of the Puerto Rico population.

Figure 2.32: Aguadilla TMA Population Distribution by Age Brackets
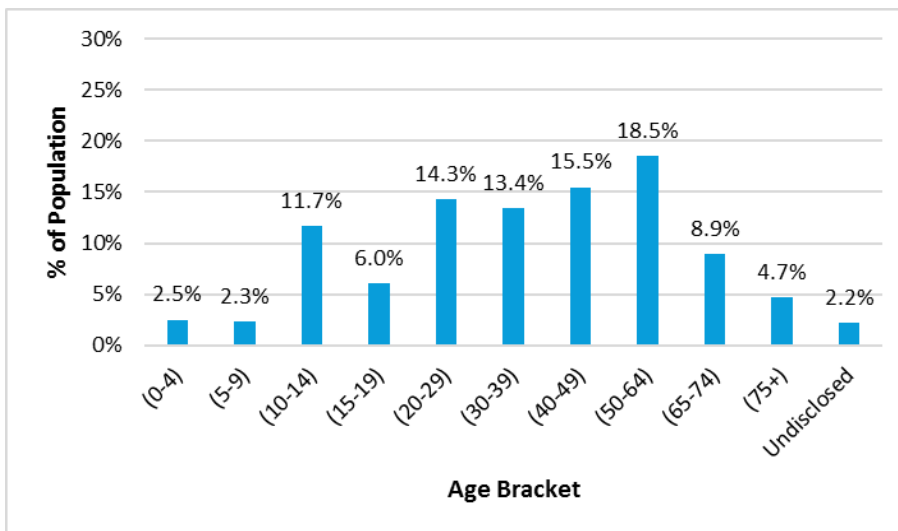
Source: SDG – Using Weighted Survey Results

Figure 2.33, using weighted survey results, shows that in Aguadilla TMA 35.5% of the Region's population are employed. In 2016, using BLS employment by residence and U.S. Census population, data showed that 24.8% of the population was employed.

Figure 2.33: Aguadilla TMA Distribution by Employment/Student Status
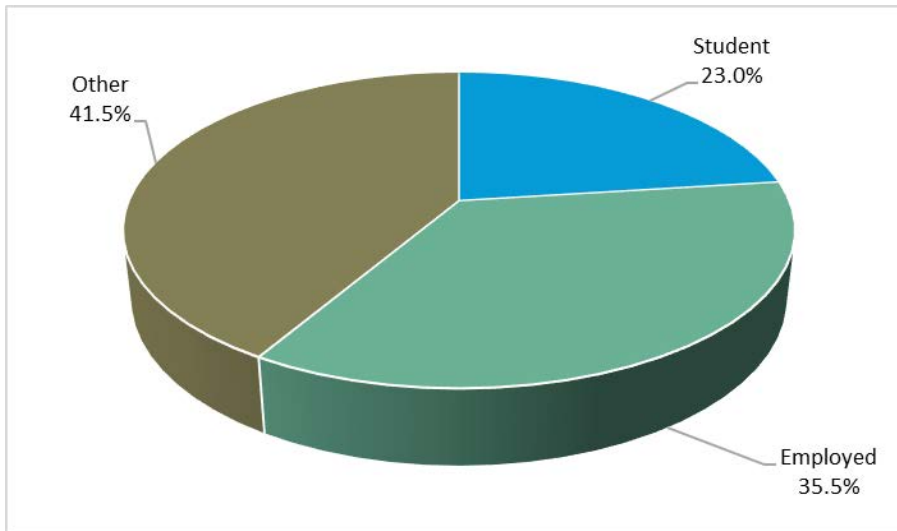
Source: SDG – Using Weighted Survey Results

At the Aguadilla TMA level, shown in Figure 2.34, using weighted survey results, close to 75% of all households own and have either paid in full or are currently paying for their residence, while just 22% are renting their current residence. From the American Community Survey, in 2016, over 66% and 33% of Aguadilla housing units were owner-occupied and renter-occupied respectively.

Figure 2.34: Aguadilla Household Distribution by Home Ownership Status
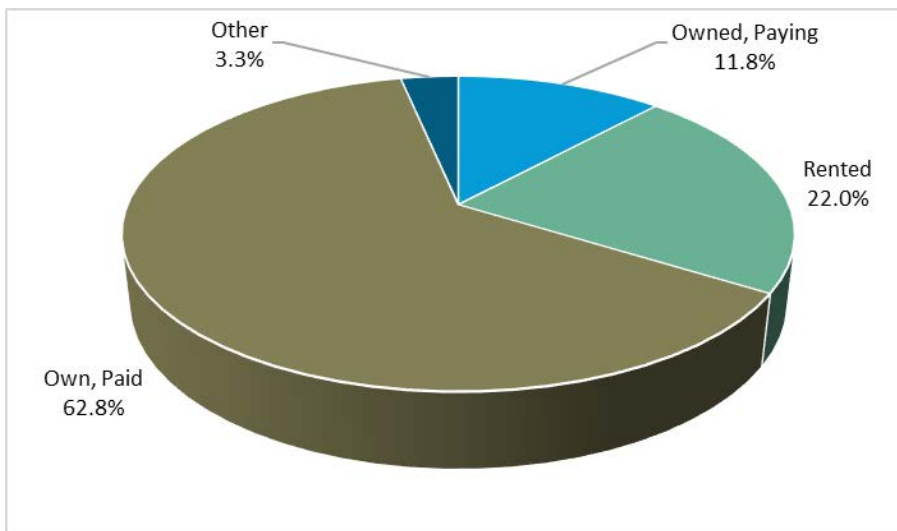
Source: SDG – Using Weighted Survey Results

Household Level Demographic Data

Household demographic data was captured for the 341 households in the Aguadilla TMA who participated in the survey. Results are shown in Figure 2.35 to Figure 2.38.

- Household Occupants: Just over 23% of Aguadilla TMA's households have 4 or more occupants; 2-person households make up close to 33% of the households in the area (Figure 2.35);
- Vehicles per Household: At the Aguadilla TMA level 56.3% of households have 1 or less available vehicles, with just under 13.5% of households without access to a private vehicle (Figure 2.36);
- Housing Structure: In Aguadilla TMA, just over 88% of households live in single-family homes, with just over 8% living in multi-family homes (Figure 2.37); and
- Income: With just 64% of the population's income unknown due to survey respondent's choice to not disclose, this is unable to provide as much information as would be desired. Of those who disclosed income the majority of household incomes fall under $25,000 (Figure 2.38).

Figure 2.35: Aguadilla TMA Household Distribution by Household Size
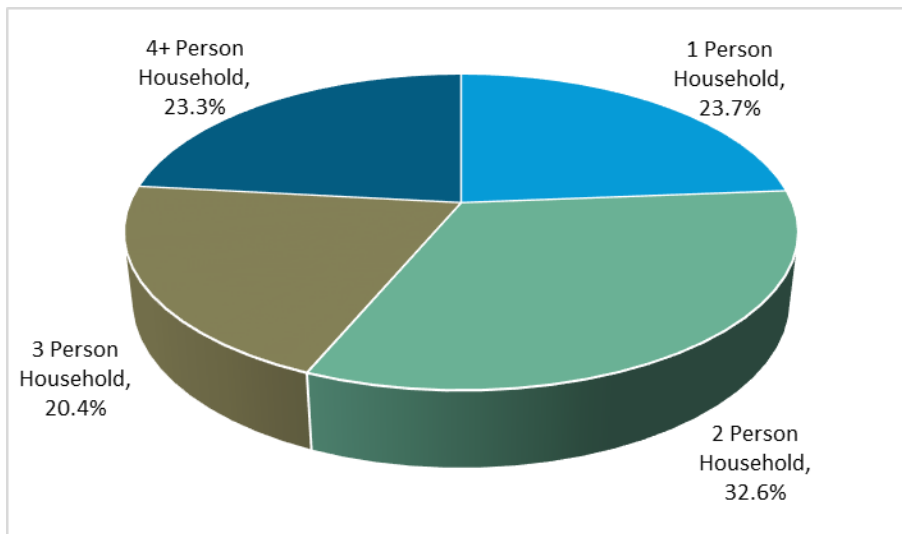
Source: SDG – Using Weighted Survey Results

Figure 2.36: Aguadilla TMA Household Distribution by Vehicle Ownership
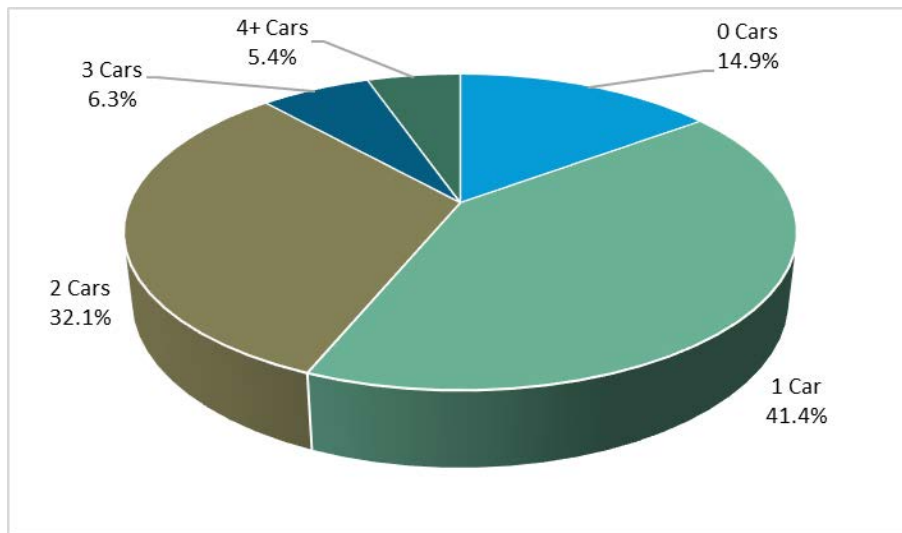
Source: SDG – Using Weighted Survey Results

Figure 2.37: Aguadilla TMA Household Distribution by Household Type
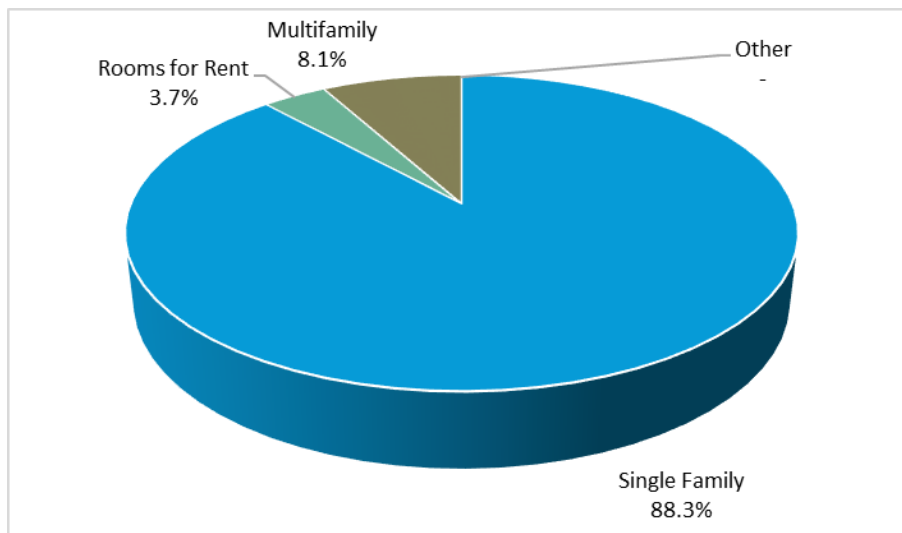
Source: SDG – Using Weighted Survey Results

Figure 2.38: Aguadilla TMA Household Distribution by Household Income Brackets
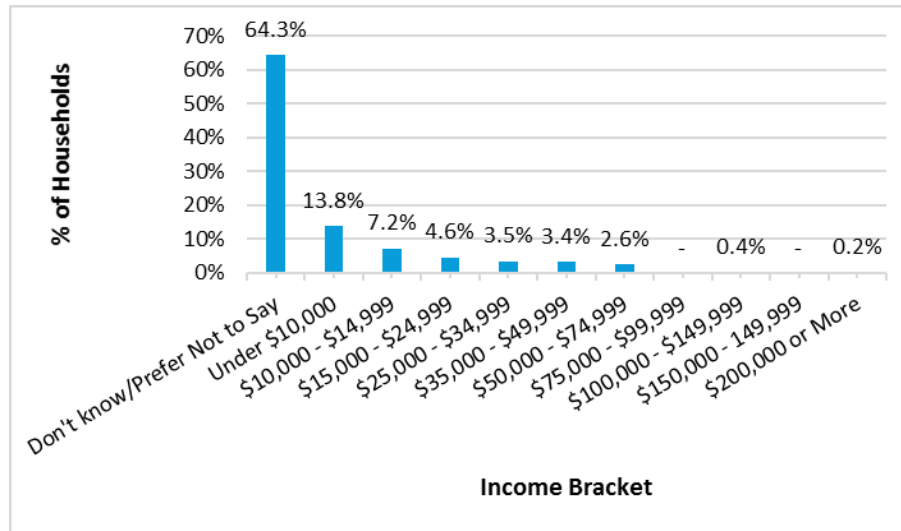
Source: SDG – Using Weighted Survey Results

Person Level Demographic Data

Person level demographic data was captured for the 805 people from the Aguadilla Region who participated in the survey.

- Education Level: Close to 70% of the Aguadilla population have achieved High School completion or above (Figure 2.39);

- Industry Level Employment: Most people work in Other Services, 19.2%, other significant employment industries from the survey results are Public Administration, 10.7%, and Utilities, 9.6% (Figure 2.40); and

- Resident Status: In Aguadilla TMA, just over 2% of residents are proclaimed as temporary household members (Figure 2.41).

Figure 2.39: Aguadilla TMA Population Distribution by Education Level
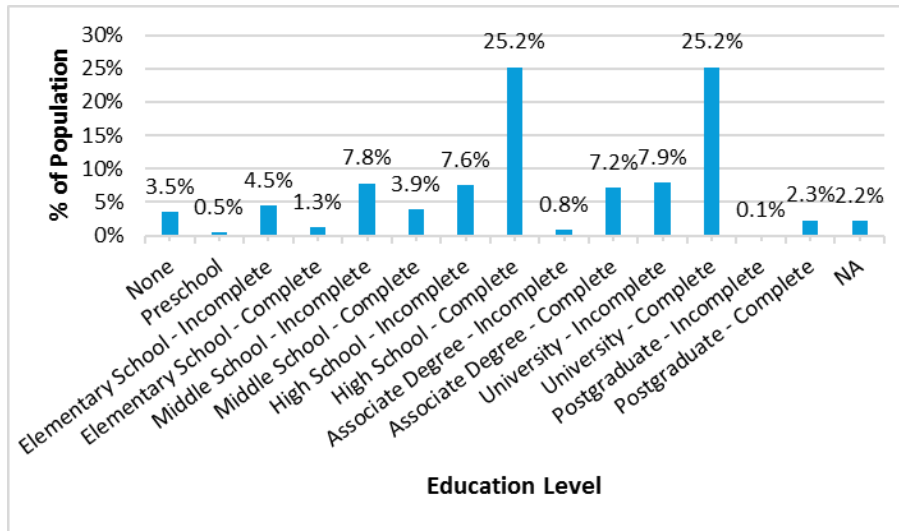
Source: SDG – Using Weighted Survey Results

Figure 2.40: Aguadilla TMA Employed Population Distribution by Industry
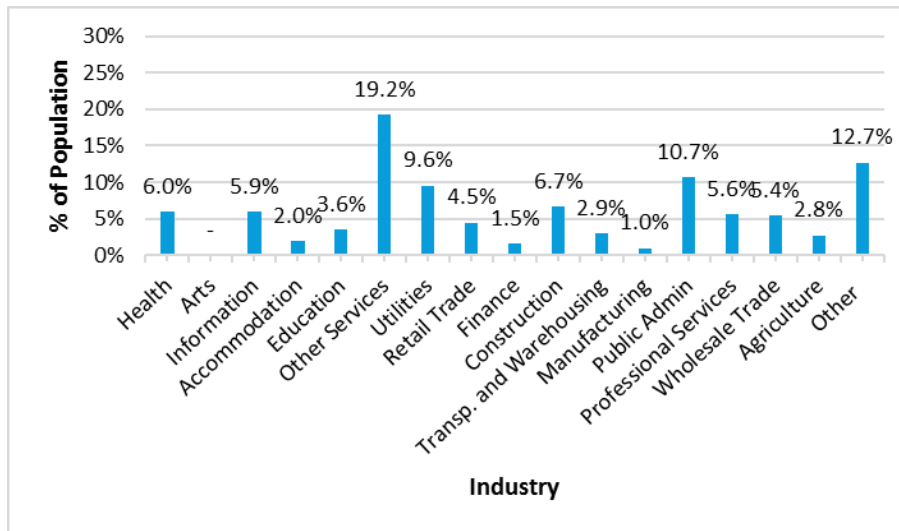
Source: SDG – Using Weighted Survey Results

Figure 2.41: Aguadilla TMA Employed Population Distribution by Resident Status
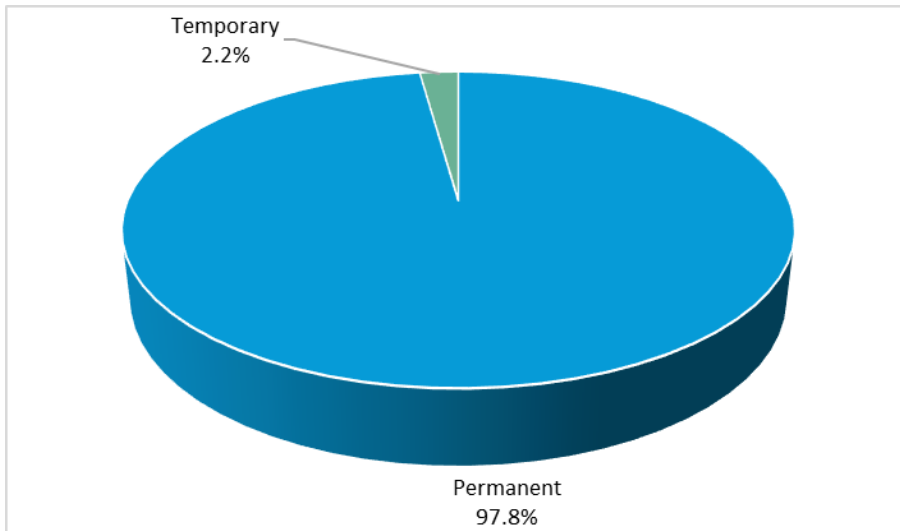
Source: SDG – Using Weighted Survey Results

Analysis of Trip Purpose and Frequency

The trip level data for participants with completed travel diaries is analyzed in this section, there were 1,248 trips made in the Aguadilla Region and their respective details captured by the survey.

- Trips Per Household: the mean trips generally increase with growth in household size. Looking at all households in Puerto Rico, they make an average of 3.93 daily trips; 2-person households, representing over 30% of all households make a mean of 3.48 trips per day;

- Transportation Mode: Close to 90% of trips in Aguadilla TMA are made in private vehicles as either the driver or as a passenger; only 0.4% of people take the bus as a transportation mode (Figure 2.42);

- Trip Purpose: Close to 70% of trips in Aguadilla are related to work commute and returning home; trips made to drop off individuals, other, and shopping compose close to 20% (Figure 2.43); and

- Trip Frequency: In Puerto Rico, close to 65% of all specific trips are recurring and completed 5 times or more a week; trips completed only once a week make up slightly higher than 8% of trips (Figure 2.44).

Figure 2.42: Aguadilla TMA Trip Distribution by Transportation Mode
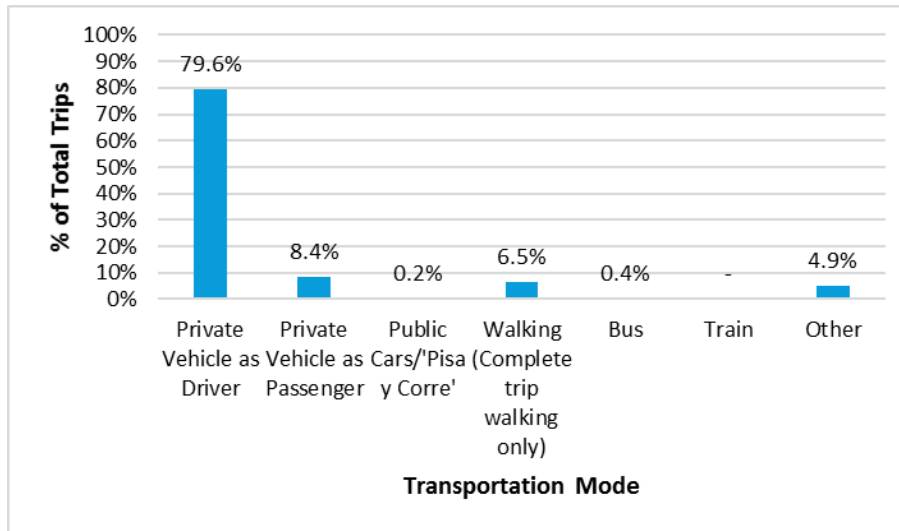
Source: SDG – Using Weighted Survey Results

Figure 2.43: Aguadilla TMA Trip Distribution by Trip Purpose
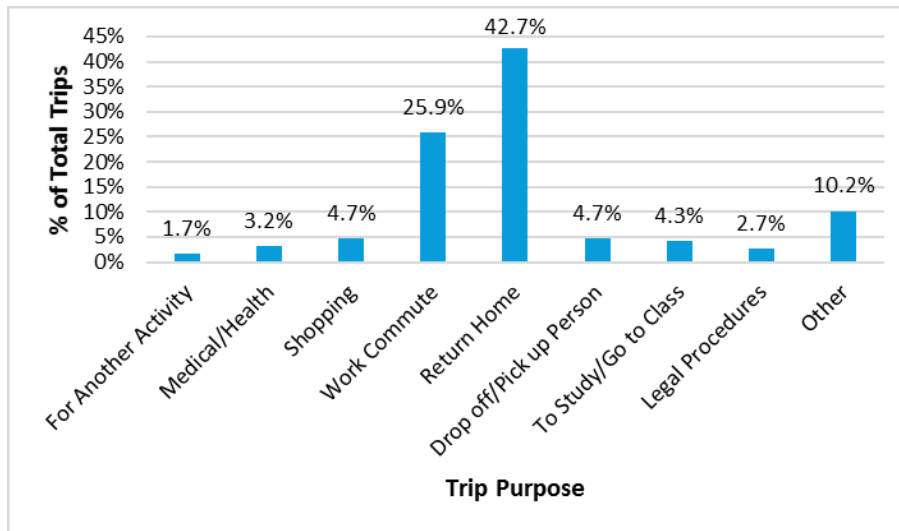
Source: SDG – Using Weighted Survey Results

Figure 2.44: Aguadilla TMA Trip Distribution by Trip Frequency Per Week
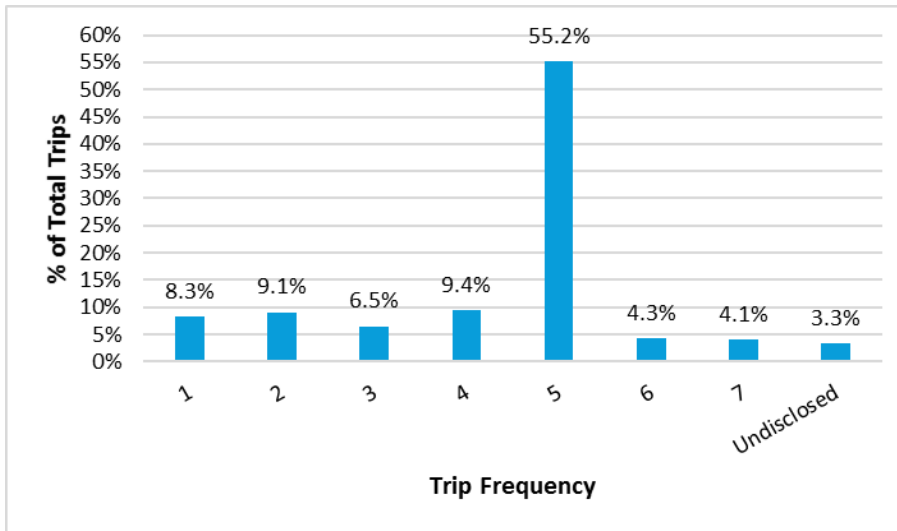
Source: SDG – Using Weighted Survey Results

Vehicle Type and Classifications

Vehicle data was logged by survey participants for 505 vehicles in the Aguadilla Region.

- Vehicle Brand: Close to 39% of vehicles in Aguadilla TMA are manufactured by Toyota, with Suzuki in second place with close to 10% of total vehicles (Figure 2.45);

- Model Year: In Aguadilla TMA, close to 30% of vehicles were manufactured prior to 2000. The largest portion of vehicles manufactured in any 5-year window were between 2001 and 2005, at close to 25% of total vehicles (Figure 2.46);

- Vehicle Type: In Aguadilla TMA, close to 63% of vehicles are standard cars/sedans, while over 29% are SUV's (Figure 2.47);

- Primary User: Close to 80% of the time, the primary users of vehicles are the head of household or spouse/partner; with just over 15% of vehicles being primarily used by children in a household (Figure 2.48); and

- Parking Status: Close to 92% of all vehicles are stored in personal garages/driveways in Aguadilla TMA, with just over 3% stored on street-parking (Figure 2.49).

Figure 2.45: Aguadilla TMA Vehicle Distribution by Brand
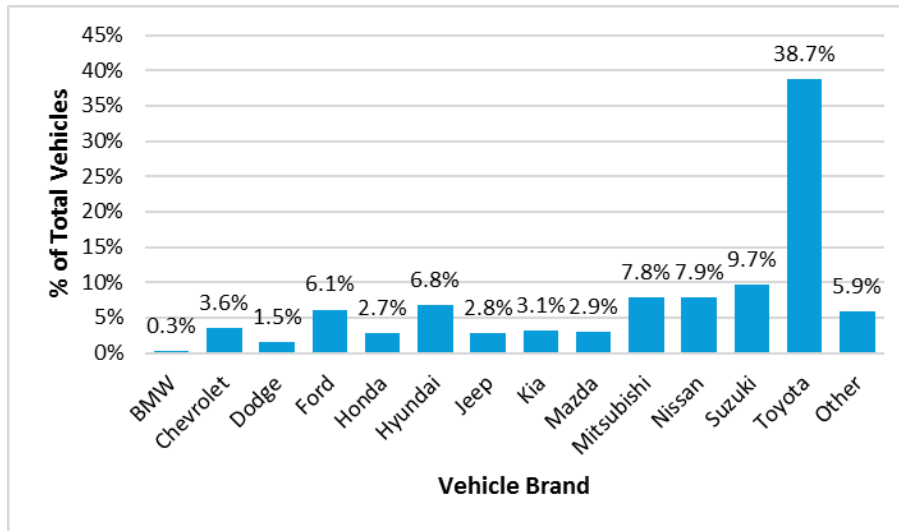
Source: SDG – Using Weighted Survey Results

Figure 2.46: Aguadilla TMA Vehicle Distribution by Model Year
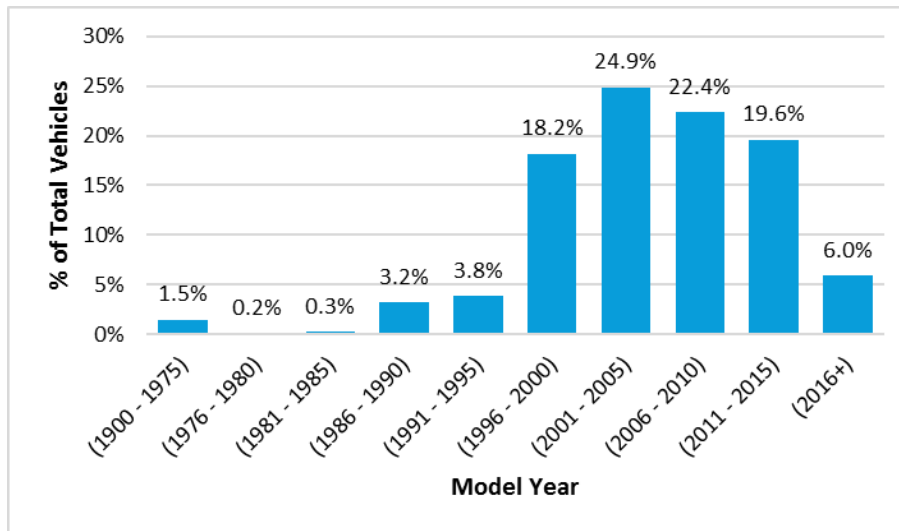
Source: SDG – Using Weighted Survey Results

Figure 2.47: Aguadilla TMA Vehicle Distribution by Vehicle Type
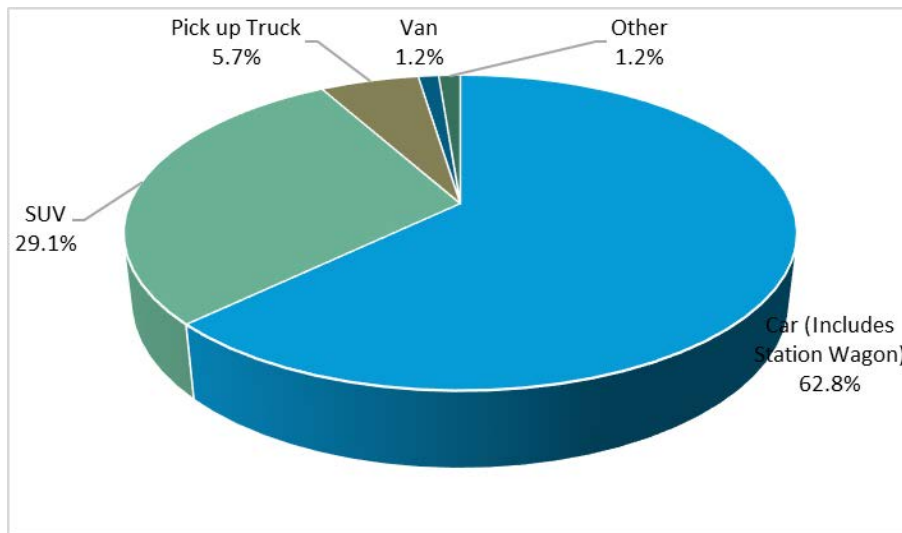
Source: SDG – Using Weighted Survey Results

Figure 2.48: Aguadilla TMA Vehicle Distribution by Primary User
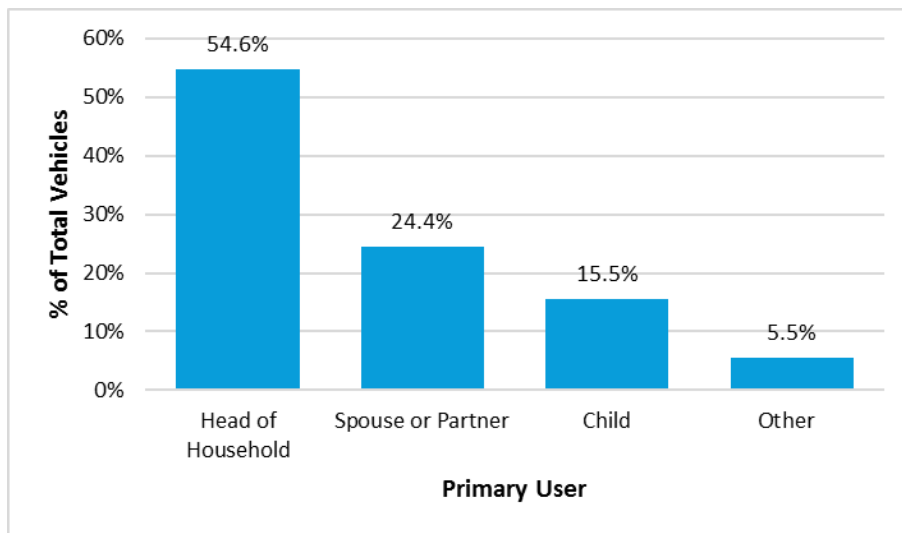
Source: SDG – Using Weighted Survey Results

Figure 2.49: Aguadilla TMA Vehicle Distribution by Parking Status
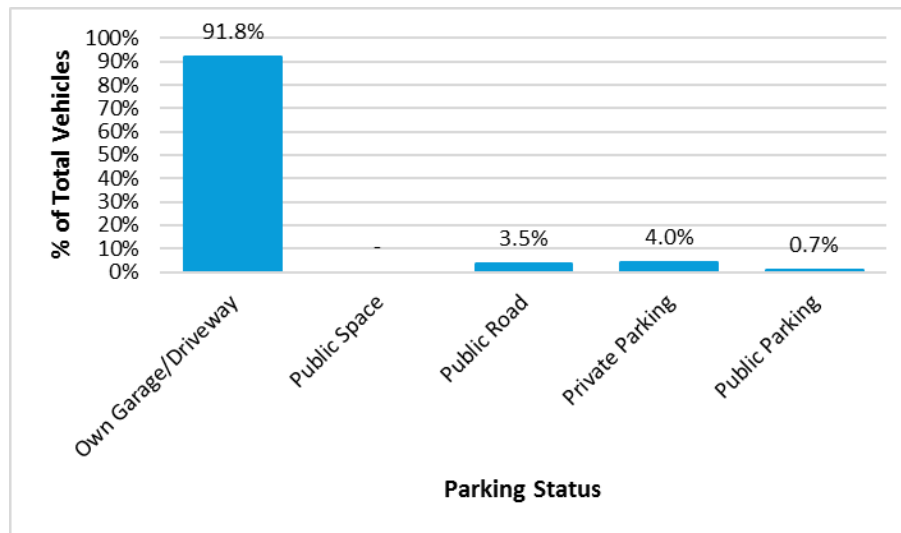
Source: SDG – Using Weighted Survey Results

Focused Study – Households/People Without Access to Vehicles

Out of the Aguadilla Region participants in the household survey, 68 persons were stated to live in households with zero private vehicles. In the weighted survey, this corresponds to close to 9% of the Aguadilla Region population. This section analyzes this group in further depth, specifically their demographics and trip patterns.

- Gender: Just over 54% and close to 43% of persons without owned vehicles are male and female respectively (Figure 2.50);

- Age: Over 55% of people who do not own a vehicle in Puerto Rico are over 50 years of age (Figure 2.51);

- Occupation Status: Students and employed individuals represent close to 33% of this subset, as those with other occupations make up over 67% (Figure 2.52);

- Transportation Mode: Of trips taken by individuals who do not own a vehicle in Puerto Rico, just over 23% of trips are completed as the passenger in a private vehicle, while close to 46% of trips are made via walking (Figure 2.53);

- Trip Purpose: The top three trip purposes for this subset of the population are returning home (35.7%), other (18.7%), and legal procedures (9.8%) (Figure 2.54); and

- Trip Frequency: Close to 50% of trips made by this group are made 5 or more times during a week; under 5% of trips are made only once a week (Figure 2.55).

Figure 2.50: Aguadilla TMA Population Distribution, Persons Without Owned Vehicles, by Gender
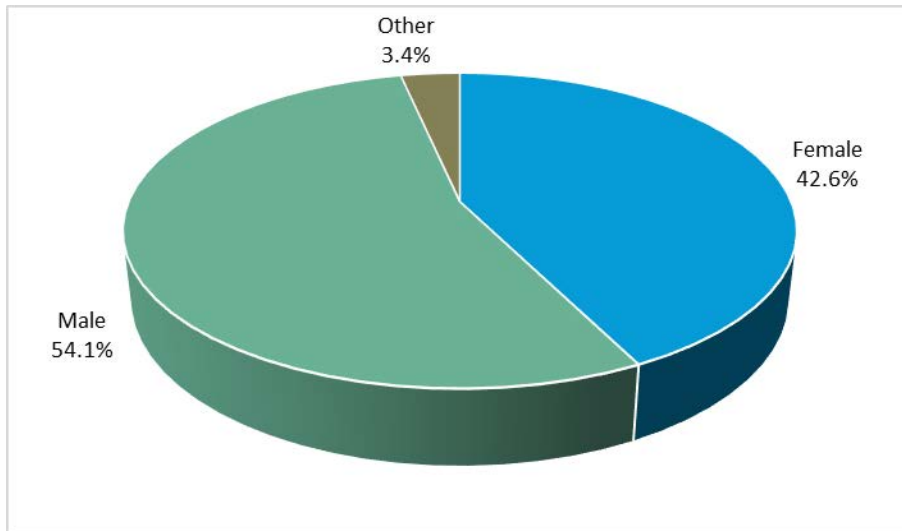
Source: SDG – Using Weighted Survey Results

Figure 2.51: Aguadilla TMA Population Distribution, Persons Without Owned Vehicles, by Age Bracket
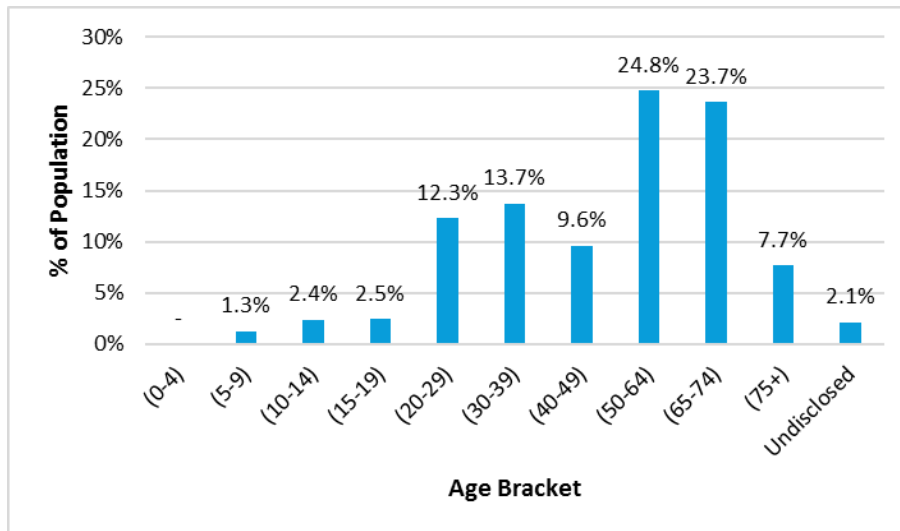
Source: SDG – Using Weighted Survey Results

Figure 2.52: Aguadilla TMA Population Distribution, Persons Without Owned Vehicles, by Employment/Student Status
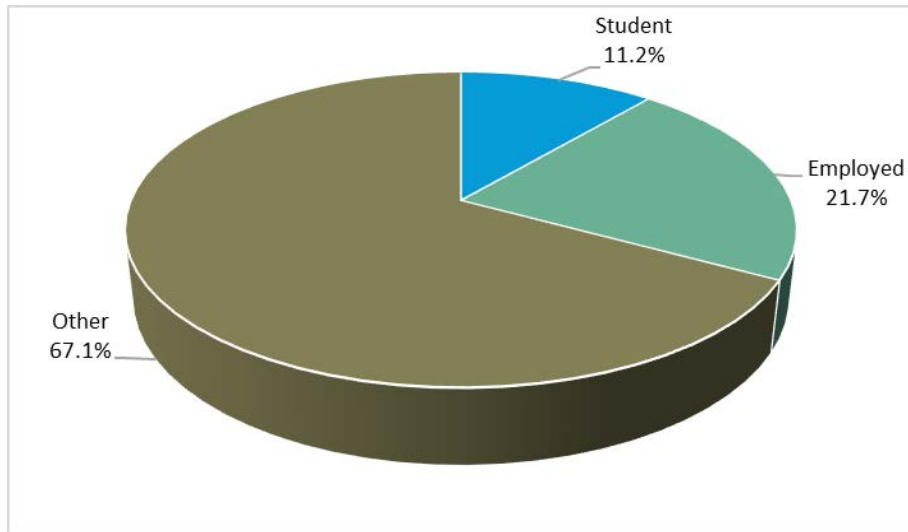
Source: SDG – Using Weighted Survey Results

Figure 2.53: Aguadilla TMA Trip Distribution, Persons Without Owned Vehicles, by Transportation Mode
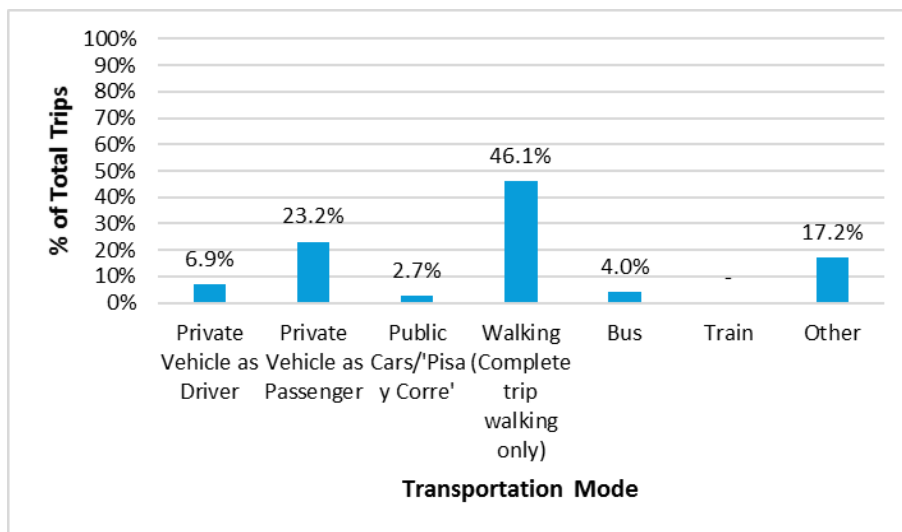
Source: SDG – Using Weighted Survey Results

Figure 2.54: Aguadilla TMA Trip Distribution, Persons Without Owned Vehicles, by Trip Purpose
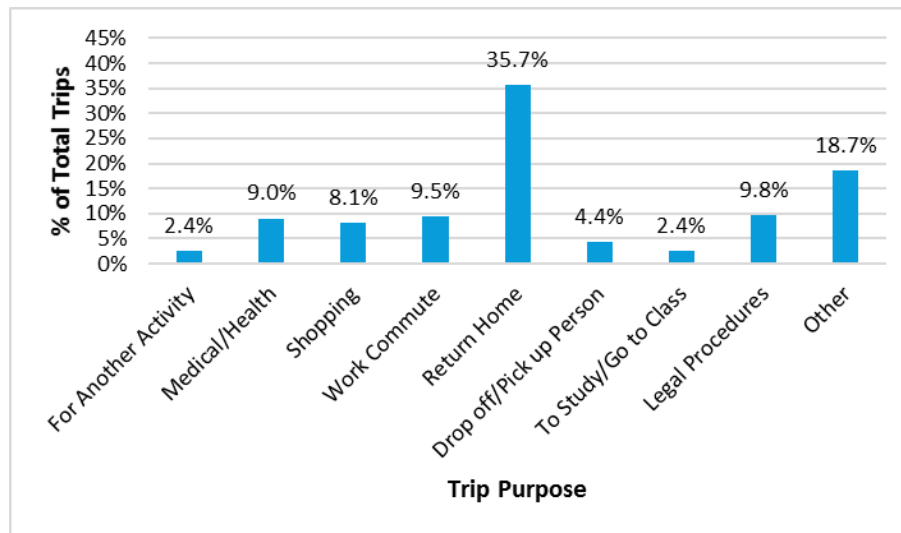
Source: SDG – Using Weighted Survey Results

Figure 2.55: Aguadilla TMA Trip Distribution, Persons Without Owned Vehicles, by Trip Frequency Per Week
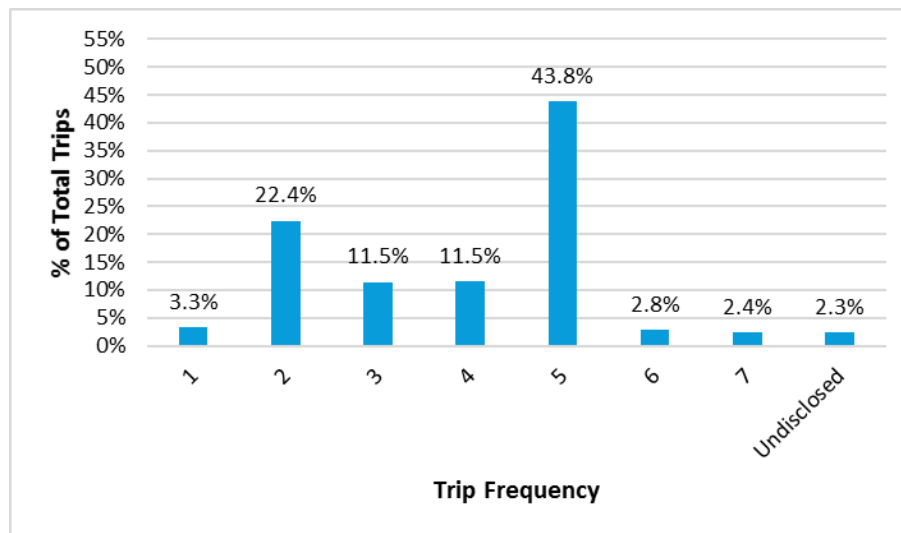
Source: SDG – Using Weighted Survey Results

Focused Study – Transportation Affected by Hurricane María

Out of the Aguadilla TMA participants in the household survey, 179 persons stated that their trips were affected by Hurricane María. This section analyzes this group in further depth, specifically their demographics and trip patterns.

- Trip Affected by Hurricane María: Just under 24% of all trips made by individuals in the Aguadilla TMA were affected by Hurricane María. (Figure 2.56);
- Gender: Of those in the Aguadilla TMA with trips affected by Hurricane María, just under 56% and over 41% were male and female respectively (Figure 2.57);

- Age: Just over 35% of individuals in the Aguadilla TMA whose trips were affected by Hurricane María are over 50 years of age (Figure 2.58);
- Occupation Status: Close to 43% of these individuals are employed, while under 7% were students (Figure 2.59);
- Transportation Mode: Close to 90% of trips affected by Hurricane María were completed as either driver or passenger of a private vehicle (Figure 2.60);
- Trip Purpose: Returning home (38.8%), commuting to work (21.0%), and other (10.2%) were the three major trip purposes (Figure 2.61); and
- Trip Frequency: Just over 55% of all trips were made 5 times or more a week; under 15% of trips were made only once a week (Figure 2.62).

Figure 2.56: Aguadilla TMA Trip Distribution by "Was Trip and/or Transportation Mode Affected by Hurricane María"
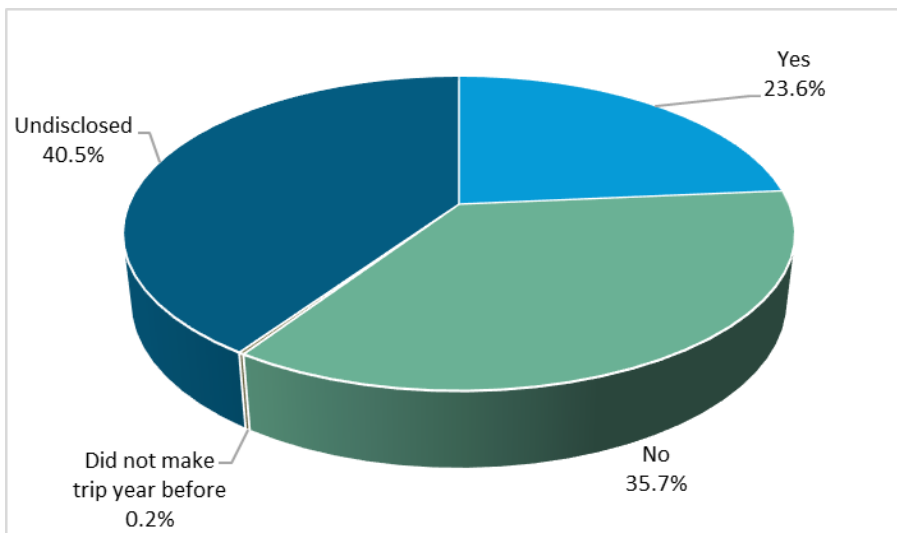
Source: SDG – Using Weighted Survey Results

Figure 2.57: Aguadilla TMA Population Distribution, People with Trips Affected by Hurricane María, by Gender
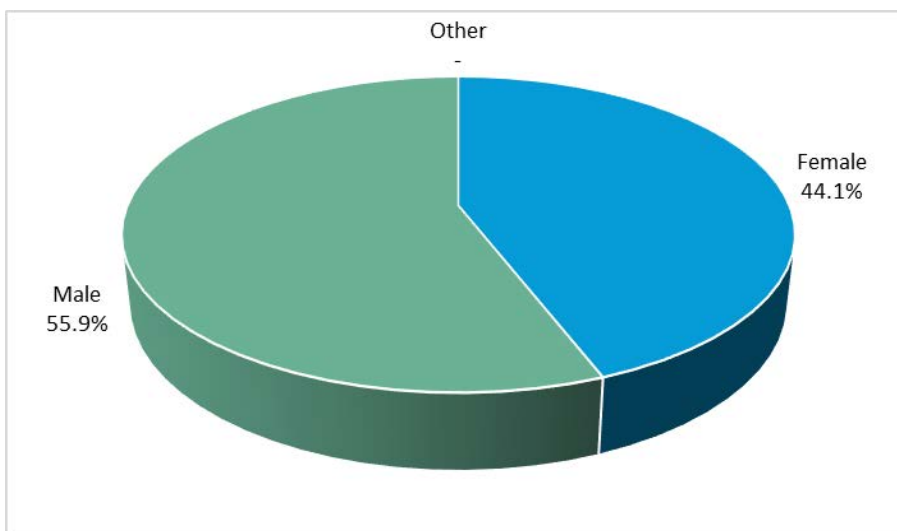
Source: SDG – Using Weighted Survey Results

Figure 2.58: Aguadilla TMA Population Distribution, People with Trips Affected by Hurricane María, by Age Bracket
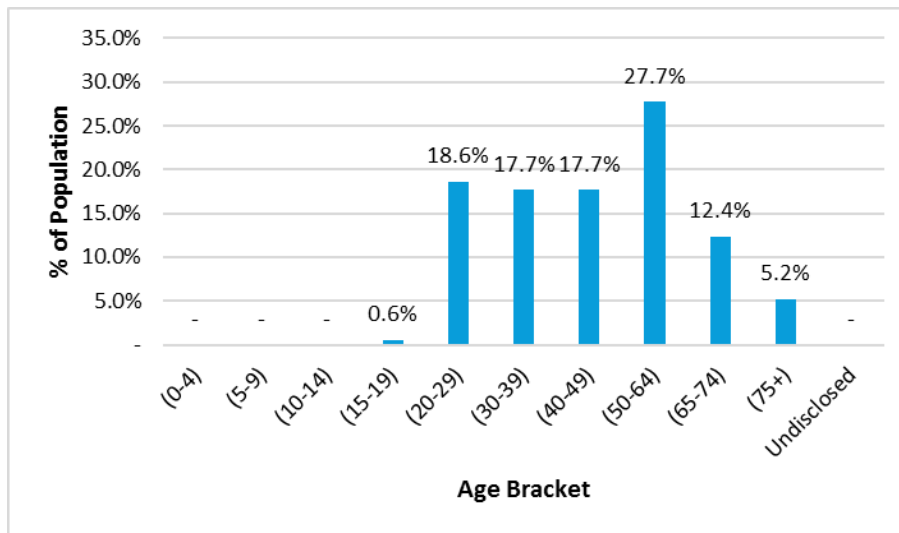
Source: SDG – Using Weighted Survey Results

Figure 2.59: Aguadilla TMA Population Distribution, People with Trips Affected by Hurricane María, by Employment/Student Status
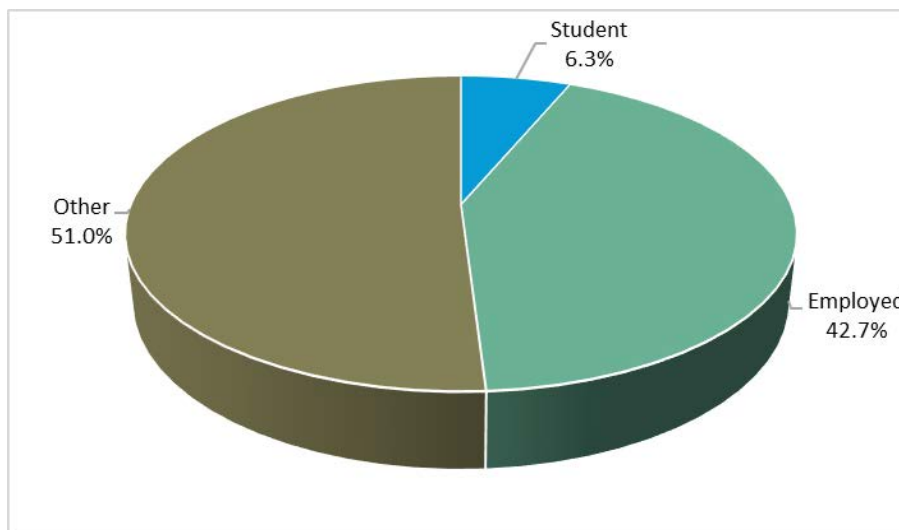
Source: SDG – Using Weighted Survey Results

Figure 2.60: Aguadilla TMA Trip Distribution, Trips Affected by Hurricane María, by Transportation Mode
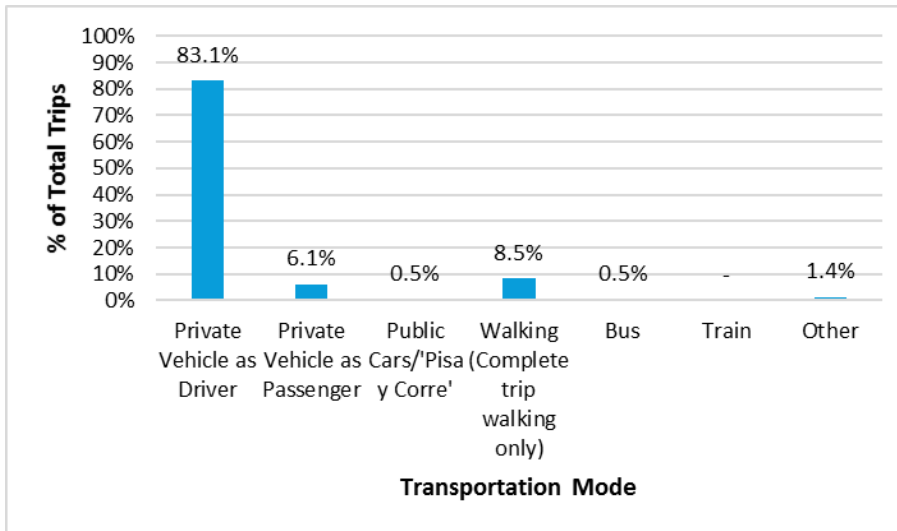
Source: SDG – Using Weighted Survey Results

Figure 2.61: Aguadilla TMA Trip Distribution, Trips Affected by Hurricane María, by Trip Purpose
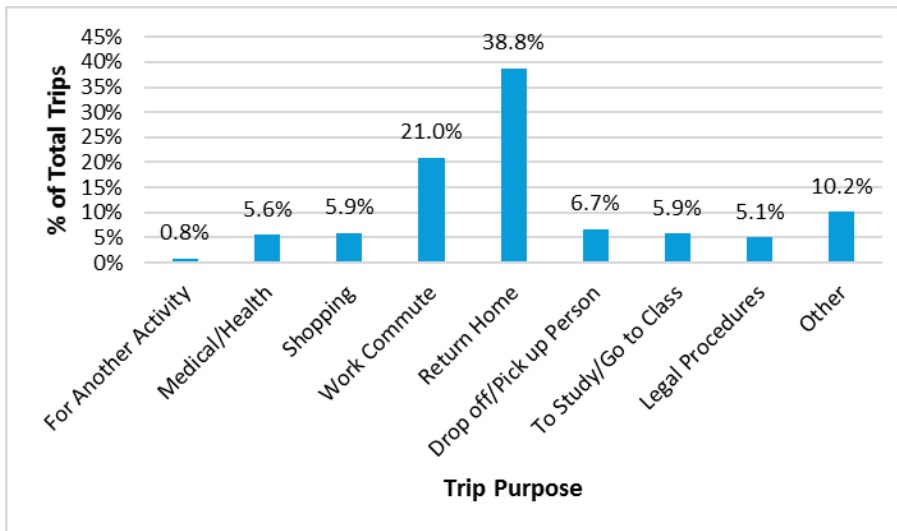
Source: SDG – Using Weighted Survey Results

Figure 2.62: Aguadilla TMA Trip Distribution, Trips Affected by Hurricane María, by Trip Frequency Per Week
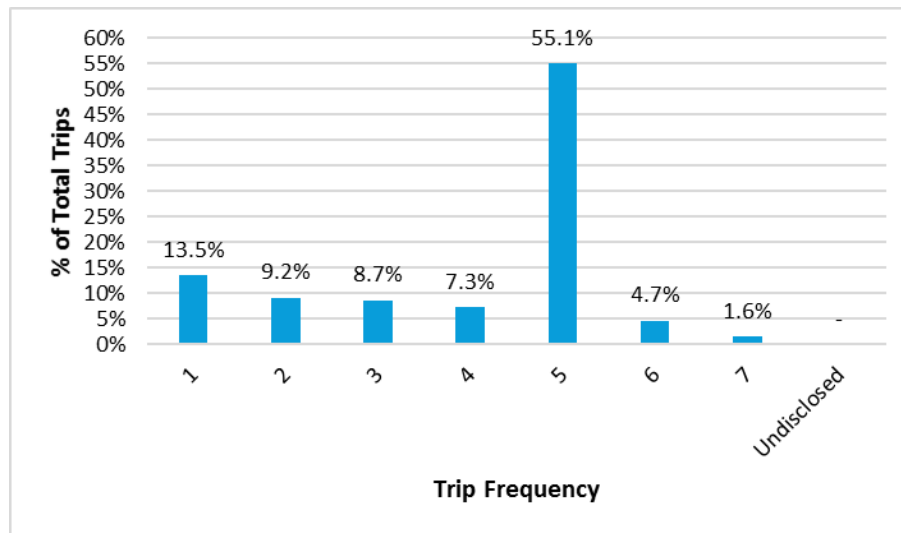
Source: SDG – Using Weighted Survey Results

Forecasting

This section outlines the 2045 LRTP forecasts for population and employment in the Aguadilla TMA. The forecasts were produced using a combination of regional economic forecasting techniques with demographic analysis. For additional details on socio-economic forecasting see Appendix B.

The analysis follows standard practice in regional economic forecasting by focusing on the relationship between population growth (or decline) and economic growth (or decline). The approach focuses on the interplay between population, employment and the cost-of-doing business, as measured by regional wage rates. Wage costs are important to Puerto Rico, as they play a key role in attracting mainland US firms by providing a relatively competitive labor force. Figure 2.63 shows Puerto Rico's average weekly wages by Region.

Figure 2.63: Puerto Rico Average Weekly Wages (Constant 2010 Prices)
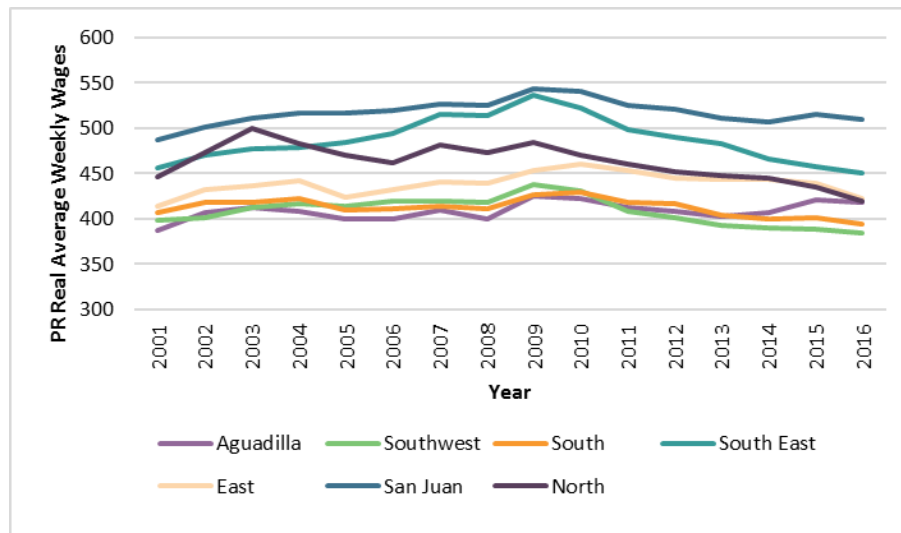
Source: Analysis of Bureau of Labor Statistics Data

The process of forecasting population and employment growth in Puerto Rico needed to contend with the fact that Island is undergoing structural change in its employment base. This change, coupled with several other events both discussed below and in previous sections, have led to a decrease in both employment and population within the last decade. This was shown above in Figure 2.10 and Figure 2.13.

It was found the reversal to be rooted in several factors, including:

- A significant decline in birth rates;
- A decline in manufacturing employment, tied to changes in federal taxation policy, international competition and the fact that manufacturing productivity growth with tend to decrease employment through automation; and
- An increase in the rate of out-migration to the rest of the United States.

This trend is likely to continue and, from initial estimates, has already been exacerbated by a series of impactful exogenous events, including:

- The recent Hurricane María (Sept. 2017) that gravely disrupted economic activity; and
- A long-running fiscal imbalance that culminated in the appointment of the federal oversight board in 2017. The financial crisis has exacerbated the economic challenges on several fronts, forcing cuts in public sector spending and employment and increasing the perceived risk of investing in Puerto Rico's economy.

The forecasts described below suggest that Puerto Rico will recover from recent events, most notably Hurricane María, but will continue to see employment levels declining but at a much slower rate. In Aguadilla, for the period 2016 to 2045, population and employment both have projected growth as seen in Table 2.10 and Table 2.11. Population growth will continue to be negative (but at a much slower rate than recent experience), as lower birth rates will tend to amplify a long-standing pattern for Puerto Rico of net out-migration, principally to the United States mainland.

Puerto Rico is expected to lose nearly 520,000 persons and over 90,000 jobs by 2045. This corresponds to an 15.2% decline in population and an 10.4% decline in employment from Puerto Rico's 2016 figures.

The forecasting approach, described below, does not include scenarios, in the sense that the forecasts do not consider various changes in policy given their uncertainty, such as:

- The possibility that debt restructuring for Puerto Rico could yield a relaxation of fiscal constraints for the government of the Island;
- The possibility that changes in the structure of Federal taxes affects Puerto Rico's competitive position negatively; or
- The possibility that Puerto Rico develops new sources of employment and growth, for example in high technology sectors.

Forecasting Methodology

The models developed for Puerto Rico build "bottom-up" from separate models for the seven Regions in Puerto Rico.

<u>Description of Econometric Models</u>

The econometric models used for this exercise consider population, employment, and wages. The models can be understood to be a representation of labor market conditions. These models use past values of related variables to predict future ones, while also incorporating the dynamics of regional economies and labor markets.

While growth tends to follow a general trend, high wages will, at the margin, act as a break on growth and investment. Similarly, lower wages will tend to attract investment. The model structure is therefore grounded in regional economic theory and is capable of predicting beyond trend growth.

Specifically, the models were used to estimate in the growth rates for each of the seven Regions in Puerto Rico. Forecasted growth rates are then applied to base historic levels of population and employment. The models also use manufacturing value added as an exogenous predictor.

The general system of equations takes the following form:

$$Population_t = \alpha_0 + \alpha_1 Population_{t-1} + \alpha_2 Employment_{t-1} + \alpha_3 Real\ Wages_{t-1} + \alpha_4 Manuf\ Value\ Added_{t-1} + u_{pt}$$

$$Employment_t = \beta_0 + \beta_1 Population_{t-1} + \beta_2 Employment_{t-1} + \beta_3 Real\ Wages_{t-1} + \beta_4 Manuf\ Value\ Added_{t-1} + u_{et}$$

$$Real\ Wages_t = \gamma_0 + \gamma_1 Population_{t-1} + \gamma_2 Employment_{t-1} + \gamma_3 Real\ Wages_{t-1} + \gamma_4 Manuf\ Value\ Added_{t-1} + u_{wt}$$

Estimation of Impact of Hurricane María

One advantage of using these models for this exercise is their ability to predict impacts of exogenous shocks. In addition to forecasting long-term growth, these models are used to estimate the persistent effects of an event such as Hurricane María. Studies of other Regions suffering natural disasters show that post-disaster population can be slow to recover to pre-disaster trends. These models first estimate long-term population and employment forecasts based on pre-Hurricane levels, then separately estimate the impact of Hurricane María. What these models can do is tell us the trajectory of outmigration specifically due to the Hurricane, followed by the return of some residents. They determine how long population and employment levels should take to return to the trends forecasted without the impact of the Hurricane. Specifically, the model captures the persistence effect of the hurricane's impact (generally estimated to have been a 7.7% reduction population[21] in 2017).

Population

Figure 2.64 presents the formal population forecasts for the Aguadilla TMA. This includes historical population trends, the impacts of Hurricane María and the subsequent return to a forecasted population trend of slower population decline. Aguadilla is the only Region expected to experience population growth over the time period 2016-2045. [22]

Figure 2.64: Population Forecasts – Aguadilla TMA
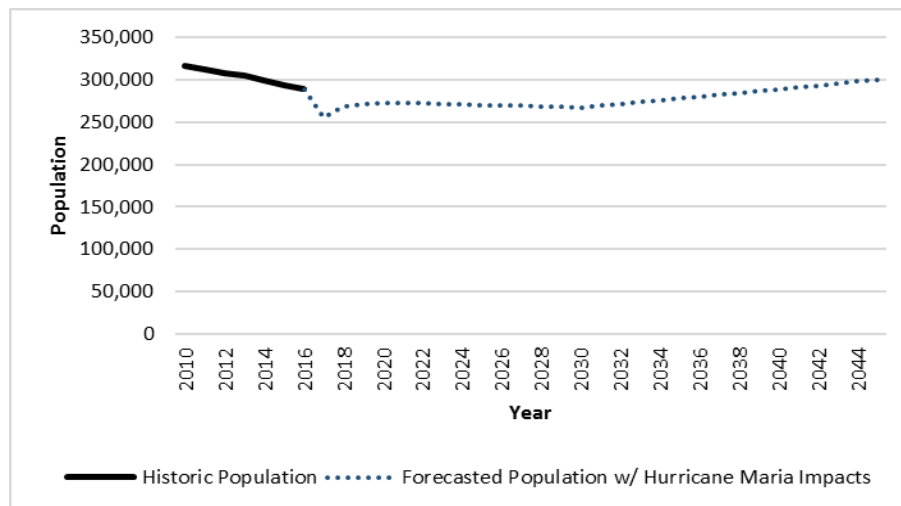
Source: Population "Constrained" Forecast[23]

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[21] PR Fiscal Board.

[22] SDG developed its forecasting models using decennial and annual population estimates spanning 2001-2016 from the U.S. Census Bureau. Following the release of the decennial census, preceding annual population estimates are adjusted to produce intercensal estimates. SDG models do not use intercensal estimates, choosing to specify models on annual estimates, and are presented in graphics from 2010-2045.

[23] For additional details on socio-economic forecasting and the "Unconstrained" and "Constrained" forecasts, see Appendix B.

Table 2.10 breaks down the population forecast into temporal segments. Over the 29-year timespan, 2016-2045, population is forecasted to grow by 3.9% and analysis of CAGR points to focused population decline from 2016 to 2020. Population during this 4 year-period is forecasted to decline 1.4% annually, a reduction of just under 16,000 people.

Over the time-scale 2016-2045, the population CAGR is slightly positive at 0.1%. This population growth from 2025 to 2045 results from the relationship between employment, population, and wages present in the forecast models and discussed in the model development section. Figure 2.65 and Figure 2.66 show the forecasted 2045 population and population changes respectively.

Table 2.10: Population Forecast Growth Rates – Aguadilla

Year	PR Population	Percent Change from 2016	CAGR from 2016	Aguadilla Population	Percent change from 2016	CAGR from 2016
2016	3,411,307	-	-	288,777	-	-
2020	3,168,498	(7.1%)	(1.8%)	272,906	(5.5%)	(1.4%)
2025	3,094,020	(9.3%)	(1.1%)	270,331	(6.4%)	(0.7%)
2040	2,929,693	(14.1%)	(0.6%)	288,743	(0.0%)	(0.0%)
2045	2,893,950	(15.2%)	(0.6%)	300,126	3.9%	0.1%

Source: Population "Constrained" Forecast

Figure 2.65: Aguadilla TMA Population 2045
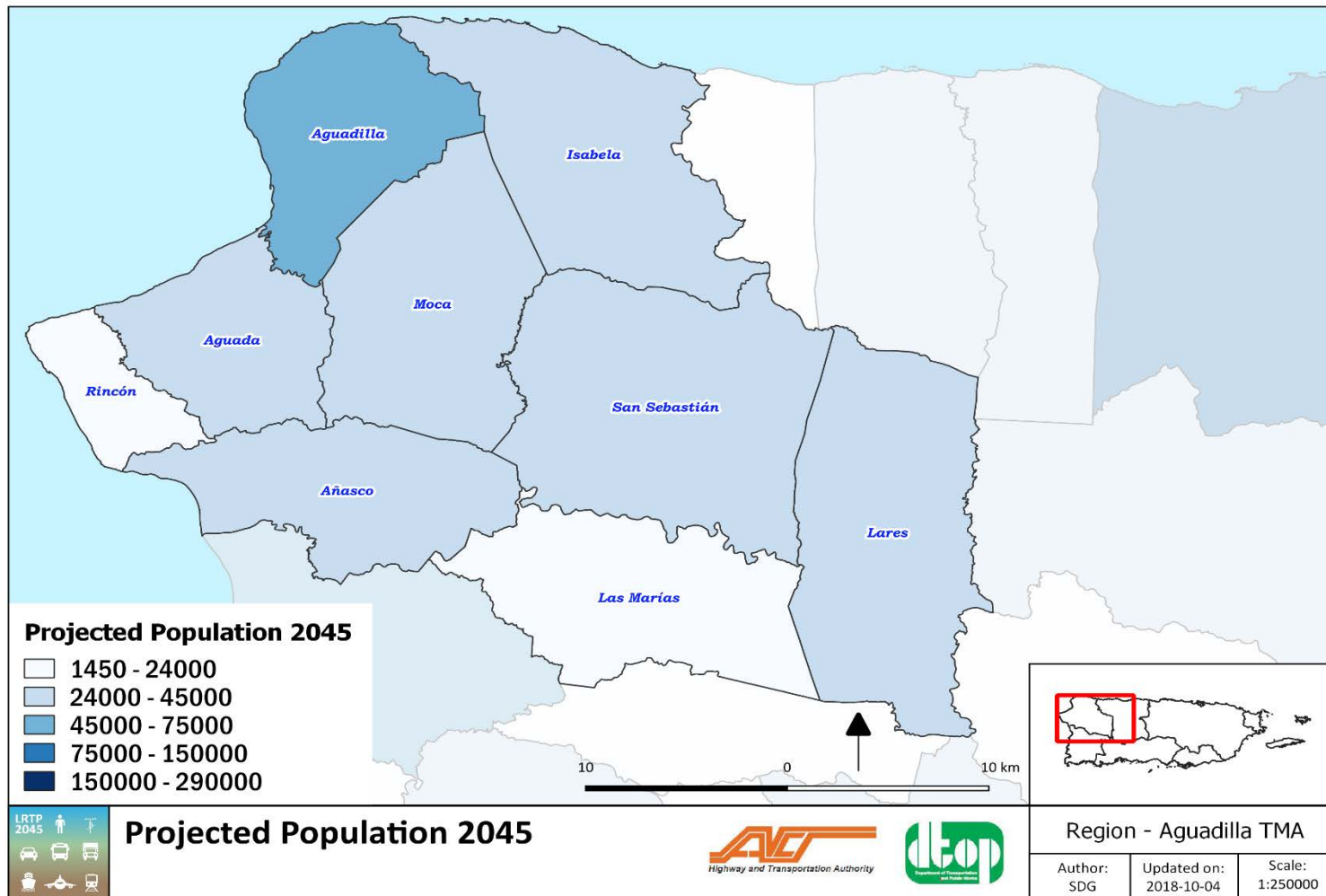
Source: Population Projections carried out by Steer Davies Gleave on U.S. Census Bureau Population Estimates.

Figure 2.66: Aguadilla TMA Population Change 2016-2045
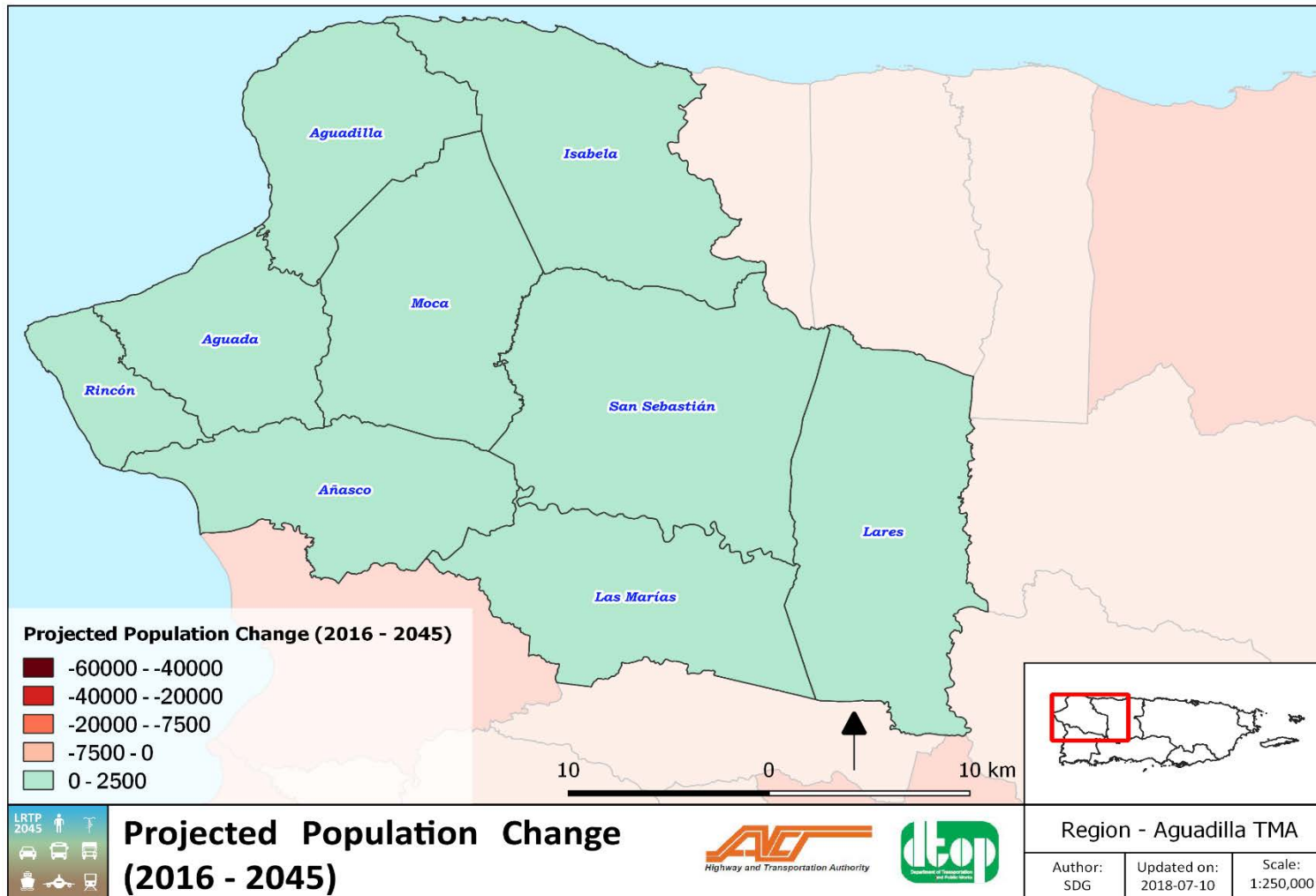
Source: Population Projections carried out by Steer Davies Gleave on U.S. Census Bureau Population Estimates.

Employment

Two employment data sources were used to produce final forecasts of employment by municipality. The ultimate data source was the BLS -LAUS which encompasses all employment including agricultural employment and the self-employed. BLS LAUS displays employment by place of residence. While useful for many types of analyses, employment by home location was not ideal for much of the modelling, which required employment by place of work. For example, employment by place of work is required as inputs to the trip generation phase.

The LAUS data was the reference point in terms of total employment for Puerto Rico, as it includes the broadest coverage of employment categories. In the base 2010 dataset at the Traffic Analysis Zone (TAZ) level, the BLS LAUS employment was the reference data but it was transformed into employment by place of work using journey-to-work information. The approach is to base the analysis on this 2010 employment transformed from place of residence to place of work which matches the 2010 employment totals for Puerto Rico reported in the LAUS.

The BLS Quarterly Census of Employment and Wages (QCEW) was used to update the 2010 base data to 2016, however, the dataset does not include agricultural employment or the self-employed. The BLS QCEW is reported by place of work and is available for historical years 2001-2016, which allowed for the generation forecasting models to update the 2010 data by TAZ. The QCEW was not used for employment totals, as the coverage is more limited than the LAUS.

In short, while the QCEW is preferable to generate models of growth, it is not preferable as an indicator of total employment (which is essential for trip generation). For this reason, the total employment numbers for 2016 used in the econometric models for forecasting are lower than the total 2016 employment numbers from the 2016 TAZ level employment dataset.

Figure 2.67 presents the formal employment forecasts for the Aguadilla TMA. This includes historical employment trends, the impacts of Hurricane María and forecasted employment growth into the future. Aguadilla has experienced employment growth in the retail and service industries from 2014 through 2016, to counteract declines in manufacturing employment[24]. The positive employment outlook can be seen in the forecasts, where by 2020, employment is predicted to rebound from Hurricane María, and post 1.5% growth from 2016. Aguadilla is one of the two Puerto Rico TMA Regions with forecasted employment growth.

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[24] "Bureau of Labor Statistics, U.S. Department of Labor, *Quarterly Census of Employment and Wages*, [Puerto Rico - Municipality Industry Employment], on the Internet at [http://www.mercadolaboral.pr.gov/Tablas_Estadisticas/Industrias/T_Composicion_Industrial.aspx] (visited [5/17/2018])."

Figure 2.67: Indexed Employment Forecasts – Aguadilla TMA – (Index = 2010)
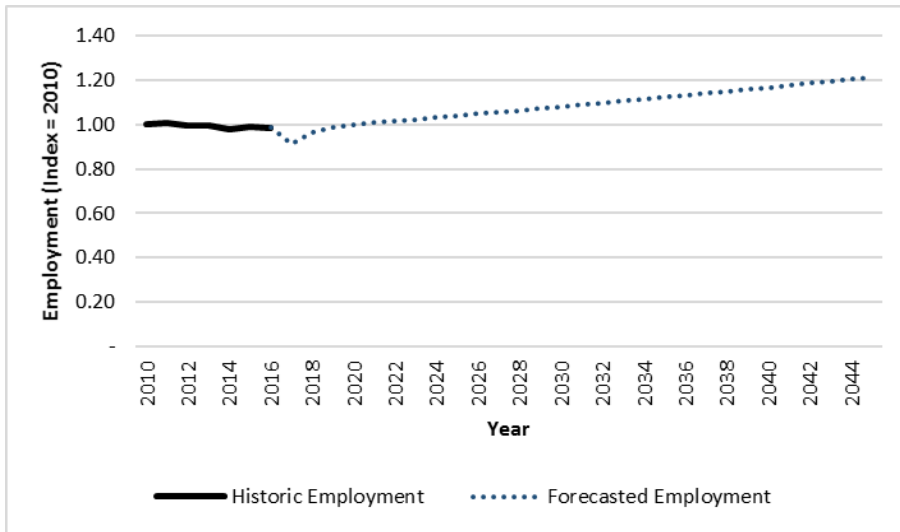
Source: Employment Forecast

Table 2.11 breaks down the employment forecast dynamics into temporal segments. Over the timespan 2016-2045, employment is forecasted to increase by 23.2%, with focused employment growth from 2025-2040, where employment is forecasted to increase close to 20,000 jobs. One of the explanatory variables leading to this predicted employment increase is the forecasted growth in wages, which increases the attractiveness of this Region for employment. Over the time-scale 2016-2045, the employment CAGR is just over 0.7%. Figure 2.68 and Figure 2.69 show forecasted employment totals and changes over time respectively.

Table 2.11: Employment Forecast Growth Rates – Aguadilla TMA

Year	Employment	Percent change from 2016	CAGR from 2016
2016	81,952	-	-
2020	83,194	1.5%	0.4%
2025	86,526	5.6%	0.6%
2040	97,168	18.6%	0.7%
2045	100,998	23.2%	0.7%

Source: TAZ Level Employment Forecast

Figure 2.68: Aguadilla TMA Employment 2045
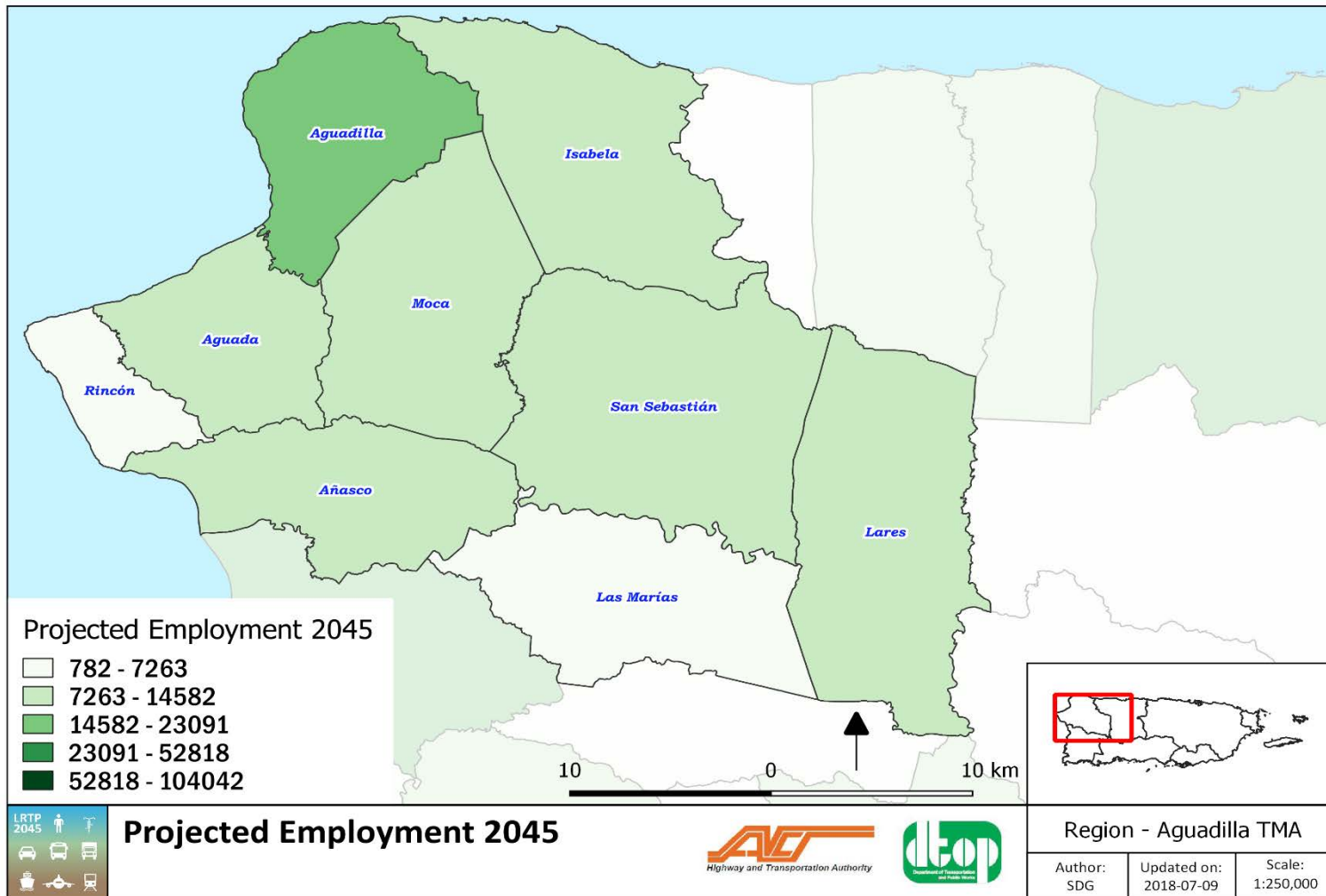
Source: Employment Projections carried out by Steer Davies Gleave on Buerau of Labor Statistics (BLS) datasets.

Figure 2.69: Aguadilla TMA Employment Change 2016-2045
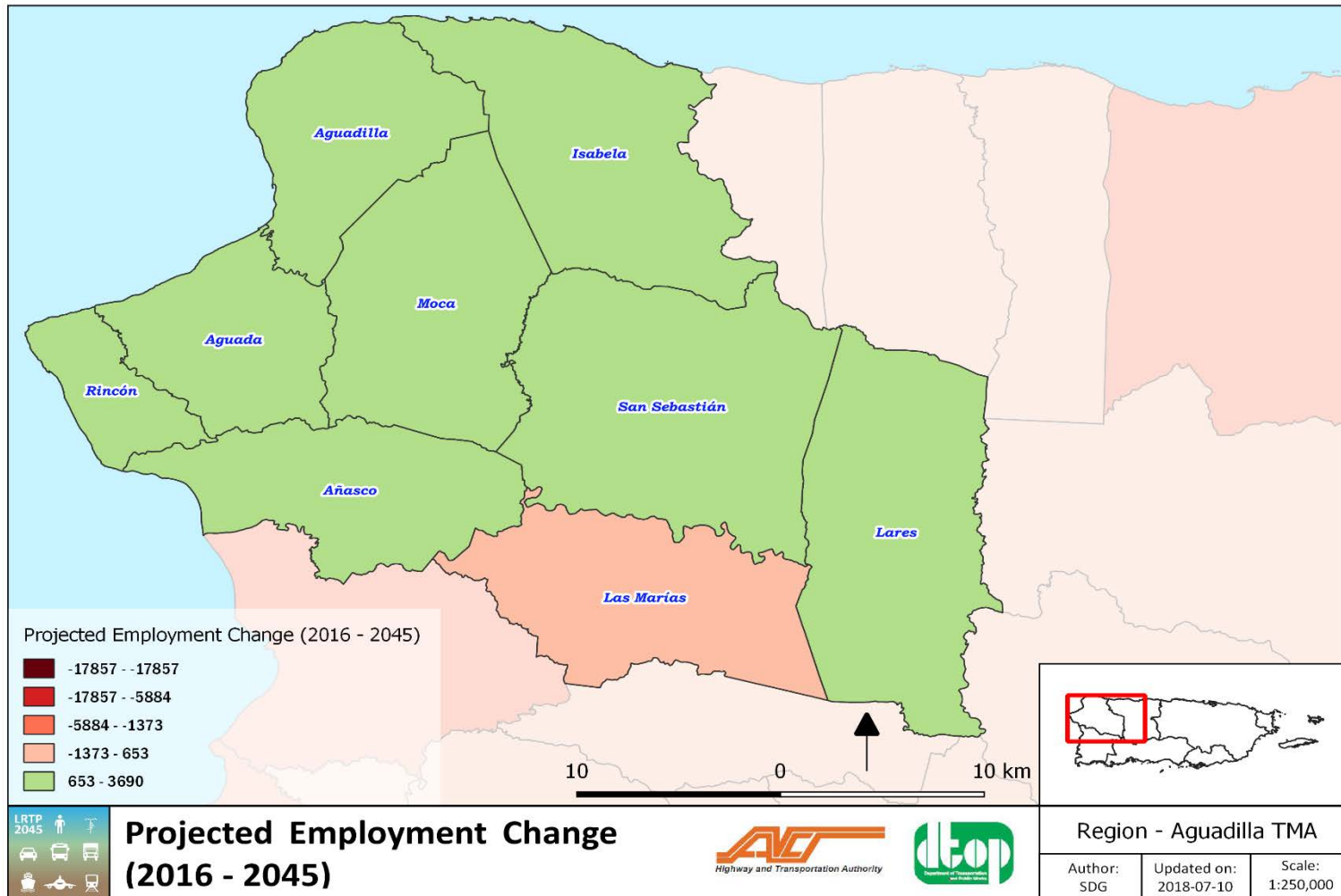
Source: Employment Projections carried out by Steer Davies Gleave on Buerau of Labor Statistics (BLS) datasets.

TRANSPORTATION SYSTEM

Highways

Roadway System

The Aguadilla TMA model network for 2016 has a total of 1,274 route miles (bi-directional), 1,337 lane miles and 5.72 Million daily vehicle miles, as reported by the 2016 LRTP model calibration[25]. Figure 2.70 show the Aguadilla TMA regional highway system as defined by the Transportation National Highway System (NHS) and non-NHS system.

For an additional level of detail; Table 2.12 and Figure 2.71 display roadway network functional classifications according to the Puerto Rico Department of Transportation NHS information layer. The goal of this classification is to define the role of a roadway in the overall roadway network.

Table 2.12: Roadway System by Functional Classification – Aguadilla TMA

Functional Classification	Route Miles
Interstate	52
Freeways and Expressways	-
Principal Arterials	43.58
Local Principal Arterials	2.72
Minor Arterials	-

Source: 2045 LRTP Plan Development

FHWA defined each one of the functional classification categories as follows:

- **Interstate**: they are designed and built considering mobility and long-distance travel, and they are the highest classification of Arterials;
- **Other Freeways and Expressways**: designed and built to increase mobility function, and adjoining land uses are not directly served by them; access and egress points are limited to on- and off-ramp locations or a limited number of at-grade intersections; and they have directional travel lanes, usually separated by some type of physical barrier;
- **Principal Arterials**: serve main centers of metropolitan areas, offer both high mobility degree and mobility through rural areas; and adjoining land uses can be served directly;
- **Minor Arterial**: provide connectivity to the higher Arterial system and service for trips of moderate length; also serve geographic areas;
- **Major Collector**: provide more mobility, might have more travel lanes, have higher annual average traffic volumes and speed limits, have lower connecting driveway densities, are longer in length and are spaced at greater intervals than their Minor Collector counterparts; and
- **Minor Collector**: offer less mobility and more access than their Major Collector counterparts. Also, they serve both land access and traffic circulation in lower density residential and commercial/industrial areas instead of the higher density service in Major Collectors.

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[25] These values include all classifications but connectors therefore minor road values are omitted in these numbers.

There is a complex non-NHS system within the Island (local system) due to their provision of direct access to adjoining land, they are not intended for use in long distance travel, except at the origin or destination end of the trip26.

The Aguadilla TMA map shown in Figure 2.71 illustrates the present road network on the Aguadilla TMA Region as it is described on the HPMS by its Functional Classifications. The road system encompassing the Region consists primarily of PR-2 as the main arterial connecting the coastal counties within the Region, these being: Isabela, Aguadilla, Aguada, Rincon and Añasco, while not a highway PR-2 is still part of the interstate system. The Region also has a network of principal and minor arterials interconnecting the other inland counties, Moca, San Sebastian, Lares which can be reached through PR-111 and Las Marías which can be reached through PR-119. Another important arterial is PR-129, a secondary route into and out of the Region which stems northeast after intersecting PR-111 in Lares in direction of Arecibo.

A more detailed description of the Interstate, Principal and Minor Arterial roads for the Aguadilla TMA is included below:

Interstates

- **PR-2:** is both a principal arterial and part of the Interstate system. It runs west from Santurce Barrio (in San Juan, where it starts) and travels the whole north of the Island intersecting PR-22 at various points along the way. It runs through Aguadilla TMA for 41.7 Km between km 104.5 and km 146.2, through which it connects the municipalities of Isabela, Aguadilla, Aguada, Rincon and Añasco, from PR-107 onwards until Añasco the road is also known as Exp. Rafael Hernández El Jibarito, where it continues south through Mayagüez and Hormigueros after which it turns east to Ponce and connects with PR-52.

Principal Arterials

- **PR-111:** a 91.9 km road that starts at Aguadilla pueblo and runs south parallel to PR-2 for approximately 6 km, then turns east intersecting PR-2 and continuing for another 35 km through Moca and San Sebastian and into Lares. After Lares, PR-111 continues east as a minor arterial another 32 km outside the Aguadilla TMA Region through Utuado.
- **PR-129:** is a 43 km long principal arterial that starts at PR-135 in Adjuntas and ends at Utuado pueblo, it forms part of the Aguadilla TMA Region from km 6.3 until km 23.7.

Minor Arterials

- **PR-119:** runs for 80.2 km from barrio Cain Bajo in San German to Hatillo pueblo. Crossing the Aguadilla TMA Region from south to northeast for 40 km from km 20 to km 60.2. It passes through Las Marías pueblo at km 30 and intersects PR-111 on km 45.8 at San Sebastian pueblo.

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26 U.S. Department of Transportation. Federal Highway Administration. Office of Planning, Environment, and Realty (HEP).

Figure 2.70: Aguadilla TMA Roadways by NHS Identification

National Highway System 2018

— INTERSTATES
— NHS
— NON-NHS
☐ Municipal Boundaries

National Highway System and Road Network for Puerto Rico

Region - Aguadilla TMA

| Author: SDG | Updated on: 2018-09-24 | Scale: 1:250000 |
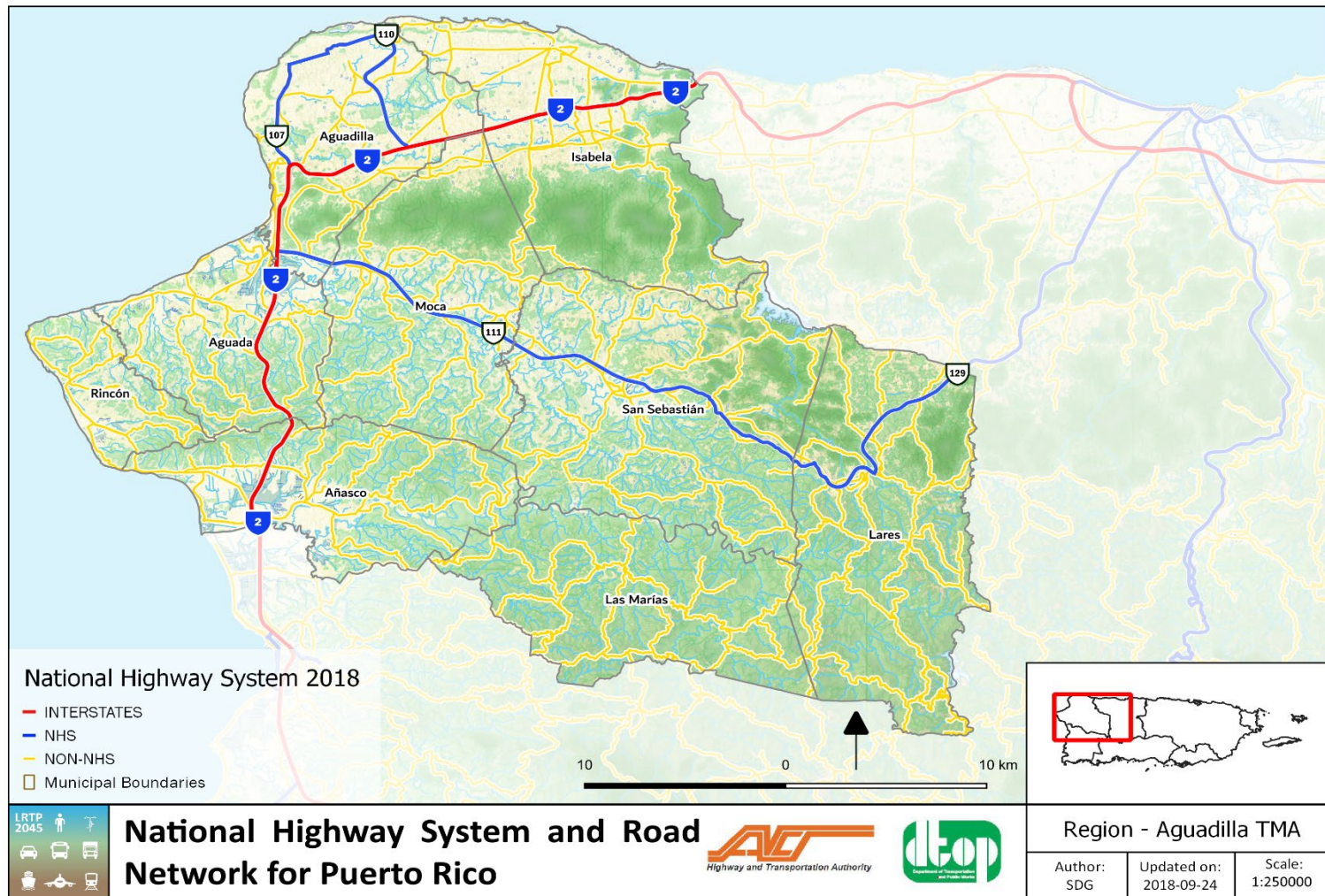
Source: PRHTA's Roadway Systems' Office, 2016 HPMS

Figure 2.71: Aguadilla Region Roadways
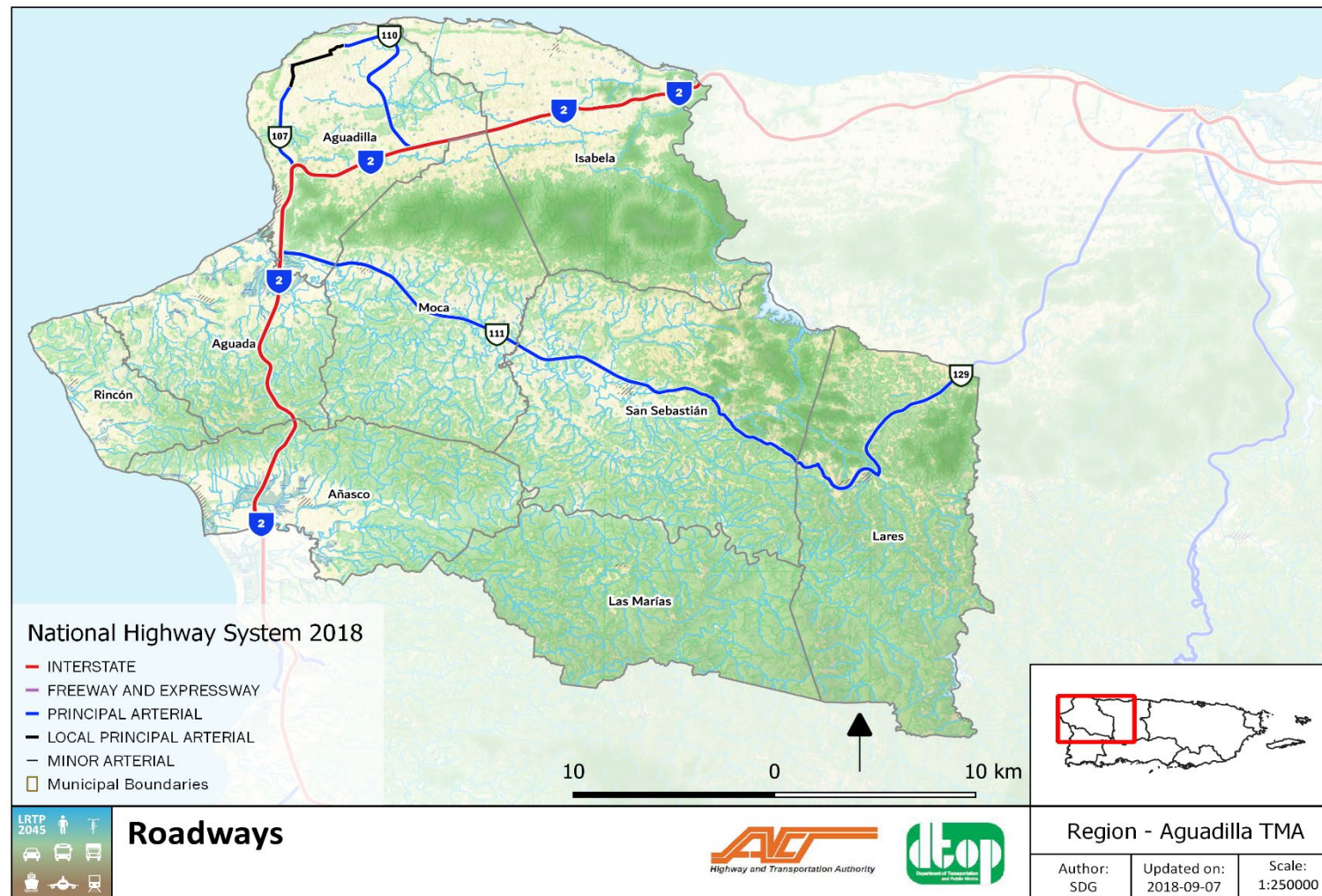
Source: National Highway System as it appears on the NHS 2018 layer for Puerto Rico provided by the Puerto Rico Highway and Transportation Authority (ACT by its spanish acronym)

Effect of Hurricane María on Roadway System

As a consequence of Hurricane María's hit over Puerto Rico on September 2017, the roadway infrastructure was damaged by flooding, debris and landslides, 28 bridges were reported with damages out of which two of these were reported as collapsed, three with failure in approach and the rest with other harms. Damaged bridges by municipalities are included in Table 2.13.

Table 2.13: Bridges Over Waterways with Reported Damages due to María in Aguadilla TMA

Municipality	Bridges with Reported Damages due to María	Total Number of Bridges	Percentage of Damaged Bridges
Aguada	1	17	5.9%
Moca	3	12	25.0%
Lares	7	13	53.8%
Añasco	2	22	9.1%
Las Marías	6	18	33.3%
San Sebastián	9	30	30.0%
Total	**28**	**112**	**25.0%**
Puerto Rico	**388**	**1774**	**21.9%**

Source: PRHTA

Municipalities with higher closed bridges due to collapse are: Moca and San Sebastián, as shown in Table 2.14.

Table 2.14: Closed Bridges Due to Collapse

Municipality	Closed Bridges Due to Collapse
Moca	1
San Sebastián	1
Total	**2**

Source: PRHTA

In the Region, only Moca, Las Marías and San Sebastian reported bridges with failure in approach, as shown in Table 2.15.

Table 2.15: Bridges with Failure in Approach Roadways / Slab

Municipality	Bridges with Failure in Approach Roadways / Slab
Moca	1
Las Marías	1
San Sebastian	1

Source: PRHTA

Traffic Patterns

Figure 2.72 presents 2016 traffic volumes throughout Aguadilla TMA, displaying the road density in terms of graduated bandwidth and color. It shows that the traffic is concentrated on the primary interstate leading in and out of Aguadilla TMA with minimum nearing 33,600 vehicles per day and reaching a maximum just under 60,000 vehicles, PR-2 lands on this category. The principal arterials PR-111, PR-129, PR-119 and PR-107 along other minor arterials make part of the second densest category with almost 15,000 vehicles daily. The third is distributed on remaining local collectors and roads with under 5,000 vehicles daily.

The Highway Capacity Manual (HCM) 2010 defined Level of Service (LOS) as "a quantitative stratification of a performance measure or measures that represent quality of service" [27]. Where service measures are used to determine LOS for transportation system elements. There are six levels of service, ranging from A to F: from the traveler's perspective, LOS A denotes the best operating conditions and LOS F the worst.

LOS for vehicles are determined, based on the HCM, using density calculation; nonetheless, a volume over capacity (v/c) calculation was used to determine LOS in the model considering the model does not provide link specific volumes but rather trip volumes between nodes. Table 2.16 shows LOS criteria for Freeway facilities as a function of volume to capacity ratio based on HCM 2000 that interrelate v/c LOS with current (HCM 2010) Density LOS definitions.

Table 2.16: LOS Criteria as a Function of Volume Capacity Ratio

Level of Service	v/c
A	< 0.34
B	0.34 - 0.56
C	0.56 - 0.76
D	0.76 - 0.90
E	0.90 - 1
F	> 1

Source: HCM 2000

Figure 2.73 presents 2016 LOS throughout Aguadilla TMA based on information from the calibrated model for the average day period. LOS E and F are mainly observed intermittently on PR-2 and other principal and minor arterials including:

- PR-2;
- PR-1107;
- PR-107;
- PR-109;
- PR-110;
- PR-111;
- PR-113;
- PR-115; and
- PR-417.

[27] Highway Capacity Manual (2010).

Figure 2.72: Aguadilla TMA Traffic Volumes 2016; Average Day
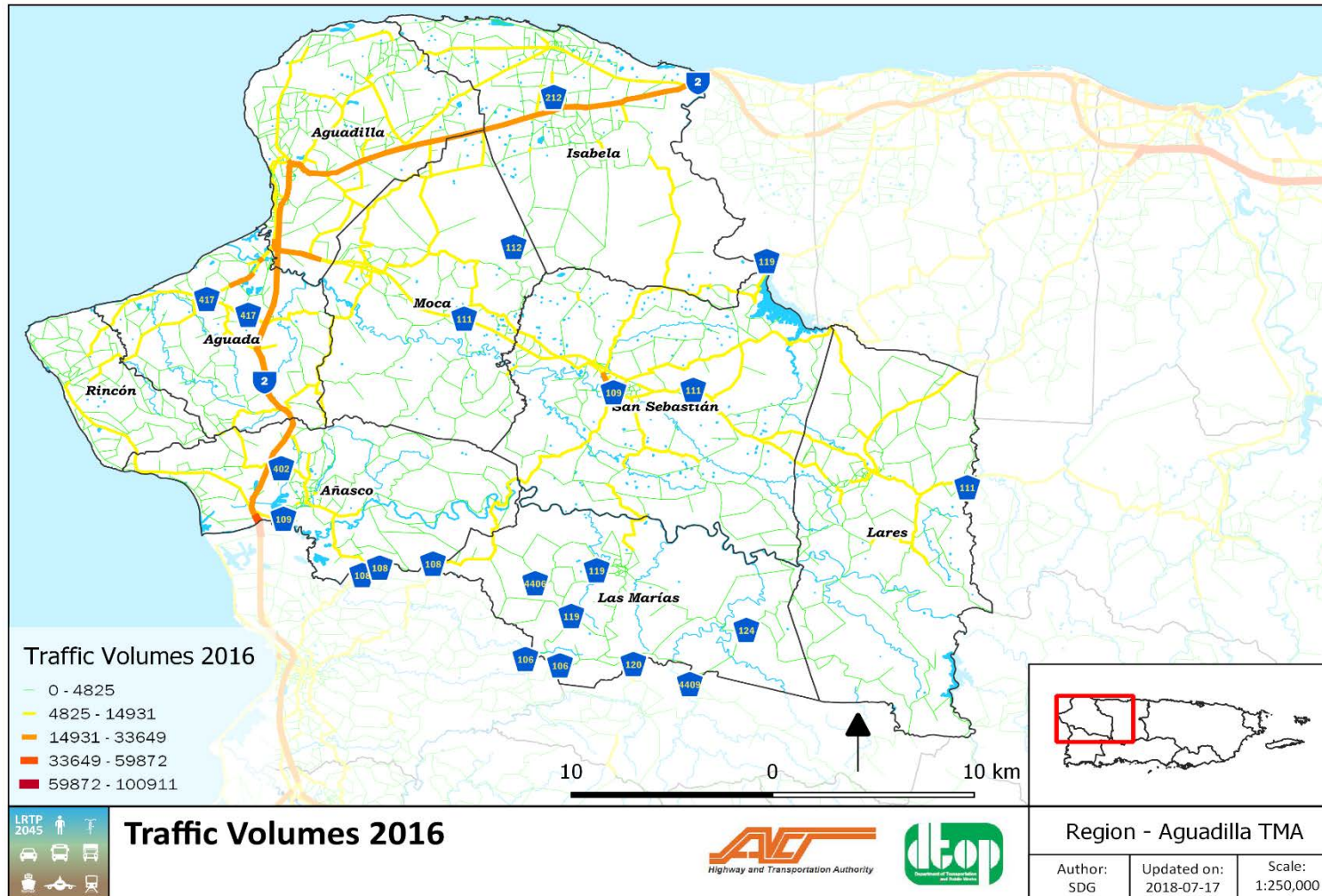
Source: P.R. Network Model Calibrated by Steer Davies Gleave for the year 2016 using Cube Voyager

Figure 2.73: Aguadilla TMA Levels of Service 2016; Average Day
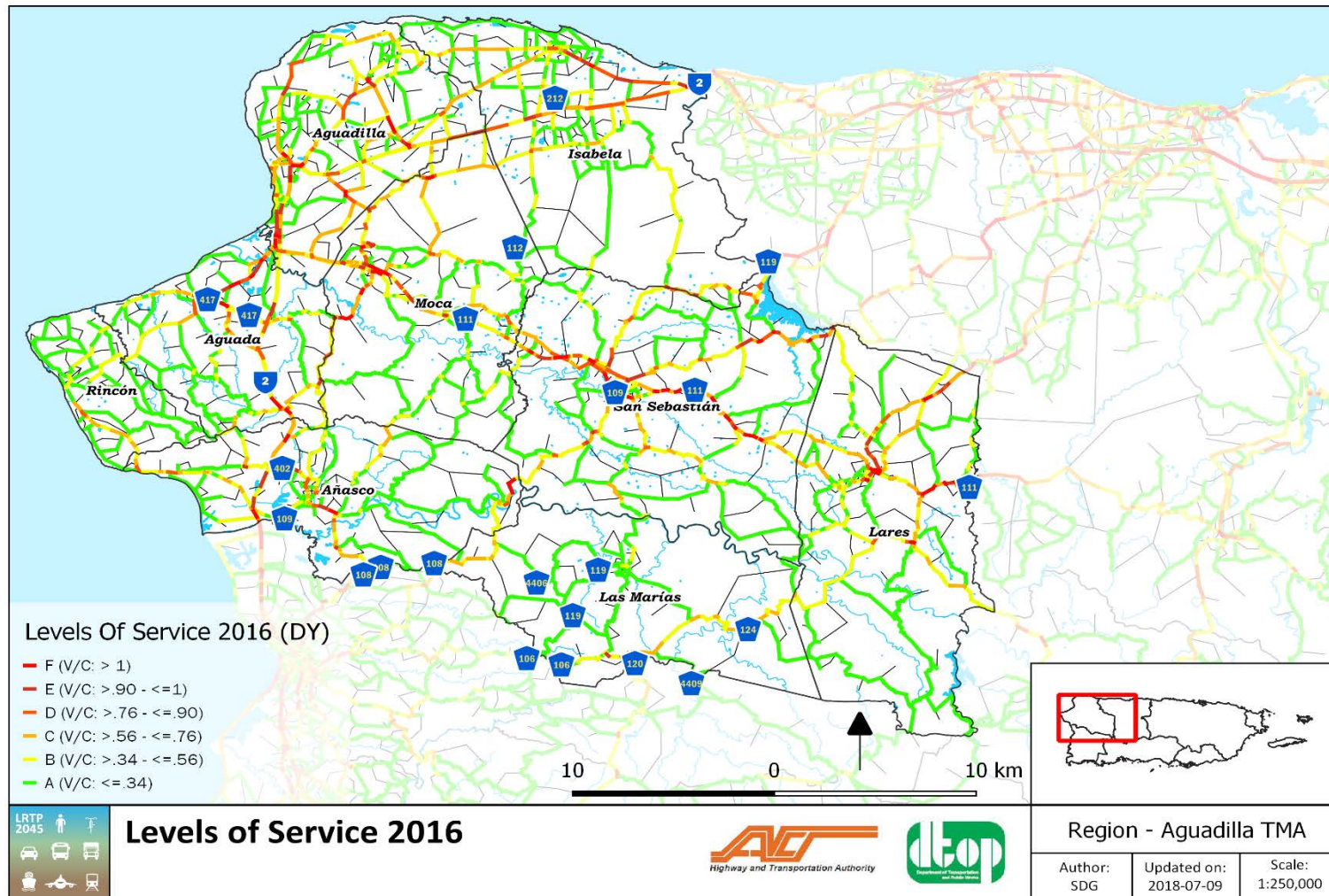
Source: P.R. Network Model Calibrated by Steer Davies Gleave for the year 2016 using Cube Voyager

Regional Freight Network

Figure 2.74 shows the freight network in Aguadilla TMA. The network as defined from the FHWA consists of the primary interstate system and other principal arterials that provide access to town centers. As describe in previous sections, the primary highway that makes up the network is PR-2.

Figure 2.75 displays truck activity in the Aguadilla TMA MPO Region as a graduated color graph that represent daily vehicle traffic in terms of a truck volume to total vehicle volume ratio categorized in three classes: Less than 5.0%; Between 5.0% and 10.0%; and Greater than 10.0%. The map illustrates how truck traffic represent less than 5.0% of total traffic moving in and out of the Aguadilla TMA Region through the primary interstate highway. It can also be observed an increased traffic in minor arterial roads crossing town centers.

Figure 2.76 shows the freight network hotspots in Aguadilla TMA, indicating sections of the road where traffic is operating at or over the capacity of the road and at the same time being highly used by trucks. These roads mainly include the interstate road PR-2 as well as principal arterials such as PR-111 and PR-129 and they also frequently occur in egress and aggress points throughout the Region in addition to roads like PR-115 and PR-416 that lead to and from town centers. Some of these hotspots can also be observed in PR-107 and PR-110 which provide access to the Rafael Hernandez International Airport.

Figure 2.74: Aguadilla TMA Freight Network

Source: The existing Freight Network information layer was obtained form the Federal Highway Administration (FHWA)

Figure 2.75: Aguadilla TMA Existing Truck Activity
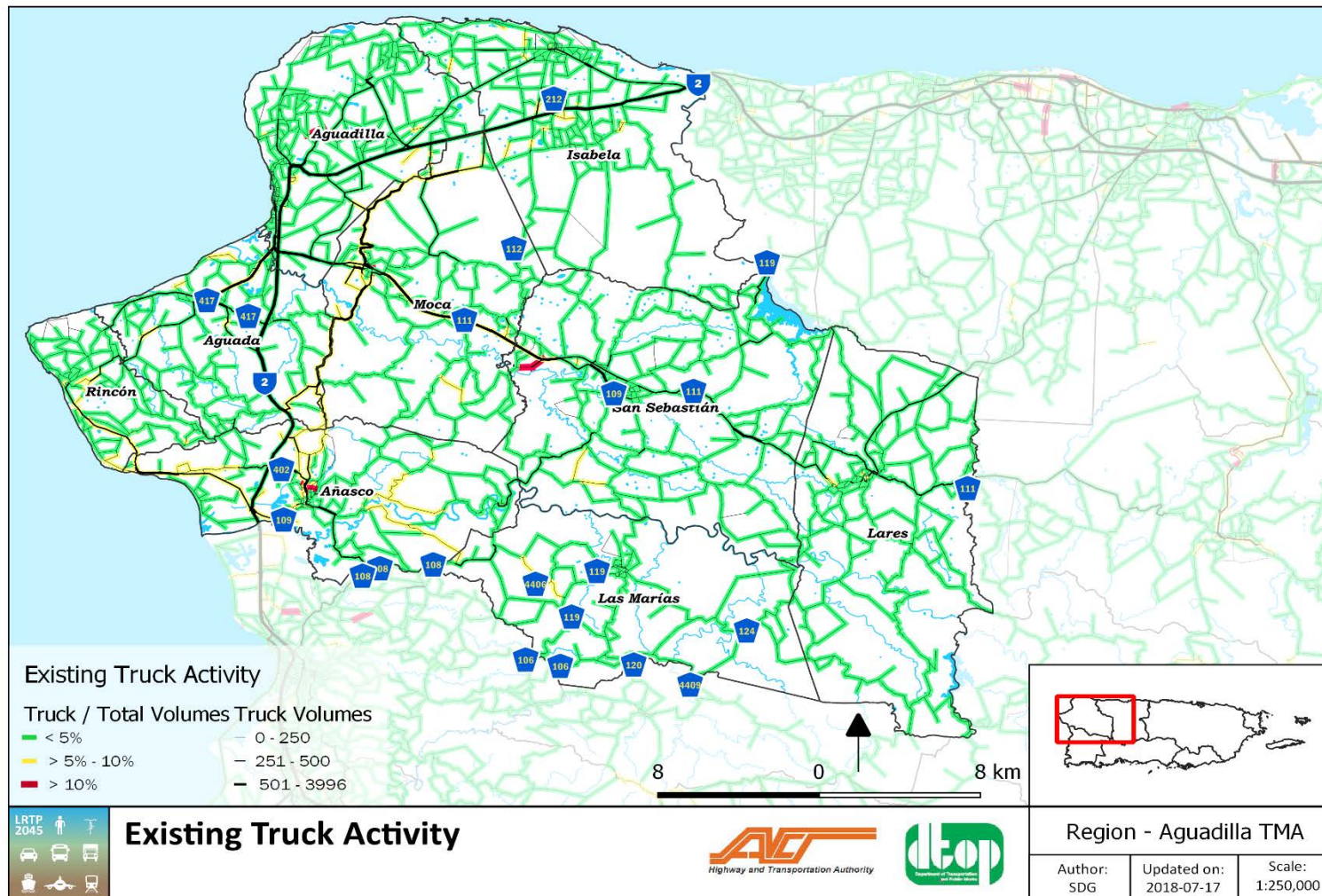
Source: P.R. Network Model Calibrated by Steer Davies Gleave for the year 2016 using Cube Voyager

Figure 2.76: Aguadilla TMA Freight Network Hotspots
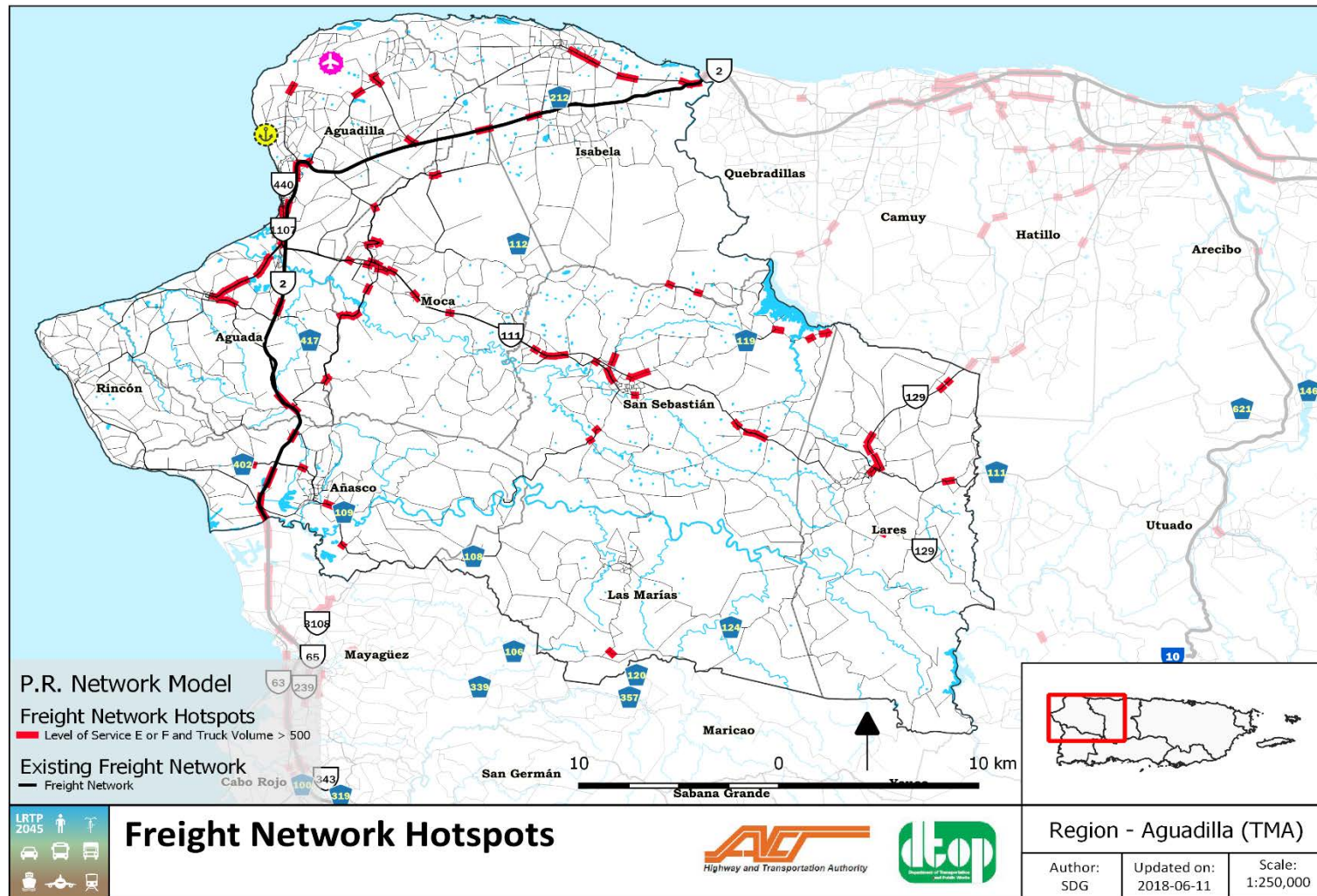
Source: P.R. Network Model Calibrated by Steer Davies Gleave for the year 2016 using Cube Voyager

Size and Weight Enforcement Program

<u>Semi-Permanent Weighting Stations</u>

The weight and size of trucks is regulated in Puerto Rico by the traffic and vehicle regulations of the DTPW. Through Puerto Rico there are 68 semi-permanent weighting stations, seven (7) of them are located in Aguadilla TMA, as shown in Figure 2.77 and Table 2.17.

Table 2.17: Semi-Permanent Weighting Stations in Aguadilla TMA

Station Number	Road	Km	Municipality	Direction
18	PR-2	145	Añasco	Ponce
45	PR-2	132	Aguada	Aguadilla
15	PR-2	117	Isabela	Arecibo
19	PR-2	145	Añasco	Arecibo
17	PR-111	4.1	Moca	San Sebastian
16	PR-2	117	Isabela	Mayagüez
46	PR-2	133	Aguada	Mayagüez

Source: PRHTA

Figure 2.77: Semi Permanents Weighing Stations in Aguadilla TMA
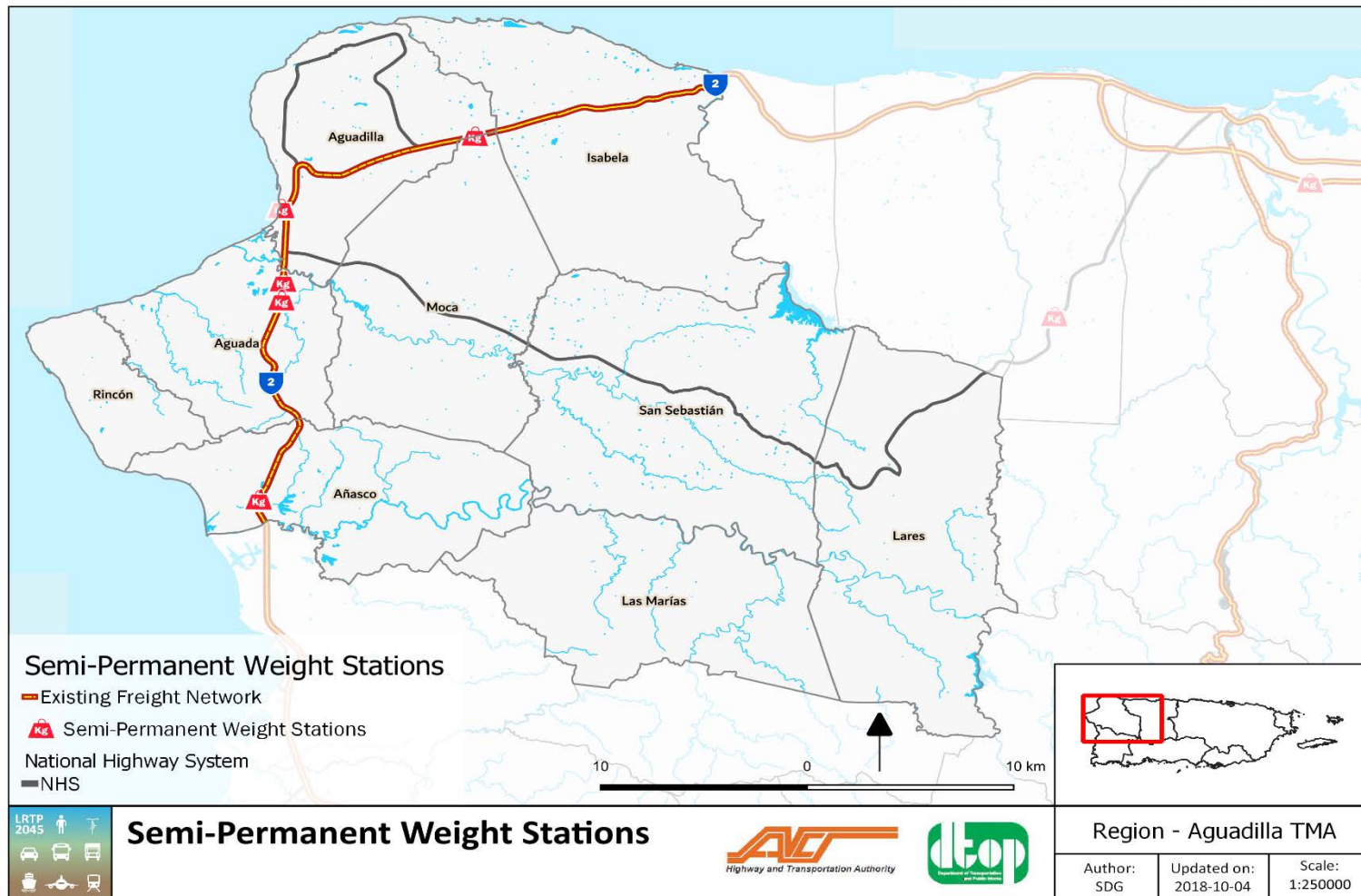
Source: the Semi-Permanent Weight Stations information layer was provided by the Puerto Rico Highway and Transporation Authority (ACT by its spanish acronym). The PR Freight Network was obtained from the Federal Highway Administration (FHWA)

Transit

The Aguadilla TMA has transit services throughout Públicos and Municipal services.

Públicos

Públicos are privately owned and operated services regulated under the Public Service Commission. Services are allowed to serve specific routes but without specific schedules or stopping points. Públicos are operated under individual or franchise agreements, with fares regulated by route and have special insurance requirements. Vehicle capacity varies from eight to 24, and the vehicles may be owned or leased by the operator.

From data obtained from the National Transit Database (NTD), it is quite evident that the Públicos suffered a significant loss of trips in the past years as summarized in Table 2.18. From 2010 to 2016 there have been a reduction of more than 20,000 trips made by Públicos across Puerto Rico. Another characteristic that show a significant reduction is the annual passenger miles which has shown a decrease from 122,570,478 in 2013 to 90,291,870 in 2016.

Also, between Fiscal Year 2012 and Fiscal Year 2016, the Público system has lost 23% of its routes (from 453 to 346, a net reduction of 107 routes), while the vehicles available to provide transportation services have decreased by 31% during the same 5-year period[28]. Similarly, the sponsorship has suffered a significant decline, and is expected to continue to decrease in the absence of policies and programs aimed at stabilizing this transportation service.

Table 2.18 presents the annual unlinked trips for Públicos from 2010 to 2016 in Puerto Rico.

Table 2.18: Percentage of Change of Annual Unlinked Trips for Públicos from 2010 to 2016

	2010	2011	2012	2013	2014	2015	2016
Público (annual unlinked trips)	42,134,000	38,706,000	32,670,000	27,021,382	27,881,893	25,796,436	21,353,376
Change	-	(3,428)	(6,035)	(5,649)	861	(2,085)	(4,443)
% Change	-	(8.1%)	(15.6%)	(17.3%)	3.2%	(7.5%)	(17.2%)

Source: Prepared by SDG with data from the National Transit Database (NTD)

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[28] Based on information provided by MTCG, Inc.

In Aguadilla TMA Region there are approximately 100 Público routes. Figure 2.78 presents the Público routes in the Aguadilla TMA. These services have terminals in almost all the municipalities (at least one terminal) and at least one route in this Region including: Aguada, Aguadilla, Añasco, Isabela, Lares, Las Marías, Moca, Rincón and San Sebastián. There were at least 754,186[29] annual unlinked passenger trips for the Aguadilla TMA zone.

Municipal Services

According to information obtained from the NTD, there are several Municipalities (32) in Puerto Rico that provide and operate a transit service for their citizens that use diverse types of vehicles – predominantly motor trolleys. Three (3) of these are within the Aguadilla TMA; all free of charge; operating under fixed routes with pre-defined[30] stops within the municipal limits. For the 32 municipalities with transit service, there were approximately 6,564,210 total annual unlinked passenger trips[31], with 6,438,421 for the regular transit service and 125,789 for the demand response service.

For the Region there were approximately 52,077 total annual unlinked passenger trips, with 40,598 for the regular transit service and 11,479 for the demand response service.

Table 2.19 and Figure 2.79 present the Municipalities with a transit service in the Aguadilla TMA:

Table 2.19: Municipalities with a transit service within Aguadilla TMA

#	Municipalities with a Transit Service within Aguadilla TMA
1	Aguada
2	Lares
3	San Sebastián

Source: Prepared by SDG with data from the National Transit Database (NTD).

Additionally, there are several Municipalities that provide paratransit services to the elderly and people with disabilities regardless of providing municipal transit services.

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[29] According to data obtain from MTCG, Inc.

[30] In some cases, there are fixed routes without predefined stops (as long as a user it's in the establish route the driver picks up the passenger – request stop service) especially in rural communities. Additionally, in the aftermath of Hurricane María, some of the infrastructure from stops was destroyed or badly damaged (signage poles, signs, shelters, etc.).

[31] According to NTD, 2016 data.

Figure 2.78: Público Routes in the Aguadilla TMA
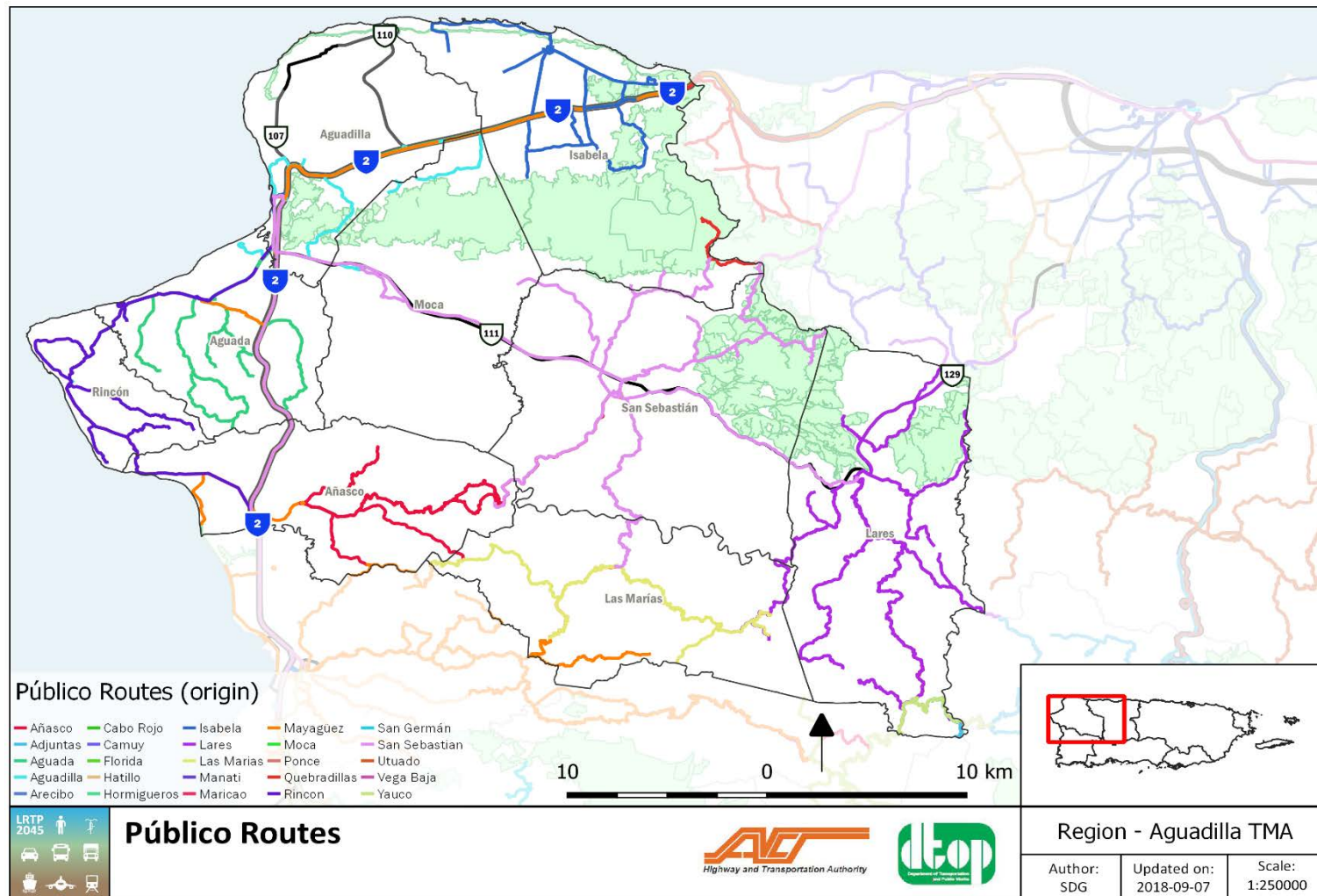
Source: the "carros públicos" information layer was provided by the office of Strategic Planning from the Puerto Rico Highway and Transportation Authority (ACT by its spanish acronym)

Figure 2.79: Municipalities with a Transit Service within Aguadilla TMA
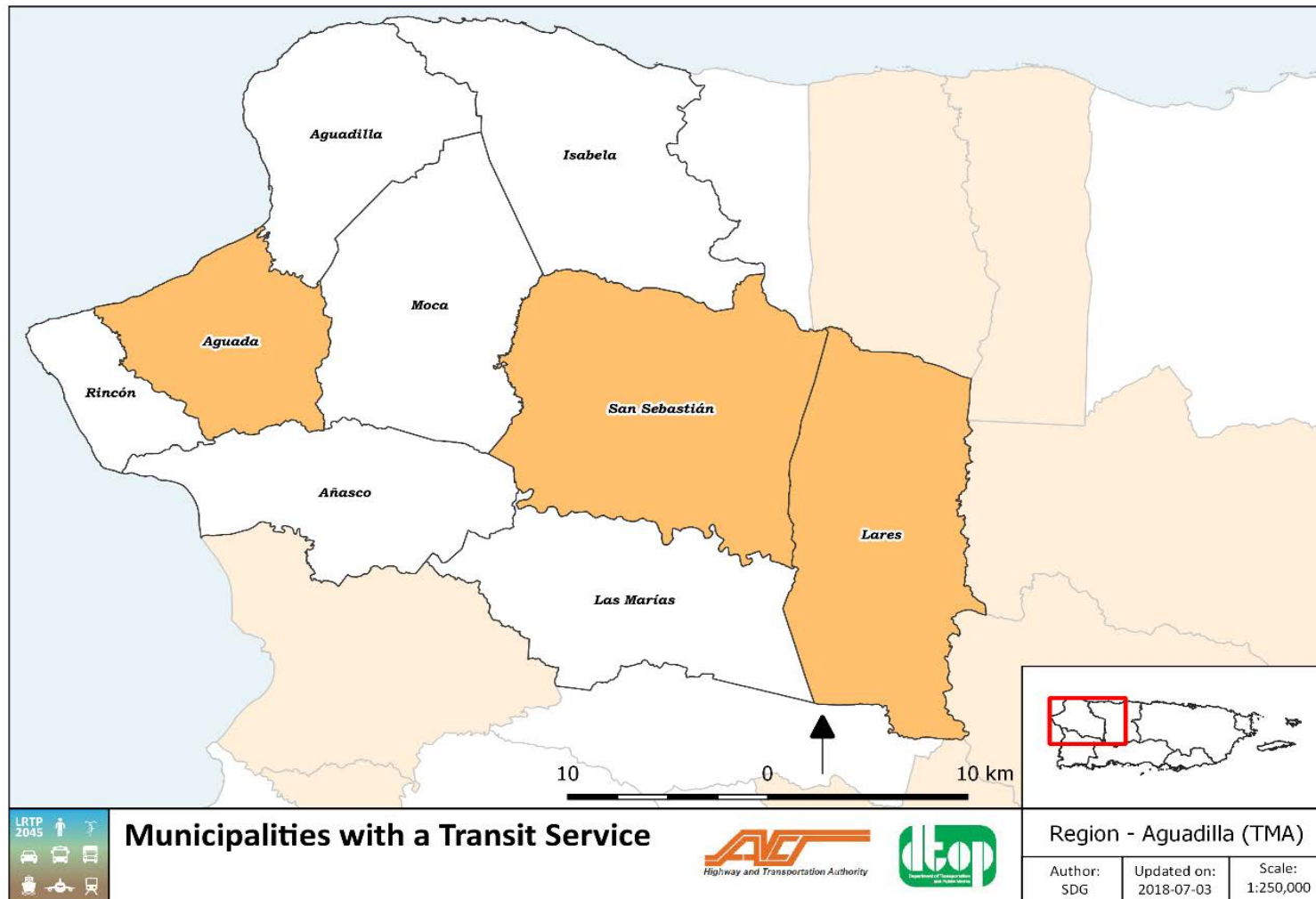
Source: Prepared by SDG with data from the National Transit Database (NTD)

Bicycle and Pedestrian Facilities

The Puerto Rico Department of Transportation and Public Works (DTPW), the Highway and Transportation Authority (PRHTA) have adopted goals and objectives to plan and develop a multi-modal transportation system that integrates all transportation modes to improve the mobility and access conditions, create a more livable urban environment and a more efficient transportation system, including the use of non-motorized modes.

The Comprehensive Bicycle and Pedestrian Plan for Puerto Rico, adopted by the Public Policy Committee of the Puerto Rico MPO on September 18, 2018, was developed as the policy document to guide state and local efforts to improve access and mobility conditions and develop new pedestrian and cyclist facilities to improve the quality of life of our communities. (See Appendix C).

Table 2.20 identifies the main roads with high incidence of pedestrians in the Aguadilla TMA Region.

Table 2.20: Aguadilla TMA Most Used Roads for Walking[32]

Aguadilla TMA		
Aguada	**Aguadilla**	**Rincón**
PR-115R	Borinquen Ave.	PR-413
Rotario Ave.	Path to Las Ruinas	PR-115
Narciso Street	**Añasco**	
San Francisco Street	PR-2	
Cristobal Colón Street	**Isabela**	
Carrizales Street	PR-2	
Camino Playa	PR-466	
Manuel Ruiz Street	PR-4466	

Source: Comprehensive Bicycle and Pedestrian Plan for Puerto Rico

Existing bicycle facilities are present in eight out of nine municipalities as displayed in Figure 2.80. There are twelve cycling facilities in Puerto Rico, one is located in the Aguadilla TMA. There is a proposed cyclist network for the long term in the Comprehensive Bicycle and Pedestrian Plan for Puerto Rico, as shown in Figure 2.81.

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[32] Comprehensive Bicycle and Pedestrian Plan for Puerto Rico, 2017.

Figure 2.80: Bicycle Facilities by Region – Aguadilla TMA

Source: Comprehensive Bicycle and Pedestrian Plan for Puerto Rico

Table 2.21 displays the most used roads for cycling in the Aguadilla TMA.

Table 2.21: Aguadilla TMA Most Used Roads for Cycling

Aguadilla TMA		
Isabela	**Aguada**	**Moca**
PR-2	PR-115	PR-111
PR-466	PR-441	**San Sebastián**
Aguadilla	Camino Playa	PR-111
PR-2	**Rincón**	Lares
PR-111	PR-115	PR-111
PR-467	PR-413	
PR-107	**Añasco**	
PR-110	PR-115	
PR-459	PR-402	

Source: Comprehensive Bicycle and Pedestrian Plan for Puerto Rico

Figure 2.81: Aguadilla TMA Bicycle and Pedestrian Conceptual Network 2045
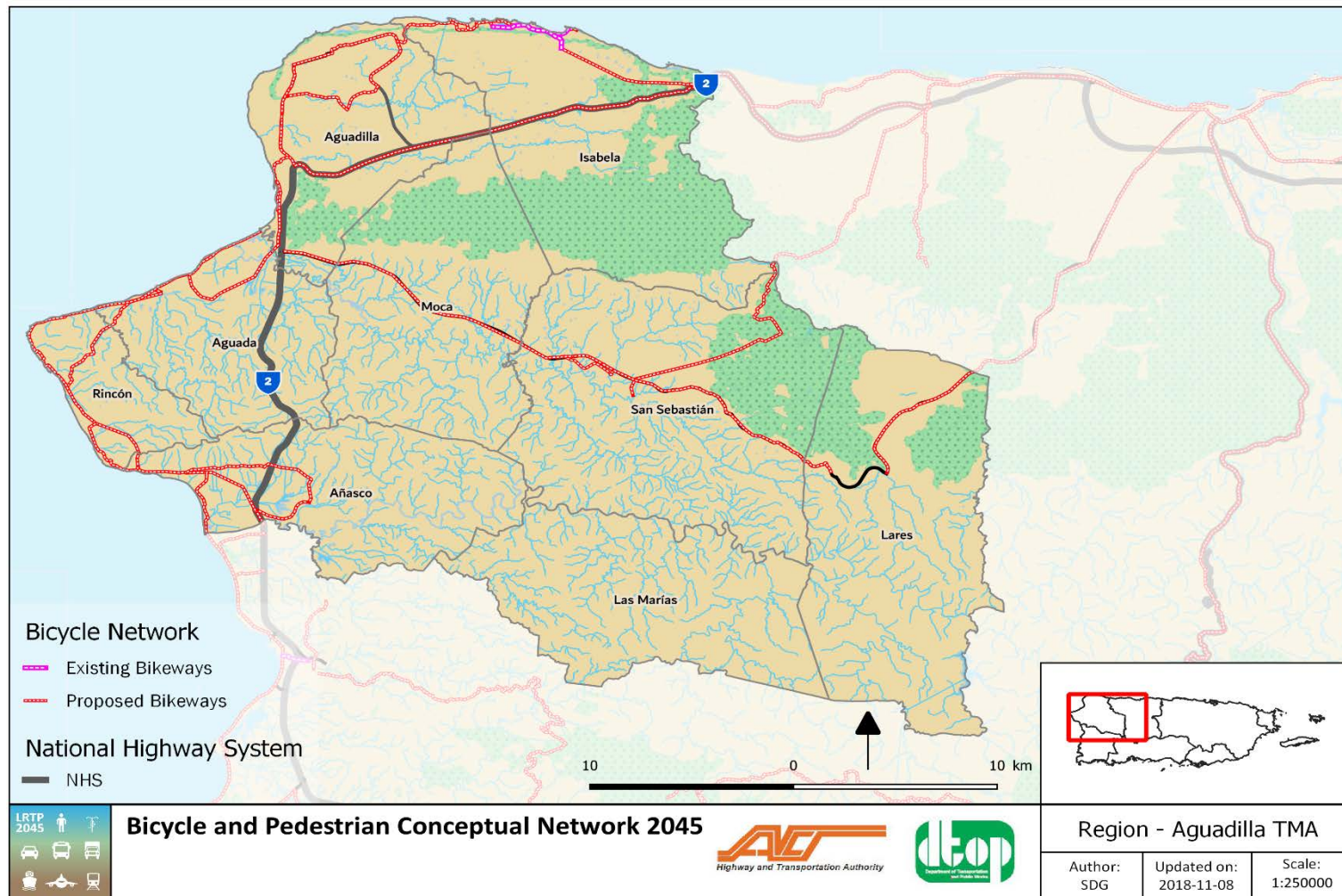
Source: Existing Bicycle Network was provided by the Puerto Rico Highway and Transportation Authority, 2017.
Proposed Bicycle Network created by Steer Davies Gleave, 2017.

Airports, Seaports, and Freight

Movement of passengers and goods in the Region occurs through one airport and a seaport; as shown in Figure 2.82. The airport is Rafael Hernández International. There is a seaport in Aguadilla with limited private commercial activity. Each facility is discussed in detail below.

Rafael Hernández International Airport (BQN)

It is located between PR-110 and PR-107 Borinquen/Ramey streets in Aguadilla and is the second largest international airport in Puerto Rico. It is classified as a primary (small/non-hub) commercial facility by the Federal Aviation Administration's National Plan of Integrated Airport Systems (NPIAS) for the period 2017-2021[33].

Operations

For the twelve months ending on December 2016, BQN registered 48,633 operations classified as follows:

- 4,935 from air carrier;
- 3,464 from air taxis;
- 15,748 from local general aviation[34];
- 11,220 from itinerant general aviation[35]; and
- 13,266 from military[36].

34 aircrafts are based at the airport. This airport manages an average of 133 aircraft operations per day[37].

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[33] www.faa.gov/airports/planning_capacity/npias/reports/**. T**he plan identifies existing and proposed airports that are significant to national air transportation and thus eligible to receive grants under the Airport Improvement Program (AIP).

[34] Definition from Federal Aviation Administration: "Local operations are those operations performed by aircraft that remain in the local traffic pattern, execute simulated instrument approaches or low passes at the airport, and the operations to or from the airport and a designated practice area within a 20–mile radius of the tower".

[35] Definition from Federal Aviation Administration: "Itinerant operations are operations performed by an aircraft, either Instrument Flight Rules (IFR), Special Visual Flight Rules (SVFR), or Visual Flight Rules (VFR), that lands at an airport, arriving from outside the airport area, or departs an airport and leaves the airport area".

[36] AirportIQ 5010 Airport Master Records.

[37] AirNav.com

Figure 2.82: Aguadilla TMA Airport and Seaport
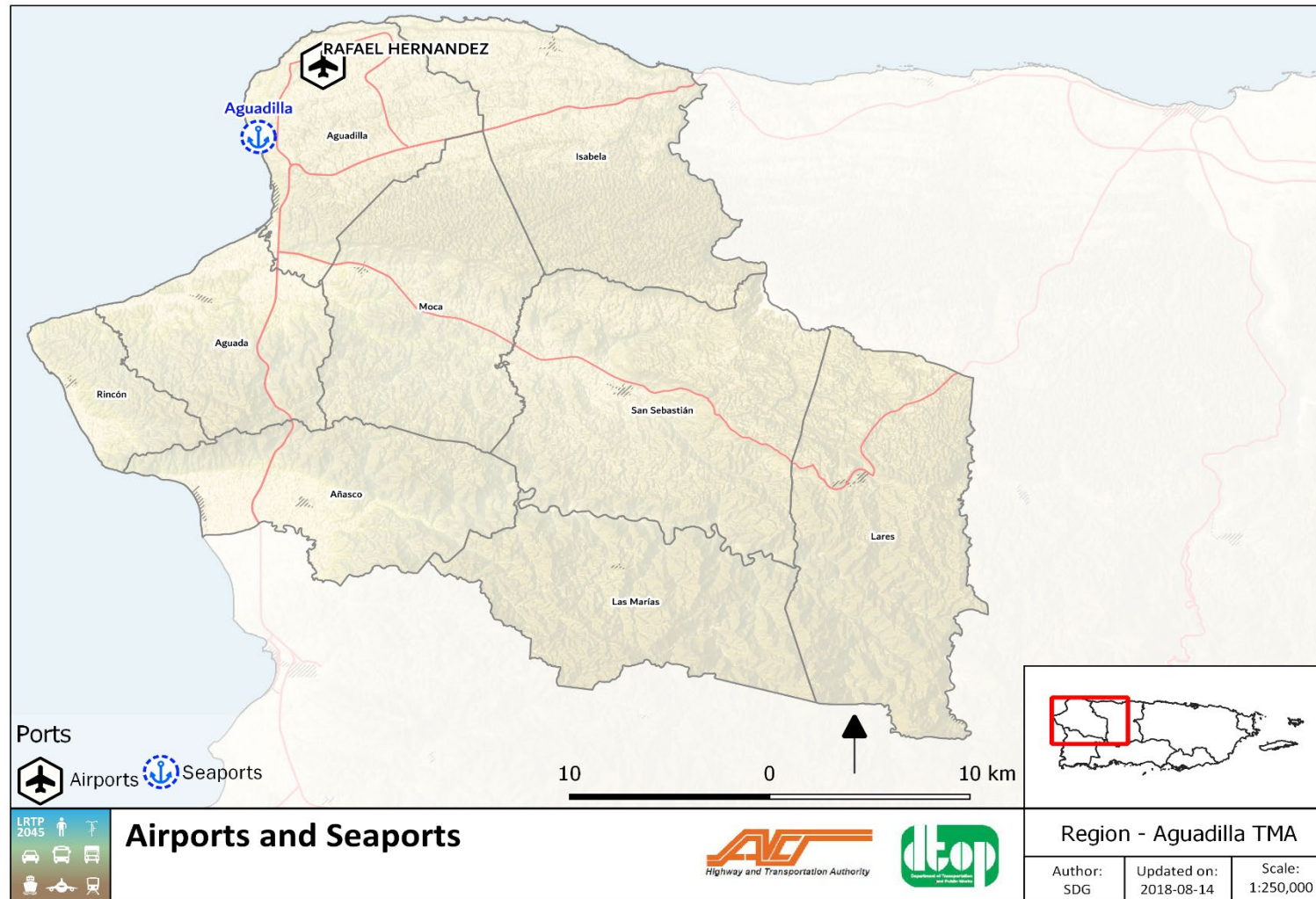
Source: the Airports and Seaports layer was obtained from the Puerto Rico Planning Board gis server at: http:/geoserver.gis.pr.gov/wfs

Passengers

In 2016, BQN served the following volumes of scheduled enplaned revenue passengers[38]: 248,384 arriving passengers and 256,031 departing passengers.

Between 2010 and 2016, there was a 6.4% increase of total passengers, both arriving and departing. In 2016 in terms of passengers, 50.8% correspond departures and 49.2% to arrivals. Between 2010 and 2016, an increase of 6.6% in departing passengers and 6.1% in arriving passengers was observed, as shown in Figure 2.83. It is worth noting that 99.9% of passenger movement in 2016 was domestic.

Figure 2.83: Passengers Departure versus Arrival
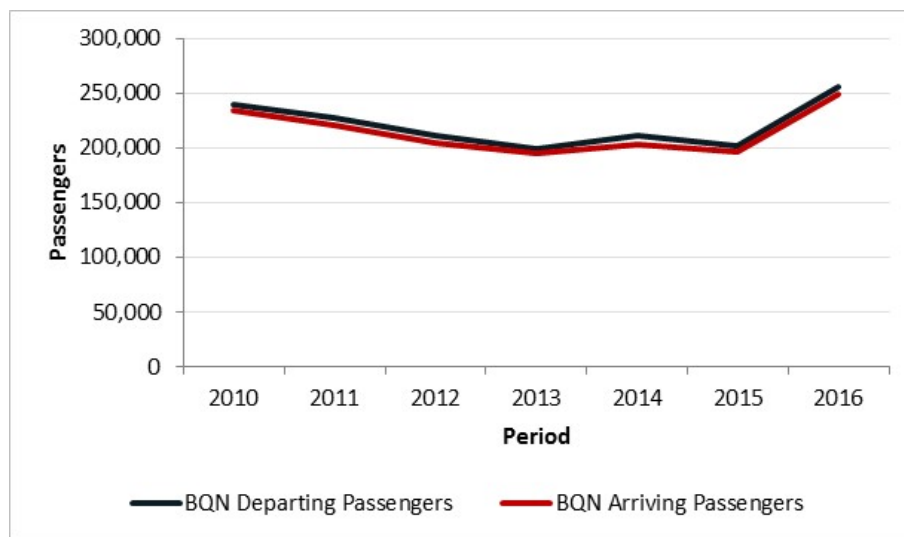
Source: SDG Analysis of Bureau of Transportation Statistics

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[38] According to 14 CFR 152.3 [Title 14 Aeronautics and Space; Chapter I Federal Aviation Administration, Department of Transportation; Subchapter I Airports; Part 152 Airport Aid Program; Subpart A General], Passengers enplaned means—"(1) United States domestic, territorial, and international revenue passenger enplanements in scheduled and non-scheduled service of air carriers; and (2) Revenue passenger enplanements by foreign air carriers in intrastate and interstate commerce".

Between 2010 and 2016, there was a 6.8% increase of domestic passengers. This is shown in Figure 2.84.

Figure 2.84: Domestic versus International Passengers – BQN
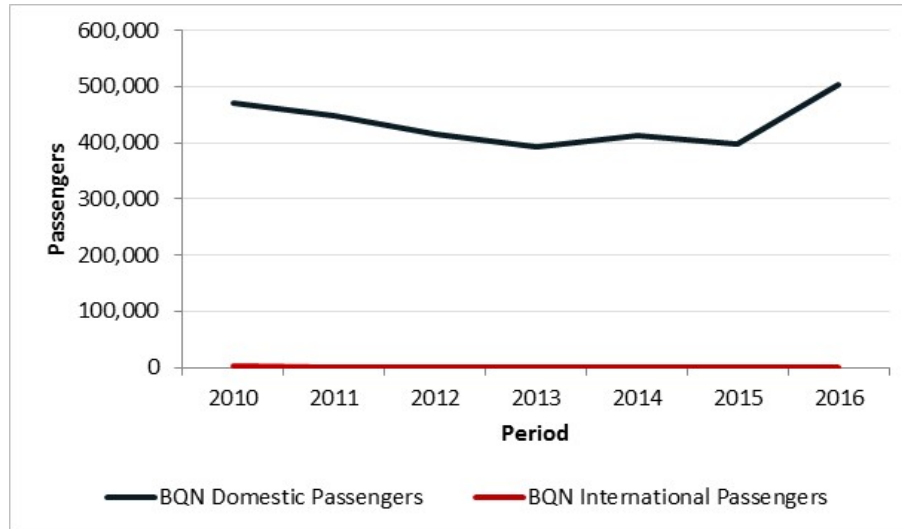
Source: SDG Analysis of Bureau of Transportation Statistics

Flights

In 2016, BQN served 3,686 total flights, including both arriving and departing flights. Since 2010 to 2016 there was a 4.5% reduction of total flights. Of those, 50.0% correspond to departing flights and 50.0% to arriving flights, which sowed respective decreases of 4.6% and 4.4% between 2010 and 2016, as shown in Figure 2.85.

Figure 2.85: Flights' Departure versus Arrival
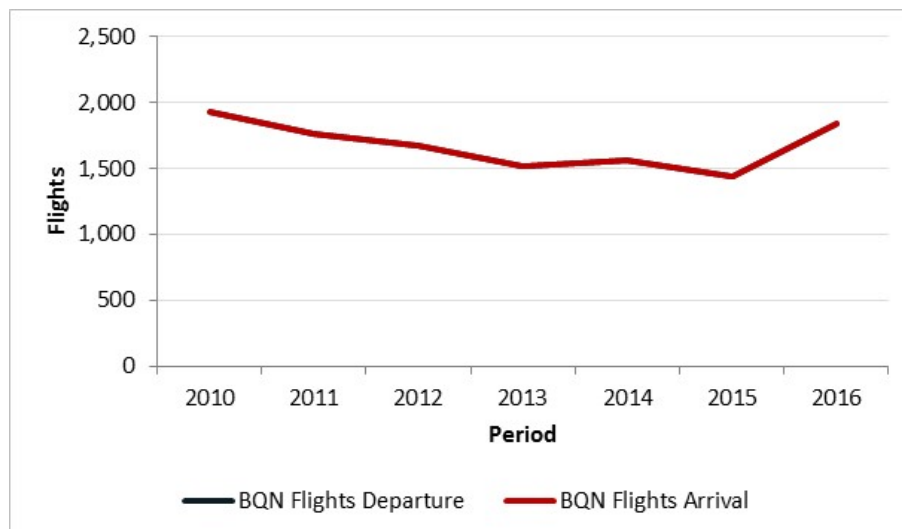
Source: SDG Analysis of Bureau of Transportation Statistics

Between 2010 and 2016, there were decreases in both domestic and international flights. Domestic flights declined 0.8% overall but most of the declined happened between 2010-2015

followed by and increase to near 2010 values in 2016. International flights declined 4.3%, as shown in Figure 2.86.

Figure 2.86: Domestic versus International Flights – BQN
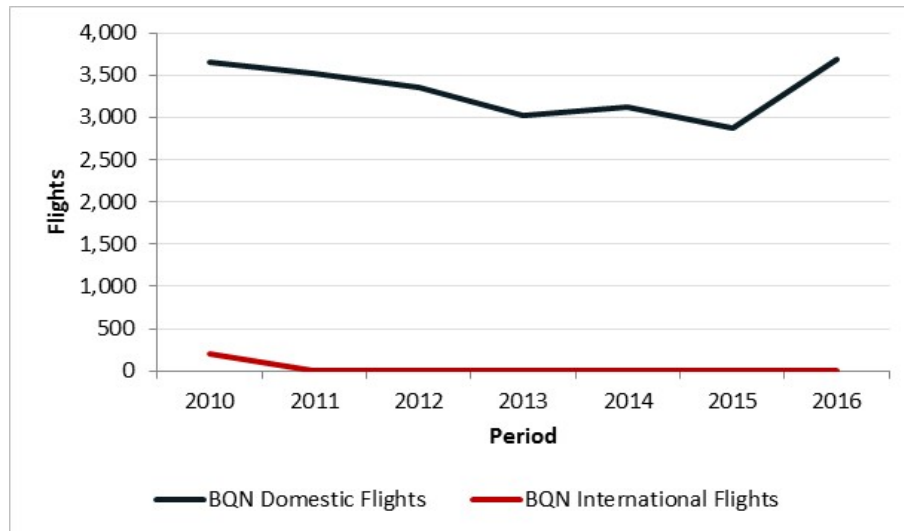
Source: SDG Analysis of Bureau of Transportation Statistics

Cargo

Regarding cargo[39] the airport ranked 49th nationally in 2016[40]. This ranking is an indicator of the key role the airport plays as a cargo terminal for the Island and the TMA. There were 532,393,460 million pounds of landed weight[41], a 7.6% increase over 2015, as shown in Figure 2.87. Between 2010 and 2016, there was a 3.4% increase in cargo volumes at the airport.

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[39] Aeroweb. Forecast International's Aerospace Portal. Top 100 U.S. Airports in 2016.

[40] Aeroweb Forecast International's Aerospace Portal.

[41] Definition from Federal Aviation Administration: "Landed weight means the weight of aircraft transporting only cargo in intrastate, interstate, and foreign air transportation. An airport may be both a commercial service and a cargo service airport".

Figure 2.87: BQN Landed Weights
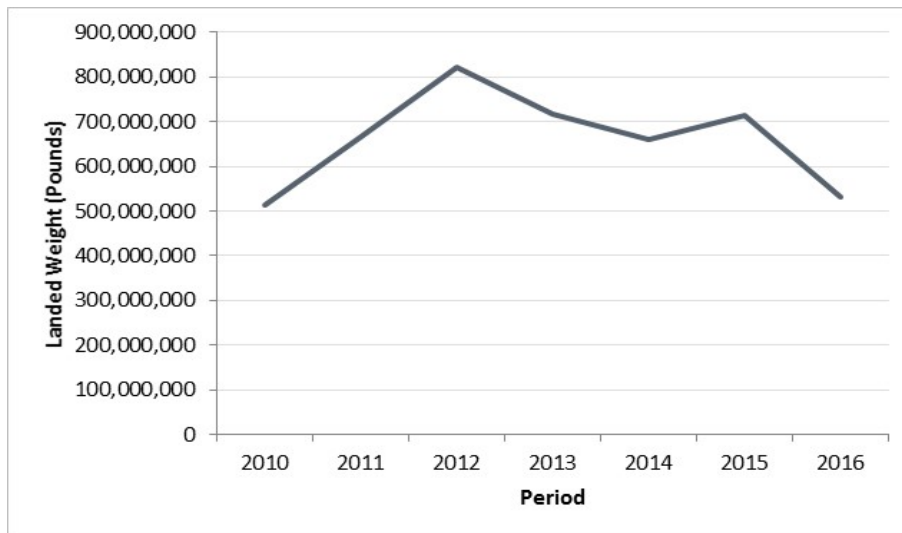
Source: SDG Analysis of Federal Aviation Administration

Port of Aguadilla

This seaport is located in the Aguadilla Municipality within the Aguadilla TMA. There is no official information for this Port from the Puerto Rico Ports Authority.

3   CHAPTER 3 TRANSPORTATION PLANNING PROCESS FOR THE FUTURE

This chapter presents the 2045 LRTP's planning process, starting with the definition of its vision, goals and objectives. Also, this chapter will cover how the latest Fast-Act planning factors are being considered in the plan, the strategic approach in terms of transportation modes and to mitigate the effects of extreme weather events through a resilience infrastructure. The chapter is divided into 3 sections:

1. Vision, Goals and Objectives;
2. Planning Factors; and
3. Strategic Approach to Transportation Planning in Aguadilla TMA.

VISION, GOALS AND OBJECTIVES

Vision

The 2045 Long Range Transportation Plan for the Aguadilla TMA Region should guide the development of its multimodal transportation system to build up livable communities and contribute to a strong competitive economy of the Region and the Island. Current changing trends in Puerto Rico require a comprehensive plan to address infrastructure needs that best contribute to conform the city envisioned for the future. The 2045 Plan is a platform that analyzes and develop the policies and strategies toward transportation investment in the Island for the next 27 years through a participatory process integrating the diversity of the economic, social, functional abilities as well as ages and different needs in the community. This planning process attempted to reach out the general public and key stakeholders, in conformance with regulations allowing effective citizen participation to assist the process of defining the path towards an integrated and multimodal transportation system.

The first step in this process was to define how our citizens foresee the future of the Region and Puerto Rico; how we envision our communities to be in terms of our living spaces which include where do we live, work, recreate, shop, and how do we travel to those daily destinations.

An Aguadilla TMA Region LRTP should guide the development of the Region's multimodal transportation system. As future trends are ever changing, a comprehensive plan is required to attend to those needs and changes. This Plan is the principal guide for investing in the Island's transportation infrastructure over the next 27 years. It has been developed through

interaction with the public and key stakeholders, in conformance with regulations. These interactions enable effective citizen participation to assist the process of defining the path towards an integrated and multimodal transportation system.

The 2045 LRTP vision was originally based on the 2040 LRTP and was revisited in a consulting participatory process developed through active participation with the public and the committees that supported development of this document. Also, the importance of resilience (especially after Hurricane María) is considered. The plan's **Vision** states:

"The Puerto Rico multimodal transportation system will offer safe, efficient, and effective accessibility and mobility for people and goods; focusing on infrastructure resilience, promoting livable and accessible communities and the sustainable socioeconomic development".

The 2045 LRTP's framework is multimodal in nature and focusses on meeting the Island's need for resilient and sustainable transportation options for all its residents. This framework will support the definition of specific interventions within each Region to: (1) rehabilitate existing roadway network, or complete the current strategic highway network; (2) improve transit services; (3) consider non-motorize accessibility infrastructure and interventions; (4) allow for proper access to air, and sea ports; (5) allow for more efficient freight movements, while working to integrate and interconnect the respective modes considering the complete street principles.

Goals and Objectives

To aid the implementation of the 2045 LRTP Vision; four goals were developed with specific objectives. The updated 2045 LRTP goals and objectives are focused on four general topics, or the four E's: Efficiency, Environment, Effectiveness and Economy.

The 2045 LRTP's goals and objectives were updated to reflect the interests and views of the citizens, while continuing the previously set goals in the Island's 2040 LRTP and following modern planning trends and requirements. These updated goals and objectives also emphasize the imperative to adapt to climate change, and the capability of the transportation infrastructure to withstand extreme weather events.

Several open houses and interactive technical workshops were held as part of the required public involvement (the public involvement process is detailed in Chapter 4), which ensured that decisions were made considering the public insight. The Island's 2045 LRTP goals and objectives were presented in interactive materials, informational boards and surveys for the citizens, municipalities and advisory committees to assess the priorities of each group and to all them to propose changes. The results supported a project rating methodology towards future investment in transportation infrastructure.

Table 3.1 presents the resulting updated goals and objectives that guided the development of the 2045 LRTP. All goals and objectives play a specific role in fulfilling the vision's intent and complement each other. These goals and their supporting objectives are clearly described, along with narrative to amplify their meaning.

Table 3.1: 2045 LRTP's Goals and Objectives

Focus	Goal	Objectives	
Efficiency	**GOAL A: To Improve Transportation System's Performance** Manage the Island's transportation facilities and services in a proactive and efficient manner to enable better economic development, maximizing the use of available assets and concentrating in safety and security.	1	Ease traffic delays and travel time through accurate congestion management programs.
		2	Optimize the use of available transportation assets and develop a better investment management structure to balance the efficiency of prior investments.
		3	Use available resources to preserve transportation assets in state of good repair.
		4	Develop strategies to deal with the cost of managing and operating the Island's transportation systems.
		5	Improve transportation system's safety and security and its ability to provide support when emergencies occur.
Environment	**GOAL B: Focus on the environment's sustainable development** Incorporate a careful and responsible environmental management to harmonize the need of a clean environment, social justice and a well-functioning economy.	1	To promote transportation infrastructure that preserves balanced ecosystems minimizing adverse impacts to the Island's natural environments.
		2	Reduce greenhouse gas emissions, energy consumption, and carbon footprint emittance; promote "smart growth", livable communities and improve air quality.
		3	Support integrated transportation and land use planning to achieve livable communities, less motorized vehicle dependency and enhance alternative modes of transportation.
		4	Improve alternative modes of transportation and travel demand strategies.
		5	Reduce transportation infrastructure's vulnerability for it to withstand extreme weather events through resilient infrastructure.
Effectiveness	**GOAL C: Improve transportation mobility and access for the people and for goods** Achieve better mobility and access for all the transportation system users; provide more travel choices, integration between modes and connections between major population centers.	1	Improve connectivity between the Island's fundamental activity Regions, such as, but not limited to employment centers, touristic areas, and dense residential districts.
		2	Concentrate efforts in enhancing the connectivity of the Island's available modes of transportation.
		3	Facilitate mobility to residents, visitors and workers in the Island by increasing the availability of travel choices.
		4	Invest in areas where users get the most benefit.
		5	Facilitate the access of transportation to elderly population, people with disabilities, or economic disadvantaged communities.

Economy	**GOAL D: Reinforce Economic Vitality** Procure the sustainment of livable and viable communities by encouraging economic strength, economic competitiveness and the flexibility to withstand economic difficulties.	1	Facilitate the efficient movement of freight, business and tourism activities to achieve economic competitiveness.
		2	Encourage potential public-private collaborations.
		3	Focus in providing commercial connectivity throughout the Island.

Source: SDG/PRHTA

Goal A: To Improve Transportation System's Performance

Description

Manage the Island's transportation facilities and services in a proactive and efficient manner to enable better economic development, maximizing the use of available assets and concentrating in safety and security.

Supporting Objectives

Objective A.1: Ease traffic obstruction delays and travel time through accurate congestion management programs:

Assess congestion management needs by using objective criteria, analysis and evaluation on a small scale to improve intersections and transit access; and on a larger scale to address system bottlenecks.

Objective A.2: Optimize the use of available transportation assets and develop a better investment management structure to balance the efficiency of prior investments:

Concentrate investment to achieve a better use of existing significant infrastructure, increase available street's capabilities and corridor person capacity, in a cost-effective manner.

Objective A.3: Use available resources to preserve transportation assets in state of good repair:

Allow investment and available economic resources to preserve and rehabilitate existing transportation infrastructure in good service condition to extend its life and provide a safe and secure operating environment for users.

Objective A.4: Develop strategies to deal with the cost of managing and operating the Island's transportation systems:

Increase the possibility of (1) achieving better project definition; (2) targeting priority projects; and (3) maximize benefits in relation to costs, by utilizing infrastructure inventories, asset management plans and congestion management network data files.

Objective A.5: Improve transportation system's safety and security and its ability to provide support when emergencies occur:

Provide investment to promote safe-secure transportation facilities, better services before and after emergencies, resilience-redundancy capabilities to resist or assist during extreme climatic events, incidents and system blockage.

Goal B: Focus on the Environment's Sustainable Development

<u>Description</u>

Incorporate a careful and responsible environmental management to harmonize the need of a clean environment, social justice and a well-functioning economy.

<u>Supporting Objectives</u>

Objective B.1: To promote a transportation infrastructure that preserves balanced ecosystems minimizing adverse impacts to the Island's natural environments:

Develop transportation related solutions focused in minimizing adverse impact to the natural environments, including better use of existing infrastructure

Objective B.2: Reduce greenhouse gas emissions, energy consumption, and carbon footprint emittance; promote "smart growth", livable communities and improve air quality:

Pursue projects and programs that reduce reliance on motorized travel and better manage vehicle congestion; promote the use of energy efficient products and more "reduce, reuse, recycle" practices in infrastructure projects.

Objective B.3: Support integrated transportation and land use planning to achieve livable communities, less motorized vehicle dependency and enhance alternative modes of transportation:

Invest in the redevelopment of Traditional Urban Centers, with higher population density, to facilitate access to alternative modes of transportation and make them pedestrian/transit friendly. Intensify interagency coordination to focus on better land use, travel efficiency and easier access to businesses.

Objective B.4: Improve alternative modes of transportation and travel demand strategies:

Use Congestion Management Programs or transportation network analysis to manage travel demands and improve the coverage, capacity and service of alternative modes of transportation.

Objective B.5: Reduce transportation infrastructure's vulnerability for it to withstand extreme weather events through a resilience and reliable infrastructure:

Develop plans and design/reconstruction approaches to reduce the chance that transportation infrastructure gets damaged during hurricanes or severe weather events, through focusing primarily on resiliency and redundancy. Meet the needs of the citizens by enabling emergency services and the flow of goods in the event of any extreme climate conditions.

Goal C: Improve Transportation Mobility and Access for the People and for Goods

<u>Description</u>

Achieve better mobility and access for all the transportation system users; provide more travel choices, integration between modes and connections between major population centers.

<u>Supporting Objectives</u>

Objective C.1: Improve connectivity between the Island's fundamental activity Regions, such as, but not limited to employment centers, touristic areas, and dense residential districts:

Address the Island's most important transportation corridors, their infrastructure and surroundings, and help serve numerous travel demand markets such as commercial centers, employment areas, dense housing districts, education facilities, airports, seaports, industrial and distribution districts and tourism hubs.

Objective C.2: Concentrate efforts in enhancing the connectivity of the Island's available modes of transportation:

Improve connectivity and continuity of the Island's transportation networks, establish links for easier movement from a non-motorized transportation area to a motorized area; promote use of the bicycle not only for recreational activities, but as part of the transportation chain. Facilitate connections between pedestrian and/or bicycle establishments and transit.

Objective C.3: Facilitate mobility to residents, visitors and workers in the Island by increasing the availability of travel choices:

Focus in promoting the use of non-vehicular modes of transportation, improving designated facilities, their connections and their capability to function as a dependent way to address citizens' needs.

Objective C.4: Invest in areas where users get the most benefit:

Investment will be directed taking first into account the citizens' traveling tendencies and needs.

Objective C.5: Facilitate the access of transportation to elderly population, people with disabilities, or economic disadvantaged communities:

The 2045 LRTP will continue to provide mobility for citizens with imminent needs such as, but no limited to people with functional diversity, the elderly, those with no accesso to a private vehicle and/or with income limitations.

Goal D: Reinforce Economic Vitality

<u>Description</u>

Procure the sustainment of livable and viable communities by encouraging economic strength, economic competitiveness and the flexibility to withstand economic difficulties.

<u>Supporting Objectives</u>

Objective D.1: Facilitate the efficient movement of freight, business and tourism activities to achieve economic competitiveness:

Analyze the Island's principal freight corridors and travel tendencies to manage traffic congestion and improve the efficiency of deliveries and goods movement

Objective D.2: Encourage potential public-private collaborations:

Consider private sector collaborations when appropriate to work as a partner with the public sector in successful project implementation, investment effectiveness and achieve costs-effective of capital and operating expenditures

Objective D.3: Focus in providing commercial connectivity through the Island:

Invest in the completion of projects that facilitate connections to airports, seaports, distribution areas, and commercial/industrial districts. Improve effectiveness of the

commercial distribution process through the Island. Invest in completing the Island's strategic highway network.

PLANNING FACTORS

The Fixing America's Surface Transportation Act, also known as the FAST-Act, was signed into law in December 2015 and replaces the previous Moving Ahead for Progress in the 21st Century Act (MAP-21). This legislation, like its predecessor, outlines the requirements for the transportation planning process, including the compliance with planning factors. Although planning factors have been part of previous highway legislation, the FAST-Act added some factors, for a total of ten planning factors, two more than the previously stated by MAP-21. Key transportation planning factors of the FAST-Act are, resiliency and reliability, the mitigation of storm water impacts and the enhancing of travel and tourism

Planning factors identify the most important aspects of the transportation development. All projects, strategies, goals and objectives considered in developing the 2045 LRTP were designed to meet the FAST-Act required planning factors. Taking this into account, the ten identified factors in this legislation were considered when analyzing the Island's economic development patterns, the path to achieve a more efficient use of the transportation system and resilience capabilities and the possible strategies to attend congestion issues, improve safety and mobility. The 2045 LRTP goals and objectives considered the planning factors. The FAST-Act is the authorizing legislation in the development of Puerto Rico's 2045 LRTP. Table 3.2 summarizes how the Island's 2045 LRTP goals and objectives will meet the planning factors as required by the referred legislation. All planning factors where adequately considered by relating them to two or more goals/objectives. These key objectives will determine the priority of the projects included in the plan's financial analysis and help secure the proposed investment on the short, mid and long-term compliance with the FAST-Act Planning Factors.

Table 3.2: Relation between planning factors and 2045 LRTP Goals

	Planning Factors	2045 LRTP Goals related to Planning Factor
1	Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency	Goal A: considers traffic congestion reduction, optimize use of assets and use of resources and existing infrastructure while dealing with efficient cost management. Goal C: considers improving and enhancing connectivity, increase travel choices, and invest in higher cost/benefit initiatives. Goal D: considers improving economic competitiveness thru movement, private investment in infrastructure and improving commercial connectivity.
2	Increase the safety of the transportation system for motorized and nonmotorized users.	Goal A: considers state of good repair maintenance and improving safety. Goal B: considers integrated transportation and land use planning to achieve enhance alternative modes of transportation. Goal C: considers improving access to elderly population, people with disabilities.
3	Increase the security of the transportation system for motorized and nonmotorized users.	Goal A: considers state of good repair maintenance and improving security. Goal B: considers integrated transportation and land use planning to achieve livable communities. Goal C: considers improving access to activity centers, improving and increasing people movement populating the streets.
4	Increase the accessibility and mobility of people and freight.	Goal A: considers managing the Island's transportation facilities and services. Goal B: considers developing transportation related solutions by better use of existing infrastructure. Goal C: considers better mobility and access for all the transportation system users. Goal D: considers facilitating efficient movement of freight, business and tourism activities.
5	Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and state and local planned growth and economic development patterns.	Goal A: considers extending its life and provide a safe and secure operating environment for users. Goal B: considers incorporating a careful and responsible environmental management to harmonize the need of a clean environment, social justice and a well-functioning economy. Goal C: considers better mobility and access for all the transportation system users; provide more travel choices, integration between modes and connections between major population centers. Goal D: considers sustainment of livable and viable communities by encouraging economic strength, economic competitiveness and the flexibility to withstand economic difficulties.
6	Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight.	Goal B: considers projects and programs that reduce reliance on motorized travel and better manage vehicle congestion; promote the use of energy efficient products and more "reduce, reuse, recycle" practices in infrastructure projects and improve alternative modes of transportation and travel demand strategies. Goal C: considers improving and enhancing connectivity, increase travel choices, and invest in higher cost/benefit initiatives. Goal D: considers providing commercial connectivity Island-wide.
7	Promote efficient system management and operation.	Goal A: considers managing the Island's transportation facilities and services in a proactive and efficient manner to enable better economic development, maximizing the use of available assets and concentrating in safety and security. Goal B: considers applying Congestion Management Programs or transportation network analysis to manage travel demands and improve the coverage, capacity and service of alternative modes of transportation. Goal C: considers addressing the Island's most important transportation corridors, their infrastructure and surrounding developments. Goal D: considers investing in the completion of projects that facilitate commercial connections.
8	Emphasize the preservation of the existing transportation system.	Goal A: considers optimizing the use of available transportation assets and preservation of these assets. Goal D: considers congestion management on the Island's main freight network.
9	Improve the resiliency and reliability of the transportation system and reduce or mitigate storm water impacts of surface transportation.	Goal A: considers investment to promote better services before and after emergencies, resilience-redundancy capabilities to resist or assist during extreme climatic events, incidents and system blockage. Goal B: considers reducing transportation infrastructure's vulnerability for it to withstand extreme weather events for a resilience and reliable infrastructure.
10	Enhance travel and tourism	Goal A: considers traffic congestion reduction, optimize use of assets and use of resources and existing infrastructure while dealing with efficient cost management. Goal C: considers facilitating mobility to visitors in the Island by increasing the availability of travel choices. Goal D: considers facilitating the efficient movement of tourism activities to achieve economic competitiveness.

Source: SDG and PRHTA

STRATEGIC APPROACH TO TRANSPORTATION PLANNING IN AGUADILLA TMA

The envisioned planning approach for the updated 2045 LRTP focuses on enhancing the quality of life through management of assets, environmental and social justice, improved accessibility and better economic development. This section presents the strategies needed to address transportation planning in Aguadilla MA considering:

- Transit;
- Traffic;
- Non-motorized modes;
- Freight; and
- Resiliency.

Strategies for Transit in Aguadilla TMA

Transit has an important role, specifically as an alternative mode reducing congestion and pollution. As mentioned in Chapter 2, there is a tendency showing local population is aging which presents the need to increase accessible transit services widely Island-wide to provide alternatives to those with no access to private vehicle or who cannot drive (including the elderly, the young and people with disabilities). It is important to make transit a more available, attractive and competitive alternative to the private automobile. Also, there is a need to maintain transit assets in a state of good repair as required by Transit Management Plans (TrAMP[42]). Therefore, the LRTP has set out the following strategies:

Provide New Inter-Regional Express Transit Services

Rehabilitate, expand, and develop the transit system through the development of an inter-regional express transit service. This service will provide connections between major destinations within and between the Regions resulting in an Island-wide transit network.

This service should be associated with mix-use developments. It would be important to support this service with incentives to encourage walking and the use of transit throughout community and land use planning from a local and regional perspective. This service will not be successful in isolation. It would require municipal-level local bus feeder services that would provide users with comprehensive transit networks beyond the main corridors. Such a network of services would be a competitive alternative to motor vehicles by providing access between major residential areas or municipal centers to major destinations including work, educational and service areas.

Provide Enhanced and Improved Local Transit Service

As previously mentioned, support from local transit services is required for the support inter-regional services. As stated early in Chapter 2, Públicos have experienced a significant drop in ridership, routes and trips. A trend that is expected to continue in the absence of policies and programs aimed at stabilizing the services. The municipalities have been increasing their offering

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[42] Transit Asset Management Plan, the official acronym is TAMP, but is the same acronym as the Transportation Asset Management Plan (TAMP), so in this report the term TrAMP is used.

of transit services due to the needs of their communities in response to the reduction of Público services. As a result, ridership on municipal services has been increasing. Municipal services operations are paid by the municipalities and tend to be free of charge. The lack of fares possesses challenges to the services' coverage areas and long-term funding. As a result, it is important to provide recommendations about how to strengthen and support these services.

The integration of both Municipal and Públicos to the transit network system could be a practical alternative for many reasons including better use of resources, economic development alternatives and cost-effectiveness. Municipal and Públicos drivers in some municipalities have already entered into agreements. Agreements could include provisions such as:

1. Provide drivers with an economic incentive suitable for the specific route to ensure minimum income levels;
2. Stablish the service requirements including vehicles/drivers available to a particular route, fares, standards of service and frequencies;
3. Provide savings in mechanical and maintenance service consolidation; and
4. Define the required improvements for vehicles and costs of the responsible parties.

Transit Asset Management Plan

In 2016, the Federal Transit Administration (FTA), established a requirement for all public transportation providers that receive federal transit assistance to develop a TrAMP[43]. According to 49 CFR Section 625.5, transit asset management is:

> "the strategic and systematic practice of procuring, operating, inspecting, maintaining, rehabilitating, and replacing transit capital assets to manage their performance, risks, and costs over their life cycles, for the purpose of providing safe, cost-effective, and reliable public transportation".

The goals and objectives defined by the LRTP must be followed by strategies that will help achieve a State of Good Repair (SGR) established by the TAM. The Final Rule for the TAM requires transit providers to collect and use asset condition data, set targets, and develop strategies to prioritize investments to meet their goals. The PRHTA will serve as the sponsor for the group plan that will include, the 78 municipalities and the Metropolitan Bus Authority (MBA). The Maritime Transport Authority (MTA) and the Tren Urbano will have their individual TAM under the PRHTA.

Following the principles of Performance-Based Planning for management of transit assets, systems and networks must be part of the planning and management process for the PRHTA. Performance Measures and Targets must be implemented to help analyze and improve the decision-making process for the transit systems. The Performance Measures and Targets for the TAM are divided into four categories of transit assets: rolling stock, facilities, infrastructure and equipment. The performance measures on Table 3.3 are based on FTA regulations.

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[43] Transit Asset Management Plan, the official acronym is TAMP, but is the same acronym as the Transportation Asset Management Plan (TAMP), so in this report the term TrAMP is used for the Transit Asset Management Plan to distinguish between both Plans.

Table 3.3: TAM Performance Measures

Type of Assets	Performance Measure
Rolling Stock	% of revenue vehicles that exceeded the Useful Life Benchmark (ULB)
Equipment	% of non-revenue vehicles that exceeded the Useful Life Benchmark (ULB)
Facilities	The percentage of facilities (by group) that are rated less than 3.0 on the Transit Economic Requirements Model (TERM) Scale.
Infrastructure	The percentage of track segments (by mode) that have performance restrictions. Track segments are measured to the nearest 0.01 of a mile.

Source: TAM Performance Measures Fact Sheet https://www.transit.dot.gov/TAM/FTAOutreachMaterials/perfmsrFS

As part of the Final Rule for the TAM, PRHTA established performance targets for these performance measures. The targets were developed using data from capital assets that was collected from transit operators (26 municipalities and 3 agencies in total). Each inventory was analyzed and validated to determine the performance measure for each type of asset. The targets developed are shown in the Table 3.4:

Table 3.4: Targets for PR TAM

PRHTA Group Plan				
	Fleet Size	FTA Default ULB	FY18 Base	FY19 Targets
Asset-Rolling Stock				
Articulated Bus (AB)	2	14	0%	0%
Bus (BU)	184	14	9%	10%
Cutaway bus (CU)	100	10	6%	6%
Minibus (MB)	33	10	27%	14%
Minivan (MV)	2	8	0%	0%
Trolleybus (TB)	16	13	44%	44%
Van (Van)	80	8	39%	27%
Automobile (AO)	25	8	0%	0%
Asset-Equipment				
Automobile (AO)	40	8	53%	53%
Truck and other rubber vehicles	20	14	45%	45%
Maritime Transit Authority				
Asset Rolling Stock				
Ferryboat (FB)	14	41	0%	0%
ATI-TU				
Asset Rolling Stock				
Heavy Rail Passenger Car (HR)	74	31	0%	0%
Asset-Equipment				
Automobile (AO)	32	8	28%	34%
Trucks and other rubber vehicles	14	14	64%	56%
Asset-Facilities				

	Facilities	TERM Scale (below 3)	FY18 Base	FY19 Targets
Passenger/Parking	16	3	0%	0%
Administrative/Maintenance	2	3	0%	0%
Asset-Infrastructure				
	Track Segments	**FY18 Base**	**FY19 Targets**	
Rail Fixed Guideway-Performance Restriction	262	1.65%	5%	

Source: PRHTA

The performance measures and targets will become part of the planning process in the programming documents of the PRHTA, including the TIP and STIP. The future updates of the performance targets will be included in the TIP/STIP documents.

Strategies for the Aguadilla TMA Roadway Network

The strategies for Aguadilla TMA roadway network aim to improve and maintain roadways and bridges in the Region. Since most of the road network is in need of preservation and improvements; the costs to repair these may be beyond the capacity of the government making this strategy very important considering all transportation modes depends on a safe and efficient roadway network that allows mobility.

To accomplish that, it is necessary to follow the strategies described below.

Improve, Rehabilitate and Preserve Existing Roadways

The PRHTA has developed a Transportation Asset Management Plan (TAMP) aiming to accomplish a systematic process of operating, preserving, and improving physical assets. Specifically, the plan seeks to rehabilitate pavements conditions and bridges to get the infrastructure to a state of good repair. As a federal requirement the NHS cannot have more that 5% of the pavement in a poor condition. That represents a challenge that needs to be addressed given that in 2016 the 16.2% of NHS pavement was estimated to be in poor condition. In the case of bridges, the target is of no more than 10% of the bridges on the NHS be in poor condition.

The objectives established to guide the TAMP are[44]:

1. Improve and implement a comprehensive pavement management process that allow to achieve the condition targets while managing pavements with effective life-cycle strategies;
2. Improve and implement a comprehensive bridge management process to achieve and sustain a state of good repair, reduce life-cycle costs, and capitalize on effective preservation strategies;
3. In partnership with the MPO integrate effective asset management projects into the Transportation Improvement Program (TIP); and
4. *Implement long-term pavement and bridge programs and strategies to address safety and achieve and sustain a state of good repair.*

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[44] Initial Transportation Asset Management Plan, April 2018; PRHTA.

In order to meet the objectives, it will be necessary to:

1. Focus on achieving bridge and pavement conditions targets;
2. Invest more in preserving assets in good condition and avoid higher future costs;
3. Continue to replace deteriorated pavements and bridges that are too damaged to benefit from preservation;
4. Rely on documented processes to select projects and treatment strategies that reduce life-cycle costs;
5. Develop a better data on the conditions of pavements and bridges, particularly to identify those assets that can benefit from preservation;
6. Use modern bridge and pavement computer models to estimate needed investment levels and select projects, and;
7. Improve bridge and pavement conditions and then sustain them in a state of good repair[45].

Enhance the Strategic Roadway Network and Other Key Roadways

As part of continuing enhancement of the strategic road network on the Island, it is important to identify projects that will promote economic development and reduce congestion. This continuing enhancement is especially important because this network connects much of the Island with a high-capacity and high-speed expressway. There are several priority roadway projects that are aligned with the PRHTA strategy to promote economic development and reduce congestion (Appendix J includes the list of Illustrative projects).

Within the Aguadilla TMA, projects such as the improvements to the PR-2 corridor from Hatillo to Aguadilla (either improving existing corridor or an alternative new road) and from Aguadilla to Mayagüez are key network enhancement projects constantly mentioned within the consultation process.

Strategies for Non-Motorized Modes

The strategy for Non-motorized modes aims to develop a multi-modal transportation system that integrates all transportation modes to improve mobility and access conditions and to create a more livable urban environment and a more efficient transportation system. To accomplish this, it is necessary to follow the strategies described below.

Comply with the Puerto Rico Complete Streets Plan and Design Guidelines

In September 2018, the MPO adopted the Puerto Rico Complete Streets Plan and Design Guidelines. The Complete Street are defined "as those designed to allow safe, comfortable and convenient access for pedestrians, cyclists, drivers, and public transport users, regardless of age, abilities or capacities". "Also, a complete street implies that mobility in all its forms, is safe, it has the infrastructure to make travel enjoyable, is aesthetically pleasing and promotes the social and economic exchange"[46]. This document considers the Americans with Disabilities Act (ADA)

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[45] Initial Transportation Asset Management Plan, April 2018; PRHTA.

[46] Puerto Rico Complete Streets Plan and Design Guidelines, Final Document; September 2018; PRHTA.

legislation which defines the responsibilities of, and requirements for, transportation providers to make transportation accessible to individuals with disabilities. This document makes part of this LRTP as Appendix D.

The main objectives of this plan and design guidelines are:

1. "Guide state and local efforts to improve access and mobility conditions and develop new facilities to improve the quality of life of our communities;
2. Improve and/or provide pedestrian and bicycle access to the transit system and the public space; and
3. Provide safe *and* "affordable access for people of all ages and abilities" [47].

The strategy of this Plan makes part of the strategies for non-motorized modes of this 2045 LRTP; which includes:

1. "Updating decision-making processes;
2. Modifying approaches for measuring performance;
3. Types of complete streets measures – align with goals above;
4. Incorporating complete streets into the development process;
5. Providing ongoing community, stakeholders/institutional and professional education and training;
6. Internal and external communication and collaboration; and
7. Implementation of Plan through "project delivery, design and funding"[48].

Comply with the Comprehensive Bicycle and Pedestrian Plan

In September 2018, the MPO adopted the Comprehensive Bicycle and Pedestrian Plan for Puerto Rico. The Plan "aims to make bicycling and walking safe, accessible and integrated transportation choices for residents and visitors"[49].

The main objectives of this plan are:

1. "Promote and increase the use of cycling and walking as alternative modes of transportation;
2. Enable the physical integration of urban centers through a cycling and pedestrian network that improves accessibility to different land uses;
3. Incorporate the development of projects and bicycle/pedestrian facilities into statewide and municipal transportation plans;
4. Provide cycling and walking infrastructure to improve mobility, accessibility, and safety for all users of public roads; and
5. Develop and educational program for all users to share the public roads in a safe manner"[50].

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[47] Puerto Rico Complete Streets Plan and Design Guidelines, Final Document; September 2018; PRHTA.

[48] Puerto Rico Complete Streets Plan and Design Guidelines, Final Document; September 2018; PRHTA.

[49] Comprehensive Bicycle and Pedestrian Plan for Puerto Rico Final Document; September 2018; PRHTA.

[50] Comprehensive Bicycle and Pedestrian Plan for Puerto Rico Final Document; September 2018; PRHTA.

The strategies of this Plan make part of the strategies for non-motorized modes of this 2045 LRTP; this includes:

1. "Identification of improvements for pedestrian and bicycle facilities;
2. Set up a timeframe to accomplish the improvements;
3. Development of a monitoring and evaluation process; and
4. Identification of many sources of grant funding available to advance walking and cycling"[51].

Strategies for Freight

Complete and Enhance Freight Network

The access route for the seaports and airports within the Region and Island-wide is the main highway network. This network provides the key connection between these facilities with the rest of the Region being important for the cargo movements and economic development.

As discussed with various stakeholders of cargo movement within the Island, there is a need to consider the addition of some main roads to the freight network. These are mainly roads providing access to/from ports and distribution centers to the strategic highway network.

Another important aspect is to continue considering strategies to reduce congestion on the strategic highway network. It is a key element within the Congestion Management Plan, which has the following objectives:

- "Monitor and evaluate performance of multimodal transportation system;
- Identify the causes of congestion;
- Identify and evaluate alternative actions that provide information supporting the implementation of actions; and
- Evaluate the efficiency and effectiveness of implemented actions"[52].

As part of this strategy, freight interventions should seek to incorporate, as possible, recommendations such as, bottleneck and capacity improvements and travel demand management that will enhance access between freight facilities and distribution centers.

Strategies for Resilience

Due to its geographical location, Puerto Rico is highly exposed to extreme weather events such as, tropical storms and hurricanes passing near or thru the Island every year usually between July and November. This exposure to heavy rains, high speed winds and storm surge, causes landslides and flooding which effects the transportation infrastructure (as proven by the recent severe damages from Hurricane María). It is very important to develop a transportation system able to "anticipate,

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[51] Comprehensive Bicycle and Pedestrian Plan for Puerto Rico Final Document; September 2018; PRHTA.

[52] Congestion Management Progress Report, October 2012; PRHTA.

prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions"[53].

Damages to the transportation resulted in the isolation of communities that in many cases limited their ability to obtain supplies and services in the recovery phase after the hurricane in an efficient and timely manner. Therefore, incorporation of resilience and vulnerability of infrastructure systems into planning is paramount.

Vulnerability Assessment

In order to incorporate actions into decision making process, it is key to understand the existing transportation infrastructure's vulnerabilities. Such an understanding would serve as basis for developing the resiliency strategy as stated by the FHWA framework: "assessing and addressing vulnerabilities allows agencies to build their resilience, or the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions"[54].

For the first time the LRTP incorporates a vulnerability assessment. This assessment was mainly triggered by the effects of Hurricane María on the transportation infrastructure. The assessment is focused in hurricane-related hazards (refer to Chapter 6).

A more comprehensive analysis should be completed not only considering flooding and landslides but also earthquakes given the possibilities of tectonic events in the Island. Additionally, analysis of design and construction elements that will make for a more resilient transportation infrastructure is recommended.

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[53] FHWA's Vulnerability Assessment and Adaptation Framework, 3rd Edition, December 2017.

[54] FHWA's Vulnerability Assessment and Adaptation Framework, 3rd Edition, December 2017.

4 CHAPTER 4 PLANNING PROCESS, PUBLIC INVOLVEMENT, AND NEEDS ASSESSMENT FOR THE 2045 PLAN

The 2045 LRTP, and in this case the Aguadilla TMA plan, involves that urbanized areas in the Region should carry out a continuing, cooperative, and comprehensive performance-based multimodal transportation planning process. The Plan 2045 document is the result of this complex process of identifying priorities for investment in surface transportation that will lead toward the economic development and mobility of the metropolitan area in the short term and at least 20 years horizon in the future (27 in this case). This chapter presents the methodology and how this process and framework was developed leading to define the criteria to identify project priorities including needs assessment toward the 2045 LRTP. This chapter is divided into 3 sections:

1. Description of the Planning Process;
2. Description of the Public Involvement Process; and
3. How to Evaluate Infrastructure's Needs Assessment: Model Development and Calibration and Overview of the Technical Approach.

PLANNING PROCESS

The Aguadilla TMA incorporated the following steps as an analytical framework toward a comprehensive process for the implementation of the 2045 LRTP considering continuing elements from the previous 2040 Plan:

1. Reviewing the plan's vision;
2. Clarifying the plan's vision by redefining goals and objectives;
3. Infrastructure needs assessment based on a travel demand model analysis and public involvement;
4. Develop a financial resources analysis; and
5. Set project options and cost-feasible plans.

The first two steps have already been discussed in this document Chapter 2 and Chapter 3. The financial analysis and project options will be discussed in 5 and Chapter 6.

As shown in Figure 1.1, all steps were approached through an analytical process that considered the public involvement requirements and continuous coordination with the Island's MPO. The following sections provide detailed information on this involvement process.

PUBLIC INVOLVEMENT PROCESS

Public participation is an important aspect of any planning process. It is an integral part of the transportation system's improvement by helping to ensure that decisions are made in consideration to and for the benefit of the public needs and preferences. This public input helps agencies to: (1) make better informed decisions through collaboration, (2) build mutual understanding and trust between agencies and citizens.

Gathering this collaborative information, as part of the MPO's planning process, requires obtaining a broad insight from the public, professional and civic organizations, private companies and key governmental stakeholders. It is compulsory to consider all sectors for a final determination, especially those traditionally underserved by existing transportation systems, such as low-income and minority households.

The 2045 LRTP public involvement plan (PIP) was developed early in the process and was developed into a PIP report (complete version included in Appendix E).

The vision goals and objectives of the PIP are:

Vision: Involve and enable agencies, the interested parties and the community to provide meaningful input to the LRTP.

Goals

- Consult with the public and stakeholders to gather their ideas for solutions to the LRTP; and
- Inform and involve the public throughout the planning process.

Objectives

- Develop an effective, and proactive participation process that includes agencies, stakeholders, interested parties[55] and the public;
- Create communication channels with the public to encourage public participation and obtain input;
- Use of innovative tools and media to inform the public of upcoming planning activities; and

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[55] The FAST-Act explicitly adds public ports and certain private providers of transportation, including intercity bus operators and employer-based commuting programs to the list of interested parties that an MPO must provide with reasonable opportunity to comment on the transportation plan.

- Encourage the participation of minority and low-income populations in the LRTP development process.

Target Audience

While the communications thru digital and written media seeks to involve residents across the Island, targeted efforts were made to engage a wider group of stakeholders. Figure 4.1 illustrates the defined committees involved in the process.

Figure 4.1: LRTP Committees
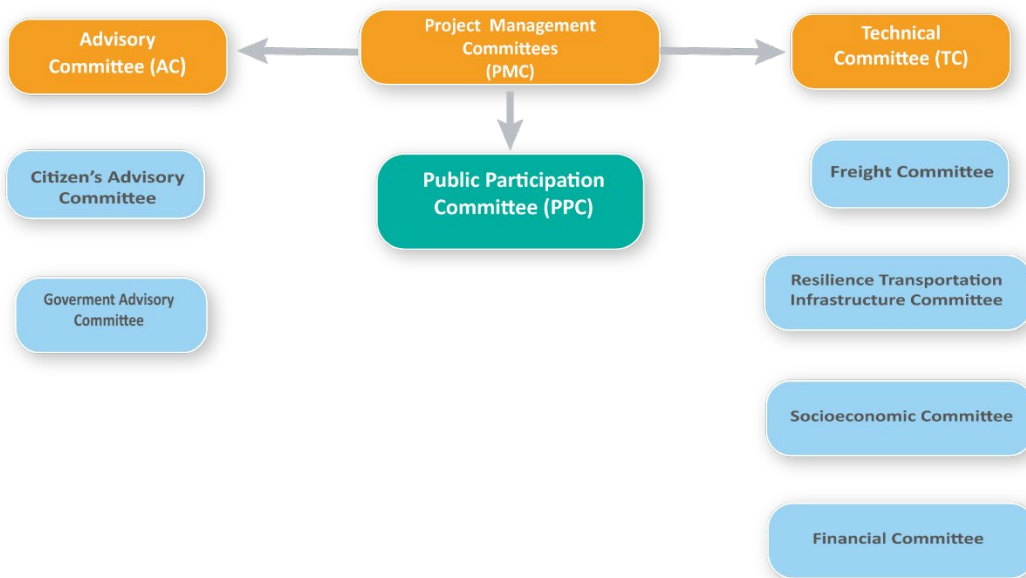
Source: SDG

Committees were designated to ensure the participation of key stakeholders and as an outreach effort to capture the impressions and needs from elderly population, persons with physical disabilities, low income communities, academia and professional organizations, as well as freight mobility, technical advice, and vulnerability analysis through the Resilience committee. Meeting with the defined committees and the MPO were held regularly to inform progress and gather insight during the planning process. Open houses were organized to engage the public in the LRTP planning process throughout the Aguadilla TMA and the Island.

Open Houses

While all aspects of community engagement and outreach are important, nothing can replace an open community forum where individuals can come and hear information about the study process and provide input regarding their specific needs and concerns. Two rounds of open houses were held to inform and received input from public. The first round took place during December 2017, and the second one between March and April 2018. Each open house round had a specific purpose.

<u>First Round</u>

The first round of open houses served as an educational process where citizens received information about the LRTP and provided input about their mobility needs. Considering Hurricane María had recently affected Puerto Rico's transportation infrastructure three months earlier, these open houses focused on gathering input on how this situation changed people's trips and which areas were most affected by the storm. For the same reason, the location of these open houses where at places attracting many people such as the CESCOs, transit hubs and universities to facilitate participation of a varied demographic. A total of 566 participants were registered in 11 locations. The locations and number of participants at each open house is shown in Figure 4.3

Figure 4.2: Open House – Aguadilla TMA

Source: SDG

These open houses had two main stations: one informative and the other interactive. The objective was to give the participants a way to receive information about the plan and to provide information regarding their needs and concerns about transportation issues. The structure allowed participants to interact by their own interest and time.

The informative stations had the general objective of informing participants about the development of a Long-Range transportation plan and to fulfill the public involvement requirements. An example is shown in Figure 4.2 and Figure 4.4.

Figure 4.3: Total Participation First Round Open Houses
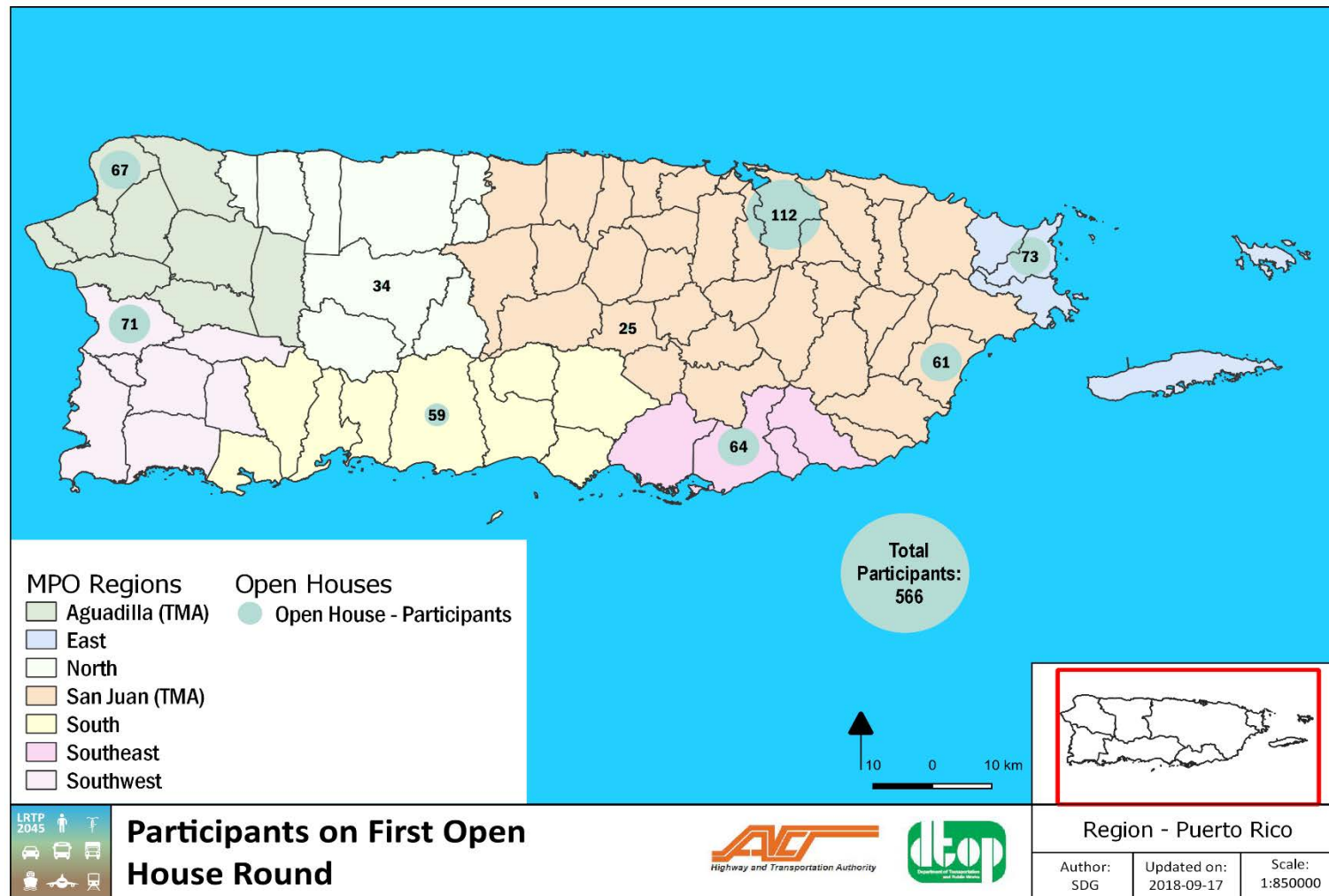
Source: SDG

Figure 4.4: Informative Boards

Source: SDG

The interactive stations had the objective of gathering information about participants' transportation needs and concerns. Participants provided their input through questionnaires, boards and maps. Through the questionnaire, participants had the opportunity to indicate their mobility needs, and transportation infrastructure effected by Hurricane María. Citizens were asked if changes were made to their regular trips because of the effects of this atmospheric event. Additionally, people had the opportunity to identify areas were the transportation infrastructure was significantly affected by the hurricane through an interactive map. For a complete report of results see Appendix E. Figure 4.5 shows participants regular trips before and after Hurricane María within the Aguadilla TMA. It is evident non-motorized modes became more efficient alternatives after the event since these are non-dependent on fuels and provide more route alternatives.

Figure 4.5: Participants Regular Trips Before and After Hurricane María – Aguadilla TMA
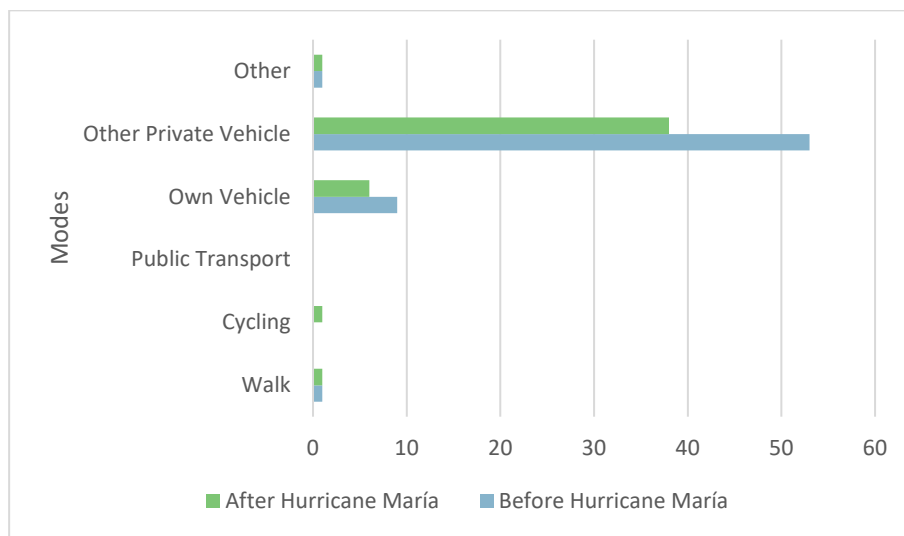
Source: SDG

As part of the interactive process, participants were asked to select five main transportation issues from twenty-five possible issues. Citizens had the opportunity to identify these issues based on different modes of transportation and level of priority. Table 4.1 shows the results for Aguadilla TMA.

Table 4.1: Transportation Issues – Aguadilla TMA

Transportation Issues	
Priority level	**Aguadilla TMA**
Urgent	Roads in bad condition
High	Lack of lighting
Medium	Lack of sidewalks
Low	Lack of cyclist infrastructure
Very Low	Insufficient routes/poor coverage

Source: SDG

Transportation investment was another topic of interest approached. Participants were asked how they would spend $100 on a list of transportación needs. Figure 4.6 shows the average results from Aguadilla TMA. Road maintenance was the main concern of the public followed by improvements to transit services.

Figure 4.6: Transportation Investment – Aguadilla TMA
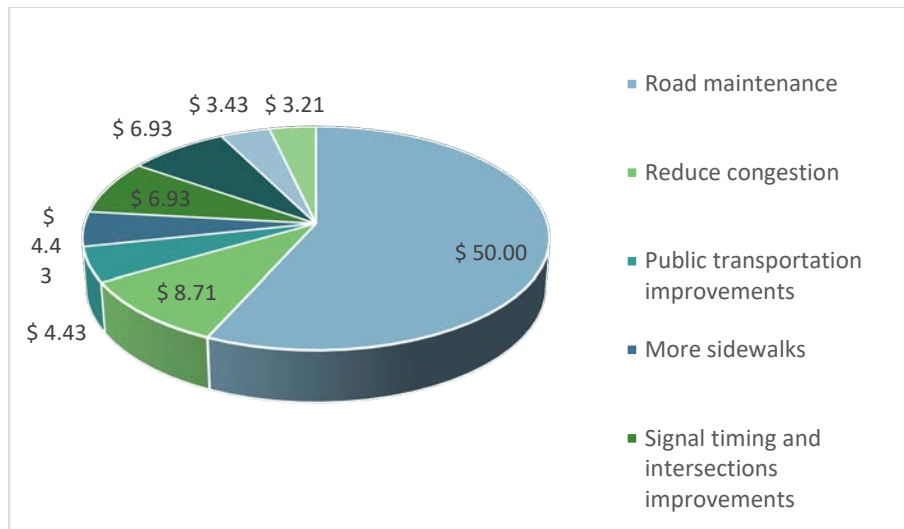
Source: SDG

<u>Second Round</u>

The second round of open houses had the objective of: (1) informing the progress of the LRTP and (2) the validation of the citizens ideas and suggestions. These were published in the local newspapers and social media and were held at specific activity centers at municipalities within each Region. For example, see Figure 4.7. A total of 160 participant attended to the 8 locations as shown in Figure 4.8. The second round was also structured in two main stations: informative and interactive. This design followed the first round's method in which the participants received information about the plan, provided their needs and concerns about transportation issues and interacted by their own interest and time.

Figure 4.7: Second Open House – Aguadilla TMA Region (Rincón)

Source: SDG

Figure 4.8: Total Participation Second Round Open Houses

Source: SDG
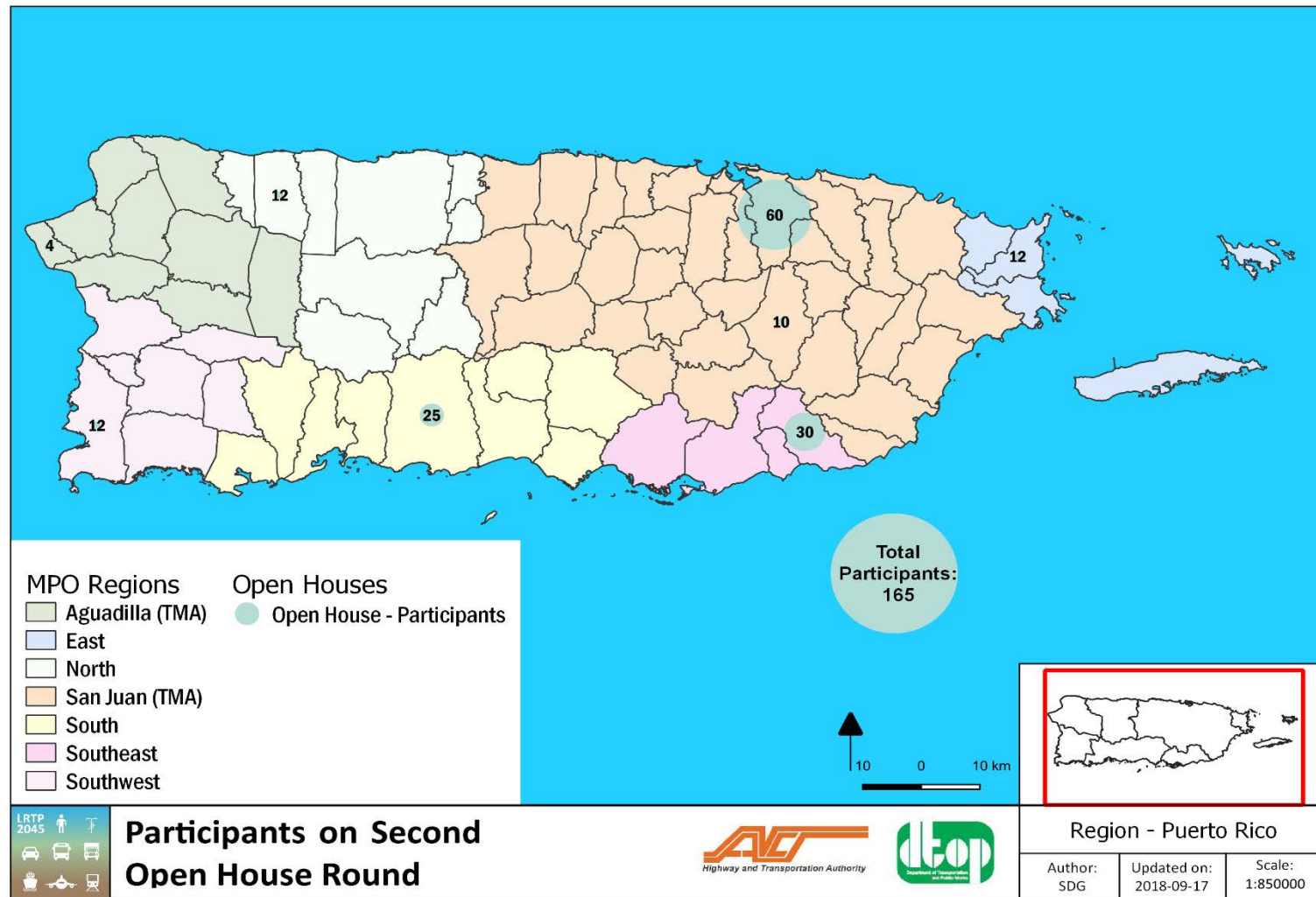
The informative station included the same data from the first round in benefit of new participants. It also included a presentation showing updates and results from the first open house as shown in Figure 4.9

Figure 4.9: Example of the Presentation

Source: SDG

The interactive station's objective was to gather information about the plan's vision, goals, objectives and strategies. Participants provided their input through questionnaires, and interactives boards.

The main interactive exercise intended to validate the plan's vision and goals. Each participant had the opportunity to approach the vision as presented and provide recommendations on how to improve it. Also, they had the opportunity to organize the goals and objectives in terms of priority.

Most, 75%, of the participants agree with the LRTP's vision as presented. Most of the recommendations provided considered the following aspects:

- Transit and non-motorized modes emphasis;
- Adaptation of the transportation system to the Island's geography; and
- Promote livability and land use within urban centers.

As part of this open house's second round of interactive exercises, participants had the opportunity to identify and organize their main strategies when investing in transportation infrastructure. This input needs to be analyzed considering funding limitations and transportation challenges. Figure 4.10 shows these results for the Aguadilla TMA. Top ranked include the vulnerability, transit service improvements and the good conditions of the existing facilities.

Figure 4.10: Transportation Strategies – Aguadilla TMA
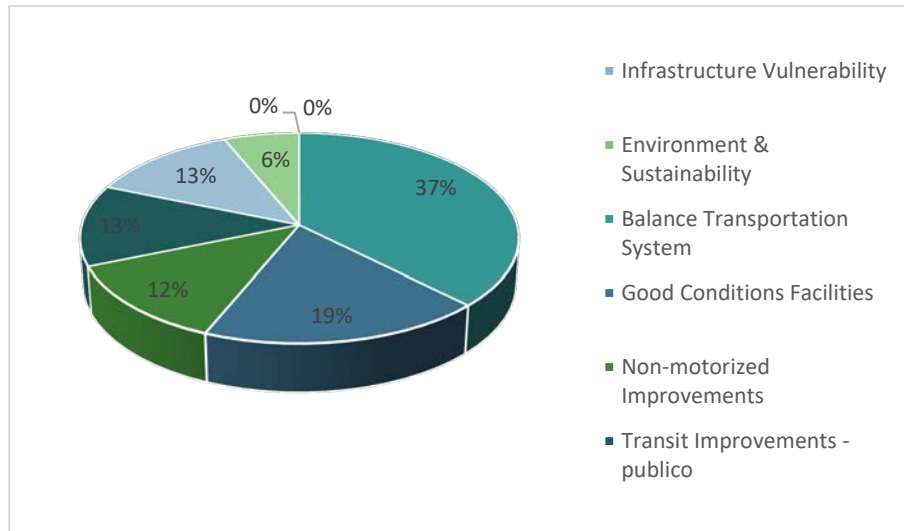
Source: SDG

Other Engagement Initiatives

Individuals, organizations and stakeholders were provided with alternatives to engage in the plan's process and development. Table 4.2 summarizes those initiatives. These sectors were invited to committee meetings to inform on up-to-date on issues and decisions and to provide their inputs.

Table 4.2: Engagements Initiatives

Effort	Description
Household Travel Survey	An exercise in which citizens are asked to provide information about their households' composition, available vehicles and information on their typical trips. The objective of the survey is to collect information that will characterize urban mobility patterns in Puerto Rico. Results are presented in Chapter 2 and in Appendix L.
Resilience Webinar	Members of the Resilience Committee took a webinar from the Federal Highway Administration (FHWA) to know how by federal requirements transportation planning process could integrate mechanism to develop a more resilience transportation system. This committee then supported the development of a vulnerability analysis prepared as part of the LRPS.
MPO Meetings	Meetings to kept updated the MPO participants on the LRTP process and to gathered inputs and recommendations.
Municipal Sustainable Infrastructure Workshop	MPO participants had the opportunity to present their needs and alternatives for improvements to their Municipal transportation system. The main objective of this workshop was to identify projects alternatives with a regional impact. This identification process was made in collaboration with the municipalities.
INSEC	In order to reach a broader participation to validate the vision, goals and objectives, a short version of the second open house was presented at the training activity for community leaders by the Socio-Economic Community Institute, Inc (*Instituto Socio-Económico Comunitario, Inc., INSEC*).
Facebook Page	Digital platform to inform about the process and to gather inputs from the public.

Effort	Description
Committee Meetings	As mentioned earlier in the chapter, meetings were held with all committees when appropriate, to provide inputs, discuss any particular point, and to be part of the decision-making process in benefit of the plan. The Committees included: Technical Committee, Freight Advisory Committee, Government Committee, Financial Committee, Economic Committee, Citizen Advisory Committee.

Source: SDG

The open houses provided information which was also presented at different audiences with the committees and with the MPO representatives. These provided an opportunity to participants to received information about the 2045 LRTP process and provide insight to influence the planning process.

The feedback on the analytical process of the PIP resulted in information that helped:
- To obtain an improved understanding of diverse opinions about the transportation conditions, its needs and general preferences;
- To refine the Vision, Goals and Objectives statement, and to rank the relative importance of goals and corresponding objectives;
- To Identify the transportation priorities by project types; and
- To identify detailed project improvement needs.

This process of gathering input from the public will serve as a powerful benchmark for the MPO's future planning works. Recurrent findings across all Regions

- Maintenance of existing facilities:
  Participants agreed on the importance of having the Island's transportation infrastructure in good condition. Feedback reflected the need of repairing existing facilities and more importantly, of maintaining available infrastructure in a well state of repair;
- More emphasis in transit and non-motorized modes:
  The need to provide alternative modes of transportation aside from the private vehicle was evident. It was a recurrent response that pedestrian and cyclist infrastructure needs to be developed. Participants also responded with the need to improve the transit system and for it to connect with the rest of the Island and with main activity centers.
- More resilient transportation system:
  Participants indicated that is important to develop a sustainable and resilient transportation infrastructure, not only to withstand extreme natural disasters but also common natural events; such as long period of rain.
- Promote livable and land use within urban centers:
  Better coordination between transportation improvements and land use was also suggested by participants. Development of the transportation infrastructure needs to take into account the avoidance of urban sprawl and the promotion of more activities within urban centers.

MODEL DEVELOPMENT AND CALIBRATION

This chapter summarizes the model update and calibration efforts of the Puerto Rico travel demand model for the 2045 LRTP.

The Puerto Rico travel demand model (LRTP Model), also named as Island-wide model, spans the main Island of Puerto Rico and the Islands of Culebra and Vieques. It includes seven Regions which are subdivided into 4,296 transportation analysis zones (TAZ).

The model is a traditional trip-based model which has four sequential steps: trip generation, trip distribution, mode choice and assignment, as shown in Figure 4.11. The forecasting process classifies all trips into one of six cores trip purposes or commercial vehicle trips:

- Home-based work (HBW), further disaggregated into three subgroups based upon income level - including trips from home to work place or from work place to home;
- Home-based retail (HBR) – including trips from home to shops or restaurants;
- Home-based school (HBS) – including school trips from home to K-12;
- Home-based university (HBU) – including trips from home to university, mainly during off-peak;
- Home-based other (HBO) – including all home-based trips beginning or ending at places not listed above;
- Non-home based (NHB) – including trips with home as neither the origin nor the destination; and
- Non-household based vehicle classes – including commercial vehicles, medium weight trucks[56], and heavy trucks[57].

This section includes separate sections on each major model component, as follows:

- Socioeconomic inputs;
- Socioeconomic forecast;
- Trip generation;
- Trip distribution;
- Time of day choice;
- Mode choice and transit assignment; and
- Highway path building and assignment.

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[56] Medium trucks are single-unit trucks with two or three axles in FHWA vehicle classifications 5-7.

[57] Heavy trucks include all single-trailer and multi-trailer combinations defined in FHWA vehicle classifications 8-13.

Figure 4.11: LRTP Model Structure
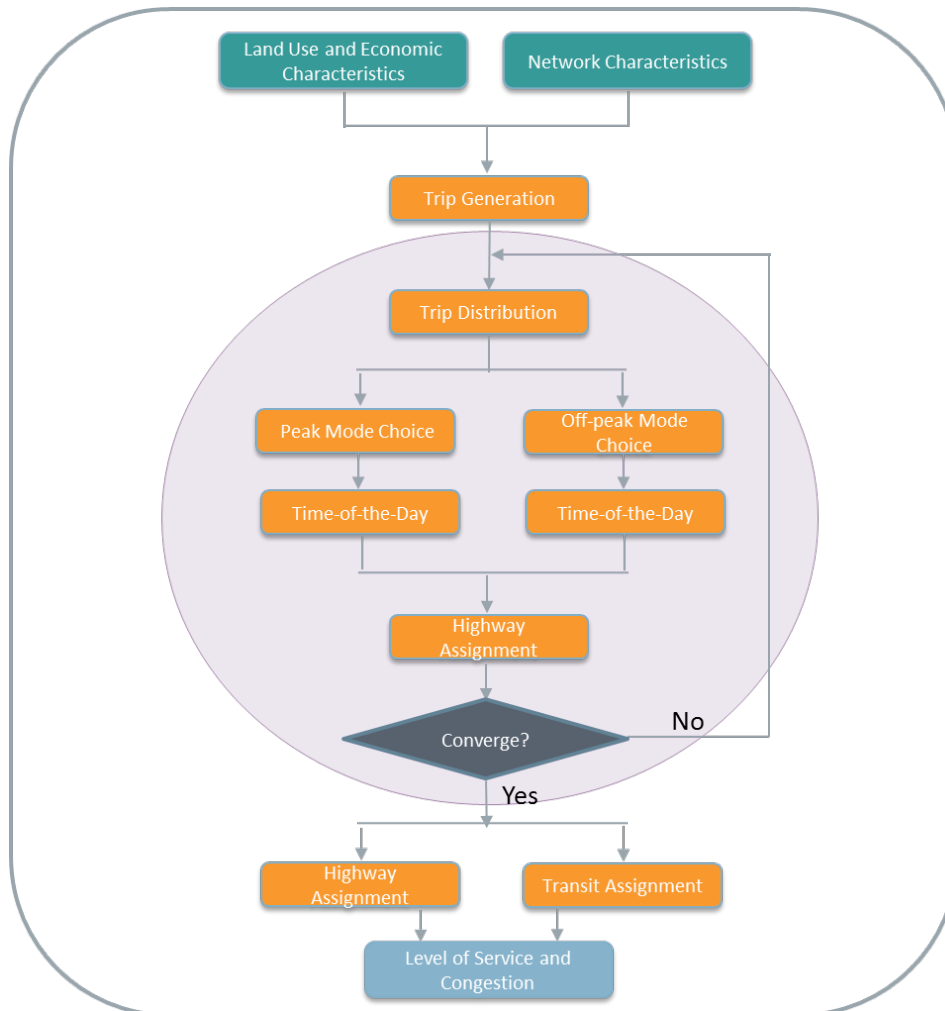
Source: SDG

Socioeconomic Inputs – Base Year 2016 Update

This section focuses on the process for updating the socioeconomics inputs of the 2045 LRTP Model from the 2010 calibrated scenario (in the 2040 LRTP Model) to new Base Year 2016. A two-stage process was completed:

- **Stage One:** Update all 4,296 Travel Analysis Zones (TAZs) from 2010 to 2016 levels using their corresponding municipal level growth from household, employment, and school data sources; and
- **Stage Two:** Holding municipal level control totals from the first stage constant, adjust individual TAZ's household and employment variables using TAZ specific information on new/closed employment centers, housing permits, and school closings/openings.

Stage One – Municipal Methodology

To properly capture socioeconomic change in the 78 municipalities from 2010 to 2016, the 2010 population was updated with real 2016 estimates from the U.S. Census Bureau and growth rates were applied to additional variables in the Base Year 2010 socioeconomic dataset, bringing them to 2016 figures. Table 4.3 outlines the data sources and methods used to update each socioeconomic variable. Growth rates were used instead of levels due to an inability to directly match original data sources on employment from the 2040 LRTP 2010 Base Year.

Table 4.3: Socioeconomic Variable Adjustment by Municipality with Explanation and Source

Socioeconomic Variables	Explanation of Adjustment	Source
Population	Used Municipality Level Population Estimates from U.S Census Bureau Annual estimates to update Population.	U.S. Census Bureau Annual Estimates
Households	The (2012-2016) ACS 5-year dataset provided number of occupied units and percent of occupied units that are 1-person, 2-person, 3-person, and 4-person plus households. From this a weighted average household size by municipality from (2012-2016) ACS 5-year dataset was calculated[58]. This was then applied to the already adjusted population to produce the number of households by TAZ.	American Community Survey (2012-2016 5-Year Estimates) (ACS) with SDG Analysis
Total Employment	Calculated growth rates by municipality between 2010 and 2016 using BLS QCEW total employment estimates, then applied to Base Year 2010 total employment. After which, used BLS LAUS total employment to scale up to 2016 reals as the LAUS accounts for agricultural and self-employment.	BLS Quarterly Census of Employment and Wages (QCEW), BLS LAUS
Retail, Service, Manufacturing, Government, and Other Employment Industries	Assumed constant share of employment by industry, used existing industry shares from 2010 Base Year, then applied these shares to adjusted Base Year 2016 total employment. Assumption was made after analysis of BLS QCEW data by industry, which supports this assumption.	BLS
Income	Calculated growth rates by municipality between (2006-2010) and (2012-2016) ACS 5-year datasets, then applied to Base Year 2010 income.	ACS
Students	Calculated growth rates by municipality between (2009-2010) and (2015-2016) school year data sets, then applied to Base Year 2010 students.	National Center for Education Statistics (NCES)
College	Calculated Compound Annual Growth Rate (CAGR) by College between 2010 and 2018 enrolment datasets. Matched colleges to their corresponding TAZ from Base Year 2010 and applied calculated CAGR over 6-years to make the proper transformation to 2016 college enrolment.	NCES
Dorms	Unchanged from Base Year 2010 (not used as inputs in trip generation model)	N/A

Source: SDG

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[58] For households with 4-plus persons, an assumed average of 5 people per household was used to produce the weighted average calculation. This is different than the average household size by municipality discussed in Chapter 3, because these are weighted averages, and this process is more closely aligned to the work done in the 2040 LRTP report 2010 data.

Stage Two – TAZ Specific Adjustment

While Stage One accurately reflects municipality-level growth, it does not capture TAZ-level changes regarding new housing complexes and new or closed employment centers. Because municipal growth rates capture these internal dynamics at an overall level, it is important to redistribute the change across the other TAZ units in the corresponding municipality so that total employment and population are not affected. This process was completed after applying the methods outlined in Table 4.4.

Table 4.4: Socioeconomic Variable Adjustment by TAZ with Explanation and Source

Socioeconomic Variables	Explanation of Adjustment	Source
Households	Calculated the number of expected apartments for each permit. Developed metric of 'project cost per apartment', from publicly available data on completed projects. Used this metric to determine number of apartments for permit projects where not data was publicly available. Each new apartment was assumed equal to a new household. This was applied to the TAZ corresponding to each permit location.	Permit Management Office of Puerto Rico, (2010-2015) housing permits
Population	Population was adjusted for the inclusion of new households by applying the household size by municipality to the new Base Year household's variable.	ACS (2012-2016 5-Year Estimates)
Retail Employment	Calculated the estimated number of employees for each retail permit. Determined which shopping centers were completed prior to 2016 via research. Developed a metric of 'project cost per employee' from publicly available data on completed retail centers. Used this metric to determine employees for projects where employee data was not publicly available. This was applied to the TAZ corresponding to each retail permit location.	Permit Management Office of Puerto Rico, (2010-2015) housing permits
Service Employment	Accounted for new major hotels (defined as having over 100 rooms) and applied the associated employment change to the TAZ corresponding to each hotel location.	Puerto Rico Industrial Development Corporation (PRIDCO)
Manufacturing Employment	Accounted for closed manufacturing companies and applied the associated change in employment to the TAZ corresponding to each firm location.	PRIDCO

Source: SDG

Overview of Population and Employment Change

The geography of the seven Regions in Puerto Rico is displayed in Figure 2.1. The resulting population and employment by Region from the updates discussed above are shown in Table 4.5. These and 2045 LRTP 2016 socioeconomic datasets are by place of work. Population has declined Island-wide, as has employment, albeit, at a slower rate.

Table 4.5: Population and Employment –2045 LRTP Base Year 2016

Region	Population - Base Year 2016	Employment - Base Year 2016
Aguadilla	288,777	81,952
East	73,438	22,329
North	284,567	69,443
San Juan	2,058,458	610,178
South	371,347	112,846

Region	Population - Base Year 2016	Employment - Base Year 2016
Southeast	106,617	22,565
Southwest	228,103	66,837
Puerto Rico	**3,411,307**	**986,151**

Source: SDG

Figure 4.12 displays changes at the TAZ level between 2010 and 2016. It also shows that below the regional level, there are some municipalities that have experienced slight population and employment growth. The change between 2010 and 2016 is discussed in further depth in Chapter 2 during the Population and Employment sections.

Figure 4.12: Population and Employment Change at the TAZ level, 2010 – 2016
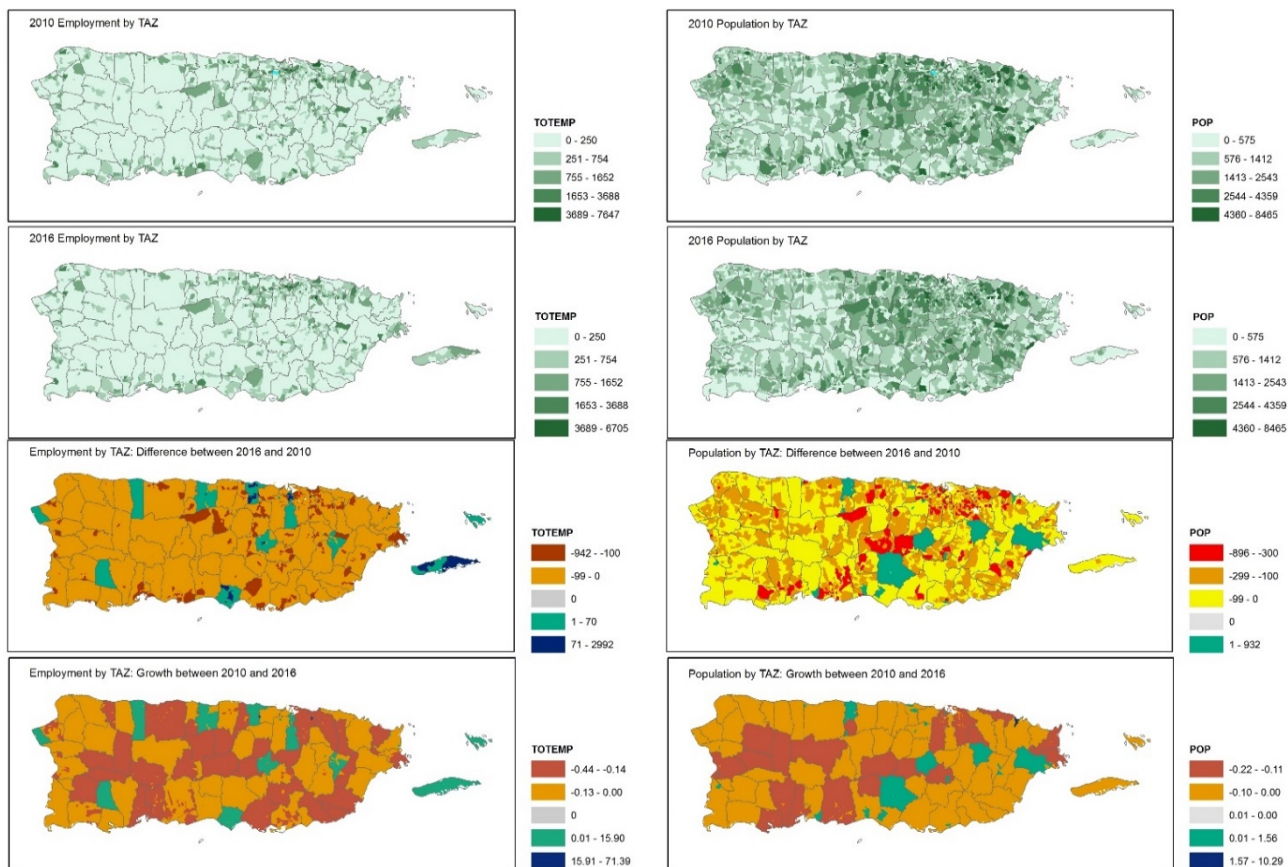
Source: SDG analysis

Socioeconomic Inputs – Forecast Year 2045

This section details the processes of distributing these forecasts to the transportation analysis zone (TAZ) level, forecasting additional input variables, and producing final constrained models. The 2016 base socioeconomic inputs serve as the origin point for these processes.

Population and Employment Forecasts

As explained in Chapter 2, Employment in the 2045 LRTP 2016 base socioeconomic inputs are produced with BLS - LAUS. The LAUS employment is reported by "place of residence, an adjustment is carried out to convert to employment by place of work."[59] The 2045 LRTP econometric forecasts were produced using the BLS Quarterly Census of Employment and Wages (QCEW), also by place of work, allowing growth rates from the 2045 LRTP employment forecasts to be applied the 2016 base socioeconomic inputs.

Detailed in Table 4.6 are the methods used to implement 2045 LRTP forecasts in producing forecasts for socioeconomic variables at the TAZ level, and other processes completed to finalize the 2045 socioeconomic inputs. The purpose of producing inputs at the TAZ level is for their use in the trip generation phase of the network model. They additionally serve as an insightful baseline for discussions around existing trends and potential alternative scenario's that would shift the trajectory outlined here.

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[59] The adjustment is described in the 2010 report by 2040 LRTP. 2045 LRTP 2016 socioeconomic inputs applied growth rates to the 2040 LRTP 2010 data as noted in the chapter on Socioeconomic Inputs – Base Year 2016, making it also by Place of Work.

Table 4.6: Socioeconomic Variable Adjustment by Municipality, Explanation, and Source

Socioeconomic Variables	Explanation of Adjustment	Source
Population	Distributed population from forecasts by Region down to their respective municipalities using the shares established in the base year 2016 socioeconomic inputs. After 2030, in the constrained forecasts, population is tied to forecasted employment growth.[60]	SDG Population Forecast
Households	Utilizing the average year over year growth rates from 2005-2016 for the Island of Puerto Rico, household size by municipality from the 2016 base year socioeconomic inputs was forecasted out until 2030, at which point rates were frozen.[61]	Forecast – Produced from ACS, Public Use Microdata Sample (PUMS) and SDG analysis
Total Employment	Applied growth rates by Region from the employment forecasts to the base 2016 socioeconomic inputs, distributing growth rates to the municipalities and TAZ corresponding to their associated Region.	Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW), BLS Local Area Unemployment Statistics (LAUS)
Retail, Service, Manufacturing, Government, and Other Employment Industries	With the basis of historical trends at industry level employment the technical team assumed a 10% decline by 2045 in manufacturing and government employment. This employment was redistributed to the retail, service, and other employment sectors, based on each TAZ's relative loss and the breakdown of employment in the retail, service and other employment sectors. Because of this, total municipality employment is left unaffected.	SDG Analysis
Income	Growth rates stemming from wage rate forecasts produced as part of the population and employment econometric models, were applied uniformly across incomes by municipality in the Base Year 2016 dataset, to adjust income out to 2045.	SDG Analysis and Forecast
Students	Student to population rates were forecasted and applied uniformly across the # of students by municipality in the base year 2016 dataset, to realize the impact of population loss and birth rate decline in Puerto Rico.	SDG Analysis and forecast
College	College students to population rates were forecasted and applied uniformly across the # of college students by municipality in the base year 2016 dataset, adjusting the college student population to forecasted 2045 levels.	SDG Analysis and Forecast
Dorms	Unchanged from Base Year 2010 (not used as inputs in trip generation model)	N/A

Source: SDG

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[60] The constrained forecast methodology is discussed further in the technical forecasting note in Appendix B.

[61] After analysis of the declining birth rate in Puerto Rico, the assumption of constant household size, population/household ratio, did not reasonably hold. Forecasts were developed for household size using their historical trend, carrying out the final year over year growth rate between 2015 and 2016. It was assumed that at 2030, birth rates would not continue to decline, as they are approaching a floor, being already one of the lowest in the world. Which is why the decline in household size is discontinued at 2030 levels as the forecasts continue.

Overview of Population and Employment Change

In the Aguadilla TMA, from 2016 to 2045 seen in Table 4.7, population is forecasted to increase by around 12,000 people, reaching over 300,000 in total, as employment increases by close to 20,000, representing over 23.0% growth. Aguadilla represents the only Region to have forecasted both population and employment growth out to 2045. This data is visually mapped in Chapter 2, from   Figure 2.65 to Figure 2.69.

Table 4.7: Population and Employment Change in Aguadilla TMA, Base Year 2016 – Forecast Year 2045

MPO	2016 Pop	2045 Pop	Change	2016 Emp.	2045 Emp.	Change
Aguadilla	288,777	300,126	(3.9%)	81,952	100,998	(23.2%)
Puerto Rico	3,411,307	2,893,950	(15.2%)	986,151	897,987	(8.9%)

Source: SDG Forecast

Networks and Analysis

TAZ Urban Density

Figure 4.13 represents population density by square mile, allowing a visual distribution of population throughout municipalities and larger Regions. With public transportation's ridership base generally focused and made sustainable by high population densities, this can be a helpful and guiding graphic to identify corridors or areas to be assessed. The designations described in the graphic were guided by the U.S. Census Bureau's urban and rural classifications, and it is important to note that the map does not distinguish between land use, being strictly defined by population density. The ranges of the designations are defined in Table 4.8 below.

Table 4.8: Urban Density Area Types

Area Type	Population by Square Mile
Rural	(0-300)
Exurban	(300-1000)
Suburban	(1000-2000)
Suburban Dense	(2000-3000)
Urban	(3000-5000)
High Density Urban	(5000-20000)
High Density Urban Core	(20000+)

Source: 2016 population from Bureau of Census estimates, distributed to TAZ by SDG. Ranges produced by SDG guided by Bureau of Census definitions.

Figure 4.13: Area Types – Aguadilla (TMA)
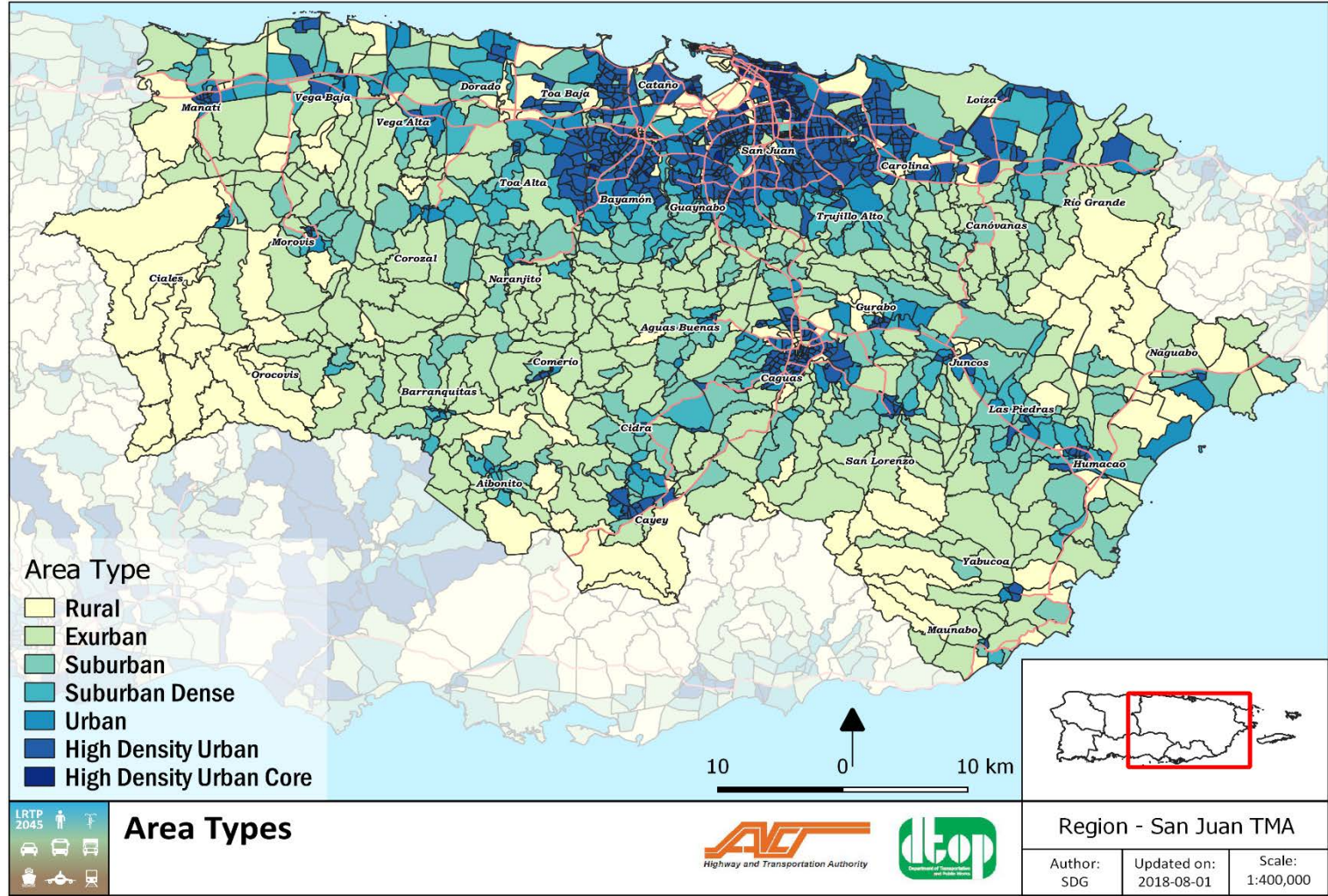
Source: 2016 population from Bureau of Census estimates, distributed to TAZ by SDG. Ranges produced by SDG guided by Bureau of Census definitions.

Trip Generation

This section describes the modifications made to the trip generation component of the 2045 LRTP Model. The effects of those modifications are illustrated on the end-result of trip generation, i.e. the balanced productions and attractions by trip purpose. The modifications consisted of:

- Updates to some of the source data;
- Re-estimation of the models that support the population synthesizer with the updated data; and
- Miscellaneous changes to the general methodology which the technical team considered were appropriate.

Data Source Updates

The data sources that serve as input to the population synthesizer component of the trip generation models were updated, but no changes to the production or attraction models were introduced. Table 4.9 shows the components of the trip generation model, the purpose of each component, and the nature of the updates made, if any.

Table 4.9: Components of Trip Generation Model

Model(s)	Dataset	Estimation Method	Purpose	Update
Household size and income group models	Census Tract	Linear regression of average household size / income on size / income group distribution	Disaggregate households into the 384 types by size, income group, numbers of workers, children, and seniors	Replaced 2010 Census with 2016 ACS 5-Year Data
Household composition models	PUMS	Cross-classification with household size and income group		Replaced 2006-08 with 2012-16 PUMS Data
Household auto ownership model	PUMS	Logit	Estimate probability of having 0, 1, 2 or 3+ autos per household for each household type	
Production models for each trip purpose (other than truck trips)	2011 Puerto Rico Household Travel Survey (HHTS)	Linear regression of trips generated on household characteristics derived from PUMS / IPF process	Generate productions by TAZ	None
Attraction models for each trip purpose (other than truck trips)	NCHRP 365[62]	n/a	Generate attractions by TAZ	None
Truck productions / attractions model	External Models	n/a	Generate truck productions and attractions by TAZ	None

Source: SDG

As described in the prior section, the TAZ data from the prior model base year 2010 to 2016 was updated. This data serves as the backbone to trip generation.

Re-estimation of Population Synthesizer Models

Since the census tract and PUMS data serve as inputs to the models which support the population synthesizer, those models were re-estimated to reflect changes in demographics. These models estimate:

- The distribution of household sizes as a function of a zone's average household size;
- The distribution of income groups as a function of a zone's average household income;
- Numbers of workers, children and seniors as a function of a household's average size and income group; and
- Auto ownership as a function of household demographics.

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[62] National Cooperative Highway Research Program (NCHRP) Report 365: Travel Estimation Techniques for Urban Planning, 1998 (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_365.pdf).

Detailed information on the re-estimation of the population synthesizer process is included in Appendix F.

Changes to Trip Balancing Methodology

In addition to updating the data and re-estimating the population synthesizer models as discussed above, a full review of the methodology was conducted finding several items to be addressed, all related to balancing productions and attractions. These included:

- A "validation factor" of 1.45 for home-based work attractions;
- The balancing alternative (balancing to productions vs attractions) for several trip purposes; and
- Trip balancing within each Region individually.

Detailed information on the changes to trip balancing is included in Appendix F.

Validation Factors in Model Update

After applying all of the above changes, the resultant Island-wide average number of trips per household had decreased from 5.29 in the 2040 LRTP Model to 4.34 in the 2045 LRTP Model update. This is, by most sources, a very low number – the Florida Department of Transportation Travel Demand Model Validation Standards[63], used to validate the prior LRTP model's trip generation output, suggests a range of 8 to -10 person-trips per household. Although Puerto Rico travel per household may be lower, it seems unlikely that it would only be 50% as much as in Florida. To corroborate that difference, initial runs of the model produced traffic volumes that were generally significantly lower than observed traffic counts across the whole Island.

Thus, Region-specific factors to increase all trips were implemented (both productions and attractions), based on the general level of modeled traffic volumes, as compared to traffic counts. Table 4.10 presents those factors.

Table 4.10: Region-Specific Trip Generation Factors

Region	Factor
Aguadilla	1.960
East	1.843
North	1.940
San Juan	1.186
South	1.323
Southeast	1.303
Southwest	1.803

Source: SDG

Truck Trip Generation

Due to the lack of the survey data, the production or attraction models for commercial and truck trips in the 2045 LRTP model were not updated, although global factors to adjust the trip productions and attractions based upon the general level of modeled truck volumes, as compared

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[63] Florida Travel Demand Model Validation Standards, Cambridge Systematics, Inc. for Florida Department of Transportation, 2009.

to the observed counts, were introduced. See Table 4.11. The resulting medium and heavy truck demand in 2016 increased by approximately 40,500 and 1,200 from the 2010 traffic conditions, respectively.

Table 4.11: Truck Trip Generation Factors

Vehicle Type	Factor
Commercial Vehicles	1.00
Medium Truck	1.31
Heavy Truck	1.10

Source: SDG

Validation of Trip Generation Output

Table 4.12 presents a comparison of the trip shares within each trip purpose, for the 2040 LRTP model (prior to any of the changes discussed in this report), and for the 2045 LRTP Model update, prior to and after the regional validation factors from Table 4.10: .

Table 4.12: Comparison of Person Trip Shares and Total Trips per Household to Florida DOT Validation Standards

	Florida DOT Standard	2040 LRTP Model	2045 LRTP Model Update –	
			Before Regional Validation Factors	After Regional Validation Factors
Home-Based Work	12%-24%	31%	27%	27%
Home-Based Retail	10%-20%	17%	20%	20%
Home-Based School	5%-8%	18%	7%	7%
Home-Based Other (includes University)	23%-40%	20%	28%	28%
Non-Home Based	20%-33%	15%	18%	18%
Total Number of Person Trips Per Household	8.0 – 10.0	5.29	4.34%	5.87%

Source: SDG

Table 4.12 shows that in the 2040 LRTP Model, both work and school trips were a much larger share of overall trips than in the validation standards, while home-based other and non-home-based trips had shares below the lower ends of their ranges. Balancing home-based school trips to attractions rather than productions and making school enrollment control the total trips addressed that inconsistency and brought the share of home-based school trips into the recommended range. Reductions to home-based work trips due to the census data update helped bring the share of home-based work trips closer to the recommended range, albeit still slightly above. Finally, the regional validation factors did not affect relative shares between trip purposes, but increased the number of trips per household to 5.87, a level still below the Florida standard, but much closer, as opposed to 50% below the low end of the range.

Overall, the trip generation updates bring both the relative numbers of trips between purposes and the total numbers of trip generated closer to well-established standards.

Trip Distribution

This section focuses on the updates and the calibration of the trip distribution component of the 2045 LRTP Model. Trip distribution links trip productions in the model Region with trip attractions to create matrices of inter and intra-zonal travel flows. The results of trip distribution will be used as inputs to mode choice and later assigned to highways and/or transit systems to determine the travel demand constrained by the supply capacities of the underlying facilities.

Gravity Model

The LRTP Model uses a standard gravity model to distribute trips from each origin zone to each destination zone in the model Region. The number of trips between zones is a function of the attractiveness of a zone and the travel impedance between zones:

$$Tij = Pi \frac{AjF(Cij)Kij}{\sum_{j=1}^{n} AjF(Cij)Kij}$$

Where:

- T_{ij}: trips from zone i to zone j;
- P_i: trips produced from zone i;
- A_j: trips attracted to zone j;
- $F(C_{ij})$: generalized cost friction factor; and
- K_{ij}: zone-to-zone calibration factor, which adjusts the attractiveness from zone i to zone j.

Travel Impedances

The trip distribution uses the minimum travel impedances among the generalized costs of auto trips, transit trips, and non-motorized trips from an origin zone to a destination zone. The travel impedances of auto, transit and non-motorized travel are functions that convert all measures, namely vehicle journey time, operating costs, highway tolls, transit fares, and walk distances, into equivalent minutes.

To accurately estimate the travel cost, it is essential to use the up-to-date value of time (VOT) to calculate the travel impedance. The 2040 LRTP Model assumed the VOTs at $12 and $21 per hour for a car trip and a truck trip, respectively. These values seemed slightly high related to the median household income of the Island[64]. Based upon US Department of Transportation (USDOT)

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[64] Median household income and Gini Index in the past 12 months in 2016 in Puerto Rico is $20,078 (https://www.census.gov/content/dam/Census/library/publications/2017/acs/acsbr16-02.pdf).

The BLS's third quarter (2016) county employment and wages in Puerto Rico is $524/week. **(**https://www.bls.gov/Regions/new-york-new-jersey/news-release/countyemploymentandwages_puertorico.htm).

revised VOT Guidance 2016[65], the VOT of a business traveler is assumed to be equal to a median hourly gross wage, while the VOT of local personal travel is typically estimated at 50 percent of hourly median household income. The VOT of both passenger car and truck travelers were re-estimated, resulting in values presented in Table 4.13.

Table 4.13: Value of Time ($/hour, in 2016$)

Vehicle Class	2040 LRTP	2045 LRTP
Auto	12.0	10.10
Truck	21.0	17.68

Source: SDG analysis of value of time

The auto operating cost (AOC) was set at $0.20/mile based upon the American Automobile Association (AAA) 2016's Your Driving Costs[66] for gas, maintenance, and tires, with adjustment to the average gas price in Puerto Rico in 2016. This value is comparable to the auto operating costs implemented in the Southeast Florida Regional Planning Model (SERPM 7.0)[67]. For trucks, it was assumed a truck operating cost (TOC) of $0.80/mile. The truck value comes from a combination of trucking industry interviews, which suggested a cost range from $0.80 to $1.75, and the fuel, maintenance, and tires costs published in American Transportation Research Institute (ATRI) 2012 Cost of Trucking[68]. Table 4.14 shows the vehicle operating costs used in the 2040 LRTP Model and the updated values.

Table 4.14: Vehicle Operating Cost ($/mile, in 2016$)

Vehicle Class	2040 LRTP	2045 LRTP
Auto	0.1625	0.20
Truck	0.5833	0.80

Source: SDG analysis of vehicle operating cost

The highway costs did not include parking costs in the 2045 LRTP Model since uniform data was not available for the entire Island.

Friction Factors

The gamma function from the 2040 PR LRPT Model to calculate friction factions was adopted:

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[65] The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations Revision 2 (2016 Updates), September 2016 (https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-valuation-travel-time-economic).

[66] Available at https://exchange.aaa.com/wp-content/uploads/2017/05/2016-YDC-Brochure.pdf.

[67] SERPM 7.0 uses an assumed auto operating cost of 19.80 cents/mile, including 13.50 cents/mile of fuel cost, and 6.30 cents/mile of maintenance cost (in 2009 dollars).

[68] American Transportation Research Institute, "An Analysis of the Operational Costs of Trucking: A 2012 Update".

$$FF = t^b \times e^{ct}$$

Where t is the travel impedance, and b and c are parameters to be calibrated.

During the calibration process, due to the lack of observed data, only the coefficients of gamma function for the home-based work trips were re-estimated, in order to keep the average travel time and travel time distribution close to that of the 2040 LRTP Model. Table 4.15 presents the changes of coefficients made for the 2045 LRTP Model.

Table 4.15: Coefficient of Gamma Functions of HBW Trips

Trip Purpose	2040 LRTP Model		2045 LRTP Model	
	b	c	b	c
HBW Low Income	0	(0.064)	0	(0.07)
HBW Medium Income	0	(0.048)	0	(0.056)
HBW High Income	0	(0.04)	(0.01)	(0.055)

Source: SDG 2045 LRTP model update

The resulting friction factors of the HBW trips and the comparison between the 2040 and 2045 LRTP models for low, medium, and high income travel are presented in Figure 4.14, Figure 4.15, and Figure 4.16 respectively.

Figure 4.14: Comparison of Friction Factors of Low Income HBW Trips (2040 LRTP vs. 2045 LRTP)
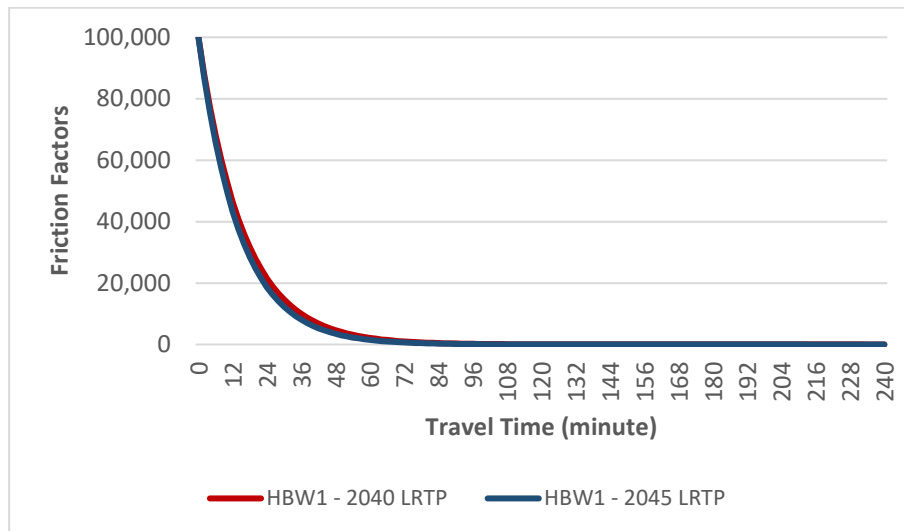
Source: SDG analysis of friction factors

Figure 4.15: Comparison of Friction Factors of Medium Income HBW Trips (2040 LRTP vs. 2045 LRTP)
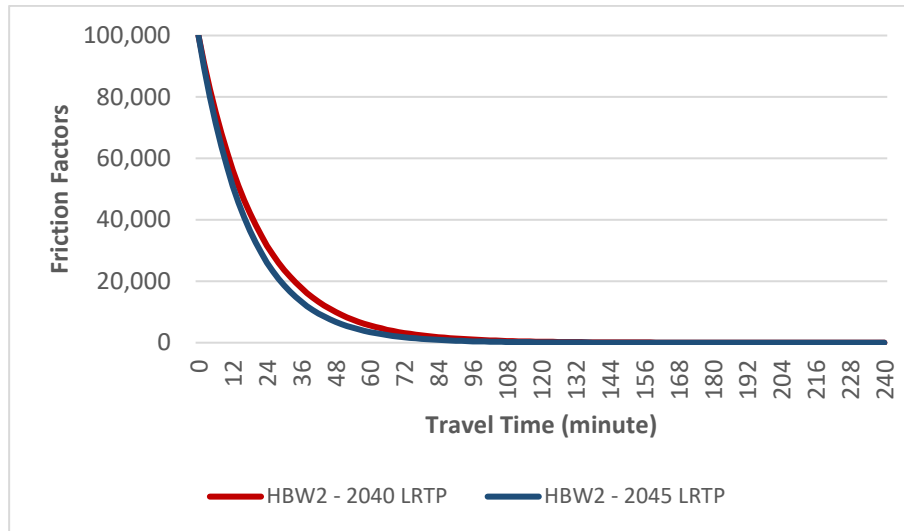
Source: SDG analysis of friction factors

Figure 4.16: Comparison of Friction Factors of High Income HBW Trips (2040 LRTP vs. 2045 LRTP)
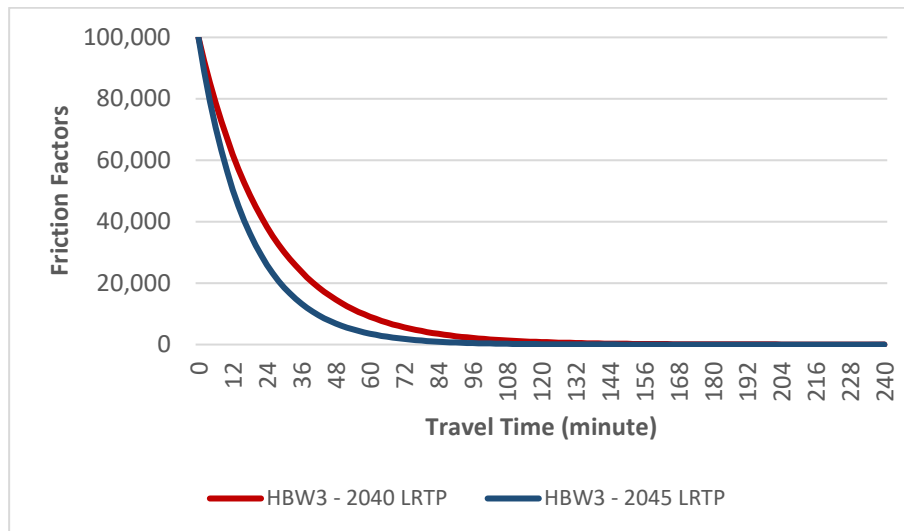
Source: SDG analysis of friction factors

K Factors

The K factor is a zone-to-zone trip adjustment coefficient that modifies the attractiveness of one trip attraction to trip production. Normally, the use of K factors helps to capture certain characteristics that influence travel patterns, from which a gravity model cannot directly estimate. Examples of these characteristics include tax policies that reduce or support travel to certain Regions, travel time reliability that affects the likelihood of travel, and geographic and/or topographical features, namely large water bodies, reserved/restricted areas, and mountain ranges as intermediate stops which may prevent travel. These limitations introduce an

inconsistency into the distribution process and may further justify the use of k factors for some situations.

The 2040 LRTP model did not have K factors in place. After reviewing the 2016 traffic flows from highway assignment on screenlines, new coefficients were introduced to the 2045 LRTP Model to adjust the municipality-to-municipality trip flows. Table 4.16 presents the K factors developed for home-based work, home-based other, home-based retail, and non-home-based trips. With them, the attractiveness of travel within San Juan and between North Region and San Juan was increased, while reduced between Aguadilla and San Juan.

Table 4.16: K Factors for 2045 LRTP Model

Region	Aguadilla	East	North	San Juan	South	Southeast	Southwest
Aguadilla	1.00	1.00	1.00	0.85	1.00	1.00	1.00
East	1.00	1.00	1.00	1.00	1.00	1.00	1.00
North	1.00	1.00	1.00	1.10	1.00	1.00	1.00
San Juan	0.85	1.00	1.10	1.10	1.00	1.00	1.00
South	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Southeast	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Southwest	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source: SDG 2045 LRTP Model update

Model Validation

The trip distribution of 2040 LRTP Model was calibrated by the average trip lengths and the trip length frequency distributions calculated from the 2011 Puerto Rico household survey. To examine the changes of travel patterns in the past 5-years (2011 – 2016), it was proposed to conduct a new household survey for information on origin-destination travel data for all trip purposes. However, due to Hurricane Irma and Hurricane María in Summer 2017 causing great damage to the Island, the planned Island-wide household survey was postponed. Because of this delay, it was not possible to update the trip length frequency distribution calculation, or re-estimate coefficients of the gamma function from the survey results.

A limited validation to the trip distribution step with three measures was conducted:

- Region-to-Region travel patterns;
- Average trip length; and
- Trip length frequency distribution.

Detailed information on this validation process is included in Appendix F.

Time of Day Choice

This section describes the methodologies available to segment the daily demand into peak and off-peak periods in preparation for mode choice, and after mode choice, further disaggregate the auto and truck trips into finer time periods for highway assignment.

Both trip generation and trip distribution were developed on a daily basis. In the 2040 LRTP Model, the mode choice was also performed on a daily basis. As the outputs of mode choice process, the daily vehicle trips were then disaggregated into four periods (AM Peak, midday, PM Peak, and night) for highway assignment. In reality, the choice of travel mode made by individuals would vary by time due to the changes of level of service and congestion. Thus, in the 2045 LRTP Model, the mode choice model was modified from daily basis to peak and off-peak periods.

Pre-Mode Choice Time-of-the-Day Trip Distribution

In preparation for mode choice, diurnal factors were applied to subdivide the daily trips by purpose into peak and off-peak trips. These factors, as presented in Table 4.17, were initially adopted from the 2040 LRTP Model, by combining the AM and PM peak factors to derive peak period, and midday and night factors to derive off-peak factors. During the model calibration, these were adjusted upon the observed traffic data.

Table 4.17: Daily to Peak and Off-peak Factors

Trip Purpose	Peak	Off-Peak
HBW – Low Income	0.500	0.500
HBW – Medium Income	0.500	0.500
HBW – High Income	0.500	0.500
HBO	0.201	0.799
HBR	0.100	0.900
HBS	0.720	0.280
HBU	0.420	0.580
NHB	0.190	0.810
COM	0.400	0.600
MTK	0.330	0.670
HTK	0.350	0.650

Source: SDG 2045 LRTP Model update

Time of Day Distribution for Highway Assignment

The transit trips estimated by the mode choice process were retained in peak and off-peak designations for purposes of assignment. The highway assignment was performed by finer time-of-day breakdowns to account for congestion effects and the subsequent diversion of trips caused by that congestion. The 2045 LRTP Model adopts four periods covering the AM and PM peak, the Midday period, and the other off-peak periods.

Peak periods comprise of multiple hours. Since link capacity is normally defined hourly, peak period factors were developed to convert hourly capacities to period capacities. Table 4.18 presents the period definition, the length of each period, and the hourly-to-period capacity factors.

Table 4.18: Hourly to Period Capacity Factors

Period	Timeframe	Number of Hours	Period Capacity Factor
AM Peak	7am – 9am	2	2.0
Midday	9am – 3pm	6	5.8
PM Peak	3pm – 6pm	3	2.9
Other Off-peak (Night)	6pm – 7am	13	6.2

Source: 2045 LRTP Model

The peak and off-peak auto trips generated by the mode choice process were in production/attraction (P/A) format, except for the non-home-based purposes which were estimated in an origin/destination (O/D) format. The commercial vehicles and truck trips were in the O/D format too. In preparation for highway assignment, the peak and off-peak P/A trip tables were converted to period-specific O/D trip tables using time-of-day and direction split factors. These factors are presented in Table 4.19 and Table 4.20.

Table 4.19: Peak to AM and PM Factors

Trip Purpose	AM		PM	
	P-to-A	A-to-P	P-to-A	A-to-P
HBW – Low Income	0.389	0.059	0.008	0.544
HBW – Medium Income	0.389	0.059	0.008	0.544
HBW – High Income	0.389	0.059	0.008	0.544
HBO	0.376	0.211	0.014	0.399
HBR	0.178	0.283	0.034	0.505
HBS	0.437	0.042	0.092	0.429
HBU	0.526	0.078	0.050	0.346
NHB	0.179	0.321	0.179	0.321
COM	0.213	0.287	0.213	0.287
MTK	0.200	0.300	0.200	0.300
HTK	0.216	0.284	0.216	0.284

Source: SDG 2045 LRTP Model update

Table 4.20: Off-peak to MD and NT Factors:

Trip Purpose	MD		NT	
	P-to-A	A-to-P	P-to-A	A-to-P
HBW – Low Income	0.128	0.435	0.12	0.317
HBW – Medium Income	0.128	0.435	0.12	0.317
HBW – High Income	0.128	0.435	0.12	0.317
HBO	0.252	0.214	0.267	0.267
HBR	0.316	0.193	0.262	0.229
HBS	0.333	0.233	0.333	0.101
HBU	0.169	0.238	0.366	0.227
NHB	0.348	0.152	0.348	0.152
COM	0.367	0.133	0.367	0.133

Trip Purpose	MD		NT	
	P-to-A	A-to-P	P-to-A	A-to-P
MTK	0.280	0.220	0.280	0.220
HTK	0.290	0.210	0.290	0.210

Source: SDG 2045 LRTP Model update

During the model calibration, the time-of-day factors based upon the traffic counts were adjusted. Figure 4.17 and Figure 4.18 compare the demand distribution by time-of-day between 2010 and 2016 for auto and trucks respectively. For auto trips, the 2016 model has significantly higher demand in the overnight period (NT) than the 2010 model. It seems reasonable since this period starts from 6pm when a lot of activities are still on-going.

Figure 4.17: Comparison of Time-of-Day Demand Distribution (2016 vs. 2010) - Auto Trips
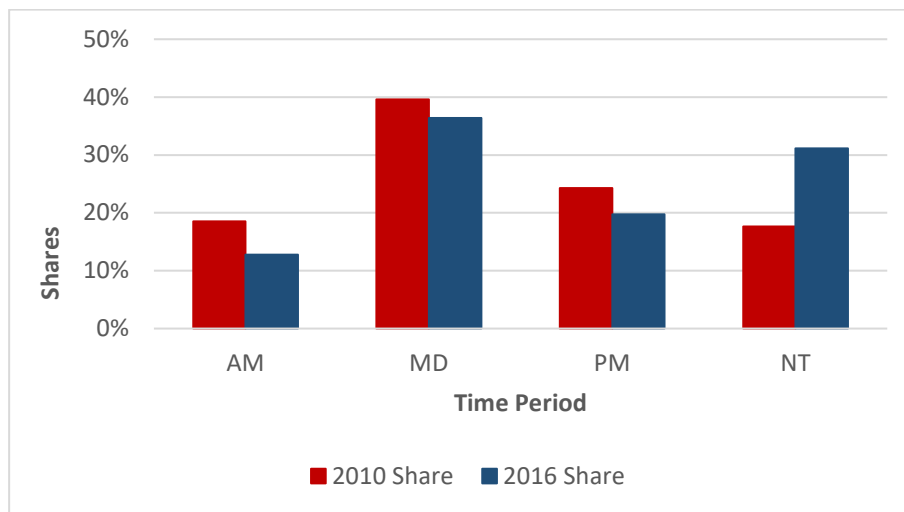
Source: SDG analysis of auto trip shares by time period

Figure 4.18: Comparison of Time-of-Day Demand Distribution (2016 vs. 2010) - Truck Trips
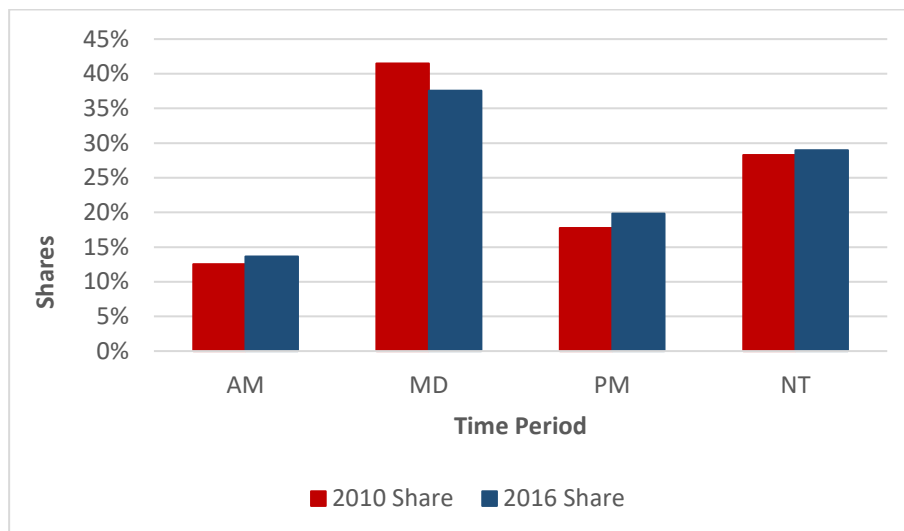
Source: SDG analysis of auto trip shares by time period

Mode Choice and Transit Assignment

In this section the update to the mode choice and transit assignment is presented. Following this introduction, the section continues with a brief review of the mode choice framework established for 2040 LRTP, including a summary of the level of validation reported for the 2040 RP LRTP Model development. Improvements and updates undertaken for the 2045 LRTP are presented, followed by the calibration and validation of these improvements. The Appendix F includes a final part for this section presenting a range of sensitivity tests to show how responsive the model is to changes in input assumptions.

The 2040 LRTP model includes a complicated three-tiered nested multinomial mode choice model. The structure of the model, which is used for each of the eight trip purposes, is shown in Figure 2.1.

Note, however, that no data collection was undertaken for the estimation of the model with all parameters instead based on US benchmark values extracted from various Transportation Research Board (TRB) publications.

All-purpose target mode shares for each of the 10 modes were estimated from the household travel survey data which was collected as part of the 2040 LRTP Model, infilled with observed transit ridership and on-board survey data. Constants were applied to the final outputs of the mode share model in order to align the mode share forecasts with 2040 LRTP' target.

The mode share of the 2040 LRTP Model shows a reasonably match to the HTS data which is to be expected as it was used to derive the target mode shares. The model is better at capturing the mode choice decision in the San Juan Region compared to the performance across the rest of Puerto Rico. No details have been provided by 2040 LRTP regarding the reasonableness of the model in "forecasting mode" or if there are any possible weaknesses which need to be accounted for in the future years.

Developments for the 2045 LRTP

As a result of Hurricane María, no data collection proposed as part of the original project scope would be available for the model updates. In particular, the household travel survey data would not be completed and analyzed in time to update the relevant model inputs. As such, model development was relatively limited in scope. The main tasks are summarized as follows.

- Updated inputs where new data is available;
- Updated hierarchy of PT modes within the transit assignment;
- Mode choice modelling of the peak and off-peak periods for each trip purpose; and
- Revalidation for Base Year 2016.

Each of these tasks is discussed further in Appendix F.

Mode Choice

The target mode share for Auto, Transit, and Nonmotorized modes was estimated using the combined dataset, as shown in Table 4.21.

Table 4.21: Target Mode Share Evolution.

Scenario	HTS only	With On Board Transit Survey	And Journey to Work
Auto	90.2%	91.3%	91.4%
Transit	4.2%	3.0%	2.8%
Non-Motorized	5.6%	5.7%	5.8%

Source: SDG combined data set

Given the nature of the data, only limited information was available regarding mode choice at lower levels of the nested structure. In Figure 4.19 the mode choice model results are compared to the observed data at an Island-wide level for both the peak and off-peak periods.

Figure 4.19: Mode Choice Validation – Island-wide by Time of Day
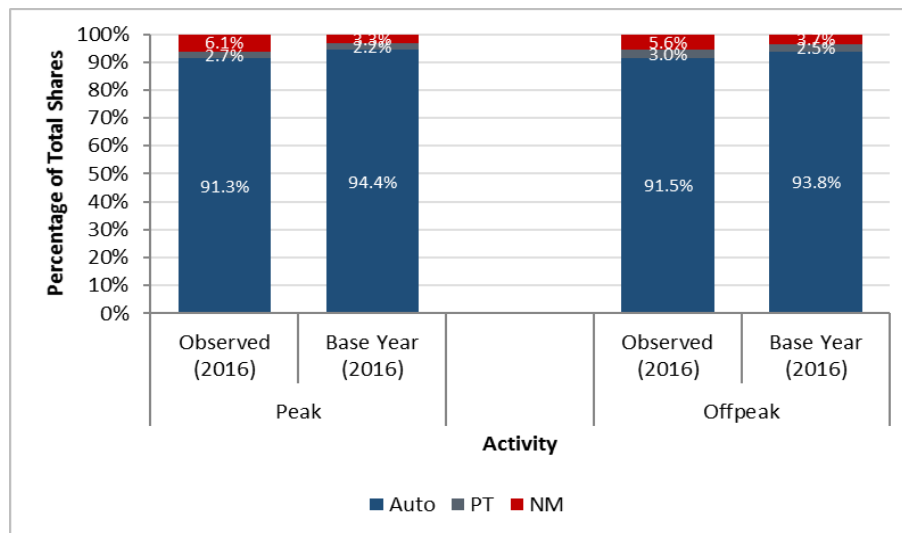
Source: 2045 P LRTP Model

Several data sources were combined to create a multimodal, island-wide 'observed' dataset for model calibration. The 2012-2016 American Community Survey Journey to Work data, the 2040LRTP 2010 Household Travel Survey, and On Board Transit Survey were adjusted and compiled to form a representative set of trip matrices by TMA, split by journey purpose and mode of travel.

From Figure 4.19 it is observed that during both the peak and off-peak periods the mode share for auto is slightly high at the expense of non-motorized trips. Transit trips show a good match to observed data. The overallocation of auto trips is not considered to be a concern for the following reasons:

- Given that auto demand makes up over 90% of the observed travel demand, it is prudent to focus on this market segment. Indeed, a good match for auto trips is shown;
- The combined dataset represents one point of reference for travel demand. This dataset is made up of relatively subjective and sparse data when compared to other sources such as toll road transactions and other highway count data. The latter two data sources form the basis of the highway validation and insight from this stage of work indicated that the

highway demand coming out of the mode choice was too low. Thus, there is a tradeoff to be made between the various data sources. For this reason, the mode choice was revised to increase the auto mode share to improve the highway validation at the expense of the mode choice validation; and

- The forecasting for the 2045 LRTP is focused on auto and transit schemes. The schemes to be tested are not expected to have a significant impact on non-motorized trips. As such the validation of non-motorized trips is not considered to be a priority.

The mode choice for the key trip purposes at an Island wide level is shown in Table 4.22.

Table 4.22: Island-wide Mode Choice Results by Purpose and by Period

Purpose	Peak			Off peak		
	Auto	Transit	Non-motorized	Auto	Transit	Non-motorized
Home-based work	95.6%	1.5%	2.8%	95.8%	1.4%	2.8%
Home-based other	93.2%	3.5%	3.3%	93.2%	3.5%	3.3%
Non-home based	94.6%	0.3%	5.2%	94.6%	0.2%	5.1%

Source: 2045 LRTP model

From Table 4.22 the following findings are observed:

- Auto share is high for all trip purposes and highest for home-based work trips;
- Home-based other trips are the most likely to use transit with a mode share of 3.5%, over double that of home-based work;
- Non-home based other trips are the most likely to use a non-motorized mode. This is likely due to the short distance of most of these trips; and
- As observed in other comparisons, the mode shares do not vary much between the peak and off-peak periods.

Overall these results make sense, with users with a higher value of time favoring the faster auto mode, while the shorter distance trips are more likely to walk or cycle.

Given that transit is more widely available within San Juan Region, the mode shares are validated separately for San Juan and the Rest of Puerto Rico. These results are Figure 4.20 and Figure 4.21.

Figure 4.20: Mode Choice Validation – San Juan and Rest of Puerto Rico – Peak period
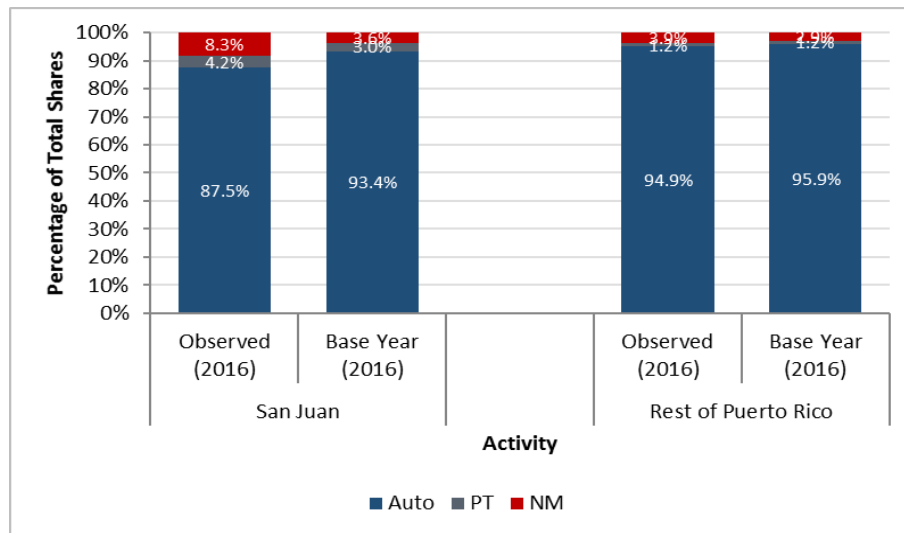
Source: SDG 2045 LRTP calibration of Mode Choice

Figure 4.21: Mode Choice Validation – San Juan and Rest of Puerto Rico – Off-peak period
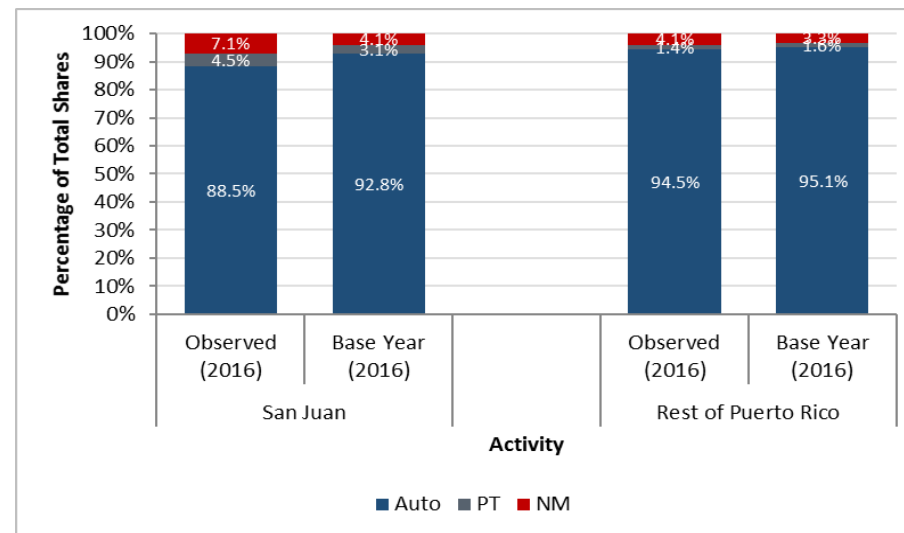
Source: SDG 2045 LRTP calibration of Mode Choice

In general, the mode choice model is providing a good representation of the choices made between auto, transit, and nonmotorized modes. Consistent results are seen across each geography and each trip purpose with no erroneous behavior in the model.

Transit Boardings

Transit services exist across the entire Island of Puerto Rico. However, outside of San Juan these are limited to Públicos and local services (trolleys) only. The Puerto Rico multi-modal model uses a simple uncrowded transit assignment to allocate the Premium, Local, and Público transit demand onto the relevant services.

Only limited data is available regarding transit ridership in Puerto Rico. The sources available for this work are summarized below:

- AMA bus ridership extracted from April-May 2016 AMA report;
- Monthly Ridership for First Transit operated services for July 2016 to June 2017 – Metrobus, TU Conexión, Metro Urbano;
- Público ridership by time period (6-9am, 9am-3pm, 3pm-6pm) collected for National Transit Data Base. Final Report. October 2015; and
- Tren Urbano boardings by station for 2010 as used in the 2040 LRTP. This was cross checked against total boardings in 2016 Q4 American Transit Association report which had an identical total ridership.

Highway Path Building and Assignment

This section contains a description of the updates made in the highway network coding, the highway path building and assignment process, and summarizes the highway assignment calibration in the model base year of 2016. More detail is included in Appendix F.

Network Updates from 2010

When creating the updated base year 2016 network, extensive review to examine network coding accuracy and to ensure proper network connectivity was conducted. The network was compared against Google Maps imagery and a list of recently completed projects from PRHTA. Two major roadway improvements that have been completed since the 2010 model version were identified and coded into the 2016 highway network:

- PR-66 extension from PR 188 to PR-3, partially tolled; and
- PR-22 reversible toll lane with dynamic toll varied by time period (DTL) from PR-693 to PR-167.

None of these affect the Aguadilla TMA road network area. A detailed network comparison was shown in Appendix G.

Speed and Capacity Estimation

Speed and capacity variables are two primary inputs of highway path building and assignment processes. During the course of the model update and calibration, the hourly lane capacities for the 2016 highway network were adjusted based upon professional judgement introducing only minor changes to previous values.

The uncongested speeds were updated using the average speeds in the night period from 2017 NPMRDS travel time data[69]. Note that these speeds represent theoretical upper limits before taking the road topographic features into account. Based upon the terrain classification, the following reductions to the uncongested speeds were applied:

- Level: 0%;
- Rolling: 5%; and

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[69] NPMRDS travel time data are in February, March, and April of 2017.

- Mountain: 30%.

The estimates of congested speeds were used as inputs to the very first iteration of the highway path building process. To create a pseudo congested condition (a so-called warm-up condition), the input speeds were assumed to be approximately 20 percent lower than the uncongested speeds during peak periods, and 10 percent lower than the uncongested speeds during off-peak periods.

The hourly lane capacities were defined by facility type and by area type. These initial hourly capacities per lane were adjusted to consider geometric constraints or other impedances along the link, such as number of lanes, and the condition of the approaching intersection or ramp configuration.

Toll Variables

The LRTP model network incorporates all toll facilities. Most of the toll roads in Puerto Rico have fixed toll rates throughout the day. The locations rates of toll plazas coded in the network were updated to 2016 conditions.

In April 2013, a new dynamic toll lane was opened between the Buchanan and Toa Baja toll stations on PR-22. The DTL comprises two reversible lanes located in the PR-22 median, which are opened for eastbound travel in AM peak, and for westbound travel in PM peak. During midday and night periods, the DTL is closed for a few hours to facilitate the switch of travel directions. The toll rates on the DTL are determined by traffic volumes, ranging from $0.50 to $6.00 per trip. To simulate the change of direction in DTL during the day, reductions of lane capacities in the off-peak periods were assumed to replicate the partial lane closure. To model the various toll rates on DTL, new link variables to the 2016 highway network were introduced to contain the average toll rates of passenger cars during each period.

Highway Path Building

The highway path building process provides necessary travel time, distance, and cost estimates for several model components, such as trip distribution and mode choice. This process was performed for both peak and off-peak periods, based upon the minimum generalized cost between each zonal pair.

$$auto\ GC = congested\ time \times AVOT + distance \times AVOC\ + \text{auto toll}$$

$$truck\ GC = congested\ time \times TVOT + distance \times TVOC\ + \text{truck toll}$$

Where:

$auto\ GC$: generalized cost of a passenger car ($)

$truck\ GC$: generalized cost of a truck ($)

$AVOT$: auto value of time ($/hour)

$AVOC$: auto vehicle operating cost ($/mile)

$TVOT$: truck value of time ($/hour)

- *TVOC: truck vehicle operating cost ($/mile).*

The intrazonal time and distance were estimated in the final step of the highway path building process, using half of the sum of time from the two closest nonzero zones.

Highway Assignment

The 2045 LRTP model incorporates a multiclass assignment combining the passenger trip tables with truck trip tables. For use in the highway assignment, vehicles were converted into Passenger Car Equivalents (PCEs[70]), using the factors described in Table 4.23, commonly used in transportation modeling:

Table 4.23: Passenger Car Equivalents (PCEs) used in PR LRTP Model

Vehicle Class	PCE
Auto (SOV, HOV2, HOV3+)	1.0
Commercial Vehicle	1.0
Medium truck	1.5
Heavy truck	2.0

Source: SDG

Travel times are estimated based on the volume-delay relationship, which is implemented through the volume-to-capacity (V/C) ratio on each link of the network. The 2045 LRTP model uses the traditional Bureau of Public Road (BPR) formula.

Calibration

The following section describes how the 2016 Base Year model's highway trip assignment has been validated to observed conditions.

Observed Data

Due to consequences of Hurricane Irma and Hurricane María, it was not possible to collect traffic counts on the roads in fall 2017 as originally proposed. The best available vehicle classification counts were gathered from various data sources. The observed data used for model calibration contained the following sets:

- 2015 – 2017 vehicle classification counts from various months;
- One month of transaction data by vehicle class in September of 2015 and 2016; and
- NPMRDS travel time data in February, March, and April of 2017.

Figure 4.22 depicts the distribution of traffic counts. Among 368 one-way count locations on the entire Island, more than 55% of counts were on freeways and expressways. Approximately 15%

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[70] PCEs are used in transportation modeling to reflect the greater amount of highway capacity utilized by trucks.

were on principal arterials and only about 26% were on minor arterials or local roads. These counts are not evenly distributed by road type.

Figure 4.23 highlights corridors on which travel time data was obtained from NPMRDS. Similarly, to traffic count data, most of the travel times were collected on freeways and expressways. On some road segments, the average travel speed during the night period is slower than peak periods. Therefore, travel time was not used as a primary calibration target.

Existing Traffic Counts and Travel Time Databases

This chapter provides an overview of the data collection databases on main roads in the Puerto Rico road network. Specifically, describing traffic counts and travel times collection efforts, which were essential inputs in the model development and calibration process.

Taking into consideration the recent events in Puerto Rico (i.e. Hurricanes Irma and María) and understanding that traffic patterns were not representative of pre-hurricane travel patterns; these historical datasets are the best source of information for this study. This chapter aims to describe the available traffic count and travel time data.

Traffic Counts

The traffic counts were performed by the PRHTA traffic data collection office thru their internal and subcontracted data collection resources. There were 69 counts locations identified in the Aguadilla TMA. The locations of each counts are presented in Figure 4.22.

Travel Times

The available travel time information was obtained from the National Performance Management Research Data Set (NPMRDS), through their analytics webpage. NPRMDS provides vehicle probe-based travel time data for passenger autos and trucks. The real-time probe data is collected from a variety of sources including mobile devices, connected autos, portable navigation devices, commercial fleet and sensors. NPMRDS includes historical average travel times in 5 minutes increments on daily basis covering the National Highway System (NHS). The data is provided in two parts. The first part is a Traffic Message Channel (TMC) static file that contains TMC information. The second part includes travel times and identifies roadways geo-referenced to TMC location codes. The two datasets need to be joined in Global Information System (GIS)-based software to provide the full picture.

A total of 32 corridors are identified in the platform, as shown in Figure 4.23. Data was collected for pre-hurricane conditions for the months of February, March and April of 2017, for a period of 24 hours for 15-minute intervals.

Figure 4.22: Aguadilla (TMA) Counts Locations
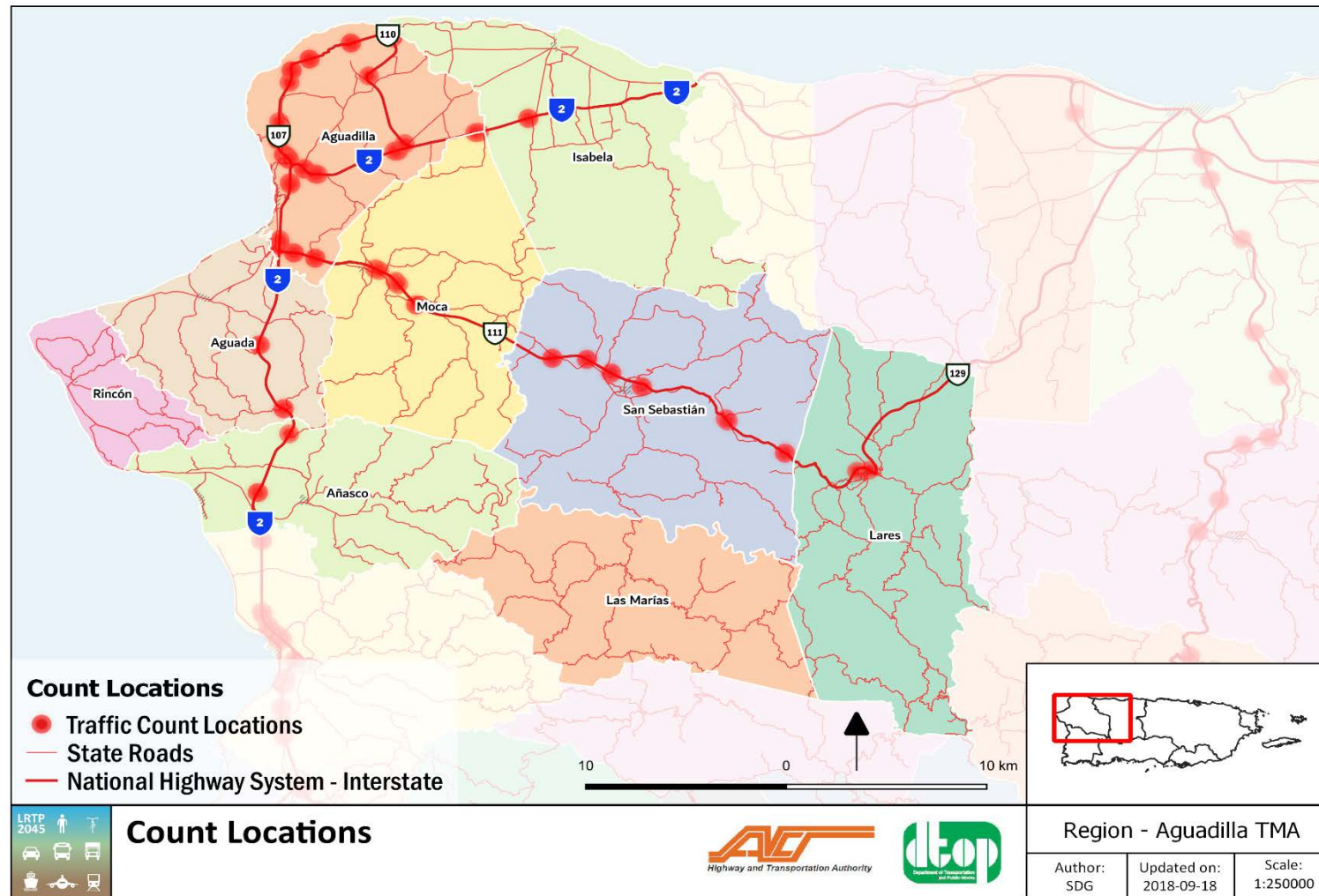
Source: Traffic Count locations layer was provided by the Puerto Rico Highway and Transportation Authority (ACT by its spanish acronym)

Figure 4.23: TMC's Location
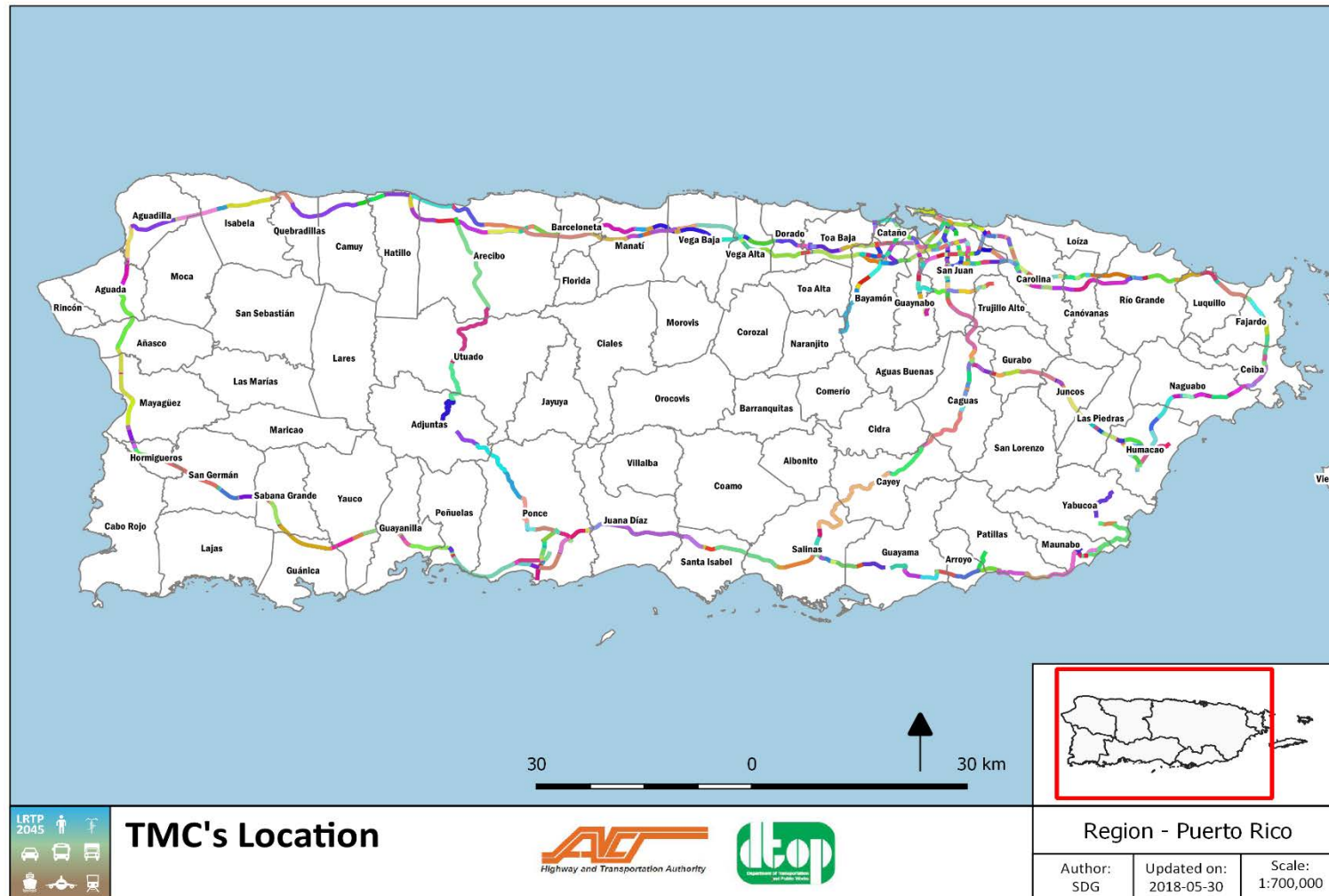
Source: Steer Davies Gleave, based on NPMRDS Analytics

Calibration Results

The calibration of highway assignment focused on the standard comparison of the modeled volumes to the observed counts by using various classifications and statistical measures of fit such as Percent Error (%Error) and Percent Root Mean Squared Errors (%RMSE) by volume group. Both %Error and %RMSE are commonly used to determine how closely estimated volumes replicate observed count data.

The overview highway assignment statistics were summarized Appendix F to depict different aspects and levels of comparison, including:

- Volumes vs. counts by facility types;
- Volumes vs. counts by sub-Regions;
- Volumes vs. counts by area types;
- Volumes vs. counts on screen lines latter described; and
- Truck volumes vs counts by facility types.

5   CHAPTER 5 FINANCE

This chapter is divided into 5 sections:

1. Context;
2. Prioritization Strategy;
3. Financial Support for Disaster Recovery;
4. Sources of Funds; and
5. Capital Cost Estimates.

CONTEXT

The impact of Hurricane María on Puerto Rico was devastating and it seriously damaged much of the Island's critical transportation infrastructure. For the immediate future, the primary HTA and DTPW's focus must be on disaster recovery and repair. However, this is also the time to be planning and investing in mitigation measures, in order to be prepared for any future catastrophic natural events and ensure greater resilience of the Commonwealth's key infrastructure.

The critical nature of the local economic situation requires economic/financial analysis to help define the available budget and minimum spending obligations, prior to defining the alternatives to be modeled.

A strategic review of funding and financing options has been prepared to provide a prudent and realistic assessment of potential financial resources likely to be accessible to PRHTA over the coming years. The financial team have identified and reviewed the availability and eligibility of various capital grants and loan programs available for transportation infrastructure and transit initiatives, including both apportionment and discretionary/competitive funds.

The PRHTA and the DTPW jointly prepare a STIP, which sets out the proposed distribution by project of federal funds assigned to Puerto Rico, covering highways and transportation related funding from the FHWA, and transit related funding from the FTA.

PRHTA's also produces a 5-year Capital Improvement Program (CIP) which is the basis for preparation of TIP for FHWA federal aid-projects. PRHTA has evaluated the condition of its highways assets, allowing it to identify and prioritize major needs given the limitations on resources, and the associated construction costs. The CIP is subject to approval by the PROMESA Oversight and Management Board.

The CIP estimates the steady state costs for FY22+ amounting to $261.8M per annum, including $130M for pavement, $86M for bridges and $33M for safety. These CIP figures exclude soft costs (in the range 10-18.5% of capital expenditure (capex). There is a separate budget for transit CIP projects. The level of projected costs implies a more than doubling of expenditure on pavement and five-fold increase in the amount allocated for bridges compared with recent STIPs[71].

For operational expenditure and construction in progress, PRHTA relies on funds from toll revenues, transit revenues, federal funds from the FHWA and FTA, and a transfer from the central Government of Puerto Rico (part of which is earmarked).

PRIORITIZATION STRATEGY

The high-level prioritization of projects, as shown in Figure 5.1, follows the PRHTA objectives set out in the Fiscal Plan[72] (page 21), to address immediate needs and backlog, and is further informed by stakeholder consultation.

Figure 5.1: Overview of capex prioritization

Source: SDG analysis

The initial focus is on emergency repairs, developing resilient infrastructure to modern standards, and meeting FHWA targets for condition of interstate and NHS pavements and bridges. Many federal programs require some degree of local match. This could be provided by drawing on toll

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[71] Source: PRHTA Initial Transportation Asset Management Plan; April 2018; PRHTA.

[72] PRHTA Revised Financial Plan 2018-2023; As certified by the Financial Oversight and Management Board for PR; Revised HTS Fiscal Plan; June 29, 2018.

revenue credits, although there will also be a need for actual funding in order to achieve key targets for state of good repair.

In view of the lack of access to bond markets (due to default on existing bond issues), combined with the government's clawback arrangements for tax streams previously dedicated to transportation, there is no alternative source of funds to provide the local contribution other than specific government transfers.

Demand for construction and project management resources are likely to drive up costs in short term. This is already being reflected in levels of construction cost inflation, which will inevitably reduce the amount of work possible within a fixed, finite budget. Timescales for project start dates may therefore be extended.

A number of possible P3 (Public-Private Partnership) projects have been identified, but their scope for covering financing charges and cost recovery through user fees is limited, which implies a requirement either an upfront capital contribution from the Government or commitment to on-going availability payments. The former is likely to be a more attractive option for investors but would depend on the ability of PRHTA to secure a project specific, discretionary federal loan, which will require time to process and with an uncertain degree of success.

FINANCIAL SUPPORT FOR DISASTER RECOVERY

The Central Office of Recovery, Reconstruction and Resiliency was created to coordinate all sources of federal funding approved for Hurricane María recovery. It estimates that the reconstruction process will take around 10 years.

Preliminary damage assessment for highways totals $652M, of which $642M is expected to be covered by federal funds. There are further costs of $114M for damage to non-highway and transit assets, of which $108M are expected to be covered by a combination of federal funds and insurance claims. It should be noted that the funding allocation is based on a preliminary damage assessment, which may need to be updated. In addition, the costs of repairs could increase, given inflationary trends, and timescales be extended.

Nationally available funding sources are set out in Table 5.1.

Table 5.1: Sources of funding for disaster recovery

	Approved/ obligated funds $M	Local match required	Notes	Allocation to highways and local transportation	Potential contribution $M
FEMA Public Assistance grants	2,432	25%	May use HUD CDBG-DR[73] funds as match	Contribution to non-Federal aid road infrastructure	59.5 (authorized) - 220* (implied)
FHWA Emergency Relief Assistance	142.5	0%	100% Federal funding authorized by Bipartisan Budget Act of 2018	100%	142.5
FTA Emergency Relief	198	10%	Authorized to use Toll Credits as match	100%	198
FTA Resilience	26	20%	Authorized to use Toll Credits as match	100%	26
HUD CDBG-DR	18,438	n/a	Estimated allocation to infrastructure repairs	0.3%	55
Treasury Disaster Relief Loan	2,065			Unknown	
Total	**23,231**				

* Value implied by local match assumed from HUD CDBG-DR
Source: SDG analysis

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[73] U.S. Department of Housing and Urban Development's (HUD's) Community Development Block Grant for Disaster Recovery (CDBG-DR).

FEMA Public Assistance Grants

Public Assistance (PA) grants typically represent the largest disbursement of federal funds for short- and long-term disaster recovery. They are the primary form of assistance offered by FEMA (Federal Emergency Management Agency) for the repair, replacement, or restoration of public infrastructure.

FEMA obligates funds for PA projects based on detailed cost estimates derived from damage assessments. FEMA's PA program has (up to July 16, 2018) obligated $2.6 billion in total funding departments and municipalities for debris removal and emergency protective measures related to Hurricane María.

Usually FEMA provides 75% of estimated costs, with the remaining 25% from local sources, although the local contribution may be covered by funds from other federal grant programs, including the U.S. Department of Housing and Urban Development's (HUD's) Community Development Block Grant for Disaster Recovery (CDBG-DR).

Public Assistance funds are intended to be applied to restore facilities to their pre-disaster state and function, and only allow for upgrades where necessary to meet applicable codes and standards.

Hazard mitigation add-on funding (designated as PA 406 program funds) may be sought for improvements designed to make the facilities more resilient and better able to withstand equivalent hazardous events, subject to a cost-benefit analysis to demonstrate cost effectiveness.

FHWA Emergency Relief Assistance

FHWA provides emergency relief (ER) assistance for repair of roads and bridges on federal-aid highways. These funds can be used for improvements that increase resilience of the infrastructure, if the additional costs can be justified based on the potential/expected future damage arising from a similar disaster.

ER funds are normally made available at the normal pro-rata share for federally funded assets: 90% for interstate highways and 80% for other highways the requirement for a local share has been waived in this instance under the terms of the Bipartisan Budget Act of 2018, which authorizes 100% Federal share for projects in construction within 2 years of the Hurricane. This covers both emergency and permanent repairs.

A total of $142.5M has so far been allocated to Puerto Rico in respect of damage caused by Hurricanes Irma ($2.5M) and María ($40M on September 27, 2017, followed by another $30M on November 16, 2017, and $70M in April 2018) as ER13 and quick release funds. "Quick release" funds are applied to restoring essential traffic and repairs to bridges, guardrails, traffic signal systems and to address mudslide and flooding damage. An additional $130M has been requested.

In addition, in response to a request from PR DTOP, FHWA received $59.5 million in reimbursable authority from FEMA to assist DTOP in completing emergency repairs to road infrastructure not eligible for Federal aid. FTA Emergency Relief Program (Statute 49 USC, s 5324).

The FTA's program provides grant funding for capital projects to repair, reconstruct or replace transit equipment and facilities which have suffered serious damage as a result of an emergency, or to protect the same if they are in danger of serious damage. Allocation of Emergency Relief is based upon review and validation of preliminary damage assessment.

The federal share is 90% of permanent or emergency repairs incurred more than 270 days after the disaster declaration date. The funds can also be applied to 100% of transit operating costs of evacuation services and temporary emergency service in the area affected by the emergency.

Funding for resilience – including flood protection, covered storage or power line protection – is available with an 80% federal share. These projects can include elements to bring facilities up to a state of good repair.

Costs already reimbursed by FEMA (or other federal agency) are not eligible, and any FEMA PA Grants approved or in progress which relate to transit costs will be transferred to the FTA Emergency Relief Program.

In response to Hurricane María, FTA allocated to Puerto Rico:

- $197.8M for emergency relief; and
- $25.7M for resilience, subject to approval of the program of projects.

Repair costs incurred within 1 year of the disaster do not need to be included in the TIP/STIP, but resilience projects must be.

HUD Community Development Block Grant for Disaster Recovery

HUD awarded a total of $18.44 Billion (B) to Puerto Rico in April 2018 under the CDBG-DR for the purposes of addressing unmet housing needs, economic development, and infrastructure repair (including bridges and roads). Of the total, $10.2B was allocated for meeting remaining 2017 unmet needs, and $8.3B is for mitigation activities designed to limit future damage. A key priority is the resilience of the electrical power supply system which is nominally apportioned $2B within the total.

The CDBG-DR allocation should be read in the context of the Government's preliminary damage estimate of $31.5B (Nov 27, 2017), and its request for $94.4B to rebuild the Island's infrastructure with adequate resilience to cope with future natural disasters[1].

CDBG-DR funds can be applied only to address needs created as a direct result of a disaster, not for general improvements. 80% of these recovery funds must also be spent in the "most impacted" areas.

PRHTA's Fiscal Plan for 2018-2023 (published April 20, 2018) indicates that it intends to target a 0.3% share of these funds, with potential to generate over $50M over 6 years (at a run rate of up to $15M). Given the importance of road infrastructure and public transportation to economic development and access to employment, it is arguable that the potential claim on available funding could be higher. However, it must be recognized the range of competing demands and the modest scale of funding available relative to the assessed needs.

As a prudent assumption, it is assumed that CDBG-DR funds will, as a minimum, be made available to provide local match for FEMA PA grants related to transportation[74].

Liquidity Funds: Treasury Disaster Loans

The U.S. Treasury initially made available $4.9B in disaster loans, although this was subsequently cut back to $2.06B. Terms have been under negotiation since October 2017 and the proposed conditions prevent access to the facility until the PR Government's cash balance falls below $1.1B.

The Treasury has indicated that it expects the loan to be paid ahead of other creditors, with reporting, collateral and security requirements made explicit. Although historically 90-95% of such debt has ultimately been forgiven, there is no guarantee that this precedent will be followed in the case of Puerto Rico.

For the purposes of this review it is assumed that these funds will not be applied to transportation projects.

Disaster Recovery and Emergency Relief

Access to disaster recovery and emergency relief funding requires satisfying strict conditions and making appropriately evidence-based applications. Although the majority of the expenditure on disaster recovery is expected to be covered by a combination of federal funds or insurance, there will be a requirement for some local funding. The gap may be closed by drawing on other Federal allocations but this would effectively imply reduction in funds notionally allocated to capital improvements and addressing the maintenance/renewal backlog.

For the purposes of preparing the 2045 LRTP Financial Plan the disaster recovery components of funding and expenditure over the next 4 years have been treated as ring-fenced. This approach is intended to provide greater clarity around the long-term capital expenditure required to achieve and sustain minimum asset condition thresholds, address the backlog of renewals and fund a prioritized program of enhancements, given the potential availability of funds. See Table 5.2.

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[74] Source: 1. www.aafaf.pr.gov/assets/newfiscalplanforpuerto-rico-2018-04-05.pdf.

Table 5.2: Disaster recovery funding and expenditure FY-2018 - FY2021

		2018 $000	2019 $000	2020 $000	2021 $000	Total $000
Funding						
	Federal Emergency Revenues	175,553	265,565	145,201	55,135	641,454
	Hurricane Loss Assessment - Insurance and FEMA	27,002	54,004	27,002		108,008
	State contribution/transfer	8,498	10,884	4,792	2,484	26,658
	Total funding	**211,053**	**330,453**	**176,995**	**57,619**	**776,120**
Capital Expenditure[1]						
	Federal Emergency Repair Program	175,553	265,565	145,201	55,135	641,454
	Local Emergency Repair Program	6,946	7,780	3,240	2,484	20,450
	Hurricane Loss Assessment - Insurance and FEMA covered	27,002	54,004	27,002		108,008
	Hurricane Loss Assessment - Local Funding Needs	1,552	3,104	1,552		6,208
	Total Capex	**211,053**	**330,453**	**176,995**	**57,619**	**776,120**

1: Including soft costs and matching funds for FEMA ER program
Source: SDG analysis on Disaster Funds data

SOURCES OF FUNDS

Figure 5.2 sets out the outlook for long range funding of operations and capital expenditure.

There are several sources of funds available to the PRHTA:

- Federal Funds;
- State Funds;
- Local Taxes;
- Tolls and farebox income; and
- P3 project Investment

The formal documents that define the shorter-term investment regarding the PRHTA available funds are:

- The Capital Improvement Plan (CIP);
- The Statewide Transportation Improvement Program (STIP); and
- The TAMP.

Federal Funds

FHWA Fixing American Surface Transportation Act (FAST-Act)

As mentioned in Chapter 3; the FAST-Act establishes and funds new programs to support critical transportation projects to ease congestion and facilitate the movement of freight on the Interstate System and other major roads. It requires improvements to the resilience and reliability of the transportation system, storm water mitigation, and enhancements to travel and tourism.

The FAST-Act provides apportioned funding to states/territories for federal-aid highway programs over a 5-year period (at the time FY-2016 through FY-2020). The Highway Trust Fund is the source of funding for most of the programs in the act. However, the FAST-Act also transfers additional funds to the Highways Trust Fund to keep it solvent.

Although Puerto Rico is included in the definition of "state" for most purposes under title 23, it is not eligible to receive funds apportioned among states. Specific authorization for the Puerto Rico Highway Program (PRHP) is provided, with an allocation of $158M annually for fiscal years 2016 through 2020. Penalties are imposed because of the lower minimum drinking age and minimum penalties for repeat offenders due to driving while intoxicated, reducing the available funds to $138.8MM. Section 1115 of the FAST-Act amends the PRHP under 23 U.S.C. 165, which sets out program requirements.

The lump sum payments for each year cover all the apportioned highway programs combined, including pre-defined allocations to:

- National Highway Performance Program (NHPP) [under 23 U.S.C. 119] 50%;
- Highway Safety Improvement Program (HSIP) [under 23 U.S.C. 148] 25%;
- Puerto Rico Highway 25%

Figure 5.2: Funding Sources: Long Range Outlook

Federal programs

Opex

HTA Operations and Maintenance

Toll revenues
- Expected to grow in line with GNP
- Toll rates subject to review
- Toll operations funded directly from electronic fines

Debt Service

Dedicated taxes and licence fees
- Currently subject to clawback by PR Government ✗

HTA Reserves
- Fully utilised, no capacity ✗

Capex

Capital Improvement Program / STIP
Subject to approval by PROMESA

FHWA FAST Act allocation
- Fixed annual allocation (future level post FY20 uncertain)
- 80% funding – local match possible from toll revenue credit
- Funds conditional on project advancement.

Transportation Development Credits
- Formerly toll revenue credits
- Applied to local match

PR Government transfer
- Assumed to cover shortfall, pending end of clawback on taxes

Supplementary sources

Bond issue
- Currently unavailable due to bankruptcy ✗

P3 private sector finance
- Concession options
- Project viability assessment necessary
- May require gap funding

Discretionary: INFRA grant or TIFIA loan
- Subject to competitive process
- Potential use for loan guarantee

Source: SDG analysis

The Federal share of funding for projects is governed by 23 U.S.C. 120. Although generally limited to 80 percent, it can be up to 100 percent in the case of traffic control signalization, pavement marking, commuter carpooling and vanpooling, installation of traffic signs, traffic lights, guardrails, impact attenuators, concrete barrier end treatments, breakaway utility poles, or priority control systems.

Funds are available for obligation for a period of 3 years after the last day of the fiscal year for which the funds are authorized. Any authorized funds that exceed the amount of obligation will be deducted for re-distributed to the States for Surface Transportation Block Grant Program funded projects[75].

A condition of funding is that the grantee demonstrates specific and well defined technical, financial and organizational capabilities. Historically, more than $400MM in available funding was not deployed due to delayed processes for project advancement, project completion and provider payments. PRTHA and FHWA signed a Memorandum of Understanding (MoU) in February 2016 with the objective of implementing enhancements to PRTHA's Project and Program Delivery capabilities.

The default by PRHTA in terms of bond debt obligations could potentially raise questions as to its financial capacity and could put federal funding at risk if the debt restructuring process should breakdown[76].

FHWA Allocation - Asset Management and 10-year Financial Plan

Federal grant funding typically falls into two categories: apportioned and allocated, depending on the manner in which the funds are distributed. The federal aid provided to Puerto Rico is not determined by the standard formula apportionment (which applies to states), but instead by a fixed term allocation.

The FHWA requires a (minimum) 10-year financial plan to be developed which sets out how the authority expects to fund future work and investment as set out in the asset management plan. The plan is to be based on funding levels that can be expected to be "reasonably available" by year, with the planning process required to address the anticipated sources of funding.

The FHWA acknowledges that future funding amounts may be uncertain, and in these circumstances, allows the financial plan to use estimates based on historical values. In the case of apportionment, the potential variance is reasonably limited, with the base allocation to each state typically reflecting their respective share of prior year funding[77]. With a fixed allocation (rather than a formula-based apportionment) it is extremely difficult to predict the future level of funding

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[75] Sources: www.fhwa.dot.gov/fastact/summary.cfm.

www.fhwa.dot.gov/specialfunding/prhp/160224.pdf.

www.aafaf.pr.gov/assets/fiscal-plan---pr-highway-and-transportation-authority.pdf.

[76] Source: www.aafaf.pr.gov/assets/fiscal-plan---pr-highway-and-transportation-authority.pdf.

[77] Initial Transportation Asset Management Plan; April 2018; PRHTA.

beyond the current commitments. The fiscal plan assumes that funding for the period up to 2023 will continue at the current level of $138.8M per year net of penalties.

For the purposes of the 2045 LRTP Financial Plan, it has been assumed that the level of funding will be maintained at its current level in real spending terms. In practice this could imply an uplift of 20% to allow for the surge in construction prices post Hurricane María. Much of this could be covered simply by removing penalties. The available transportation development (toll revenue) credits would be adequate to provide the required 20% local match, allowing projects to be fully federally funded.

Discretionary Federal Loan: Transportation Infrastructure Financing and Innovation Act (TIFIA) Discretionary Federal Loan

The TIFIA loan program was established to provide federal credit assistance to eligible transportation projects. The objective is to provide access to funding for large scale transportation projects which are dependent on user (toll) revenues, but where the future revenue stream is subject to uncertainties which would make alternative financing options expensive.

The FAST-Act authorized $1.43 billion in capital over the five years 2016-20 for the program. Direct loans can be for a period of up to 35 years, with repayments starting up to 5 years after opening, to allow for ramp up. TIFIA can also provide loan guarantees for non-Federal financing. The FAST-Act also authorizes payment of subsidy cost (similar to a commercial bank's loan reserve requirement) of supporting Federal credit.

Given that dynamic toll lanes are already in the spending program, and that other funding sources are potentially committed to achieving a state of good repair and improving resilience, this type of loans could be aimed at supporting P3 projects, although the principal amounts of credit assistance are generally limited to 33% of eligible project costs[78].

Discretionary Federal Grant: INFRA Grants

The Nationally Significant Freight and Highway Projects (NSFHP) program was established by the FAST-Act to provide competitive grants, known as INFRA grants, to support regionally significant highway, bridges and freight projects that align with the program goals which include:

- improving the safety, efficiency, and reliability of the movement of freight and people;
- generating national or regional economic benefits;
- reducing highway congestion and bottlenecks;
- improving connectivity between modes of freight transportation;
- enhancing resiliency of critical highway infrastructure and help protect the environment.

An INFRA grant may not exceed 60% of the total eligible project costs, although a further 20% of project costs may be funded with other Federal assistance.

Of the $1 billion funding available in FY-2020, 90% will be allocated to projects which represent more than 30% of the Federal highway aid apportionment, and 10% for smaller projects (with a

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[78] Sources: www.fhwa.dot.gov/fastact/summary.cfm.

minimum value of $5 million). It is also stipulated that there should be access to additional stable and dependable source(s) of funding and financing to support the construction, maintenance and operation of the project.

PRHTA was unsuccessful in its application for INFRA grants to support several Dynamic Toll Lanes projects in FY-2017-2018. Successful applicants typically sought a smaller percentage grant contribution, but this approach would not be viable given the financial situation of Puerto Rico.

Matching contribution – Toll Transportation Development Credits (Formerly Toll Revenue Credits)

Section 120(i) of Title 23 of the United States Code permits states to substitute certain previous toll-financed investments for state matching on current Federal-aid projects. The non-federal share of a project's cost may be met through a "soft match" of toll credits. This means the federal share can effectively be increased to 100 percent of the total project cost. The credits can be applied for the construction of new infrastructure, or the maintenance or improvement of existing public highways, including those which have received federal-aid funding in the past.

It should be noted that although these credits are often referred to as a source of funding, they do not represent actual available funding. They are typically applied in order to free local funds (which would otherwise need to be committed), allowing the flexibility to fund other transportation projects (which may not themselves be eligible for federal funds), or to support operating costs.

Toll credits may be claimed only for the share of a project's capital expenditures which are supported by toll revenues accruing to a toll authority (public agency or private entity). The allowable credit excludes revenues needed for debt service, returns to investors, or the operation and maintenance of toll facilities.

In addition, an annual maintenance of effort (MOE) test is applied, which must certify that the toll facilities are being properly maintained in the year to which the credit relates before excess revenues can be credited. The actual level of maintenance spend in relation to initial estimates is also monitored and any shortfall will result in a requirement to replace federal funds with local funds on projects where the credit was applied. Future ability to accrue additional credits will therefore depend on meeting the MOE requirements.

The amount of credit earned equals the amount of excess toll revenues spent on Title 23 highway capital improvement projects. However, if federal funds were used for the project which generates the tolls, then the available credit is reduced by the percentage of the total project cost sourced from federal funds, i.e. if 80% of the original project was federally funded, the toll credit is reduced by 80%. Once approved the credit remains available until used.

In the PRHTA Fiscal Plan 2017-2023 it was stated that there was an outstanding balance of $665M toll credits. In Q1 2016, PRHTA validated compliance with FHWA guidance. The use of these credits as matching contributions is estimated at approximately $30M per year based on the

current level of allocated funding, implying potential for these credits to be applied over the next 20 years[79].

Local Taxes Dedicated to Transportation and Government Transfers

The Authority's funding originally included a range of pledged tax and licence revenue streams. However, starting in 2016 these revenues have been subject to government clawback, being used instead to make payments on bonds of the Government Development Bank (GDB), guaranteed by the government. The clawback covers: Gasoline tax; Diesel tax; Petroleum products tax; Vehicle license fees; and Cigarette tax.

However, in Puerto Rico these allocations are not constitutionally dedicated and the funds can be re-purposed by the government, as is the case under the "clawback" arrangement now applied. At the present time there is no end date for the clawback and, as a prudent and conservative approach, it has been assumed that these funds will not be available over the term of the 2045 LRTP.

The net result of the clawback to date is that PRHTA has been unable to make interest or principal payments on bonds, or interest payments due to the former GDB. PRHTA initially continued to make bond payments using reserve funds, but they were unable to do so beginning in July 2017. The result has been PRHTA filing for bankruptcy under Title III of PROMESA.

The clawback has also resulted in an overall shortfall against approved expenditures. To address the shortfall there is expected to be transfer payments from the Commonwealth, amounting to 26% of the clawback in FY-2017-18 but averaging 30% over the term of the current Fiscal Plan and projected to rise to over 40% by FY-2022-23. The advice from DTOP is that this it should be assumed that such transfers will continue at a similar rate after the Fiscal Plan period ends[80].

State Funds Earmarked for Capex

PRHTA has received a one-off appropriation of $75M for capital expenditure from the Central Government. This includes a contribution to local construction and other projects beyond the limit of federal funding. It expects to receive $475M from state funds for matching of federal funds, for maintenance related activities and to cover soft costs (although notionally earmarked for Capex) during the period of the fiscal plan. However, the profile of payments shows a fall from $160M in 2017-18 to $53M in the last two years of the plan[81].

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[79] Sources: www.fhwa.dot.gov/fastact/summary.cfm.

[80] Sources: PRHTA Initial Asset Management Plan, April 2018.

[81] Sources: PRHTA Revised Financial Plan 2018-2023; As certified by the Financial Oversight and Management Board for PR; Revised HTS Fiscal Plan; June 29, 2018.

Toll Rates and Additional Tolling Opportunities

Toll revenues

The level of tolls in Puerto Rico is low in absolute terms but at upper levels in relation to incomes, in comparison to US states (Fiscal Plan 2018 p.49[82]).

Toll revenue estimates included in the Fiscal Plan are based on a tiered catch-up of historical CPI since the last toll raise, plus an average CPI of 1.62% to account for current year(s), over the 5 years to FY2023. Subsequent years assumed tolls would continue to be increased by CPI plus 1.5%. The revenue was expected to contribute $167M in FY2023, up from $120M in FY-2018.

However, plans to increase tolling above CPI have been abandoned, for at least the next five years, as being inconsistent with the public policy of PRHTA and the Government of Puerto Rico. Future increases are now seen as conditional on improving road conditions.

Toll Highway Administration and Maintenance

Toll highway administration and maintenance costs are estimated at around $35M per year. This was largely offset by electronic toll fines in FY-2018, but this contribution is expected to decline to $19M per year subsequently, only partly compensated by rising ancillary revenues (for example, advertising signage). This will leave a cumulative shortfall of around $41M by FY-2023.

Potential for Additional Tolling

Federal law limits the imposition of tolls on existing highways which have been built or maintained using federal funds. Tolls can be imposed for single occupant use of HOV lanes or with the objective of congestion pricing. In other circumstances, tolls can only be levied on existing roads following reconstruction (e.g. for capacity expansion or other improvements).

If the authority certifies that the facility is being adequately maintained, and generating sufficient revenue to pay for operations, the surplus can be applied to contribute to the cost of other highway activities or support public transportation operations, provided that the application would not be in violation of the authority's bond covenants.

The fiscal plan includes a $5M contribution up to FY-2023 but opportunities may be limited unless the approach included ways to protect residents with no other access routes.

P3 Project Investment

Encouraging private sector capital investment would appear to offer a means of implementing projects whilst minimising the dependence on government funding. The Puerto Rico Government is proposing to further strengthen the P3 legal framework to facilitate critical infrastructure investments.

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[82] PRHTA Revised Financial Plan 2018-2023; As certified by the Financial Oversight and Management Board for PR; Revised HTS Fiscal Plan; June 29, 2018.

The P3 Authority is focused on developing critical infrastructure projects, and unsolicited private sector proposals can be submitted. The success of toll road concessions for PR-22 and PR-5 would appear to provide a successful precedent. Current priority projects in development include a concession to modernise, operate and maintain government-owned parking facilities.

New Projects

Any investor in a P3 will have expectations of a return over the duration of a concession, either from user fees or availability or service fees payable by PRHTA or the PR Government. A complicating factor is that there is considerable uncertainty associated with forecasts of future usage of any infrastructure, given the outlook for the macro-economic environment and a decline in population through continued net migration.

At the same time, PRHTA is unlikely to be able to provide cast iron assurances with regard to providing either a minimum revenue guarantee or making availability and service payments without access to additional funds. The Government is equally unlikely to be able to offer such guarantees as a backstop given other demands on its finite resources. Similarly, there may be concern about the ability of PRHTA to fund the construction or maintenance of essential related infrastructure (e.g. roads which feed or distribute traffic using the tolled facilities).

The potential return for investors could be improved by an upfront government contribution to offset capital costs. This might be recovered in the longer term by a revenue sharing mechanism. In these circumstances, it may be possible to apply for a discretionary TIFIA loan with appropriate grace period (during construction) and a 35-year repayment term, as discussed earlier. The credit contribution from a TIFIA loan is typically limited to 33% of eligible project costs which may prove a significant constraint, given the relatively low levels of revenue generated by potential highway projects identified by PRHTA.

In these circumstances, the potential to secure P3 investment is likely to be a binary option, depending on whether an application for a TIFIA loan is granted (or not). Given the time required to make an application, and for its evaluation, it is suggested that any associated projects cannot begin before FY2024.

P3 Covering Existing Assets

The option of transferring existing highway infrastructure assets with a proven history of toll revenue generation is subject to uncertainty in view of the associated direct loss of a revenue stream supporting PRHTA's activities, and because of potential competing claims to the associated cash flow from PRHTA's creditors. However, there would be more certainty if the proposed transactions and associated asset transfers as part of a P3 were to be included in a fiscal plan certified by the PROMESA Board.

Capital Improvement Program (CIP)

The Fiscal Plan approved and certified by the Financial Oversight and Management Board (FOMB) on June 29, 2018 covers anticipated revenues and capital and operating spending through to FY-2023. It includes completion of current projects and a projected level of transfers from the Government, in addition to state funds already earmarked for capex.

The construction program reflects the Capital Improvement Program (CIP) budget produced by PRHTA. The projected "steady state" run rate of $261.8MM in hard costs per year, which reflects the level of spending deemed necessary to keep the National Highway System (NHS) and Interstate system in a state of good repair compliant with federal standards, but only a minimal level of intervention on non-NHS roads. An average of $129.6M is allocated to pavement works, $85.5M to bridges, $33.5M to safety and $13.2M to traffic signalling (in 2018 USD).

The implied breakdown by highway classification is shown in Table 5.3.

Table 5.3: Notional Allocation of CIP Budget by Highway Classification

Highway classification	Lane-kms	Anticipated spend per annum $M	Equivalent spend/km $000
Toll roads	874	35	40.0
Primary roads	2225	32	14.4
Urban Primary	2052	29	14.1
Secondary	5936	61	10.3
Tertiary	8049	85	10.6
All highways	19136	242	12.6

Source: Based original CIP budget of $242MM (the validated version of CIP totals $262MM and includes a higher allocation to bridges with reduction in funds for pavements and safety).

Transportation Asset Management Plan (TAMP)

The TAMP is designed to provide a comprehensive management program to address the backlog of pavements and bridges in poor condition, bringing them up to standards which meet FHWA targets and sustaining a state of good repair.

Development of TAMP is a federally mandated requirement: failure to produce a plan would have resulted in substantial penalties, increasing the local match for use of Federal funds.

In view of the expected levels of available financing, PRHTA is only seeking to meet the minimum standards for pavements and bridges. Even before Hurricane María, the condition of interstate pavements was well below target, and bridges close to the maximum permitted level in poor condition as shown in Table 5.4.

Table 5.4: Target Standards and Actual Condition (Pre-María)

	Poor condition - FHWA target	Poor condition - PRHTA target	Poor condition - actual (2016)
Interstate Pavement	<5%		16.2% (19.4% lane miles)
Non-Interstate NHS Pavement		<20%	7.4% measured (+12.9% non-measured)
NHS Bridges (by deck area)	<10%		9.5%

Source: PRHTA Initial Asset Management Plan, April 2018

Failure to meet the standards over 2 consecutive years for pavements (and 3 years for bridges) will lead to penalties which are likely to restrict the potential obligation of NHPP and STP funds,

forcing their allocation to remedial works to bridges and pavements. The reality is that PRHTA expects to take over 10 years to bring the interstate pavements up to standard, and is already proposing to allocate all the available federal funds in this manner, plus meeting the obligation with respect to the funding allocation to safety projects.

The backlog of highway pavement work is estimated at $185M for interstates and $342M for NHS.

A number of scenarios were considered as part of the TAMP, reflecting more or less aggressive strategies for the replacement, rehabilitation and renewal of assets, from an unconstrained budget case with a 5-year time horizon, through to less expensive, longer term options intended to allow an alternative distribution of available finance. All cases imply a higher level of spending than historic levels, and spending will peak before reverting to a level necessary to sustain steady state condition.

The TAMP did not settle on any scenario, as it needed to align with the CIP, which was not yet accepted at the TAMP date of publication (April 2018).

For bridge works TAMP Scenario 5 (Table 7.5) was applied for the purposes of the financial plan, reflecting the "preferred" scenario which spent the allocation in the fiscal plan as quickly as reasonably possible, starting with light rehabilitation and allowing time to develop more ambitious projects. Within this total, the allocation to non-NHS bridges follows TAMP Scenario 4 (Table 7.10). For pavements, the profile of spending followed the balanced scenario set out in PRHTA 2019-2028 Capital Improvement Program Validation (June 22, 2018) report.

Allocation of Funds - Highways

Illustrative Allocation of Funds: State of Good Repair (SGR)

The 2045 LRTP assumes that the first priority, post disaster recovery, will be to meet federal targets for the interstate and NHS bridges. Failure to meet the targets will, in any case, oblige all Federal funding would be directed towards these efforts. The assume spending profile is based on PRHTA's "balanced" scenarios, which seek to apply a realistic approach to a ramp up of work. 25% of the available FHWA funds also need to be committed to safety projects. See Table 5.5.

There are sufficient toll revenue credits available as local match over the next 20 years, so the available level of federal funding should not be available in full, irrespective of the level of local contribution. However, the level of funding currently provided by FHWA is below the level of expenditure required to deliver the state of good repair (SGR) program over the next 10 years. This means there will be a continuing need for Government of Puerto Rico to transfer funds to balance the books, beyond the period covered by the present fiscal plan.

Illustrative Allocation of Funds: Highways, Bridges

Post-2028 there is expected to be a levelling off in expenditure on SGR for interstate and NHS pavements, and reduction in allocation to NHS bridges, assuming the catch-up is largely completed. However, the initial funding allocation had a minimal allocation to the non-NHS network, which also faces a substantial renewal backlog. It is envisaged that an increase of 25% in the allocation to non-NHS pavements and bridges is likely to be required, as a minimum, going forward.

In overall terms, the allocation to interstate and NHS highways and bridges is projected to continue at around $128M per year in real terms, which is above the notionally available FHWA funding of $102M (after deducting the $37M which must be allocated to safety measures). A continuing level of state contributions is therefore inevitable if SGR targets are to be met.

Any additional capex on non-SGR projects is going to depend on the ability of the government to either relax the clawback on taxes/license fees, or willingness to continue to make funds available via a transfer payment.

As an illustrative case, a prioritized list of capex projects has been developed, with estimated start dates, indicative timeline (1-5 years depending on project scope) and cost profiles to arrive at a broadly even rate of annual spend. Expenditure on safety related projects, bike and pedestrian interventions and resilience studies was excluded, as these are assumed to be covered by specific allocations from within the FHWA budget.

The net result is project spending in the immediate post Fiscal Plan period FY 2024-2028, rising from $10M in 2025 to $20M by 2028. Spending is then assumed to ramp up to an average of $25M per year through to 2045. This illustrative scenario implies transfers from Government at a broadly consistent rate of $200M per year in real terms (2018 prices) through to the end of the LRTP, which is less than half of the amount of clawback of taxes and fees. It should be noted that the affordability of priority projects is based on cost estimates at 2018 prices with 20% inflation, and makes no allowance for further cost inflation.

Source and Allocation of Capital: Highways FY-2018-2028

Table 5.6 sets out the anticipated level of funding and capital expenditure during the period of the current fiscal plan (to FY-2023) and the following 5 years, based on the TAMP balanced scenarios to achieve target state of good repair.

Source and Allocation of Capital: Highways Projections FY-2029-2045

Table 5.7 sets out the anticipated level of funding and capital expenditure in the period FY-2029 to FY-2045, assuming continued expenditure to sustain SGR on interstates and NHS, and start to address the backlog on non-NHS highways. Modest levels of funding are allocated to identified priority projects. It is recognized that there is potential for some slippage in the planned timeline for project start and completion, particularly in view of construction community capacity and resource constraints.

Table 5.5: State of Good Repair and Safety Project FY-2019-2028 – Balanced Scenario (Costs in $000)

	FY	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate Pavement Asphalt	SGR	14,228	6,693	6,693	66,93	6,693	6,693	30,681	30,681	30,681	30,681
Interstate Pavement Concrete	SGR	16,940	16,613	3,271	44,171	44,171	44,171	44,171	44,171	27,416	27,416
NHS Pavement Asphalt	SGR	53,758	53,233	51,152	51,152	51,152	51,152	28,685	28,685	28,685	28,685
NHS Pavement Concrete	SGR	12,610	16,058	12,611	12,611	12,611	12,611	2,205	2,205	2,205	2,205
Non-NHS Pavement	SGR	28,784	30,238	28,396	28,396	28,396	28,396	28,396	28,396	35,209	35,209
All Pavement		126,320	122,835	102,123	143,023	143,023	143,023	134,138	134,138	124,196	124,196
NHS Bridges (Scen 5-Scen 4 non-NHS)	SGR	10,000	28,000	26,000	41,000	61,000	52,000	52,000	52,000	52,000	52,000
Non-NHS Bridges (TAMP Table 7.10, Scenario 4)	SGR	17,000	17,000	24,000	24,000	24,000	34,000	34,000	34,000	34,000	34,000
All Bridges (TAMP Table 7.5, Scenario 5)	SGR	27,000	45,000	50,000	65,000	85,000	86,000	86,000	86,000	86,000	86,000
TAMP - Interstate and NHS Pavements & Bridges	SGR	107,536	120,597	99,727	155,627	175,627	166,627	157,742	157,742	140,987	140,987
TAMP - Non-Interstate Pavements & Bridges	SGR	55,784	75,238	78,396	93,396	113,396	114,396	114,396	114,396	121,209	121,209
Traffic signals	SGR				13,229	13,229	13,229	13,229	13,229	13,229	13,229
Safety projects					36,649	36,649	36,649	36,649	36,649	36,649	36,649
Total		**163,320**	**195,835**	**178,123**	**298,901**	**338,901**	**330,901**	**322,016**	**322,016**	**312,074**	**312,074**

Source: PRHTA 2019-2028 Capital Improvement Program Validation (June 22, 2018)

Table 5.6: Highways – Source and Application of Funds 2018-2028 (All Figures in $000 at 2018 Prices)

		FY	Fiscal Plan 2018	2019	2020	2021	2022	2023	TAMP scenarios (balanced) 2024	2025	2026	2027	2028
Funding sources													
	FWHA - after penalty		132,766	401,926	313,922	168,768	138830	138,830	138,830	138,830	138,830	138,830	138,830
	State Funds Earmarked for Capex		159,963	82,073	67,334	59,067	53020	53,761					
	Transfer from PR Govt (balancing item)		31,288			109,898	145075	144,031	203,253	194,368	203,253	203,768	206,368
	Total Capex Funding - Highways		**324,017**	**483,999**	**381,256**	**337,733**	**336925**	**336,622**	**345,198**	**344,256**	**342,344**	**323,256**	**323,256**
Capital Expenditure													
FHWA	FHWA Construction Spend		95,768	340,801	255,567	140,769	120009	117,156					
	FHWA Construction Soft Costs		36,260	51,315	49,614	22,967	18821	21,674					
	FWHA Capex projects												
	FHWA contribution to SGR Pavements & Bridges								102,181	102,181	102,181	102,181	102,181
	FHWA Safety projects (based on req funding allocation)								36,649	36,649	36,649	36,649	36,649
State	Non-Federal Construction Projects		111,750	20,796	27,606	129,169	152734	152,734					
	Non-Federal Construction Soft Costs		14,153	6,800	6,481	22,556	24989	24,686					
	Construction Local		23,160	9,190	9,190	9,190	9190	9,190					
	State Capex projects												
	State contribution to Interstate and NHS SGR								64,446	64,446	55,561	55,561	38,806
	State contribution to non-NHS SGR								114,396	114,396	114,396	121,209	121,209
	Prioritized highways projects (excl safety)											9,400	12,000
	Traffic signals SGR								13,229	13,229	13,229	13,229	13,229
	Design		23,000	7,769	10,716	7,882	7882	7,882	7,882	7,882	7,882	7,882	7,882
	Right of Way		3,300	3,300	3,300	3,300	3300	3,300	3,300	3,300	3,300	3,300	3,300
	Right of Way Payments		16,626	12,736	7,068	1,900							
	Total Capital Expenditure - Highways		**324,017**	**452,707**	**369,542**	**337,733**	**336925**	**336,622**	**342,083**	**342,598**	**345,198**	**344,256**	**342,344**

Source: SDG analysis

Table 5.7: Highways – Source and Application of Funds 2029-2045 (All Figures in $000 at 2018 Prices)

		Projections											Average year
		2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040-45
Funds													
	FWHA - after penalty	138,830	138,830	138,830	138,830	138830	138,830	138,830	138,830	138,830	138,830	138,830	138,830
	State Funds Earmarked for Capex												
	Transfer from PR Govt allocated to Capex (balancing item)	195,962	198,557	198,208	200,448	203,686	198,870	203,284	200,237	197,416	199,167	204,597	201,798
	Total Capex Funding - Highways	334,792	337,387	337,038	339,278	342,516	337,700	342,114	339,067	336,246	337,997	343,427	340,628
Capital Expenditure													
FHWA	FHWA Construction Spend												
	FHWA Construction Soft Costs												
	FWHA Capex projects												
	FHWA contribution to SGR Pavements & Bridges	102,181	102,181	102,181	102,181	102181	102,181	102,181	102,181	102,181	102,181	102,181	102,181
	FHWA Safety projects (based on req funding allocation)	36,649	36,649	36,649	36,649	36649	36,649	36,649	36,649	36,649	36,649	36,649	36,649
State	Non-Federal Construction Projects												
	Non-Federal Construction Soft Costs												
	Construction Local												
	State Capex projects												
	State contribution to Interstate and NHS SGR	25,806	25,806	25,806	25,806	25,806	25,806	25,806	25,806	25,806	25,806	25,806	25,806
	State contribution to non-NHS SGR	125,511	125,511	125,511	125,511	125,511	125,511	125,511	125,511	125,511	125,511	125,511	125,511
	Prioritized highways projects (excl safety)	20,234	22,829	22,480	24,720	27,958	23,141	27,556	24,509	21,687	23,439	28,868	26,069
	Traffic signals SGR	13,229	13,229	13,229	13,229	13,229	13,229	13,229	13,229	13,229	13,229	13,229	13,229
	Design	7,882	7,882	7,882	7,882	7,882	7,882	7,882	7,882	7,882	7,882	7,882	7,882
	Right of Way	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300
	Right of Way Payments												
	Total Capital Expenditure - Highways	334,792	337,387	337,038	339,278	342,516	337,700	342,114	339,067	336,246	337,997	343,427	340,628

Source: SDG analysis

Transit Funds and Capex

Transit capital funding comes principally through the FTA 5339 allocation for bus and bus facilities. The associated capex can therefore be treated separately from highway expenditures. See Table 5.8

A series of service expansion projects are envisaged with associated investment in buses, route infrastructure and terminal facilities. The level of expenditure is presented in five-year intervals from the end of the current Fiscal Plan.

There also needs to be continued investment in renewal of the existing fleet and refurbishment of facilities.

Table 5.8: Transit – Source and Application of Funds (All Figures in $000 at 2018 Prices)

			Fiscal Plan						Projections		
		FY	2018	2019	2020	2021	2022	2023	2024-2028	2029-2033	2034-2038
Funds											
FTA 5339 funds (bus & bus facilities + statewide allocation)			4,890	5,007	5,124	5,000	5,000	5,000	25,000	25,000	25,000
FTA additional capex funding allocation (disaster recovery)			45,110	44,994	44,876						
	Total		**50,000**	**50,000**	**50,000**	**5,000**	**5,000**	**5,000**	**25,000**	**25,000**	**25,000**
Capital Expenditure											
Transit CIP			31,000	50,000	50,000	5,000	5,000	5,000			
Transit Prioritized projects (service expansion)									15,797	14,362	5,859
Other fleet renewal and SGR									9,203	10,638	19,141
	Total		**31,000**	**50,000**	**50,000**	**5,000**	**5,000**	**5,000**	**25,000**	**25,000**	**25,000**

Source: SDG analysis

CAPITAL COST ESTIMATES

Context

A list of potential projects for inclusion in the LRTP was prepared based on:

- Needs of the Municipalities to comply with their land use and transport plans;
- Existing projects requiring further investments; and
- Projects included in 2040 LRTP that are in the pipeline.

As explained earlier, the list of potential projects was analysed based on the priorities defined for the Goals and Objectives of this 2045 LRTP. The projects were then ranked (the methodology applied is described in Appendix H). The project identification and ranking process were discussed in detail with the Technical Committee and the leadership of the PRHTA.

Approach

Capital costs were calculated for each individual investment being considered, reflecting the key project characteristics regarding the scope and scale of the project (for example, the extent and length of highway widening).

The project phasing was based on the combination of rankings with the expected availability of funds, and the combination of anticipated construction periods and assumed spread of costs by construction year. Projects were added up to the level of funding assumed be available in each year.

Source Data

Project Details

A wide range of projects have been included in the LRTP, covering investments in the following categories:

- Operations;
- Reconstruction;
- Technologies;
- Improvements;
- Capacity Increases;
- New Construction;
- Congestion Management; and
- Preservation.

In each case, information is provided including a description of the project, and key statistics regarding the scale and scope of the project.

Costs

Estimated costs associated with the project metrics have been developed based on:

- Estimates of capital costs associated with projects included within the PRHTA Capital Improvement Program (CIP) database, June 2017;

- Costs associated with project metrics included within the PRHTA Initial Transportation Asset Management Plan (TAMP), April 2018;
- Unit costs associated with project metrics included within the PRHTA 2019-2028 Capital Improvement Program Validation report, June 22, 2018;
- Estimates of capital costs associated with projects included within the State-wide Transportation Improvement Program (STIP), Fiscal Years 2017-2020, Amendment #2 report, February 23, 2018.

The reference costs are intended to reflect latest estimates at 2018 prices, allowing for 20% cost inflation, post Hurricane María, which reflects the combination of a relatively small Island, limited construction community and rapid increase in demand for services. Full project cost tables are included in Appendix H.

6   CHAPTER 6 2045 PLAN

This chapter presents the 2045 LRTP. It is divided into 2 main sections that include the conclusion of the scenarios analysis, the definition of project priorities and the modelling results for the future 2045:

1.   Tested Scenarios:

   a.   Freight Network Extension;
   b.   Transit Service Extension;
   c.   Roadway Network Vulnerability Assessment; and
   d.   Bottleneck Analysis.

2.   Cost Feasibility Plan Scenarios:

   a.   Transportation Funding Summary; and
   b.   2045 Models.

TESTED SCENARIOS

As part of the development of this 2045 LRTP, 4 scenarios were analyzed based on the planning approach discussed earlier. These scenarios are:

- Freight network extension;
- Transit service extension;
- Roadway network vulnerability assessment; and
- Bottle neck identification.

The results from these scenarios are discussed in more detail in the next sub-sections.

Freight Network Extension

The planning factors include the priority of Increasing accessibility and mobility of freight and the integration and connectivity of the transportation system, across and between modes, for people and freight.

Based on this planning factor, the 2045 LRTP model was tested considering an extended truck network system defined beyond the FHWA network presented in Figure 6.1; the map represents suggested key freight network roads based on inputs from the Freight Advisory Committee

meetings with cargo movement experts as part of the engagement process of this Plan. This scheme includes access to/from port zones and major cargo mobility areas as well as the completion of the strategic roadway system based on the results of the Freight Advisory Committee meetings discussions. Table 6.1 and Table 6.2 list the new freight corridors and other roadways that were coded as freight corridors within the Island-wide model. This analysis was performed with the travel demands under the condition of 2016 population and employment.

Table 6.1: New Freight Corridors

Name	Distance (mile)	Facility Type
PR-22 Extension to Aguadilla	27.63	Freeway
PR-53 Extension Patillas to Maunabo	8.38	Freeway
PR-2 convert to Freeway	17.83	Freeway
PR-10 Extension	4.52	Principal Art
PR-53 Extension from Humacao and Maunabo	3.54	Freeway

Source: SDG analysis of freight scenario

Table 6.2: Improved Freight Corridors

Name	MPO
PR-2	Aguadilla
PR-111	Aguadilla/North
PR-129	Aguadilla/North
PR-106/PR-120	Southwest/Aguadilla
PR-137	San Juan
PR-155	San Juan
PR-142	San Juan
PR-839/PR-861	San Juan
PR-5	San Juan
PR-28	San Juan
PR-21	San Juan
PR-172	San Juan
PR-1	San Juan
PR-14	San Juan
PR-143	South/San Juan
PR-140	North

Source: SDG analysis of freight scenario

Figure 6.1: Freight Networks
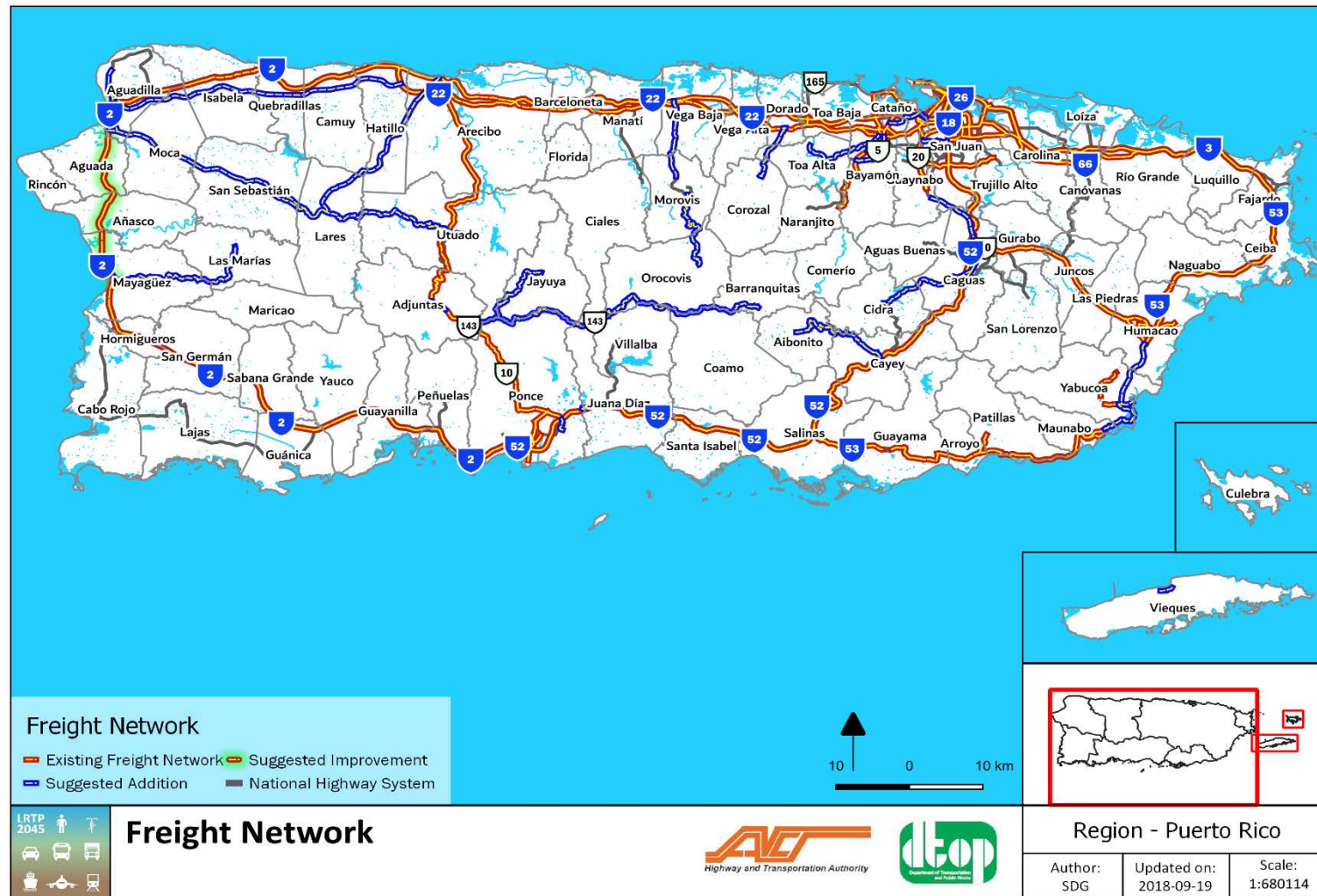
Source: The existing Freight Network information layer was obtained form the Federal Highway Administration (FHWA)

Presented in Table 6.3 through Table 6.5, the results statistics were compared to the 2016 base condition, namely the Base Case. The Base Case can be described as, which is the 2016 population and employment operating on the 2016 transportation system. Because of some major freight network improvements in the Aguadilla TMA, the overall truck vehicle mile traveled (VMT) and truck vehicle hours traveled (VHT) increased by 8.5% and 2.8%, respectively. In 2016, Aguadilla TMA does not have any roadway segments that belongs to the FHWA defined freeway or principal arterial categories. Proposed in this scenario, the PR-22 extension will add approximately 27 miles of freeway between the existing PR-22 to PR-2, and the PR-2 will be converted to freeway to facilitate freight movement. Therefore, the truck vehicle mile traveled (VMTs) and truck vehicle hours traveled (VHTs) on freeways have minor significantly increases from the Base Case, while VMTs and VHTs on the expressways slightly decreased. Since some expressway and minor arterials are converted into the freight corridor and upgraded to freeways or principal arterials, the truck VMTs and VHTs increased significantly notably on the principal arterials, while decreased on the expressway and minor arterials. The speeds are increased in the Aguadilla TMA in the freight scenario.

As presented in Table 6.5, the improvements of freight network result in faster travel speeds in Aguadilla TMA. At the same time a marginal decrease of hours that traveler spend on the road is observed.

As expected, no material changes in terms of cost or accessibility are seen with the introduction of the freight scenario. The most significant benefit that results from this proposal is an optimized distribution of trucks on roadways; according to Table 6.3 and Table 6.4, freight related vehicles are moving from minor, local roads to those offering better and most suitable capacity as expressways and major arterials. It is likely that this spreading of heavy traffic could result on positive effects on other road users, result in better LOS, more reliable travel times and ideally, improved road safety. Not all of these effects are reflected in previously mentioned statistics.

Table 6.3: Truck VMT by Vehicle Class and by Road Type

	Medium Truck			Heavy Truck			Total Truck		
	Base Case	Freight Scenario	% Change	Base Case	Freight Scenario	% Change	Base Case	Freight Scenario	% Change
Freeway	0	38,295		0	11,979		0	50,274	
Expressway	37,802	18,079	(52.2%)	14,533	10,023	(31.0%)	52,335	28,102	(46.3%)
Principal Arterial	0	22,026		0	8,200		0	30,225	
Minor Arterial	65,537	44,422	(32.2%)	25,033	17,229	(31.2%)	90,571	61,651	(31.9%)
Ramps	171	780	356.7%	63	176	179.3%	234	956	309.0%
Local Roads	92,162	88,714	(3.7%)	29,010	27,415	(5.5%)	121,172	116,128	(4.2%)
Total	**195,673**	**212,317**	**8.5%**	**68,639**	**75,021**	**9.3%**	**264,312**	**287,337**	**8.7%**

Source: SDG on PRHTA Island-wide Model

Table 6.4: Truck VHT by Vehicle Class and by Road Type

	Medium Truck			Heavy Truck			Total Truck		
	Base Case	Freight Scenario	% Change	Base Case	Freight Scenario	% Change	Base Case	Freight Scenario	% Change
Freeway	0	1,032	-	0	344	-	0	1,376	-
Expressway	1,264	541	(57.2%)	485	296	(39.0%)	1,749	837	(52.1%)
Principal Arterial	0	820	-	0	306	-	0	1,126	-
Minor Arterial	2,478	1,652	(33.3%)	952	645	(32.2%)	3,430	2,297	(33.0%)
Ramps	6	28	352.5%	2	7	182.0%	9	35	306.3%
Local Roads	3,494	3,373	(3.5%)	1,100	1,043	(5.2%)	4,594	4,416	(3.9%)
Total	**7,242**	**7,447**	**2.8%**	**2,539**	**2,641**	**4.0%**	**9,782**	**10,087**	**3.1%**

Source: SDG on PRHTA Island-wide Model

Table 6.5: Aguadilla TMA Measures of Effectiveness for Freight Scenario

Measures of Effectiveness	Base Case	Freight Scenario	% Change (Freight vs. Base)
System Performance			
Average network speed (mph)	26.9	28.5	5.9%
Total transit passengers per route mile	31.0	31.6	1.7%
% non-motorized trips	2.8%	2.7%	(0.8%)
% transit trips	1.5%	1.5%	4.1%
Average highway trip cost	$1.48	$1.52	2.5%
Average transit trip cost	$1.98	$2.03	2.8%
% Population within 0.5-mile walk to transit	3.5%	3.5%	0.0%
% Employment with 0.5-mile walk to transit	28.4%	28.4%	0.0%
Vehicles hours of delay	17,101	19,715	15.3%
Vehicle hours of travel/1000 vehicle miles of travel	37.1	35.0	(5.6%)
VMT above capacity	48,579	124,867	157.0%
Speed on limited access roads and expressways	30.0	37.1	23.6%
Gallons of fuel consumed[83]	279,696	295,478	5.6%
System Usage			
Vehicle miles of travel	6,460,976	6,825,543	5.6%
Vehicle hours of travel	239,842	239,159	(0.3%)
Average network speed	26.9	28.5	5.9%
Person trips	756,290	756,125	0.0%
Vehicular trips[84]	591,724	592,095	0.1%
Truck trips3[85]	25,449	25,373	(0.3%)

Source: SDG analysis of freight scenario on PRHTA Island-wide Model

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[83] Gallons of fuel consumed were calculated using AAA miles per gallon in 2016 at 23.1 mpg.

[84] Vehicle trips exclude commercial vehicles, medium trucks and heavy trucks.

[85] Truck trips include medium trucks and heavy trucks.

Transit Service Extension

The planning factors include the priority of enhancing the integration and connectivity of the transportation system, across and between modes, for people and freight; the goals and objectives of the 2045 LRTP consistently indicate the importance of accessibility, connectivity, mode choice. Considering the importance of strengthening the local transit services in Puerto Rico, multiple scenarios were tested using the Island-wide model.

Two sets of transit scenarios were undertaken under the 2016 travel demand situation. One scenario looked at the impacts of introducing a Caguas BRT connecting between Caguas and San Juan along PR-52. The other scenario tested an enhanced San Juan local bus network together with the Caguas BRT route. Since these transit network improvements are largely within San Juan TMA, the impacts on the performance measures in Aguadilla are minimal (presented in Table 6.6).

Table 6.6: Summary of Transit Scenarios in Aguadilla TMA.

Measures of Effectiveness	Base Case	BRT Service	% Change (BRT vs. Base)	BRT + Local Bus Service	% Change (BRT + Local vs. Base)
System Performance					
Average network speed (mph)	26.9	27.0	0.1%	26.9	0.0%
Total transit passengers per route mile	31.0	31.0	0.0%	31.0	0.0%
% non-motorized trips	2.8%	2.8%	0.0%	2.8%	0.0%
% transit trips	1.5%	1.5%	0.0%	1.5%	0.0%
Average highway trip cost	$1.48	$1.48	0.0%	$1.48	0.0%
Average transit trip cost	$1.98	$1.98	0.0%	$1.98	0.0%
% Population within 0.5-mile walk to transit	3.5%	3.5%	0.0%	3.5%	0.0%
% Employment with 0.5-mile walk to transit	28.4%	28.4%	0.0%	28.4%	0.0%
Vehicles hours of delay	17,101	16,978	(0.7%)	17,038	(0.4%)
Vehicle hours of travel/1000 vehicle miles of travel	37.1	37.1	(0.1%)	37.1	0.0%
VMT above capacity	48,579	47,492	(2.2%)	46,100	(5.1%)
Speed on limited access roads and expressways	30.0	30.0	0.1%	30.0	0.0%
Gallons of fuel consumed	279,696	279,717	0.0%	279,698	0.0%
System Usage					
Vehicle miles of travel	6,460,976	6,461,472	0.0%	6,461,019	0.0%
Vehicle hours of travel	239,842	239,733	0.0%	239,774	0.0%
Average network speed	26.9	27.0	0.1%	26.9	0.0%
Person trips	756,290	756,289	0.0%	756,285	0.0%
Vehicular trips	591,724	591,723	0.0%	591,718	0.0%
Truck trips	25,449	25,450	0.0%	25,450	0.0%

Source: SDG analysis of transit scenarios on PRHTA Island-wide Mode

Roadway Network Vulnerability Assessment

Resilience Component for The Long-Range Transportation Plan

Due to its location, Puerto Rico is highly exposed to hurricanes passing by the Island every year usually between July and November. The hurricane season is characterized by heavy rain, high-velocity winds and storm surge, causing flooding and landslides in different areas of the Island. However, the extent of damage varies depending on different variables such as track, intensity, size, forward speed of the hurricane, geotechnical conditions of each area, land elevation, etc. Additionally, hurricane season presents different characteristics each year, for example shifts in track, as presented in Figure 6.2 and Figure 6.3, duration and intensity as it can be seen by the dispersion in the historical average shown in Figure 6.4.

Figure 6.2: Puerto Rico Hurricane Map
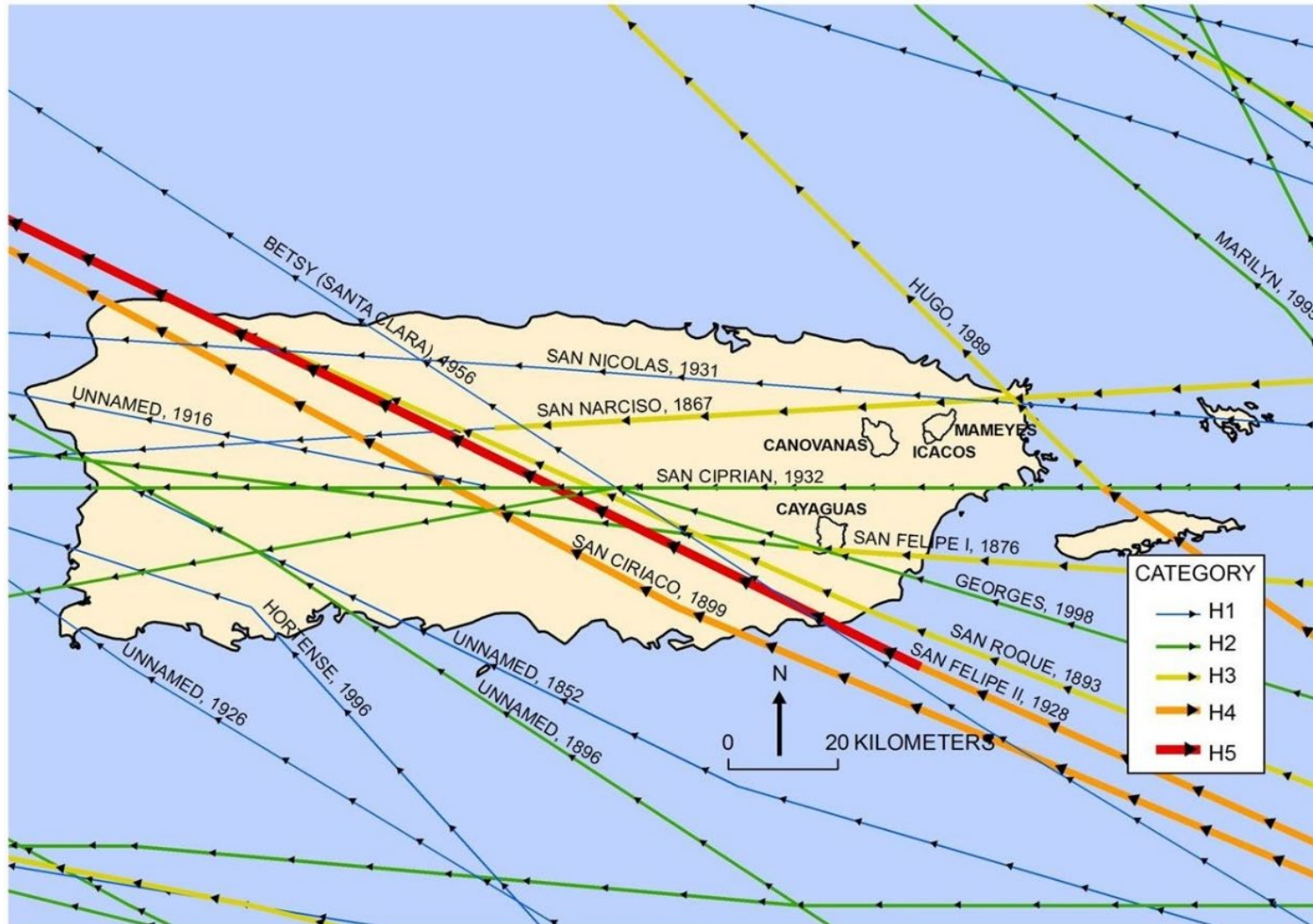
Source: USGS, Puerto Rico Hurricanes Map, 2018. https://www.usgs.gov/media/images/puerto-rico-hurricanes-map

Figure 6.3: Hurricane María Best Track
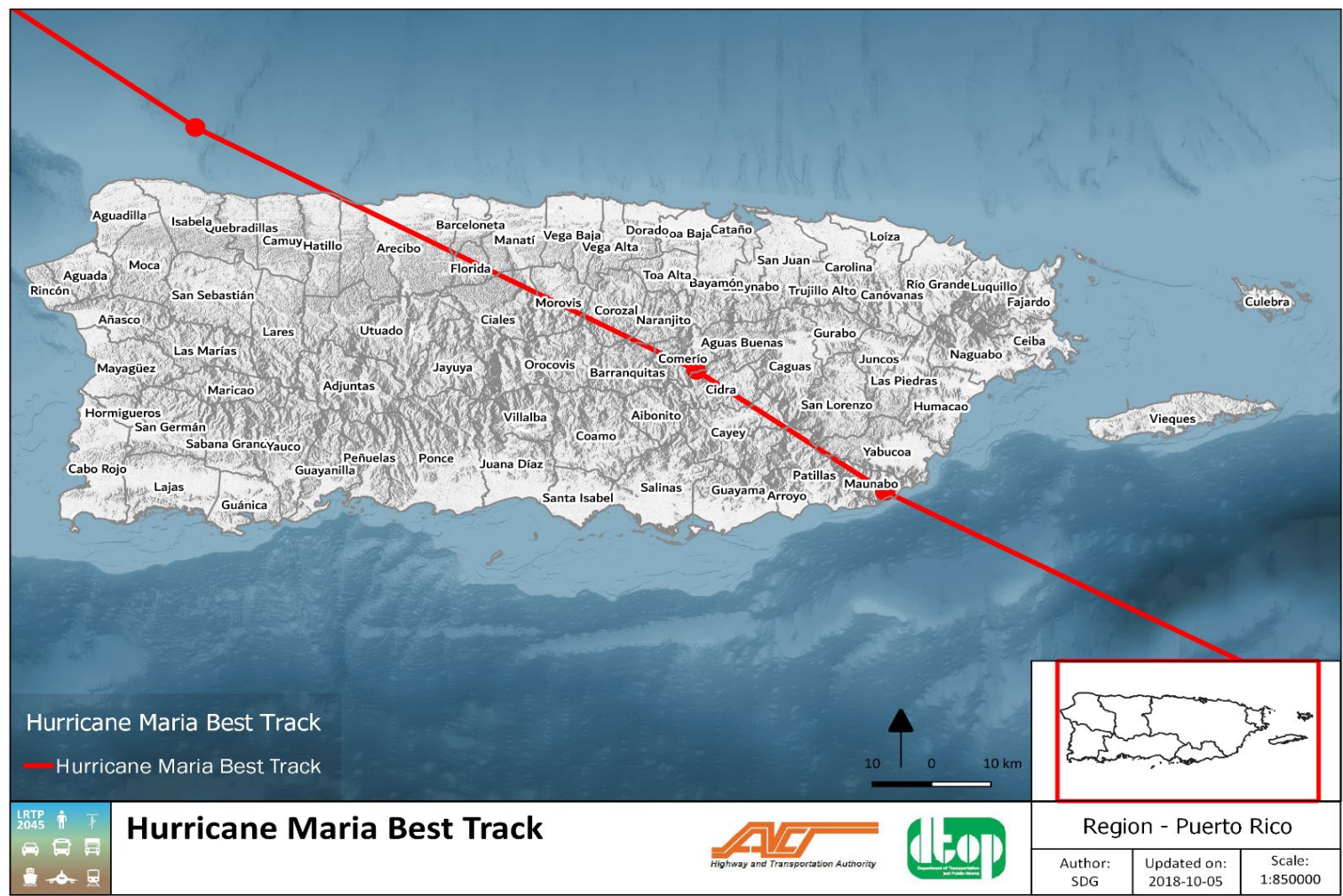
Source: SDG based on information from the National Hurricane Center. Hurricane Maria Best Track obtained from: https://www.nhc.noaa.gov/data/tcr/index.php?season=2017&basin=atl

Figure 6.4: Historical Monthly Precipitations (1981-2010) – All Stations
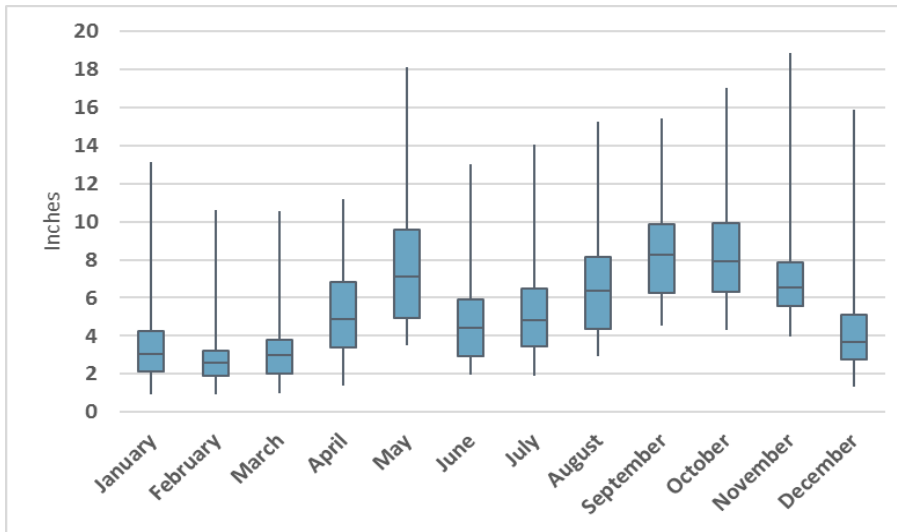
Source: SDG based on historical data in (National Weather Service, 2017)

The 2017 hurricane season was particularly intense, with two consecutive storms striking the Island, Hurricane Irma and Hurricane María, the latter being the worst to hit Puerto Rico in over 80 years and the third costliest hurricane in United States history[86]. In terms of infrastructure, the electric power system, communication system and water supply system were left without service.

The transportation network did not suffer to the same extent as other infrastructure systems, however many roads were affected either by floods, landslides or storm surge, as it can be seen in Figure 6.6. The highest structural damage in the transportation system was in bridges, where river flooding due to rainfall caused total or partial failure.

The 2017 hurricane season in Puerto Rico follows the trend of climate-related events becoming more frequent and/or more intense. Therefore, incorporation of resilience and vulnerability of infrastructure systems into planning is paramount. In the following sections a vulnerability analysis for the transportation network is carried out following the vulnerability assessment and adaptation framework of the U.S. Department of Transportation[87].

[86] Richard J. Pasch, 2018.

[87] Federal Highway Administration, 2017.

Figure 6.5: Affected roads by María Hurricane
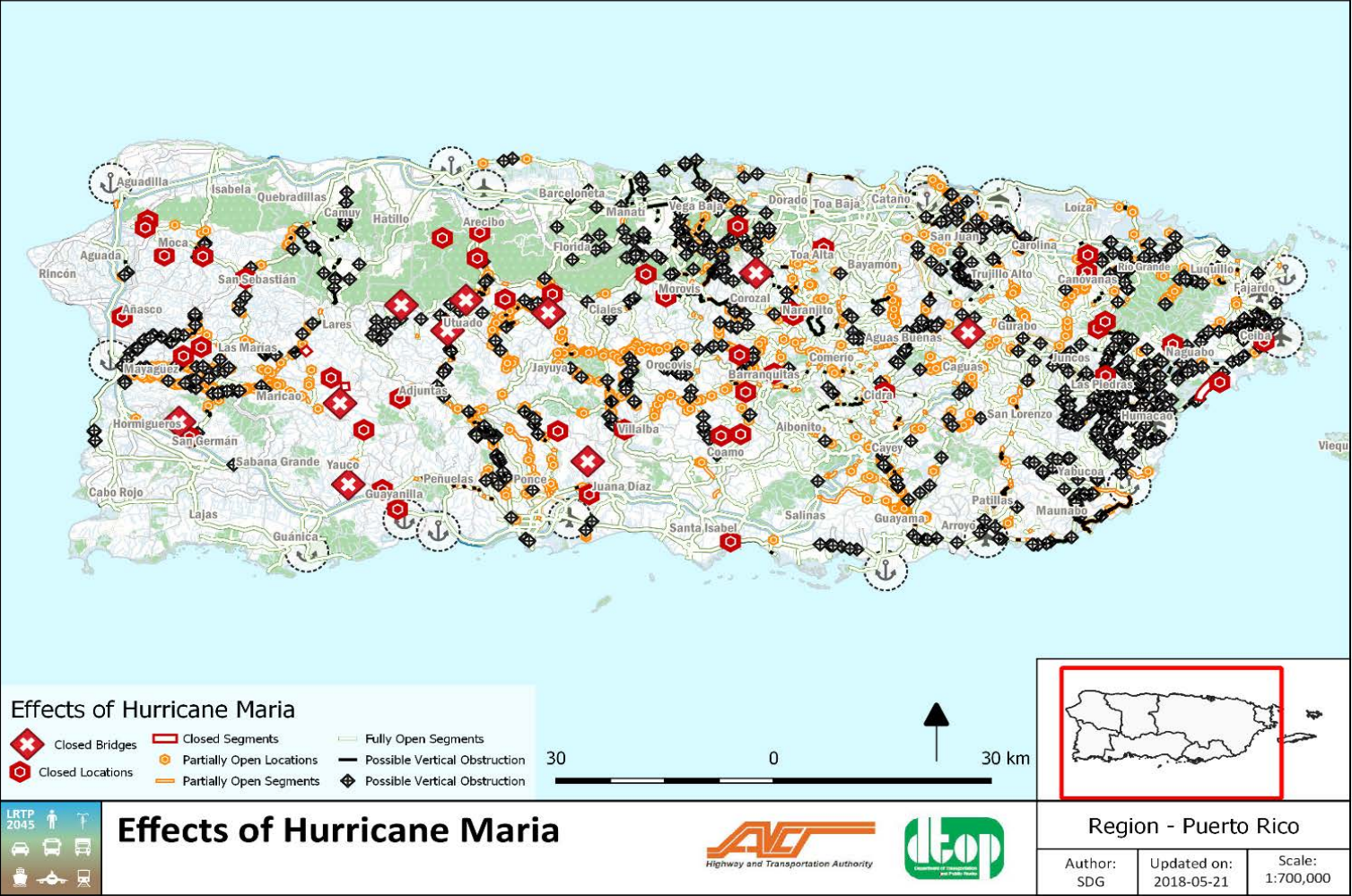
Source: Hurricane Maria impacts were geolocated with the aid of information obtained from multiple meetings with the Highway and Transportation Authority Regional Directors during the first quarter of 2018.

Figure 6.6: Examples Of effects of Hurricane María on the roadway network

Source: Federal Highway Authority, 2018

Vulnerability Analysis Methodology

According to PROAG, 2014 vulnerability is defined as "*the degree to which a system, or part of it, may react adversely during the occurrence of a hazardous event*", therefore, vulnerability analysis includes: a characterization of the system, its response to a hazard and, the "likelihood of occurrence" of such hazard. As it can be seen, this is a broad concept that involves different aspects of interaction between hazard and infrastructure.

On the other hand, resilience is a more specific characterization of a system and complements vulnerability in the context of hazard management and climate change. It can be defined as "(The systems') ability to reduce both the magnitude and duration of a deviation (caused by a disruptive event) as efficiently as possible to its usual targeted system performance levels"[88]. Incorporation of resilience policies into transportation planning allows a long-range improvement of the system's response to a hazard, which is part of the system's vulnerability.

In concordance with these definitions, the FHWA in 2017 released a Vulnerability Assessment and Adaptation Framework for carrying out vulnerability analysis in transportation infrastructure. The framework includes a five-step process:

1. Definition of objectives and scope
2. Data compilation
3. Vulnerability assessment
4. Analysis of adaptation options
5. Incorporation of results into decision-making

A description of each step is included in Appendix I. A complete explanation and examples are available within the framework's document.

Objective and Scope

The vulnerability assessment is a component of the 2045 LRTP of Puerto Rico and as a result of the plan's time horizon the vulnerability assessment is limited to a system-level decision-making context. Furthermore, the transportation infrastructure that can be analyzed from a system-level perspective is limited to roads, which are relevant for emergency response, distribution of goods and connectivity of municipalities.

The incorporation of a vulnerability assessment component into 2045 LRTP was mainly triggered by the devastating effects of Hurricane María into the transportation infrastructure. Therefore, in terms of climate variables, this study focuses in hurricane-related hazards. It explicitly excludes other hazards such as earthquakes though they are also present in the Island.

As previously mentioned, hurricanes are characterized by high-speed winds, rain and storm surge. These features while not generally direct threats to roads pose a major hazard as they trigger landslides and floods. Specifically, rainfall is the most common trigger for both hazards. Large volumes of precipitations over a short period increases water levels in rivers, lakes and any other bodies of water leading to overflows that when combined with uneven topography lead to floods.

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[88] Taken from PROAG, 2014.

Additionally, the accumulation of water in soil may result in landslides. This is especially dangerous in soil that is highly susceptible to landslides. As a result, the vulnerability assessment is mainly focused on the variables related to floods and landslides.

The key climate variables identified for this analysis are:

1. Landslides in Hurricane María
2. Flooding data
3. Weather stations
4. Rainfall historic data
5. Slope
6. River map
7. Land use
8. Susceptibility to landslides
9. Infrastructure damage due to Hurricane María
10. Coastal floods

Regarding infrastructure, a stakeholders-input methodology was sought (see Appendix I for details) and through a series of workshops with several participants, 49 segments were identified as the most critical assets, as seen in Figure 6.7. The vulnerability assessment focused on identifying the vulnerability components of these facilities.

Figure 6.7: Relevant Segments Identified by Stakeholders
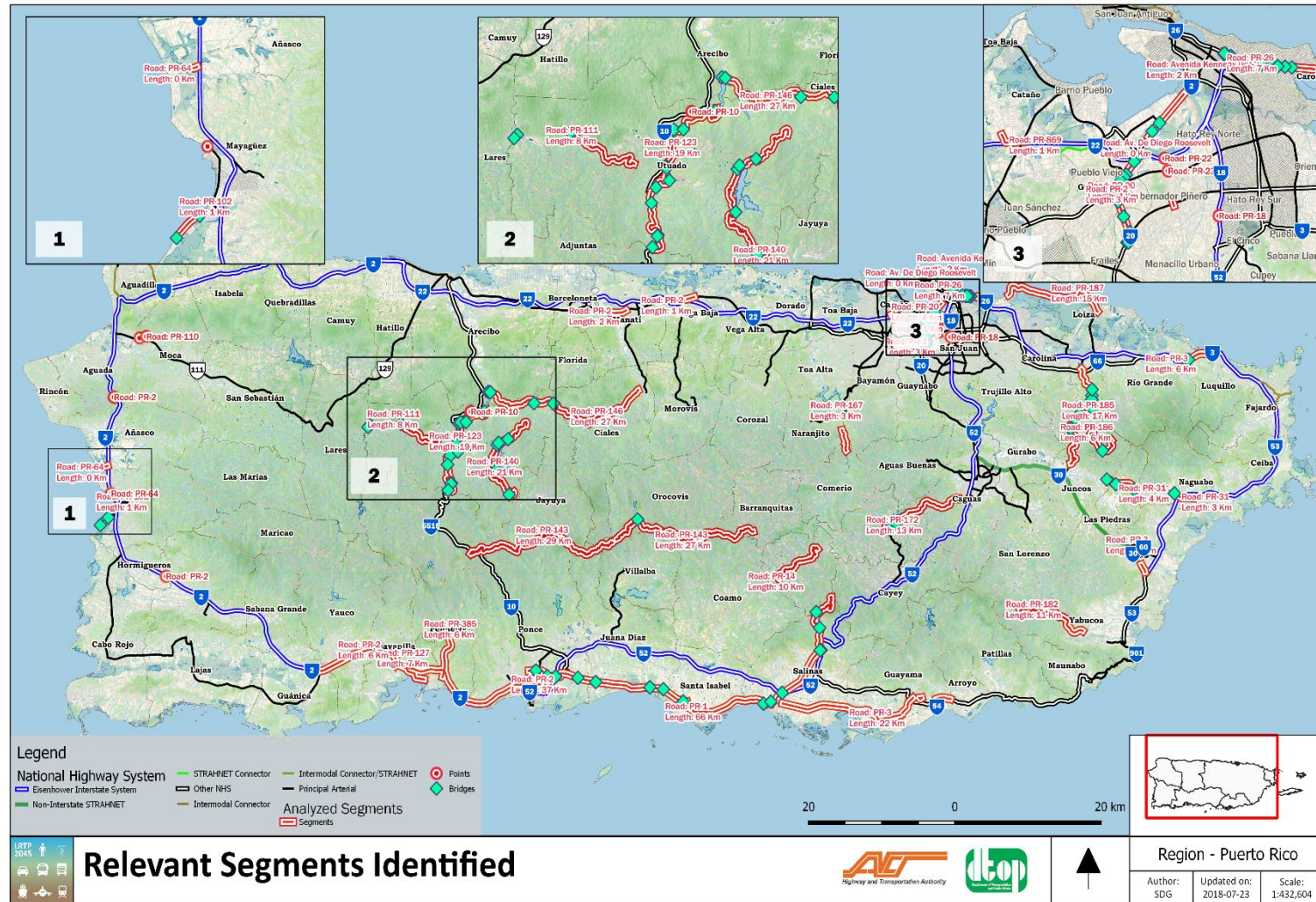
Vulnerability Assessment

According to the FHWA vulnerability can be expressed in terms of: Exposure, Sensitivity, and Adaptive capacity. Exposure is the representation of hazard and can be obtained from the hazard maps and hazard information available. Sensitivity should reflect the asset's state and resistance to failure; this information is represented mainly by stakeholder input. Finally, Adaptive capacity is a system-level indicator and can be calculated from data given by the transportation model. Figure 6.8 summarizes the three components of the vulnerability assessment.

Figure 6.8: Components of vulnerability
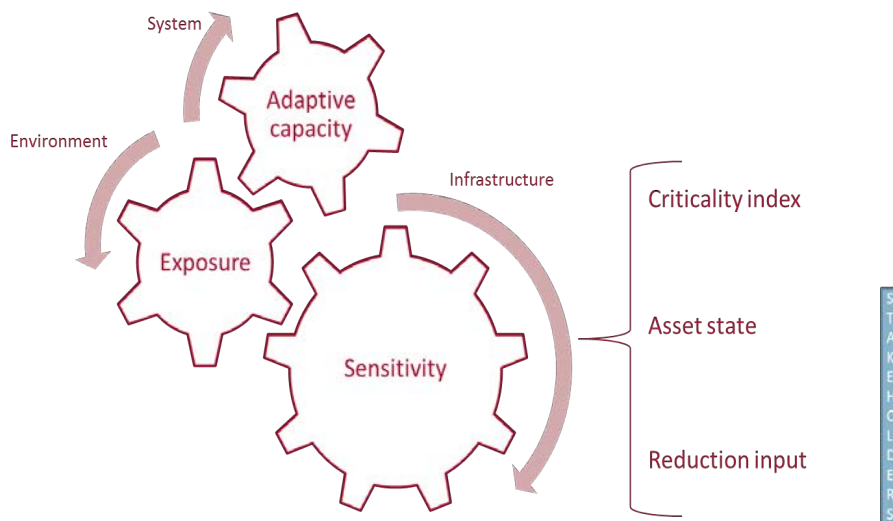
Source: SDG

The following sections explain the procedure to calculate each component of the vulnerability assessment for the 2045 LRTP.

Exposure

- Trigger: Rainfall

As the precipitation levels are not constant over the year, neither periodical between years, due to climate change, it is paramount to examine multiple hazard scenarios. For this analysis three scenarios were defined according to their corresponding level of hazard to reflect an average scenario, a critical scenario and the worst-case scenario (from historical data). The three categories, from minimum to maximum are (all in inches per day):

1. Average scenario: Corresponds to the average annual precipitation for Puerto Rico obtained from an historical data in a 1981 to 2010 period[89]
2. Intensive scenario: Corresponds to the cumulative precipitation of the months with the higher levels of rainfall during the 1981 – 2010 period: September, October and November[90].

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[89] National Weather Service, 2017.

3. Hurricane María scenario: Corresponds to the precipitation levels estimated during the Hurricane María, obtained from a 48-hour total data from September 19 to 21, 2017[90].

The precipitation data for each weather station was georeferenced and using an inverse distance weighted (IDW) process, the precipitations level for the entire Island were obtained (the resulting maps and detailed procedure is explained in Appendix I for details).

- Floods

The flood hazard is based on precipitation levels and the flood zones identified by FEMA's Flood Insurance Rate Map (FIRM). Rainfall is the critical trigger for the occurrences of flooding. Therefore, each of the rainfall scenarios were intersected with the FIRM layer, resulting in three flood hazard scenarios, as seen in Figure 6.9 through.

These maps show the level of flood hazard for each area in Puerto Rico, joining the exposure of flood (i.e., FIRM map) with the amount of water in each scenario. Each area is susceptible to flooding according to flooding data from FEMA and the severity of the flooding is obtained from the rainfall scenario that is being evaluated.

The coastal flood maps were adapted from the coastal flood frequency produced by the National Oceanic and Atmospheric Administration (NOAA, 2017), in which the potential impact associated with coastal flood advisories for the 3 ft. and 6t. sea level rise were obtained; the resulting hazard map is shown in Figure 6.12.

- Landslides

The landslide analysis was based on the creation of a model that can model the landslides that occurred during Hurricane María, using the listed variables as triggers:

- Slope;
- Proximity to rivers: Binary variable that indicates if within a unit of analysis (100m X 100m) there is a relevant water body;
- Land use data: Categorical variable indicating the areas of each land use classification;
- Landslide susceptible zones from the Planning Board: Categorical variable that indicate the level of susceptibility for a landslide event ranging from 1 (the lowest susceptibility) to 4 (the highest susceptibility); and
- Precipitation levels for Hurricane María and Average seasons in inches.

A binomial logistic regression model was used to predict the concentration of landslides for the Hurricane María rainfall scenario. The accuracy obtained with this model was 0.741 (see Appendix I for details), which corresponds to a fair error rate given the scope of this study. After this model was developed, the precipitation levels were changed to the average rainfall scenario and a second landslide hazard map (i.e., concentration of landslides) was obtained, as shown in Figure 6.13 and Figure 6.14.

Figure 6.9: Hurricane María Average Flood Hazard
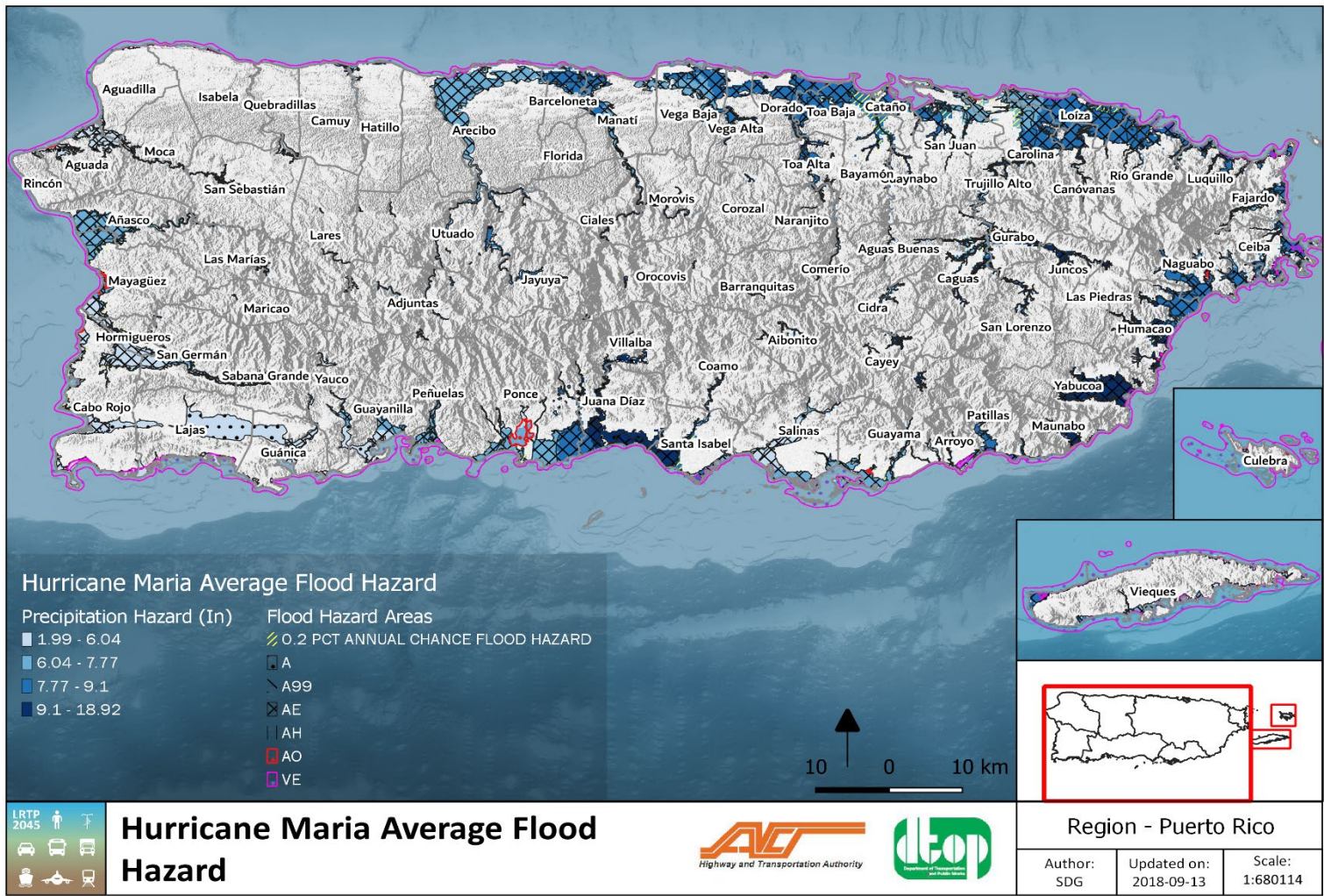
Source: SDG based on information from the National Weather Service

Figure 6.10: Intensive Flood Hazard
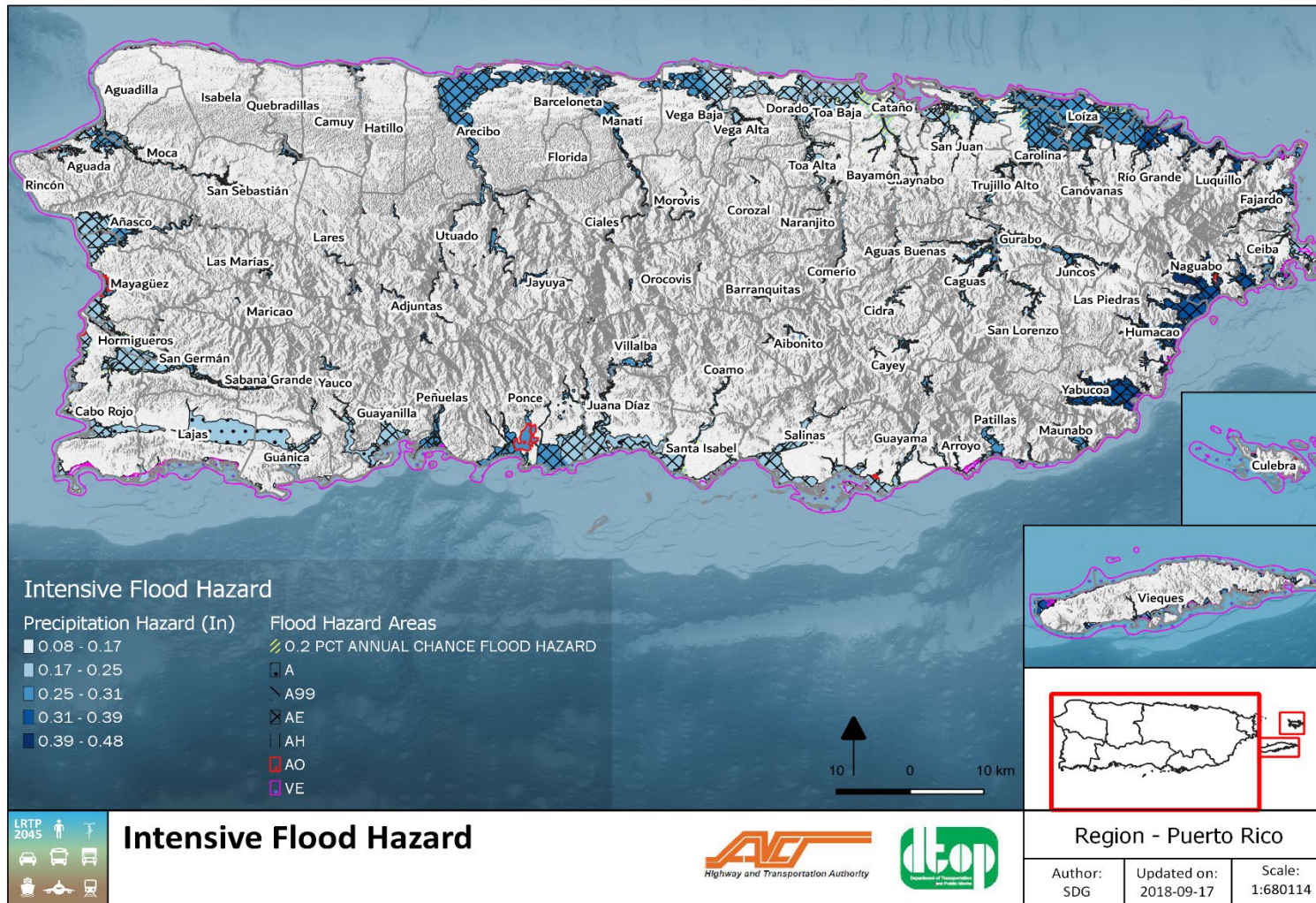
Figure 6.11: Average Flood Hazard

Average Flood Hazard

Precipitation Hazard (In)
- 0.08 - 0.17
- 0.17 - 0.25
- 0.25 - 0.31
- 0.31 - 0.39
- 0.39 - 0.48

Flood Hazard Areas
- 0.2 PCT ANNUAL CHANCE FLOOD HAZARD
- A
- A99
- AE
- AH
- AO
- VE

Average Flood Hazard

Region - Puerto Rico

Author:	Updated on:	Scale:
SDG	2018-09-13	1:680114
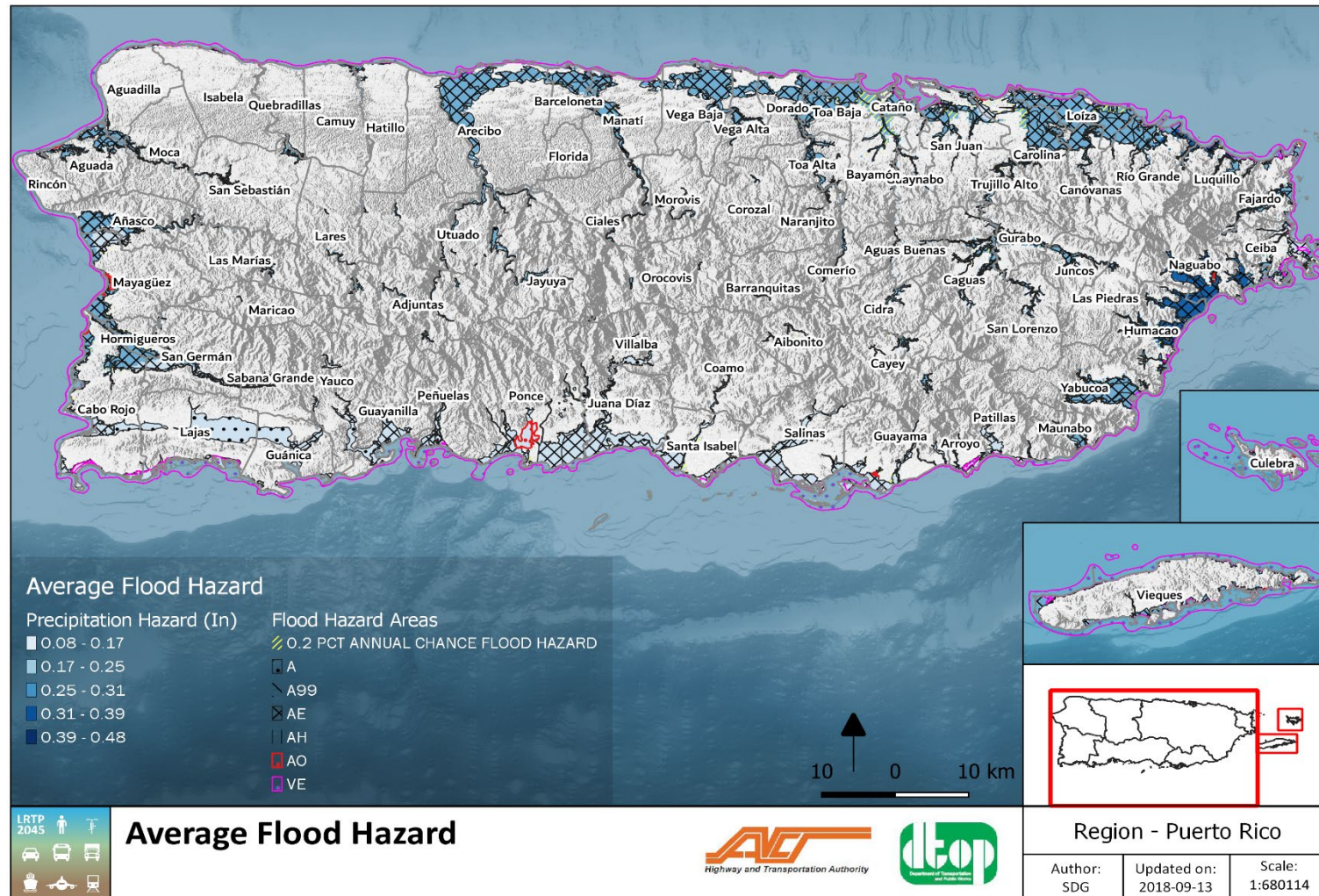
Source: SDG based on information from the National Weather Service

Figure 6.12: Coastal Flood Hazard Map

NOAA Coastal Flood Hazard
- 3 - 6 Feet
- 6 Feet
- Hydrography

NOAA Coastal Flood Hazard

Region - Puerto Rico

Author:	Updated on:	Scale:
SDG	2018-09-13	1:680114
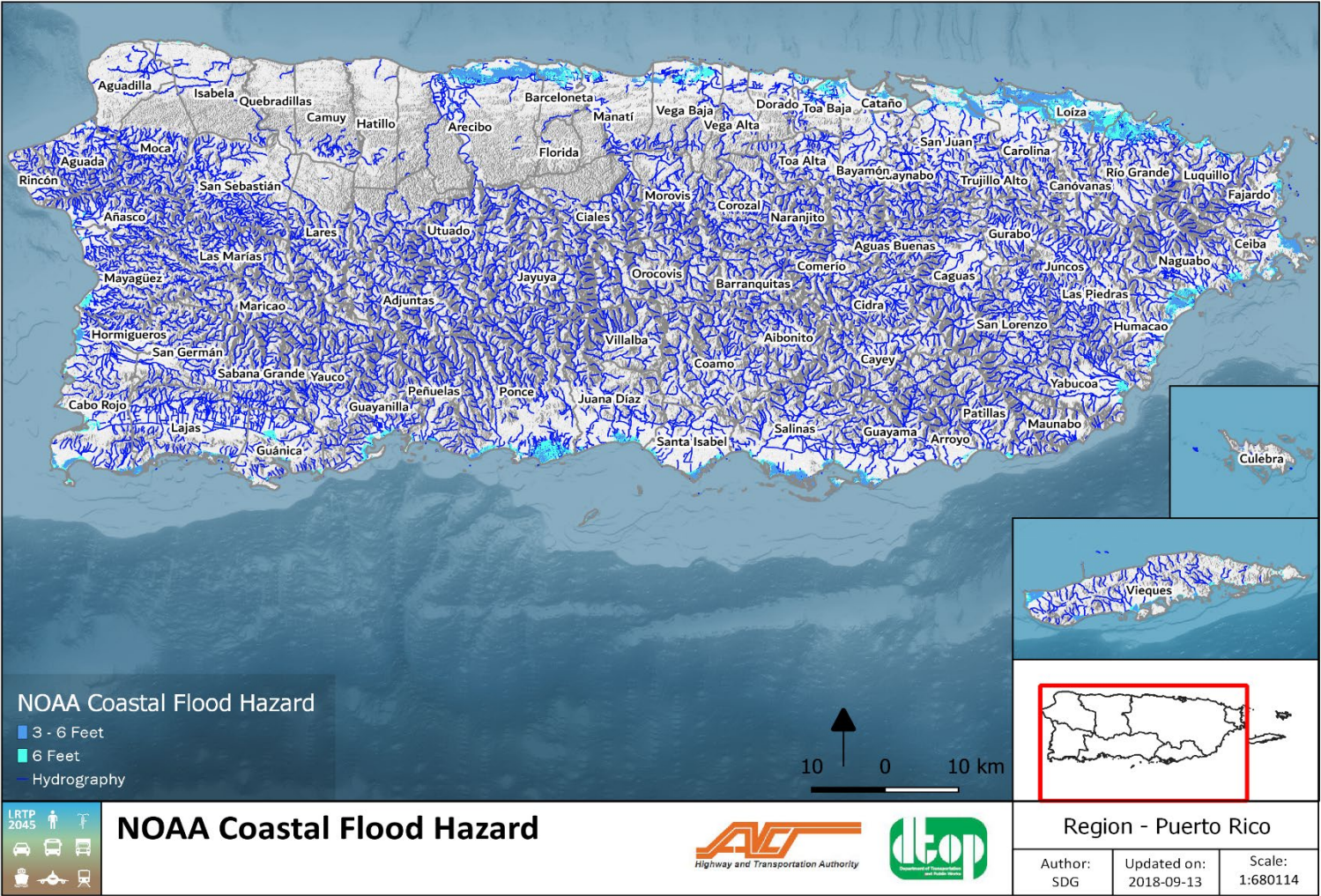
Source: SDG based on the National Oceanic and Atmospheric Administration information.

Figure 6.13: Hurricane María Predicted Landslides
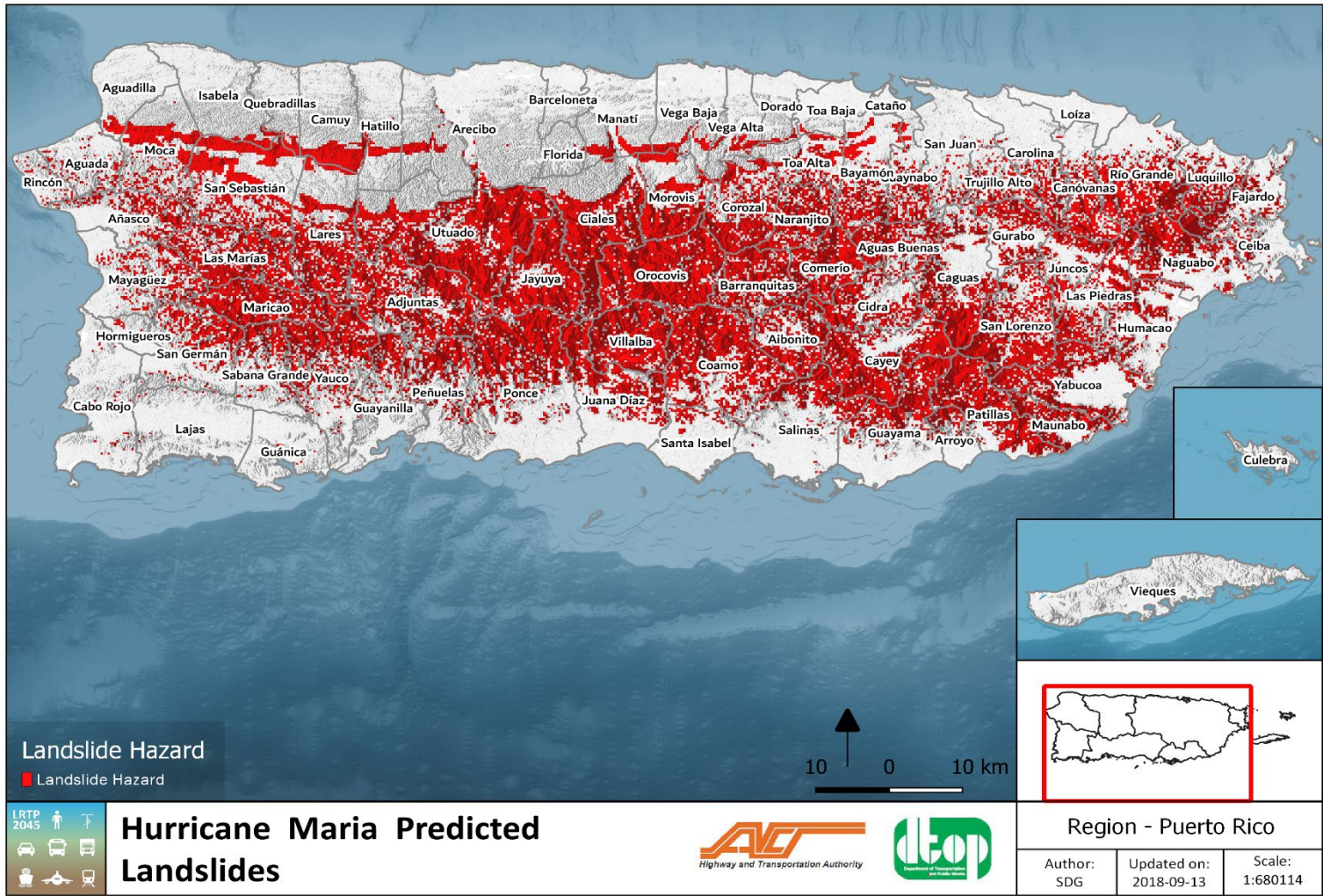
Source: SDG

Source: SDG

Figure 6.14: Average Predicted Landslides
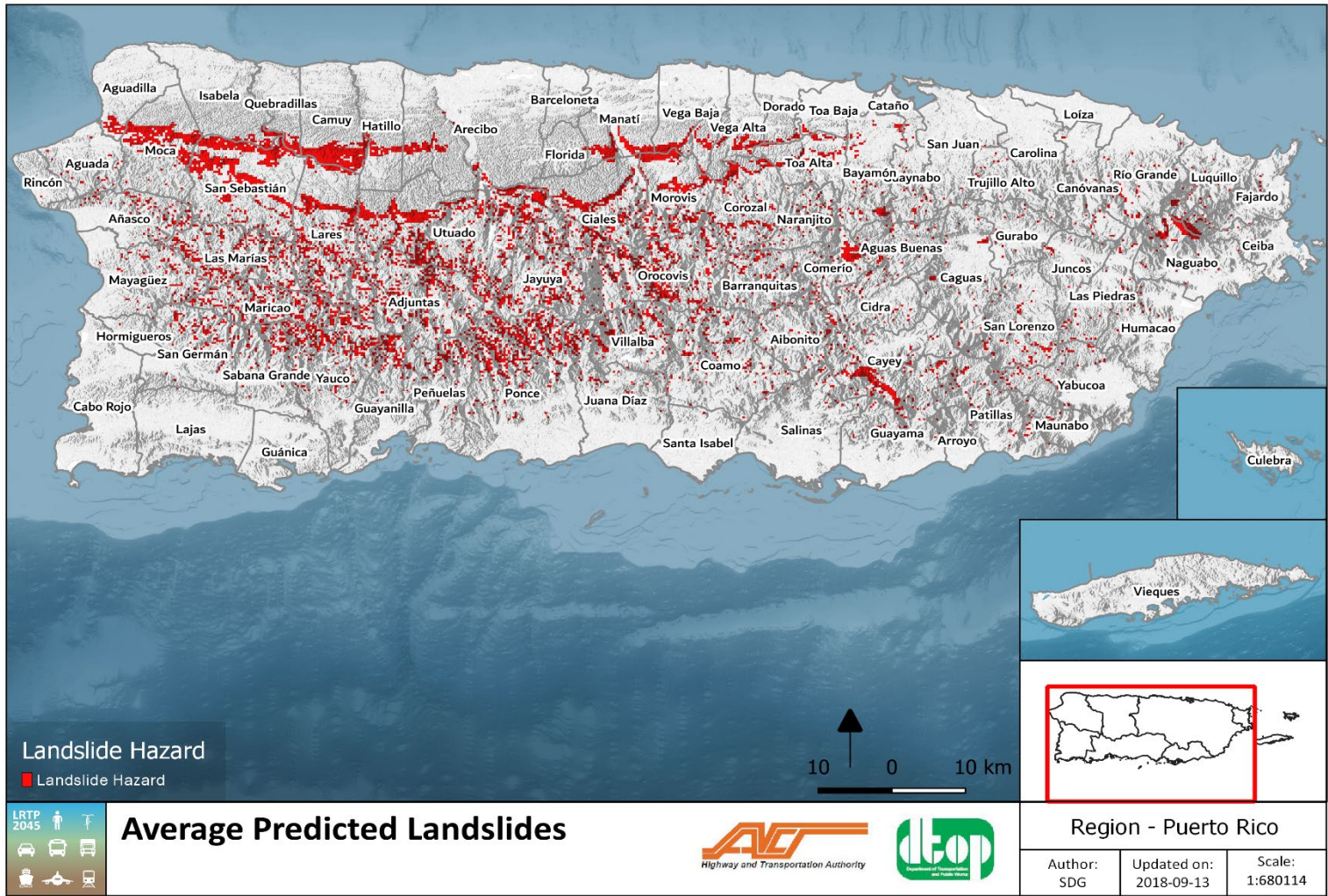
Sensitivity

According to FHWA, Sensitivity is defined as "how the asset or system fares when exposed to a climate variable". The response of the asset to certain climate variables can be expressed in terms of the probability of certain magnitudes of failure, given some magnitude of hazard. Since the scope of this analysis is not to characterize each segment of road in the Puerto Rico transportation system, but to give a broad assessment regarding vulnerability, this probability of failure will be broken down into three components: frequency of failure, magnitude of failure and criticality index.

For each segment analyzed. frequency of failure provides insights regarding asset state and where the segment is in its lifecycle. Typically, towards the end of design life, assets tend to have higher maintenance costs as their failure rate increases. Therefore, this measure, even in a qualitative scale, give a sense on the general state of the infrastructure.

The magnitude of failure provides information regarding how well the asset withstands a disturbance due to a climate event. The failure can be a result of the original design, where resistance to the identified hazard was not strongly included, or it might be related to the age of the asset, and it continuous exposure to the hazard. In most cases, this measure provides an insight on how the asset is affected each time it interacts with the hazard.

Finally, a criticality index is included in the study as a measure of the level of use of each analyzed segment and its importance in the overall network This allows the measure to differentiate between two assets in terms of how significant they are in terms of the networks dynamics. This index is developed for every link of the transportation network and was also used as part of the Adaptive Capacity analysis.

For each identified asset, stakeholders provided input in terms of frequency of failure and magnitude of failure. This data was transformed into a score between 1 and 5 depending on the level of each response. These two scores are averaged with the criticality index and for each asset a final score is given (see Appendix I for details).

Adaptive Capacity

The final component of the vulnerability analysis is the Adaptive Capacity analysis. This is a system-level measure and aims at measuring how a failure in one element of the system reflects in the overall performance. There are two possible approaches for this measure:

- Direct: Using the transportation model, each segment is removed from the network and the model demand is assigned again. Using performance statistics of the transportation model (e.g. average volume/capacity ratio), the effect of the removal of such link is measured.
- Indirect: Using graph theory, the transportation model is represented by a weighted-directed graph and a centrality statistic (before and after removal) is used to measure the effect of a link failure in the system.

The indirect measure was selected to measure adaptive capacity because it is less time intensive than the direct measure and the centrality measures successfully captures the global effect removing a segment from the network. Detailed methodology can be found in Appendix I).

As a result, a score between 1 and 5 was developed for each asset depending on the resulting index.

Results

The vulnerability index was obtained by combining the three components: Exposure, Sensitivity and Adaptive Capacity. A simple average might hide single-component criticalities that is why the scoring for vulnerability index followed these rules:

- Score=5: If the three components had score of 5
- Score=4: If two out of three had a score equal or higher than 4
- Score=3: If at least one of the components had score equal or higher than 4, or the average is above 3
- Score=2: If the average is above 2 and below 3
- Score=1: Any other case

The results for each component and the final vulnerability index for the selected segments is shown in Figure 6.15.

Figure 6.15: Vulnerability Index for Relevant Assets
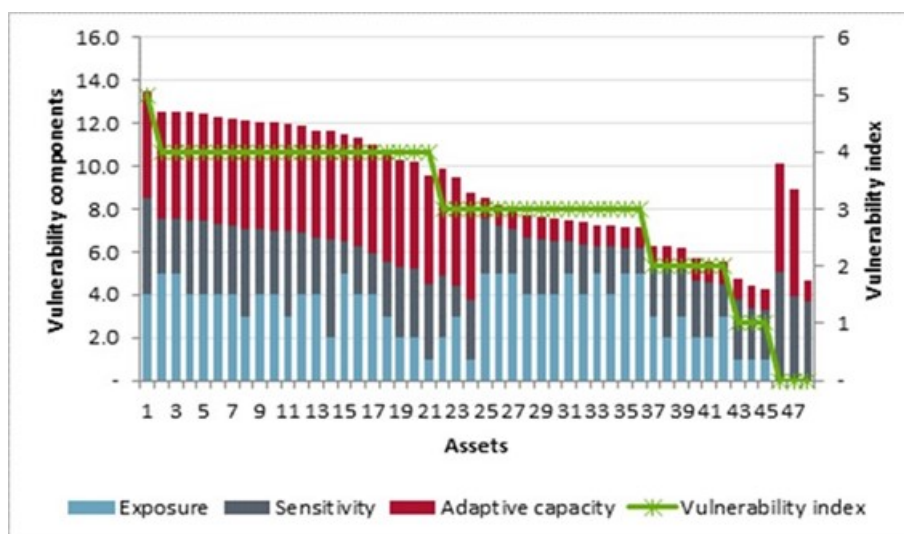
Source: SDG

Due to the level of detail defined in this analysis, the vulnerability index is defined as a discrete scale from 1 to 5, where "1" is the lowest score and "5" the highest. It is important to note that three of the selected segments where given a score of "0" because there was no evidence of Exposure and without it, there is no vulnerability. However, these might be due to uncertainties in the location or type of hazard responsible for failure. Therefore, it is important to re-visit these points and develop further hazard analysis.

These results were shared with the stakeholders in a final workshop, where the top 21 segments (i.e., score 4 and 5) were selected for further analysis and definition of mitigation analysis. The prioritized projects are shown in Figure 6.16. No segments were identified within the Aguadilla TMA.

Figure 6.16: Prioritized Segments

Prioritized Segments

Region - Puerto Rico

Source: SDG
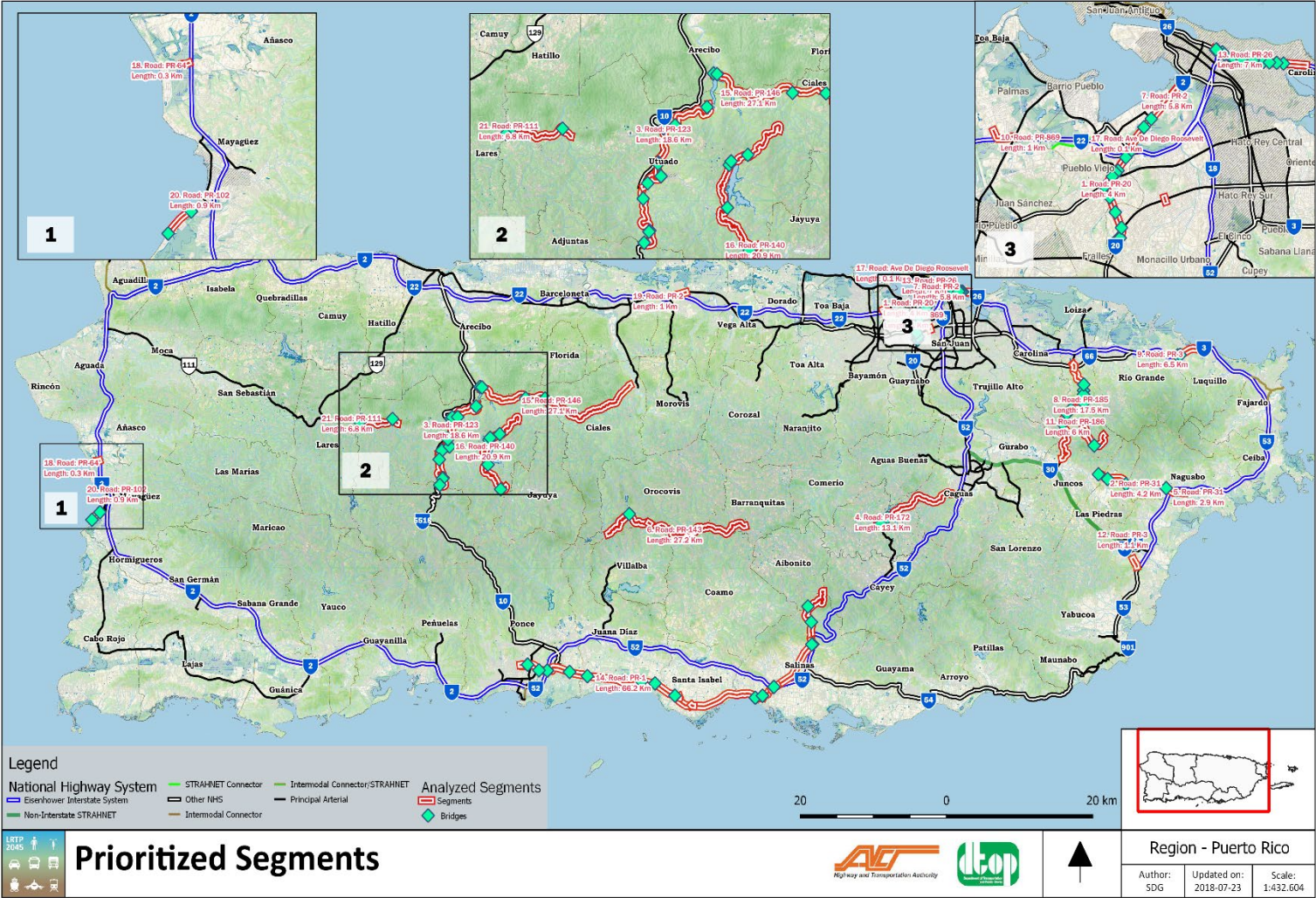
Bottleneck Analysis

Introduction

The planning factors include the priority of supporting the economic vitality, especially by enabling global competitiveness, productivity, and efficiency as well as promoting efficient system management and operation. Congestion management and reduction is an important factor to consider within this 2045LRTP

Typically, road congestion is associated with traffic volume, level of service (LOS), and speed. These indicators can be measured considering the following key performance indicators (KPIs): delay, queue, LOS, volume to capacity ratio (V/C), speed, travel time or density.

As part of the 2045 LRTP, a bottleneck analysis based on delays identification was performed for the NHS. For this analysis, data from NPMRDS corresponding to years 2016-2018 was utilized for extracting speed and distance of TMC coded segments, in order to calculate travel time. The variable delay was obtained through comparing travel time at reference speed and travel time at traffic speed, to assess the time of delay for all segments, per period of day.

Travel Time Reliability

Generally, urban areas face congestion during peak hours. As a result, citizens are required to adjust the travel time to account for the estimated delay and ensure arriving at their destination on time. The reliability of this travel time adjustment influences user's decision on whether to leave early to account for that delay or risk being late to their destination. Travel time dependability affects citizen's everyday life factors such as value of time, quality of life and well-being.

Bottleneck Analysis

According to FHWA, bottlenecks are recurring congestion events, and considered "active if traffic is detected to be queued upstream of the location and unqueued downstream (page 106)".[90] As opposed to nonrecurring events of congestion attributed to traffic anomalies such as car accidents, bottlenecks are predictable in cause, location, time of day and approximate duration. This specific bottleneck analysis focuses on identifying segments with major delays along the NHS in Puerto Rico. By identifying these segments, there can be a determination of: specific locations where congestion is highest along a road and the daily period of occurrence.

Methodology

Segment Identification

To identify possible bottlenecks, it is necessary to consider segments with travel times higher than the expected at reference speed for a road segment or TMC. Subsequently, vehicle delays per segment were obtained in minutes by subtracting the average travel and reference travel time. By

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[90] Daganzo, C.F. (1999). "Remarks on Traffic Flow Modeling and its Applications," Traffic and Mobility, 105–115, Springer Berlin Heidelberg, Berlin, Germany.

measuring delay, possible bottleneck segments and roads can be identified as those with higher delays on traveling time.

To conduct the Bottleneck Analysis this analysis was conducted in each Region, per period of the day (AM, MD, PM, NT). Once all the Regions were analyzed by period, a recurrence assessment was made for the same months to identify the top ten (10) worst segments in terms of delays. The ten (10) segments (TMC) with the highest recurrence were the TMC selected for the analysis of the average delays per Region per period, presented in the following section.

Analysis of Results

For Aguadilla, all TMC segments studied were located along PR-2. The top 10 TMC segments with the worst delays recorded values between 1.0-9.0 minutes on average per month. The past-midday period had the highest delay on average throughout the period of study with 4.6 minutes, in comparison to mid-day period with 3.8 minutes, night period with 3.2 minutes, and morning period with 2.0 minutes on average.

- For the morning period, segments with the worst delay were: with 3.2 minutes in Isabela between intersection PR-2 with PR-113 (Cara del Indio site) and intersection with PR-4494 in the westbound direction; segment with 2.8 minutes delay along PR-2 from PR-417 in Aguada to intersection with PR-109 in Añasco (southbound). Other segments with delays between 1.5 to 2.0 minutes were in PR-2 section between Isabela and Aguadilla from PR-110 to PR-107 in both directions.
- For the mid-day period, segments with the worst delay were: with values ranging between 6.0-7.0 minutes in PR-2 from PR-417 in Aguada to intersection with PR-109 in Añasco (southbound); with 4.3 minutes delay on average, the first located in PR-2 section between Aguada and Añasco northbound (PR-109 to PR-417), and second along PR-2 westbound between PR-107 and intersection with PR-110. Other segments with delays ranging between 3.0-3.6 minutes were located along PR-2 section between Aguadilla and Isabela.
- For the past-midday period, segments with the worst delays were: with 6.6 minutes on average, along PR-2 westbound between PR-107 and intersection with PR-110; with delays between 5.0-6.0 minutes, located between Aguada and Añasco both north and southbound. Other segments with high delays, between 4.0 and 4.6 minutes, were between PR-107 and intersection with PR-110 in the eastbound direction.
- For the night period, segments with the worst delays were: with 5.0-6.0 minutes delay (Aguada to Añasco segment), with 4.5 minutes delay on average, and other segments mentioned in other periods of the day with delays between 3.0-3.8 minutes.

Thus, overall, segments with highest recurrence of delays throughout periods of the day were located in areas between Aguada and Añasco (PR-417 to PR-109) in both directions, Aguadilla from PR-107 to intersection with PR-110, Isabela from PR-113 (Cara del Indio site) to PR-4494 as shown in Figure 6.17.

Figure 6.17: Aguadilla TMA, bottleneck locations.
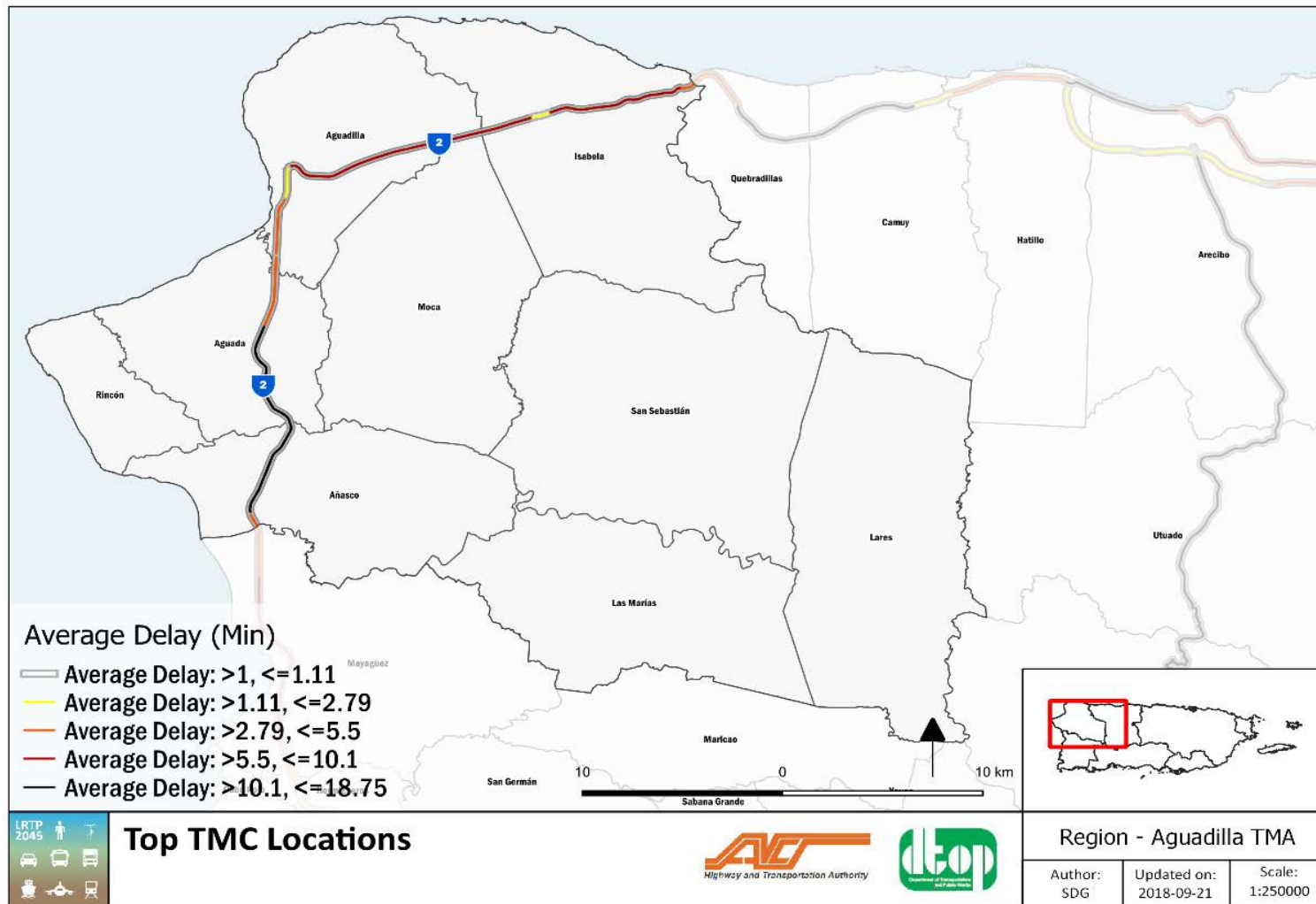
COST FEASIBILITY PLAN SCENARIOS

Transportation Funding Summary

This section describes the Cost-Feasible Plan recommendations from 2019 to 2045, a 27-year period. The initial period of 2019-2023 is covered by the PRHTA Revised Fiscal Plan 2018-2023 as certified by the Financial Oversight and Management Board for Puerto Rico on June 29, 2018, including completion of current projects. The requirements of the TAMP then dominate the spending projections through to 2028. From 2029 to 2045 the projections will remain cost-constrained, depending on the combination of future FHWA funding allocation and potential transfers from the Government of Puerto Rico.

As outlined in Chapter 5, the forecasts of the sources and allocation of transportation revenues were developed though to 2045, the horizon year of this plan. It is necessary for the LRTP to be developed as fiscally constrained, and to only recommend projects and improvements where there is identified funding to support their implementation. In practice there is no certainty around any of the funding streams except in the very short term, and prudent assumptions are therefore required.

It has been assumed that the level of Federal funding available will remain constant in real terms, and that the PR Government transfers will be maintained at around $200m per year in real terms, in order to maintain the SGR targets for interstates and NHS, and to progressively address the SGR backlog on non-NHS highways. The limited remaining highways funds are then applied to address the prioritized list of projects, including studies; operational improvements; and limited new construction for capacity improvement. A specific allocation is made towards safety including bicycle and pedestrian projects, for design and right of way for enhanced bicycle/pedestrian facilities. All available FTA 5339 funds are assumed to be dedicated to transit fleet renewal and SGR of transit facilities.

During the period through to 2028, the pattern of transportation system expenditure follows the TAMP balanced scenarios, and reflects an obligation to apply all available FHWA funds to achieve minimum required condition of interstate pavements and NHS bridges condition, and to work towards the PRHTA specified target for the condition of non-interstate NHS pavements. A specific mandatory allocation of FHWA funds is also made towards safety projects. There will also need to be state contributions to interstate and NHS SGR projects during this period, and towards SGR on the non-NHS network. During this period the scope to undertake additional highways projects will be extremely limited, although initial work could start from 2025 and gradually ramp up.

Both the available funding and costs are expressed in 2018 prices rather than Year of Expenditure estimates, given the significant uncertainties around both funding and construction price inflation over the medium and longer term. It is implicitly assumed that inflationary pressures will be compensated by increases in the level of funding made available. To the extent that this presumption is not met, it will be necessary to either postpone or delay projects. The over-riding priority to achieve SGR targets could mean that there is minimal funding available for other long-term projects unless there is either scope for an increase in PR Government transfers, or a restoration of the taxes and levies previously made available to PRHTA which are currently the subject of a clawback.

The projected allocation of funding is summarized in Table 6.7 below.

Table 6.7: Forecast of Regional Transportation Funds and Allocation ($000s, 2018 prices)

		2019-23 Fiscal Plan	2024-28 TAMP	2029-33	2034-39	2040-45
FHWA	FHWA Construction Spend	974,302				
	FHWA Construction Soft Costs	164,391				
	FHWA contribution to SGR Pavements & Bridges		510,905	510,905	613,086	613,086
	FHWA Safety projects		183,245	183,245	219,894	219,894
State	Non-Federal Construction Projects	483,039				
	Non-Federal Construction Soft Costs	85,512				
	Construction Local	45,950				
	State contribution to Interstate and NHS SGR		253,180	129,030	154,836	154,836
	State contribution to non-NHS SGR		585,606	627,556	753,068	753,068
	Prioritized highways projects		61,488	118,220	149,201	156,416
	Traffic signals SGR		66,145	66,145	79,374	79,374
	Design	42,131	39,410	39,410	47,292	47,292
	Right of Way	58,631	16,500	16,500	19,800	19,800
	Total Capital Expenditure - Highways	**1,833,529**	**1,716,479**	**1,691,012**	**2,036,550**	**2,043,765**
FTA	Transit CIP	115,000				
	Transit fleet renewal and SGR		25,000	25,000	30,000	30,000
	Total Capital Expenditure - Transit	**115,000**	**25,000**	**25,000**	**30,000**	**30,000**

Source: SDG analysis of fiscal plan, TAMP and priority project list

Projects Considered

Projects considered for the 2045 LRTP are detailed in Appendix H. This list was compiled during the meetings with different committees (primarily the Freight Advisory Committee and the technical committee), list sent in by municipalities and revision of projects in the STIP that will not be completed within the STIP (current STIP project list relevant to Aguadilla TMA included in Table 6.8 to Table 6.9; including the bridge and safety projects - Table 6.10 to Table 6.12) timeframe (more detail on the list of projects in Appendix H). The list of projects underwent a detailed revision with the Technical Team of the PRHTA to eliminate those projects already considered as part of other streams of funds such as:

- Under construction or will be within the next 5 years as defined in the STIP or the pipeline of the PRHTA; and
- Considered within emergency funding such as the FHWA Emergency funding, Detailed Damage Inspection Reports (DDIR lists) – the lists used are included in Appendix H.

Projects falling within the following classifications were compiled a list of projects that will be candidates for funding under their respective funding allocations:

- Pavement and Bridge Preservation;
- Safety (according to Strategic Highway Safety Plan);
- Pavement and Bridge Reconstruction
- Bridges;
- Transit; and
- Intelligent Traffic System.

There is a series of projects identified to be considered for CDBG-DR funding that will potentially have access to additional funds in the short to mid-term; these are:

1. PR-10 (AC-100069, AC-100071, AC-100055, AC-100076) Adjuntas-Utuado;
2. San Lorenzo South Bypass, from PR-183/ PR-181 to PR-745 (AC-918101) San Lorenzo;
3. Aguas Buenas North Bypass, from PR-156 East to PR-156 West (AC-020802, AC-020803) Aguas Buenas;
4. PR-158 Connector, Phase I and Phase II from PR-52 to PR-1, (AC-015802)Cayey;
5. PR-122, Lajas-San German Connector from PR-321 to PR-166, (AC-012201)   Lajas-San German;
6. PR-18N to PR-21E ramp and Medical Center Connector   San Juan;
7. Extension PR-5, from PR-199 to PR-167, Bayamón-Toa Alta;
8. Isabela Connector, from PR-472 to PR-112 (AC-047205) Isabela;
9. Expressway Conversion of PR-2 Ponce-Mayagüez;
10. Higuilar Avenue from PR-696 to PR-22/PR-694   Dorado;
11. PR-22 extension, Hatillo- Aguadilla from PR-22/PR-2 to PR-2/PR-111   Hatillo-Aguadilla;
12. Cidra Connector, from Avenida Industrial to PR-184 (AC-017242, AC-017246, AC-017247)   Cidra;
13. Relocation of PR-111 from PR-111/PR-448 to PR-111/PR-111R   San Sebastián-Lares;
14. Barranquitas Bypass from PR-156 to PR-759 (AC-010194)   Barranquitas;
15. Villalba Bypass, from PR-151 to PR-150, (AC-556103)   Villalba;
16. Improvements to Aguadilla's Airport Access, from PR-110 to PR-107, includes Burns Street Connector (AC-000218) Aguadilla;
17. Loíza Bypass, from PR-188 to PR-187, (AC-018760)   Loíza;
18. Widening PR-845, from PR-844 to PR-199, (AC-084511) San Juan-Trujillo Alto;
19. Widening PR-545, from PR-52 to PR-14   Coamo; and
20. Peñuelas South Bypass (PR-3132) from its intersection with PR-3132 (Northwest limit) to existing PR-3121 (Northeast Limit)   Peñuelas.

Additionally, list of vulnerable roads and cycling safety projects are referred to in Appendix H, as these can be apportioned as part of safety, emergency or reconstruction projects. Illustrative major projects requiring funding identification thru P3 alternative and federal loans are included in Appendix J. It is considered a systematic preservation program is continued beyond reaching SGR.

There are initiatives underway for repair work in the entire Island road network such as State Road Modernization Program (PEMOC – in spanish Programa Estatal de Modernización de

Carreteras) and "Abriendo Caminos"; the full list of projects under these two initiatives are included in Appendix H.

Other agencies such as the Eastern Federal Lands Highway Division (EFLHD) develop improvement programs including transportation infrastructure. Appendix H includes the FY 2019-2022 EFLHD Transportation Improvement Program for Puerto Rico.

The rest of the projects were considered within the main list of projects which were ranked based on the how these responded to the 2045LRTP Goals and Objectives. Costs were assigned to these projects determining when in time these projects will have funding available. For the Aguadilla TMA, the projects and their expected year of construction start are included in Table 6.13 to Table 6.15 for the Medium to Long Term periods.

These projects have been assigned based on the ranking (Appendix H) and funding available; nonetheless, if additional funding becomes available these could be developed at an earlier stage.

Table 6.8: List of Aguadilla TMA projects in STIP Short Term (2017-2020)

AC #	Description	Municipality	STIP Total Costs
411901	Las Marias Connector, from KM 119 To Ramón Rivera Street	Las Marias	$4,640,250
000213	Additional Funds for the Feasibility Study RFP - Improvements PR-2, Aguadilla - Mayagüez Corridor from its intersection with PR-107 Municipality of Aguadilla to its intersection with PR-114 Municipality of Mayagüez	Aguadilla / Mayagüez	$380,000
011191	Relocation of PR-111 km. 27.9 a km. 34.0	San Sebastian / Lares	$2,500,000
500023	Bicycle and Pedestrian Route	Rincon	$5,175,954
011213	Improvements to PR-112 and Connector to PR-4494 - access to the Industrial Zone to the Isabela Connector, it includes improvements to PR-112. This project will be known as the Cano Rosa Connector	Isabela	$125,000
000218	Improvements to access to Aguadilla Airport through PR-110, 107 and connector to Burn Street	Aguadilla	$1,000,000
TOTAL			$13,821,204

Source: STIP 2017-2020; Feb 2018

Table 6.9: List of Island-wide projects in STIP Short Term (2017-2020)

AC #	Description	STIP Total Costs
800474	Rehabilitation of Complex Bridge #300, Naranjito	$13,341,876
800477	PR-52 from km 66 to km 71.6 to km 77	$32,172,982
900123	SPR-54 - State Planning and Research Program (2017)	$6,000,000
990133	Intelligent Transportation System (ITS) (2017) Reversible Lane Barrier Operation PR-18 and PR-52	$900,000

AC #	Description	STIP Total Costs
992477	Bridge Inventory System NBIS (33) (2018)	$1,874,961
990134	Upgrade of Safety Devices in the Highway System (2017) PR-66 km 0 to km 20	$7,173,465
990135	Island-wide Roadwide Traffic Signals, Pavement Marking, Signing and Geometric Safety Improvements Projects (2017) PR-52, from km 49 to km 52.3, Salinas -PR-52, from km 55.3 to km 61, Salinas -PR-20 from km 0 to km 10, Guaynabo - PR-152 from km 0 to km 11.5, Barranquitas - Naranjito PR-152 km 13.65 to km 20.5, Barranquitas - Naranjito	$27,431,780
800485	Pavement Rehabilitation and Reconstruction of Roads (2018)	$50,211,087
800486	Rehabilitation and Replacement of Bridges (2018)	$9,316,000
900128	SPR-55 - State Planning and Research Program (2018)	$6,000,000
900129	Bridge Critical Findings (2018) Island-wide	$6,268,000
990146	Intelligent Transportation System (ITS) (2018)	$2,375,000
800487	Systematic Bridges Preservation Program (2018)	$3,094,000
992478	Bridge Inventory System NBIS (33) (2019)	$1,791,141
800493	Implementation of Strategic Highway Safety Plan (2018)	$2,500,000
990144	Upgrade of Safety Devices in the Highway System (2018)	$14,356,261
990145	Island-wide Roadwide Traffic Signals, Pavement Marking, Signing and Geometric Safety Improvements Projects (2018)	$6,459,210
990152	Highway Safety Improvements - Puerto Rico Section 154 and 164 Penalty (HSIP- Elegible Activities) (2018)	$3,800,000
800511	Pavement Rehabilitation and Reconstruction of Roads (2019)	$14,820,069
800512	Rehabilitation and Replacement of Bridges (2019)	$13,307,000
900132	SPR-56 - State Planning and Research Program (2019)	$6,000,000
990153	Intelligent Transportation System (ITS) (2019)	$3,400,000
900133	Bridge Critical Findings	$2,800,000
992479	Bridge Inventory System NBIS (33) (2020)	$1,750,000
800514	Island-wide Roadwide Traffic Signals, Pavement Marking, Signing and Geometric Safety Improvements Projects (2019)	$12,519,684
800515	Implementation of Strategic Highway Safety Plan (2019)	$6,000,000
990155	Upgrade of Safety Devices in the Highway System (2019)	$13,454,000
990154	Highway Safety Improvements - Puerto Rico Section 154 and 164 Penalty (HSIP- Elegible Activities) (2019)	$3,800,000

AC #	Description	STIP Total Costs
800516	Rehabilitation and Replacement of Bridges (2020)	$12,490,000
800518	SPR-56 - State Planning and Research Program (2019) Pavement	$40,107,356.00
900134	Intelligent Transportation System (ITS) (2019) SPR	$6,000,000.00
900135	Island-wide Roadwide Traffic Signals, Pavement Marking, Signing and Geometric Safety Improvements Projects (2017)	$3,594,000
990156	Intelligent Transportation System (ITS) (2020)	$5,736,842
TBD	Upgrade of Safety Devices in the Highway System (2019) NBIS	$2,000,000
800519	Upgrade of Safety Devices in the Highway System (2020)	$5,000,000
800520	Implementation of Strategic Highway Safety Plan (2020)	$3,801,628
800521	Island-wide Roadwide Traffic Signals, Pavement Marking, Signing and Geometric Safety Improvements Projects (2020)	$24,948,372
990157	Highway Safety Improvements - Puerto Rico Section 154 and 164 Penalty (HSIP- Elegible Activities) (2020)	$3,800,000
TOTAL		**$380,394,714**

Table 6.10: List of Aguadilla TMA Bridge Projects STIP (2017-2020)

Bridge ID2	Road	Km	Municipality	Costs
1492	Off PR 110	0.30	Moca	$ 126,000
881	PR 497	2.70	San Sebastian	$ 282,000

Source: STIP 2017-2020; Feb 2018

Table 6.11: List of Aguadilla TMA Safety Projects STIP (2017-2020)

Program/Project	Municipality	Costs
AC-800515 SHSP Funds		
Safety Corridor PR-115 km 0 @ km 10	Añasco- Rincon	$3,000,000
Safety Corridor PR-115 km 10 @ km 20	Rincon-Aguada	$3,000,000
AC-990145 Safety Improvements Island-wide		
Safety Corridor PR-420 km. 0 @ km 9	Moca	$2,801,628

Source: STIP 2017-2020; Feb 2018

Table 6.12: List of Island-wide Safety Projects STIP (2017-2020)

Program/Project	Municipality	Region	Costs
RFP SHSP Update and Implementation	All	Island-wide	$ 2,500,000

Source: STIP 2017-2020; Feb 2018

Table 6.13: List of Aguadilla TMA Committed Projects; Mid Term (2021-2030)

Project Name	Reference Cost	Municipality	Start Date
Improvements to PR-112 and Connector to PR-4494- access to the Industrial Zone to the Isabela Connector, it also includes improvements to the PR-112. This project will be known as the Cano Rosa Connector (AC-011213)	$4,350,000	Isabela	2028
Vulnerability Study, Island-wide	$1,000,000	Island-wide	2029
Construction Las Marías Connector, from PR-119 to Ramón Rivera street (AC-411901)	$3,600,000	Las Marías	2030
Operational Traffic Study, PR-2 KM 111.5 (Intersection KFC) Operational traffic study to determine if the traffic signals to control traffic method in the intersection is the right one to avoid accident	$204,130	Isabela	2030

Reconstruction, considering safety and security, PR-466 km 7.2 & PR-466 km 6.5.	$664,486	Isabela	2030

Source: PRHTA technical team with SDG support

Table 6.14: List of Aguadilla TMA Committed Projects; Mid to Long Term (2031-2040)

Project Name	Reference Cost	Municipality	Start Date
Design, ROW, and Construction of Isabela connector PR-112 to PR-472 (AC-047205)	$ 7,174,042	Isabela	2034
Feasibility Study, PR-404 by-pass	$ 900,000	Moca	2036
Additional Funds for Feasibility Study, Improvements to Aguadilla Airport access through PR-100, PR-107and connector to Burn street (AC-000228)	$7,200,000	Aguadilla	2036
Study, Design, permit process and reconstruction, PR-4466 km 3 Bo. Bajuras (study, Design, permit process and construction of pluvial, safety guard and Signalization)	$900,000	Isabela	2036
Reconstruction, including general improvements PR-4455 from km 0 to 2.5 (scarification, pavement, marking and road sign)	$4,596,989	Isabela	2036
Reconstruction, PR-459 from km 9 to 15 (Bo. Jobos/Bo. Bejucos); potentially including, scarification, pavement, marking and road sign	$ 3,000,000	Isabela	2038
Construction, Relocation of PR-111 km. 27.9 a km. 34.0 (AC-011191)	$ 43,200,000	San Sebastian/ Lares	2040

Source: PRHTA technical team with SDG support

Table 6.15: List of Aguadilla TMA Committed Projects; Long Term (2041-2045)

Project Name	Reference Cost	Municipality	Start Date
Feasibility PR-113 Connector of the beach area	$ 900,000	Isabela	2045

Source: PRHTA technical team with SDG support

2045 Models

Using the calibrated 2016 model and updating the socioeconomic inputs for 2045; 2045 scenarios models were prepared. These included the base scenario considering:

- No changes in the roadway network (No-Build Scenario);
- The scenario considering the committed roadway projects (2045 Existing and Committed (E+C)); and
- The scenario with committed projects plus the new construction projects included in the Fiscal Plan as strategic/P3 projects (2045 E+C plus PR-22 and PR-5).

2045 No-Build (Do-Nothing Scenario)

Land use patterns, growths in population and employment, and trends in travel patterns will affect the demand on the Region's transportation system in different ways. In order to understand the future demands on the transportation system for this 2045 LRTP, a No-Build scenario in 2045 travel demand situation was firstly analyzed. The No-Build condition in 2045 assumes that there are no improvements to the existing transportation system in the next 27-year horizon. Only the land use patterns, population, and employment are changed based upon our socioeconomic forecasts presented in Chapter 2. Table 6.14 presents the statistics of performance measures of the 2045 No-Build and the results comparisons to the Base Case.

Different from other TMAs on the island, the Aguadilla TMA has growing population and employment in 2045. As a result, the person trips and vehicle trips within Aguadilla TMA have increased by approximately 10% and 13%, respectively. Trucks trips also increased by 14%. Because of the trip growth, the vehicle mile traveled and fuel consumptions grew correspondingly.

Both vehicle hour traveled and vehicle miles of traveled on the roadway segments with volumes exceeding their capacities in the Aguadilla TMA increased significantly. Although the average travel speed of the entire Aguadilla roadway network reduced by 4%, The average travel speed on the entire roadway system and on the limited access roads (freeways and expressways) of Aguadilla has reduced. All these suggest the highway level of service (LOS) in the 2045 become worse if no improvement to transportation system is undertaken.

Due to the increased congestion, the buses become even slower and less reliable. Therefore, the overall transit shares in Aguadilla decrease by 0.3%.

Table 6.16: Summary of 2045 No-Build Scenario in Aguadilla TMA

Measures of Effectiveness	Base Case	2045 No-Build	% Change (No-Build vs. Base Case)
System Performance			
Average network speed (mph)	26.9	25.9	(4.0%)
Total transit passengers per route mile	31.0	30.1	(3.1%)
% non-motorized trips	2.8%	3.6%	29.3%
% transit trips	1.5%	1.2%	(17.0%)
Average highway trip cost	$1.48	$1.47	(0.8%)
Average transit trip cost	$1.98	$1.94	(2.2%)
% Population within 0.5-mile walk to transit	3.5%	3.5%	0.0%

Measures of Effectiveness	Base Case	2045 No-Build	% Change (No-Build vs. Base Case)
% Employment with 0.5-mile walk to transit	28.4%	28.3%	0.0%
Vehicles hours of delay	17,101	23,900	39.8%
Vehicle hours of travel/1000 vehicle miles of travel	37.1	38.7	4.2%
VMT above capacity	48,579	75,101	54.6%
Speed on limited access roads and expressways	30.0	29.0	(3.3%)
Gallons of fuel consumed	279,696	304,862	9.0%
System Usage			
Vehicle miles of travel	6,460,976	7,042,302	9.0%
Vehicle hours of travel	239,842	272,328	13.5%
Average network speed	26.9	25.9	(4.0%)
Person trips	756,290	828,612	9.6%
Vehicular trips	591,724	668,187	12.9%
Truck trips	25,449	29,075	14.2%

Source: SDG analysis of 2045 No-Build scenario on PRHTA Island-wide Model

2045 Existing and Committed (E+C) Scenario

This model considers the list of projects presented in Table 6.17. This model considers the effect of the road improvement project in the roadway network.

Table 6.17: Committed Projects reflected in the 2045 modeling

AGUADILLA TMA
Construction Las Marías Connector, from PR-119 to Ramón Rivera street (AC-411901)
Design, ROW, and Construction of Isabela connector PR-112 to PR-472 (AC-047205)
Feasibility Study, PR-404 by-pass
Additional Funds for Feasibility Study, Improvements to Aguadilla Airport access through PR-100, PR-107and connector to Burn street (AC-000228)

Source: PRHTA technical team with SDG support

Due to several highway improvements in Aguadilla TMA, the 2045 E+C scenario results (Table 6.13) in slightly increase of travel speed in an average weekday compared to the No-Build scenario. This suggest a better roadway mobility in the Region.

Overall mode share of transit trips within Aguadilla in an average weekday was raised from 1.2% in the No-Build scenario to 1.5%. This mode shift occurs while travel speeds on the roadway slightly increased. This means that local transit services in Aguadilla are faster and more reliable, mitigating some of the potential mode shift away from transit. This also represents an increase in passengers per route mile by approximately 26%.

Figure 6.18: 2045 Traffic on The Existing Plus Committed Network- Aguadilla TMA
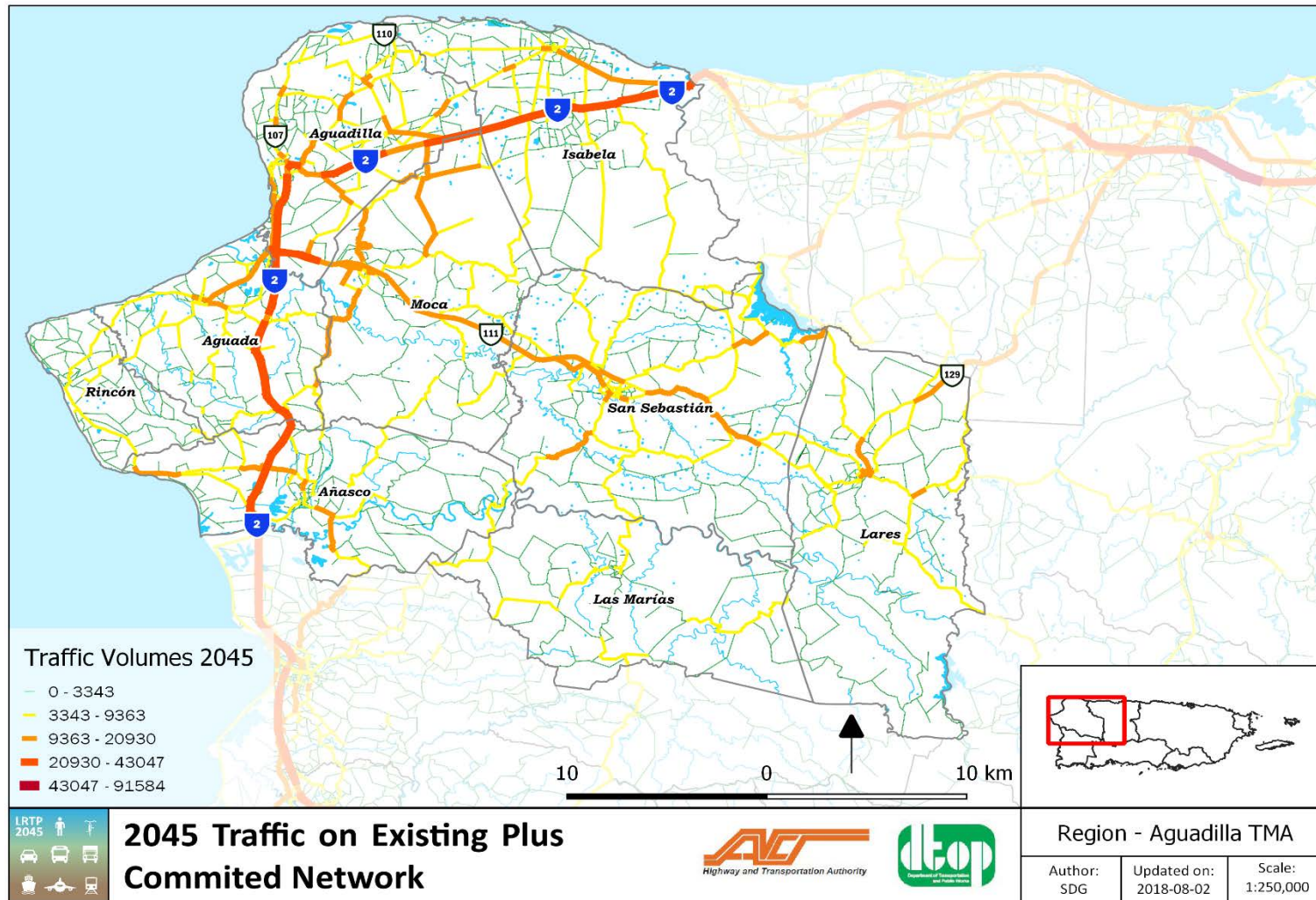
Source: P.R. Network Model Forecasts by Steer Davies Gleave for the year 2045 using Cube Voyager

Figure 6.19: 2045 Traffic Service on the Existing Plus Committed Network- Aguadilla TMA
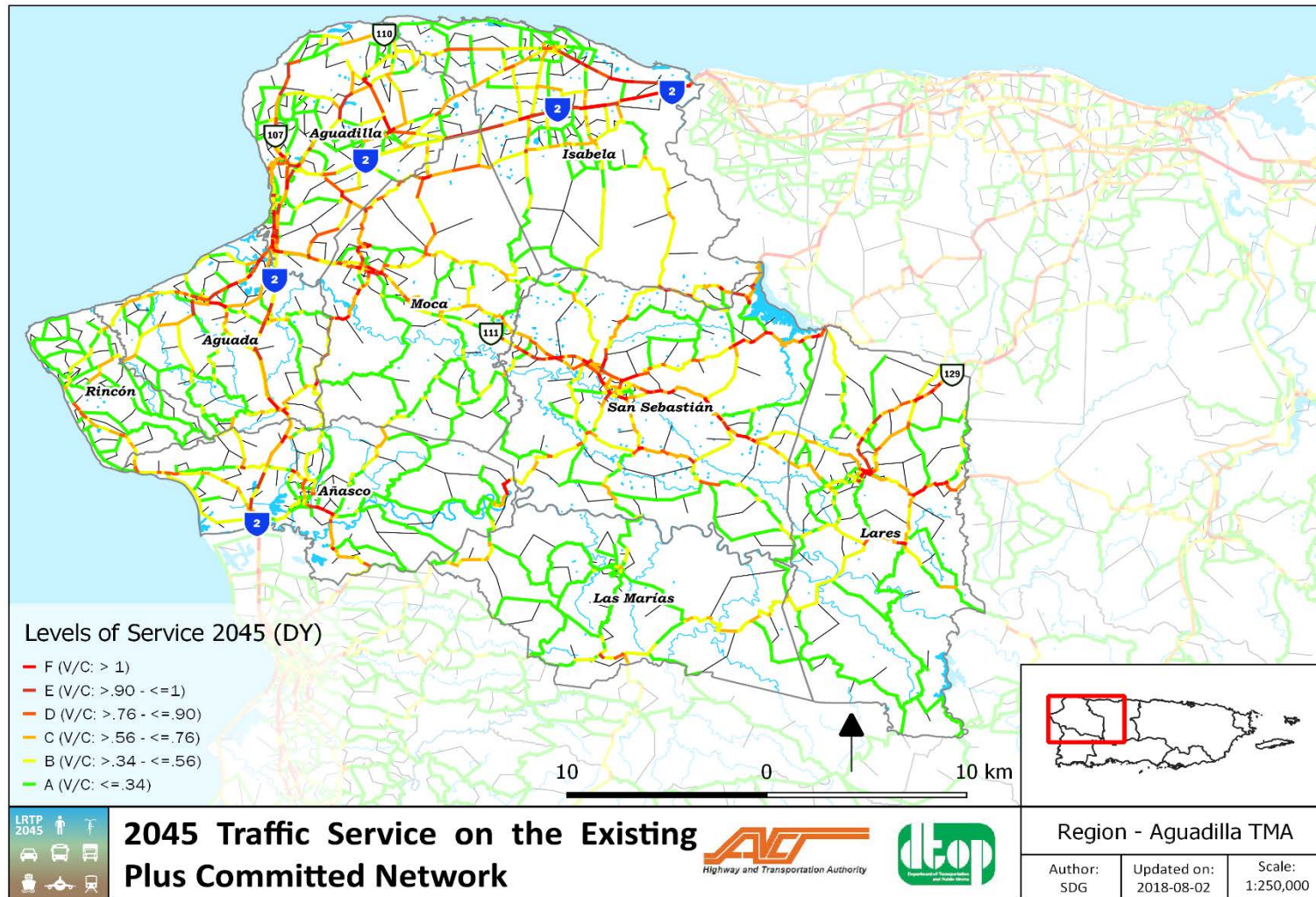
Source: P.R. Network Model Forecasts by Steer Davies Gleave for the year 2045 using Cube Voyager

2045 PR-22 Extension + PR-5 Extension

This scenario considers the E+C plus the strategic/P3 projects for extensions of PR-22 from Hatillo to Camuy and PR-5 Toa Alta to Bayamón.

The results in Table 6.18 show both VMT and VHT were decreased in this scenario compared to those in the No-Build scenario. The improvement of travel mobilities are largely contributed from the extension of PR-22 in the Region. As a result, the VMTs on the congested roadway segment that have volumes over their capacities reduced by approximately 5%. Transit passengers per route miles an approximate uplift in transit passengers of 25%.

Results (Present the table of Measures of Effectiveness with the 3 scenarios mentioned above*)*

Table 6.18: Summary of 2045 Scenarios in Aguadilla TMA

Measures of Effectiveness	2045 No Build	2045 E+C	% Change (E+C vs. No-Build)	2045 PR-22 Ext. & PR-5 Ext	% Change (PR-22 Ext & PR-5 Ext vs. No-Build)
System Performance					
Average network speed (mph)	25.9	26.2	1.5%	25.9	0.3%
Total transit passengers per route mile	30.1	37.9	26.1%	37.8	25.7%
% non-motorized trips	3.6%	3.0%	(16.2%)	3.0%	(16.0%)
% transit trips	1.2%	1.5%	26.4%	1.5%	25.2%
Average highway trip cost	$1.47	$1.48	0.7%	$1.47	(0.1%)
Average transit trip cost	$1.94	$1.98	2.5%	$1.95	0.7%
% Population within 0.5-mile walk to transit	3.5%	3.5%	0.0%	3.5%	0.0%
% Employment with 0.5-mile walk to transit	28.3%	28.3%	0.0%	28.3%	0.0%
Vehicles hours of delay	23,900	24,980	4.5%	22,725	(4.9%)
Vehicle hours of travel/1000 vehicle miles of travel	38.7	38.1	(1.4%)	38.6	(0.3%)
VMT above capacity	75,101	96,354	28.3%	71,608	(4.7%)
Speed on limited access roads and expressways	29.0	30.8	6.0%	28.9	(0.3%)
Gallons of fuel consumed	304,862	306,982	0.7%	303,332	(0.5%)
System Usage					
Vehicle miles of travel	7,042,302	7,091,275	0.7%	7,006,971	(1.5%)
Vehicle hours of travel	272,328	270,279	(0.8%)	270,228	(2.0%)
Average network speed	25.9	26.2	1.5%	25.9	0.4%
Person trips	828,612	828,508	0.0%	828,506	0.0%
Vehicular trips	668,187	668,937	(0.5%)	668,643	(0.4%)
Truck trips	29,075	29,032	0.0%	29,039	0.0%

Sources: SDG analysis of 2045 scenarios on PRHTA Island-wide Model

Figure 6.20: 2045 Traffic on The Cost-Feasible Network- Aguadilla TMA
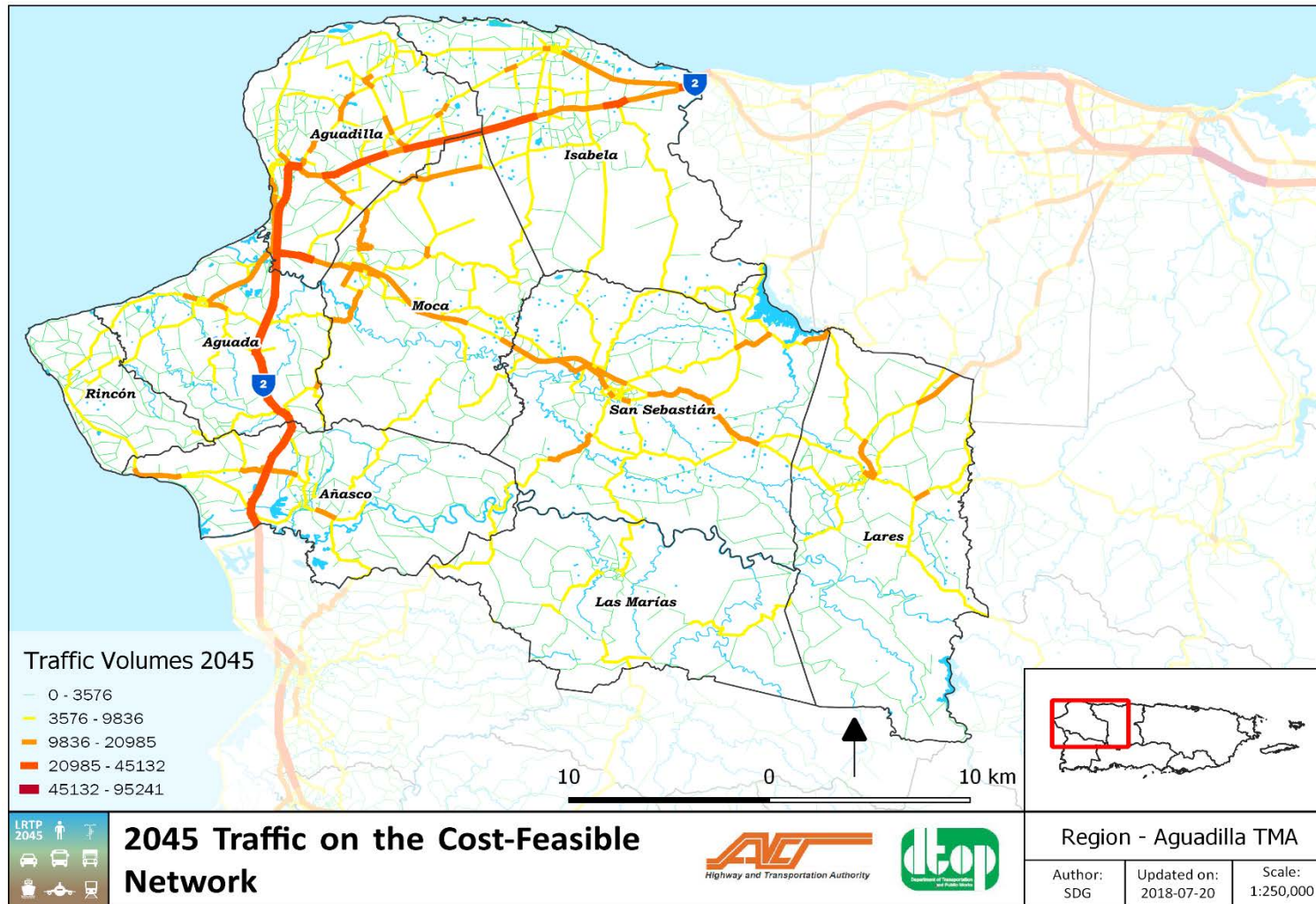
Source: P.R. Network Model Forecasts by Steer Davies Gleave for the year 2045 using Cube Voyager

Figure 6.21: 2045 Traffic Service on The Cost-Feasible Network- Aguadilla TMA
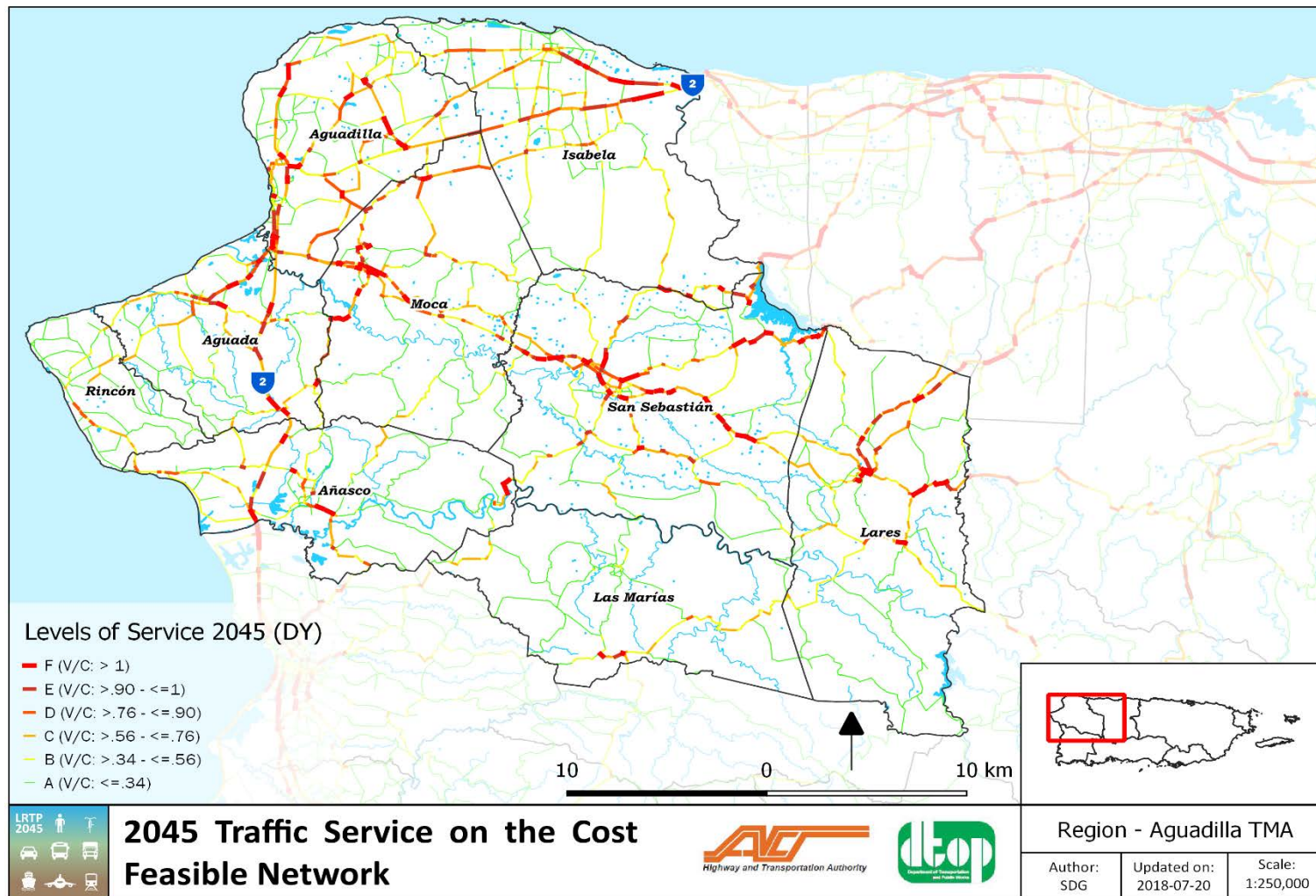
Source: P.R. Network Model Forecasts by Steer Davies Gleave for the year 2045 using Cube Voyager

7 CHAPTER 7 POLICY GUIDELINES TOWARD THE TRANSPORTATION INFRASTRUCTURE

The DTPW, along with its affiliated agencies, the PRHTA and the Puerto Rico MPO, face an unprecedented future that requires policy direction. This 2045 LRTP update, by following the national transportation goals, emphasizing in safety (reduce fatalities), improving asset conditions to state of good repair, reducing congestion, improving freight mobility, and maintaining the environment and air quality. This section mentions policies defined to address these challenges in the incoming future.

This chapter is divided into 6 sections:

1. New TSM&O Technologies for Next 5 Years;
2. Congestion Management Process;
3. Freight;
4. Safety and Security;
5. Environment and Sustainability; and
6. Looking Forward.

NEW TSM&O TECHNOLOGIES FOR NEXT 5 YEARS

Transportation Systems Management and Operations: Recent ITS Developments and Future Needs

This section provides an overview of recent ITS developments in Puerto Rico, as well as upcoming projects – both in place and recommended for the next 5 years. It also touches on mobility of the future, and how any new technologies should be firmly focused on the end-user and their needs. Topics include:

- Advanced Traffic Signals Systems;
- Traffic Incident Management and Traveler Information Dissemination;
- Travel Time Reliability Improvement;
- Highway Safety Patrol Program (SEGURO); and
- Intelligent Mobility and Disruption.

The Puerto Rico DTPW and the PRHTA during recent years have performed several activities to move forward with the implementation of the Transportation Systems Management and Operations (TSM&O) Program for the Island. The most important activities related to the TSM&O Program performed in recent years are presented in Figure 7.1.

Figure 7.1: TSM&O Program Development Timeline
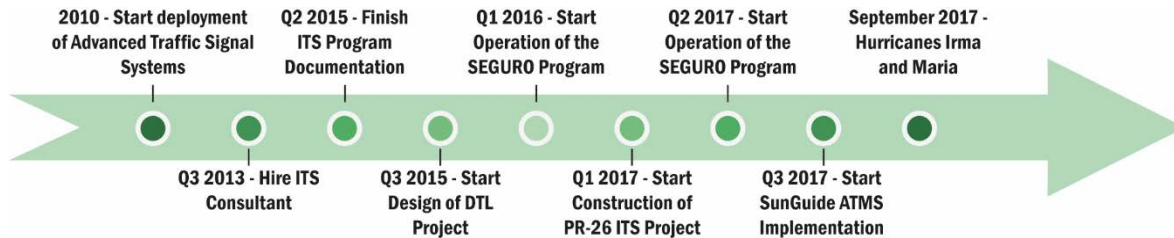
Source: PRHTA

The needs identified provided an initial framework of the areas for project implementation. These are included below:

- **Traffic Management:**
  - Effectively manage arterials system-wide;
  - Improve traffic flow monitoring;
  - More widespread centralized computer control;
  - Improve ability to remotely modify signal timing;
  - Reduce emergency vehicle delays at signals;
  - Improve detection of incidents on roadways;
  - Improve management of incident response;
  - Improve inter-jurisdictional continuity for traffic management;
  - Upgrade signal hardware;
  - Improve signal coordination;
  - Better management of periods of high traffic demand;
  - Improve the quality real-time congestion information;
  - Communicate with adjacent cities;
  - Monitor emissions and air conditions along roadways;
  - Improve control of lighting along roadways;
  - Automate local parking management;
  - Enable regional coordination for parking;
  - Monitor vehicular speed along highways and arterials;
  - Improve management of roadway closures; and
  - Alert drivers to approaching roadway hazards.

- **Electronic Payment:**
  - Capability for drivers to pay tolls without stopping their vehicles (open road tolling); and
  - Integration of electronic payment for transit, toll roads, and parking.

- **Regional Traveler Information:**
    - Provide real time congestion information;
    - Provide real time transit vehicle arrival/departure information;
    - Expand traveler information delivery methods;
    - Disseminate static and real-time traffic information through a variety of methods;
    - Improve/simplify procedure to obtain travel information;
    - Provide information to private information service providers;
    - Better road construction information;
    - Provide in-route traveler information; and
    - Improve inter-agency operational data sharing and coordination.

- **Transit Management:**
    - Improve regional trip planning;
    - Improve patron safety (in-vehicle and at stations);
    - Implement transit vehicle location and tracking;
    - Implement transit dispatching and management;
    - Implement automatic passenger counting;
    - Coordinate with roadway agencies regarding incident and construction information;
    - Implement Transit Signal Priority at signalized intersections; and
    - Enable real-time transit information, including dissemination/display of bus arrival/departure times.

- **Maintenance and Construction Operations:**
    - Provide location and tracking of maintenance vehicles and field equipment;
    - Improve provision of real-time information on maintenance and construction activities to the public and other agencies;
    - Increase application of smart work zone technology to provide real-time work zone information and increase safety for field staff;
    - Improve coordination of construction and maintenance activities;
    - Improve fleet management and vehicle diagnostic capabilities;
    - Increase application of portable traffic control devices;
    - Coordinate traffic control plans among different agencies and jurisdictions; and
    - Improve weather data collection and processing capabilities.

- **Emergency Management:**
    - Increase broad understanding of existing incident management procedures;
    - Improve incident detection and verification;
    - Improve coordination of incident response;
    - Improve real-time traveler information regarding incidents, special events, and emergencies; and
    - Sharing of real-time and data to support inter-agency incident and emergency response.

- **Commercial Vehicle Operations:**

- Review opportunities for CVISN implementation; and
- Explore opportunities for Weigh-In-Motion sensors.

- **Advanced Traffic Signal Systems:**

In 2010, the PRHTA started with the modernization of many of the traffic signal systems around the Island to improve the safety and operation of signalized intersections. This effort started with the update of traffic signal systems on highway PR-2 from Moca to Hormigueros on the west-northwest area of Puerto Rico. These projects consisted in setting up modern traffic signals components, including controllers, to allow for remote systems configuration and monitoring. The projects also included the installation of other devices, such as CCTV surveillance cameras and microwave radar vehicle detection systems for queue detection and intersection surveillance. All these devices were interconnected via wireless communication which in turn connect via other means to the Traffic Management Center (TMC), located in San Juan.

Other projects developed as part of the traffic signal update effort included:

- PR-2 from Hatillo to Isabela;
- PR-3 from Rio Grande to Fajardo;
- Rio Mar – including PR-1, PR-25, and PR-35 in San Juan;
- PR-1 from San Juan to Caguas;
- PR-23 from San Juan to Guaynabo;
- PR-181 from San Juan to Trujillo Alto; and
- PR-199 from Trujillo Alto to Guaynabo.

These projects were completed or at advance construction stages as of late 2017. In Q1 2016, as part of the TSM&O Program activities, the PRHTA started the evaluation of the traffic signals systems operation on the PR-2 Moca to Hormigueros section with the purpose of performing a signal timing optimization project. This effort however was not able to be completed due to several problems that were affecting the remote communication with ITS devices, which disturbed configuration and monitoring capabilities. During this period, the PRHTA also started the procurement of a Preventive Maintenance and Emergency Repair Services contract to improve the uptime and upkeep of the ITS devices installed as part of the traffic signals systems update projects.

On September 2017, Puerto Rico was affected by hurricanes Irma and María, which rendered most of the traffic signals systems inoperable due to the lack of electrical power in the Island. Other impacts associated with the hurricanes include the displacement of wireless communication antennas affecting the communication line of sight, rendering the ITS network inoperable. Taking into consideration these situations, the PRHTA will perform an evaluation on how to restore the advanced traffic signal systems network. This evaluation will take into consideration the lessons learned from recent atmospheric events to improve its resiliency.

Once this evaluation is performed, the PRHTA plans to modify the traffic signals systems project delivery procedures to implement a systems engineering approach. Based on this new method, the PRHTA will continue to implement advanced traffic signal systems on the most important

corridors but the focus of the project delivery will shift towards improving the testing, verification, and validation of the systems being implemented. Another important aspect is that the PRHTA will provide special emphasis on measuring the performance of the signalized corridors to reduce delays and improve mobility.

Deployment of ITS Devices for Traffic Incident Management and Traveler Information Dissemination

As mentioned, recently the focus of the TSM&O Program has been to improve the management of events that affect travel time reliability. The effort to improve the management of these events can be divided in two categories: (i) implementation of ITS technologies to aid in the management of traffic incidents, and (ii) the deployment of services and protocols to expedite traffic incident clearance.

The implementation of ITS technologies to aid in the management of traffic incidents began with the deployment of advanced traffic signal systems. These projects included the installation of CCTV cameras, and microwave radar vehicle detection systems which the PRHTA leveraged the TMC personnel to identify incidents on signalized roads and expressways/freeways. This approach, however, was altered due to the impacts of Hurricane María on September 2017. Due to the loss of communication with ITS field devices most of the installations were rendered inoperable.

Recently, the PRHTA initiated the deployment of ITS Devices on expressways/freeways with the purpose of traffic incident management and dissemination of traveler information. The first project of this kind started construction in Q1 2017 on Baldorioty de Castro Expressway (PR-26).

The traveler information component of these projects will also aid the PRHTA in complying with federal regulations, especially 23 CFR 511.

The PRHTA has staffed (outsourced) the TMC to cover the functions of traffic incident management and traveler information dissemination. The current operational period covers Monday to Friday from 6:00 am to 9:00 pm and is expected to expand with time to a 24/7 schedule, as the PRHTA TSM&O program evolves.

The O&M lifecycle stages are crucial to the continued success of the TSM&O Program and shall be budgeted into the recurring costs of the transportation systems expenditures. Therefore, the PRHTA will evaluate different funding sources to cover the cost of the O&M expenditures.

Multidisciplinary Transportation Operations – Regional Traffic Management Center

The PRHTA is currently building a Regional Traffic Management Center (RTMC) at the PR-52 Caguas Norte Toll Plaza. The RTMC will be the hub for Puerto Rico's traffic management activities, including but not limited to traffic incident management, and traveler information dissemination. The RTMC will be co-located with the Puerto Rico Police and Medical Emergencies Bureaus, and will be the central location for coordination for major incidents and emergencies affecting the surface transportation network.

The PRHTA expects that the expansion of the ITS network in Puerto Rico will be integrated into this RTMC to continue with the centralized management and operation of the surface transportation network. The PRHTA will also evaluate the possibility of center-to-center interaction between different facilities, such as the Metropistas PR-22 TMC and other emergency

management complexes to continue promoting a multidisciplinary approach to the transportation network management.

Intelligent Mobility and Disruption

Mobility is expanding globally. With the rise of the smartphone, access to mobility is becoming simpler and more 'on demand'. New modes, such as Transportation Network Companies (TNCs), electric bike share, electric scooters etc. are mixing with more traditional modes such as transit, providing a much broader 'transportation ecosystem' to the user. In many cases, these new services are providing 'first/last mile' solutions for riders who live a distance from transit stops and stations. Much progress has been made with transportation 'user experience' through the release of app-based services such as Uber, and the user now expects a much more fluid and seamless interaction with transportation services. In the future, these systems are expected to deliver 'autonomy' – driverless vehicles that provide a door to door service without the need for human interaction.

It is important that the 2045 LRTP builds on the progress made with ITS, that has primarily focused on congestion management in key corridors and focuses on non-car mode trips to influence behavior change – for residents and visitors. This should include transit as well as new modes and consider how the two will integrate. The smartphone, and the opportunities that it could bring, should be carefully considered.

Consideration has already been given to a new Advanced Traveler Information System (ATIS) website to promote multi-modal trip planning, and provide the public with real time information. The implementation of version 2.0 was delayed due to the impact that the hurricanes had over the ITS network. The PRHTA expects that the implementation of the most recent version will be carried out once the ITS projects already in deployment start coming on-line. Future version of the ATIS website could include features towards improving the transit user experience, such as providing trip planners, parking management information, real-time routing information, among other value-added features.

However – serious consideration should also be given to third party applications for traveler information, that source data from ITS systems. With the availability of free to use navigation apps and websites such as Waze, Google Maps, Apple Maps, Transit App and CityMapper, it is now very easy to plan a trip from A to B using only addresses and a set of best available options. The standardization of transit data, via the GTFS feed approach, has meant that it is relatively simple for a large city to provide its citizens with point to point trip planning, without investing in expensive web technologies. Google Maps (and similar apps) will do this for free if the data is made available; apps tend to be global in approach, so the 'user experience' is the same for someone visiting from London than it is for a local resident.

Like the traffic information provided on Google Maps overlay, these tools can also provide 'real time' updates on transit services (alerts and departures) and shared mobility (i.e. number of bikes at a station). Apps will consume data provided by the city and third parties in an appropriate format such as GTFS-RT, via Automatic Vehicle Location (AVL) and Automatic Passenger Counter (APC) systems. There are huge opportunities for Puerto Rico in this arena.

Overall, navigation apps make it easy for riders (or potential riders) to see where local bus stops and stations are, the routes they serve and importantly, services on route. This type of information provides confidence to the rider and encourages users to leave their car at home. Currently, Google Maps or any other GTFS-powered app are extremely unreliable in Puerto Rico. This is frustrating for many types of user, including those who are tempted for mode alternatives different from cars.

Mode Integration

The integration of all transportation modes to ITS is paramount to achieve a successful implementation in Puerto Rico. Looking ahead, accurate trip planning will form the backbone of a 'mobility as a service' delivery model - to encourage multi-modal travel considered on trip by trip basis, rather than growth in car ownership and TNC trips.

Key improvements should at least include:

Currently, most transit services operate somewhat independently from each other, resulting in reduced ridership on public transportation modes and a higher number of trips on private vehicles. These effects in turn contribute to congestion problems in many parts of the Island. The PRHTA plans to implement ITS strategies included in the Public Transportation Management User Services Bundle to integrate information collected from different transportation modes and present it to travelers so they can make an informed decision as to which transportation mode is better at a certain moment in time. It is desirable that an integrated system is open to:

- Provide real time information about multi-modal transportation services on kiosks, websites and apps – and present in GTFS-RT format;
- Dynamic signage at bus stops and trains stations to provide travelers with information about expected arrival times;
- Ability for users to reliably plan a complete trip using online electronic tools (Tren Urbano, Metro Urbano and AMA Metrobus websites), including accessible trips (wheelchair users etc.). This will require the integration of different data sets, via GTFS;
- Ability for the rider to purchase tickets online or via smartphone;
- Ability for the rider to understand in real time train or bus location. In the future, this could also include availability of bikes, scooters and car shares;
- Provide real time parking information in terms of availability, costs and payment methods – particularly at parking serving public transportation services; and
- Ability for the city to understand transit ridership through better data collection and analysis.

For improvements to happen, the Long-Range Transportation Plan should take the following into consideration:

> Carry Out User Research

How do people use the system? What are the flaw points? What can be learned from user behaviors? Interview riders and create user personas to better understand user profile, and what changes are needed to increase ridership.

> The Creation of a Strategic Roadmap for Passenger Information

The PRHTA should focus on becoming a 'platform' for the delivery of transportation modes, through the provision of data to third parties. To do this a product roadmap should be developed in the short term – this will set expectations and user requirements for future mobility.

The Development of an AVL/APC System for All Buses

Key to the delivery of a more open and accessible transit network is the provision of real time information for all vehicles. This data should then be made available publicly via the platform. Ideally, the data collected by these systems should be feedback to the agency for further analysis – using performance data to better improve the transit network.

Creation of a GIS Database of Geo-Located Bus Stops/Stations and Routes

Another key item is the creation of a GIS layer for transit assets – including bus stop locations. Innovative approaches have been taken globally to capture bus stop locations via smart phone apps.

Creation of a Central Transportation Website/App, with Integrated Trip Planner

There is currently no single user resource for accessing online transportation information, formatted for smart phones. As a priority, a new website should be developed that provides key information to transit riders, including trip planning, fare purchase and service alerts.

Incorporation of Accurate GTFS Data, and Transit Mapping, into Google Maps

Once complete, and a robust updating procedure is in place, regular checks should be made to Google Maps, Apple Maps and others. Feedback should be sought from end-users. Importantly, this information needs to be accurate and well maintained.

A Centralized Platform for the Dissemination of Transit 'Rider Alerts' to All Media Sources and User Groups

Another key element of a passenger information system is regularly updated Rider Alerts (GTFS-RT Alerts). This system will provide timely updates for users, via dedicated transit websites, apps and other sources such as Google and Apple Maps. Often, this system will form part of a software service connected with the creation and management of GTFS.

Interactions with Key Stakeholders Such as Google, Waze, Uber etc. to Better Understand What Services Could Be Provided.

Establish effective collaborative relationships with data collection agencies and private companies.

Consider strategies to ensure that new mobility services, such as dockless bike share and scooters can be managed to promote a more sustainable transport, in line with the benefit of users and a larger mode shift from car trips.

Development of a Digital Mobile Ticketing System, Potentially Integrated with Existing Tolling Accounts.

Make it easier for riders to purchase and use tickets. Allow for multiple points of purchase – including app and web-based systems. Where possible, tie to existing payment accounts.

Integrations with the Broader ITS Community/Stakeholders, as Stated in the ITS Regional Architecture.

Work closely with other key departments, data providers and consumers to share silos of information and knowledge.

CONGESTION MANAGEMENT PROCESS

Congestion Management System

The Congestion Management Process (CMP), previously known as Congestion Management System, is an essential part of the planning process. The CMP is a methodical approach for managing congestion to obtain up to date information of a Region's transportation system tendencies and performance. It uses analytic tools to address congestion within a territory, activity center, or corridor and to establish the method for reducing or eliminating traffic congestion issues. The FAST-Act's CMP suggests new management techniques, direct links to the planning process and to environmental considerations, as well as to travel demand reduction.

The general purpose of the Congestion Management Process appoints to: (i) apply an organized and systematic approach to traffic congestion in a metropolitan Region; (ii) reduce travel demand; (iii) address congestion management through effective administration and planning considerations; and (iv) help enhance the mobility of people and goods.

The previously discussed FAST-Act, as the binding law for the Island's 2045 LRTP, requires the Puerto Rico jurisdiction (San Juan TMA and Aguadilla TMA) to develop a Congestion Management Process as part of its planning operations. New and existing facilities in the Island will benefit from its results, for example by maximizing their use and by helping in the decision-making. See Table 7.1.

In summary, the CMP is being added to the roadmap established in the PRTHA's 2010 Congestion Management Plan Report, with benchmark measures of congestion established through the 2012 Congestion Management Process Report. This latter report identified and quantified measures for all road segments on the congestion management network; these links were characterized in terms of average speed, travel times and delays, traffic volumes and traffic service, safety conditions, transit ridership and other transit measures. With this frame of reference in place, the effect of congestion management improvements can be gauged in terms of the extent and degree of their positive impact on transportation system conditions. To advance the CMP, a technical committee is being formed to identify and prioritize new projects to address the highest need congestion management components.

Development of projects that contribute to congestion management is currently in progress. Significantly, one of the more important groups of projects in the FY2013-2017 period involves development of the ITS network, with an emphasis on the incident management component. The PRHTA has also established an interim traffic center in its headquarters building for management of the traffic signal system. There are also many capacity and non-capacity projects in the 2013-2017 CIP program that address elements of congestion management as highlighted in Chapter 5.

Table 7.1: Relation between Planning Factors and 2045 LRTP Goals

CONGESTION MANAGEMENT GOALS	2045 LRTP GOALS
Improve intermodal connectivity	A, B, C and D
Minimize delays caused by accidents	A, C and D
Optimize average travel time	A and C
Reduce traffic demand	A and C
Maximize existing capacity	A, B, C and D
Provide reliable travel times	A, B, C and D
Improve travel safety and security	A, C and D

Source: SDG and PRHTA

FREIGHT

2045 LRTP

The movement of goods (freight) is an important contributor to the economy of Puerto Rico. Freight's mobility affects the competitiveness of individual businesses and residents throughout the Island. The importance of freight in the Island wide transportation system is recognized in the Congestion Management Process (CMP) and in the 2045 LRTP's vision, goals, and objectives framework (specifically with the focus of Economy, the goal of Reinforce Economic Vitality and the objective of Facilitate the efficient movement of freight, business and tourism activities to achieve economic competitiveness). As part of the public outreach program, targeted efforts were made to engage a wider group of stakeholders (LRTP committees), freight interests were considered during the Plan development process with the establishment of the Freight Advisory Committee.

This Advisory Committee responds to the needs of the freight industry to be a proactive participant in the transportation planning process. The comments that the members of the Freight Advisory Committee mentioned are included in the appendices; some of these comments include the need to improve access to major airports/distribution centers and the need to complete the road network in the Island including:

- PR-5 extension;
- PR-22 extension;
- Mayagüez to Aguadilla corridor;
- Completing PR-10;
- PR-53 completion; and
- Also, the need to improve cargo services to Vieques and Culebra.

Also, the Advisory Committee had some specific suggestions on an extension of the freight network, some of these sections are presented in Figure 6.1.

Regional and national economic factors affect how freight moves. A shift between freight modes is not relevant in Puerto Rico once are transported by air of maritime shipments as trucking is the only mean of distribution in the island. For this reason, freight mobility becomes an economic factor tied to the performance of highways, particularly the strategic network. Improvements made to the network will benefit the freight industry as well as the other highway users.

Separate from the internal movement of freight in Puerto Rico there are also the Island's freight links to the Caribbean, continental United States, Latin America, and trans-Atlantic markets. These occur through Puerto Rico's primary airports and seaports, which carry air cargo, and serve as portals for the import and export of goods. Various government initiatives have focused on expanding these air and sea cargo hubs and the essential land access connections to them.

The new federal transportation legislation, the FAST-Act includes several provisions to improve the condition and performance of the national freight network and to support investment in freight-related surface transportation projects. The FAST-Act establishes a national policy of maintaining and improving the condition and performance of the National Multimodal Freight Network, one that provides a foundation for the U.S. to compete in the global economy. The FAST-Act specifies goals associated with this national policy related to the condition, safety, security, efficiency, productivity, resiliency, and reliability of the network, and in the reduction of adverse environmental impacts related to freight. FAST-Act requires DOT to establish (and publish on its website) a national freight strategic plan. The DOT will develop (and update) the plan in consultation with State DOTs, MPOs, and other appropriate public and private transportation stakeholders.

The national freight strategic plan will include:

- An assessment of:
  - The condition and performance of the network; and
  - Barriers to improved freight transportation performance and opportunities to overpass them;
- Forecasts of freight volumes for the succeeding 5-, 10-, and 20-year periods;
- An identification of:
  - Major trade gateways and national freight corridors that connect major population centers, trade centers, and other major freight generators;
  - Bottlenecks on the network that create significant freight congestion;
  - Corridors that access energy exploration, development, installation, or production areas;
  - Corridors that access major areas for manufacturing, agriculture, or natural resources;
  - best practices for improving the performance of the network, including critical commerce corridors and rural and urban access to critical freight corridors; and
  - Best practices to mitigate the impacts of freight movement on communities;
- A process for addressing multistate projects and encouraging jurisdictions to collaborate; and
- Strategies to improve freight intermodal connectivity.

Within 5 years of completing the national freight strategic plan, and every 5 years thereafter, DOT must update the plan and publish it on its website.

National Multimodal Freight Network

<u>Goals of the Network</u>

The FAST-Act directs DOT to establish a National Multimodal Freight Network to:

- "assist States in strategically directing resources toward improved system performance for the efficient movement of freight on the Network;

- inform freight transportation planning;
- assist in the prioritization of federal investment; and
- assess and support federal investments to achieve the goals of the National Multimodal Freight Policy established in 49 U.S.C. 70101 and of the National Highway Freight Program described in 23 U.S.C. 167"[91].

Establishment of Interim Network

The DOT must establish an interim Network, that includes:

- "the National Highway Freight Network that DOT establishes under the National Highway Freight Program (23 U.S.C. 167);
- the freight rail systems of Class I railroads;
- U.S. public ports that have total annual foreign and domestic trade of at least 2 million short tons;
- U.S. inland and intracoastal waterways;
- the Great Lakes, the St. Lawrence Seaway, and coastal and ocean domestic freight routes;
- the 50 U.S. airports with the highest annual landed weight; and
- other strategic freight assets, including strategic intermodal facilities and other freight rail lines"[92].

Other Freight Provisions

<u>State Freight Advisory Committees</u>

The FAST-Act requires DOT to encourage each State to establish a local freight advisory committee, to consist of a representative cross-section of public and private freight stakeholders. The role of a State freight advisory committee is to:

- "advise the State on freight-related priorities, issues, projects, and funding needs;
- serve as a forum for discussion for State transportation decisions affecting freight mobility;
- communicate and coordinate regional priorities with other organizations;
- promote the sharing of information between the private and public sectors on freight issues; and
- participate in the development of the freight plan of the State"[93].

State Freight Plans

To receive funding under the National Highway Freight Program (23 U.S.C. 167), the FAST-Act requires each state to develop a local freight plan, which must comprehensively address the State's freight planning activities and investments (both immediate and long-range). A state may develop its freight plan either separately from, or incorporated within, its statewide strategic long-

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[91]49 U.S. Code § 70103 - National Multimodal Freight Network.

[92] 49 U.S. Code § 70103 - National Multimodal Freight Network.

[93] 49 USC 70201: State freight advisory committees.

range transportation plan required by 23 U.S.C. 135. Among other requirements, a state freight plan must:

- "Cover a 5-year forecast period;
- Be fiscally constrained;
- Include a "freight investment plan" with a list of priority projects; and
- Describe how the State will invest and match its National Highway Freight Program funds"[94].

The state must update its freight plan at least every 5 years, and may update its freight investment plan more frequently than the overall freight plan.

The FAST-Act includes many provisions that modify federal requirements regarding the size and weight of vehicles that may travel on the Interstate System and the National Network.

For the Aguadilla Region, efficient freight movement equates to reduced business costs and improved competitiveness. Full recognition of the importance of freight planning in the MPO's planning processes, including the 5-year program, the LRTP, the congestion management process, and establishing a freight working group will facilitate a more targeted and prioritized approach to addressing freight mobility, and in cross-connecting transportation system planning, project definition and priorities, and coordination with congestion management. Figure 7.2 presents some of the logistics road additions that the Freight network that the Committee suggested for the Aguadilla TMA.

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[94] 49 USC 70202: State freight plans.

Figure 7.2: Additions to actual Freight Network – Aguadilla TMA
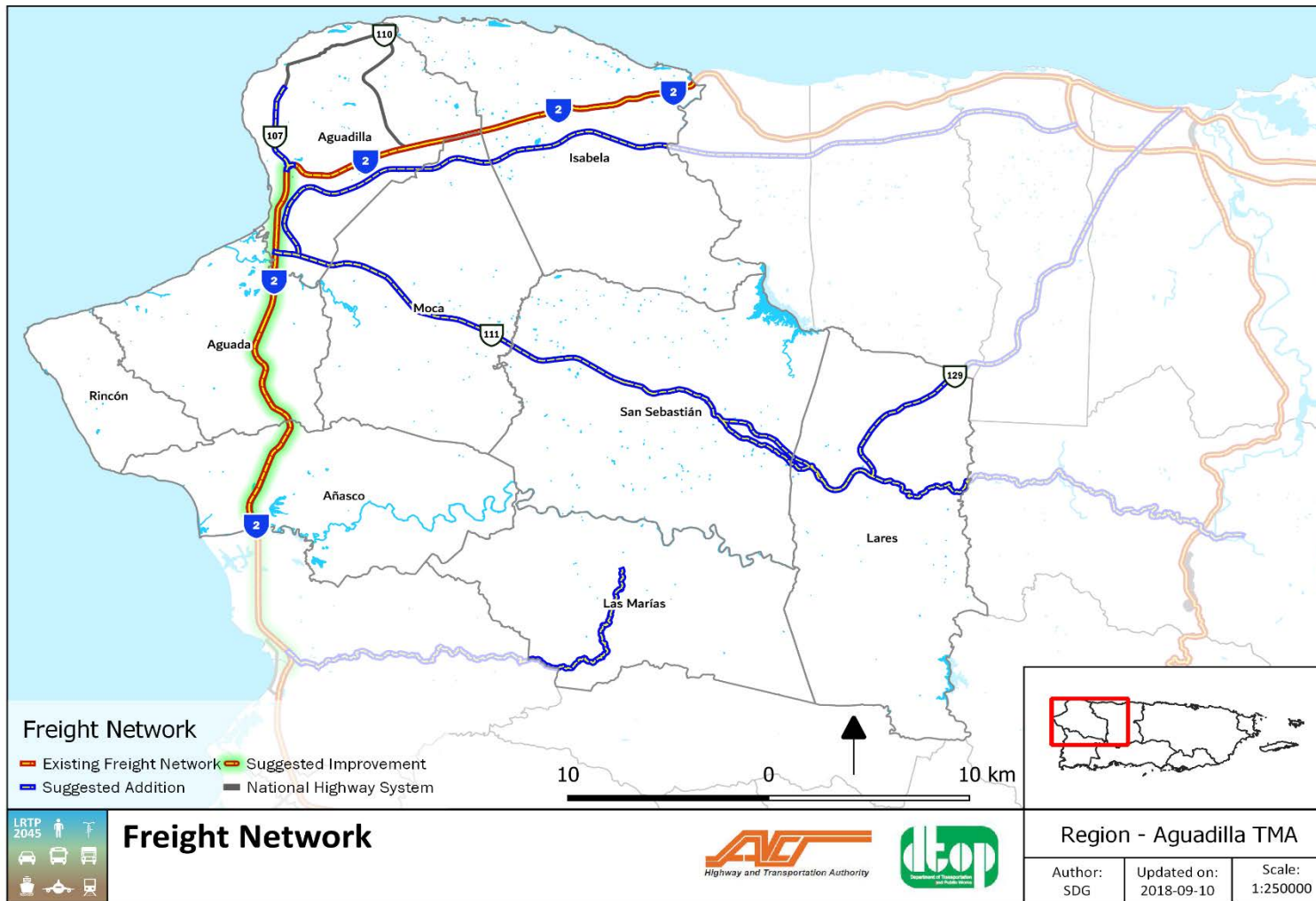
Source: The existing Freight Network information layer was obtained form the Federal Highway Administration (FHWA)

SAFETY AND SECURITY

Safety

Security based initiatives are intended to cover all existent modes of transportation. This aspect is a priority for the PRHTA and therefore related enterprises have been constantly developing.

Transportation service's operators apply specific security measures based on the mode's demands. This security plan is broadened and designed based on the FTA's guides. Every service operator has a duty to execute the plan to achieve all defined security goals and objectives.

Puerto Rico has been the object of countless efforts to improve the security of its roads and highways. For the PRHTA, road security is an essential topic of discussion and priority. For this reason, security measures need to be included in the Highway Work Program, where, among others, geometric intersection improvement, traffic controls and highway reconstruction are analyzed.

Additionally, Puerto Rico's Transit Security Commission has the duty to implement and develop security measures and traffic accident prevention programs. Its main mission is to reduce the number of transportation related casualties and damage to property. The latter is achieved by establishing educational programs and proactive efforts to inform citizens about existent transit laws and regulations[95].

The commission's effort, through all of its related programs, has helped reduce the rates in transit related accidents and addressed numerous security concerns. This has been achieved as a collaborative work between the PRHTA, other agencies and organizations.

The National Road Security Plan (HSP) is the guide by which the commission, along with the PRHTA, identify security problems, define transportation objectives and goals and presents its project implementation. The Puerto Rico Strategic Highway Safety Plan[96] comprehend the following areas:

- Traffic Records & Information System;
- Emergency Medical Response;
- Occupant Protection;
- Alcohol Impaired Driving;
- Aggressive Driving;
- Vulnerable Road User;
- Young Drivers;
- Roadway Departure; and
- Intersections.

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[95] Norms and Procedures for the Administration of Federal Resources Manual, Transit Security Commission, reviewed June 2016.

http://comisionparalaseguridadeneltransito.com/wp-content/uploads/2017/02/MANUAL-DE-PROC-Y-NORMAS-DE-FONDOS-FEDERALES.pdf.

[96] Puerto Rico Strategic Highway Safety Plan 2014-2018.

Security

Security plans and concerns focus primarily on safer transportation facilities, crime prevention and addressing possible terrorist threats. All agencies responsible for managing transportation issues, including those in charge of ports and airports, have a duty to integrate and comply with the federal requirements established by TSA.

The Strategic Highway Network is relevant when considering security issues. This facility provides access and continuity for the movement of citizens, goods, services and freight, not only in a daily basis, but during war, threats or emergencies. Its importance resides in its capability to serve as a connection between the principal cities and is an asset in terms of defense.

Coordination between the DTPW/PRHTA, the state and municipal police departments is a must. This is essential to maintain security along the Island's principal roads and highways. Implementation of applications such as the ITS will expand or amplify the transportation facilities' capabilities to provide security services.

ENVIRONMENT AND SUSTAINABILITY

Overview

The Aguadilla TMA is a composite of land forms ranging from dense urban development to natural settings including the Guajataca Natural Reserve Forest. From the surveys conducted with the public during the planning process, considerable interests and concerns were expressed about preserving environmental quality and fostering a more sustainable environment. The governor has established three initiatives, discussed below, that respond to the importance that Puerto Rico and its citizens place on the environment. Consequently, the topics discussed in this section – environmental sustainability, social sustainability, and economic sustainability are vital and relevant to transportation planning across the Aguadilla Region. This planning Region of the Island, is well positioned to capture the opportunities of its urban structure to evolve into a more livable urban environment.

Conservation and protection of the environment have been a long-standing principle of the Puerto Rico Commonwealth. Concern for the environment has been embraced within the broader concept of sustainability, which is defined by the U.S. Environmental Protection Agency (EPA) as a process that "creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations." Sustainability is focused on managing what we consume, how we consume it, and the byproducts of our consumption, in such a way that resources are preserved, regenerated, renewed, and available to those who follow.

From a review of several transportation agencies, their treatment of sustainability in relation to the transportation planning process encompasses environmental sustainability, social sustainability, and economic sustainability. Within this framework, sustainability can be viewed as including the following facets:

- Environmental sustainability:

- Air quality;
- Climate change;
- Environmental management and mitigation;
- Travel demand management; and
- Congestion management.
- Social sustainability:
  - Livability: travel choices (transit, bicycles and pedestrians);
  - Transportation and land use linkage; and
  - Public health.
- Economic Sustainability.

As evidence of the continuing commitment to sustainability in Puerto Rico, the government issued in 2013 Executive Order (OE-2013-017), calling for the creation of a Sustainability Action Council with responsibility for:

- Formulating strategies to reduce reliance on carbon-based energy;

- Advising the Governor on climate change mitigation and response;

- Proposing laws for further protection of environmental resources;

- Identifying ways to create "green" jobs related to new forms of energy and environmental restoration;

- Supporting the development and implementation of policies and laws, strategies and programs, and communications between academic centers for ongoing technical exchange of sustainability advances.

The Council was established to comprise a cross-section of membership drawn from academics, environmentalists, economists, businesses that have embraced the concept, technical professionals, and the public. This council on sustainability presents an opportunity for the MPO and PRHTA to provide input and information on an ongoing basis as it relates to the transportation system.

The following sections describe how the activities of the MPO and its transportation partners relate to the important environmental topics that are essential components of a well-rounded transportation planning and transportation system management framework.

Sustainability and the Environment

Air Quality

This section summarizes the status of air quality for the Aguadilla TMA.

Pursuant to the provisions of the Clean Air Act (CAA) and its subsequent amendments, the EPA has established the National Ambiental Air Quality Standards (NAAQS) for six criteria pollutants. These standards have been established to protect the public health. When an area meets a particular standard, it is stated that it is an "Attainment" area. Otherwise it is designated as a "Non-Attainment" area, which implies that a compliance plan shall be developed until the "Attainment" status is obtained. Nevertheless, transportation sources contribute to four of the six criteria pollutants for which EPA has established standards to protect public health and/or safety. The

pollutants are: ozone (O3), carbon monoxide (CO), particulate matter (PM10 and PM2.5), and nitrogen dioxide (NO2). Until 1991, the entire Island was designated as one in which all the NAAQS were met. In September 2005, the 2030 San Juan LRTP was found in transportation conformity since requirements of the federal CAA PM10 emissions associated with the surface transportation network were less than the SIP emissions inventory established in 1993.

However, an exceedance of the Particulate Matter (PM10) was verified in the municipality of Guaynabo, after which the Urbanized area of this municipality was places under a "Non-Attainment" status. After developing and implementing compliance measures that were incorporated in the State Implementation Plan (SIP), air quality monitoring data provide support for a delisting request that was submitted and approved by the EPA in January 12, 2010. The decision was published in the Federal Register (Volume 75, No. 7, pages 1543 and 1544) and is part of the required conformity analysis which established a maximum level of PM10 pollutants that may be emitted by the area's transportation system. LRTPs for areas where attainment for any of the pollutants does not exist must show that the implementation of the plan will not exceed the allowable level of emissions.

The Aguadilla TMA is not within the designated "Non-Attainment Area" and therefore is considered an "Attainment-Area" for all criteria pollutants.

The responsible agencies and officials in the Commonwealth have committed to policies, specific projects, and a general course of action that promote good development, efficient transportation systems, and protection of the environment. This in turn contributes to improved air quality and creates more sustainable communities. A variety of concerted actions and policies such as pedestrian friendly land uses and improvement of pedestrian facilities, intersection improvements and other low-cost transportation measures, covering of loads on trucks, stabilizing the sides of roadways, paving parking areas, street cleaning and removal of road dust, and restoring roads to good repair can help in this endeavor. The increased emphasis on and implementation of transit improvements is a major commitment that will bring benefits for many years to come. These and other actions of the responsible agencies and officials will serve to improve the air quality.

The importance of air quality and the need of addressing the issue of greenhouse gases prompted the issuance of Executive Order (EO-2013-018). This EO required to perform a study of greenhouse gases in Puerto Rico to was to be jointly led by the Energy Affairs Administration, the EQB, and the Department of Natural Resources and Environment. The purpose of the study was to provide a profile of the level and sources of greenhouse gases in Puerto Rico, the impact on the environment of these carbon emissions, and strategies to reduce the emissions. The MPO and PRHTA participated in this effort as the emission of greenhouse gases from the transportation system contributes to the overall mix of gas sources. In September 2014, the agencies issued the Puerto Rico Greenhouse Gases Baseline Report. Perhaps the most relevant conclusion of the report is that the Green House Gases (GHG) emissions in Puerto Rico rose faster that the US average through 2005, falling and stabilizing afterwards. However, future emission levels are predicted to be significantly higher than 1990 levels in 2020 and beyond. These levels are higher than many subnational, national, and international targets for GHG

emission reduction. The EO provides strategies targeting the two (2) primary emitting sectors: the electric power generation and the transportation and land use.

Regarding to the transportation and land use sector, which are the one pertinent to this report, the forecasts for emission reductions are encouraging, even before the establishment of a concerted local policy adoption. The emissions from the on-road fleets (light duty cars and trucks as a well as heavy-duty trucks), reached peak levels during the 2000-2010 decades and are being predicted to fall over time. This trend is the result of the expectation that the total amount of driving (VMT) has been holding steady without growth in recent years. This observation is compatible with the one observed on a nationwide basis in the United States, due to higher fuel prices and greater levels of urbanization, and has broken decades-long linkages between economic and VMT growth. Also, the expected dramatic improvement of light duty vehicles is expected to play a starring role in the predicted emissions due to the relatively great number of them constitute a primary source of on-road fuel use. Mandated federal corporate average fuel economy (CAFE) standards, require new vehicles average the emissions equivalent of 54.5 miles driven per gallon of gasoline combusted by year 2025. For heavy trucks, there is also a forecast to achieve higher efficiency gains.

Even though that projected emissions reductions are expected, they are not sufficient to reach the desired goal which is to have emission levels comparable to 1990 levels. Additionally, the most significant driver for the reductions in emissions, new fuel efficiency standards, are not predicted to continue up to 2050. Therefore, additional measures shall be implemented. The most promising of them is the adoption of a local strategy that provides incentives for the conversion of the auto fleet to electric vehicles. Potential candidates for this strategy are:

- Provide vehicles charging infrastructure;
- Easing of the permitting process for the construction of private charging facilities;
- Establishing or enhancing subsidies for charging equipment and/or vehicles; and
- Enhancing tax credits for electric vehicles purchases.

The MPO is already and continue to be involved with transportation planning and management activities that should be an integral part of the study recommendations.

Climate Change

Climate change issues and their effects on developed environments are a rapidly emerging consideration in LRTP documents across coastal areas and specially in Puerto Rico in the aftermath of Hurricane María. The relation to transportation is through transportation greenhouse emissions from vehicles using the transportation system. Overall, transportation accounts for 29 percent of all greenhouse gas emissions. The EPA reports that the average car owner releases 4.8 million metric tons of carbon dioxide each year by driving. The total amount of carbon generated by the transportation system is a function of the vehicle mix in the fleet, the fuels used, and the operational efficiency of the system (network travel speed). The federal government has recently approved new Corporate Average Fuel Economy (CAFE) standards for new vehicles, which will further reduce emissions. Changing vehicles and their emission rates is reasonably manageable. Changing how well the system moves these vehicles and how people change their needs to consume transportation mobility is more challenging.

There are two dimensions to the transportation reach: mobility and accessibility. Mobility refers to how much ground or distance can be covered rapidly; thus, vehicle miles of travel is a positive indicator of this dimension. Automobiles on uncongested freeways greatly expanded urban mobility, encouraging suburbanization. Accessibility, the other dimension, means the ability to reach a desired range of various needs (shopping, services, schools, work, recreation) within a relatively short distance. If such resources, or at least many of them, are available within a short reach, then overall vehicle miles of travel can be reduced, so strategies and policies to adjust personal decisions about place of residence, place of work, and place of other destinations can influence trip lengths and travel mode choices, thus reducing the amount of travel and the environmental consequences of that travel. And if that travel involves more non-motorized travel by walking or bicycling, a collateral benefit that has been demonstrated in the literature is improved personal health and better quality of life.

The publication by the FHWA, *Integrating Climate Change Considerations into the Transportation Planning Process: Final Report* (2008) discusses how acknowledgement of climate change concerns can be coordinated with transportation planning processes. Regarding the LRTP process, climate change can be reflected in the plan vision, goals, and objectives; it can be connected to projects that provide benefit in terms of reduced vehicle miles of travel and reduction in greenhouse gas emissions; and it can be monitored in terms of performance measures of programs and projects.

Under Goal 4 of this 2045 LRTP—promote environmental sustainability—the four stated objectives address minimizing adverse impacts to the natural and built environments; reducing greenhouse gas emissions and energy consumption, and improve air quality; supporting integrated transportation and land use planning for more livable communities and reduced travel; and enhancing alternative modes and travel demand strategies. All of these objectives interface with climate change concerns. Other plan objectives also connect to climate change as discussed in the FHWA report. Various projects in the plan relate to reduced vehicle miles traveled and emissions, and the outputs from the travel demand model include a number of useful performance measures that relate to climate change impacts.

In terms of the planning process, the FHWA report notes there are avenues to integrate climate change into the MPO's ongoing activities; these are related to coordination with other agencies, land use planning and integration, and funding linkages. On these fronts, the MPO has opportunities to introduce climate change into to its coordination with the Island planning and environmental agencies, in its coordination with the Planning Board regarding regional land use planning that is presently underway, and in linking funding decisions in part to climate change considerations.

This impact of transportation activity can be addressed through the following means:
- Reducing the direct emissions from vehicles:
  - Improving vehicle miles per gallon via the CAFE standards established by the EPA and USDOT); and
  - Improving traffic conditions by reduced congestion and improved signal timing.
- Reducing vehicle miles of travel:
  - By reducing trip length;

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- By increasing vehicle occupancy through higher automobile occupancy (carpooling);
- By increasing vanpooling;
- By increasing use of transit;
- By decreasing required trip lengths by improved land use decisions;
- By promoting more non-motorized travel by walking and bicycling;
- By eliminating the need for travel (compressed days of work and telecommuting); and
- By promoting the development of walkable, mixed land use activity centers with access to transit for longer distance trips.
- Reducing congestion on major travel corridors:
  - By improving travel speeds; and
  - By providing competitive transit service.

PRHTA has been active on a number of these fronts with projects that contribute to reduced transportation impacts on the environment, through its development of the CMP and through the implementation of other projects that address traffic operations. In addition, PRHTA has been coordinating with various municipalities and regional economic development organizations on potential transit projects as well as trails and greenways projects.

One of the primary concerns of climate change besides air quality is the longer-term effect of rising sea levels due to increases in atmospheric temperatures and the melting of the arctic icepack. Since 1880, sea levels have risen by 8 inches. Some projections say sea level will rise by a foot by 2040 and by up to two feet by 2060. According to climatologists at Climate Central (www.climatecentral.org)), as reported in their peer-reviewed surging seas report, 55 sites across the United States were analyzed to evaluate the level at which the "storm of the century" would normalize, determining that most major storm events would normalize at about four feet above the high tide line. Of the vulnerable populations in the United States, half of those living in Florida and eight of the top ten cities determined to be in Florida. It was found that two counties in South Florida, Broward and Miami-Dade, each have more people living below four feet of elevation than any state other than Louisiana. The recent storm event Sandy, impacting New Jersey and New York, is further demonstration of the devastating impact of such events.

As a result of this concern, the four counties in Southeast Florida entered into the Southeast Florida Regional Climate Change Compact to work cooperatively to address climate and the resulting sea level concerns. These issues are problematic in terms of their solution, but planning and policy development, as reflected in transportation system planning and management, is a proactive approach that was acknowledged by FHWA for its vision. As an example of the complexity in dealing with climate change effects, a recent combination of tropical storm surge and high tides caused considerable damage to the Florida State Route A1A roadway on the Fort Lauderdale beach, triggering an expensive refurbishing project to put the roadway corridor back into operational use. Various reaches of Southeast Florida beaches have experienced recurring issues with beach erosion and beach replenishment. These same issues can confront Puerto Rico's coastal realms.

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Advance planning for sea rise and climate change contingencies is a proactive measure that enhances the development of evacuation planning for low-lying coastal areas. A number of low-elevation communities in Puerto Rico coastal areas are susceptible to marginal increases in sea rise over the long term or to combinations of high tide and storm-related water elevation increases and surges. In addition, the Puerto Rico State Agency for Emergency and Disaster Management (PRSAEDM) and partners have recognized the potential for tsunami events within the Region and have done advance planning to support the preparedness and response elements of such events. PRSAEDM coordinates programs addressing disaster preparedness, response, recovery, and mitigation across focus areas including earthquake safety and risk reduction, the National Flood Insurance Program, the National Hurricane Program, Mitigation Grant Program, Assistance Program for Flood Mitigation, and Pre-Disaster Mitigation Program.

The significance of pursuing climate change response strategies was authenticated by the Governor of Puerto Rico, who issued Executive Order (EO-2013-016). This EO designated the Department of Natural and Environmental Resources (DNER) as the lead agency with the responsibility to perform an analysis of the climate of Puerto Rico and assess and identify vulnerabilities of the infrastructure with the goal to establish and develop an Adaptation Plan to cope with such findings. All local infrastructure government agencies as well as some private entities were addressed by this order. In June 2016, with the assistance of the DNER, the DTPW published a report entitled Climatic Change- Adaptation Plan. This plan established a road map that shall be followed in order to successfully adapt the agency infrastructure to the potential adverse impacts resulting from the climate change. This is an on-going multi-year process that will require the identification of economic resources and modifications to the current transportation infrastructure at some specific locations.

It is recommended that the MPO and PRHTA participate in this effort as transportation infrastructure that may be vulnerable along the coasts and elsewhere is ubiquitous. The MPO is already involved with transportation planning and management activities that should be an integral part of the study recommendations. The PRHTA and MPO, working together, could advance an analysis of the transportation network using Geographic Information System databases, including topographic information, to perform a susceptibility analysis for transportation infrastructure due to increases in seawater elevation. This analysis would provide a starting point for further discussion of land use and infrastructure concerns resulting from rising seas and related issues, and could inform certain decisions about how to invest in at-risk roadways, for example. The MPO looks to build on its current collective efforts that relate to climate change, both in terms of the processes that it is involved in, and in the planning documents that are produced.

Environmental Management and Mitigation

Another important facet of transportation is the impact of transportation projects on the environment. The prevalence of environmental assets across the Island heightens the need to plan projects to avoid or minimize environmental impacts, and to devise proactive mitigation strategies to compensate properly for needed improvements with unavoidable impacts. As individual projects are developed, they are subjected to the required environmental scrutiny,

complying with both federal and Commonwealth laws and regulations. Puerto Rico has traditionally placed a high value on its environmental resources and has in place its own robust environmental impact review process that, in tandem with National Environmental Policy Act (NEPA) requirements for environmental assessment of qualifying projects, creates a framework for minimizing environmental harm.

These process tools include agreements between PRHTA and other local and federal agencies, including the Permits Management Office, the Department of Natural Resources and Environment, the Planning Board, the State Historic Preservation Office, the Puerto Rico Culture Institute, and the EQB. Puerto Rico also recently created a Permits Management Office, which is designated to issue construction and development permits, and provides a consolidated clearinghouse for the rules and requirements of other government agencies under a Joint Permit Regulation for Construction Works and Land Uses. For federally funded projects with required environmental documentation, the PRHTA coordinates with the EQB regarding compliance with Commonwealth environmental regulations.

Congestion Management Process

As described separately in this chapter, the PRHTA has embarked on the development of its Congestion Management Plan and Process as required under federal regulations. The plan development process thus far has defined the congestion management network for the San Juan and Aguadilla Regions; established goals, objectives, and measures; developed a set of toolbox strategies to address congestion management; and identified target locations for further analysis. The identified strategies are multimodal and span a spectrum of capacity, throughput efficiency, and alternative mode approaches. The next phase of work should identify specific priority congestion management projects that can be incorporated into the 5-Year TIP and the long-range transportation plan process. The CMP should prove to be an effective channel for prioritizing high-impact projects into the transportation system, and as a result, contributing to improved air quality, reduced fuel consumption, and more efficient use of transportation assets.

Social Sustainability

Livability

Livability is planning concept that seeks to interconnect decisions about the transportation system with land use planning, environmental protection, and economic development to promote communities where reliance on the auto is greatly diminished, where a variety of mixed uses of sufficient density are highly accessible by walking or bicycling, and where quality of life is enhanced by improving environmental quality. As noted in the publication *Livability in Transportation Guidebook: Planning Approaches that Promote Livability (FHWA/FTA, 2010)*, there are a number of allied urban planning initiatives that interface with livability, including smart growth, walkable communities, transit-oriented development, life-long communities, complete streets, and new urbanism. This planning concept has received renewed visibility with the initiation in 2009 of the Interagency Partnership for Sustainable Communities formed between three (3) important United States agencies (U.S. Department of Housing and Urban Development, U.S. Environmental Protection Agency, and U.S. DOT). This partnership has advanced six (6) livability principles that are being reflected in existing and new

federal programs across these three agencies, reflecting initiatives through transportation, housing, and the natural and built environments[97].

The six livability principles are:

- **Provide more transportation choices** to decrease household transportation costs, reduce our dependence on oil, improve air quality, and promote public health;
- **Expand location- and energy-efficient housing choices** for people of all ages, incomes, races, and ethnicities to increase mobility and lower the combined cost of housing and transportation;
- **Improve economic competitiveness of neighborhoods** by giving people reliable access to employment centers, educational opportunities, services and other basic needs;
- **Target federal funding toward existing communities –** through transit-oriented and land recycling – to revitalize communities, reduce public works costs, and safeguard rural landscapes;
- **Align federal policies and funding** to remove barriers to collaboration, leverage funding and increase the effectiveness of programs to plan for future growth; and
- **Enhance the unique characteristics of all communities** by investing in healthy, safe and walkable neighborhoods, whether rural, urban or suburban.

The federal, Commonwealth, and local governments have differing roles and responsibilities in relation to the application of these principles. The Puerto Rico's Land Use Plan promotes the development of more livable communities. This plan acknowledges the role of the transportation system as supportive to workers and to the creation of an overall better quality of life. The Plan and Guide for the Design of Complete Streets from PRHTA also recognizes the important role of transportation development for development for the creation of better and livable societies. The Plan's goals and objectives pretend to achieve habitable communities by improving the transportation system

The framework of vision, goals, and objectives for the 2045 LRTP include Objective 4.3 which relates to "integrated transportation and land use planning for more livable communities and reduced (automobile) travel." Several other objectives are also supportive of livability in terms of improved connectivity, enhanced integration between and within modes, increased travel choices, reduced congestion and travel time, leveraging the efficiency of prior infrastructure investments, minimizing adverse environmental impacts, reducing greenhouse gas emissions and energy consumption, and enhancing alternative modes and travel demand strategies.

Transportation Demand Management

Transportation demand management (TDM) refers to a set of strategies that are focused on influencing individual travel choices relating to the need for a trip, the Origen and Destination points for the trip, how and when the trip is made. The intention of TDM is to help alleviate travel congestion through lower cost means than major capital investments for physical system capacity. Additionally, it provides strategies to increase shared and non-motorized forms of transportation, while addressing the need to reduce congestion and air pollution.

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[97] Livability in Transportation Guidebook: Planning Approaches that Promote Livability (FHWA/FTA, 2010).

The TDM is an integral component of a Congestion Management Process (CMP). Many TDM strategies can be employed to affect travel demand. Table 7.2 presents these strategies.

Table 7.2: TDM Strategies

TDM Strategies	Definitions
Ridership programs	Trip matching, carpooling, vanpooling, high-occupancy vehicle lanes.
Transit Usage	Improved or new transit services, favorable transit pricing through passes and fares.
Alternatives Modes	Encouraging more trips by bicycling and walking, to reduce vehicular trips and to support improved public health.
Telework/Telecommute Programs	Replacing commuting with remote work sites relying on telecommunications.
Compressed work weeks	Variable work hours to take commute trips out of the peak hour, or to reduce the number of trips.
Parking management	Managing parking supply and cost to influence travel choices.
Park & ride facilities	Built to support increased use of connecting transit services.
Congestion pricing	Dynamic pricing of toll facilities to discourage peak-period trips.
Transit oriented development	Mixed-use developments at transit nodes to reduce auto-based trips and increase transit and non-motorized travel.

Source: SDG/PRTHA

The TDM strategies mentioned, are included in the CMP developed for the San Juan TMA and Aguadilla TMA. As that process begins to find specific congestion management projects for implementation, TDM approaches will be considered. Table 7.3 presents several TDM-related projects that have been implemented in Puerto Rico.

Table 7.3: TDM – Related Projects in Puerto Rico

TDM strategy	Project & location
Transit Usage	There has been an increase on the usage of municipal transit services (contrasting a decreased on Público services), most of these services are free to the public.
Alternative modes	PRHTA has develop a Comprehensive Bicycle and Pedestrian Plans as well a Complete Street Plan and Design Guidelines. Both plans promote alternative modes trough a various initiative, publicity and educational campaign.

Source: SDG/PRTHA

Transportation - Land Use Linkage and Scenario Analysis

The prior discussions of livability and transportation demand management highlight the importance of the transportation and land use linkages. In the new era of reduced new construction funding, rising costs for transportation projects, managing an aging population Rico and considering the impacts of natural disasters in accessibility, focusing a portion of transportation project investment on projects that support community development, economic revitalization, and multimodal accessibility can be more effective than conventional roadway capacity projects. These initiatives must be coupled with land use projects that promote affordable

housing with mixed land uses and access to transit, in order to effectively reduce the amount of travel needed per person and increase modal split reducing auto dependency. This in turn reduces pollution and energy use. More use of active transportation, such as walking and bicycling, also generates benefits to personal health. Interactions between transportation and land use enhances quality of life, reduces public infrastructure costs, and makes the transportation system more efficient.

One of the challenges is in taking the first few steps toward livability and sustainability. The existing transportation and land use fabric has evolved over decades and represents the collective result of millions of individual decisions about where employment is located, where people choose to live, where they shop and go to school, and how they choose to travel between these places. Changing the shape and character of this urban landscape likewise will require the first successful steps on prototype projects under improved economic and real estate market conditions. Unfortunately, Puerto Rico has experienced a population decline over the last decade, and continued reporting indicates that the decline has continued. The population forecasts for the Island to 2045, as prepared for this LRTP, do forecast an eventual return to a population growth trend, albeit a modest one compared with the present. This will limit to some extent the opportunities for development. There is always, of course, movement in the housing, retail, and employment market places even with a stable population as housing stock ages and younger consumers seek different housing and lifestyle options.

Cities across the Island are investigating and investing in the reinvigoration of their traditional town centers, either by renovation of old underutilized buildings or by planning and developing "in-town" projects that offer new development in the city center on vacant and underused land. Some of the several examples across the Island include Fajardo, Bayamón, Caguas, San Juan, Humacao, Carolina, Ponce, and Aguadilla. As noted, even in no growth or slow growth situations, submarkets of the population can be looking for these types of live-work-shop-play walkable community lifestyles. Often such projects can serve as the nucleus for adjacent redevelopment that expands on the success of the initial phase.

Public Health

Numerous studies exist that corroborates the relationship between transportation and health. There is an overall notion that recognizes the importance of promoting active transportation, walking and bicycle riding to develop healthier and more sustainable societies.

The American Public Health Association (APHA)[98] reasserts this principle by stating that transportation related decisions affect the citizen's quality of life: "poor transportation decisions can harm health and are not always fair across all communities"

The APHA has drafted a document[99] to suggest the collaboration that needs to exist between this institution and the Metropolitan Planning Organizations (MPOs). Its main objective is to establish

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[98] https://www.apha.org/topics-and-issues/transportation.

[99] https://www.apha.org//media/files/pdf/topics/transport/health_primer_designed.ashx?la=en&hash=532EC626D143DF99445C0726665550CC9BEB0CAD.

a symbiotic relationship between the public health and the transportation sectors. This relationship can be summarized as follows: persons are inclined to walk or use a bicycle if there are (1) available facilities and (2) an adequate and safe environment to perform the activity.

On the other hand, the Federal Highway Administration (FHWA) also recognizes the relationship between transportation and public health. The FHWA highlights the importance of working with professionals in both transportation and health fields to make better decisions in transportation related matters. There is a plan to develop transportation options that help provide citizens with a better quality of life. A resulting healthier society is part of this goal. The referred plan needs to focus in the following[100].

- Promote safety;
- Improve air quality;
- Respect the natural environment;
- Improve social equity;
- Create additional opportunities for the positive effects of walking, biking, public transportation, and ride-and vehicle-sharing; and
- Conduct research on transportation's role in improving quality of life.

The FHWA, in collaboration with the Center for Disease Control and Prevention (CDC), has created an important instrument, the Transportation and Health Tool (THT), to provide access to data that can be useful to study how the transportation system is affecting the citizen's health.

Both, The Complete Street Plan and Guides and The Cyclist and Pedestrian Integral Plan recognize the benefits of using alternative modes of transportation to help improve people's health and overall quality of life. These plans seek to improve physical and mental health while promoting more accessible facilities and nonpolluting activities.

The LRTP's recognition and promotion of the relationship between alternative modes of transportation and public health, through its goals, objectives, The Complete Street Plan and Guides, The Cyclist and Pedestrian Integral Plan, contributes to achieve the intent stated by the Puerto Rico's Land Use Plan[101], which also advances better health possibilities.

Economic Sustainability

The PRTHA has the duty to develop multimodal transportation projects for the entire Island of Puerto Rico. This agency has faced important challenges in recent years, due to lack of funding for project maturation or expansion.

The PRTHA's revenue comes primarily from petroleum taxes. This revenue is adversely affected by inflation over time, but also by the development of new technologies that promote more efficient use of fuels. Together with the Island's economic depression for the last years, the increase in preservation costs and project growth and the agency's debt that requires large budget designations there are some crucial issues affecting multimodal transportation these days.

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[100] https://www.fhwa.dot.gov/planning/health_in_transportation/.

[101] Puerto Rico's Land Use Plan – Territory Organization Guides (Board of Planning, 2015).

In order to improve its fiscal stance, the PRTHA has to comply with the Certified Fiscal Plan from the Fiscal Control Board of Puerto Rico. This certified plan provides special guides to transform the agency's structure along with the transportation facilities in the Island. The plan establishes that the PRTHA must:

- Transform drastically to achieve its goals;
- Improve governance and performance management;
- Pursue grater revenue opportunities;
- Focus on operational excellence including capital efficiency; and
- Reduce traffic to drive economic growth.

To continue developing cost management and debt reduction strategies will help the agency to achieve better financial status in the long term.

LOOKING FORWARD

The plan's main goal is that all users and interested parties benefit from its results. Beyond all financial challenges presented, the LRTP has the interest of improving the transportation system in the Island.

It is crucial to be aware of new legal requirements and federal politics regarding transportation. In this context, the most recent federal transportation legislation, The FAST-Act, in force since December 4, 2015, contains updated guides to assign and manage transportation funds. This recent legislation also presents new concepts to include in the transportation planning process.

The PRTHA needs to improve its financial status to fulfill its role to maintain, administrate and develop the Island's transportation system. Once a reasonable financial status is achieved, other important actions can be managed through the MPOs. These actions will promote better land use, transportation politics and the foundation for a multimodal transportation orientation. Evolution is always required to continue improving investment capabilities and the transportation system in general.

The following are some important initiatives that the MPOs can trigger in the future:

- Project funding

  - Identify local financial sources to assist with federal investment; and
  - Identify new opportunities in the private and public sectors to finance projects and accelerate implementation.

- Transportation management

  - Maintain the non-motorized transportation crew in order to promote pedestrian and bicycle network improvements, requirements and programs;
  - Monitor the Complete Street Plan and Guides and The Cyclist and Pedestrian Integral Plan implementation;
  - Create, formalize and administrate a freight transportation work crew;

- Active participation in the development of collective and non-motorized transportation plans;
- Coordinate CMP's integration in transportation planning;
- Promote the implementation of ITS applications; and
- Support the coordination between DTPW/PRHTA, transportation agencies and the MPO to improve performance metrics and monitoring, as stated by federal requirements.

- Sustainability and Livability

    - Establish a work crew to help improve land use planning while allowing the PRTHA and the Board of Planning to continue their efforts;
    - Identify strategies to promote an intelligent and sustainable growth; and
    - Promote coordination with federal programs such as the habitability initiative from HUD/DOT/EPA.

- Communication and Coordination

    - Continue developing the Citizen's Participation Plan (CPP) to incorporate initiatives in the Island's communities;
    - Develop a digital communication program to allow access to information, meeting coordination and record keeping of programs and activities; and
    - Allow the MPO to serve as an information center and as a coordination entity through its committees, by defining its new capabilities.

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