

# Ground-Water Use from the Principal Aquifers in Puerto Rico During Calendar Year 1990



U.S. Department of the Interior—U.S. Geological Survey

## Introduction

Puerto Rico has an area of 3,460 square miles (mi<sup>2</sup>) including the offshore municipalities of Vieques and Culebra. Approximately 30 percent of the area (1,067 mi<sup>2</sup>) is underlain by alluvial and limestone deposits, which make up the principal aquifers of the islands. These aquifers extend mostly along the islands' coastal areas. Volcanic rock aquifers of limited extent also may be present locally throughout the east/west trending Cordillera Central mountain range of Puerto Rico and the interior mountainous areas of Isla de Vieques and Isla de Culebra (Gómez- Gómez, 1987). A significant amount of the water used in Puerto Rico during 1990 was withdrawn

from aquifers at a rate of 158 million gallons per day (Mgal/d).

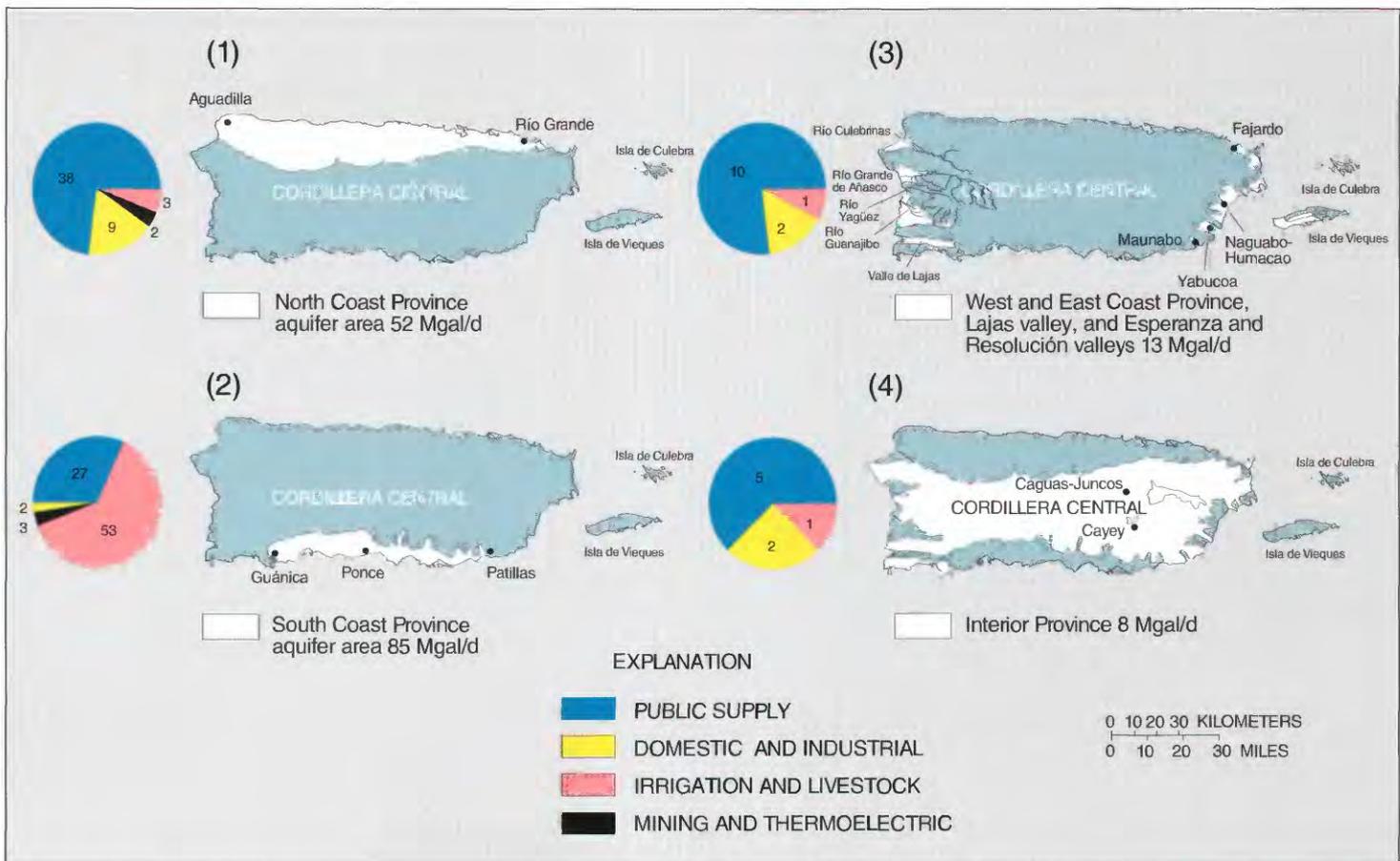
For the purposes of this report the principal aquifers of Puerto Rico have been divided into four major aquifer areas, the: (1) North Coast Province; (2) South Coast Province; (3) West and East Coast Provinces, Lajas valley, and the Esperanza and Resolución valleys; and, (4) Interior Province (Caguas-Juncos valley and Cayey valley) (fig. 1). The major aquifer types and the area of coverage in Puerto Rico are shown in table 1.

Puerto Rico has a complex rainfall pattern which is mainly controlled by the orographic effects of the Cordillera Central mountain range, with an average

**Table 1.** Major aquifer types and area covered, in square miles in Puerto Rico

Aquifer type	Area
North Coast Province	680
South Coast Province	230
West, East Coast Provinces	84
Lajas valley	35
Esperanza and Resolución valleys	18
Interior Province	
Caguas-Juncos valley	17
Cayey valley	3
<b>Total Area</b>	<b>1,067</b>

altitude of 2,800 feet (ft) at most peaks and a maximum altitude of 4,400 ft. The Cordillera Central forms a barrier to the Northeast Trade Winds and affects the distribution of rainfall throughout Puerto



**Figure 1.** Aquifer types and withdrawals, in million gallons per day (Mgal/d), by category of use in Puerto Rico during 1990.

Rico. Much of the south coast lies in a rain shadow averaging less than 45 inches per year (in/yr) of rainfall, whereas the northern part of the island averages about 80 in/yr.

On a yearly basis, Puerto Rico receives an average of 72 inches of rainfall, of which about 46 inches is lost to evapotranspiration. 23 inches is accounted as surface-water runoff, 1 inch is stored as surface water in reservoirs, 1 inch is withdrawn from coastal aquifers, and 1 inch is ground-water discharge from coastal aquifers to wetlands, estuaries, and the seabed (F. Gómez-Gómez, USGS, written commun., 1996). The offshore islands of Isla de Vieques and Isla de Culebra have a similar rainfall pattern as the south coast of Puerto Rico. A generalized water balance for the island of Puerto Rico is shown in figure 2.

### North Coast Province

The North Coast Province covers about 19 percent of Puerto Rico, extending from Aguadilla to Río Grande, and is 680 mi<sup>2</sup> in area (fig. 1). This province is comprised of two principal aquifers which includes the alluviated valleys, but is comprised primarily of a band of Tertiary limestone units of which

the uppermost four units contain the two principal aquifers. The Aguada and the Aymamón Limestone constitute the upper aquifer, which is unconfined throughout much of its extent. The Lares Limestone, the Mucarabones Sand, and the Montebello Limestone member of the Cibao Formation constitute the lower aquifer, which becomes confined to the north in a seaward direction.

### South Coast Province

The South Coast Province covers an area of 230 mi<sup>2</sup> and consists primarily of alluvial and terrace deposits, forming a continuous coastal plain from Patillas to Ponce, and alluvial stream valleys from Ponce to Guánica (fig. 1).

### West and East Coast Provinces, Lajas Valley, and Esperanza-Resolución Valley

The West and East Coast Provinces; Lajas valley; and the Esperanza and Resolución valleys cover an area of 137 mi<sup>2</sup>, consist primarily of alluvium which is the formation of the principal aquifers (fig. 1). The West Coast Province covers an area of 34 mi<sup>2</sup> and consists of the Río Guanajibo valley (13 mi<sup>2</sup>), Río Yagüez

valley (2 mi<sup>2</sup>), Río Grande de Añasco valley (15 mi<sup>2</sup>), and the Río Culebrinas valley (4 mi<sup>2</sup>). The East Coast Province covers an area of 50 mi<sup>2</sup> and consists of Fajardo (20 mi<sup>2</sup>), Naguabo-Humacao (15 mi<sup>2</sup>), Yabucoa (12 mi<sup>2</sup>), and Maunabo (3 mi<sup>2</sup>) areas. The Lajas valley, located in southwestern Puerto Rico covers an area of 35 mi<sup>2</sup>. The Esperanza valley (10 mi<sup>2</sup>) located in the south central part of Vieques is the most important aquifer in Isla de Vieques. The second most important aquifer on Vieques is the Resolución valley (8 mi<sup>2</sup>) located in the northwestern part of the island.

### Interior Province

The Interior Province covers an area of about 2,300 mi<sup>2</sup>, but contains only two significant aquifer systems which are the Caguas-Juncos valley (17 mi<sup>2</sup>) and the Cayey valley (3 mi<sup>2</sup>) (fig 1).

### Ground-Water Use

Offstream freshwater withdrawals in Puerto Rico during 1990 were estimated at 576 Mgal/d from surface-water sources (streams and reservoirs) and 158 Mgal/d (27 percent) from ground-water sources. A distribution of ground-water use by categories is shown on figure 3. A detailed description of each of these categories follows:

#### Public Supply

Public suppliers are those facilities that provide water to at least 25 people or have a minimum of 15 hookups (connections). The public-supply category includes surface- or ground-water withdrawn by public and private water suppliers. The responsibility for constructing and operating the public-supply systems in Puerto Rico lies with the Puerto Rico Aqueduct and Sewer Authority (PRASA).

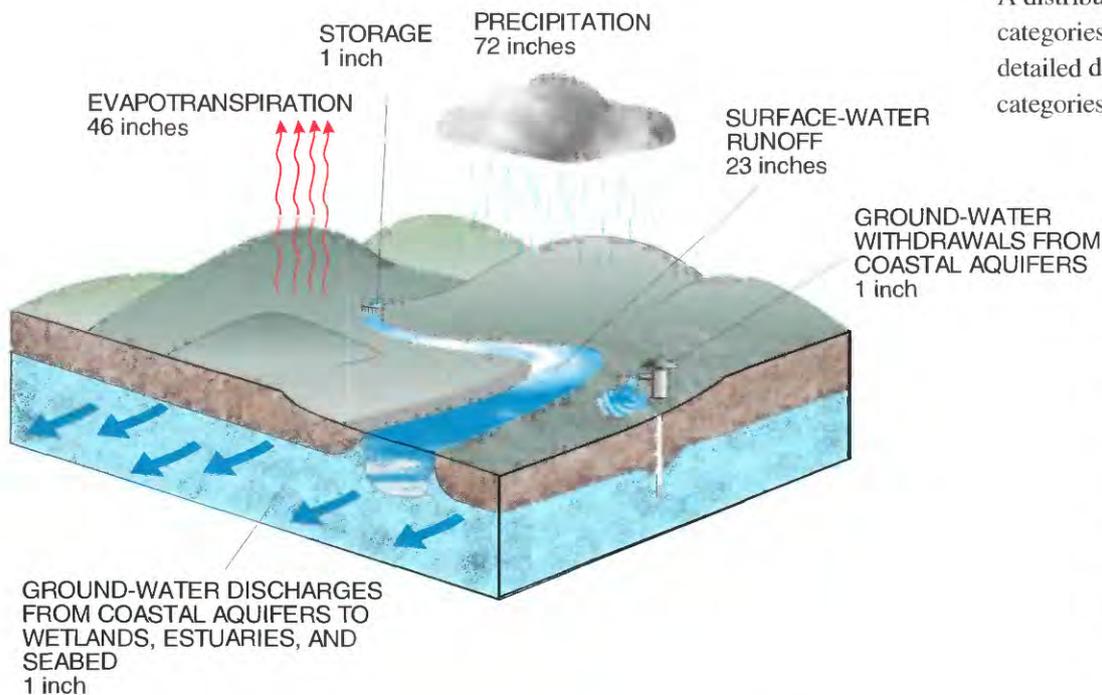
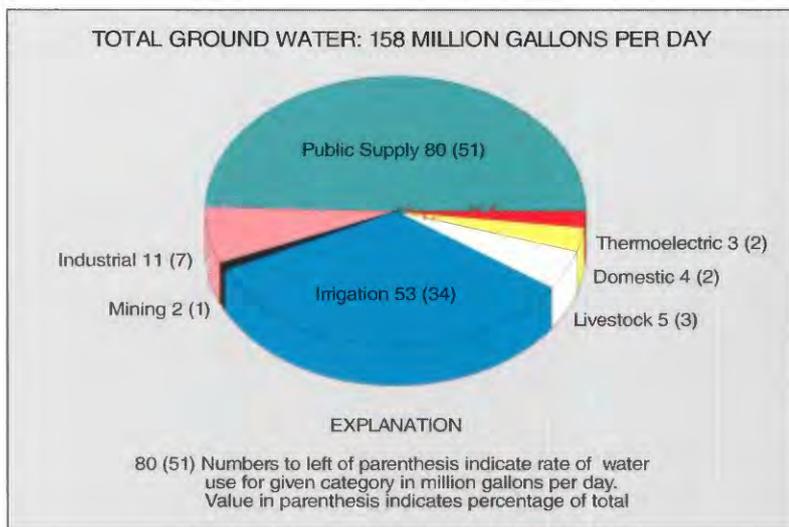


Figure 2. Generalized water balance for the island of Puerto Rico.



**Figure 3.** Distribution of ground-water use by category in Puerto Rico during 1990.

During 1990, public-supply systems withdrew an estimated 80 Mgal/d from ground-water sources, to serve a population of approximately 800,000 persons. The North Coast Province aquifer area provided the largest amount of ground water for public-supply use, 38 Mgal/d (47 percent). The South Coast Province aquifer area provided 27 Mgal/d (34 percent). The West and East Coast Provinces, Lajas valley, and the Esperanza and Resolución valleys provided 10 Mgal/d (13 percent). The Interior Province provided 5 Mgal/d (6 percent), where about 2.7 Mgal/d were provided by Caguas-Juncos valley and Cayey valley aquifers (fig. 1).

### Self-Supplied Domestic and Industrial

Domestic use refers to water for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Industrial water use includes ground- and surface-water associated with manufacturing, processing, washing, and cooling processes. Ground-water withdrawals for

domestic and industrial self-supplied use during 1990 was 4 and 11 Mgal/d, respectively, which represent about 9 percent of total ground-water withdrawals in Puerto Rico. The North Coast Province aquifer area provided 9 Mgal/d (61 percent) of self-supplied domestic and industrial ground-water withdrawals. The South Coast Province aquifer area provided 2 Mgal/d (13 percent). The West and East Coast Provinces, Lajas valley, and Esperanza and Resolución valleys provided 2 Mgal/d (13 percent). The Interior Province provided 2 Mgal/d (13 percent; fig. 1).

### Irrigation and Livestock

Irrigation water use refers to the artificial application of water to land to assist in the growing of crops and pastures or to maintain vegetative growth. Livestock water use includes watering, feed lots, dairy operations, fish farming, and other farm-related water needs. Ground-water withdrawals for irrigation and livestock uses during 1990 were 53 and 5 Mgal/d, respectively, which represents about 37 percent of all ground-

water withdrawals in Puerto Rico during 1990. The North Coast Province aquifer area provided 3 Mgal/d (5 percent) for irrigation and livestock uses. The South Coast Province aquifer area provided the largest amount of ground-water for irrigation and livestock use, 53 Mgal/d (91 percent). The West and East Coast Provinces, Lajas valley, and Esperanza and Resolución valleys provided 1 Mgal/d (2 percent). The Interior Province provided 1 Mgal/d (2 percent; fig. 1).

### Mining and Thermoelectric

Mining use refers to water used for the extraction of minerals occurring naturally including solids, liquids, and gases. The primary mining activity in Puerto Rico is the production of sand and gravel. Thermoelectric power water use refers to water used in the production of electric power generated with fossil fuel. Withdrawals for mining and thermoelectric uses during 1990 were estimated at 5 Mgal/d, which represents about 3 percent of all ground-water withdrawals in Puerto Rico. The North Coast Province and South Coast Province aquifer areas were the largest sources of ground water for mining and thermoelectric uses, with 2 (40 percent) and 3 Mgal/d (60 percent) of water withdrawn during 1990, respectively.

### Selected References

- Gómez-Gómez, Fernando, 1987, Planning report for the Caribbean Islands Regional Aquifer-System Analysis Project: U.S. Geological Survey Water-Resources Investigations Report 86-4074, 50 p.
- Solley, W.B., and Pierce, R.R., 1993, Estimated use of water in the United States in 1990: U.S. Geological Survey Circular 1081, 76 p.

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