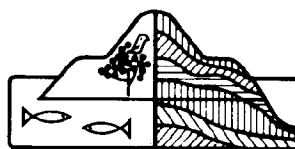


Coastal Zone
Information
Center

Flood Hazard Mitigation Plan for Portions of Coastal Flood Plain of Río de La Plata

COASTAL ZONE
INFORMATION CENTER

September 1980



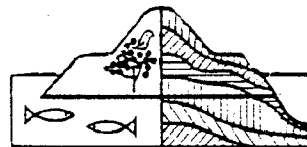
**DEPARTMENT
OF NATURAL
RESOURCES**

TC
556.5
.P84
1980

EXHIBIT 10

FLOOD HAZARD MITIGATION PLAN
FOR PORTIONS OF THE
COASTAL FLOODPLAIN OF RIO DE LA PLATA

September 1980



Financial assistance provided in part
by the Coastal Zone Management Act of
1972, administered by the Office of
Coastal Zone Management, National
Oceanic and Atmospheric Administration

DEPARTMENT OF NATURAL RESOURCES
Area for Planning of Natural
Resources
Coastal Management Program

TC 556.5 .P84 1980

Property Of
NOAA Coastal Services Center
Library

FLOOD HAZARD MITIGATION PLAN
FOR PORTIONS OF THE
COASTAL FLOODPLAIN OF RIO DE LA PLATA

September 1980

In Response to
September 1979 Disaster Declaration
(FEMA 579 DR Puerto Rico)

PROJECT STAFF

Department of Natural Resources

Fred V. Soltero Harrington, Secretary
Antonio Rodríguez Figueroa, Under-Secretary
Gabriel del Toro, Assistant Secretary for Planning
Frank Molther, Special Assistant
Rubén Freyre, Consultant
Félix I. Aponte, Natural Resources Specialist
Mariano Vargas, Natural Resources Specialist
Juan Delgado, Natural Resources Technician
Ada M. Sotto, Natural Resources Technician
Ernesto Morales, Draftsman
María Franco, Secretary

Ralph M. Field and Associates, Consultant:

Larry R. Johnston
Stuart Braman
Julie E. Troy

CONTENTS

	Page
I. INTRODUCTION	1
II. DESCRIPTION OF THE AREA	5
A. RIO DE LA PLATA BASIN	5
B. STUDY AREA	5
III. DESCRIPTION AND EVALUATION OF THE FLOOD HAZARD	11
A. HURRICANE DAVID AND TROPICAL STORM FREDERIC	11
B. TYPICAL PATTERN OF FLOODING	14
C. FLOOD HISTORY	15
D. EVALUATION OF THE HAZARD	17
IV. FLOOD HAZARD MITIGATION POLICIES AND OBJECTIVES	20
A. FORMAL ISLANDWIDE OBJECTIVES AND POLICIES	20
B. ADDITIONAL ISLANDWIDE POLICIES	21
V. IMPLEMENTATION MEASURES	22
A. SUMMARY OF RECOMMENDATIONS	22
B. WARNING SYSTEMS	25
C. RESERVOIR RELEASES	27
D. EVACUATION PLAN	28
E. INFRASTRUCTURE	31
F. RELOCATION	32
G. STRUCTURAL MEASURES	35
APPENDIX A: FEDERAL/COMMONWEALTH DISASTER ASSISTANCE AGREEMENT	44
APPENDIX B: HAZARD MITIGATION TASK FORCE	47
APPENDIX C: HAZARD MITIGATION WORK GROUP	48
APPENDIX D: SUMMARY OF RECOMMENDATIONS FROM <u>PUERTO RICO FLOOD HAZARD MITIGATION PLAN</u>	49

LIST OF FIGURES

	Page
FIGURE 1 : RIO DE LA PLATA BASIN AND STUDY AREA	6
FIGURE 2 : SUSCEPTIBLE FLOODABLE AREA MAP	8
FIGURE 3 : FLOODS AT TOA ALTA, TOA BAJA	16
FIGURE 4 : SHORT TERM MEASURES	37
FIGURE 5 : PROFILES OF FLOODS	39
FIGURE 6 : LONG TERM MEASURES	42

LIST OF TABLES

TABLE 1 : POPULATION ESTIMATES BY SECTOR IN TOA BAJA	9
TABLE 2 : DISASTER ASSISTANCE REQUEST	13
TABLE 3 : COST ESTIMATES FOR FLOOD CONTROL WORKS	36

I. INTRODUCTION

Between August 30th and September 6, 1979, Puerto Rico suffered extensive flooding from two violent storms -- Hurricane David and Tropical Storm Frederic.

On September 2, 1979, President Carter declared six municipios disaster areas; eventually the disaster declaration covered 72 of Puerto Rico's 78 municipios.

On September 7, 1979, Governor Carlos Romero Barceló signed a Federal/Commonwealth Disaster Assistance Agreement¹ to allow Puerto Rico to receive federal disaster assistance funds. Paragraph nine of this agreement requires Puerto Rico to:

...evaluate the natural hazards in the areas in which the proceeds of the grants or loans are to be used..., take appropriate action to mitigate such hazards, including safe land use and construction practices; and to follow up with applicants, within Commonwealth capabilities, to assure that appropriate hazard mitigation actions are taken.²

Shortly before Hurricane David and Tropical Storm Frederic struck Puerto Rico, an Executive Order on disaster functions³ assigned lead agency responsibility for hazard mitigation planning to the Department of Natural Resources (DNR).

¹FEMA No. 597 DR Puerto Rico. See Appendix A.

²The legal basis for this requirement is Section 406 of the Federal Disaster Relief Act of 1974 (P.L. 93-288), which requires as a condition of disaster assistance grants, or loans, that the state or local government agree that:

- 1) ...the natural hazards in the areas in which the proceeds of the grants or loans are to be used shall be evaluated...
- 2) ...appropriate actions shall be taken to mitigate such hazards, including safe land use and constructive practices, in accordance with standards prescribed or approved by the Administration of DR&R (FDAA) after adequate consultation with the appropriate elected officials of general purpose governments...; and
- 3) ...the State shall furnish such evidence of compliance with this section as may be required by regulations.

Proposed regulations governing Section 406 were not issued until April 1979. Final regulations were issued November 3, 1979 (44 CFR, Part 205, Subpart M, Hazard Mitigation.)

³Administrative Bulletin No. 3669: Governor's Executive Order for Coordination of Executive Function in Case of Disasters. August 22, 1979.

After the initial emergency operations related to the two storms were completed DNR, the Federal Emergency Management Agency (FEMA), Civil Defense Agency, and the Planning Board held a series of meetings to initiate hazard mitigation planning. These meetings clarified DNR's role as lead agency and provided the initial direction for the hazard mitigation planning effort.

As lead agency, DNR reassigned several staff members and consultants from other duties to prepare a work program for hazard mitigation planning. Recognizing that this type of effort would require interagency action, the work program called for establishment of a Hazard Mitigation Task Force¹ to include representatives from over 15 federal, Commonwealth and municipal agencies. A smaller Hazard Mitigation Work Group², with members from three federal and three Commonwealth agencies plus several municipios, was also established.

Based on the earlier discussion with other key agencies, DNR proposed two types of hazard mitigation planning: a) the preparation of site-specific plans for selected target areas (potential areas were identified for review with the Task Force); and b) because flooding from David and Frederic was so widespread, the preparation of a general hazard mitigation plan for all of Puerto Rico (called the "islandwide plan").

At its first meeting on November 7, 1979, the Hazard Mitigation Task Force concurred with this overall approach, suggested a number of changes in the work program, and selected two initial target areas for site-specific plans -- coastal floodplains of Río Grande de Loíza and Río de La Plata. A decision on additional target areas was deferred. At its second meeting on November 29th,

¹ See Appendix B.

² See Appendix C.

the Task Force approved a revised work program, which was subsequently approved by the FEMA New York Regional Office. Following these approvals, DNR began to compile data and evaluate flood hazards for the two target areas and for the islandwide plan. Regular meetings of both the Work Group and the Task Force were scheduled to periodically review this information and to recommend appropriate hazard mitigation actions.

This report -- Flood Hazard Mitigation Plan for Portions of the Coastal Floodplain of Río de La Plata -- presents the results of the investigation for the Río de La Plata target areas.³ It briefly describes the flood hazard and Puerto Rico's policies for dealing with the hazard, describes on-going actions to reduce future flood losses, and recommends additional actions to be taken in the future.

Information included in the plan is derived primarily from the following sources:

- National Weather Service. Hurricanes David and Frederic as they concerned Puerto Rico and the U.S. Virgin Island, March 1980.
- Puerto Rico Department of Natural Resources, Coastal Flood Hazards and Responses in Puerto Rico: An Overview. February 1980.
- Puerto Rico Department of Natural Resources. Hazard Mitigation Plan for Portions of the Coastal Floodplain of Río Grande de Loíza. May 1980 (Draft).
- Puerto Rico Department of Natural Resources. Puerto Rico Flood Hazard Mitigation Plan, August 1980.
- Puerto Rico Water Resources Authority. La Plata Dam, 1974.
- US Army Corps of Engineers. Flood Plain Information, La Plata River, 1965.

³ Hazard evaluations and mitigation recommendations that are specific to the Río Grande de Loíza target area are included in the Hazard Mitigation Plan for Portions of the Coastal Floodplain of Río Grande de Loíza, September 1980. Evaluations and recommendations affecting the entire island are included in the Puerto Rico Flood Hazard Mitigation Plan, August 1980.

- Meetings of the Hazard Mitigation Task Force
- Meeting of the Hazard Mitigation Work Group
- Staff work by DNR and other government agencies

In addition to these major sources, numerous other documents prepared by several commonwealth and federal agencies were also used extensively.

Several actions were taken by government agencies following David and Frederic, independent of the actions of DNR and the Task Force. Because these actions are essential to the overall hazard mitigation effort, they are incorporated into the plan, to the extent possible.

This Flood Hazard Mitigation Plan represents an intermediate stage in an ongoing hazard mitigation process. The Task Force and Work Group meetings along with DNR staff work represent the initial stage of this process. The process will continue beyond this report as steps are taken to implement the recommendations contained here. Those actions are the goal of this process.

II. DESCRIPTION OF THE AREA

A. RIO DE LA PLATA BASIN

Río de La Plata begins at an elevation of about 900 meters above mean sea level in the Sierra de Cayey Mountains in the southeastern region of the Island. It flows generally northwest through the municipios of Cayey, Comerío, Naranjito, Toa Alta, Toa Baja, and Dorado for a total river distance of 102 kms., the longest in the Island. It enters the Atlantic Ocean at point 14 kms. west of San Juan, shortly after passing near the urban centers of Toa Baja and Dorado.

Average annual rainfall over the basin varies from 130 inches at some portions of the headwaters to less than 60 inches at the coast. However, major floods in the Río de La Plata floodplain are produced by high-intensity rainfall, which usually occurs in the upper lands and by insufficient drainage on low lands.

Three dams were constructed in the river at Carite, Cayey and Comerío to produce hydroelectric power. Most recently, in 1975 the La Plata Dam was constructed upstream of Toa Alta as a water supply project.

B. STUDY AREA

The Task Force determined that flood hazard mitigation planning would include those sections of the municipios of Toa Baja and Dorado that are located in the alluvial floodplain at the lower northern end of Río de La Plata. The area is located on the north coastal plain of Puerto Rico, to the west of the San Juan Metropolitan Area (See Figure 1). It extends

CUENCA RIO LA PLATA

- 6 -
OCEANO ATLANTICO

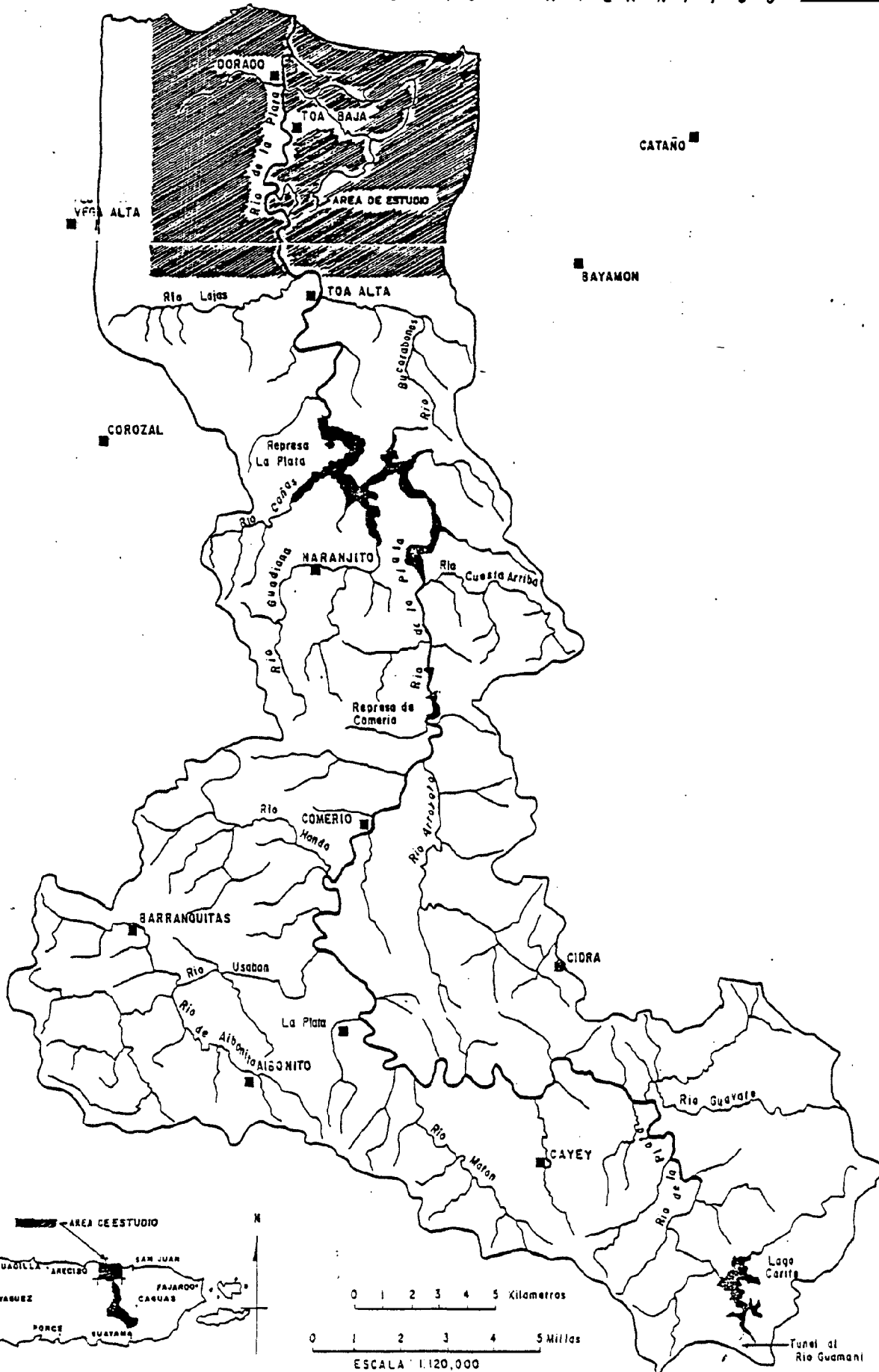


FIGURE I : RIO DE LA PLATA BASIN AND STUDY AREA

from the Sabana Seca area in the east, to various villages and hills in the municipality of Dorado in the west and from the Atlantic Ocean on the north to Toa Alta in the south.

The Susceptible Floodable Area Maps (Mapas de Zonas Susceptibles a Inundaciones) shown in figure 2 approved by the Planning Board delineate the floodplain. A recent Planning Board estimate based on this map established that the floodable area of the Río de La Plata is 13,016 acres.

The Floodplain is generally flat land intensively cultivated for sugarcane, pasture, minor crops, and dairy farms. A chain of hillocks running east-west delineate the floodplain in the south. The urban areas of Dorado and Toa Baja are located in the floodplain.

Population in the lower basin of Río de La Plata has increased rapidly in the last 20 years. Estimates prepared jointly by the Bureau of the Census and the Puerto Rico Planning Board in 1977 established the total population in 96,500 for both municipios; 74,400 in Toa Baja and 22,100 in Dorado.

According to the census, the population of Toa Baja increased 135.5 percent between 1960 and 1970; in Dorado the increase was 29.2 percent during that period. A special census conducted in 1978 in Toa Baja indicated that population had increased another 60.3 percent from 1970 to 1978. Planning Board projections estimated a 27.2 percent increase for Dorado from 1970 to 1977. (See Table 1 for population estimates by sectors in Toa Baja).



3

TABLE I: Population Estimates by Sector in Toa Baja

ESTIMADOS Y PROYECCION DE POBLACION Y VIVIENDA POR COMUNIDAD
TOA BAJA, 1978, 1985 Y 2000

COMUNIDAD	1 9 7 8			1 9 8 5			2 0 0 0		
	POBLACION			POBLACION			POBLACION		
	OCUPADAS	VIVIENDAS	VACANTES	OCUPADAS	VIVIENDAS	VACANTES	OCUPADAS	VIVIENDAS	VACANTES
Pueblo	2014	514	31	1895	531	34	1895	520	34
Toaville	300	86	8	565	113	10	565	163	10
Villa Calma	1562	388	40	1700	419	27	1700	419	27
Ingenio	3336	912	91	3622	988	63	3622	988	63
Sabana Seca	12841	3215	248	13508	3346	214	13508	3346	214
Levittown	31894	8198	928	42644	12184	728	50264	14361	917
Palo Seco	443	150	18	460	158	10	460	158	10
Campanillas	3010	757	69	3633	776	50	8833	2399	154
Villa Hoscos	2460	694	74	2557	722	46	2557	722	46
Candelaria	1711	1771	29	1793	1759	112	7193	1759	112
Macón	1651	431	29	1798	496	32	1798	496	32
El Plantío	748	258	-	3104	1034	66	3104	1034	66
Covadonga	1460	403	36	2096	577	37	2096	577	37
Pajaro Norte	480	120	8	1490	425	148	4526	1269	85
Pajaro Sur	5557	1290	86	14151	3784	203	15465	4160	225
San José	2008	458	46	2590	599	38	2590	599	38
Nuevo Centro	--	--	--	--	--	--	23030	6580	420
Total	76935	19727	1836	103000	27961	1872	143200	39560	2490

Fuente: 1. U.S. Departamento de Comercio, Oficina del Censo, Censo Especial, Toa Baja, 1978.

2. Proyecciones de René V. Balceta y Asociados en base a la Proyección de Uso de Terrenos - 8

According to the Planning Board Report, Housing Situation in Puerto Rico, 1978, there was 18,637 families in Toa Baja in 1977. The 20.74% (5,357) families was below the poverty level as established by the Food and Agricultural Act of 1977. The 14.79% (2,757) of total housing number is considered inadequate.

In Dorado there was 6,275 families in 1977. The 38.10% (2,391) of total number of families was below the poverty level. The 25.24% (1,584) of total housing number is considered inadequate.

III. DESCRIPTION AND EVALUATION OF THE FLOOD HAZARD

A. HURRICANE DAVID AND TROPICAL STORM FREDERIC

The flooding that triggered this hazard mitigation planning effort hit the Río de La Plata floodplain along with the rest of Puerto Rico during late August and early September 1979. During the night of August 29-30, Hurricane David passed 100 miles south of Puerto Rico causing heavy rainfall. Flood waters began to rise in some areas by Thursday evening, August, 30th. Flooding also occurred over the east, south, and north sections of Puerto Rico during early morning and during the day of August 31st.

During its passage south of Puerto Rico, Hurricane David delivered some of its heaviest rainfall to the Río de La Plata basin (on the order of 20 inches). The most severe flooding in the basin occurred in the coastal plain area surrounding the towns of Toa Baja and Dorado. By the evening of August 30th much of the town of Toa Baja was under water and in the low lying barrrios floodwaters reached depths of 10 feet. At it 500 people from Barrio Ingenio, one of the worst hit area, took refuge in public shelters, and over 1,100 people were evacuated from San Pedro Urbanization. Most of these people lost all or part of their belongings and suffered serious damages, or in some cases complete loss, of their homes. The river left its banks just below Toa Alta, which is somewhat higher than Toa Baja, and flooded several hundred acres of sugar cane fields surrounding the towns of Toa Baja and Dorado. The main bridge entering Dorado was overtopped and the lower sector of the town of the south had three to four feet of water.

A few days later, on September 4th, Tropical Storm Frederic entered eastern Puerto Rico, just north of Fajardo, at about 8:00 A.M. The storm continued westward across the Island during the day and left just north of Mayagüez in mid-afternoon. Serious flooding again occurred.

Following David and Frederic, the municipalities of Toa Baja and Dorado were declared Presidential disasters areas, making them eligible for individual and public assistance. Damages to infrastructure were extensive mostly to the telephone systems, roads and drainage channels. The total disaster assistance requests in both towns were 1.43 million dollars. The most affected municipality was Toa Baja with 1.36 million dollars in damages. A summary of disaster assistance requests for infrastructure is shown in Table 2.

Damages to homes and business in the lower Río de La Plata floodplain cannot be accurately documented because most records of requests for assistance and aid provided are aggregated for all Puerto Rico. However, estimates from Toa Baja and Dorado local Civil Defense offices established that 2,000 persons were evacuated and 10,000 homes affected in Toa Baja; 720 persons were evacuated and 1,000 homes affected in Dorado.

Although the flooding due to David and Frederic in this area was extensive, the recurrence interval was estimated to be on the order of one in 6 years according to data gathered by the Flood Hazard office of the Department of Natural Resources; the potential for property damage and loss of lives is higher if flooding of a greater recurrence interval hits the area in the future. The following section's provide some perspective on the extent and magnitude of flooding and damages caused by David and Frederic.

DISASTER ASSISTANCE REQUEST (DAMAGE SURVEY REPORTS)
FOR SEPTEMBER 1979 DISASTER DECLARATION
(DOLLARS)

	DORADO	TOA BAJA	NO. OF DSR'S	TOTAL
A. DEBRIS CLEARANCE				
Public Roads Systems				
B. PROTECTIVE MEASURES				
Stream Drainage Channels	4,405.00	20,653.00	7	25,058.00
C. ROAD SYSTEMS				
Roads	33,417.00	102,521.00	35	135,938.00
Bridges				
Streets				
Retaining Wall				
Culverts				
D. WATER CONTROL FACILITIES				
Drainage Channels				
E. PUBLIC BUILDINGS, EQUIPMENT				
Vehicle, other				
F. PUBLIC UTILITY SYSTEMS				
Water				
Sanitary Sewerage	19,833.38	3,104.80	9	22,938.18
Storm Sewer				
Storm Drainage		150,036.00	5	150,036.00
Light Power				
Telephone	10,686.28	1,086,942.40	22	1,097,628.68
G. FACILITIES UNDER CONSTRUCT.				
Public Facilities				
H. PRIVATE NON-PROFIT				
Yacht Club				
I. OTHER				
Park Facilities (Walkway)				
Recreational Facilities				
(Fence)				
TOTAL	68,341.66	1,363,257.20	78	1,431,598.86

TABLE 2 : DAMAGE SURVEY REPORTS

B. TYPICAL PATTERN OF FLOODING

During periods of normal rainfall the natural drainage is adequate, but during heavy rain, flooding begins quickly in the lower portions of the floodplain.

Two factors delay the discharge of floodwaters and increase flood levels. First, sand dunes about five meters high run along the north coast of the floodplain providing only two small outlets to the sea: one at the mouth of Río de La Plata (Punta Boca Juana) in the west and the other in Río Cocal (Punta Corozo) in the east. Highway #165, running across the top of the sand dunes, reinforces this natural barrier. Second, the increase in tide elevation during storms creates an additional barrier; floodwaters cannot flow rapidly into the sea, thus creating backwater along the floodplain.

A system of channels in the floodplain provide drainage to Río Cocal and Caño Campanero. Río Cocal, in the north of the floodplain, is connected in the west with the Río de La Plata and in the northeast with the sea. The drainage channels vary in length, width and depth, but practically all have only a gentle slope because of the small elevation of the floodplain. Their hydraulic capacity is further reduced because of lack of channel maintenance.

As a result of these factors, floodwaters spread over the floodplain during heavy rains. The town of Toa Baja, near Río de La Plata, is periodically flooded to depths of 0.6 to 1.2 meters. Floods with an estimated recurrence frequency of 1 in 10 years have a dramatic impact on the area, affecting 12 to 15 thousands persons.

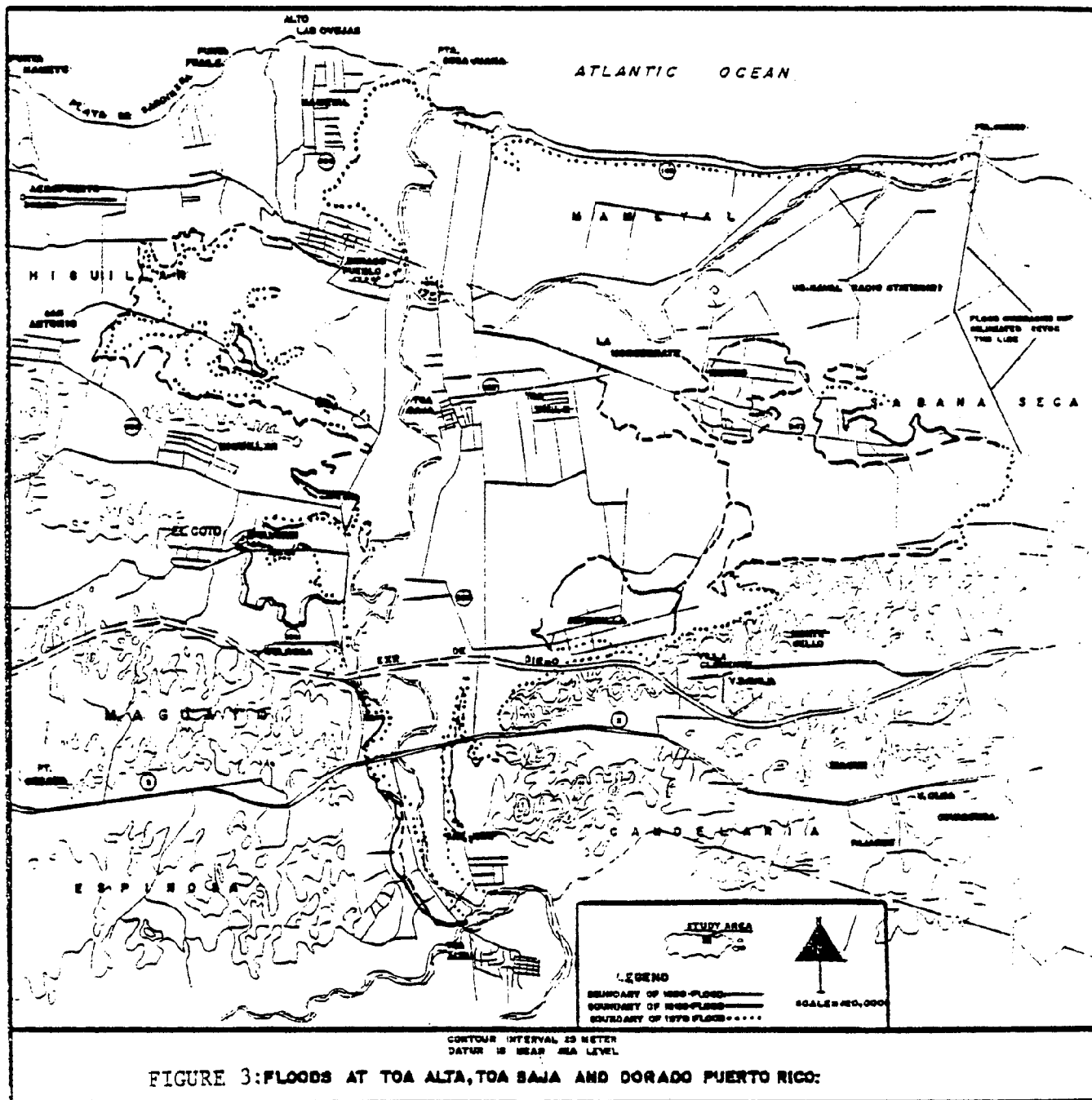
C. FLOOD HISTORY

Major flooding of Río de La Plata is usually associated with the passage of a hurricane near or over the Island. The floodplain, a 37 squaremile area below Toa Alta, had been affected by recurring major floods. See Figure (3) Floods at Toa Alta, Toa Baja and Dorado Puerto Rico.

The flood of August 8, 1899 is the greatest known flood and was associated with San Ciriaco, one of the most destructive hurricane in the history of Puerto Rico. The estimated peak flow on Río de La Plata was 140,000 cfs., with an estimated frequency of occurrence of one in 100 years. Damage were estimated at \$585,000 in the Río de La Plata Basin; more than 3,000 lives were lost throughout Puerto Rico.

Rains in the central region around Cayey associated with the passage of Hurricane San Hipólito on August 22, 1916, produced major flooding with a recurrence interval estimated at one in 35 years. Damages in the La Plata Basin were calculated at \$260,000.

On Septiembre 13, 1928 the passage of Hurricane San Felipe II caused extensive damages to agriculture, commerce, hydroelectric plants; and villages. As in previous major floods, the entire town of Toa Baja was flooded. Depth of flooding was about 0.9 meters in the streets and between 0.1 and 0.6 meters in buildings. The town was covered by water for about nine hours. Floodwaters rose to a height of 0.3 meter next to the railroad bridge near Dorado and the bridge on Highway #2. In the floodplain, about 2,500 acres of sugarcane were flooded to a maximum depth of 0.4 meter; dairy farms also suffered damages. The floodwaters had a discharge of 120,000 c.f.s. and an estimated frequency of occurrence of one in 60 years.



Damages were calculated in \$409,700 in the La Plata basin.

Numerous floods occurred between 1928 and 1960, most of them local in character or of lesser magnitude than San Felipe II.

On September 5 and 6, 1960 torrential rains occurred associated with Hurricane Donna, which passed 150 kms. north of Puerto Rico. A record 14.07 inches in 24 hours was recorded at Cayey. The flood had an estimated frequency of occurrence of one in 35 years. Damage in the floodplain were estimated in \$172,000.

Serious flooding also occurred in August 1961, October 1970 and September 1975. Recently, Hurricane David and Tropical Storm Frederick make extensive damages to the floodplain. The total disaster assistance requests in both municipios were 1.43 million dollars.

D. EVALUATION OF THE HAZARD

The Metropolitan San Juan Area is rapidly expanding into areas adjoining the La Plata floodplain. Many small villages have been established in the floodplain itself in recent years, rapidly increasing the population in the area. There has been an increase in demand for both industrial and residential sites in the area. This present and potential future development will increase the potential for flood damage in the area.

Some preliminary studies had been developed to deal with the flood problem in the area. However, at present, no general scheme of protection for the floodplain has been implemented.

The Corps of Engineers, in its report Flood Plain Information, La Plata River - June 1965, established guidelines for reducing flood damages in the area. According to the report, the flood hazard for Río de La Plata floodplain is severe, and preliminary investigations indicated that direct flood control measures would reduce flood stages and provide protection to life and property. A combination of works appeared to be the best solution to the flood problem. The general plan that was developed included channels, levees, floodwalls and various possible dams and reservoirs sites in Río de La Plata and in its tributaries (when this report was published La Plata Dam, at Toa Alta, had not been constructed).

In addition to these structural measures, the development or improvement of other non-structural measures would be required to deal adequately with the flood hazard in the area. Development of flood fighting and emergency evacuation plans, improvement of flood forecasting and warning services, revision and/or enforcement of the floodplain regulations were suggested.

Despite the severe flood problem of Río de La Plata, the Federal Government has not been able to allocate funds to assist with structural projects for flood control: annual monetary damages from flooding have not been great enough to justify the needed structural improvements. However, the low economic losses have not reflected the severe social impacts of destructive floods, principally the human suffering. Because family incomes and housing values are low, a home destroyed by flooding may represent only a few thousand dollars in economic loss, but to the family affected it could be a life's accumulated wealth. On the other hand, land and construction costs for providing structural solutions are high. As a result, annual benefits are low and costs are high. Consequently, it has been

impossible to justify Federal involvement in structural projects to reduce existing levels of damages.

In 1975 the Corps of Engineers began a Preliminary Survey Report for Río de La Plata. The Corps of Engineers identified two structural intensive plans for flood protection of the lower Río de La Plata floodplain to include the town of Toa Alta and the areas downstream.

Plan A - includes a dam and reservoir above Comerío, a floodway-type channel in the lower reaches, and a standard-type channel near Toa Alta.

Plan B - does not include the reservoir but includes the channels described above.

These preliminary plans assumed extensive urbanization of the Río de La Plata floodplain in the future. Using this assumption of extensive urbanization, a cost benefit analysis indicates the long term feasibility of the project. However, the Planning Board has classified the floodplain as a high agricultural productivity area, an alternative analysis must be developed if the flood plain is reserved for agricultural use. Until today this kind of analysis has not been studied.

The major investment required for development of large structural projects make their construction unlikely in the near future. Therefore, this hazard mitigation plan focus on minor structural and nonstructural measures as the most feasible means of reducing flood hazards.

IV. FLOOD HAZARD MITIGATION POLICIES AND OBJECTIVES

A. FORMAL ISLANDWIDE OBJECTIVES AND POLICIES

Primary responsibility for the development and implementation of public policies and actions to guide development throughout Puerto Rico, including flood hazard areas, rests with the Puerto Rico Planning Board.

Official Planning Board policies on development in flood hazard areas are contained in the Objectives and Public Policies for Land Use, adopted by the Board in June 1977. These were also incorporated into the Puerto Rico Coastal Management Program by the Department of Natural Resources in July 1978. The principal objectives and public policies relating to flooding are quoted below:¹

OBJECTIVE

To reduce to a minimum the danger of loss of life and physical damage in the country, as a result of flooding and the action of wave surge -- at the same time identify and promote those land uses and activities compatible with these conditions.

PUBLIC POLICIES

- 10.00 To protect the population actually residing in floodable areas or in areas affected by the action of wave surge.
- 10.01 To construct engineering works which will, at a reasonable cost, prevent property damage and risks to the lives of the citizenry actually affected, giving priority to these works above any other flood control measures.
- 10.02 Where necessary, to take the appropriate measures to relocate these persons.
- 11.00 To prohibit land development and construction of structures for urban expansion and other activities which are expressly excluded by current regulation in areas affected by floods and wave surge, except when flood control works or protection against wave surge already exist, are under construction or can be provided at a reasonable cost, to protect the property and guarantee the safety of all the people affected in those lands which are not agricultural(ly) productive, do not have important natural resources, and are not environmentally critical.

¹Official English translation.

12.00 To stimulate agricultural development in floodable areas which have such potential.

13.00 To construct flood control works with an agricultural approach in areas where it is appropriate, and which will result in an increase in agricultural production.

B. ADDITIONAL ISLANDWIDE POLICIES

The official Planning Board policies are the most formal and broadest statement of the Commonwealth's position -- but not the only expression of public policy -- regarding development in flood hazard areas. Regulations, programs, and activities of the Planning Board and of other agencies are a less formal, but still integral, part of the total Commonwealth policy regarding development in flood hazard areas.

The Hazard Mitigation Task Force found it desirable to formally state several of these informal policies:

1. To continually add to and improve data on the frequency, extent, and magnitude of flood hazards and their effects.
2. To develop flood hazard mitigation plans for high risk areas.
3. To increase the level of public awareness of flood hazards and what actions they can take to prevent or reduce risks to their person and property.
4. To encourage the purchase of flood insurance by those who live in floodable areas.

V. IMPLEMENTATION MEASURES

The following sections describe the measures discussed and recommended by the Hazard Mitigation Task Force to reduce future flood losses in the lower Río de La Plata Floodplain.

A. SUMMARY OF RECOMMENDATIONS¹

Following is a summary of the recommendations that apply specifically to the lower Río de La Plata floodplain. Subsequent sections provide a discussion of the considerations leading to the recommendations.

WARNING SYSTEMS

1. A fully automated flash flood warning system for the lower Río de La Plata floodplain should be developed and implemented. The warning system should consist of a radio network of event reporting rain gauges, repeater stations, river gauges, a microprocesor or minicomputer and radio flash flood alarms.
2. The Puerto Rico Civil Defense Agency should study the need for additional sirens, alternative locations for such sirens, and the cost of new sirens for the flooding areas in both municipalities.
3. Local civil defense offices in Dorado and Toa Baja should purchase NOAA band radio recervers so that weather warnings can reach the public faster. This receiver is relatively inexpensive.
4. A written agreement should be entered into between P.R. Civil Defense and the National Weather Sarvice to provide for improved information exchange.

¹

The Puerto Rico Hazard Mitigation Plan contains a number of recommendations that, when implemented, will apply throught Puerto Rico, including the lower Río de La Plata Floodplain. These islanwide recommendations are presented in Appendix D.

RESERVOIR RELEASES

1. Upon installation of gates on the La Plata Dam, PRASA should conduct a study to evaluate the impact of dam operation on downstream flooding.

This study should address:

- a. Establishment of management measures for the dam that take into account the flood hazards downstream from the dam, including:
 - Written management measures available to the State and local civil defense offices.
 - An estimate of the time it takes for water released at the gates to arrive at the floodplain.
- b. Establishment of warning systems in the municipios of Dorado and Toa Baja.
 - Warning sirens in strategic points
 - An effective communication within PRASA (dam operators), NWS and State and local civil defense offices including precipitation in the drainage area, water level in the dam, information on water release from the dam, etc.

EVACUATION PLAN

Due to the inadequacy of existing emergency evacuation plan in the area, the Task Force recommended that the U.S. Army Corps of Engineers prepare an emergency evacuation plan. The Corps of Engineers responded to the request and initiated work on the plan.

1. The study will require coordination with various local and federal agencies in the gathering of information. The Task Force encourage the Cooperation of such agencies. The P.R. Civil Defense Agency will be the principal coordinator of the study for the Commonwealth. The Civil Defense Agency should encourage public involvement so that residents understand the reason for the plan and the role they must play in its proper execution.

INFRASTRUCTURE

1. Request the Puerto Rico Highway Authority to reevaluate the design of the proposed bridge over De Diego Expressway at Toa Baja. This reevaluation should address two major concerns of the Task Force:
 - ° The proposed design of the bridge apparently does not provide for probable future stream realignment and/or channelization projects.
 - ° The proposed design apparently did not fully take into account the historical pattern of flooding in the area. The length of the bridge is not sufficient to permit the free flowing of flood waters according to the maximum historical flood in the area.

RELOCATION

Relocation should not be pursued in Dorado and Toa Baja. There would be substantial negative social impacts associated with relocation of these long - established communities, and other protective measures appear to be more cost effective.

STRUCTURAL MEASURES

This plan focuses on minor structural measures and nonstructural measures as the most feasible means of reducing flood hazards. The Task Force endorse the short - term measures presented in this plan because of the imperative need to take some protective measures. However, the major investment required for development of large structural projects make their construction unlikely in the near future.

B. WARNING SYSTEMS

Flash Flood Warnings

For Dorado and Toa Baja, as well as for the rest of the island, the National Weather Service (NWS) is responsible for issuing weather reports and forecasts. Twice a day, the NWS receives information from a network of rain gauges across the island, and issues forecasts and flood warnings through teletype and NOAA Radio (162.4 MHz - VHF). A new weather radar was installed in late summer of 1980 at Isla Verde Airport to improve weather forecasting, and the NWS is moving toward full automation to attain more accurate forecasting.

Once forecasts are prepared, they must be transmitted efficiently to local governments and the public to be of any use. At present there is insufficient direct information exchange between the Puerto Rico Civil Defense Agency and the National Weather Service. Communications most often go from NOAA Radio to the State Civil Defense then to the Regional Civil Defense offices, then to the local civil defense and finally to the public.

In Dorado and Toa Baja, local civil defense personnel use popular broadcasting (radio, T.V.), radio communications, and telephone to transmit warnings. In addition, citizen's band radio has been found to be very helpful during emergencies.

When flood warnings are issued to the local office, the civil defense employees are alerted and volunteers are activated. Local police and firemen are contacted and the possible flood situation discussed. The civil defense employees had established their own water level marks in some strategic points. Such marks indicate them when they have to alert and evacuate different sectors of the municipality. The emergency warnings are given with sirens and loudspeaker systems.

Recommendations

1. A fully automated flash flood warning system for the lower Río de La Plata floodplain should be developed and implemented. The warning system should consist of a radio network of event reporting rain gauges, repeater stations, river gauges, a microprocessor or minicomputer located in the central office of the National Weather Service in San Juan and radio flash flood alarms. This recommendation was made by the National Weather Service in its evaluation report after hurricanes David and

Frederic and has the endorsement of the Task Force.

2. The Puerto Rico Civil Defense Agency should study the need for additional sirens, alternative locations for such sirens, and the costs of new sirens for the flooding areas in both municipalities.
3. Local civil defense offices in Dorado and Toa Baja should purchase NOAA band radio receivers so that weather warnings can reach the public faster. This receives is relatively inexpensive.
4. A written agreement should be entered into between Puerto Rico Civil Defense and the National Weather Service to provide for improved information exchange.

C. RESERVOIR RELEASES

La Plata Dam is a concrete gravity structure located about 7 miles upstream from the town of Toa Baja. The dam was completed in 1974 to create a water supply reservoir that is part of the San Juan Metropolitan Water District. It presently provides a safe yield of 64 million gallons per day, and was designed for future modification to provide more water when demand so requires. The reservoir is maintained at spillway crest elevation as much as possible, providing 22,700 acre - feet of storage. Hydrologic studies made by consultants of PRASA have shown that the presently ungated dam spillway can not reduce flood hazards in the coastal floodplain downstream.

The Puerto Rico Aqueduct and Sewer Authority (PRASA) is currently preparing for an additional \$16.3 million of construction on the La Plata Dam to increase water supply reserves for the Metropolitan Area; Six bascule gates will be constructed over the spillway that will increase the storage from 22,700 acre-feet to 33,150 acre-feet and crest elevation from 47.12 to 52 meters. Although the design does not provide for flood control storage above the water supply pool elevation, PRASA feels that the additional storage and

gates can help to mitigate downstream flooding problems.

RECOMMENDATION

1. Upon installation of gates on the La Plata Dam, PRASA should conduct a study to evaluate the impact of dam operation on downstream flooding. This study should address
 - a. Establishment of management measures or procedures for the operation of the dam that take into account the flood hazards downstream from the dam, including:
 - ° Written management measures or procedures available to the State and Local Civil Defense Offices.
 - ° An estimate of the time it takes for water released at the gates to arrive at the floodplain.
 - b. Establishment of warning systems in the municipios of Toa Baja and Dorado.
 - ° Warning sirens in strategic points
 - ° An effective communication within PRASA (dam operators), NWS, and State and Local Civil Defense Offices, including information on precipitation in the drainage area, water level in the dam, information on water release from the dam, etc.

D. EVACUATION PLAN

The Puerto Rico Civil Defense Agency is designated by Law Number 22 of June 1976 as the agency responsible for coordinating the activities of all Commonwealth and municipal agencies in response to emergencies and disasters, including evacuation from flood-prone areas. Responsibility for actually evacuating people in time of flooding is shared by the Puerto Rico Civil Defense Agency and municipal Civil Defense organization. Each municipal civil defense organization is required to have an emergency operation plan which should include temporary evacuation procedures.

None of the municipalities currently has an adequate formal evacuation plan specifying evacuation routes, procedures, and so on. The evacuation procedures are based on the experience of previous flooding conditions.

Both municipalities, Dorado and Toa Baja, has limitations in personnel and funds. The restricted number of regular local civil defense employees and lack of basic equipment such as uniform, boots, vehicles, boats, etc.

Fortunately, the volunteer groups gives an important support to the local civil defense personnel. The utilization of CB. receivers by some of these volunteers has proved to play an important role as well as private owner boats.

Because of the known widespread flooding areas the Red Cross and the National Guard personnel are movilized rapidly to the area.

The public schools and community centers are used to shelter refugees. These refugees need to be properly supplied with beds, medical equipment, beds clothes, food, medicines, etc.

More than 3,000 persons were refugees in Toa Baja and more than 1,000 in Dorado according to local civil defense estimate. During David and Frederic near 10,000 houses were affected in Toa Baja and 1,000 in Dorado.

The principal evacuation routes utilized were roads PR-165 and PR-865 both eastward in Toa Baja and PR-693 westward in Dorado. Refugees were movilized principally to schools or public community centers.

Due to the inadequacy of existing emergency evacuation plans in the area during the early stages of this flood hazard mitigation planning effort, the Task Force recommended that U.S. Army Corps of Engineers prepare an emergency evacuation plan for this area. This Task Force recommendation was followed by formal requests to the Corps of Engineers from the Department of Natural Resources, Puerto Rico Civil Defense Agency and the municipios of Toa Baja and Dorado for assistance in preparing an emergency evacuation plan. The Corps of Engineers responded to the request and initiated work on the plan. A plan of Study issued in July 1980, lists several questions and problems to be addressed:

- a. Assess the adequacy of the Río de La Plata existing flood warning system.
- b. Assess the adequacy of the various Commonwealth and municipio preparedness plans for evacuation in the Río de La Plata area.
- c. Determine the critical areas to be evacuated.
- d. Determine the evacuation zones.
- e. Determine the evacuation routes.
- f. Determine the shelters to be used for evacuation.
- g. Determine the structural adequacy of the primary shelters.
- h. Determine the time needed for evacuation and recommended times for issuance of evacuation orders.
- i. Distribution of the Río de La Plata Flood Emergency Evacuation Plan for public information.

The emergency evacuation plan is scheduled to be completed in June 1981.

RECOMMENDATION

The study will require coordination with various local and federal agencies in the gathering of information. The Task Force encourage the cooperation of such agencies. The Puerto Rico Civil Defense Agency will be the principal coordinator of the study for the Commonwealth. The Civil Defense Agency should encourage public involvement so that residents understand the reason for the plan and the role they must play in its proper execution.

E. INFRASTRUCTURE

Heavy rains and associated flooding have caused extensive damages to floodplain infrastructure in the past. Further damage will occur in the future. Proper measures must be taken now if more serious damages to infrastructure is to be avoided in the years ahead. Special attention must be given to future structural development, particularly that which has potential to change the floodplain characteristics.

The proposed bridge over Río de La Plata on the Diego Expressway PR-22 at Toa Baja, represents the greatest potential for modifying the present floodplain characteristics. Construction of the bridge as presently designed would increase the potential for flood damages especially those areas south upstream of the proposed construction.

RECOMMENDATION

The Task Force after careful consideration agreed to request the Puerto Rico Highway Authority to reevaluate the design of the proposed bridge over De Diego Expressway at Toa Baja. This reevaluation should address two major concerns of the Task Force:

- ° the proposed design of the bridge apparently does not provide for probable future stream realignment and/or channelization projects
- ° the proposed design did not fully take in to account the historical patterns of flooding in the area. The length of the bridge is not sufficient to permit the free flowing of flood waters according to the maximum historical flood in the area.

F. RELOCATION

Since Río de La Plata floodplain is one of the largest area near the Metropolitan Area suitable for building they have been extensively developed in recent years and thousands of people live and work in the floodplain. Many of these people live in high risk areas that area subject to frequent and severe flooding.

The analysis of this situation have focus around the possibility or desirability to permanently relocate all of these people from the floodplain.

The Department of Housing has recognized that there are many floodplain residents that could be permanently relocated. They also recognized the potential social and economic impacts of undertaking such a program. In addition they have recognized the need for a socioeconomic study of the floodable areas, prior to relocation. This activity will provide for a proper selection of the most critical areas and the analysis of the feasibility, relocation cost, identification of alternate locations and source of funds.

The Department of Housing has developed an analysis of the cost of acquisition and relocation of buildings located in floodable areas of Dorado and Toa Baja. Key Figures from this analysis are presented below.

Areas under study		Estimated No. of Structures
Municipality/Sector		
Dorado:		
Villa Caito		23
Villa Plata		364
El Caño		35
Villa Santa		51
	Sub-total	473
Toa Baja:		
Villa Calma		361
Villa Pelusa & Hostos		430
	Sub-total	791
	Total	1264 -

Total cost for the relocation of all these communities is estimated at \$46 million, of which \$14 million would be utilized for acquisition and \$31.6 million for relocation.

René Batista and Associates, as consultants of Toa Baja municipality, estimates the cost of relocation of Toaville, Villa Calma, sectors of Villa Hostos and Candelaria at \$60.1 million. This estimate includes the relocation of 1,954 structures and was calculated based on cost estimates utilized by the Housing Department.

Recommendation:

Relocation should not be pursued in Dorado and Toa Baja. There would be substantial negative social impacts associated with relocation of these long-established communities, and other protective measures appear to be more cost effective.

G. STRUCTURAL MEASURES

Various studies for flood control had been developed for the Río de La Plata floodplain. In 1975 the Corps of Engineers developed a preliminary cost-benefit analysis of the channelization of Río de La Plata assuming future extensive urban development of the area. René Batista and Associates, consultants to Toa Baja Municipality, has been preparing a plan for flood control measures. They have recommended various measures, both short - and long - term to mitigate the severe impacts of flooding in the Río de La Plata floodplain. A brief description and Key points of these studies follow.

Short-Term Measures

The short-term measures for flood control are intended to protect againsts floods with a relative low frequency of recurrence. Measures recommended by Batista and Associates are expected to protect against floods with a recurrence interval of one in 10 years. These short-term measures have a preliminary estimated cost of 14.9 million dollars.

These measures were presented and discussed both at Work Group and Task Force meetings. The Hazard Mitigation Task Force endorsed the short-term measures for flood control. Table 3 and Figure 4 details the short-term measures proposed for the Río de La Plata floodplain by Batista and Associates. The municipality of Toa Baja expressed his disposition for use Housing and Urban Development (HUD) funds to share the cost for the development of these measures if other agencies, local or federal, assign funds to complement the total cost.

TABLE 3

COST ESTIMATES - FLOOD CONTROL WORKS - SHORT-TERM PLAN
RIO DE LA PLATA - TOA BAJA AND DORADO

ACTIVITIES	QUANTITY	UNIT COST	TOTAL
1. Realignment of Río de la Plata from Highway PR-2 to the mouth	700,000 meters ³	\$ 6.00	\$ 4,200,000
2. Construction of a ford at the entrance of Dorado Town	100,000 meters ³	6.00	600,000
3. Enlargement and cleaning of Río de la Plata mouth	30,000 meters ³	6.00	180,000
4. Close the flow entrance from Río de la Plata to Río Cocal	100 yards ³	300.00	30,000
5. To rise the level of RR-867 in a ford bridge way	1,200 mts./l.	750.00	900,000
6. Improvement of Caño Campanero and other local channels	450,000 meters ³	6.00	2,700,000
7. Protection levees at Toa Baja Town, Toaville, Villa Calma, Villa Hostos and San José	196,000 meters ³	10.00	1,960,000
8. Water pump systems at Toaville, Villa Calma, Toa Baja Town y Villa Hostos	4 c/u	400,000.00	1,600,000
9. Cleaning of sinkholes at Candelaria and Macón	8 c/u	30,000.00	240,000
10. Improvement of Río Cocal stream	420,000 meters ³	6.00	2,520,000
		TOTAL	\$ 14,930,000

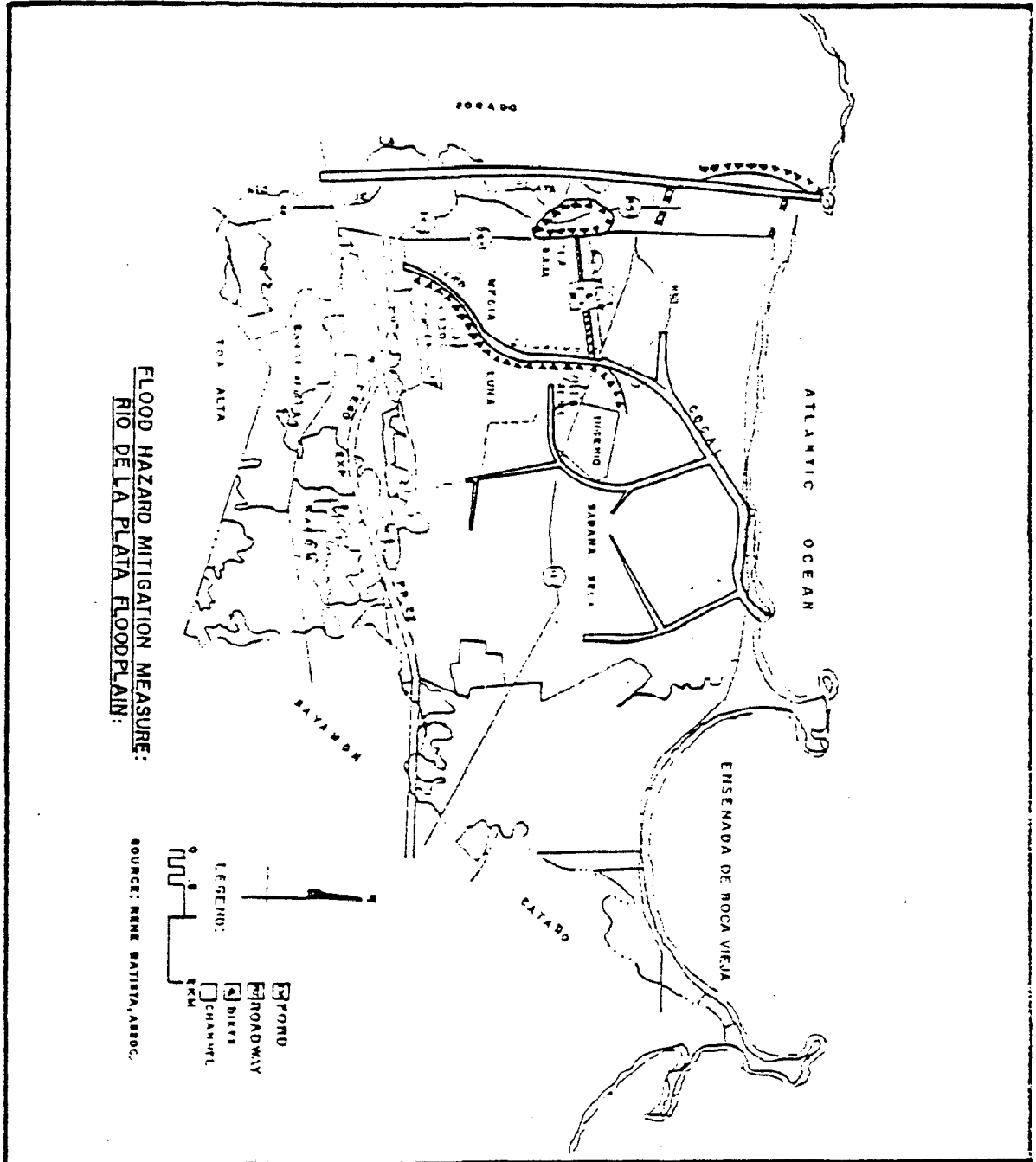
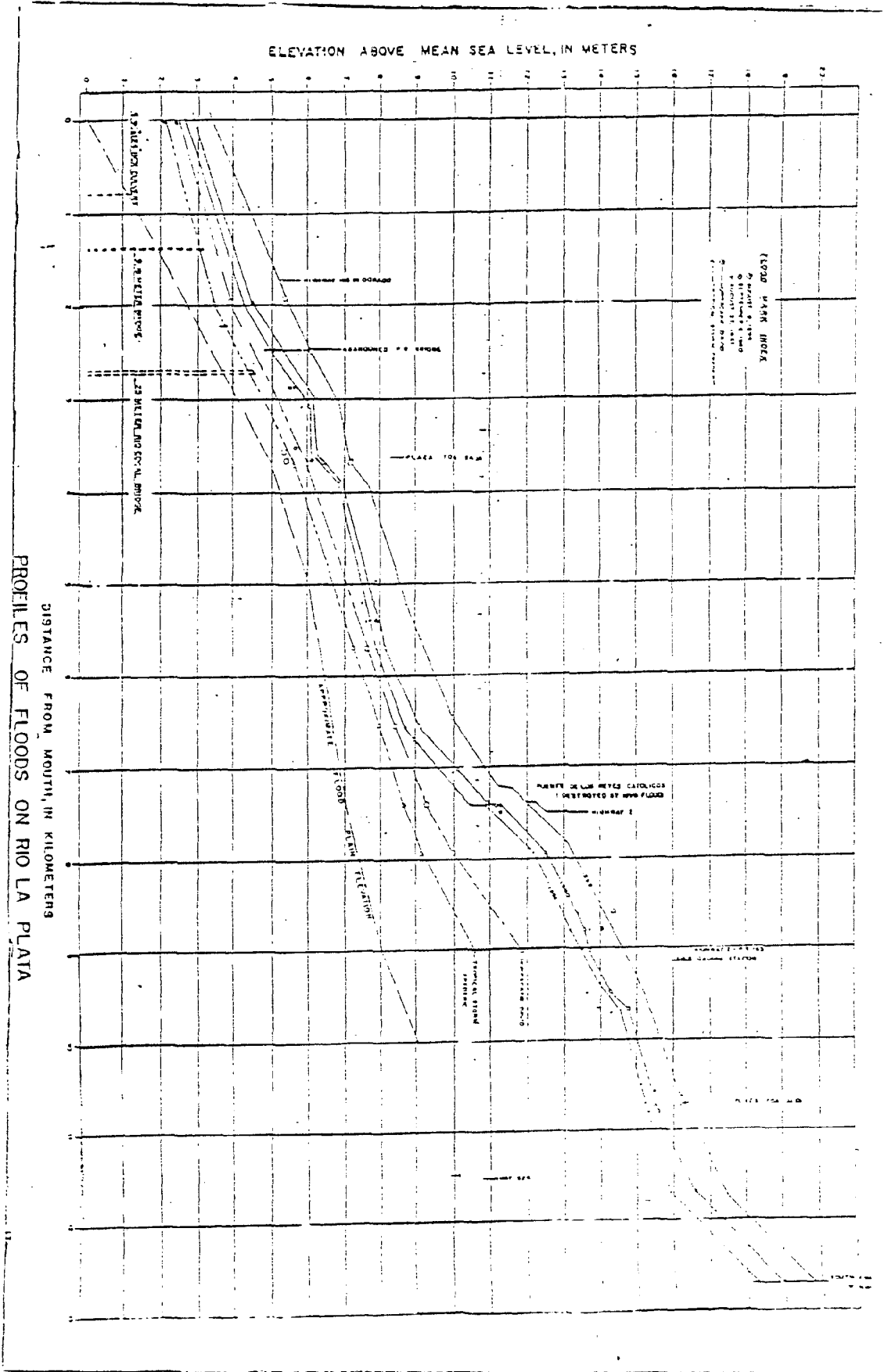


FIGURE 4 : Short Term Measures

The Flood Hazard Office of the Department of Natural Resources developed a profile of flood discharges in Río de La Plata during David and Frederic (See Figure 5). DNR staff also determined that these floods on the Río de La Plata floodplain had an estimated frequency of recurrence of one in six years. Despite this low return frequency, damages were extensive along the floodplain. Therefore, it can be expected that the short-term measure proposed can help extensively to mitigate flood hazards in the areas of Toa Baja and Dorado.

The following protection measures were recommended by the local Government of Dorado in the disaster report after David and Frederic in September 1979 and has the endorsement of the Task Force.

1. Cleaning, conservation, alignment and stream wall of 1.5 kms. of channel south of the town for protection of Korea and San Antonio Communities \$50,000.00
 2. Cleaning and conservation of drainage channel of 0.8 kms. south-east of Villa Plata and Villa Terrones Communities 12,000.00
 3. Reconstruction of storm sewer in the Urb. Costa de Oro to protect 30 homes 8,000.00
 4. Cleaning and conservation of channel in Villa Santa Sector 10,000.00
 5. Construction of storm sewer and reconstruction of street to protect El Coto Community in Barrio Maguayo 80,000.00
-
- \$160,000.00



FIGURES 5

Long-Term Measures

The long-term solution for La Plata floodplain is the channelization of Río de La Plata to give protection from a 100-year flood.

In 1975 the Corps of Engineers prepared a preliminary analysis of alternative plans and economic analysis. They recommended two basic plans.

Plan A - Include a flood control reservoir above Comerío, a floodway-type channel in the lower river reaches and a standard-type channel near Toa Alta

Plan B - Include the channels described above but eliminate the reservoir.

Cost estimates (1975) for these plans are:

<u>Plan A - Reservoir with Channel</u>	<u>Amount</u>
Total Investment -----	\$ 106,800,000
Total Annual Cost -----	6,600,000
 <u>Plan B - Channel Only</u>	
Total Investment -----	\$ 87,100,000
Total Annual Cost -----	4,200,000

Flood control benefits assuming future urbanization of agricultural areas was also computed for Plan B. The results of the analysis are:

Annual flood reduction benefits	\$ 1,500,000
Annual location and intensification benefits	<u>4,300,000</u>
Total Annual Benefits	\$ 5,800,000

René Batista and Associates, recently (1980) estimated the costs for channelization of Río de La Plata at \$132 million. The large cost of channelization contrasted with the lower value of damages, at present indicates a low probability for federal financial assistance for channelization in the near future. Justification for channelization works, however, will depend on future development plans for the floodplain.

(See Figure 6)

RECOMMENDATION

This plan focuses on minor structural measures and nonstructural measures as the most feasible means of reducing flood hazards. The Task Force endorses the short-term measures presented in this plan because of the imperative need to take some protective measures. However, the major investment required for development of large structural projects makes their construction unlikely in the near future.

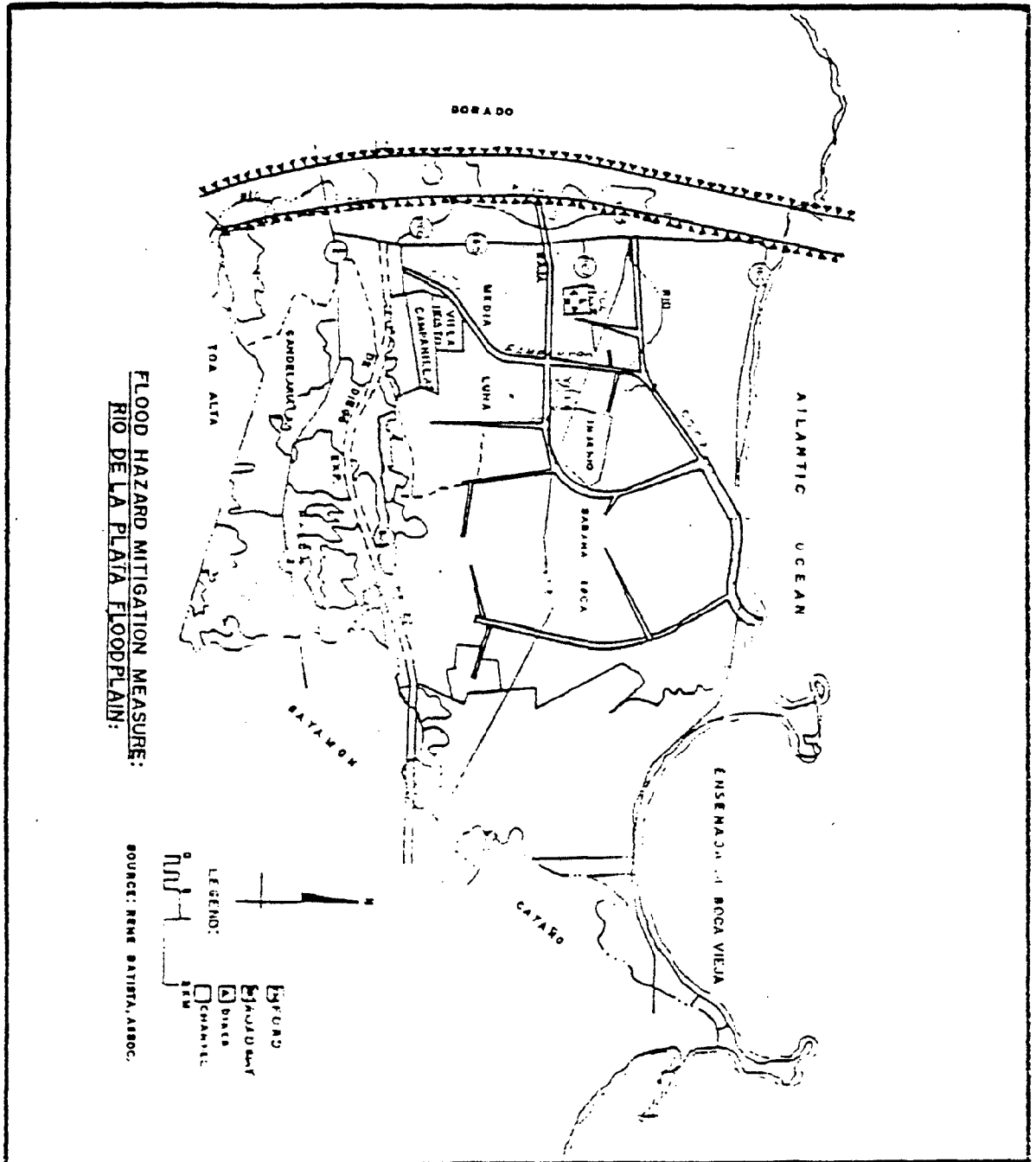


FIGURE 6 : Long Term Measure

APPENDICES

APPENDIX A: FEDERAL/COMMONWEALTH DISASTER ASSISTANCE AGREEMENT
FEDERAL EMERGENCY MANAGEMENT AGENCY

REGIONAL OFFICE

36 FEDERAL PLAZA, NEW YORK, NEW YORK 10007

REGION II

IN REPLY REFER TO:

September 5, 1979

Honorable Carlos Romero-Barceló
Governor of the Commonwealth of
Puerto Rico
San Juan, Puerto Rico 00903

Dear Governor Romero-Barceló:

1. This letter is the Federal/Commonwealth Disaster Assistance Agreement for a Major Disaster, No. FEMA 597 DR Puerto Rico, under Public Law 93-288, in accordance with Section 2205.44 of the Federal Disaster Assistance Regulations. A copy of the Regulations and Exhibit A, Federal Financial Assistance, and Exhibit B, Commonwealth Certification Officers, are attached hereto and made a part hereof.
2. On September 2, 1979, the President determined that damages resulting from high winds, heavy rains, and flooding beginning on or about August 29, 1979, have caused a major disaster in the Commonwealth of Puerto Rico and you hereby acknowledge receipt of notice of this declaration. You have certified that the Commonwealth of Puerto Rico or other public agencies thereof are expected to expend \$5,000,000, for disaster relief purposes for which no Federal reimbursement has been or will be received, in accordance with the table contained in your request, as amended. A copy of your request is attached hereto as Exhibit C, and made a part hereof.
3. Federal assistance will be made available in accordance with Public Law 93-288, Executive Order 11795, and the Regulations attached hereto.
4. The duration of the catastrophe, causing the damage with which this Agreement is concerned, is from August 29, 1979, through September 6, 1979; no project application will be approved for assistance required to alleviate damage as a result of this major disaster occurring at any other times.
5. In the event that funds are to be transferred to the Commonwealth of Puerto Rico for disaster relief purposes; the Commonwealth and its political subdivision, agree to the following: In the event that the Commonwealth of Puerto Rico or its political subdivisions violate any of the con-

Page #2

ditions imposed upon disaster relief assistance under Public Law 93-288, this Agreement, or applicable Federal Regulations, the Director will notify the Commonwealth that additional financial assistance for the purpose of the project in connection with which the violation occurred will be withheld until such violation has been corrected. Provided, however, that the Director, after such notice to the Commonwealth, is not satisfied with the corrective measures taken to comply with his notification, the Director will notify the Commonwealth that further financial assistance will be withheld for the project for which it has been determined that a violation exists, or for all or any portion of financial assistance which has or is to be made available to the Commonwealth or local governments for the purpose of disaster relief assistance under the provisions of Public Law 93-288, this Agreement, or applicant Federal Regulations.

6. No member of or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this Agreement, or to any benefit to arise thereupon. Provided, however, that this provision shall not be construed to extend to any contract made with a corporation for its general benefit.

7. The Commonwealth Officers authorized to execute certifications and otherwise to act on behalf of the Commonwealth are listed in Exhibit B which is attached hereto and made a part hereof.

8. Federal assistance extended under Public Law 93-288 and this Agreement shall be limited to the following areas of the Commonwealth of Puerto Rico and such additional areas as may be subsequently designated by the Director of the Federal Emergency Management Agency.
The Municipios of:

Arecibo	Humacao
Arroyo	Manatí
Barceloneta	Ponce
Toa Baja	Dorado
Vega Baja	Juana Diaz
Guánica	Jayuya
Guayanilla	Canóvanas
Carolina	

for Individual Assistance only.

Page #3

9. The state agrees: (1) to review and update as necessary disaster mitigations portions of the Commonwealth Emergency Plan; (2) that, as a condition for any Federal loan or grant, the applicant shall evaluate the natural hazards in the areas in which the proceeds of the grants or loans are to be used and shall take appropriate action to mitigate such hazards, including safe land use and construction practices; and (3) to follow up with applicants, within Commonwealth capabilities, to assure that appropriate hazard mitigation actions are taken.

The Regional Director agrees to make Federal technical advice and assistance available to support these planning efforts and actions.

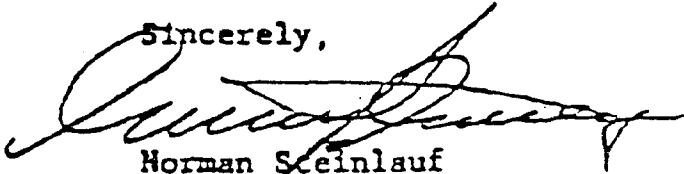
10. The Commonwealth will establish and maintain an active program under this Agreement of non discrimination in disaster assistance outlined in Part 2205.13, Title 24, CFR. This program will encompass all Commonwealth and local actions pursuant to this Agreement.

11. The Commonwealth will establish and maintain a program under this Agreement to assure that recipients of the FEMA Disaster Assistance comply with 24 CFR, Part 24, Debarment, Suspension and Ineligibility of Contractors and Grantees. This program will encompass all Commonwealth and local contracts pursuant to this Agreement.

12. The Commonwealth will notify all Commonwealth and local agencies and local governments within the areas defined by this Agreement of the time limitations agreed to herein and the terms and conditions of eligibility for Federal assistance.

13. This Agreement may be amended at any time by written approval of both parties.

Sincerely,



Norman Steinlauf
Acting Regional Director
Federal Emergency Management Agency

Agreed:


Governor

9/7/79
Date

APPENDIX B: HAZARD MITIGATION TASK FORCE

<u>AGENCY</u>	<u>REPRESENTATIVE</u>
Commonwealth:	
Department of Natural Resources	Gabriel Del Toro, Chairman Ruben Freyre
Governors Authorized Representative for (P.R. Telephone Co.)	Juan Negrón
State Civil Defense Agency	Antonio V. Munera
Puerto Rico Planning Board	Boris Oxman
Department of Transportation and Public Works	Rafael Torres García
Department of Education	Heriberto Capella
Puerto Rico Aqueduct and Sewer Authority	José R. Goitía
Department of Housing	Cesáreo Angeleró* Francisco Hernández**
Regulations and Permits Administration	Oscar Piñeior* Telesfro Carrero**
Puerto Rico Industrial Development Co.	John Smith
Municipios:	
Loiza	Felipe Sanjurjo
Carolina	Roberto Bonilla
Canovanas	Miguel Del Valle
Dorado	Manuel J. Canino
Toa Baja	Antonio Rivera
Federal:	
Federal Emergency Management Agency	Curtis Carleton
U.S. Army Corps of Engineers	Emilio Colón
National Weather Service	Robert Calvesbert
U.S. Geological Survey	Karl G. Johnson
U.S. Soil Conservation Service	Oscar Pérez
Housing and Urban Development	Arcadio Torres* Manuel Seone**

*Original representative
**Replacement

APPENDIX C: HAZARD MITIGATION WORK GROUP

<u>AGENCY</u>	<u>REPRESENTATIVE</u>
Department of Natural Resources	Félix I. Aponte, Chairman Ada Sotto
Puerto Rico Planning Board	Rafael Esteva
Department of Transportation and Public Works	René Beauchamp
State Civil Defense	Roberto Martínez Nora Zenoni
Federal Emergency Management Agency	Eduardo García* Ramón Martínez** Rafael Ramírez**
U.S. Army Corps of Engineers	Emilio Colón
National Weather Service	Robert Calvesbert

*Original representative
**Replacement

APPENDIX D: SUMMARY OF RECOMMENDATIONS FROM PUERTO RICO FLOOD HAZARD MITIGATION PLAN

FLOOD INSURANCE

Flood Insurance for Privately Owned Structures

1. Promote greater knowledge of the flood insurance program and its benefits through a program of increased public awareness.
 - a. The Federal Insurance Administration and EDS Federal Corporation should more actively promote the sale of flood insurance in Puerto Rico.
 - b. The Puerto Rico Planning Board and Department of Natural Resources should promote greater awareness of the flood insurance program as part of a general flood hazard awareness program. The following measures should be used:

Radio	Public notices in conspicuous places
Television	Banks
Newspapers	Professional and civic organizations
Special Mailings	
2. FIA should take administrative actions to lower the annual cost of a minimum flood insurance policy by extending the term of the policy from one year to two or three years. This action by FIA would make flood insurance more affordable to low income residents with low value properties.

Insurance Renewal by Recipients of Disaster Aid

1. The Government of Puerto Rico should subsidize the cost of renewing minimum flood insurance policies for about 63,000 families currently insured under the Puerto Rico/FEMA Agreement covering beneficiaries of Individual and Family Grants.
2. Before these policies must be renewed, the Puerto Rico Department of Social Services and municipios should undertake an aggressive public awareness campaign, including direct mailing, personal visits to each household or business, or other appropriate measures to explain the danger of not maintaining adequate flood insurance.

Insurance for Public Buildings

1. Government buildings should be insured against flood damages. However, before purchasing flood insurance, an inventory should be taken of public buildings located in floodable areas and of the value of buildings and building contents that should be insured. The costs and benefits to Puerto Rico of insuring these buildings and contents through the NFIP vs. establishing a qualified program of self-insurance should be evaluated.

FLOODPLAIN REGULATIONS

Enforcement of Planning Regulation Number 13

1. Before taking special measures to try and strengthen enforcement of Planning Regulation Number 13, a brief study of current implementation of the regulation should be conducted in order to document the nature and extent of problems with enforcement.
2. Following completion of this study, the Planning Board, Regulation and Permits Administration, Department of Natural Resources and Department of Housing should prepare an Interagency Agreement detailing the responsibilities of each agency for surveillance and enforcement of Planning Regulation Number 13.
3. The Department of Natural Resources and the Department of Housing should make available personnel to assist with surveillance of floodplain activity in accordance with the Interagency Agreement recommended above.

Revision of Planning Regulation Number 13

1. Planning Regulation Number 13 should be revised as needed to clarify its definitions and provisions and to make any other changes indicated by the study of present enforcement.

Better Mapping of Flood Zones

1. The Planning Board should undertake to have all regulated flood zones mapped at a scale of 1:2,000 for urban zones and 1:4,000 for rural zones.
2. The Planning Board should identify the highest priority V-zones and make a request to FIA that Puerto Rico receive high priority for remapping those V-zones.

Safe Construction and Reconstruction

1. To aid professional engineers and architects in designing and constructing safe structures, the Regulation and Permits Administration, in cooperation with the U.S. Army Corps of Engineers, should prepare a manual describing floodproofing techniques acceptable for use in Puerto Rico.

FLOOD FORECASTING AND WARNINGS

1. NOAA should take immediate steps, in coordination with the CoE, U.S. Geological Survey (USGS), FEMA, and DNR, to develop and implement a fully automated flash flood warnings system, consisting of a radio network of event-reporting rain gages, repeater stations, river gages, and computer equipment. The initial cost is estimated at 1.5 to 2.0 million dollars (including \$134,000 for the hardware for 56 rain gages and 31 river gages, and computer equipment).

2. The NWS should continue to work closely with Civil Defense Officials to improve data collection and dissemination of flood warnings. In particular, NWS should identify communities most vulnerable to flash floods, and maintain a continuing educational program for Civil Defense personnel on the potential for "worst case" versus "minimum" flood situations.
3. Plans for preparedness literature and films, whether done by NWS or FEMA, should recognize the special and unique needs of Puerto Rico and be designed accordingly.
4. A major NOAA weather radio publicity campaign should be initiated early in 1980 for Puerto Rico.

EVACUATION PLANNING

1. The Civil Defense Agency and the CoE should perform a survey of flood hazard areas and determine, in order of priority, which areas are in the most danger from flooding or isolation during flooding and need detailed emergency evacuation plans.
2. The Civil Defense Agency, through its On-Site Assistance Program, and municipal civil defense directors should prepare evacuation plans for those areas determined to need formal emergency evacuation plans. As much as possible, these plans should be prepared similar to the ones being prepared by the Corps of Engineers for the Río Grande de Loíza and Río de La Plata coastal floodplains.
3. Other agencies, such as DNR, the Geological Survey and the National Weather Service should assist in the preparation of these evacuation plans by providing funding and technical assistance.

RELOCATION

1. A study of relocation needs and the social and economic impacts of relocation should be undertaken by the Department of Housing. The study should use data available from the 1980 census.
2. Federal funding assistance should be sought for the study as well as for subsequent implementation of any specific relocation program.

FLOOD CONTROL STRUCTURES

Construction of Additional Flood Control Structures

1. Puerto Rico should request the Corps of Engineers to conduct flood control studies for all densely developed areas located within regulatory floodways.

Maintenance of Existing Flood Control Structures

1. The Puerto Rico Legislature should provide additional funding to the Department of Natural Resources (flood control section recently transferred from DTPW) for increased maintenance of storm sewer systems, channelized streams and other flood control structures under commonwealth responsibility. Municipios should likewise increase funding for maintenance of storm sewers and local canals under their jurisdiction.

IMPROVED INFORMATION ON FLOOD HAZARDS AND IMPACTS

1. Puerto Rico, federal and private agencies should collect and maintain information on flood damages and disaster assistance by municipios and socioeconomic areas.
2. The Department of Natural Resources should establish a central information repository that will contain and make available most information on flood hazards, flood damages, and emergency and disaster aid.
3. In order to ensure a complete and consistent information base, the Department of Natural Resources should establish and provide to all concerned agencies clear and simple guidance, including development of appropriate forms, regarding the collection of data on flood damages and disaster assistance.

PUBLIC AWARENESS

1. The Department of Natural Resources should establish a Public Awareness Program to coordinate the flood hazard public awareness activities of other agencies, and to prepare and distribute additional materials that are needed.

HAZARD MITIGATION PLANNING

Additional Hazard Mitigation Plans for Target Areas

1. Additional hazard mitigation plans should be prepared for high priority areas, especially for highly developed floodplains.

Hazard Mitigation Planning Following the Next Declared Flood Disaster

1. The present Hazard Mitigation Task Force should be maintained as a functioning group to assist with the preparation of additional hazard mitigation plans and to help with the implementation of recommendations included in this Puerto Rico Hazard Mitigation Plan and in the hazard mitigation plans for target areas.

2. The Department of Natural Resources, with the assistance of the Task Force, should prepare a set of detailed procedures describing each agency's responsibilities for hazard mitigation planning.
3. FEMA should provide more specific guidance, greater technical assistance, and funding assistance for hazard mitigation planning.

Hazard Mitigation Recommendations for Damage Survey Reports

1. Public agencies should be required to implement the hazard mitigation recommendations contained in Damage Survey Reports in order to receive federal disaster funds.

Follow-up to Hazard Mitigation Recommendations Contained in Hazard Mitigation Plans and Damage Survey Reports

1. The Department of Natural Resources should provide follow-up on recommendations and periodically report to the Governor on progress in implementation.

NOAA COASTAL SERVICES CTR LIBRARY



3 6668 1411100 7