FIGURAS

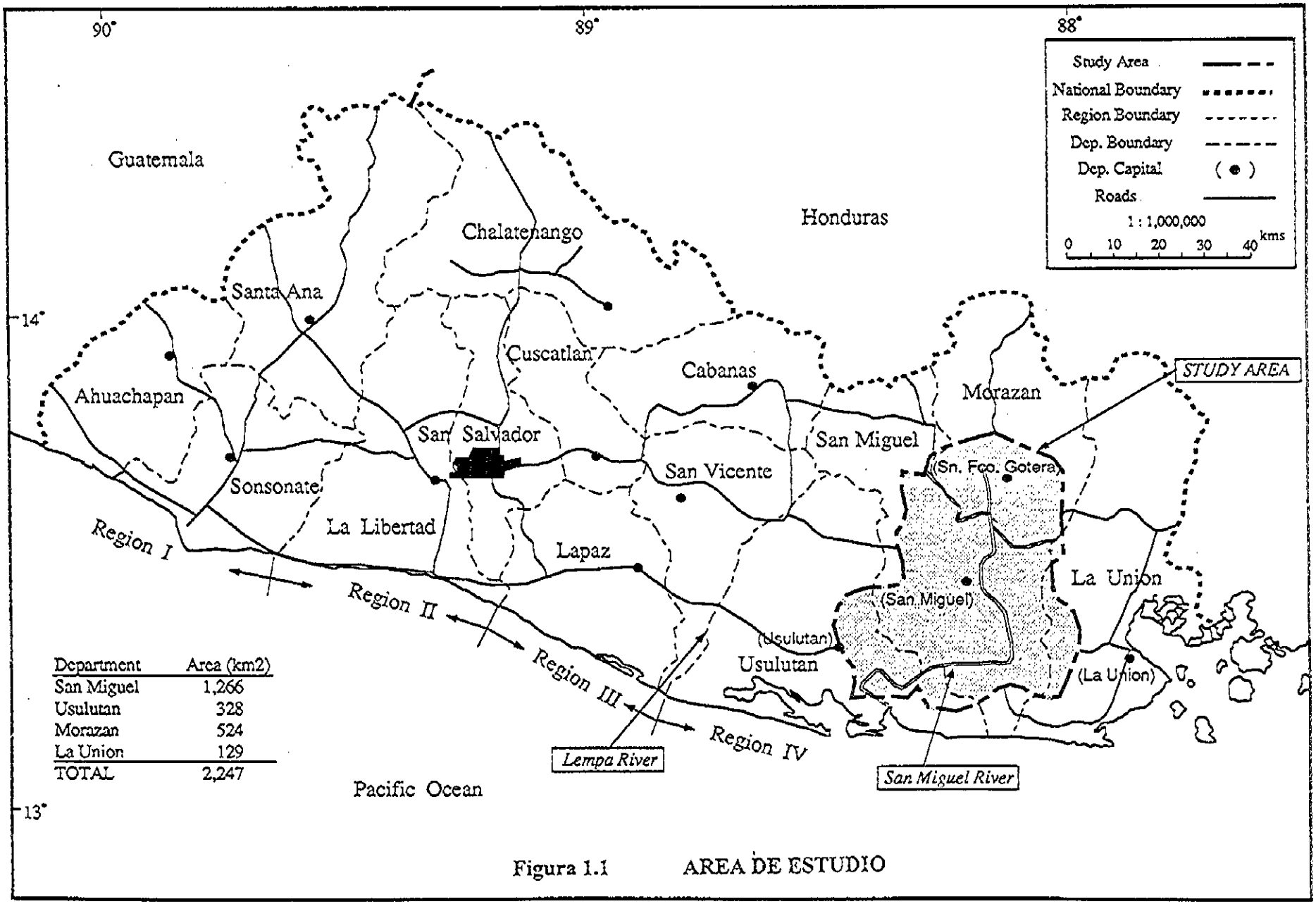


Figura 1.1 AREA DE ESTUDIO

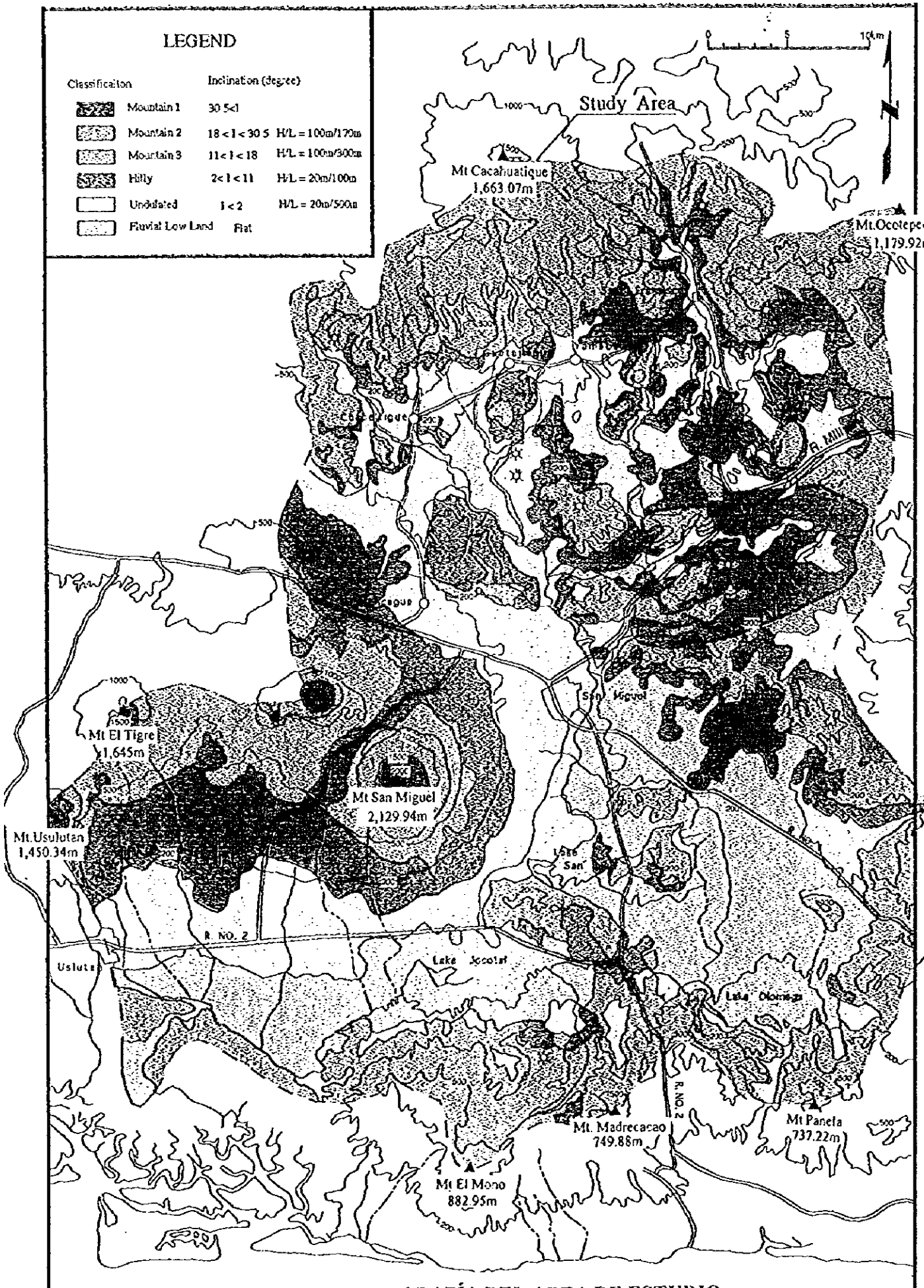


Figura 2.1 TOPOGRAFÍA DEL AREA DE ESTUDIO

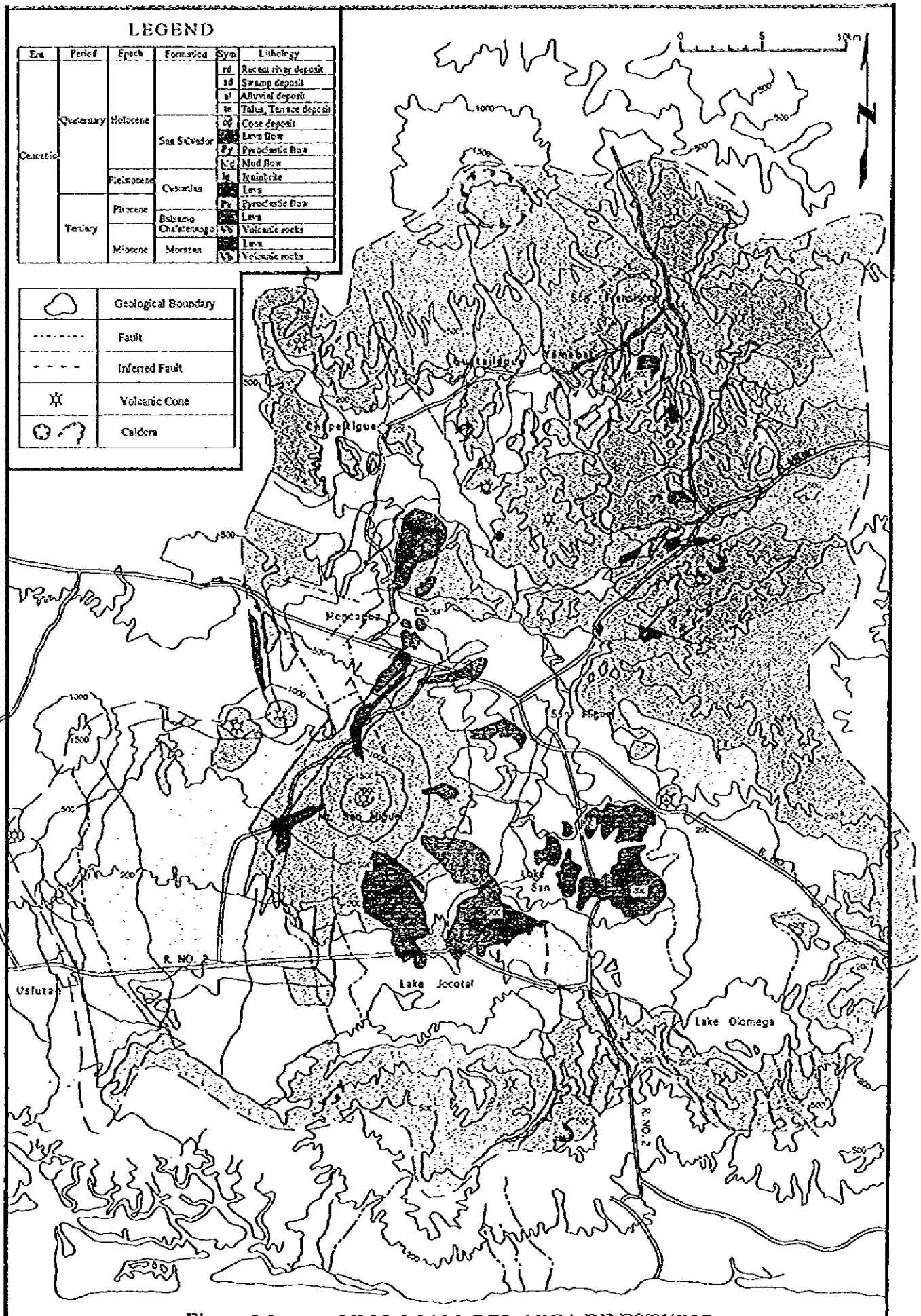


Figura 2.2 GEOLOGICO DEL AREA DE ESTUDIO

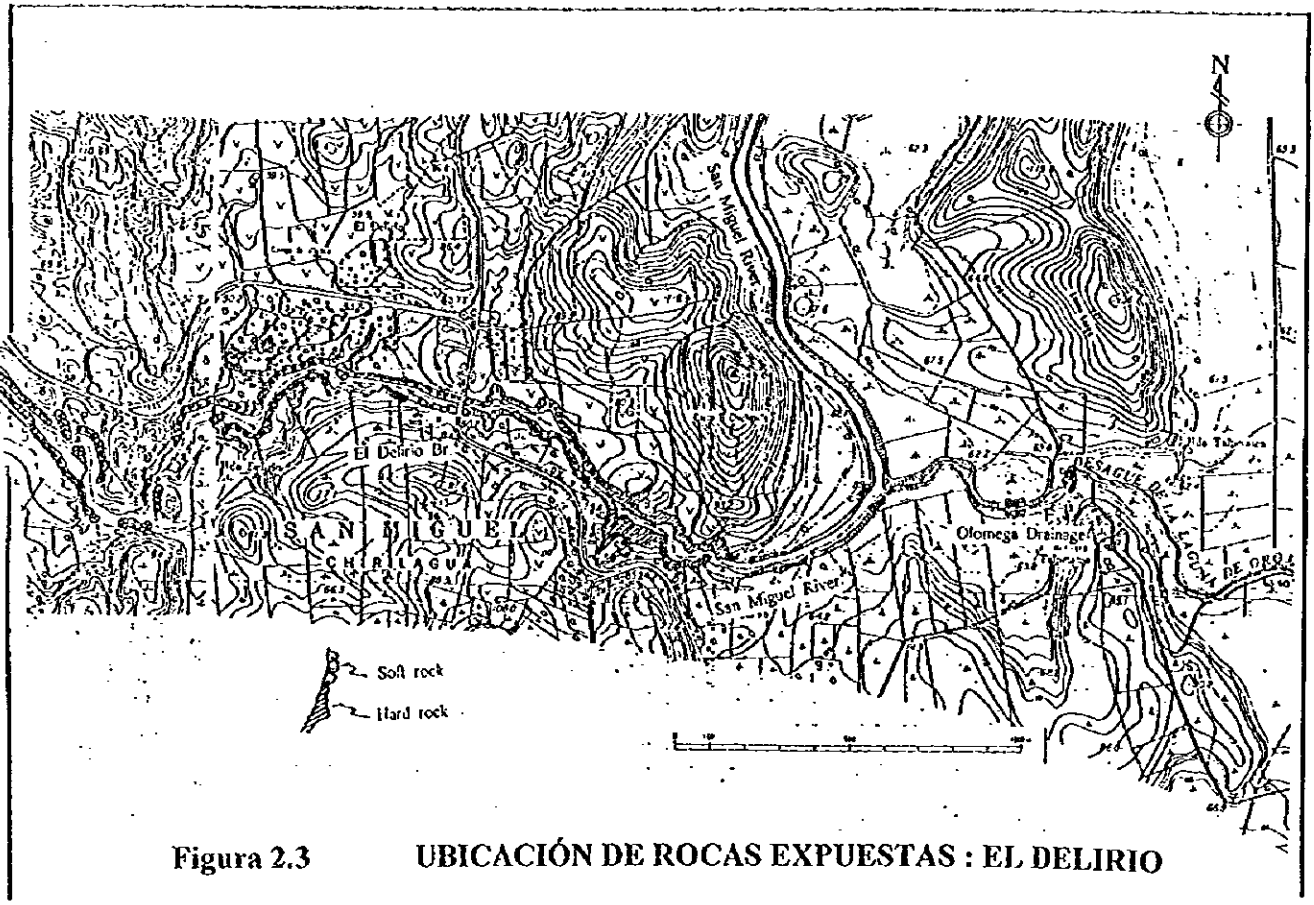


Figura 2.3 UBICACIÓN DE ROCAS EXPUESTAS : EL DELIRIO

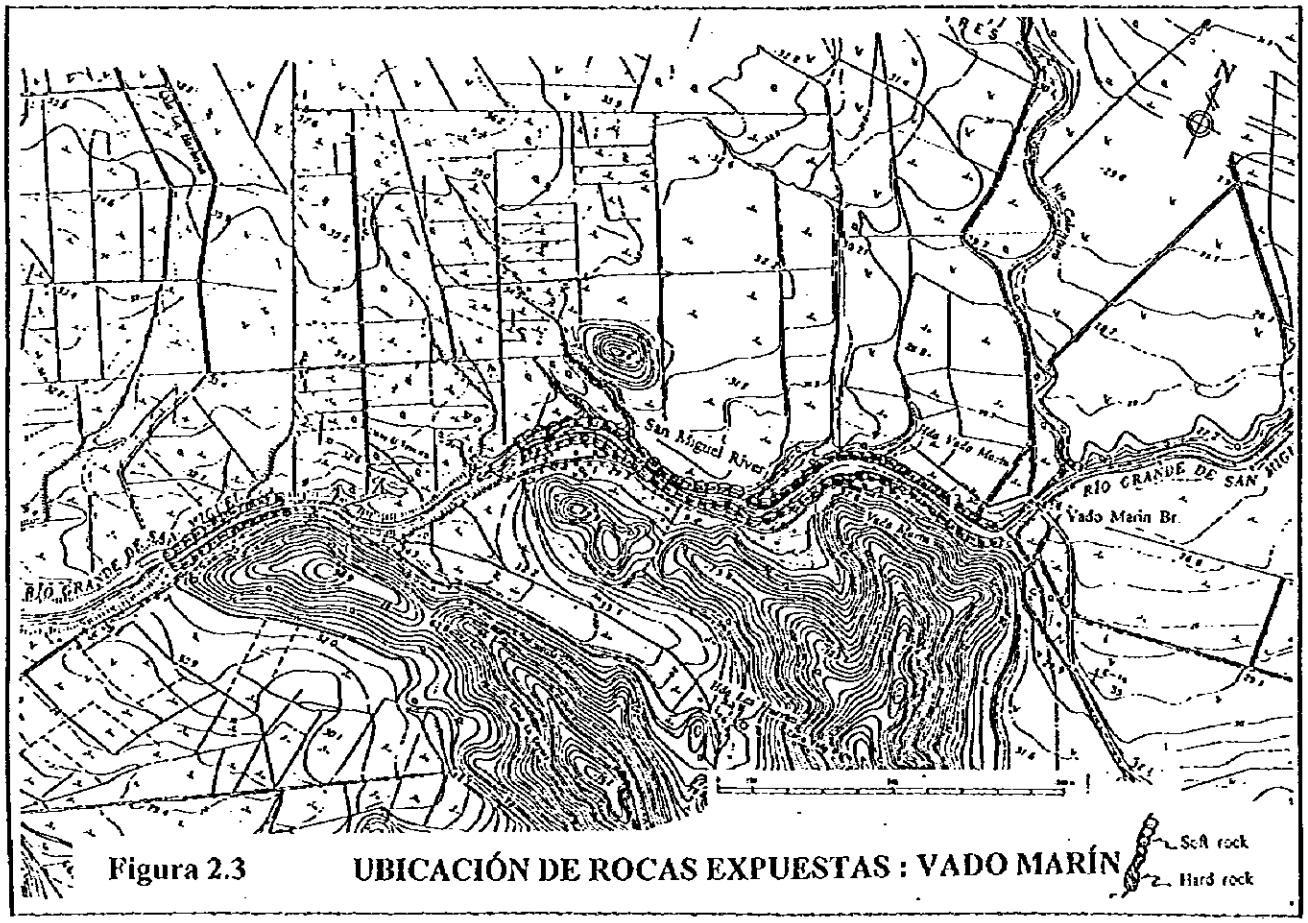
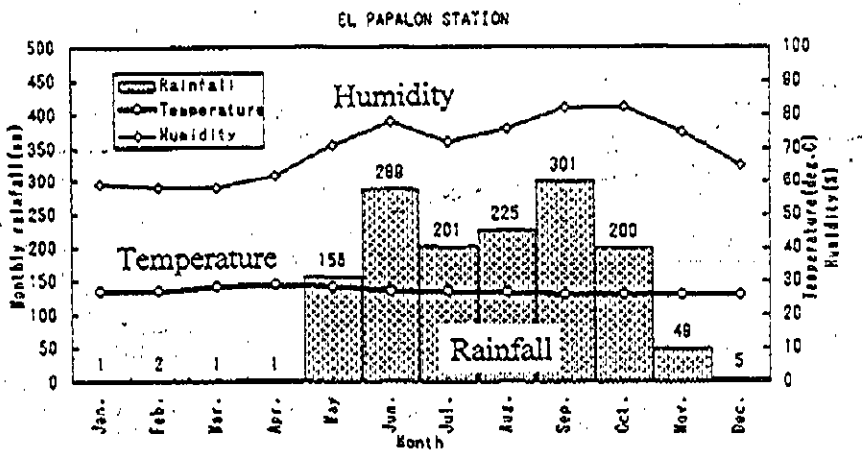
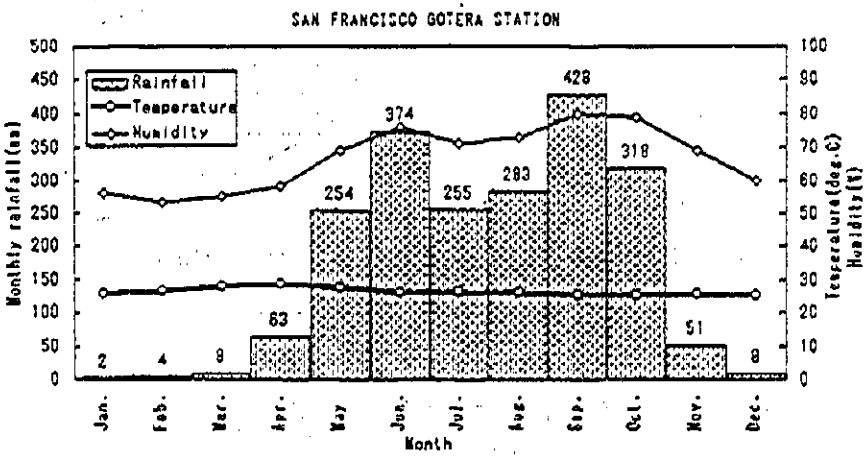


Figura 2.3 UBICACIÓN DE ROCAS EXPUESTAS : VADO MARÍN





EL PAPALON STATION

Month	Rainfall (mm)	Tempera-ture (deg.C)	Humidity (%)	Wind velocity (km/h)	Wind direction	
Jan.	1	26.9	59	5.0	N	
Feb.	2	27	58	5.0	N	
Mar.	1	28.3	58	5.0	S	
Apr.	1	29	62	5.0	S	
May	156	28.2	71	3.0	S	
Jun.	289	26.9	78	1.0	SE	
Jul.	201	26.8	72	5.0	N	
Aug.	225	26.7	76	5.0	N	
Sep.	301	25.9	82	5.0	S	
Oct.	200	25.8	82	1.0	S	
Nov	49	25.8	75	5.0	N	
For rainfall: Dec	5	25.8	65	5.0	N	For temp./humid.
Annual total(1)	1431	26.9	70			Mean
Total(May-Oct)(2)	1372	29.0	82			Max.
(2)/(1) (%)	96	25.8	58			Min.

SAN FRANCISCO GOTERA STATION

Month	Rainfall (mm)	Tempera-ture (deg.C)	Humidity (%)	Wind velocity (km/h)	Wind direction	
Jan.	2	25.8	56	3.6	N	
Feb.	4	26.5	53	3	N	
Mar.	8	27.9	55	3	N	
Apr.	63	28.6	58	3	N	
May	254	27.4	69	3	N	
Jun.	374	26	76	3	N	
Jul.	255	26.3	71	3	N	
Aug.	283	25.9	73	3	N	
Sep.	428	25.3	80	3	N	
Oct.	318	25.4	79	3	N	
Nov.	51	25.6	69	3	N	
For rainfall Dec	8	25.5	60	3	N	For temp./humid.
Annual total(1)	2048	26.4	67			Mean
Total(May-Oct)(2)	1912	28.6	80			Max.
(2)/(1) (%)	93	25.3	53			Min.

Figura 2.4 **CONDITIONES CLIMÁTICAS EN EL AREA DE ESTUDIO**

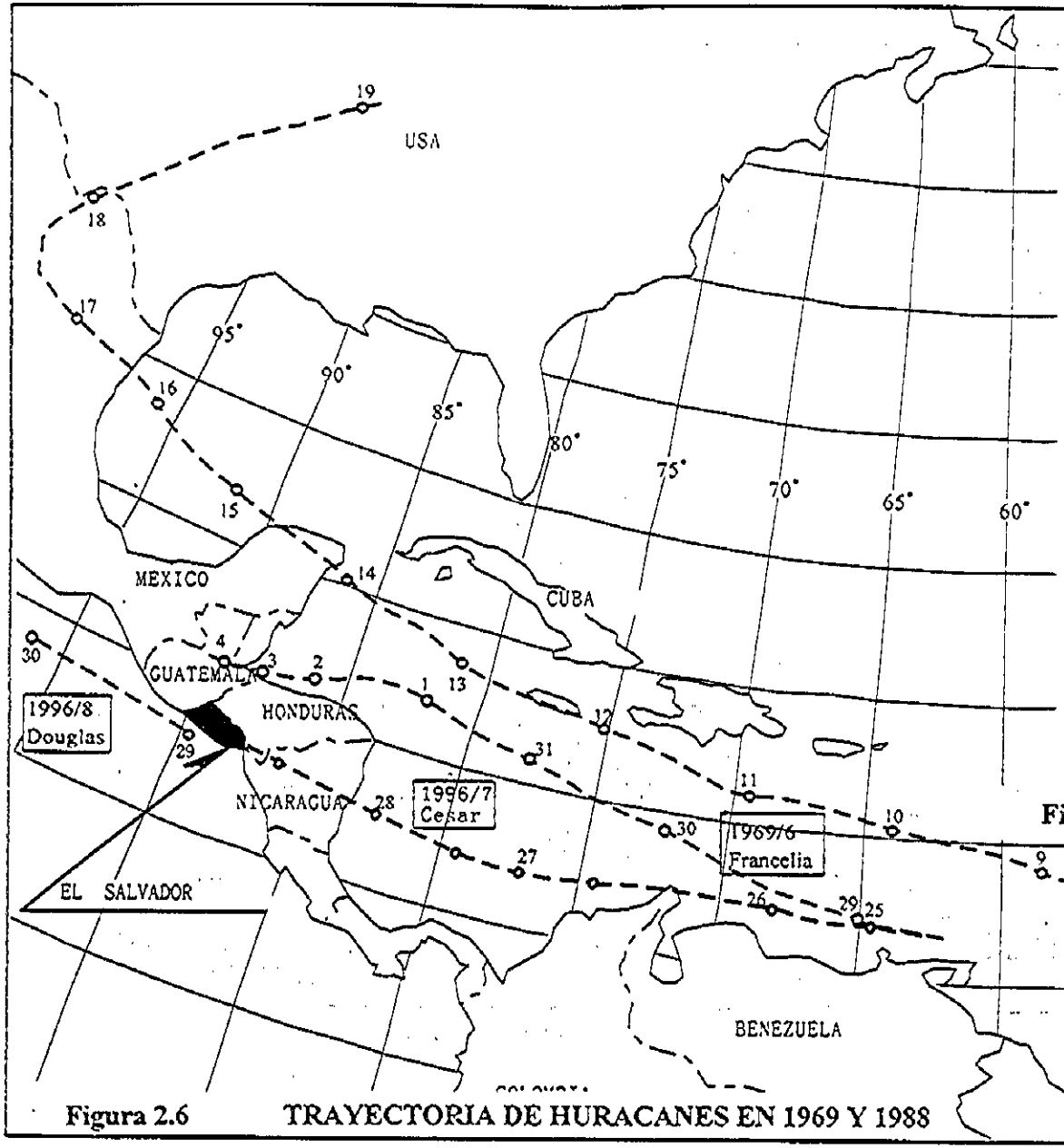


Figura 2.6 TRAYECTORIA DE HURACANES EN 1969 Y 1988

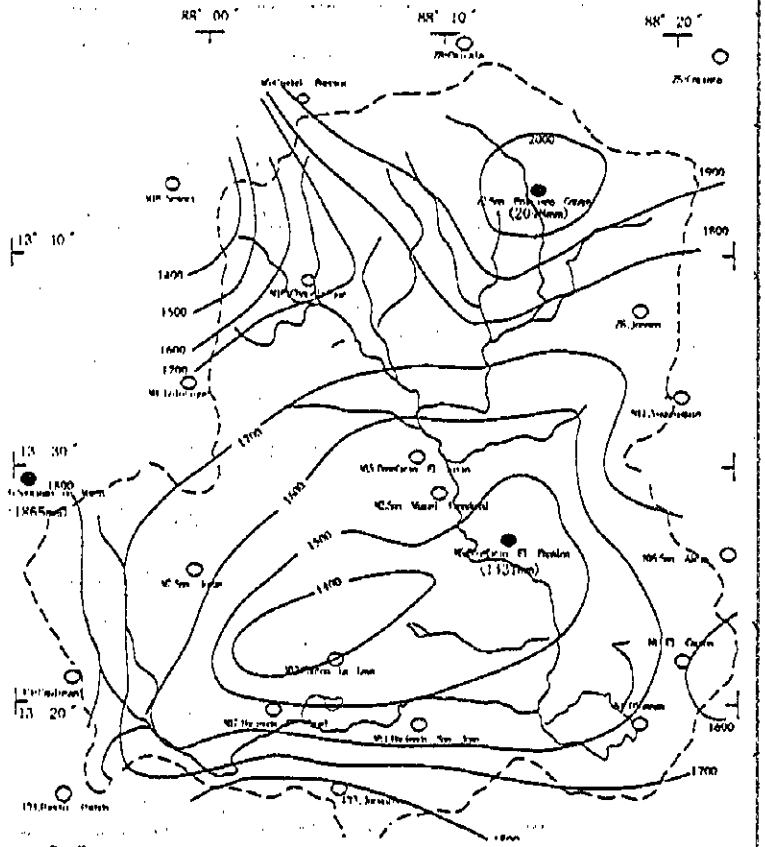


Figura 2.5 MAPA ISOHIETAL DE PRECIPITACIÓN ANUAL EN LA CUENCA

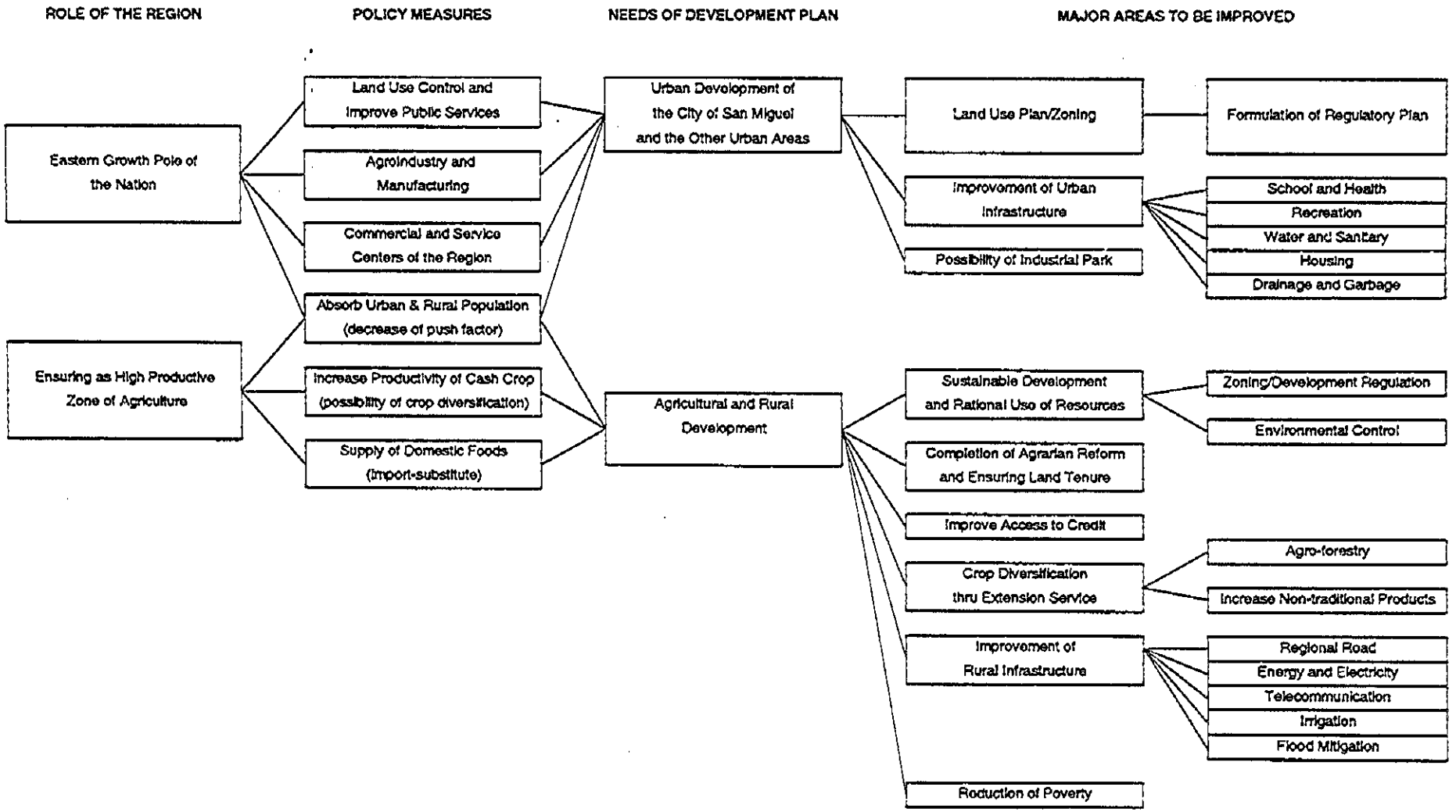
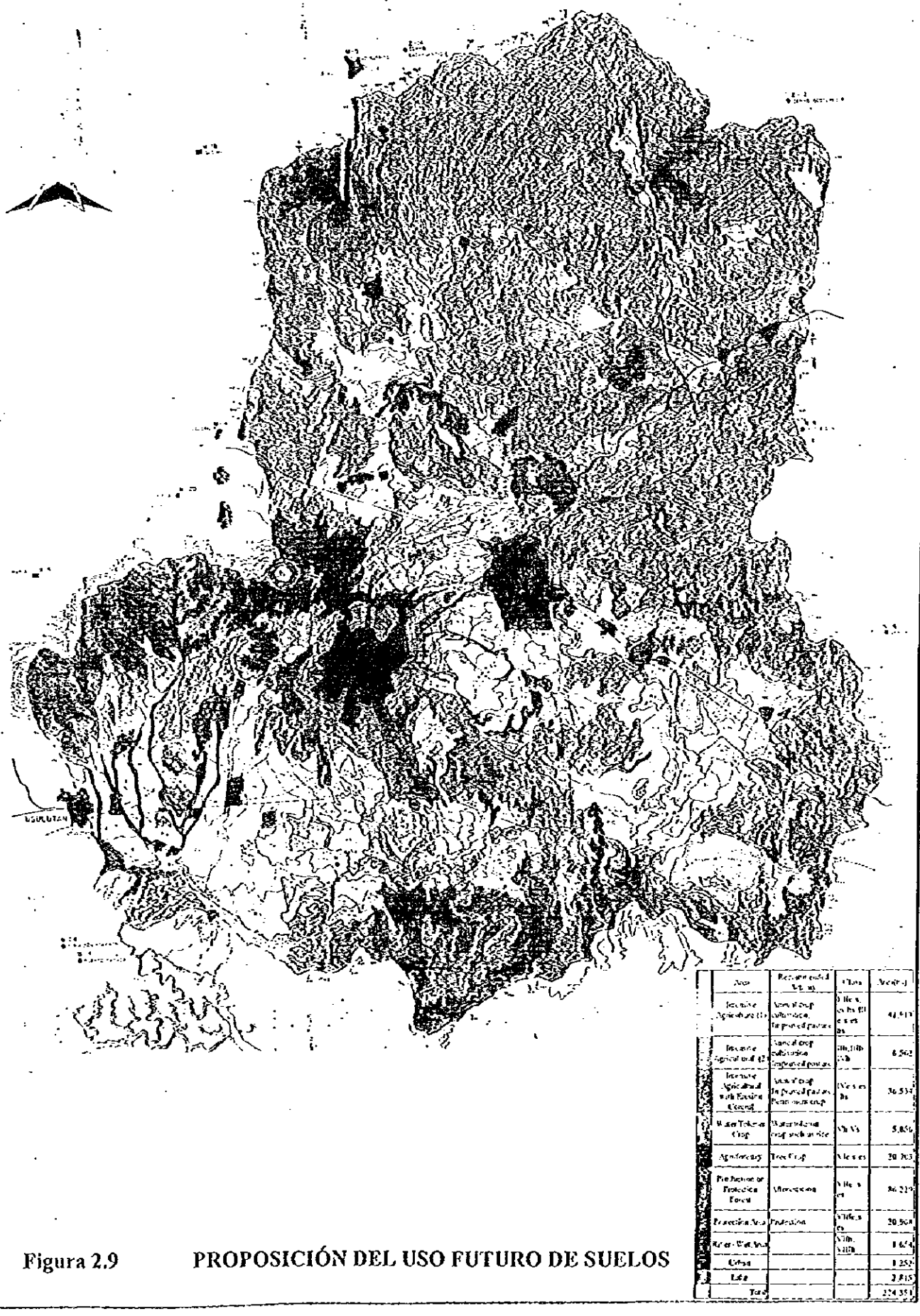


Figura 2.7 ORIENTACIÓN DEL DESARROLLO EN EL AREA DE ESTUDIO

Source:MAG

Figura 2.8 USO DE SUELOS ACTUAL EN EL AREA DE ESTUDIO (1996)



Area	Recommended Use	Class	Area (ha)
Intensive Agriculture (I)	Annual crop cultivation, Irrigated pasture	I (Best soils for cultivation)	41,917
Intensive Agricultural (II)	Annual crop cultivation, Irrigated pasture	III, IIIb, IVb	6,562
Intensive Agricultural with Erosion Control	Annual crop, Irrigated pasture, Perennial crop	IV(Less suitable)	36,534
Water Tolerant Crop	Water tolerant crop such as rice	VI, VI	5,856
Agroforestry	Tree Crop	V(Less suitable)	20,705
Production or Protection Forest	Afforestation	VI(Not suitable)	86,219
Protection Area	Protection	VI(Not suitable)	20,504
River / Wetland		VI(Not suitable)	1,654
Urban			1,252
Lake			2,815
Total			234,351

Figura 2.9 **PROPOSICIÓN DEL USO FUTURO DE SUELOS**

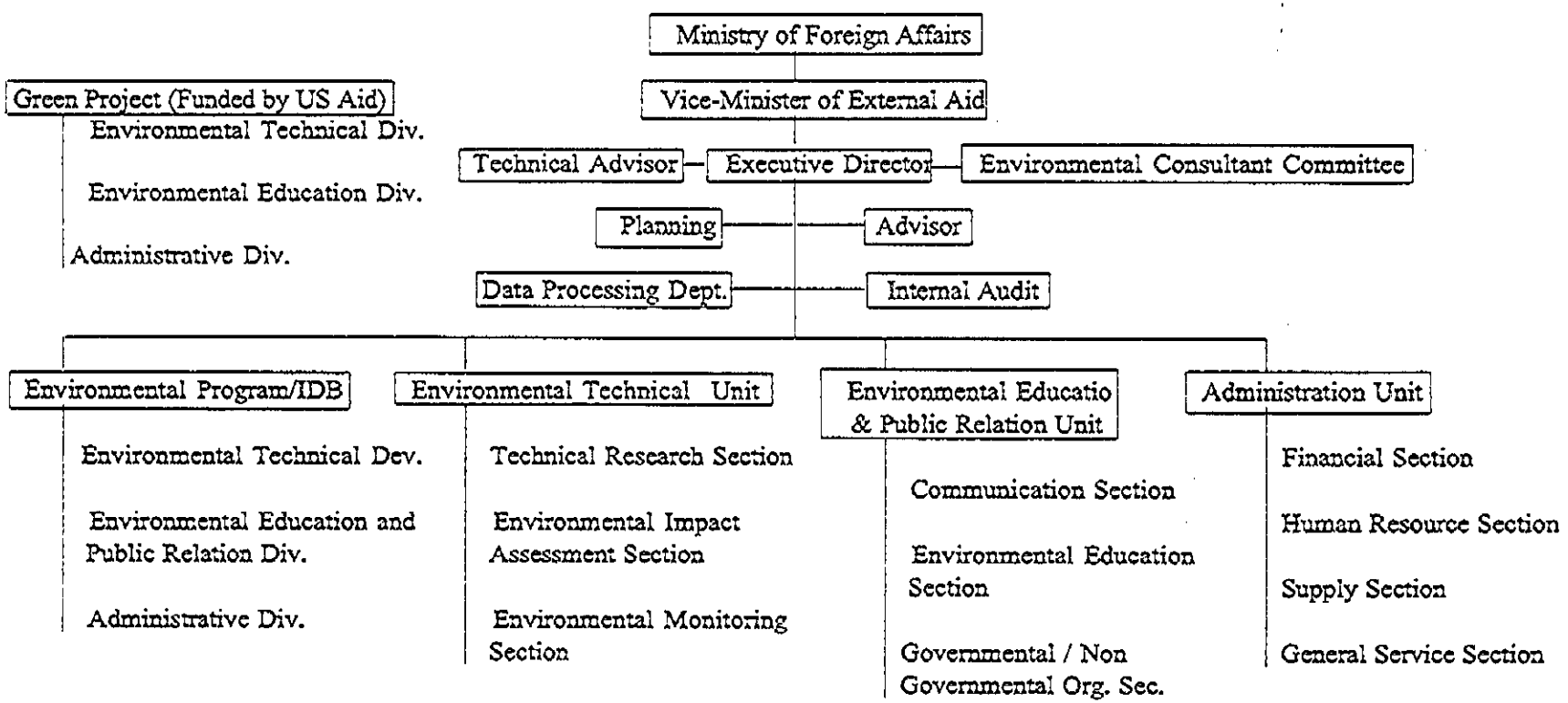


Figura 2.10 ORGANIGRAMA DE SEMA

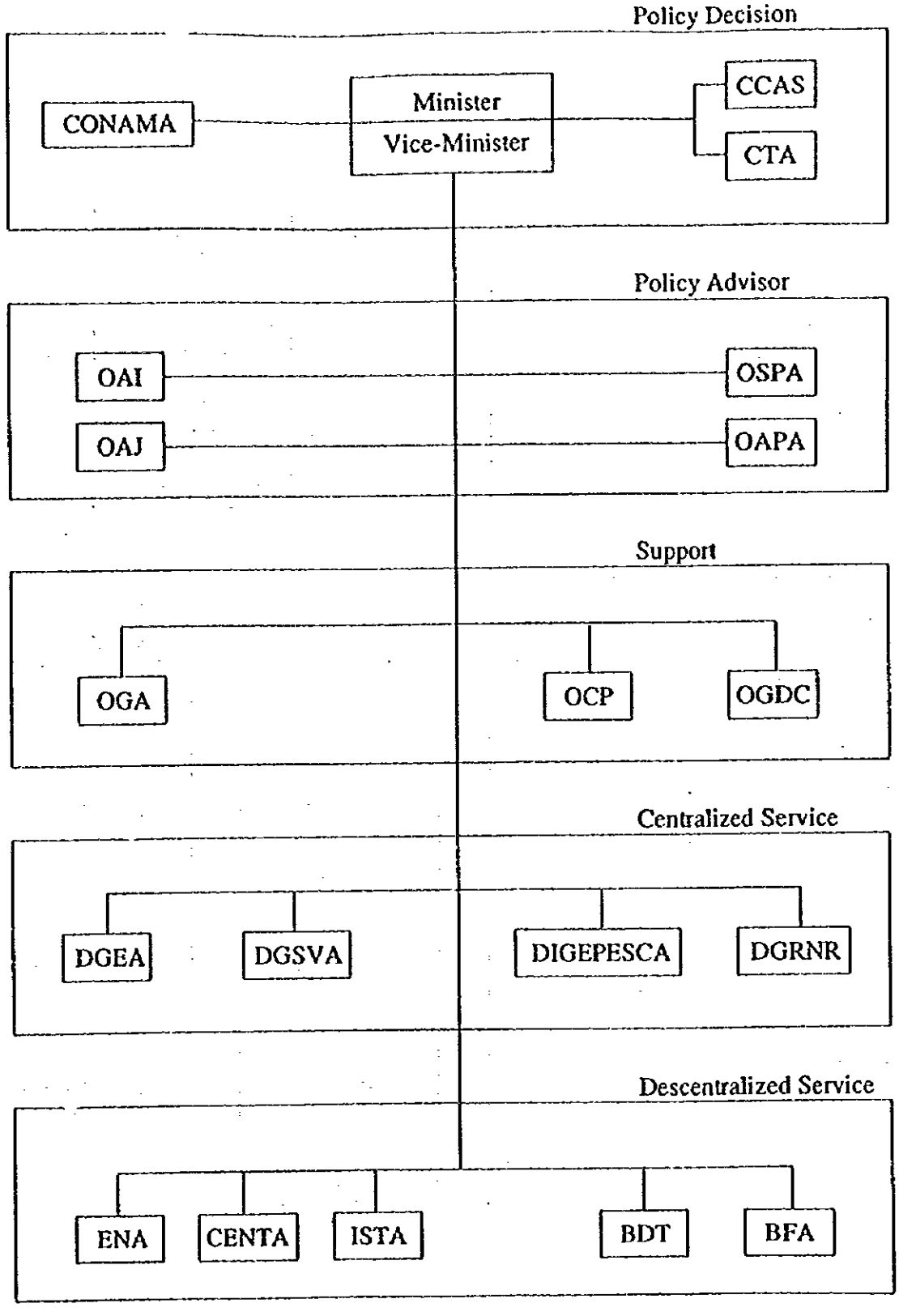


Figura 2.11 (1) ORGANIGRAMA DE MAG

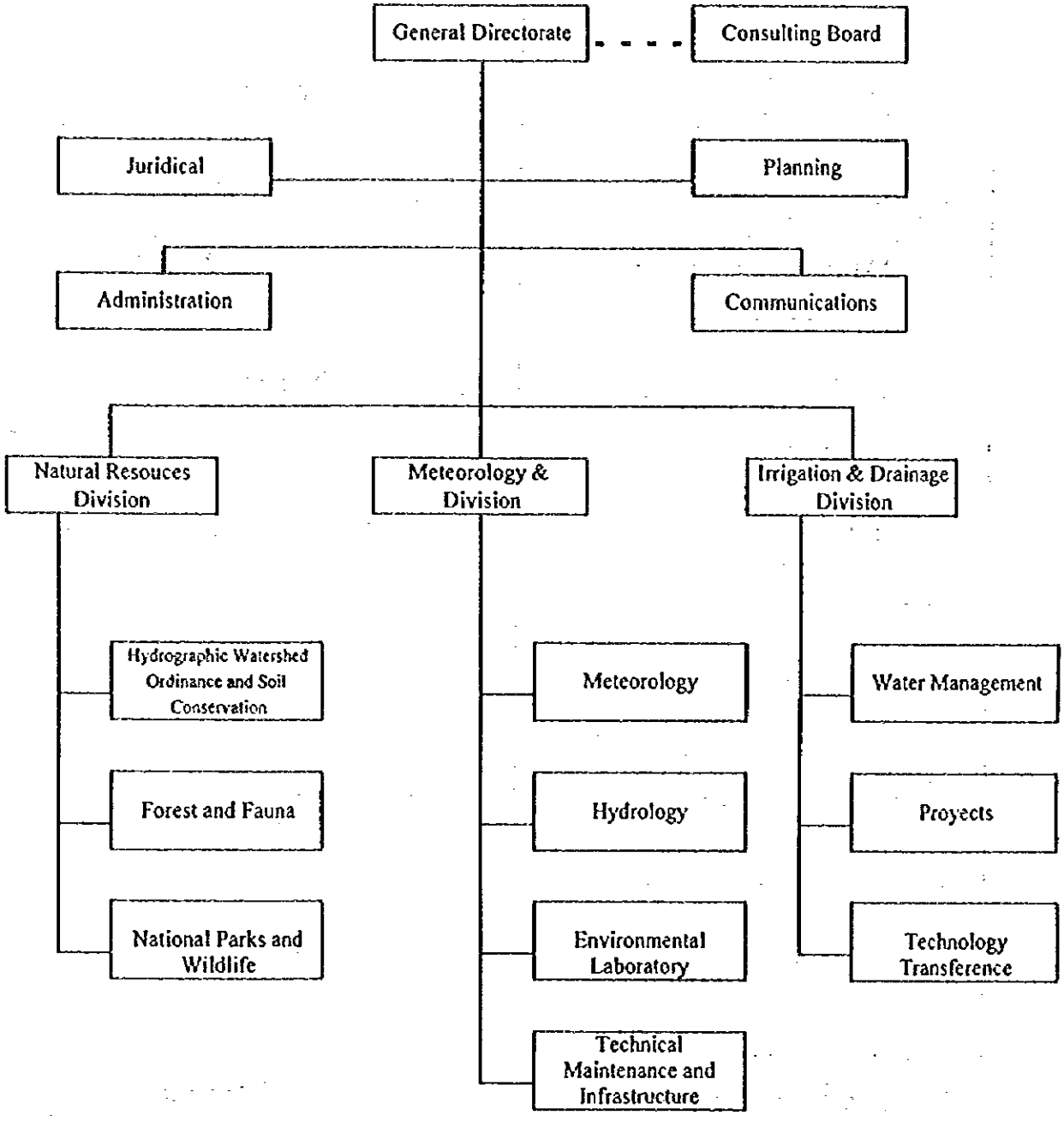


Figura 2.11 (2) ORGANIGRAMA DE LA DGRNR

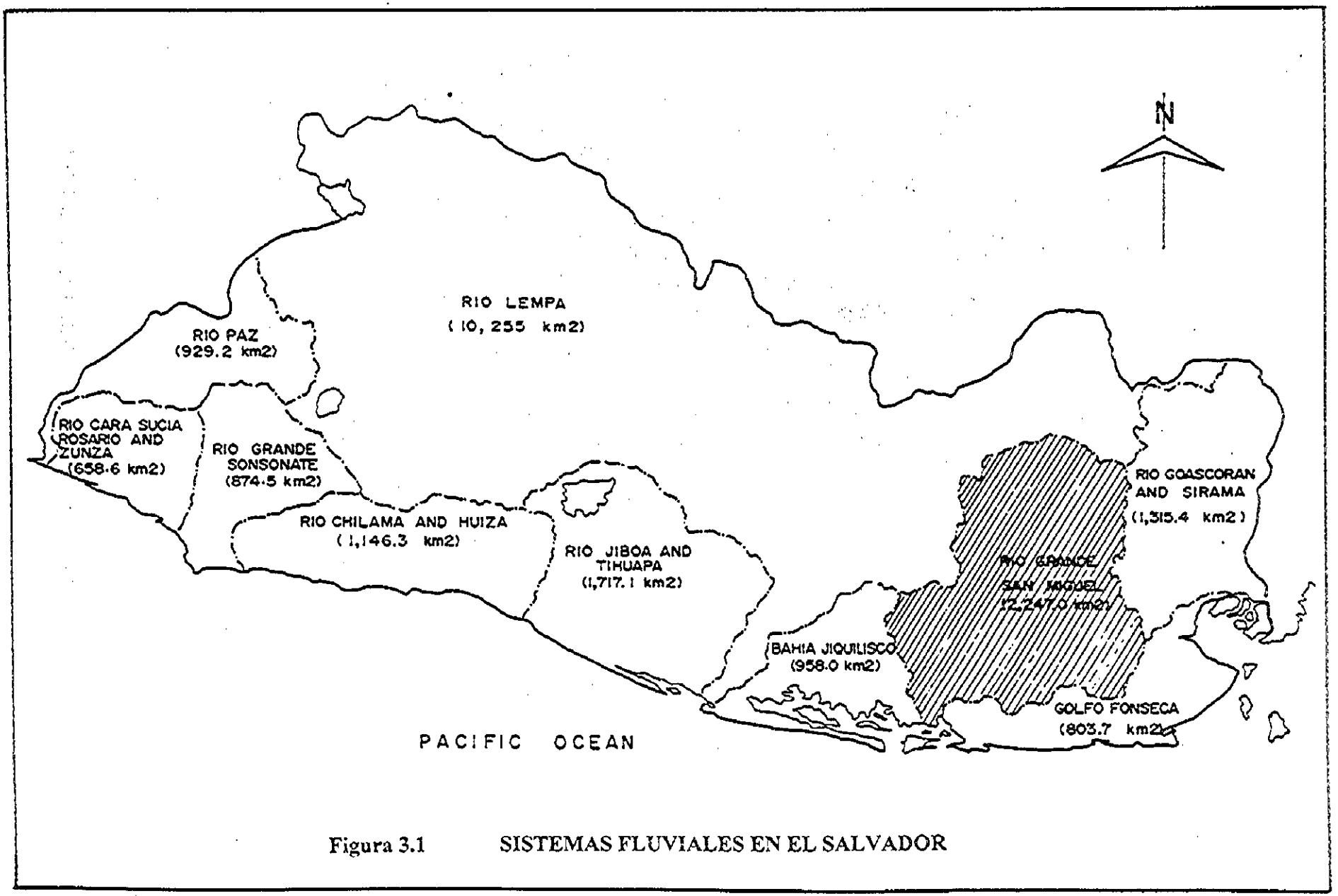


Figura 3.1 SISTEMAS FLUVIALES EN EL SALVADOR

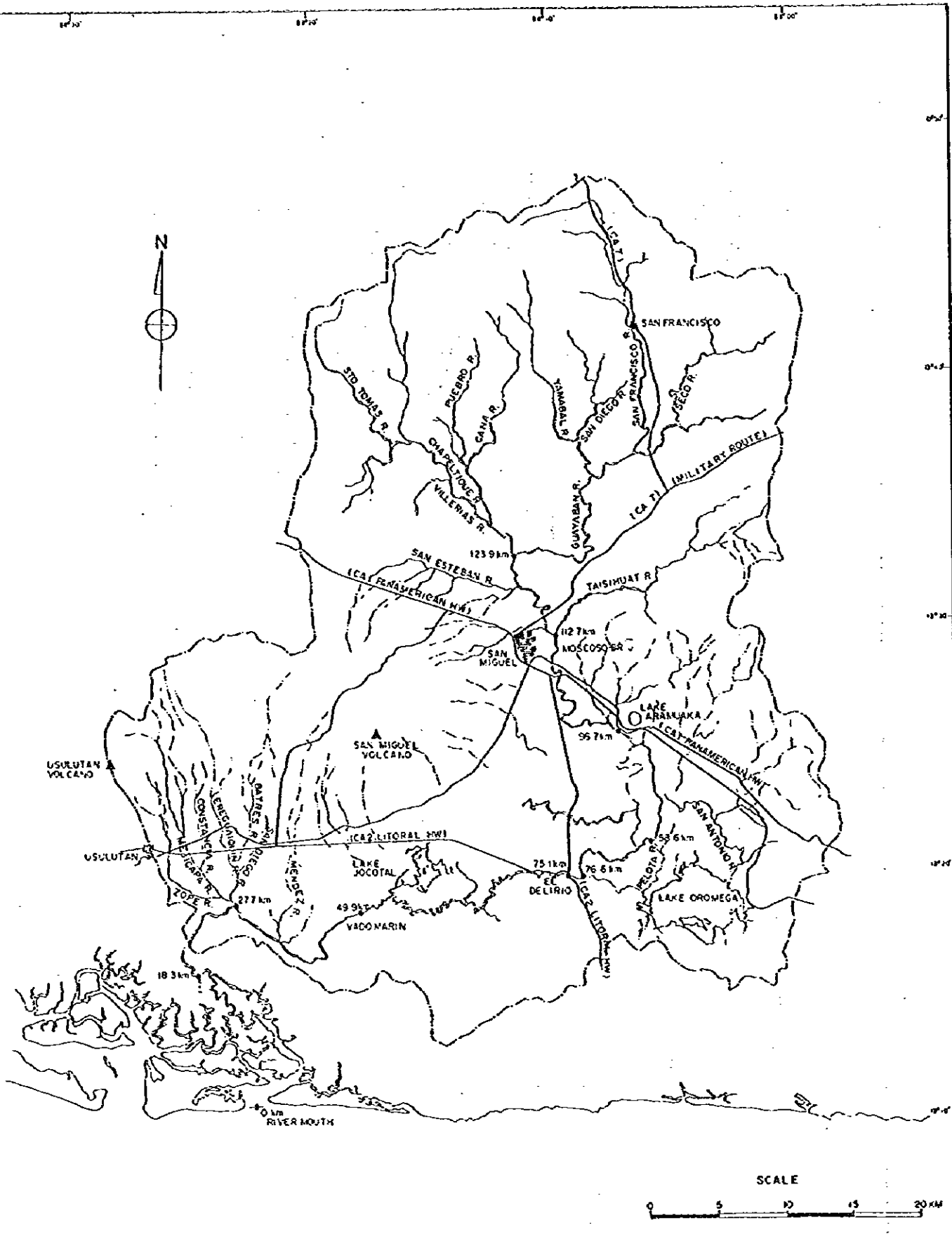


Figura 3.2 **SISTEMA DEL RÍO GRANDE DE SAN MIGUEL**

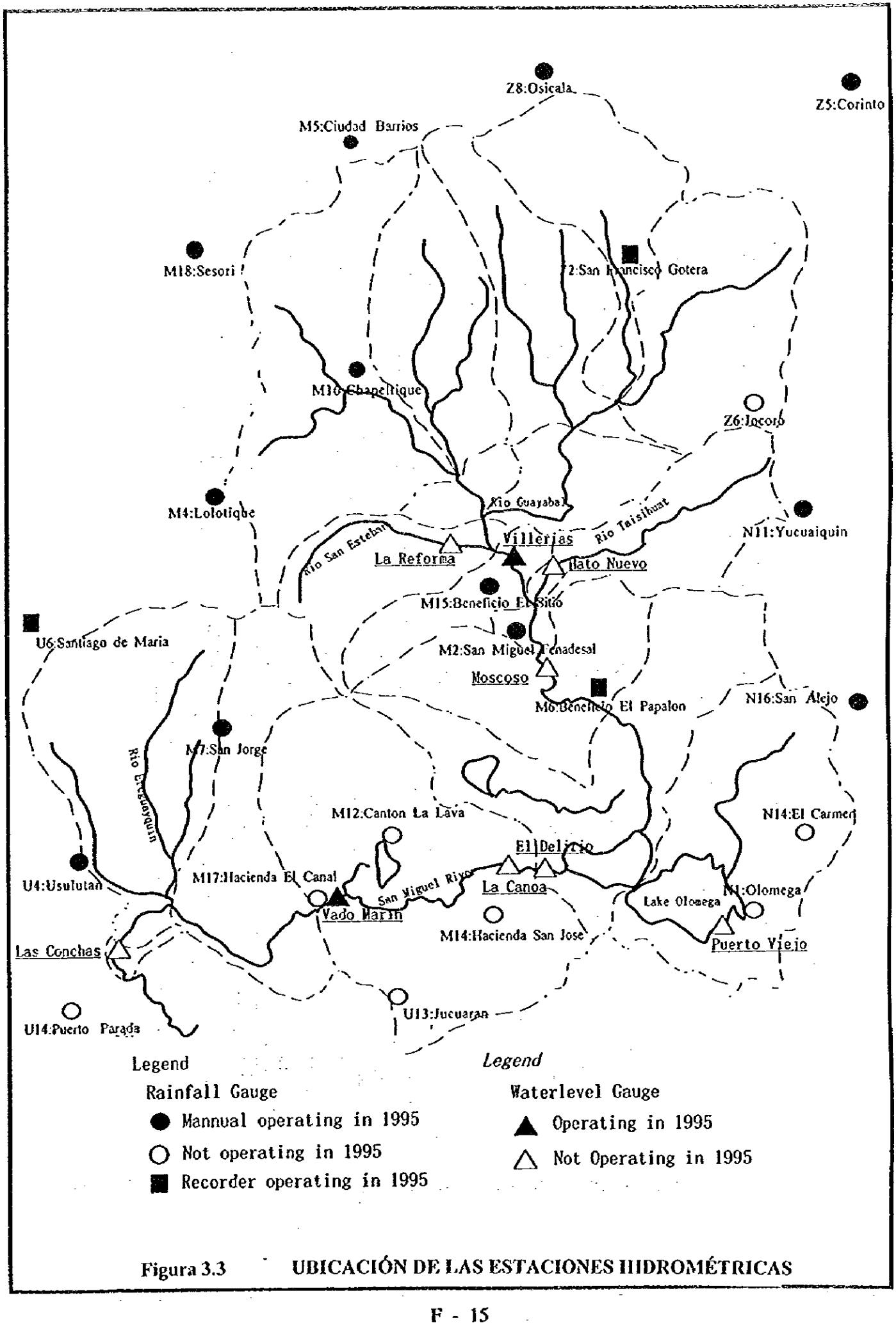


Figura 3.3 UBICACIÓN DE LAS ESTACIONES HIDROMÉTRICAS

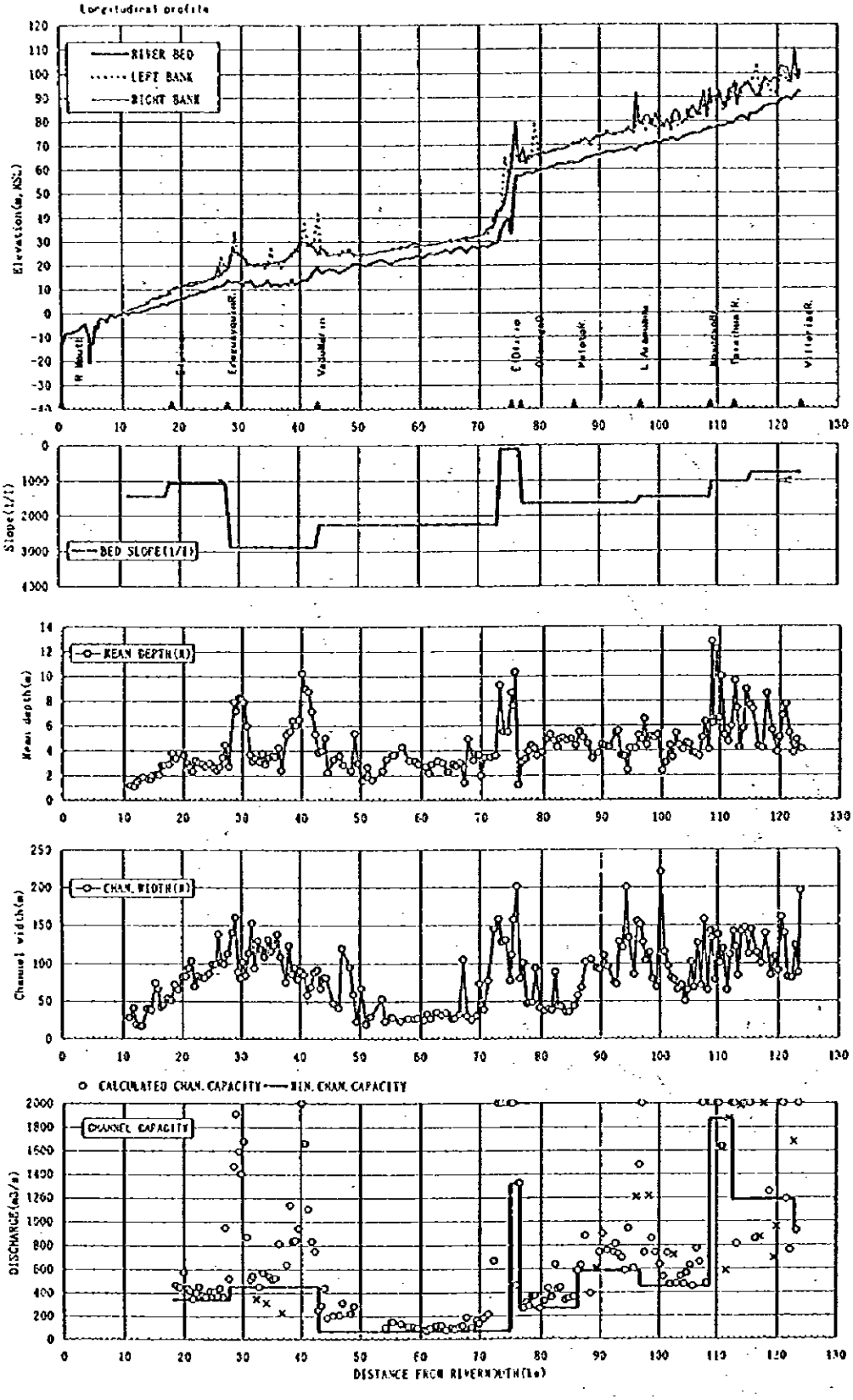
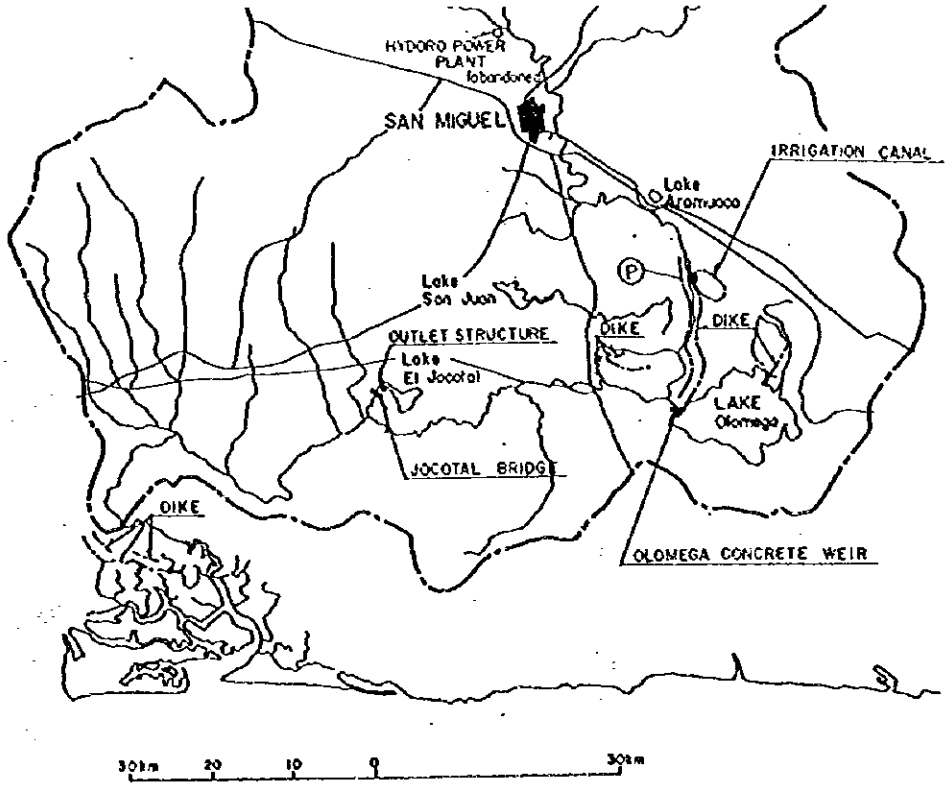
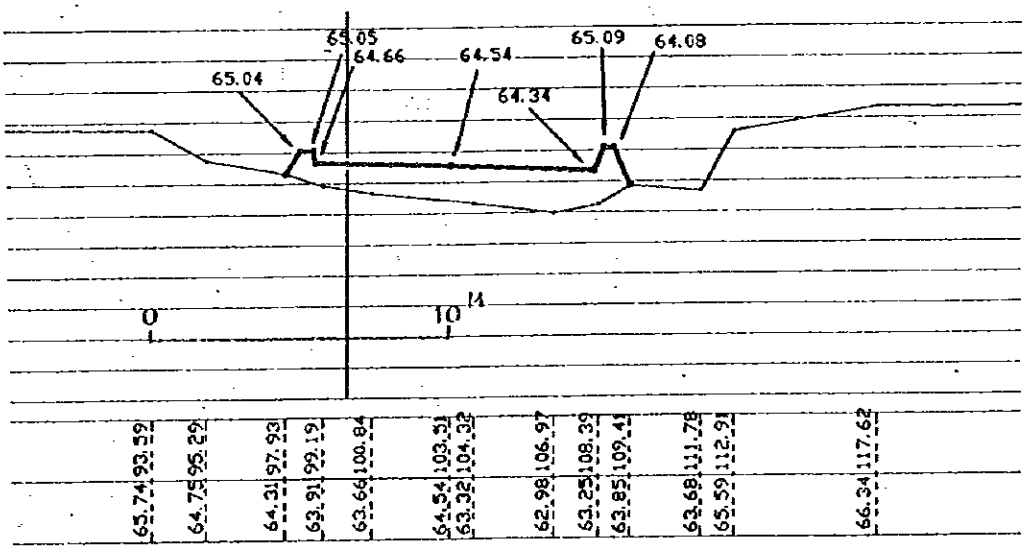


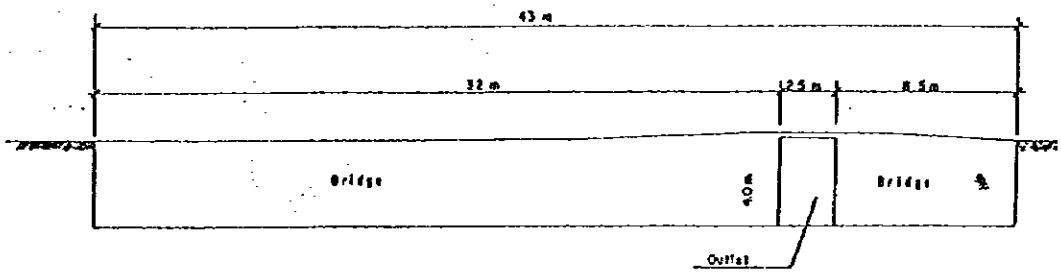
Figura 3.4 PERFILES LONGITUDINALES DEL RÍO GRANDE DE SAN MIGUEL EXISTENTE





H. 1:200

EXISITING CONCRETE WEIR AT LAKE OLOMEGA OUTLET



EXISTING BRIDGE AT LAKE JOCOTAL OUTLET

Figura 3.5

ESTRUCTURAS EXISTENTES PARA EL CONTROL DE INUNDACIONES Y RIEGO

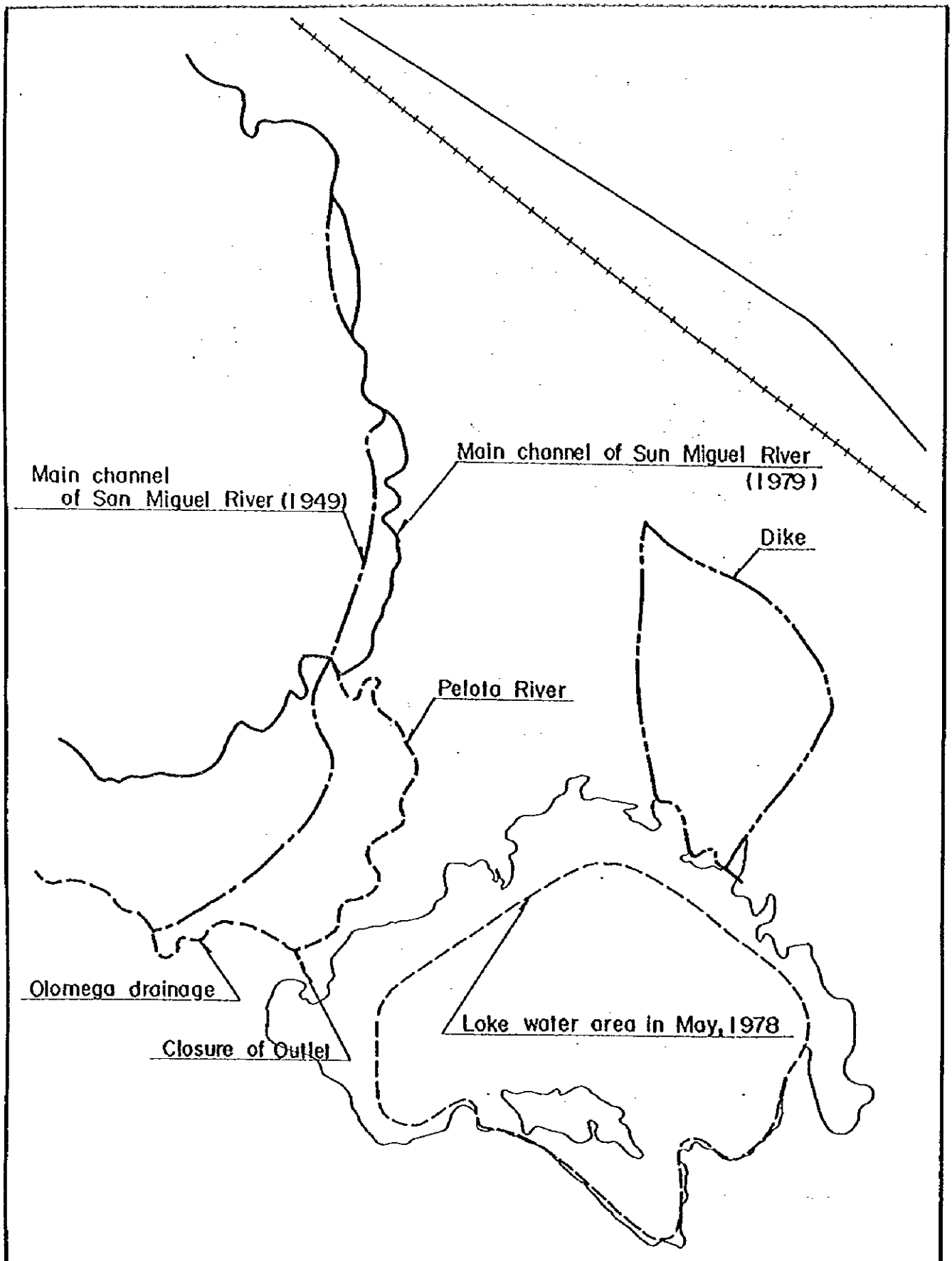


Figura 3.6

CAMBIO DEL CAUCE DEL RíO CERCA DE LA LAGUNA DE OLOMEGA

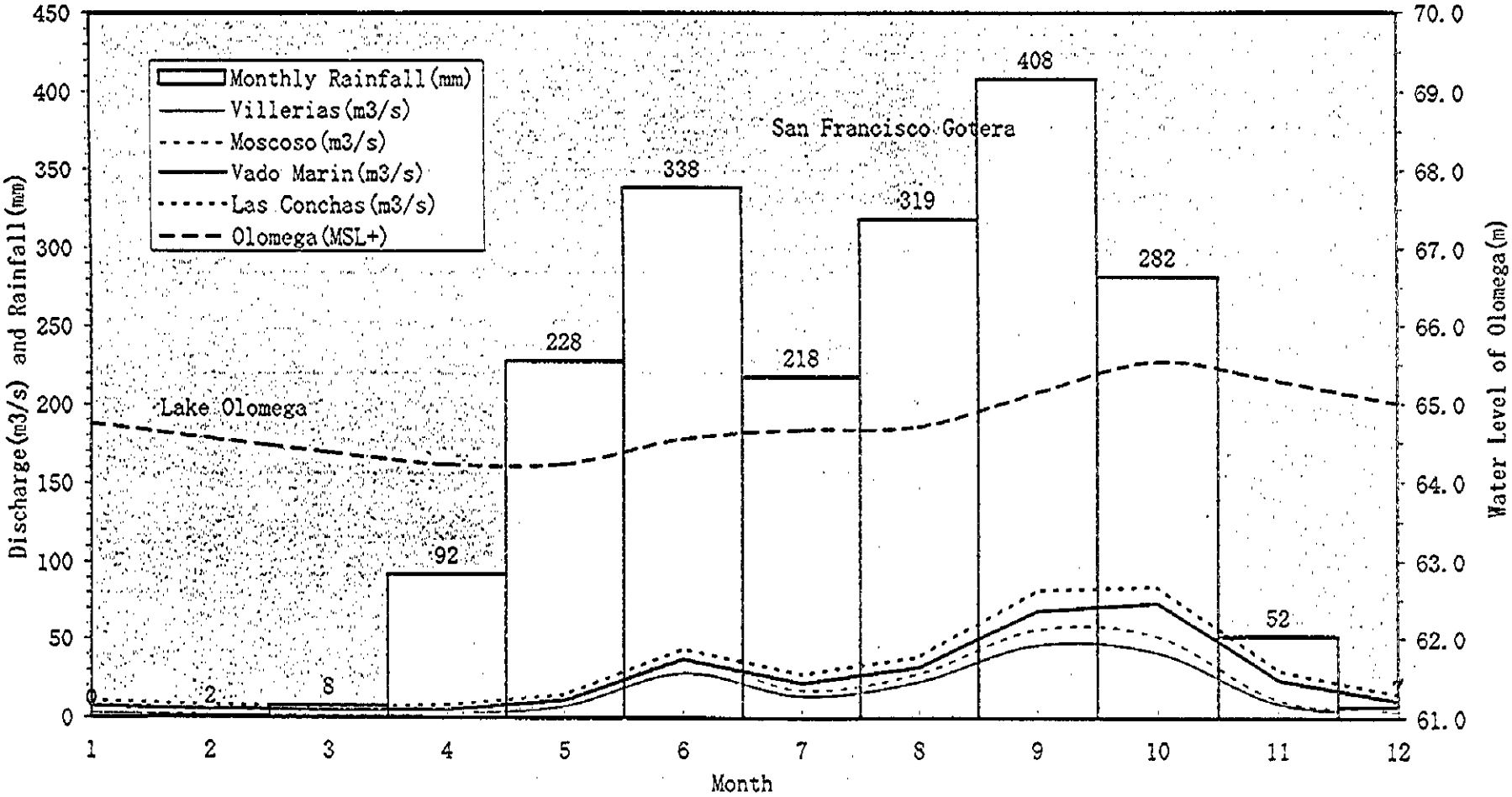
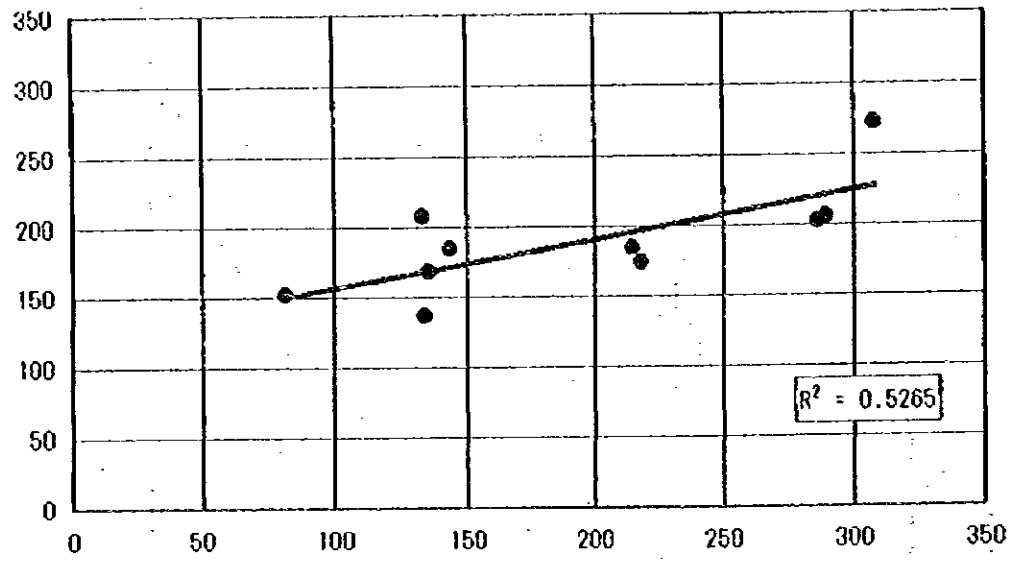
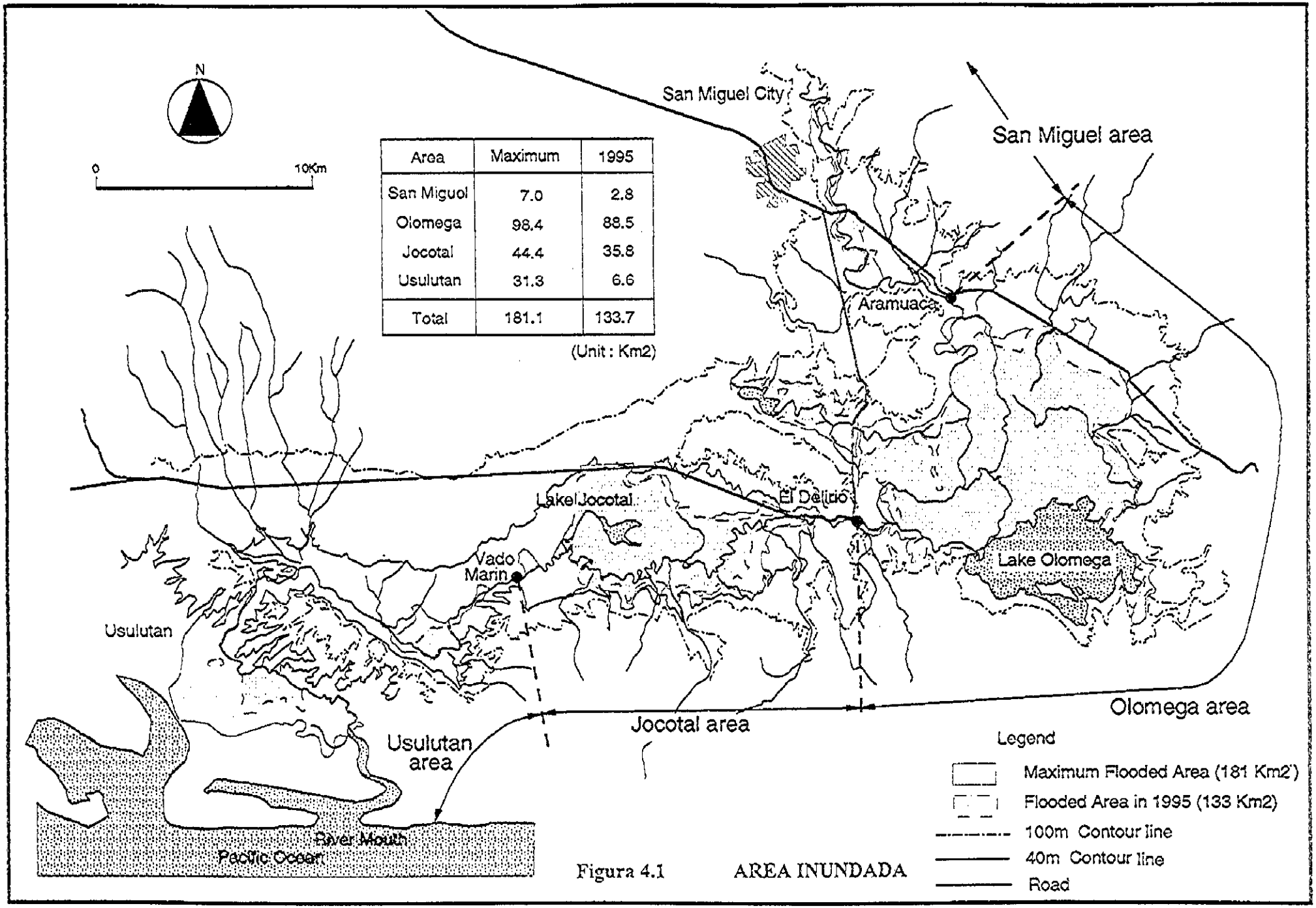


Figura 3.7 PRECIPITACIÓN, DESCARGA Y EL NIVEL DEL AGUA DE LA LAGUNA DE OLOMEGA (1970-1978)



Station: Vado Marin(May 1959 - 1981)								
Annual max. discharge						7-day basin rainfall		
Year	Ordinal month	Date	Hmax (m)	Qmax (m^3/s)	Ranking	Ordinal month	Date	R7 (mm)
1959	10	20	2.16	57.9	20	-	-	-
1960	-	-	-	-	-	-	-	-
1961	10	9	2.44	188.8	10	-	-	-
1962	9	27	2.59	156.0	11	-	-	-
1963	11	11	3.22	248.1	5	-	-	-
1964	9	4	2.56	134.4	15	9	2	136.7
1965	10	1	2.74	218.9	8	9	23	174.0
1966	7	15	2.84	289.8	3	7	14	205.4
1967	10	14	2.10	96.0	18	-	-	-
1968	9	26	2.40	155.0	12	-	-	-
1969	9	6	3.84	296.0	2	-	-	-
1970	10	5	3.13	230.9	7	-	-	-
1971	9	5	2.42	131.5	17	-	-	-
1972	10	10	2.03	82.0	19	9	29	152.1
1973	10	26	3.65	237.5	6	-	-	-
1974	9	22	4.22	307.9	1	9	23	271.8
1975	9	13	2.72	135.8	14	9	12	168.5
1976	6	14	3.90	286.7	4	6	13	202.6
1977	10	1	1.83	48.0	21	-	-	-
1978	9	22	2.62	133.6	16	9	25	207.2
1979	9	15	2.68	143.7	13	9	4	184.1
1980	6	25	3.14	215.2	9	6	15	184.7

Figura 3.8 DESCARGA MÁXIMA ANUAL Y PRECIPITACIÓN DE 7-DÍAS EN LA CUENCA



Area	Maximum	1995
San Miguol	7.0	2.8
Olomega	98.4	88.5
Jocotal	44.4	35.8
Usulutan	31.3	6.6
Total	181.1	133.7

(Unit : Km2)

Figura 4.1 AREA INUNDADA

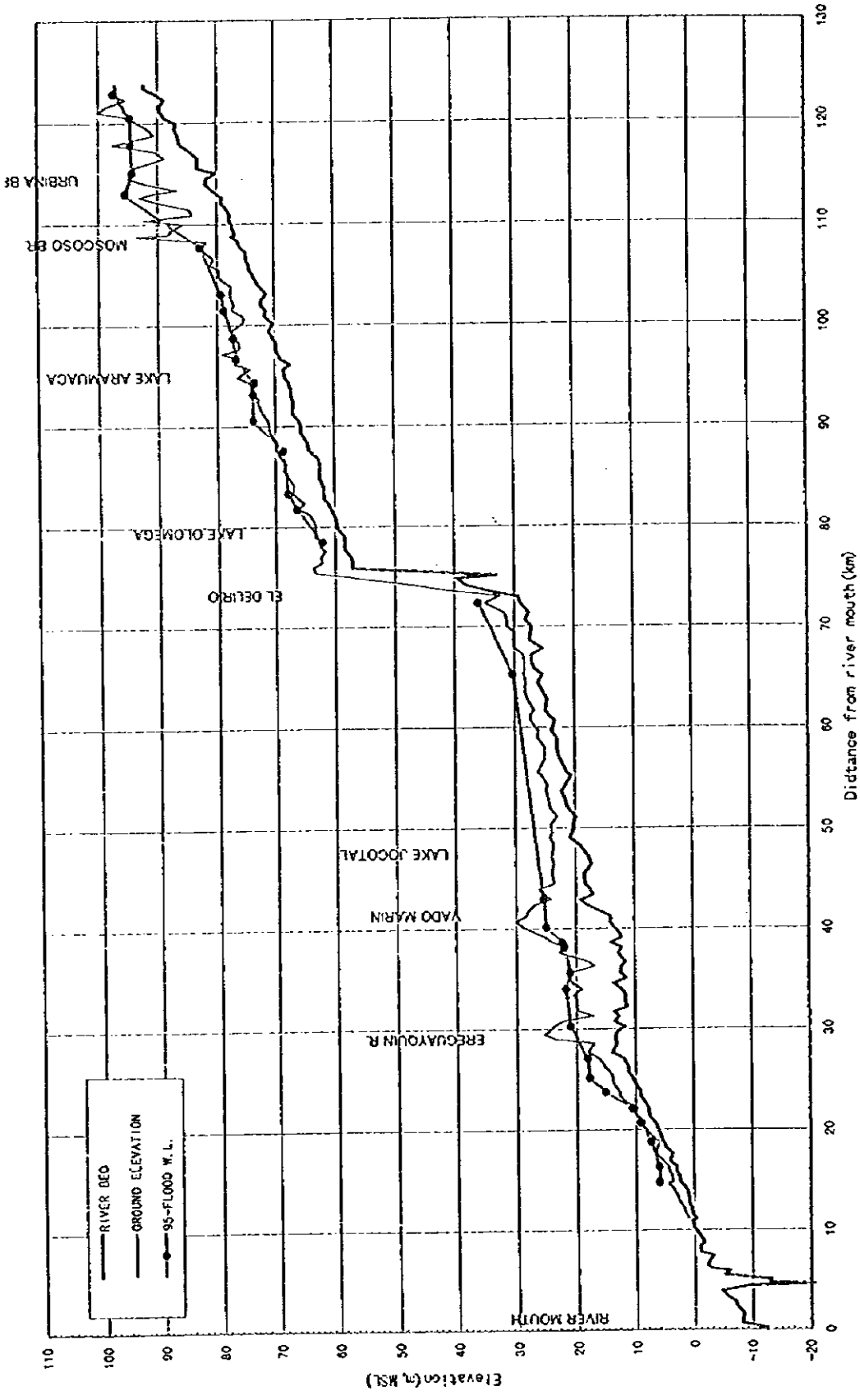
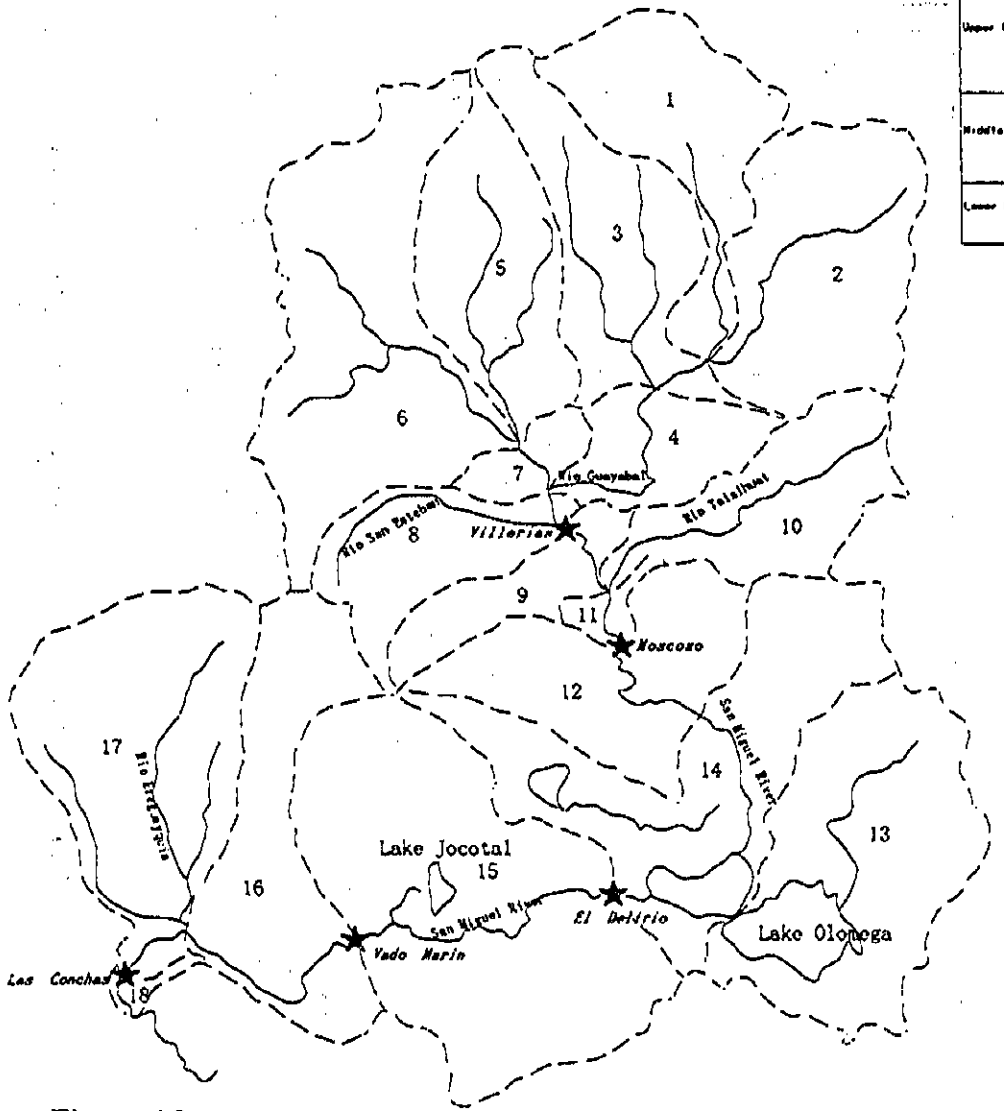


Figura 4.2 NIVEL DE AGUA MáXIMO EN LA INUNDACIÓN DE 1995

Table Area of subbasins in the Study Area

Subarea	Basin Number	Location	Tributary	Area (Km2)	Accumulated Area (Km2)
Upper Basin	1		Rio San Francisco	112.8	112.8
	2		Rio Sabo	153.8	266.2
	3		Rio Yamabal and Rio San Diego	126.5	394.7
	4		Rio Las Canas	57.8	452.5
	5		Rio Villorias	121.2	573.7
	6		Rio Gunyabal	227.1	800.9
	7			24.2	825.0
	8	Villorias	Rio San Esteban	85.0	910.0
	9		Rio Taisihuat	54.0	964.0
	10			97.2	1061.2
Middle Basin	11	Moscoso		12.8	1074.0
	12	Aranuasa		136.8	1210.8
	13		Lake Olomega	207.0	1417.8
	14	El Delirio		219.2	1637.0
	15	Vado Marin	Lake Jocotal	263.0	1900.0
Lower Basin	16			137.7	2037.7
	17	Las Conchas		199.9	2237.6
	18	End of Region "H"		9.2	2246.8



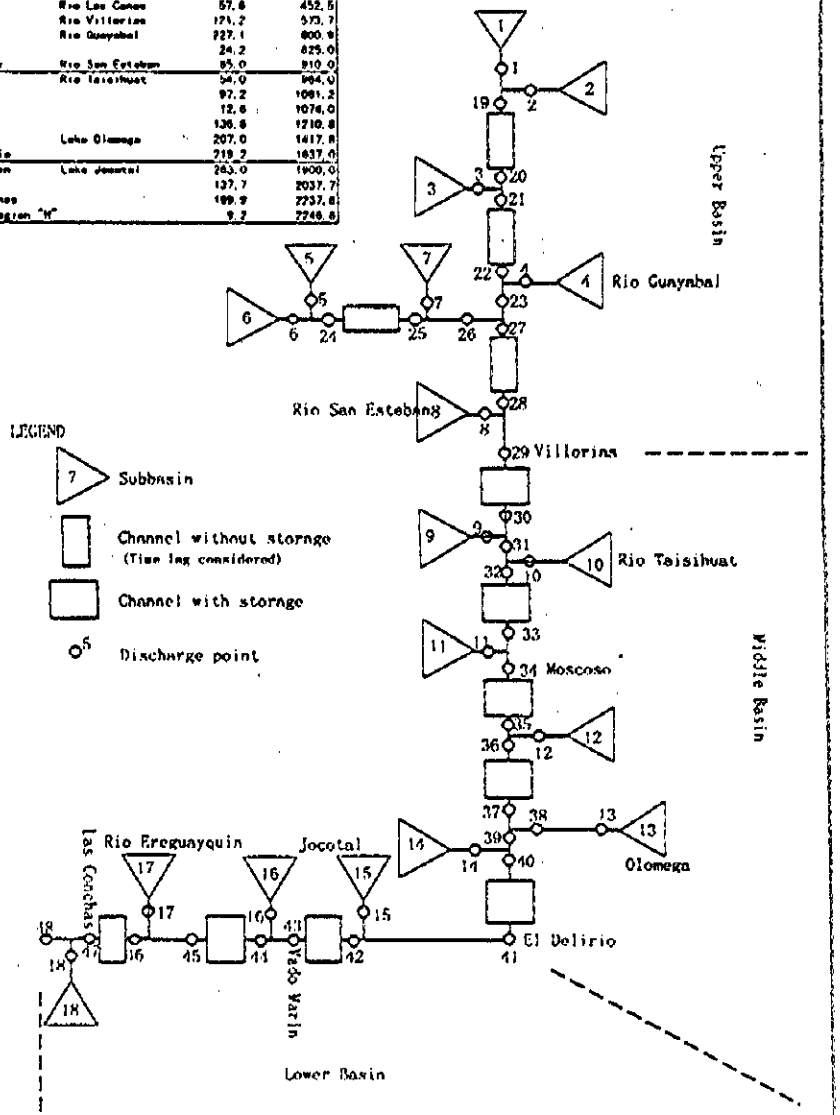
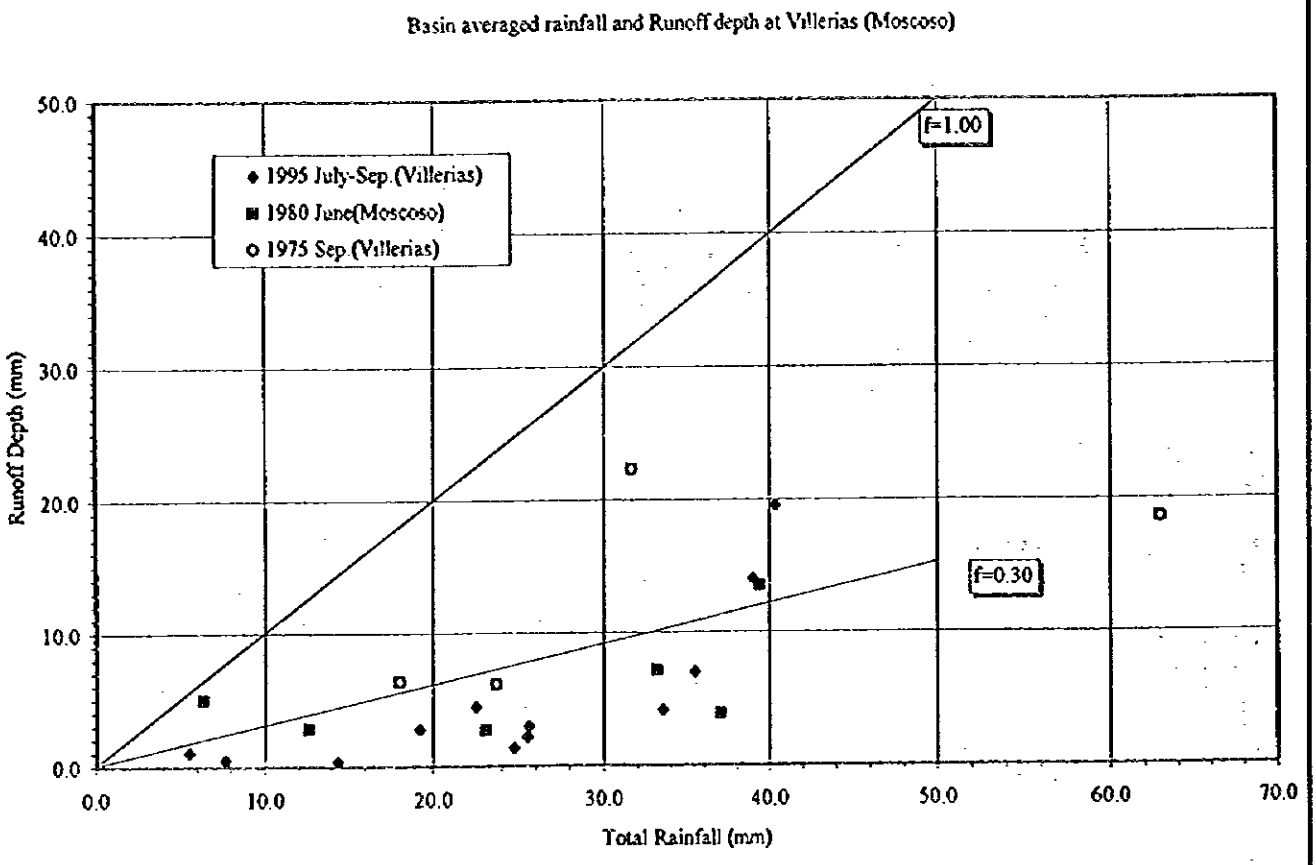


FIG. 1 Run-off Simulation Model

Figura 4.3

LIMITE DE LA CUENCA Y CONFIGURACIÓN DEL MODELO DE ESCORRENTÍA



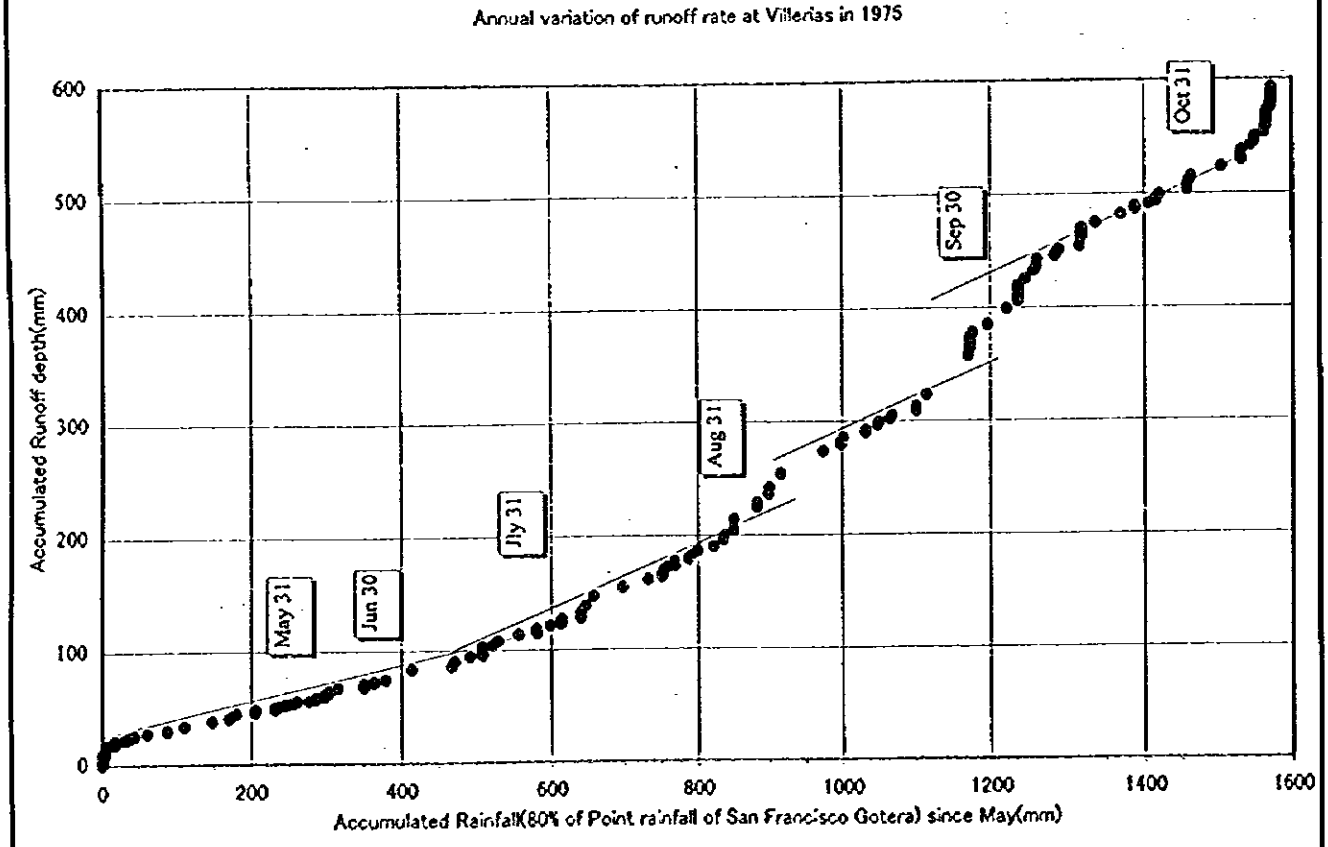
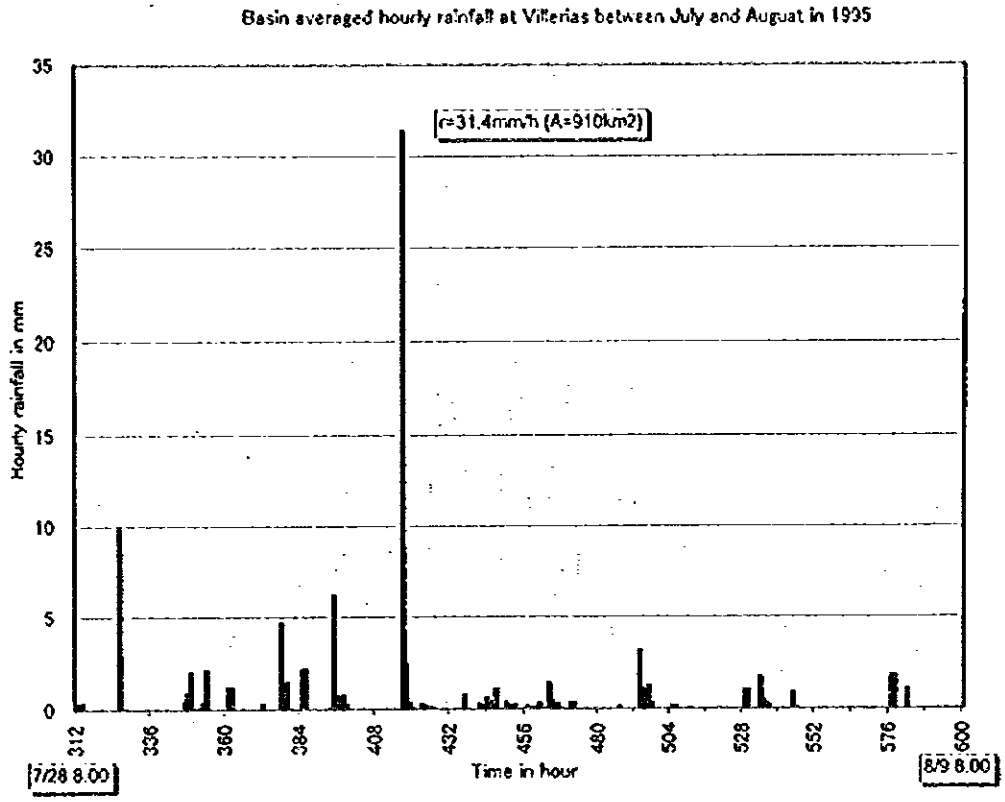


Figura 4.4 **RELACIÓN ENTRE ESCORRENTÍA Y PRECIPITACIÓN DE LA CUENCA**



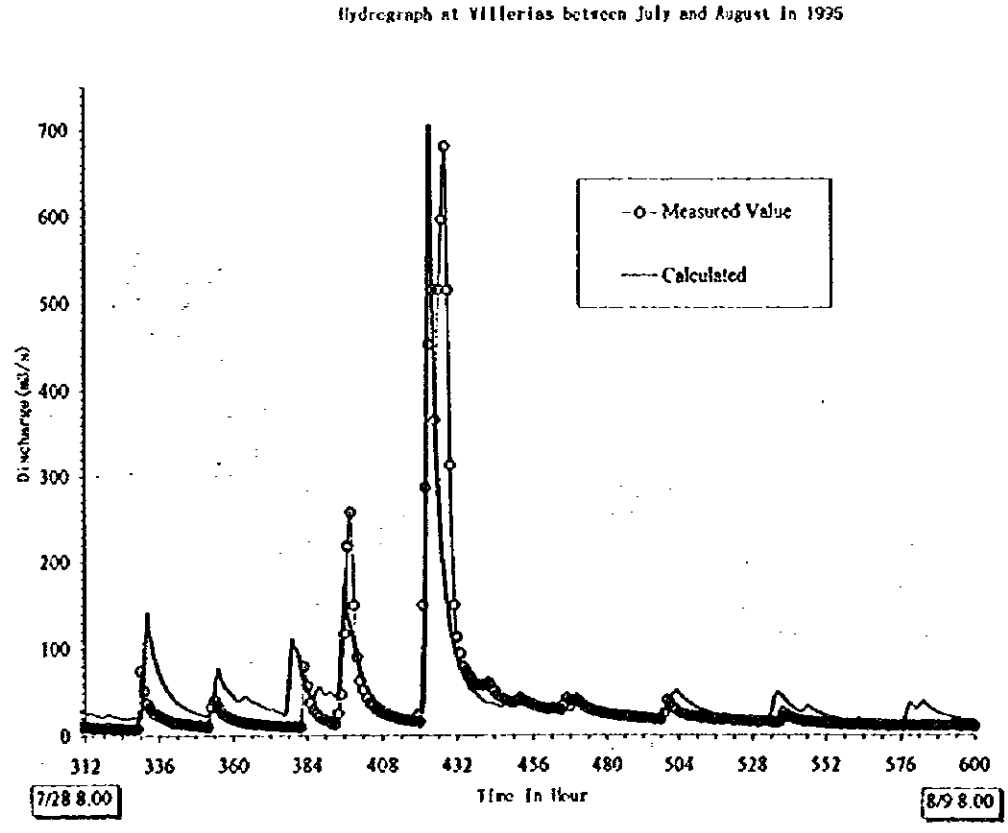
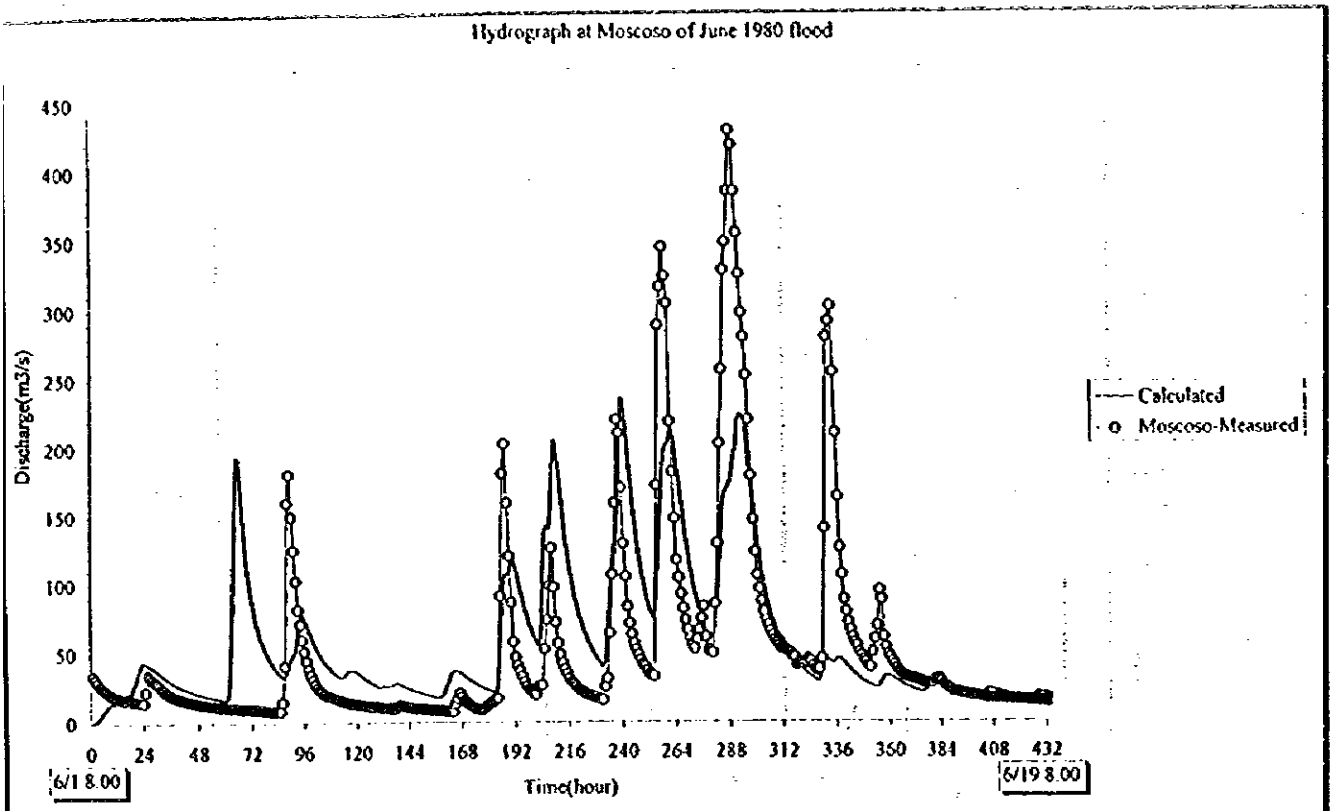


Figura 4.5 (1) RESULTADO DE LA SIMULACIÓN DE ESCORRENTÍA (1/2)



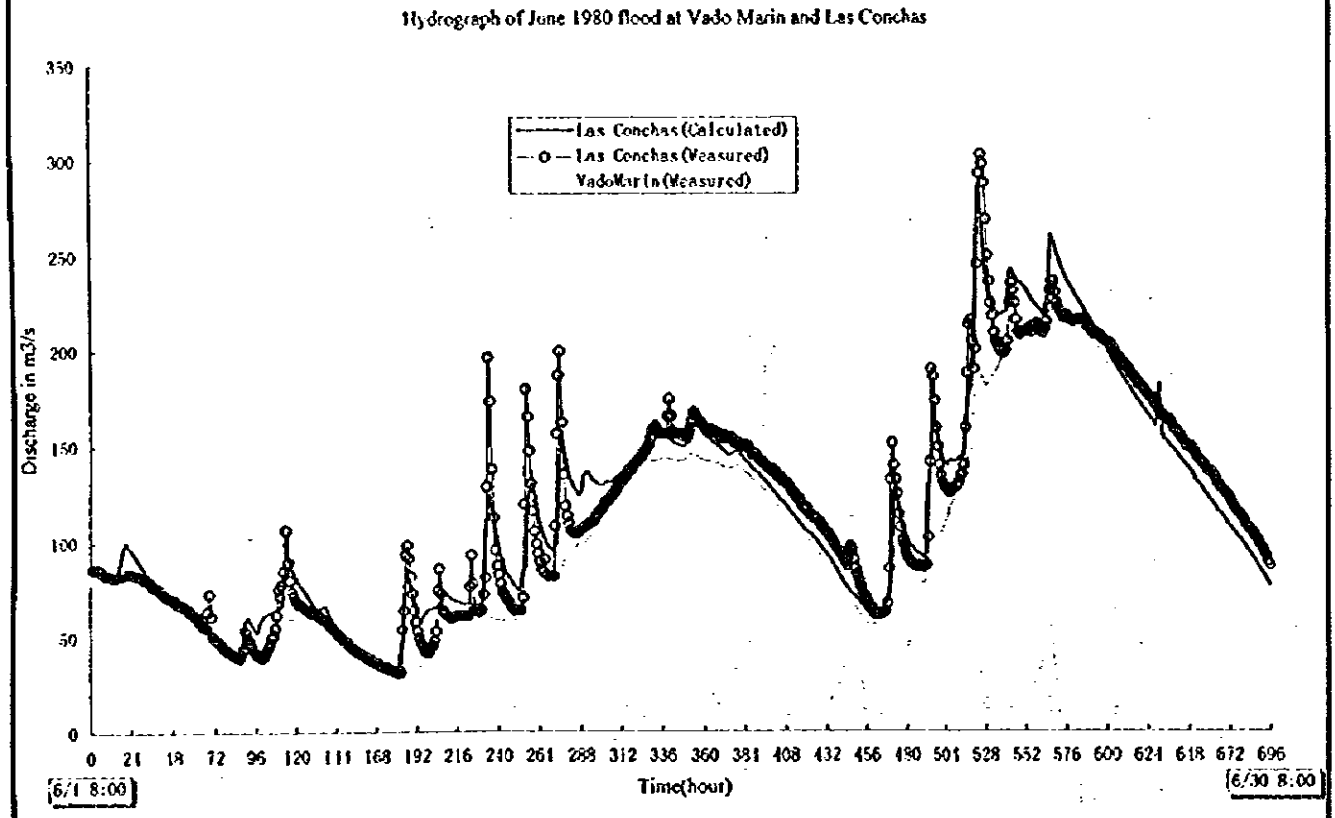
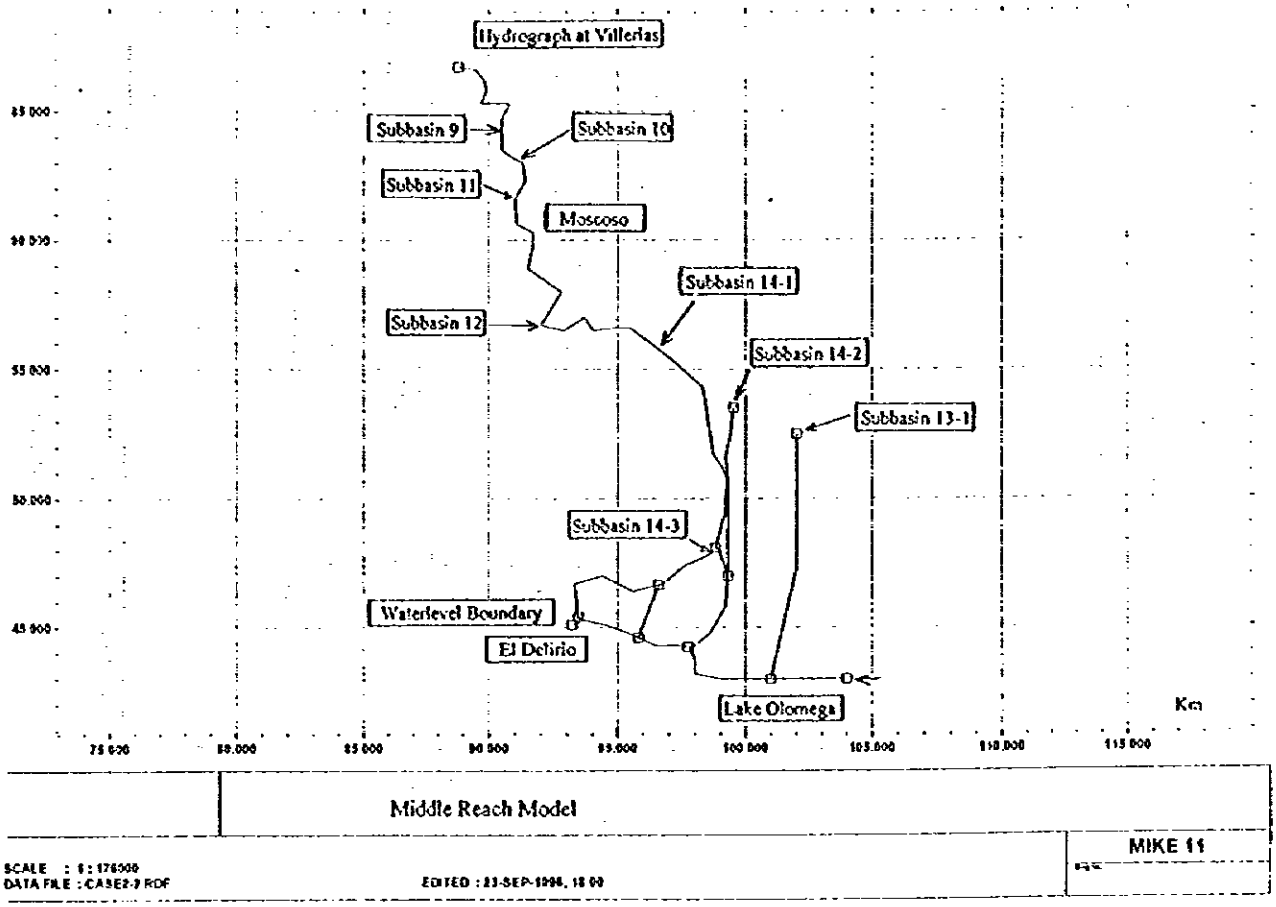


Figura 4.5 (2) RESULTADO DE LA SIMULACIóN DE ESCORRENTíA (2/2)



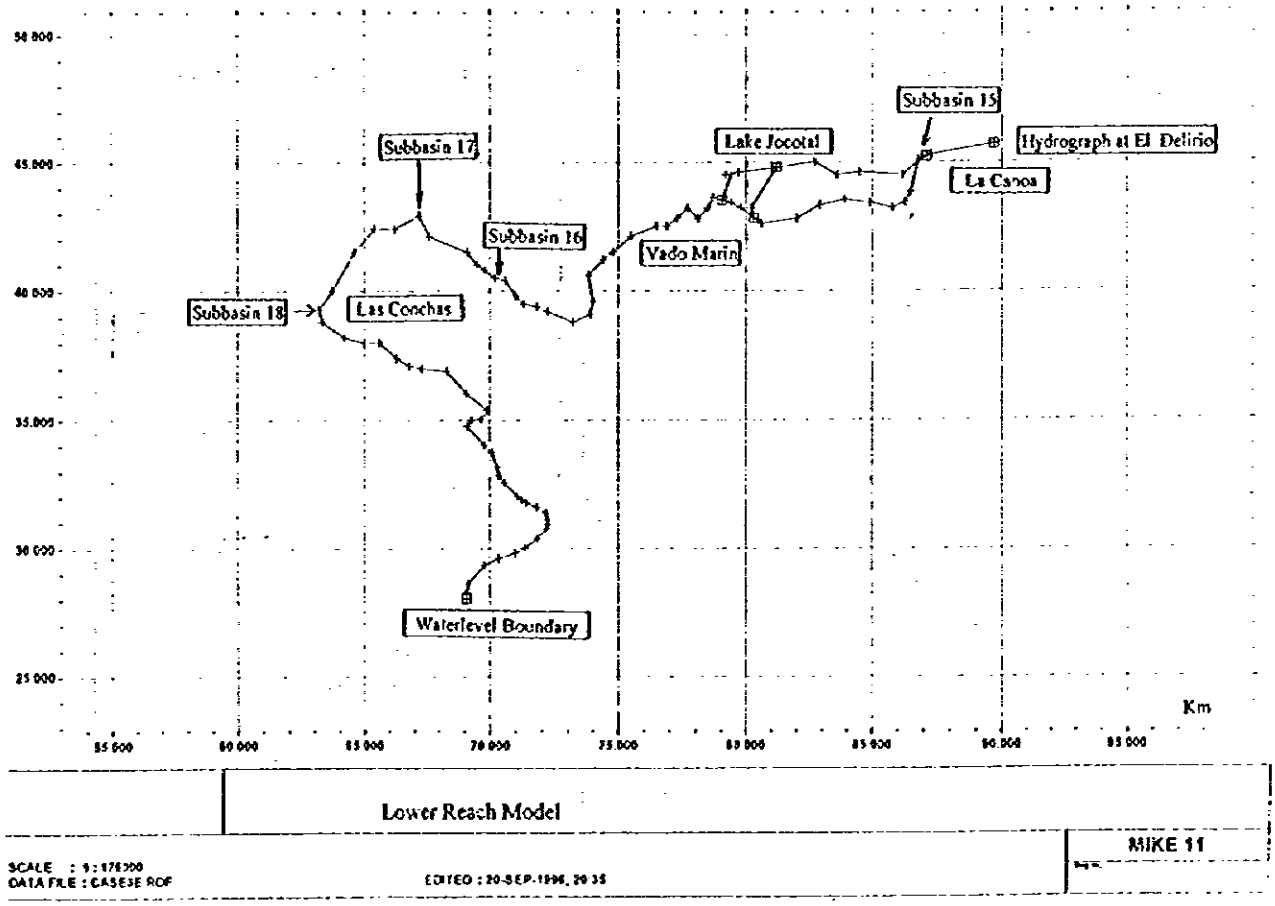
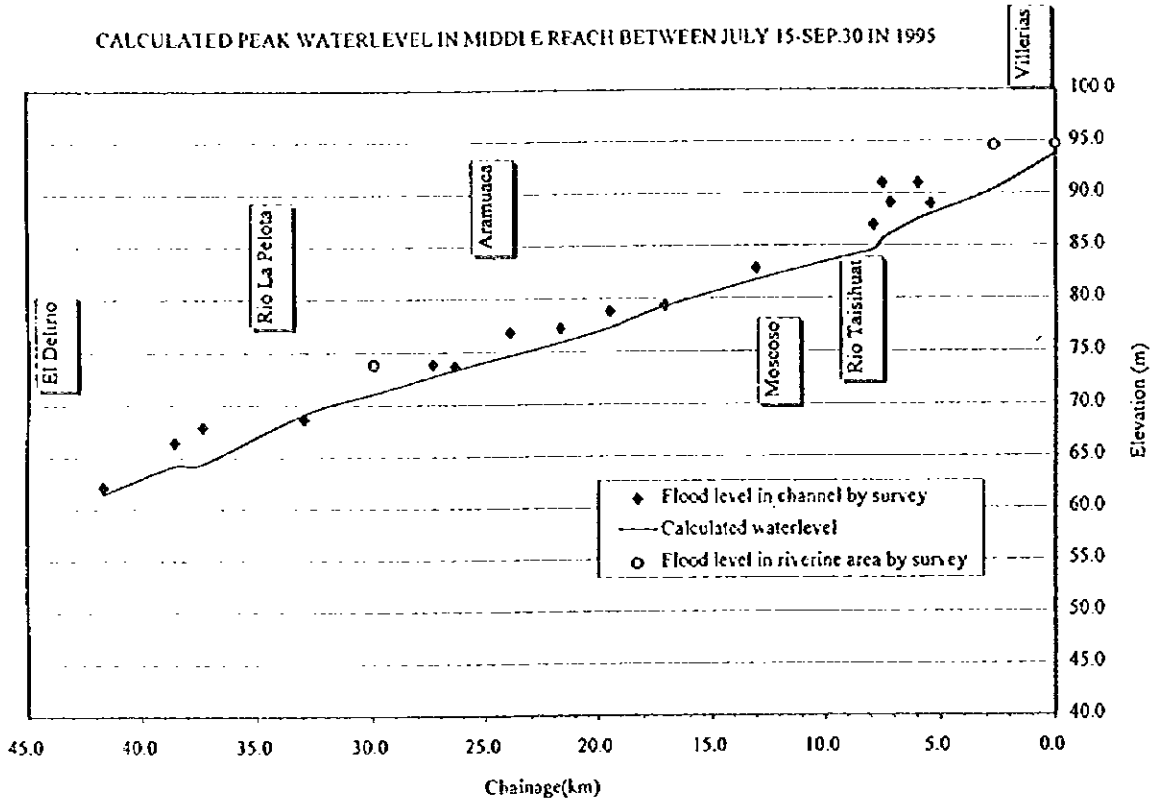


Figura 4.6 **RED DE CANALES PARA LA SIMULACIóN DE INUNDACIÓN DE 1-DÍA**



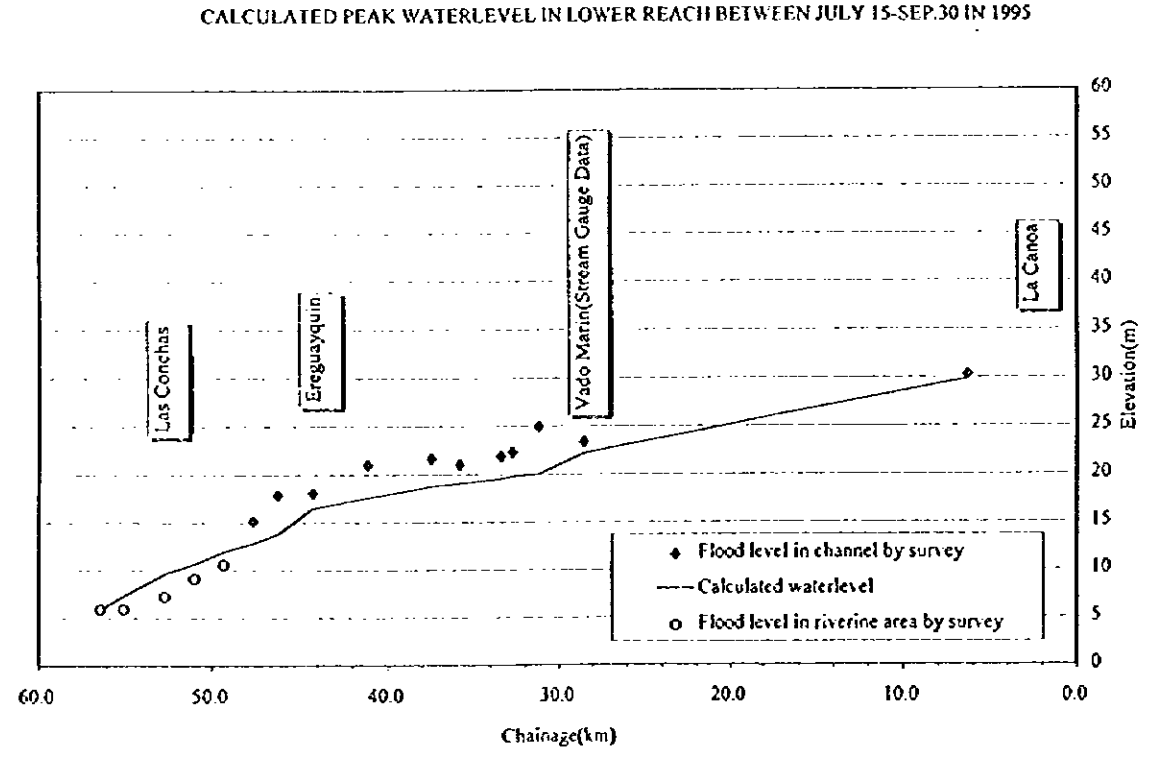


Figura 4.7 **RESULTADOS DE LA SIMULACIÓN DE INUNDACIÓN**

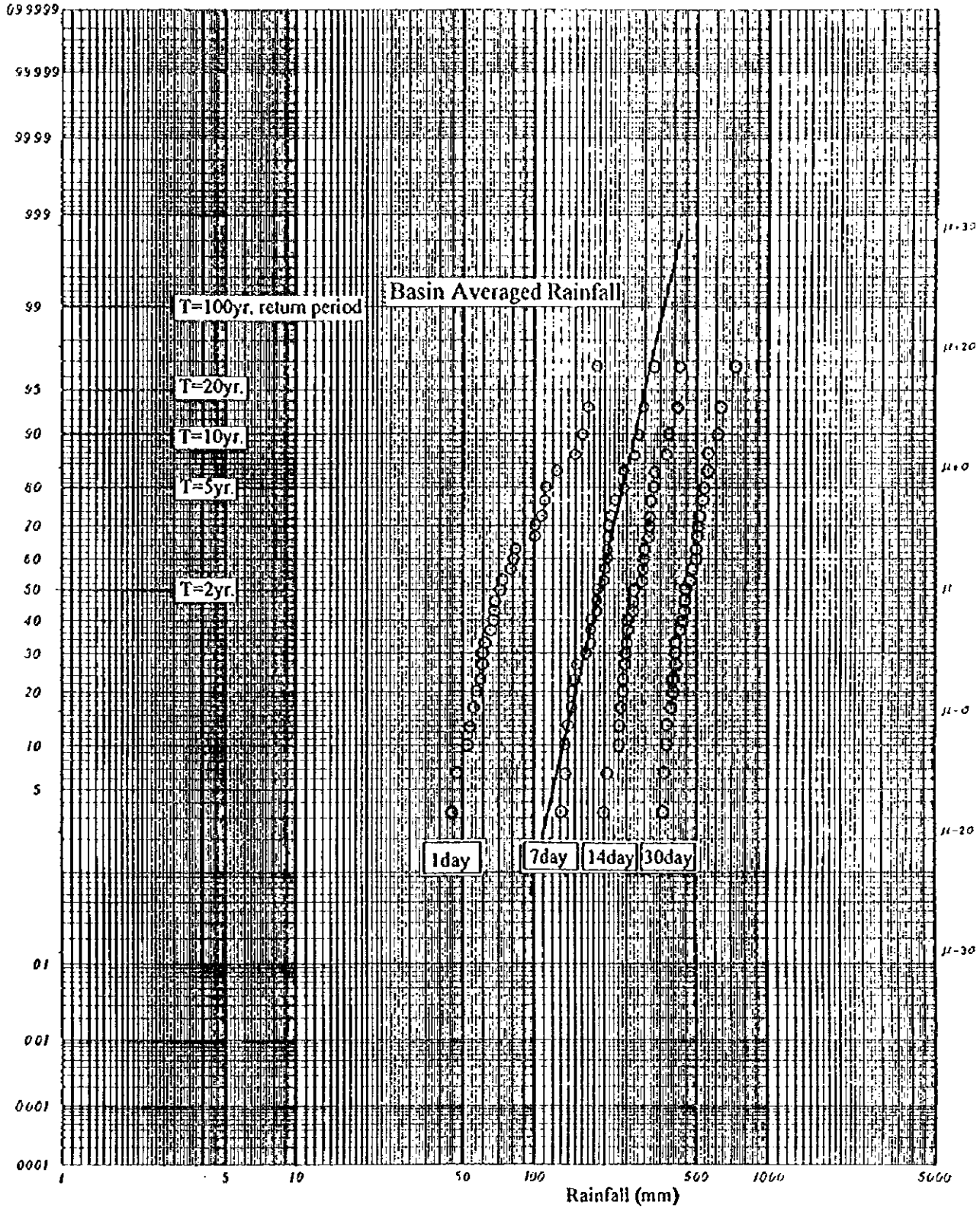


Figura 4.8 PRECIPITACIÓN MEDIA PROBABLE DE LA CUENCA

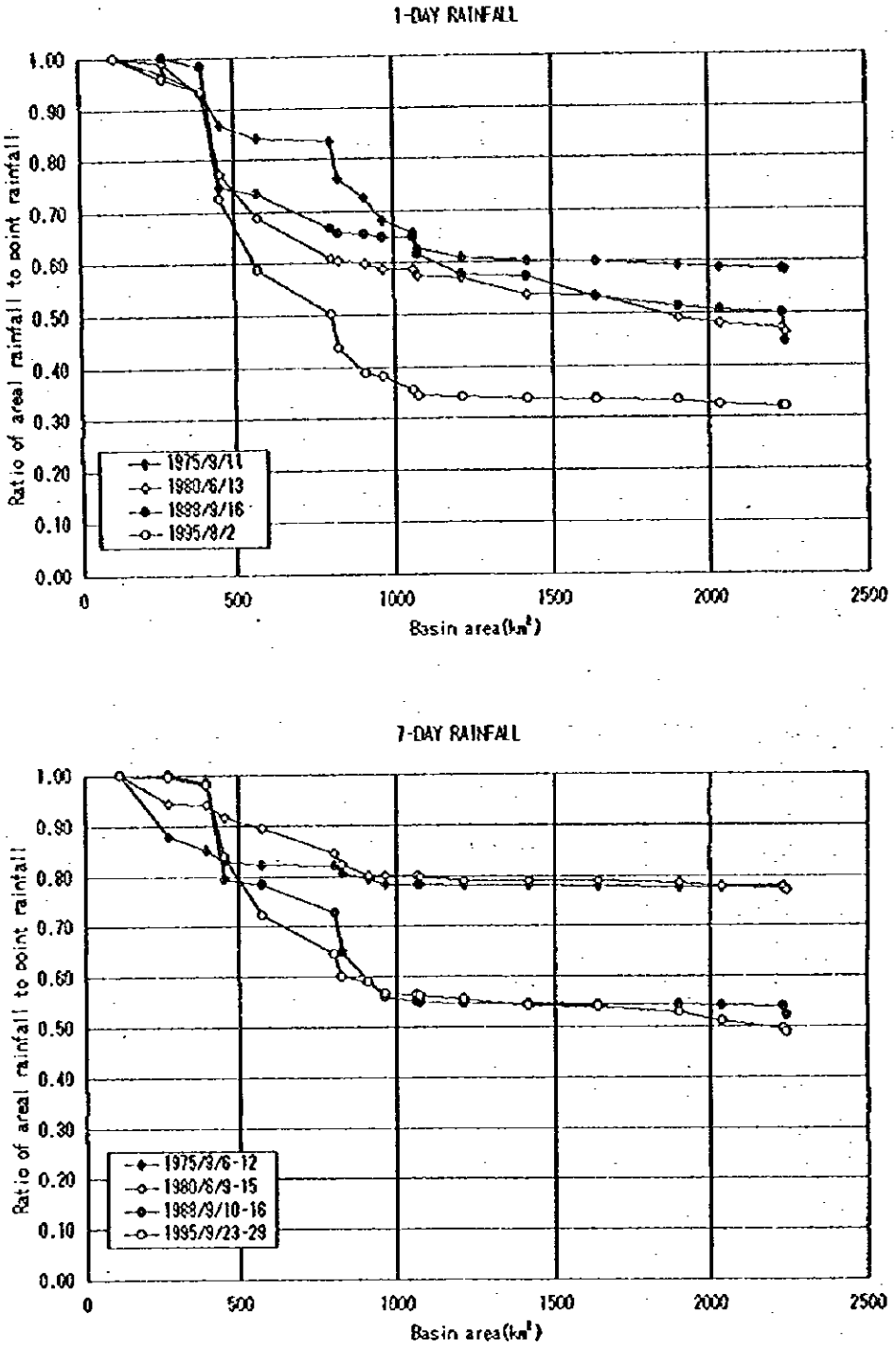
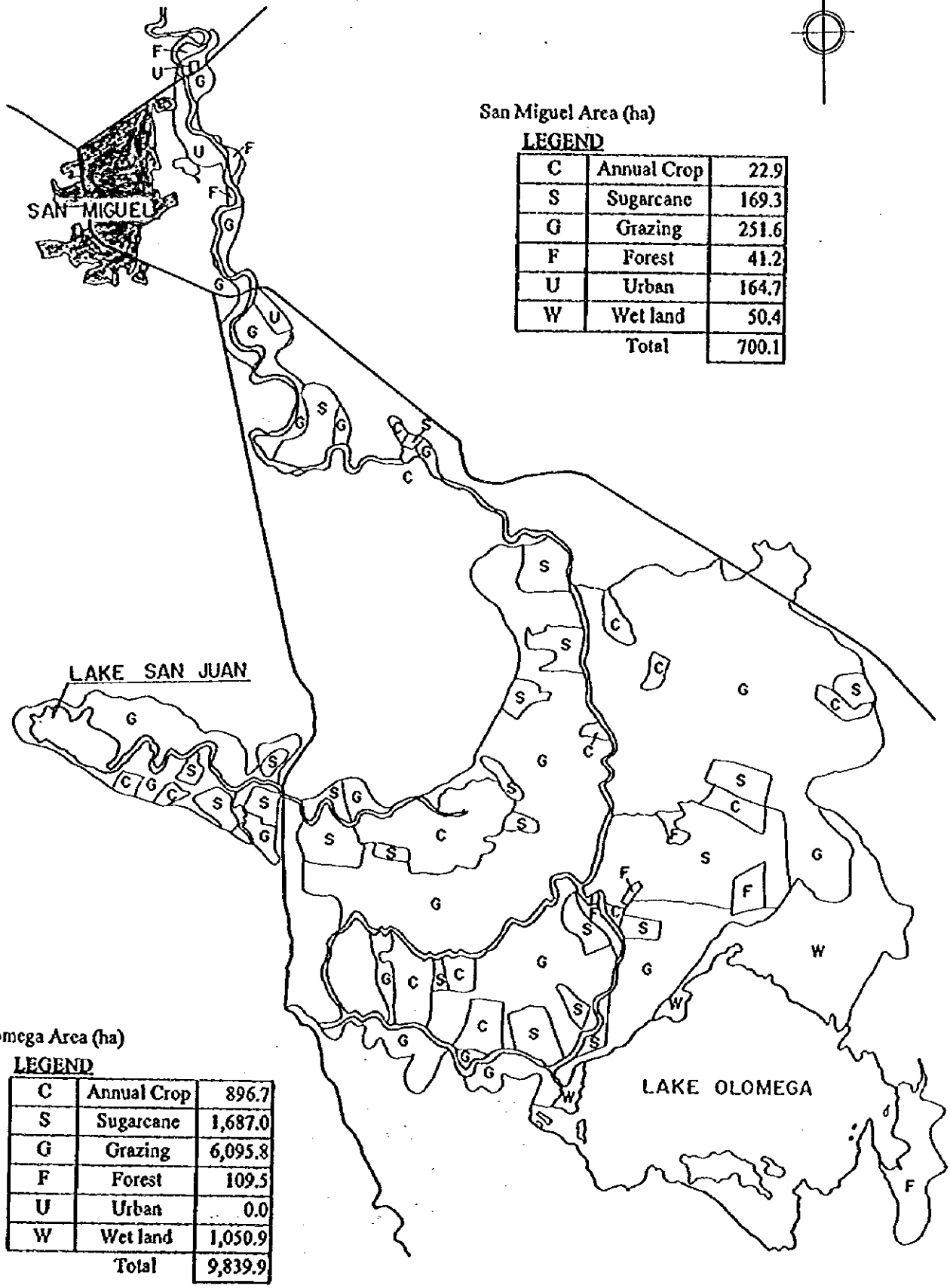


Figura 4.9 REDUCCIÓN DE LA PRECIPITACIÓN EN EL AREA



San Miguel Area (ha)

LEGEND

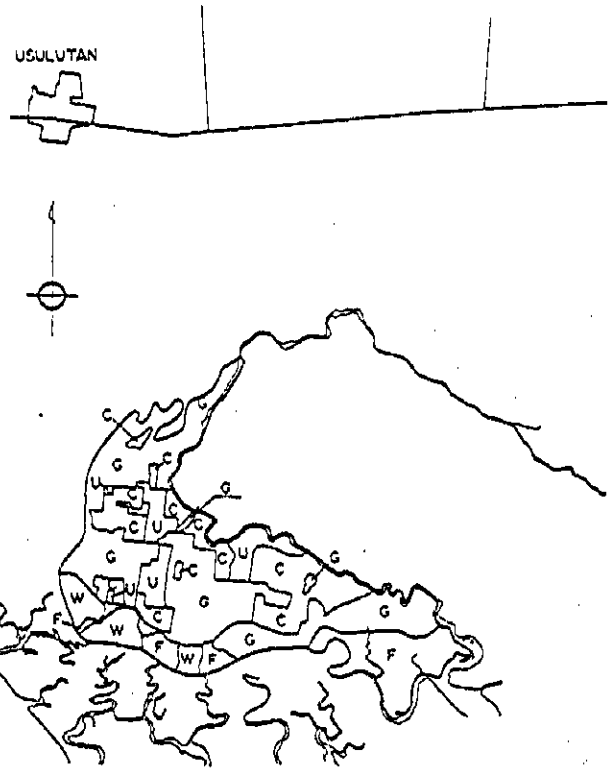
C	Annual Crop	22.9
S	Sugarcane	169.3
G	Grazing	251.6
F	Forest	41.2
U	Urban	164.7
W	Wet land	50.4
	Total	700.1

Olomega Area (ha)

LEGEND

C	Annual Crop	896.7
S	Sugarcane	1,687.0
G	Grazing	6,095.8
F	Forest	109.5
U	Urban	0.0
W	Wet land	1,050.9
	Total	9,839.9

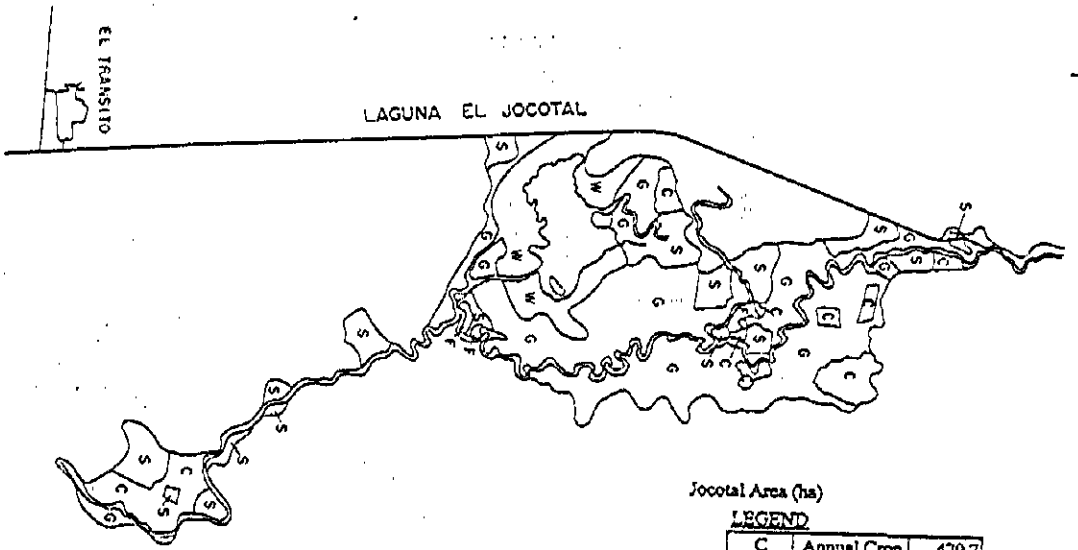
Figura 4.10 (1/2) USO ACTUAL DE SUELO EN EL AREA DE INUNDACIÓN (1)



Usulutan Area (ha)

LEGEND

C	Annual Crop	465.3
S	Sugarcane	325.6
G	Grazing	1,522.7
F	Forest	417.8
U	Urban	0.0
W	Wet land	398.6
	Total	3,130.0

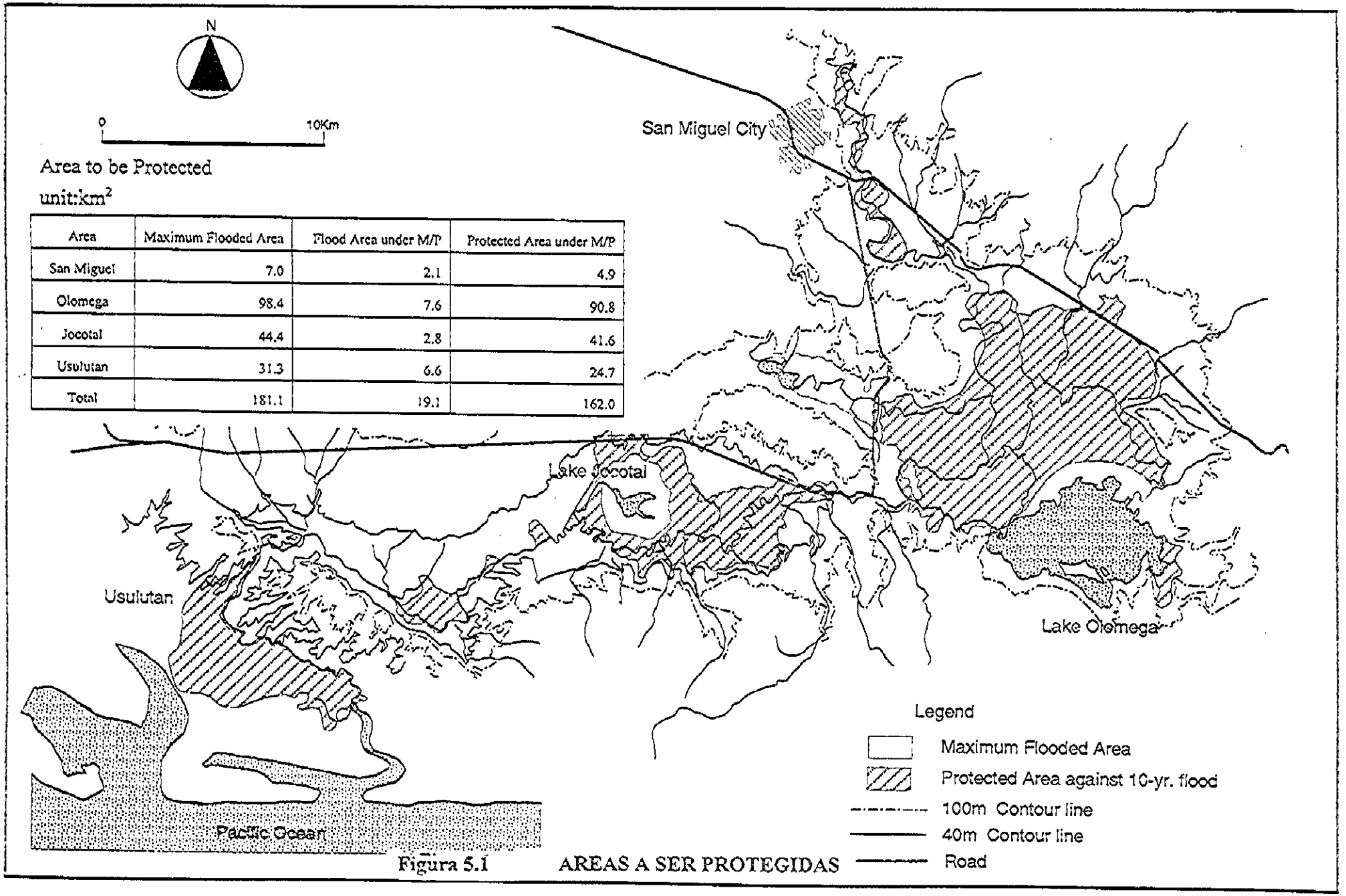


Jocotal Area (ha)

LEGEND

C	Annual Crop	479.7
S	Sugarcane	701.6
G	Grazing	2,446.7
F	Forest	36.0
U	Urban	0.0
W	Wet land	774.1
	Total	4,438.1

Figura 4.10 (2/2) USO ACTUAL DE SUELO EN EL AREA DE INUNDACIÓN (2)

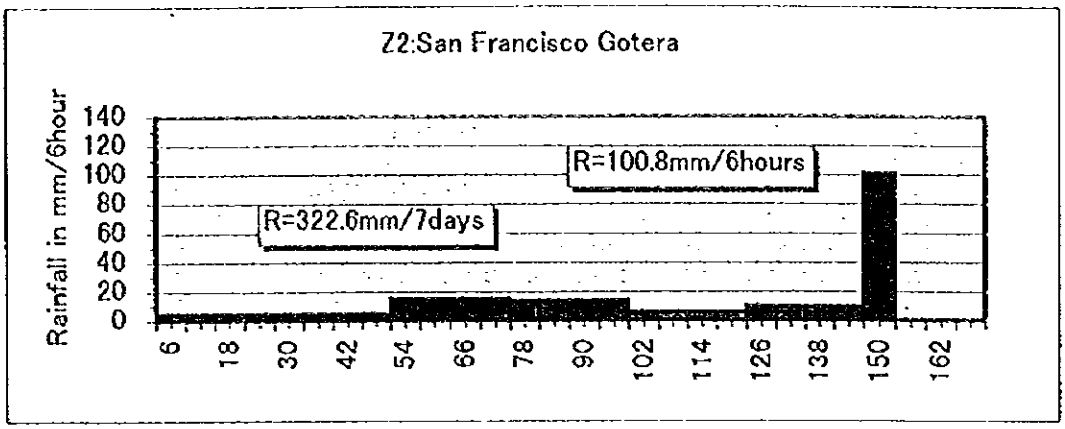


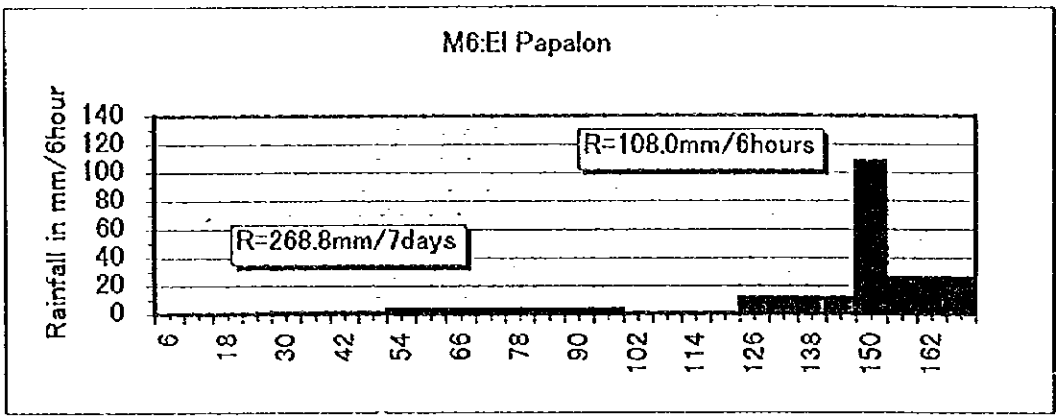
Area to be Protected

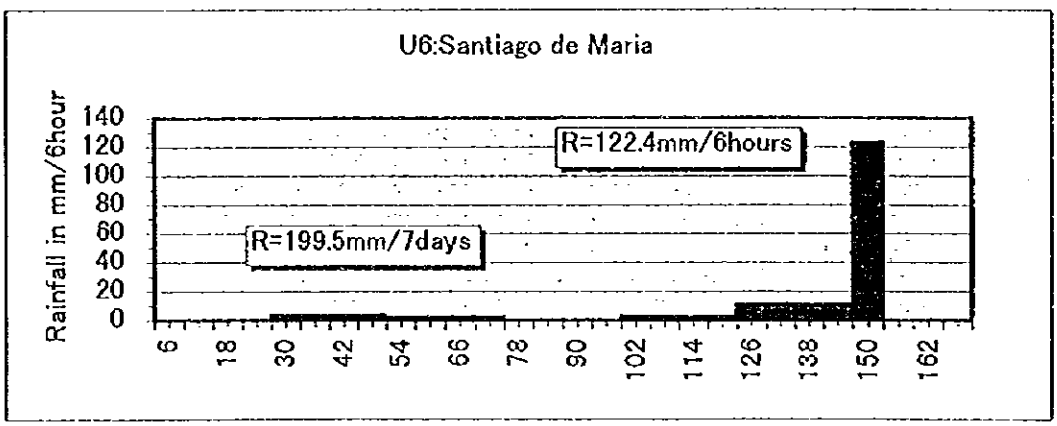
unit:km^2

Area	Maximum Flooded Area	Flood Area under M/P	Protected Area under M/P
San Miguel	7.0	2.1	4.9
Olomega	98.4	7.6	90.8
Jocotal	44.4	2.8	41.6
Usulutan	31.3	6.6	24.7
Total	181.1	19.1	162.0

Figura 5.1 AREAS A SER PROTEGIDAS







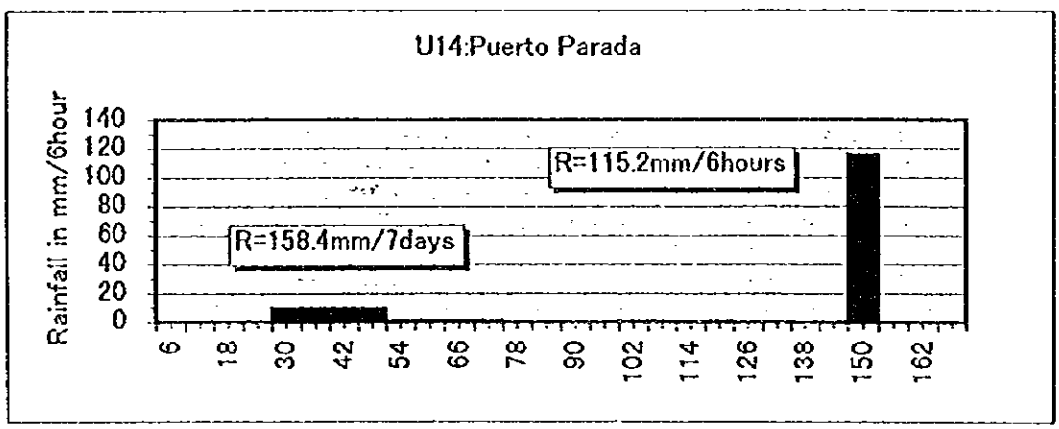


Figura 5.2 **PRECIPITACIÓN DISEÑO PARA UN PERÍODO DE RETORNO DE 10 AÑOS**

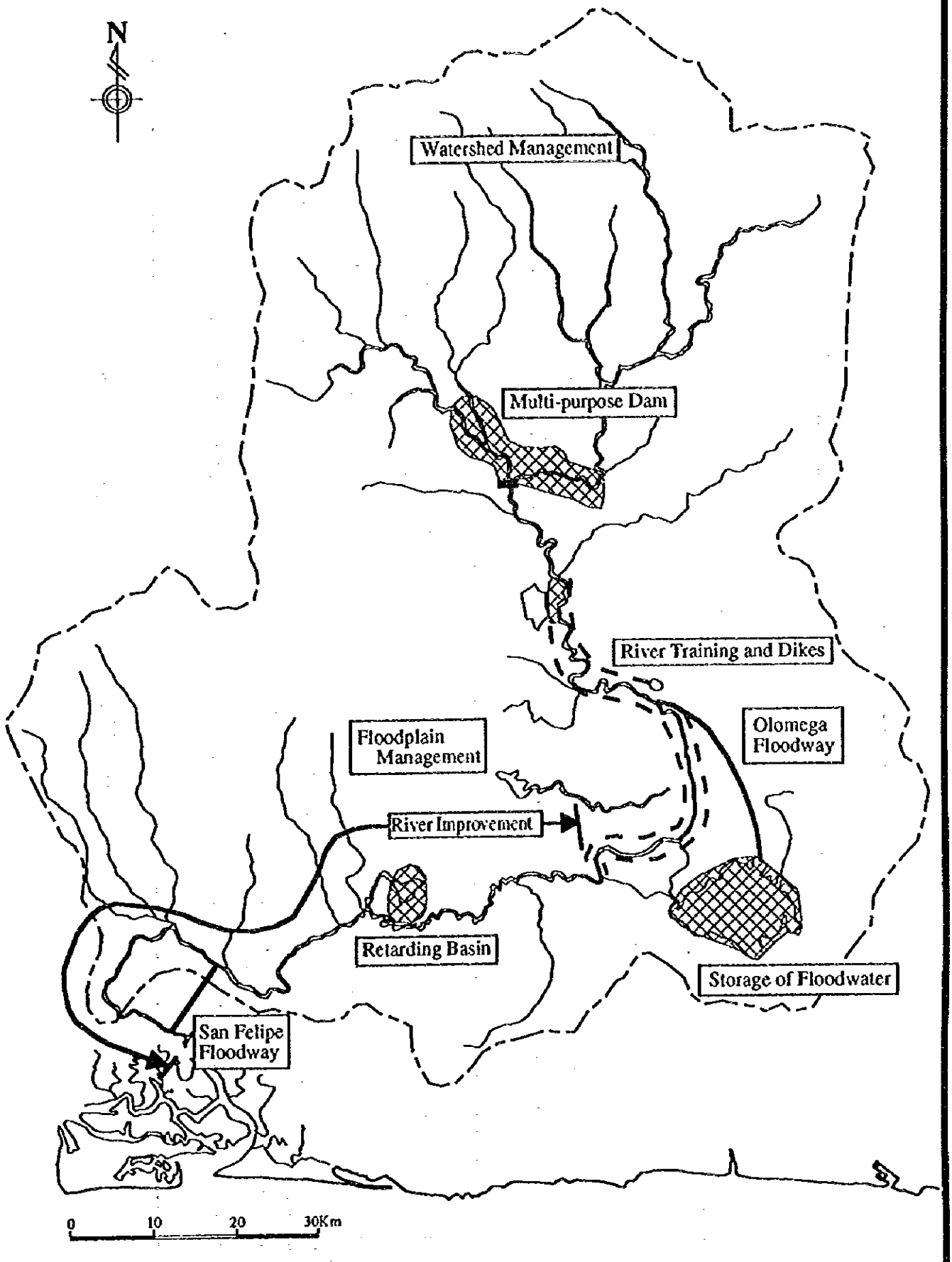


Figura 5.3 MEDIDAS CONCEBIBLES PARA EL CONTROL DE INUNDACIONES

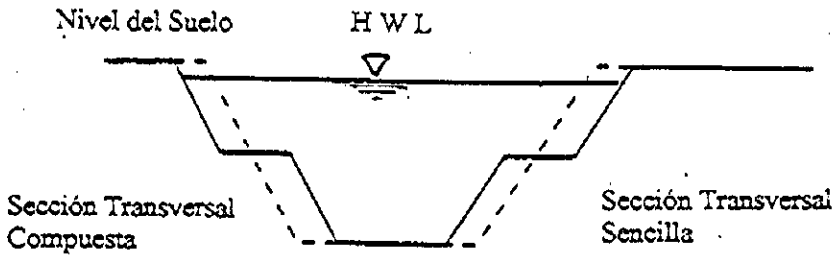
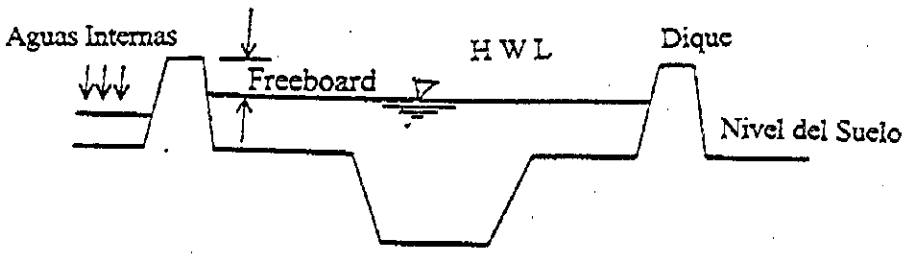
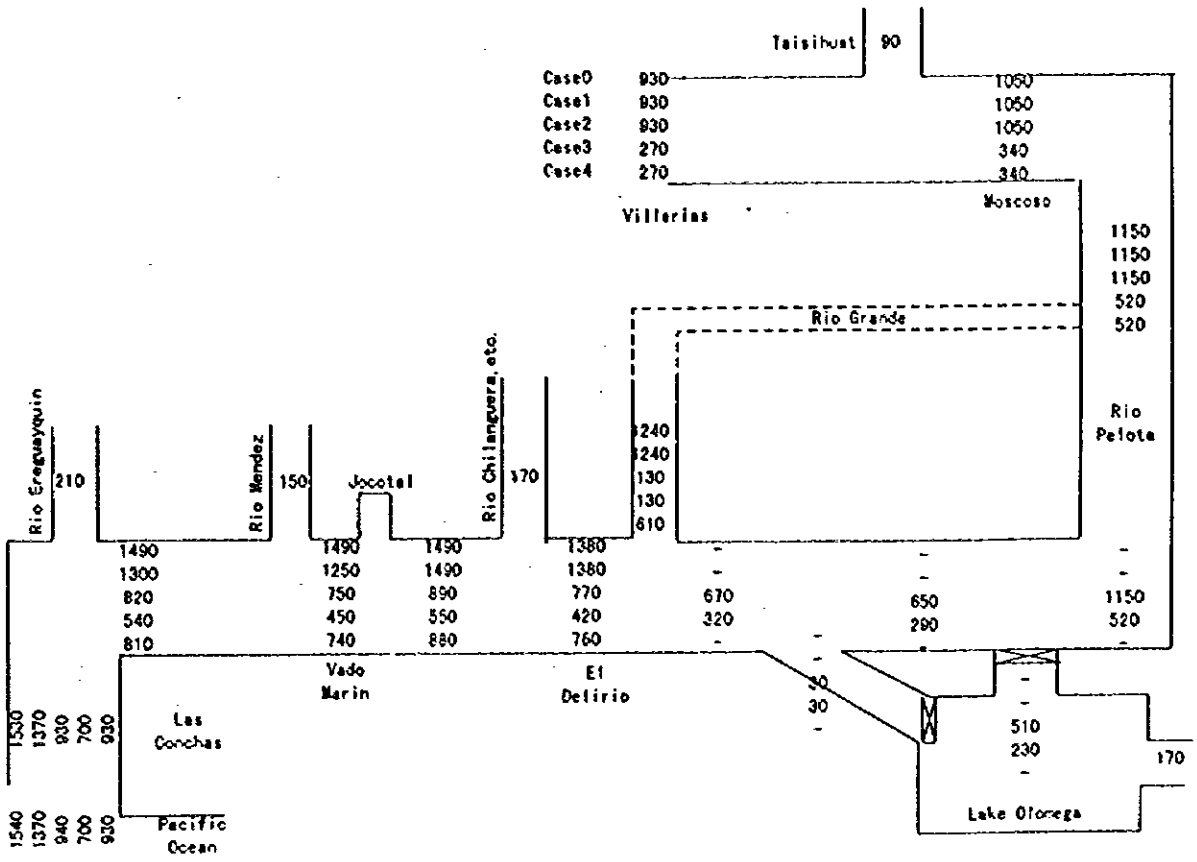
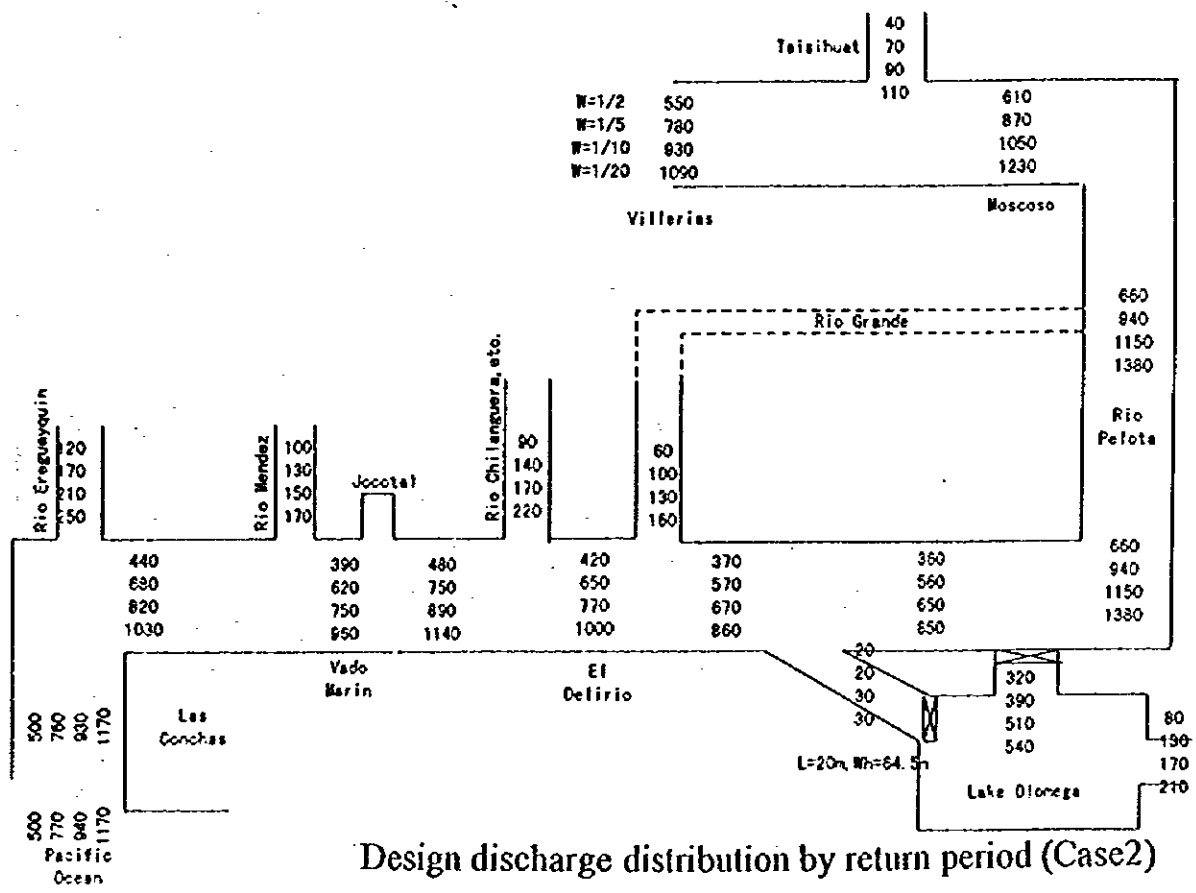
METODO DE DRAGADO / EXCAVADO	METODO DE DIQUE
 ※ H W L (Máximo Nivel de Inundación) debe ser menor que el nivel del suelo.	 ※ H W L + Freeboard son requeridos
1. Las aguas internas pueden ser drenadas por el flujo de la gravedad. 2. El daño por crecidas es mayor que el diseñado y no incrementaría mucho. 3. El costo de construcción es alto, pero el costo de adquisición del terreno es bajo. 4. Existen inconvenientes para las bocatomas debido a que el lecho del río es bajo. 5. La sedimientación en la bocana del río sería problemática si se dragara profundamente.	1. Las aguas internas no pueden ser drenadas por la gravedad. Se requerían diques para los ríos tributarios o para las estaciones de bombeo. 2. Es peligroso cuando existen grandes inundaciones 3. El costo de construcción es menor y el costo de adquisición es alto. 4. Conveniente para tomas de agua. 5. No existe problema con la sedimientación de la bocana del río.

Figura 5.4 **COMPARACIÓN DEL MÉTODO PARA EL MEJORAMIENTO DEL RÍO**

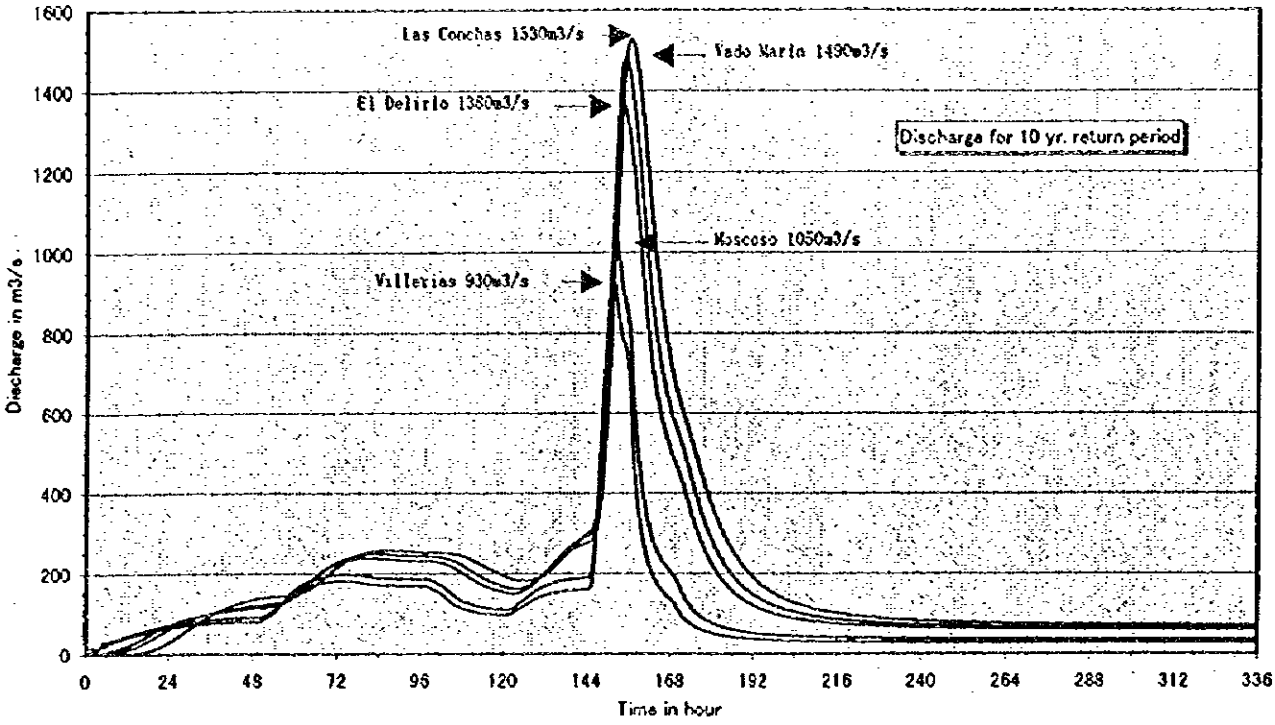


Design discharge distribution for 10-yr. (unit:m3/s)



Design discharge distribution by return period (Case2)

Figura 5.5 **DISTRIBUCIÓN DE DESCARGA DISEÑO PARA ESQUEMAS ALTERNATIVOS**



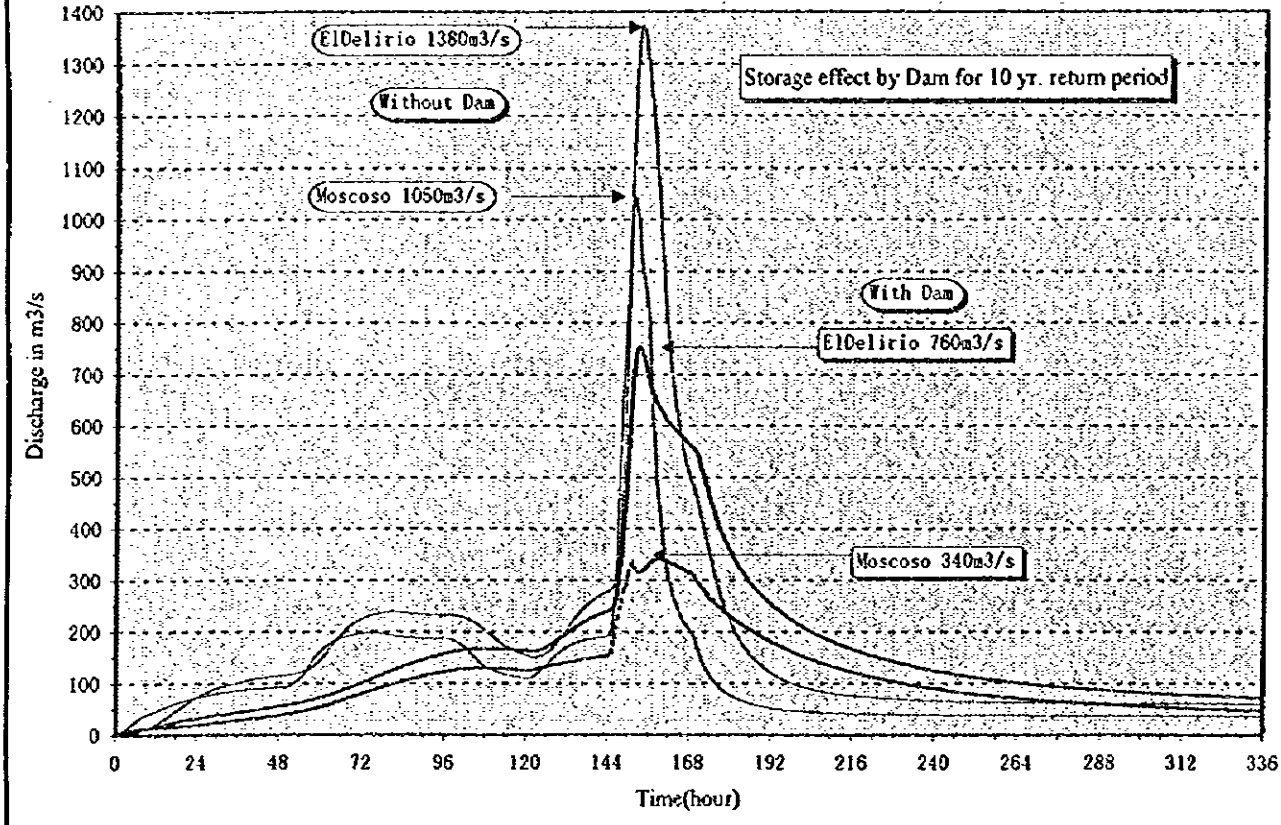
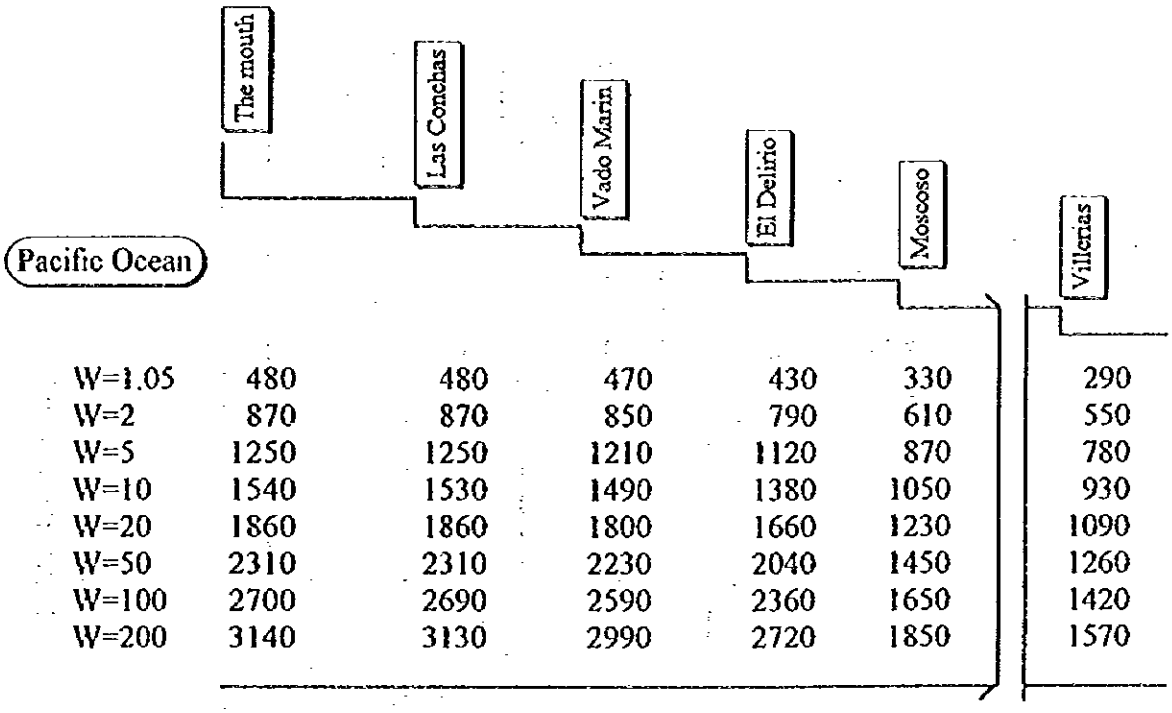
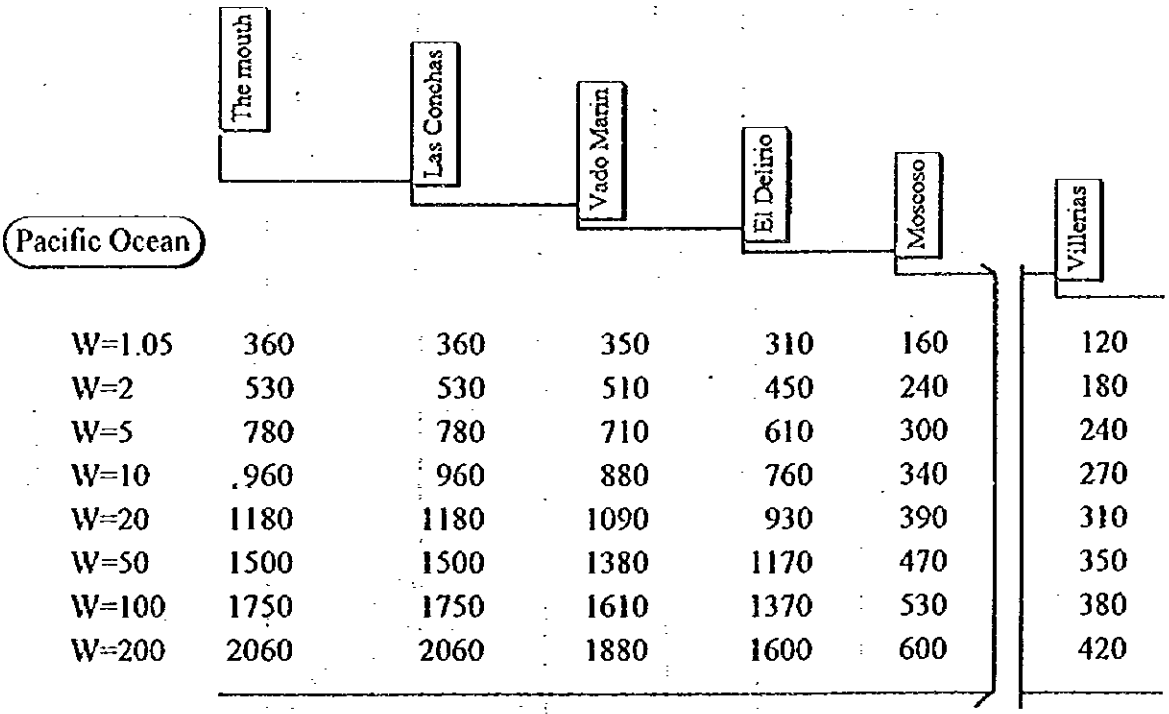


Figura 5.6 **HIDROGRAMA DISEÑO PARA UN PERíODO DE RETORNO DE 10 AÑOS**



W=1.05	480	480	470	430	330	290
W=2	870	870	850	790	610	550
W=5	1250	1250	1210	1120	870	780
W=10	1540	1530	1490	1380	1050	930
W=20	1860	1860	1800	1660	1230	1090
W=50	2310	2310	2230	2040	1450	1260
W=100	2700	2690	2590	2360	1650	1420
W=200	3140	3130	2990	2720	1850	1570

Discharge Distribution without inundation(unit; m3/s)



W=1.05	360	360	350	310	160	120
W=2	530	530	510	450	240	180
W=5	780	780	710	610	300	240
W=10	.960	960	880	760	340	270
W=20	1180	1180	1090	930	390	310
W=50	1500	1500	1380	1170	470	350
W=100	1750	1750	1610	1370	530	380
W=200	2060	2060	1880	1600	600	420

Discharge Distribution with Dam (unit; m^3/s)

Figura 5.7 DISTRIBUCIÓN PROBABLE DE DESCARGA

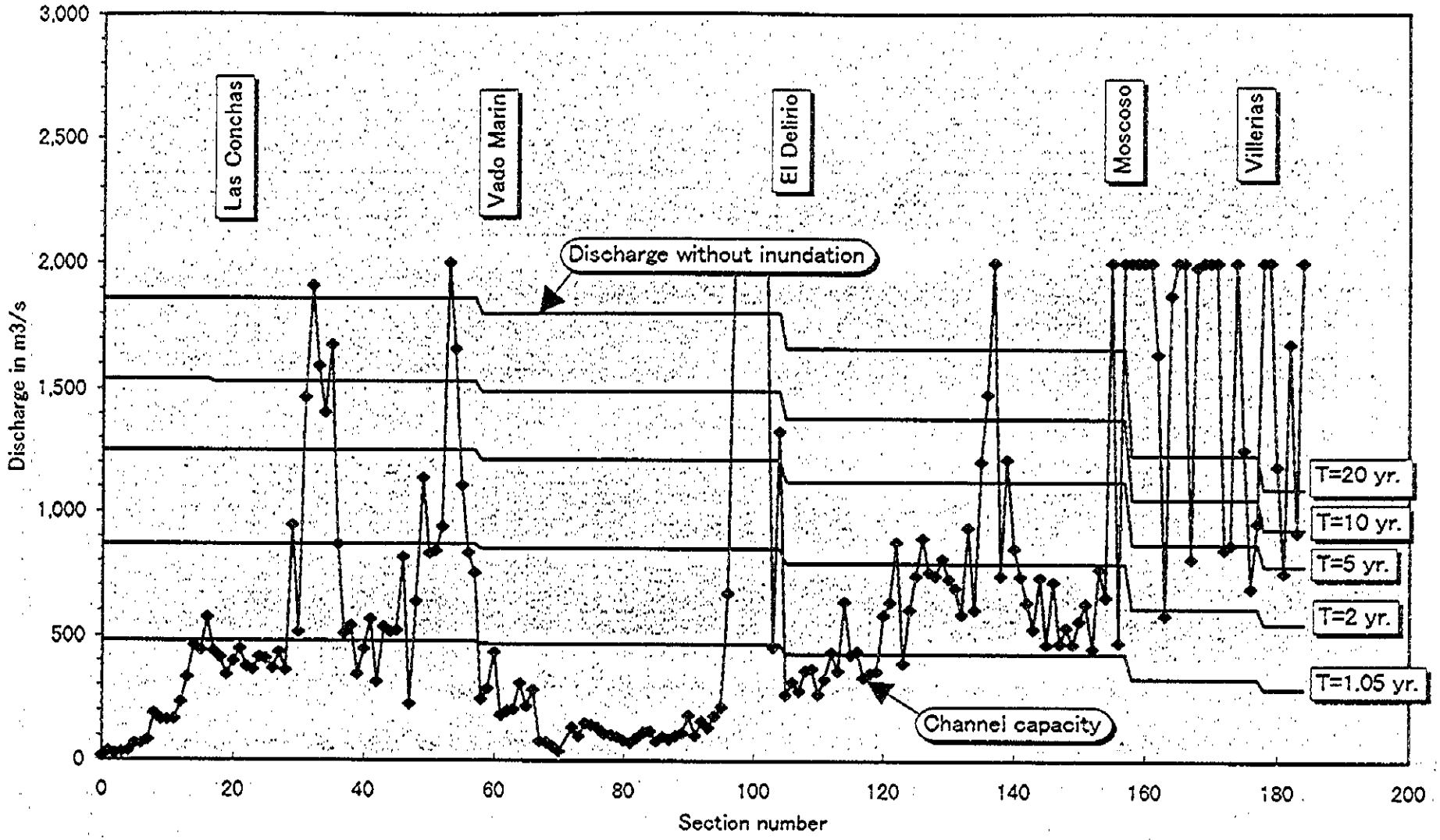
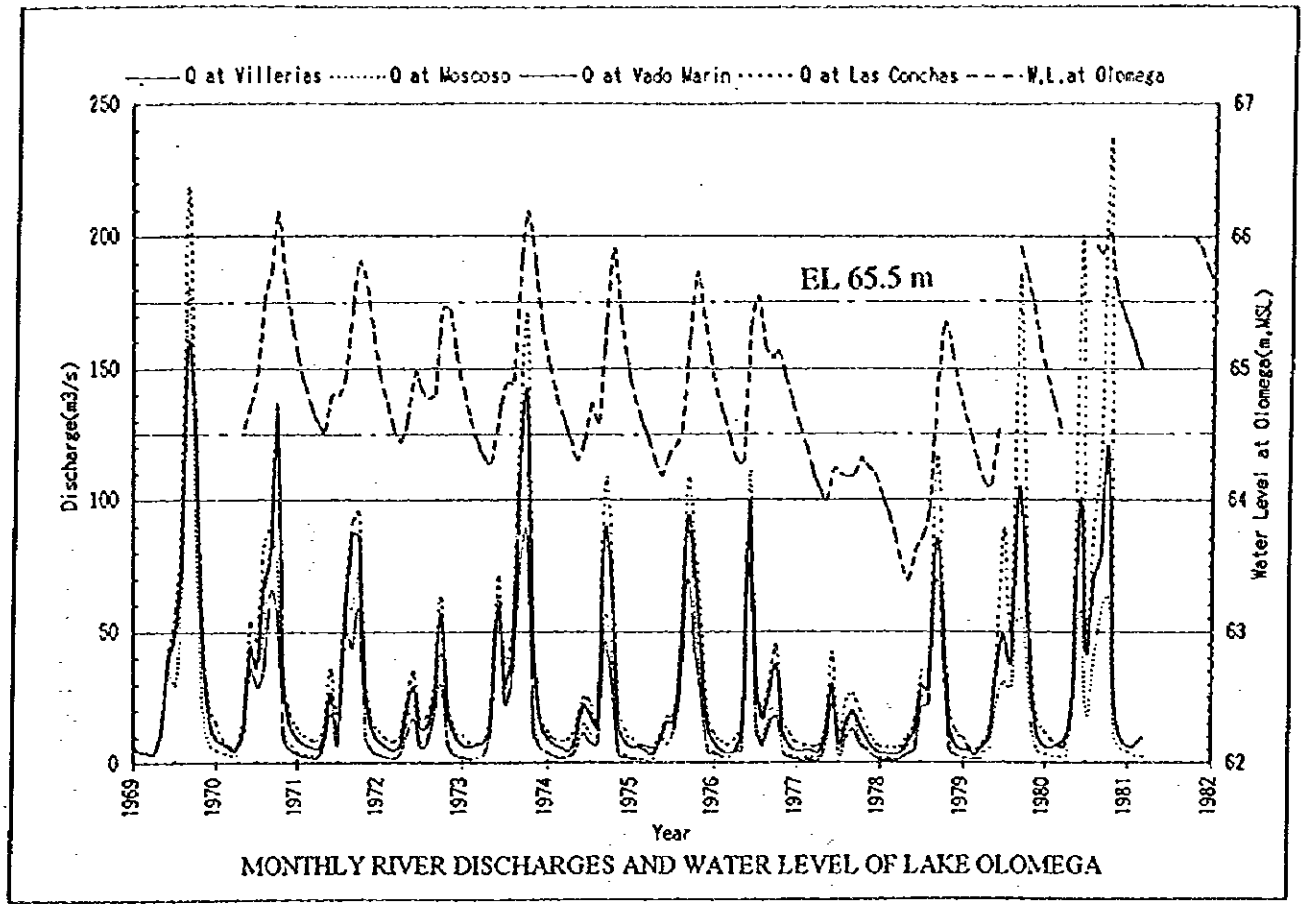


Figura 5.8 DESCARGA SIN INUNDACIÓN Y CAPACIDAD DE CANAL



MONTHLY RIVER DISCHARGES AND WATER LEVEL OF LAKE OLOMEGA

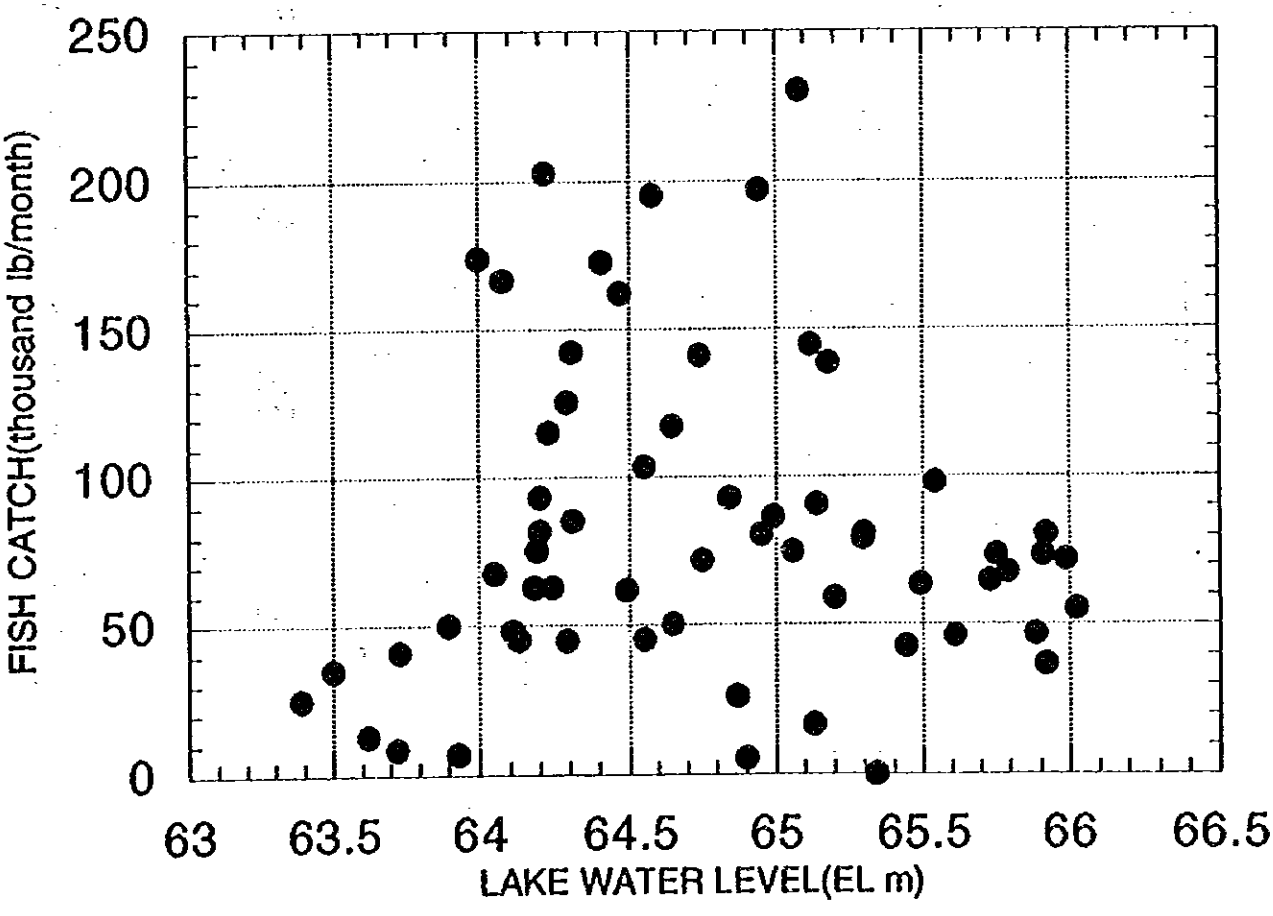


Figura 5.9 NIVEL DEL AGUA DE LA LAGUNA Y PESCA (LAGUNA DE OLOMEGA)

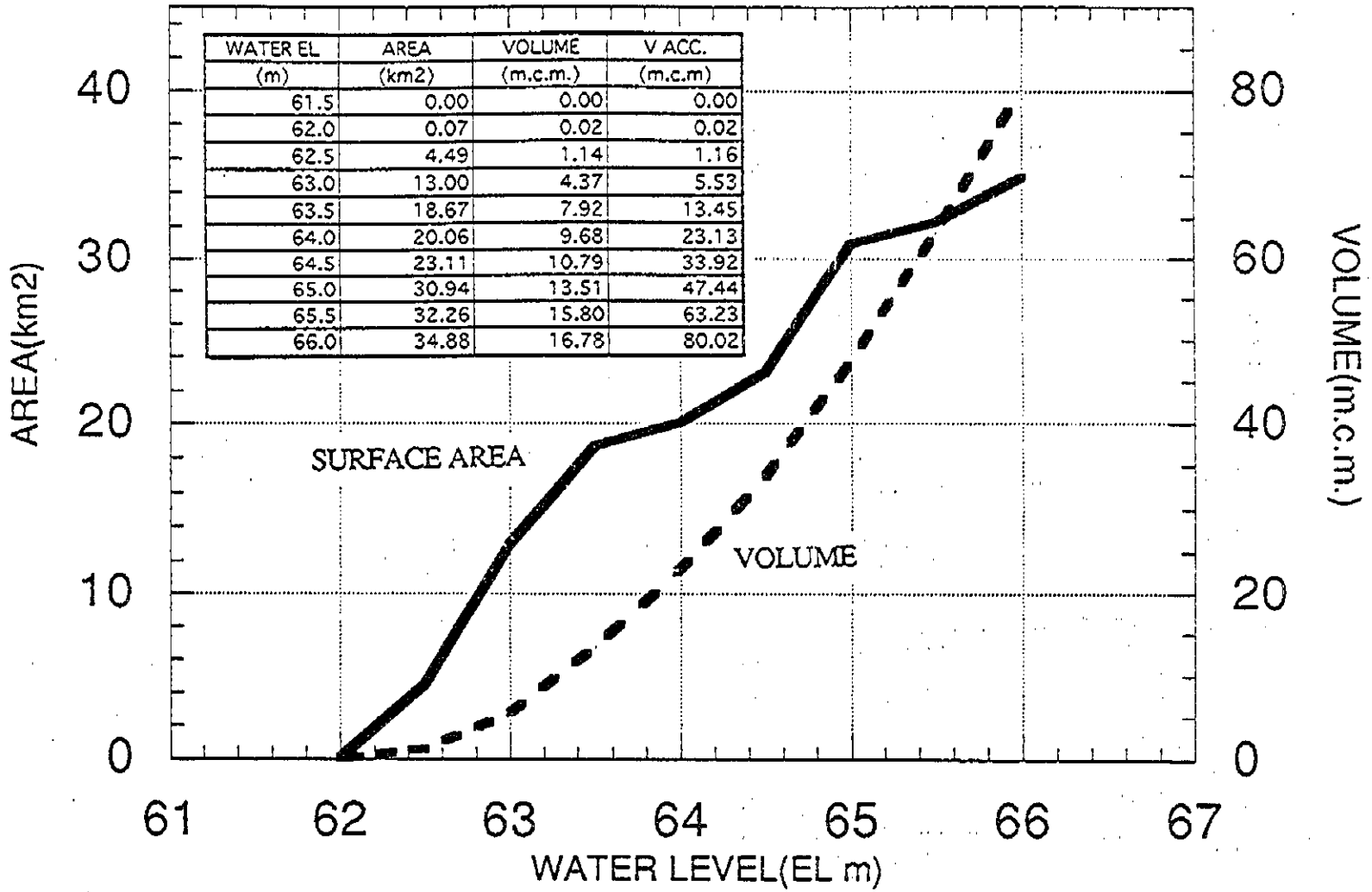


Figura 5.10 RELACIÓN NIVEL DEL AGUA - AREA - VOLUMEN (LAGUNA DE OLOMEGA)

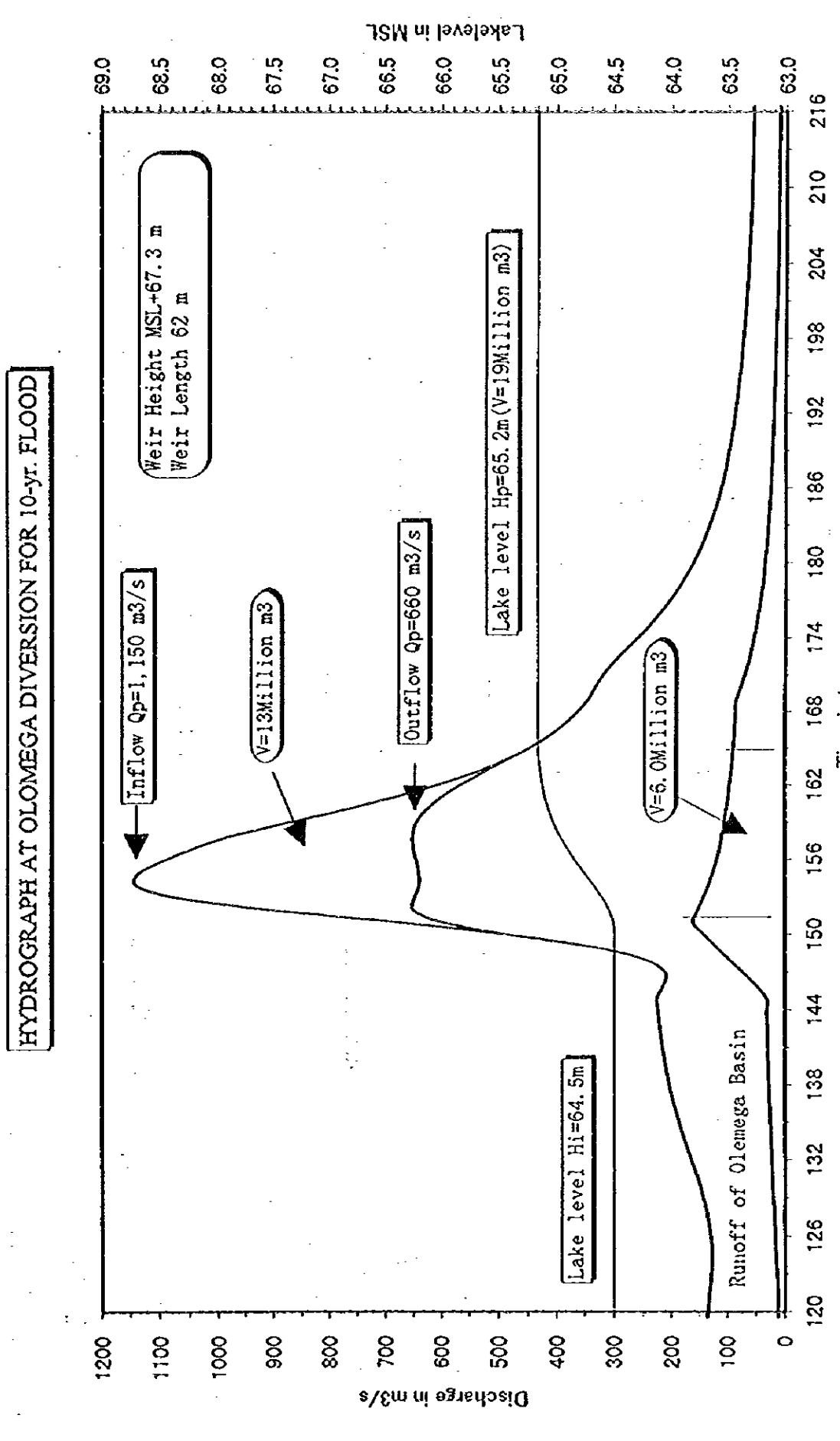


Figura 5.11 HIDROGRAMA EN LA DESVIACIÓN DE OLOMEGA PARA UN PERíODO DE RETORNO DE 10 AÑOS

Flood Area by Return period and Design level

San Miguel Area — Channel capacity (Pelota-Vado Marin)

Return period as external force	Existing	T=2yr.	T=5yr.	T=10yr.
1.05	1.6	1.6	1.6	1.6
2	1.6	1.6	1.6	1.6
5	2.0	2.0	2.0	1.8
10	2.5	2.5	2.5	2.1
20	3.0	3.0	3.0	2.6
50	3.5	3.5	3.5	3.1
100	5.1	5.1	5.1	3.7

Vado Marin Area — Channel capacity (Pelota-Vado Marin)

Return period as external force	Existing	T=2yr.	T=5yr.	T=10yr.
1.05	0.2	0	0	0
2	0.4	0	0	0
5	0.8	0	0	0
10	1.2	0	0	0
20	1.7	0	0	0
50	2.7	0	0	0
100	3.4	0	0	0

Olomega Area — Channel capacity (Pelota-Vado Marin)

Return period as external force	Existing	T=2yr.	T=5yr.	T=10yr.
1.05	25.3	0.0	-	0.0
2	41.5	9.2	-	0.0
5	54.5	14.0	9.2	4.6
10	69.4	15.5	9.6	7.6
20	78.0	17.5	14.0	10.0
50	83.7	55.4	55.4	55.4
100	88.9	59.1	-	59.1

Usulutan Area — Channel capacity (Pelota-Vado Marin)

Return period as external force	Existing	T=2yr.	T=5yr.	T=10yr.
1.05	5.1	6.2	-	6.6
2	14.1	6.3	-	6.6
5	16.7	6.3	6.6	6.6
10	19.0	6.6	6.6	6.6
20	20.0	6.4	6.6	6.6
50	22.0	6.5	6.6	6.6
100	23.5	6.6	-	25.9

Jocotal Area — Channel capacity (Pelota-Vado Marin)

Return period as external force	Existing	T=2yr.	T=5yr.	T=10yr.
1.05	22.2	0.1	-	0.0
2	25.6	3.8	-	0.0
5	29.7	16.3	9.0	0.7
10	31.0	18.0	12.0	2.8
20	32.0	19.3	19.0	10.2
50	33.0	24.1	10.0	3.8
100	34.6	26.0	-	15.7

Total Area — Channel capacity (Pelota-Vado Marin)

Return period as external force	Existing	T=2yr.	T=5yr.	T=10yr.
1.05	54.4	7.8	-	8.2
2	83.2	20.9	-	8.2
5	103.7	38.6	25.8	13.7
10	123.1	42.6	30.7	19.1
20	134.7	46.2	42.6	29.4
50	144.9	89.5	75.5	68.9
100	155.5	96.8	-	104.4

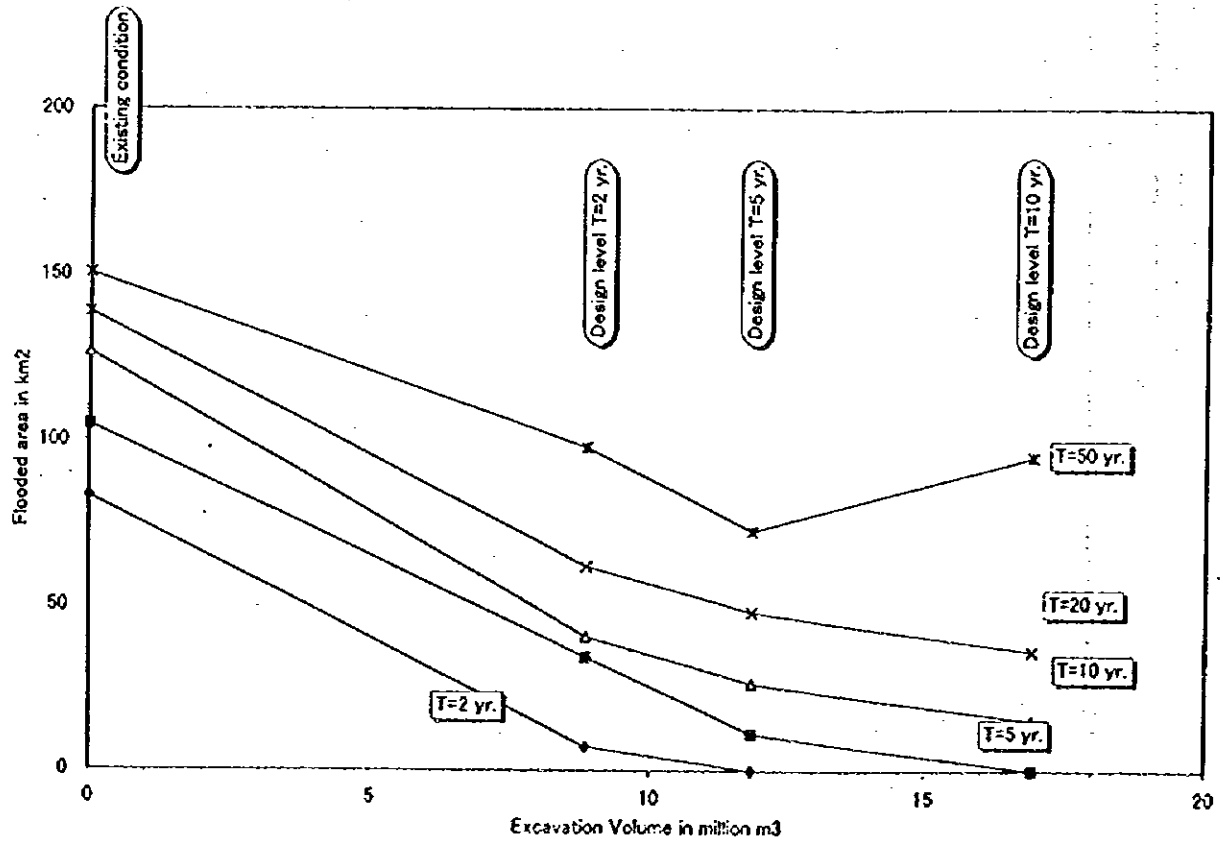


Figura 5.12 RELACIÓN ENTRE AREA DE INUNDACIÓN Y VOLUMEN DE EXCAVACIÓN

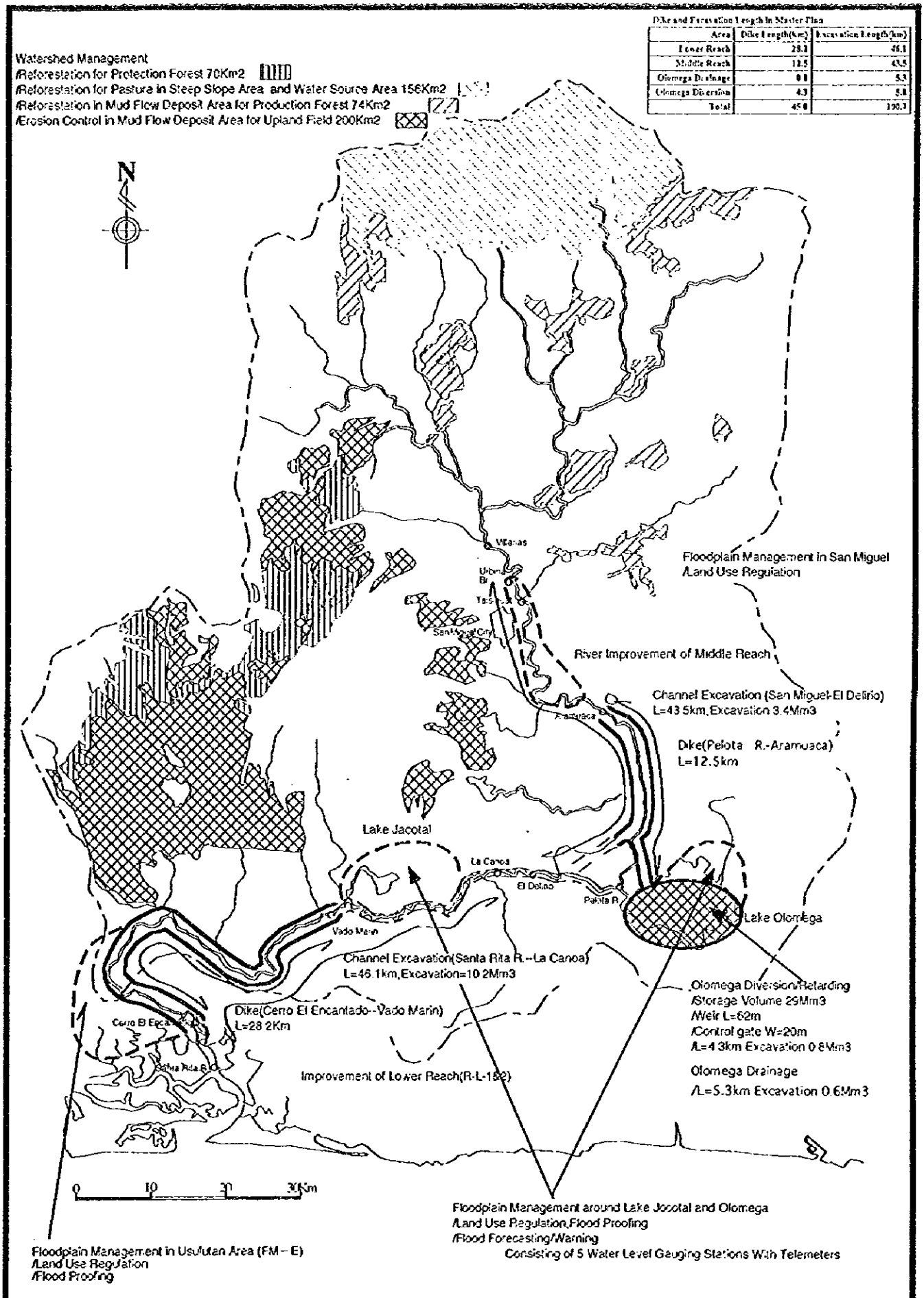
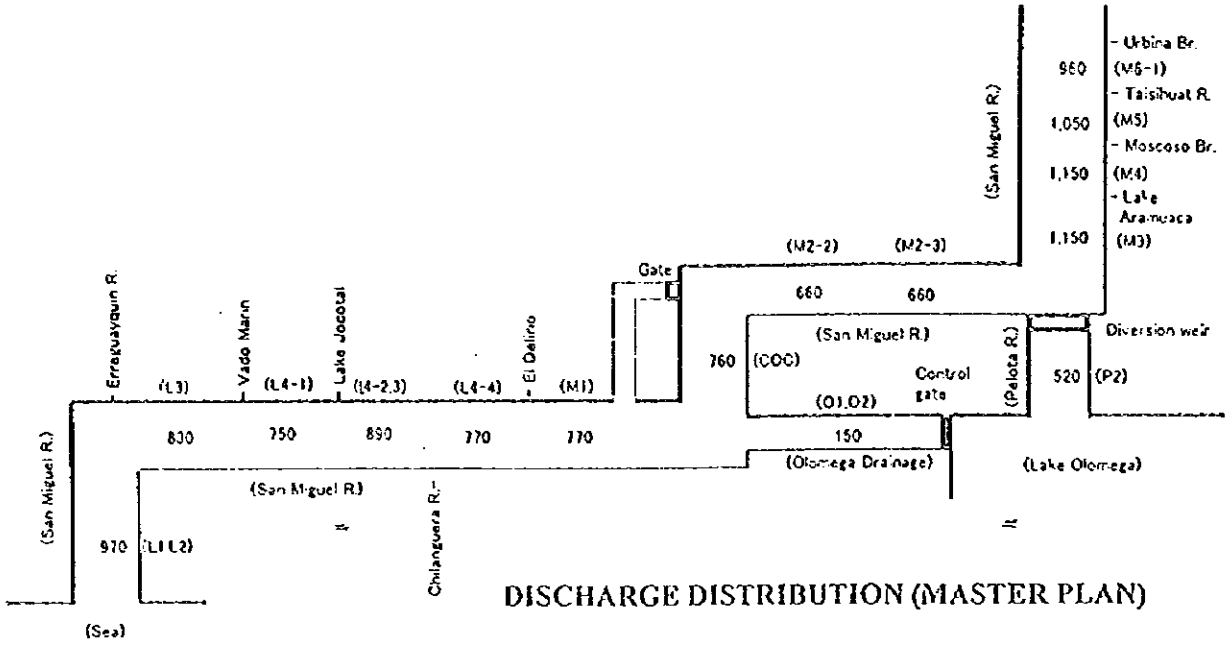
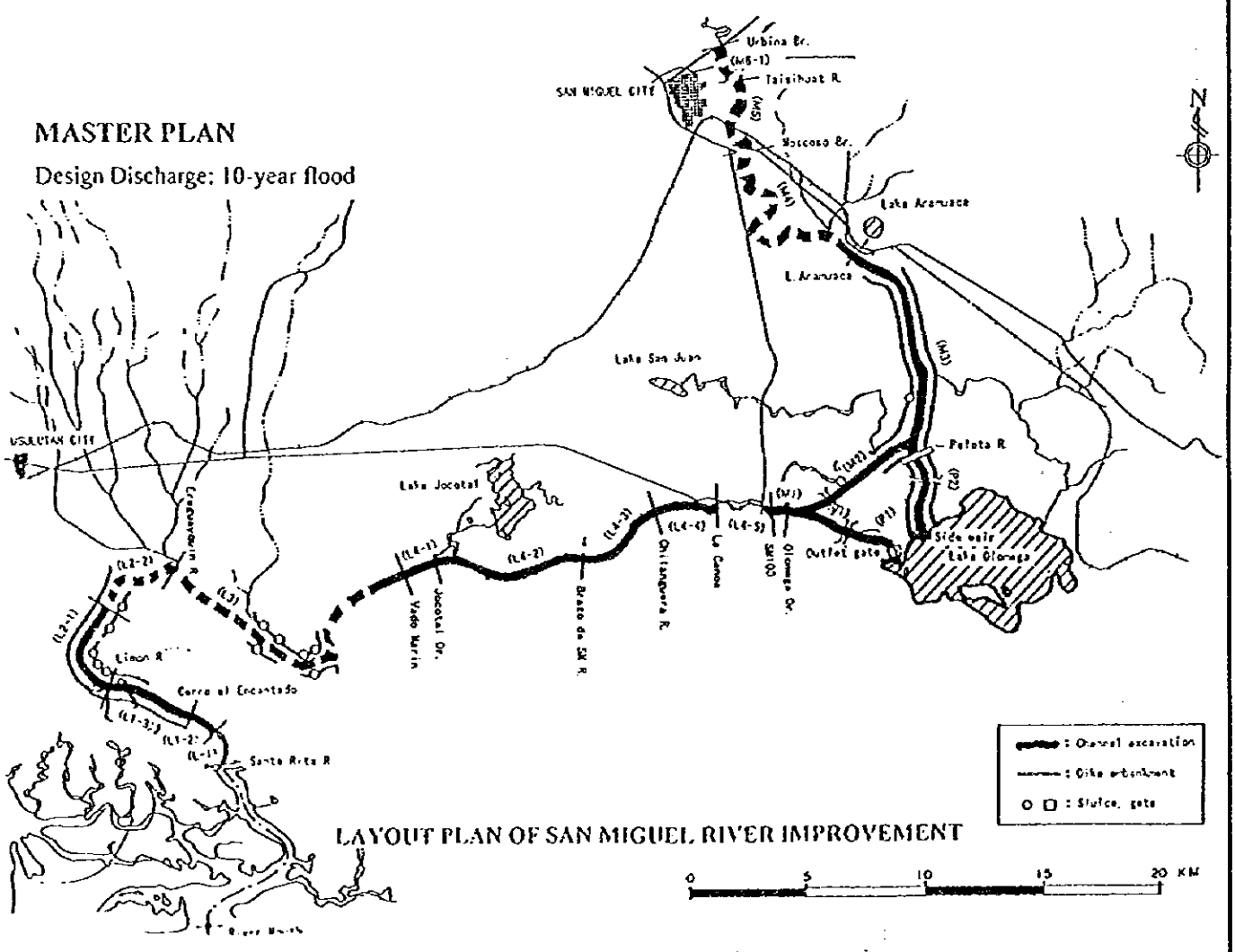


Figura 5.13 PRESENTACIÓN GENERAL DEL PLAN MAESTRO PARA EL CONTROL DE INUNDACIONES



DISCHARGE DISTRIBUTION (MASTER PLAN)



LAYOUT PLAN OF SAN MIGUEL RIVER IMPROVEMENT

Figura 5.14 **PRESENTACIÓN DEL PLAN PARA EL MEJORAMIENTO DEL RÍO GRANDE DE SAN MIGUEL**

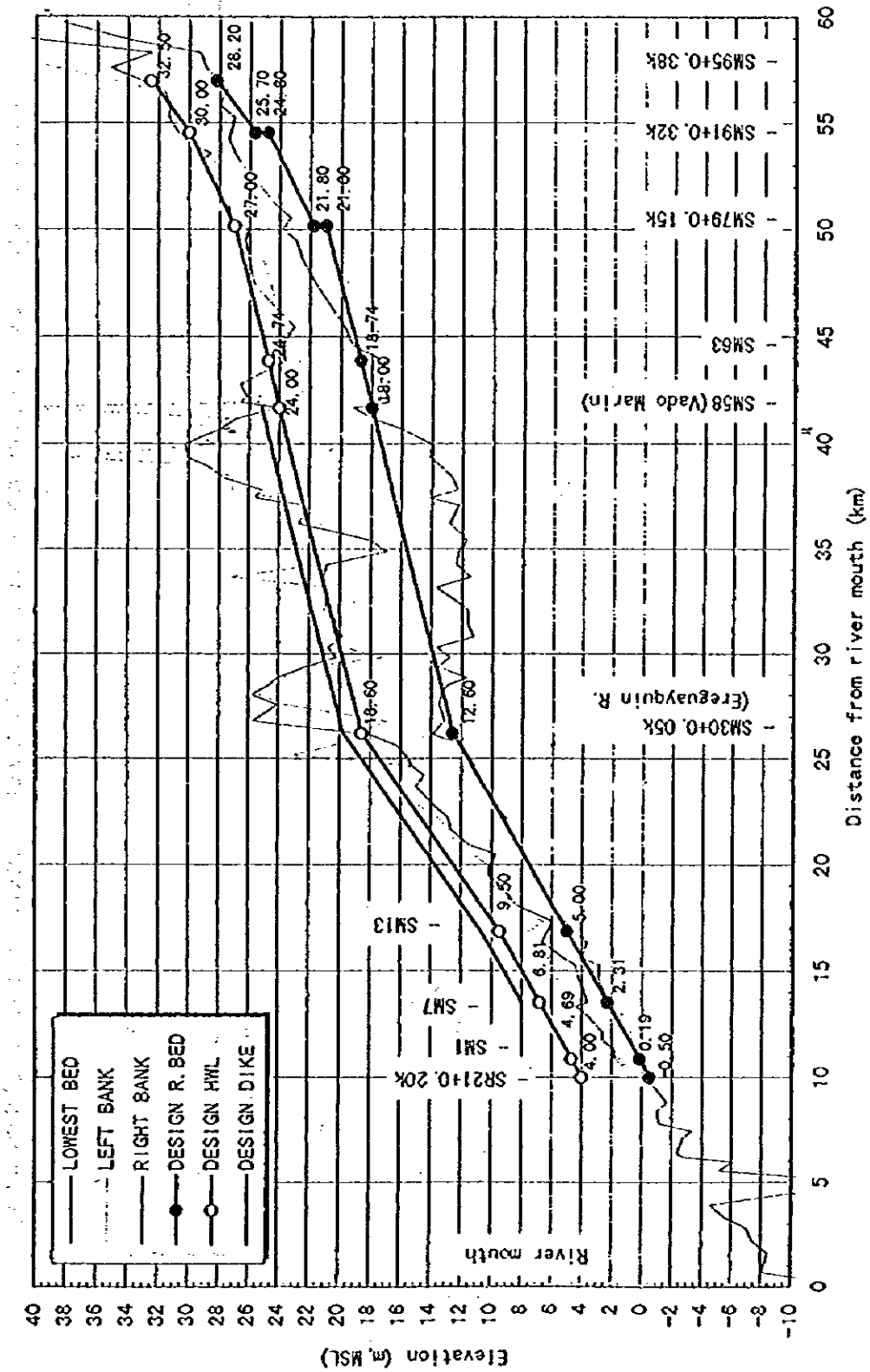


Figura 5.15 (1/3) PERFIL LONGITUDINAL PROPUESTO DEL RIO GRANDE DE SAN MIGUEL (1/3)

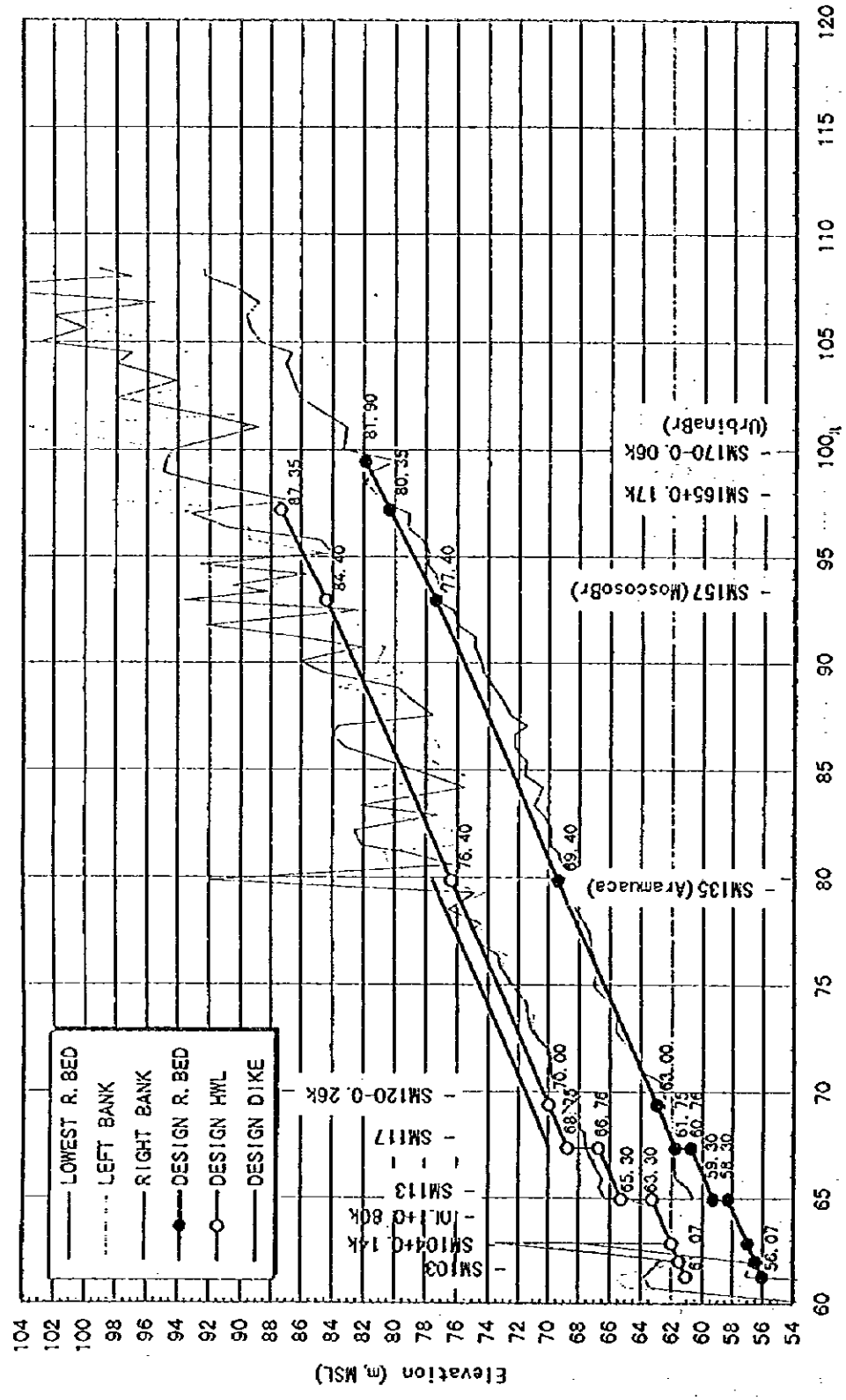


Figura 5.15 (2/3) PERFIL LONGITUDINAL PROPUESTO DEL RIO GRANDE DE SAN MIGUEL (2/3)

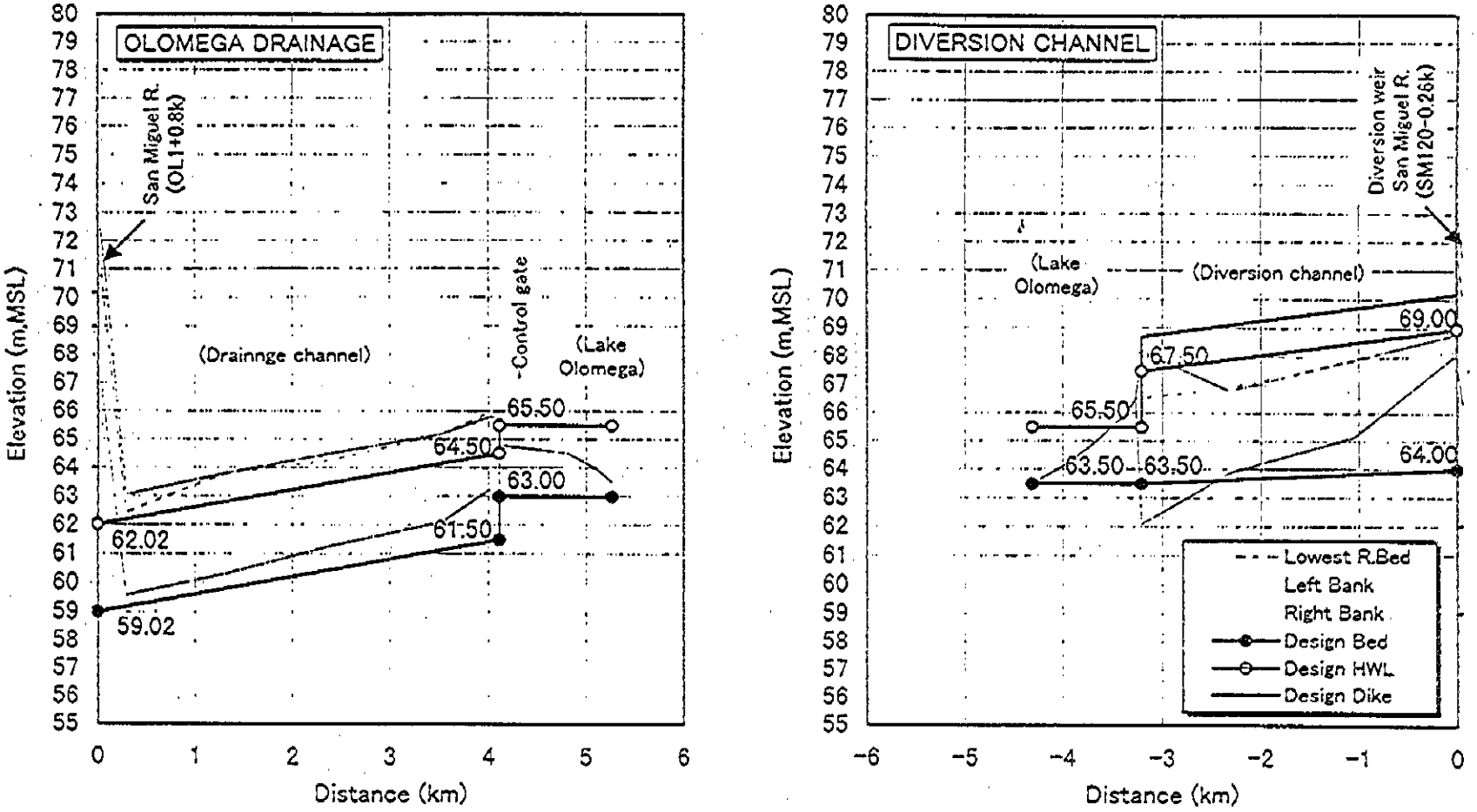


Figura 5.15 (3/3) PERFIL LONGITUDINAL PROPUESTO DEL RÍO GRANDE DE SAN MIGUEL (3/3)

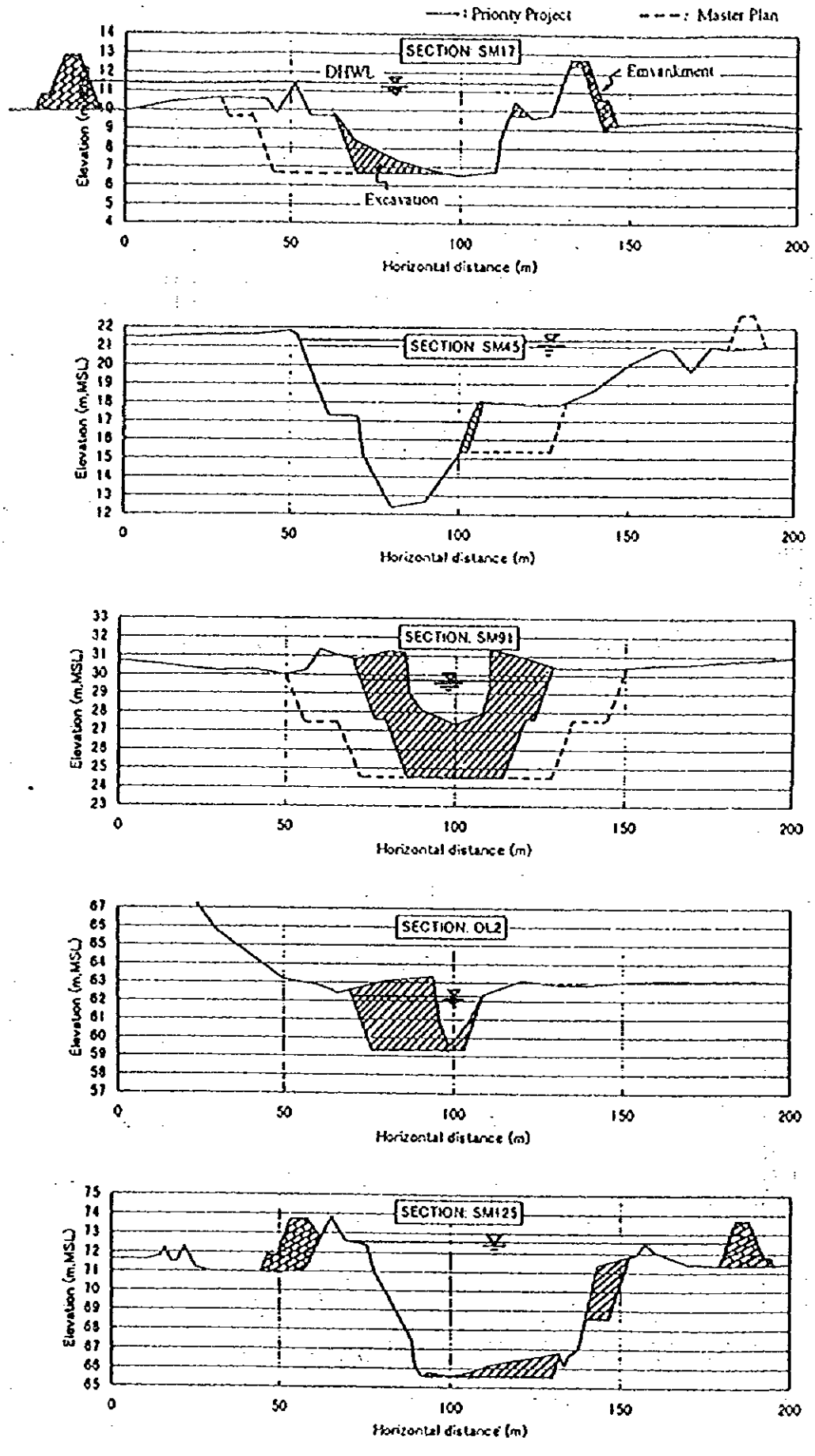


Figura 5.16 CORTES TRANSVERSALES REPRESENTATIVOS DEL RÍO GRANDE DE SAN MIGUEL PROPUESTO

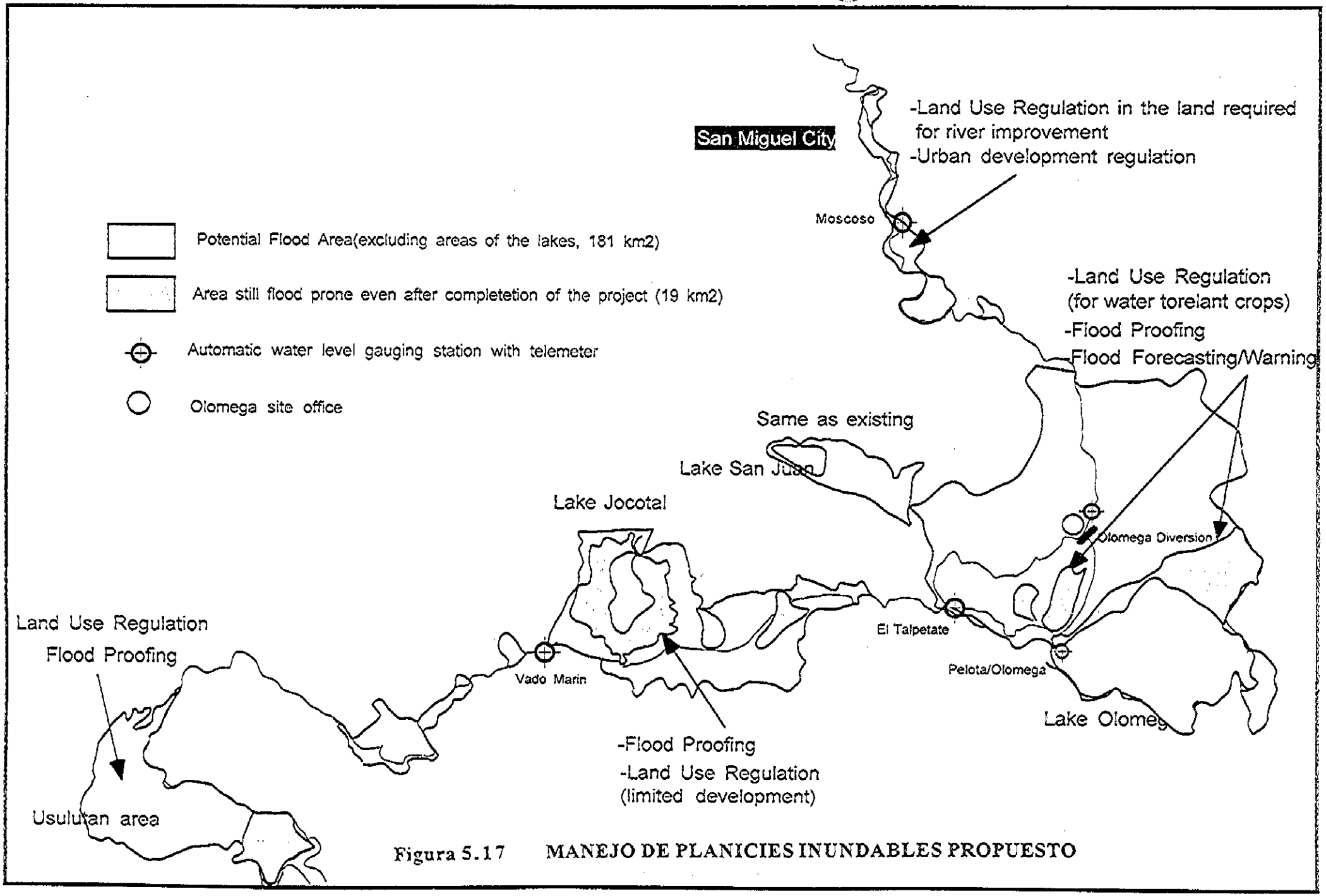
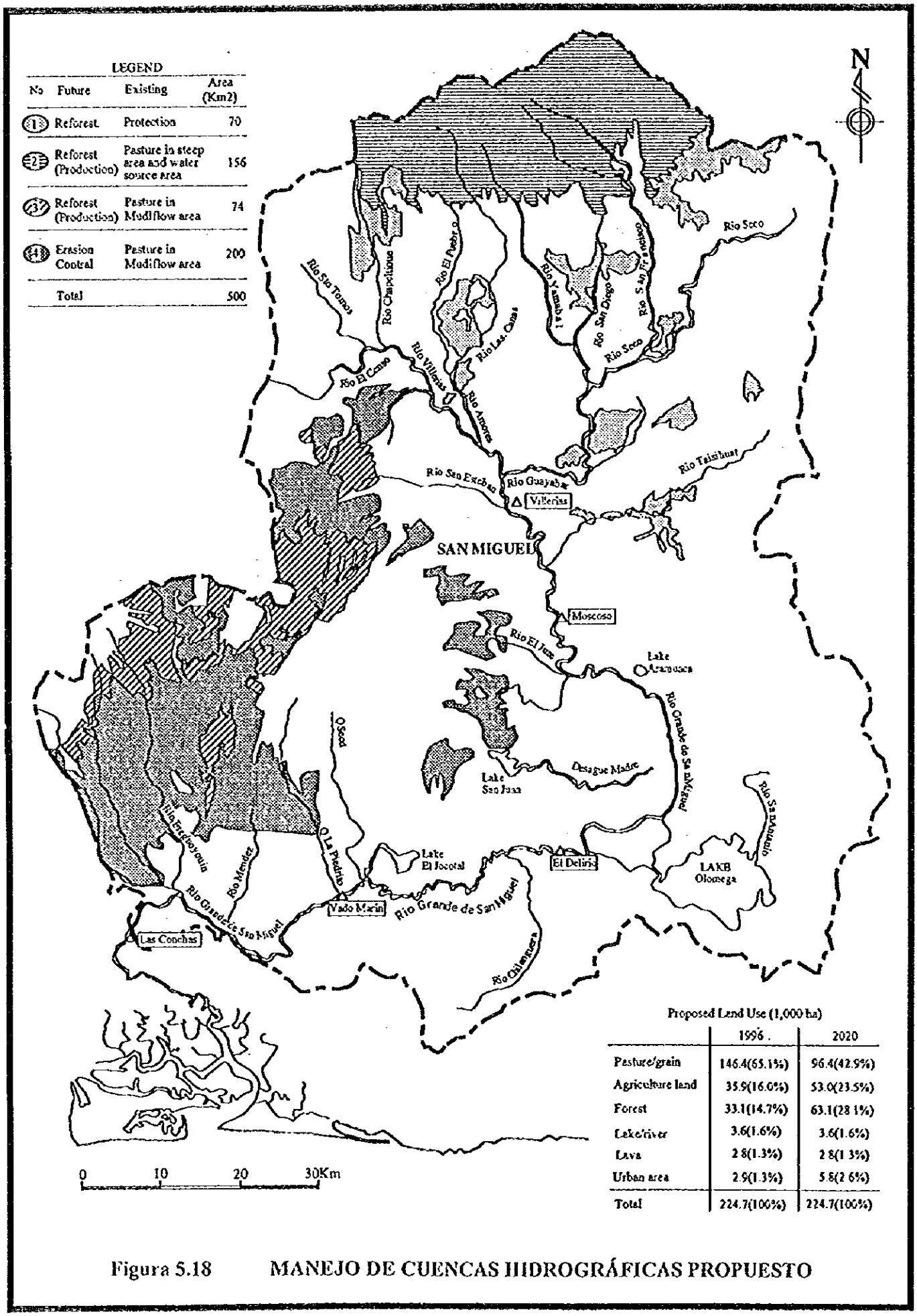


Figura 5.17 MANEJO DE PLANICIES INUNDABLES PROPUESTO



Proposed Land Use (1,000 ha)

	1996	2020
Pasture/grain	146.4(65.1%)	96.4(42.9%)
Agriculture land	35.9(16.0%)	53.0(23.5%)
Forest	33.1(14.7%)	63.1(28.1%)
Lake/river	3.6(1.6%)	3.6(1.6%)
Lava	2.8(1.3%)	2.8(1.3%)
Urban area	2.9(1.3%)	5.8(2.6%)
Total	224.7(100%)	224.7(100%)

Figura 5.18 MANEJO DE CUENCAS HIDROGRÁFICAS PROPUESTO

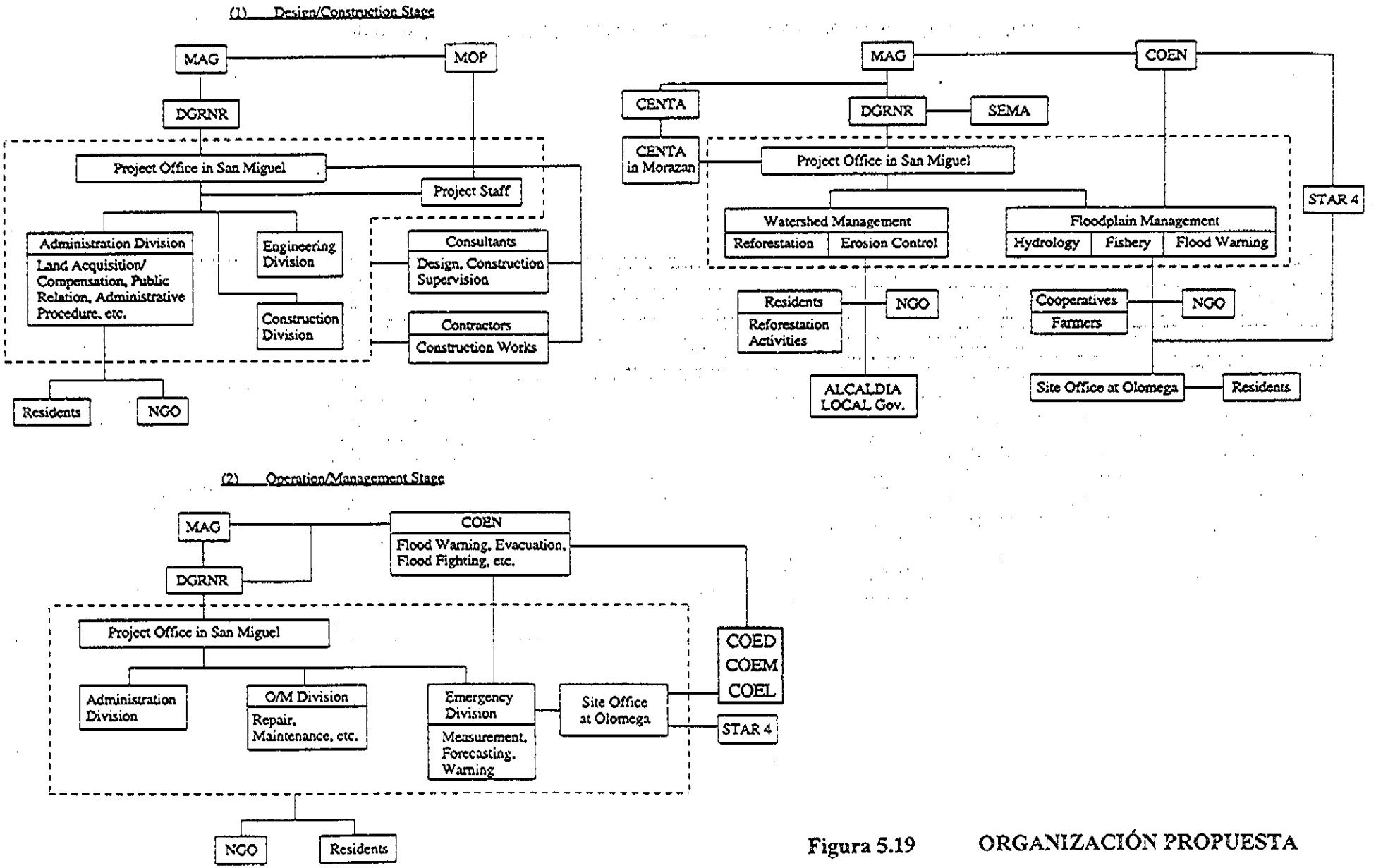


Figura 5.19 ORGANIZACIÓN PROPUESTA

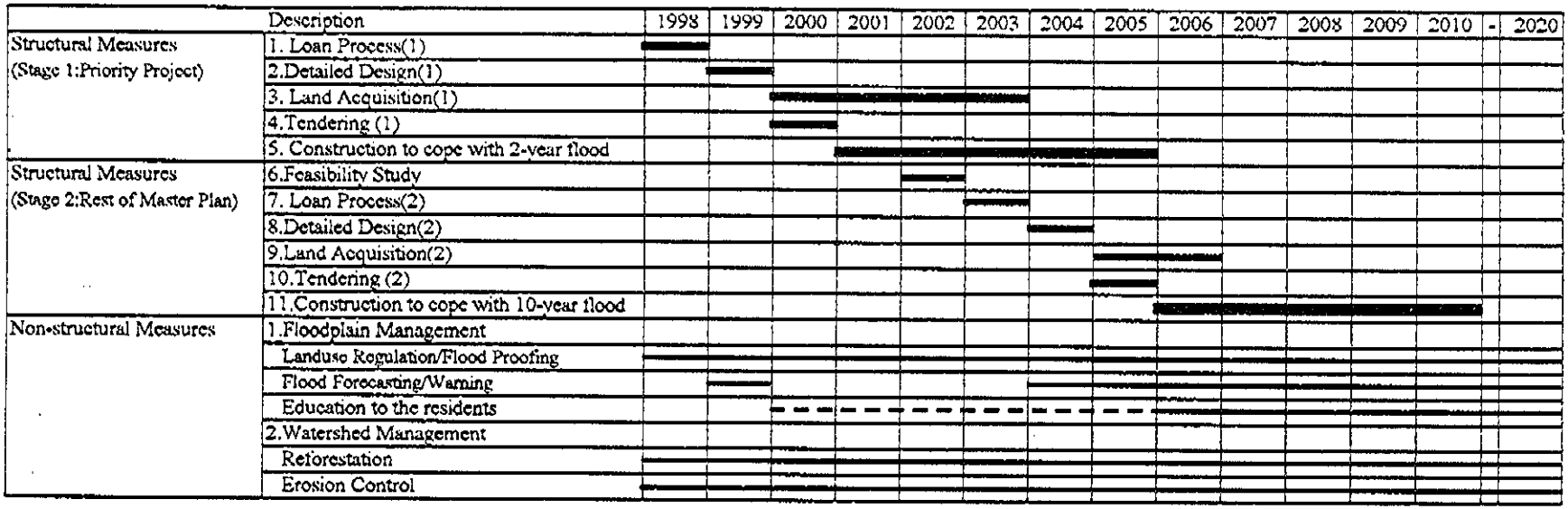
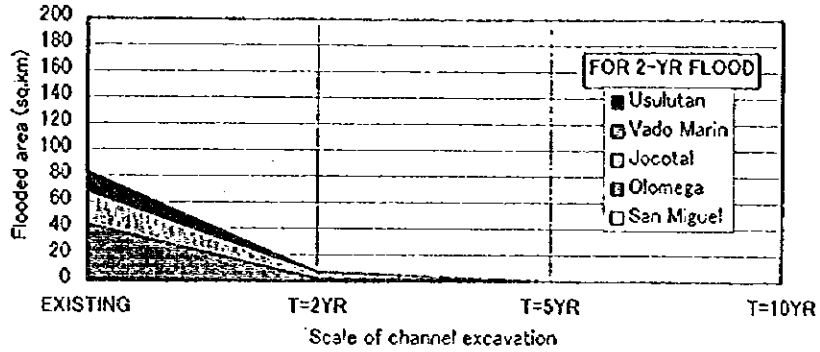
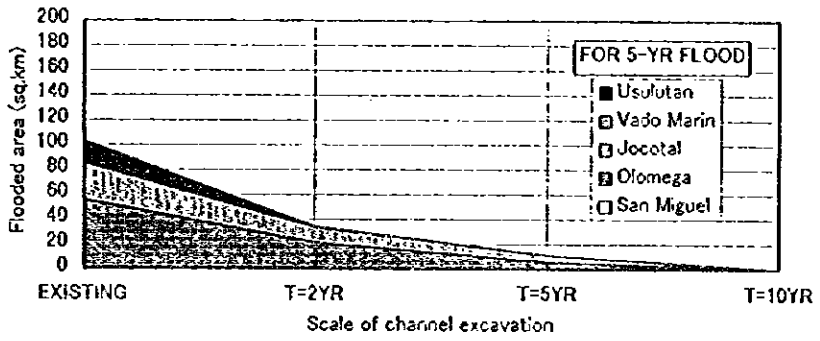
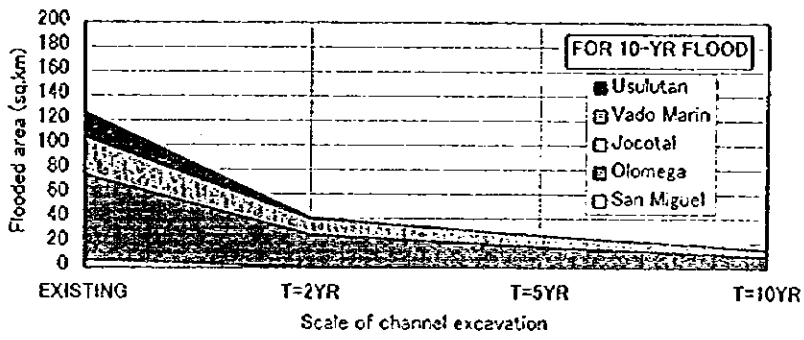


Figura 5.20 PROGRAMA DE IMPLEMENTARON PARA EL PROYECTO







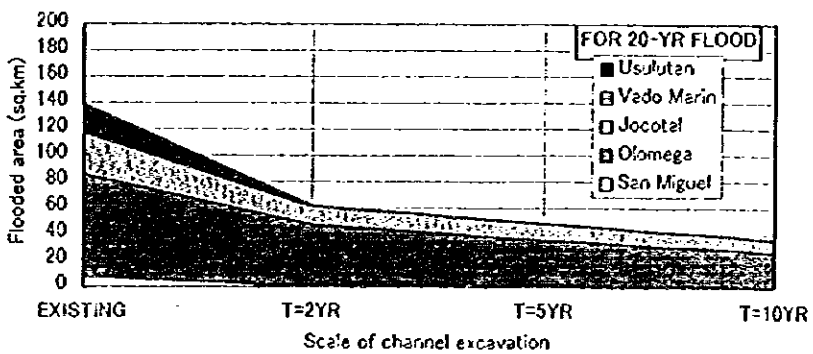
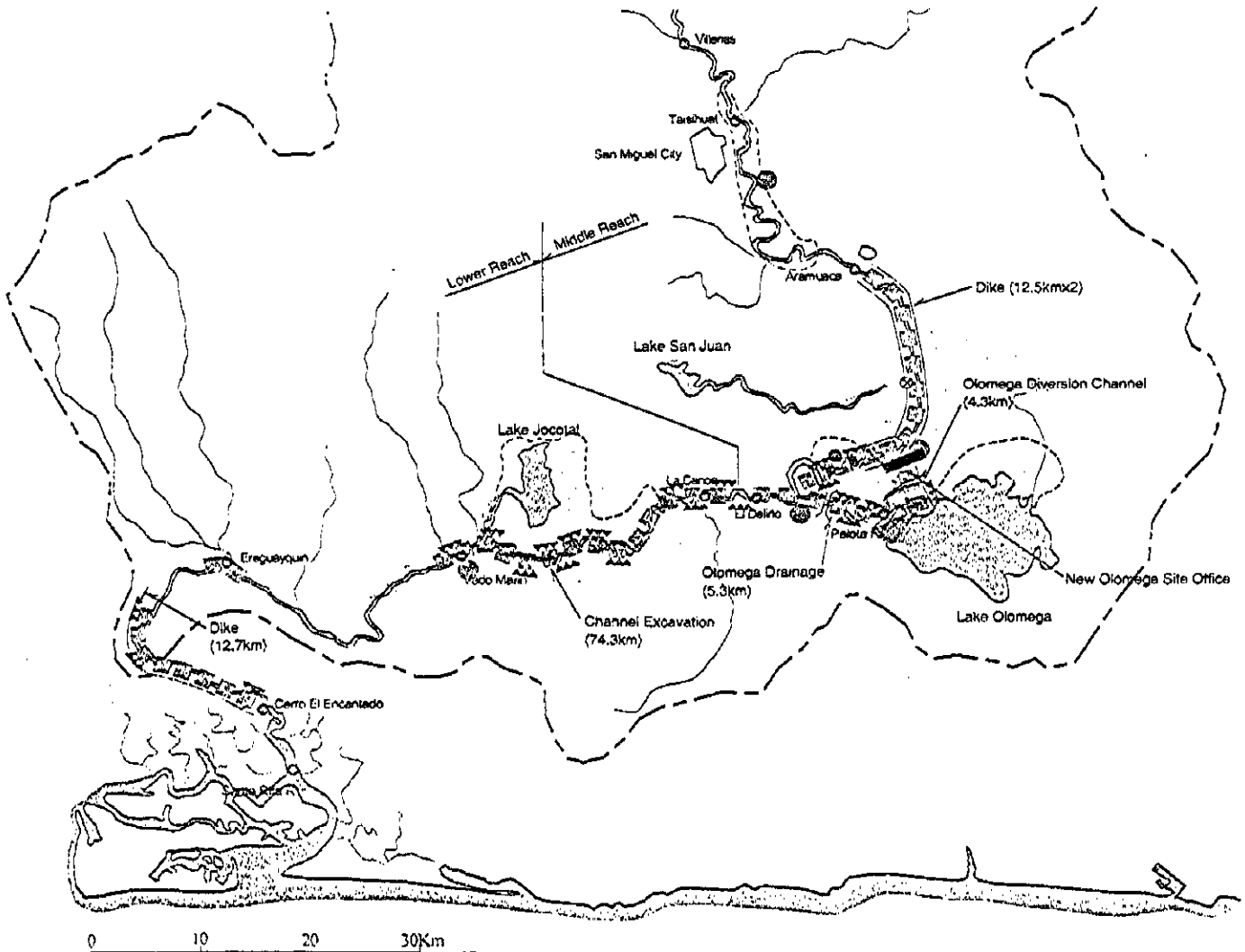


Figura 6.1 **RELACIÓN ENTRE EXCAVACIÓN DE CANAL Y AREA DE INUNDACIÓN**

Proposed Priority Project



Dike and Excavation Length

Area	Dike Length(km)	Excavation Length(km)
Lower Reach	12.7	46.1
Middle Reach	12.5	18.6
Olomega Drainage	0.0	5.3
Olomega Diversion	4.3	4.3
Total	29.5	74.3

Proposed Project Works

ITEM	AMOUNT
1. Structural Measures	
Earth Excavation	7,883,000 m³
Rock Excavation	152,000 m³
Embankment	1,173,000 m³
Revetment	6,000 m
Diversion Weir	1 place
Control Gate	1 place
Drainage Sluice	1 place
Ground Sill	229 m
Intake Gate	1 place
Bridge	3 places
Rural Road	2,640 m
Land Acquisition	6.76 km2
Compensation	20 houses
2. Non-structural Measures	
Automatic Water Level Station	5 places
Telemetering System	1 unit
Floodplain Management	3 places

Legend

- San Miguel River
- Catchment Boundary
- Maximum Flooded Area
- Dike
- Channel Excavation
- Revetment
- Olomega Diversion Weir
- Olomega Control Gate
- Automatic Water Level Station
- New Olomega Site Office
- Area for Floodplain Management
- Bridge
- Ground Sill
- Drainage Sluice
- Intake Gate

Figura 6.2 ESQUEMA GENERAL DEL PROYECTO PRIORITARIO