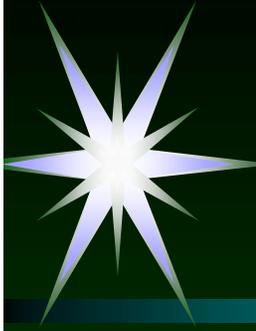


El Yunque National Forest

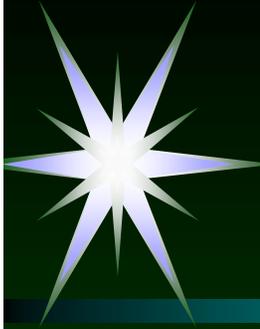


Prepared by
Ecosystem Management Team Leader



Objectives

- Develop Awareness of Luquillo Mountain Range Hydrologic Function
- Use UN World Water Development Reports Data to compare global situation with El Yunque NF
- Allow you to reach conclusions on hydrologic condition and water challenges



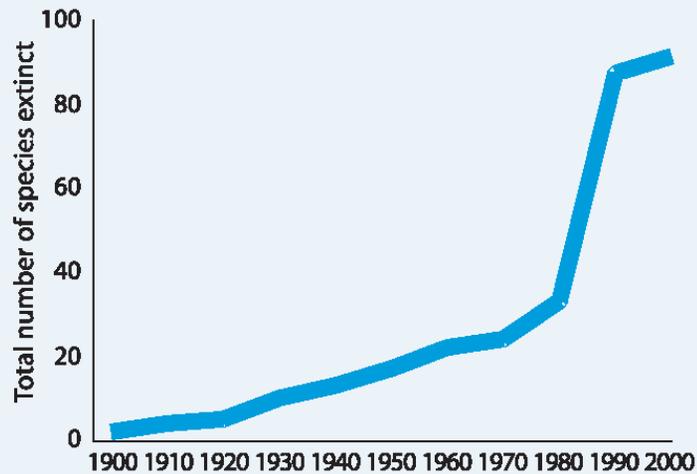
Is this important?

- World Water Development Report #1 (2003)
 - The decline in quantity and quality of water resources is causing extinction of freshwater species and severe loss of bio-diversity.
 - More than half of humanity relies on freshwater that accumulates in mountain regions.
- USGS (Fact Sheet 163-99, 2000)
 - + \$ 25,000,000 – Value of Water from El Yunque



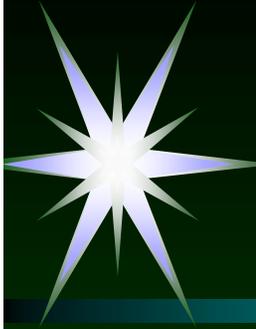
One example!

- Management Indicator Species



Known twentieth-century freshwater fish extinctions (cumulative)

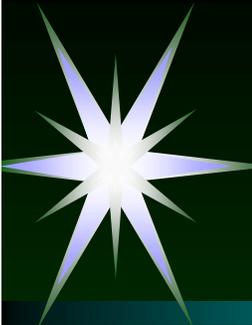




Hydrologic Resources of El Yunque

- Water Cycle
- Water Quantity
- Water Quality



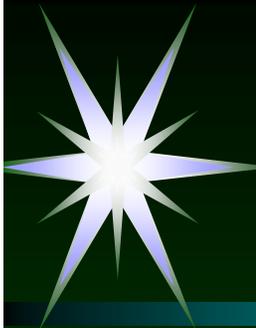


The Global Water Cycle: Where is the water?

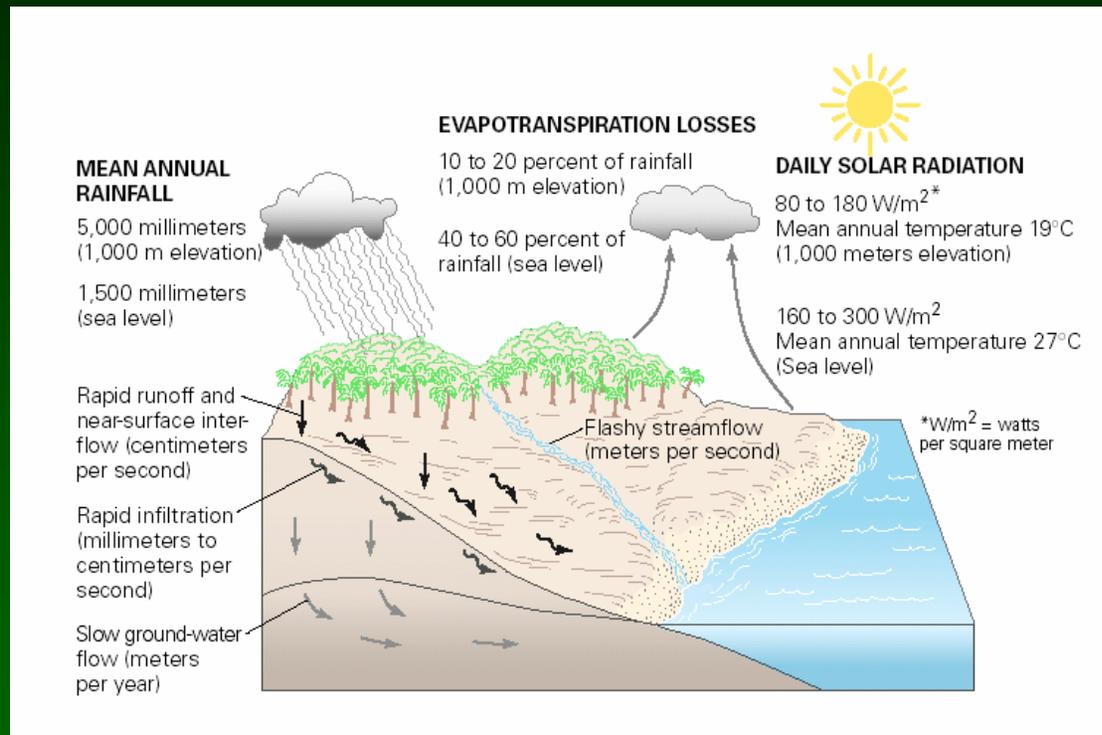
Table 4.1: The distribution of water across the globe

Location	Volume, (10 ³ km ³)	% of total volume in hydrosphere	% of freshwater	Volume recycled annually (km ³)	Renewal period years
Ocean	1,338,000	96.5	–	505,000	2,500
Groundwater (gravity and capillary)	23,400 ¹	1.7		16,700	1,400
Predominantly fresh groundwater	10,530	0.76	30.1		
Soil moisture	16.5	0.001	0.05	16,500	1
Glaciers and permanent snow cover:	24,064	1.74	68.7		
Antarctica	21,600	1.56	61.7		
Greenland	2,340	0.17	6.68	2,477	9,700
Arctic Islands	83.5	0.006	0.24		
Mountainous regions	40.6	0.003	0.12	25	1,600
Ground ice (permafrost)	300	0.022	0.86	30	10,000
Water in lakes:	176.4	0.013	–	10,376	17
Fresh	91.0	0.007	0.26		
Salt	85.4	0.006	–		
Marshes and swamps	11.5	0.0008	0.03	2,294	5
River water	2.12	0.0002	0.006	43,000	16 days
Biological water	1.12	0.0001	0.003		–
Water in the atmosphere	12.9	0.001	0.04	600,000	8 days
Total volume in the hydrosphere	1,386,000	100	–		
Total freshwater	35,029.2	2.53	100		

¹ Excluding groundwater in the Antarctic estimated at 2 million km³, including predominantly freshwater of about 1 million km³.



El Yunque's Water Cycle



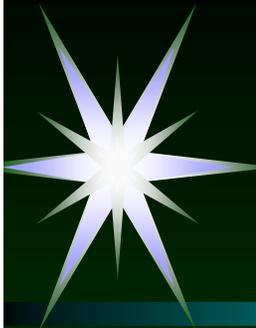
“Vientos Alisios”

Elevation 0 – 3,533 ft msl

Rain 59 – 196 inches / year

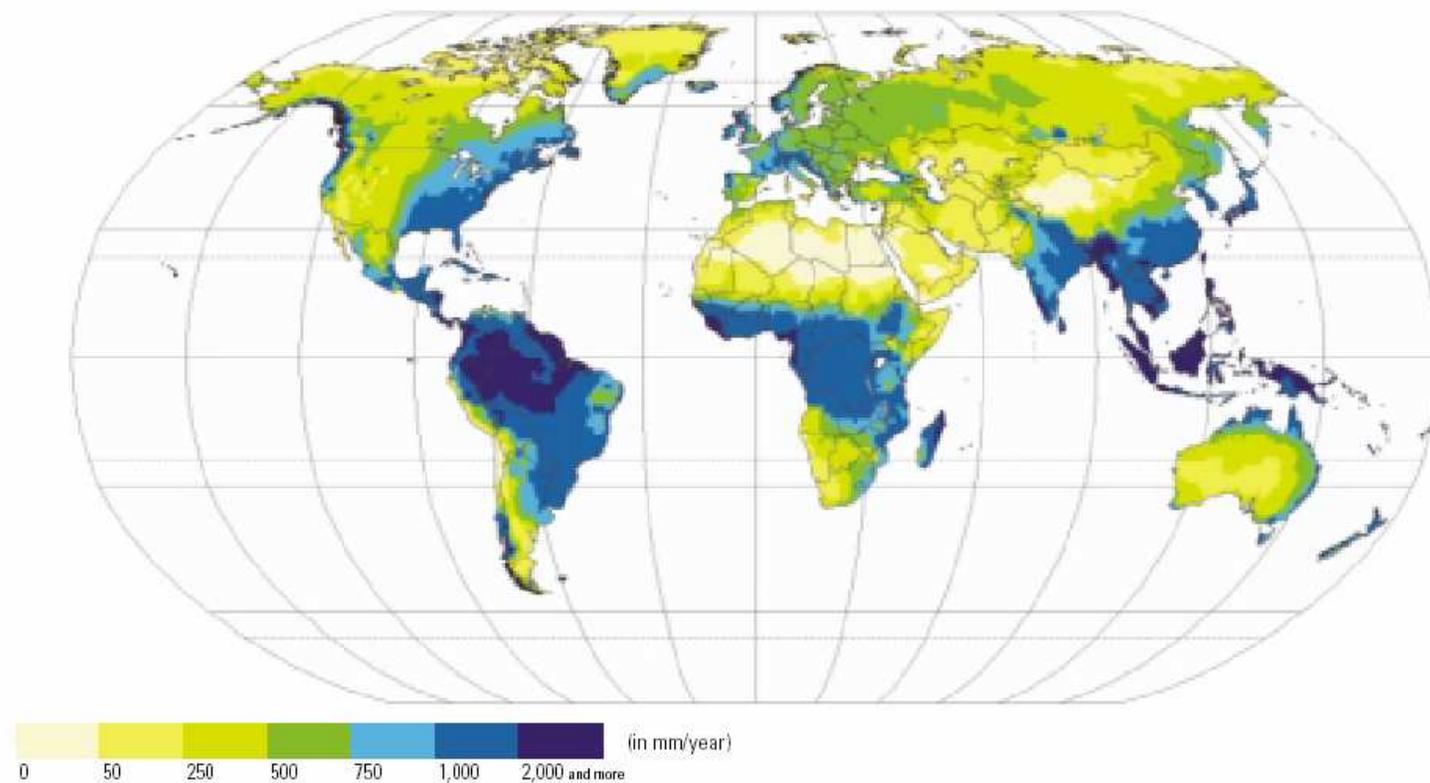
65 % of the rainfall becomes stream water – 210 MGD

(USGS, Fact Sheet 163-99, 2000)

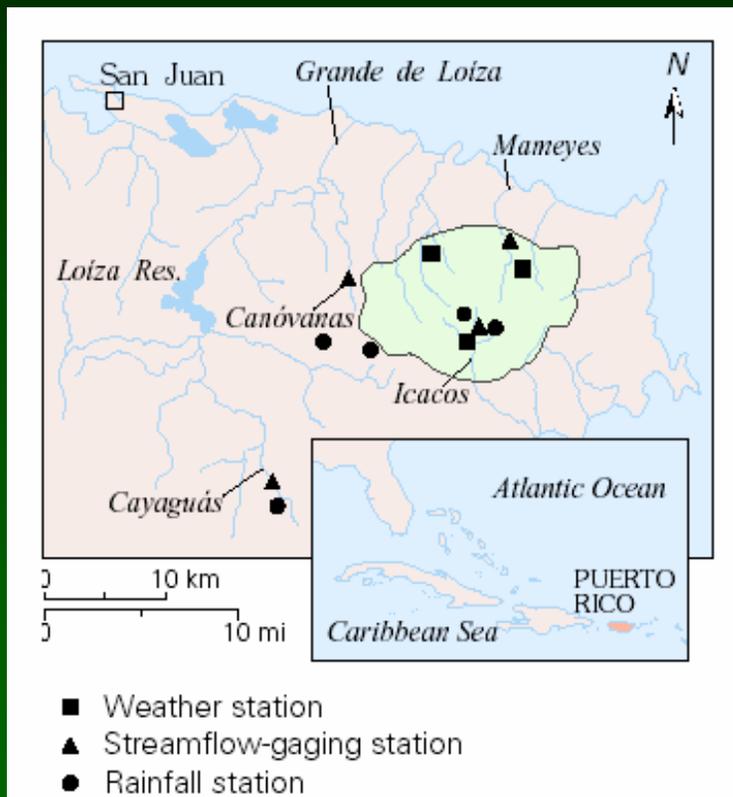


Global Precipitation

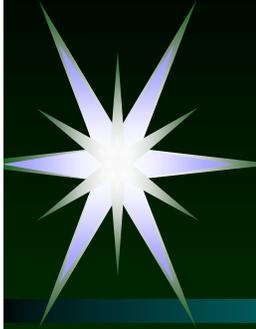
Map 4.2: Mean annual precipitation



Water Quantity



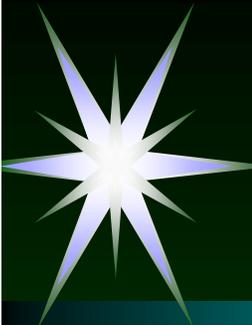
- 190,839 “cuerdas” (Eastern Region)
- 7 Major Streams (cubic meters/sec)
 - Grande de Loíza 7.9 meters
 - Espiritu Santo – 4.22
 - Mameyes – 3.37
 - Sabana – 2.23
 - Fajardo – 4.05
 - Blanco – 2.09
 - Santiago – n/d



El Yunque's Contribution



- ◆ High Quality Waters
- JCA
- ◆ Water Consumed 60
mgd
- ◆ Hydro Plant - 7 mgd
- ◆ 10 Species of Shrimp
and Crabs
- ◆ 1100 miles of streams



Global Water Quality WWDR 2

Table 4.9: The world's major water quality issues

Issue scale	Water bodies polluted	Sector affected	Time lag between cause and effect	Effects extent
Organic pollution	rivers ++ lakes + groundwater +	aquatic environment	<1 year	local to district
Pathogens	rivers ++ lakes + groundwater +	health ++	<1 year	local
Salinization	groundwater ++ rivers +	most uses aquatic environment health	1–10 years	district to region
Nitrate	rivers + lakes + groundwater ++	health	>10 years	district to region
Heavy metals	all bodies	health aquatic environment ocean fluxes	<1 to >10 years	local to global
Organics	all bodies	health aquatic environment ocean fluxes	1 to 10 years	local to global
Acidification	rivers ++ lakes ++ groundwater +	health aquatic environment	>10 years	district to region
Eutrophication	lakes ++ rivers +	aquatic environment most uses ocean fluxes	>10 years	local
Sediment load (increase and decrease)	rivers + lakes	aquatic environment most uses ocean fluxes	1–10 years	regional
Diversions, dams	rivers ++ lakes + groundwater ++	aquatic environment most uses	1–10 years	district to region

+ Serious issue on a global scale

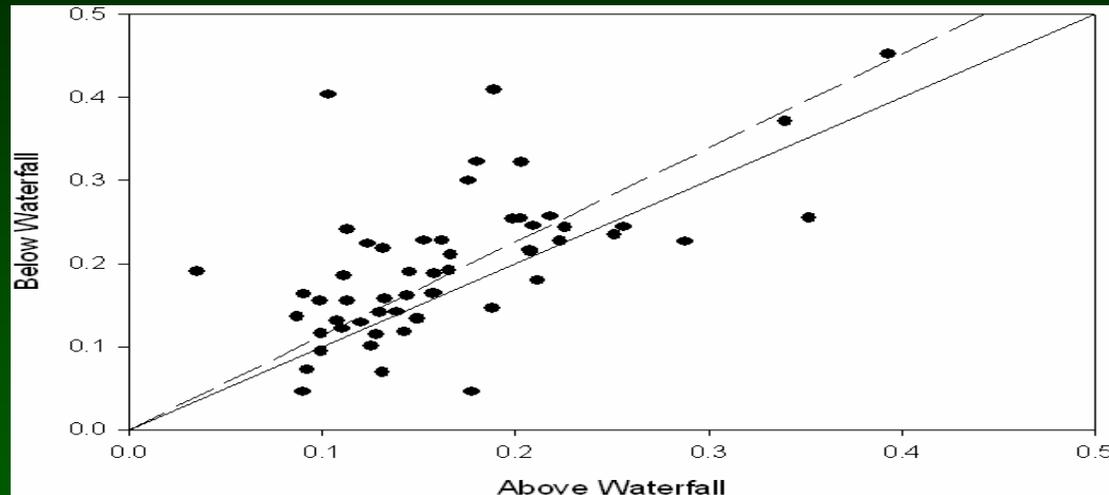
++ Very serious issue on a global scale

Pollutants of many kinds eventually find their way into water bodies at all levels. Although it may take some years for problems to become evident, poor water quality affects both human health and ecosystem health.

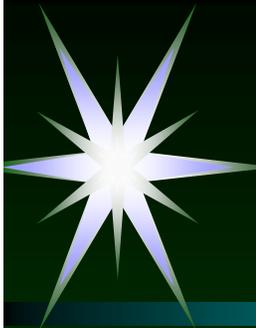
Source: WHO/UNEP, 1991.



El Yunque Water Quality: Case Study: La Mina – Concentration of TDN (mg N/L)

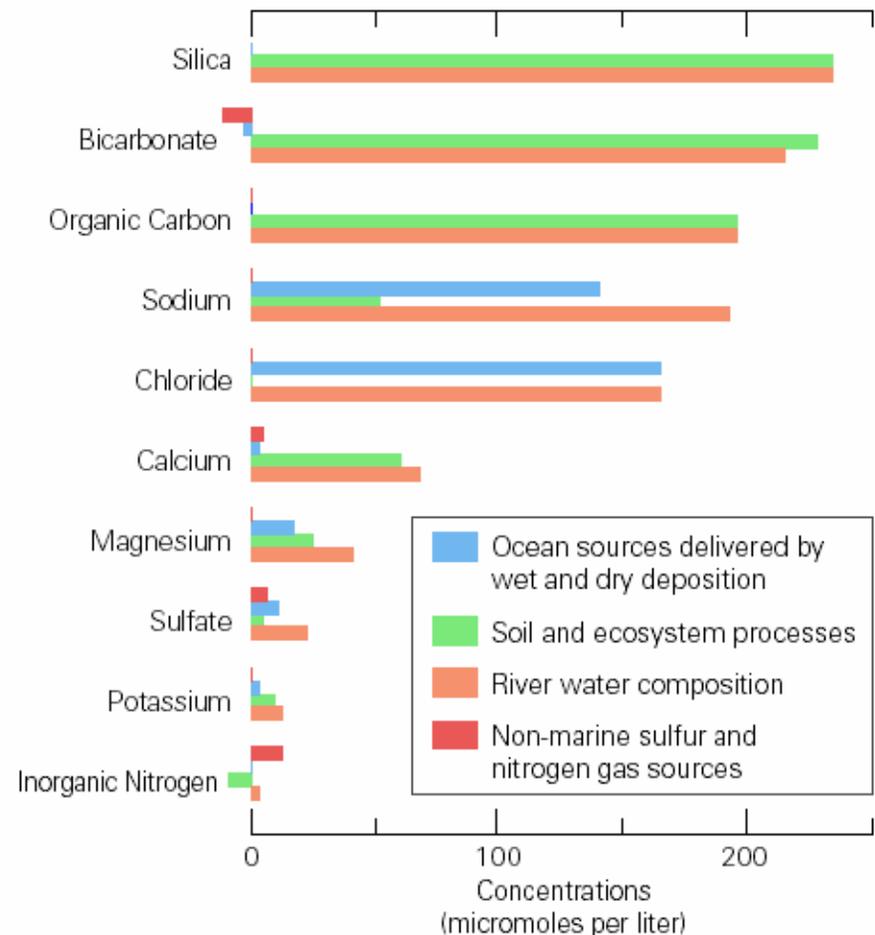


Marcial, J. Human Recreation in the Streams of CNF. 2006.



Water Quality (USGS 2000)

- Stream flow is chemically diluted
- Case: Rio Icacos Watershed

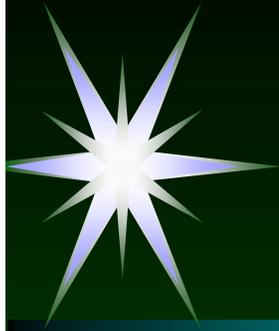




Water Quality (Mass transport dominated by sediments)

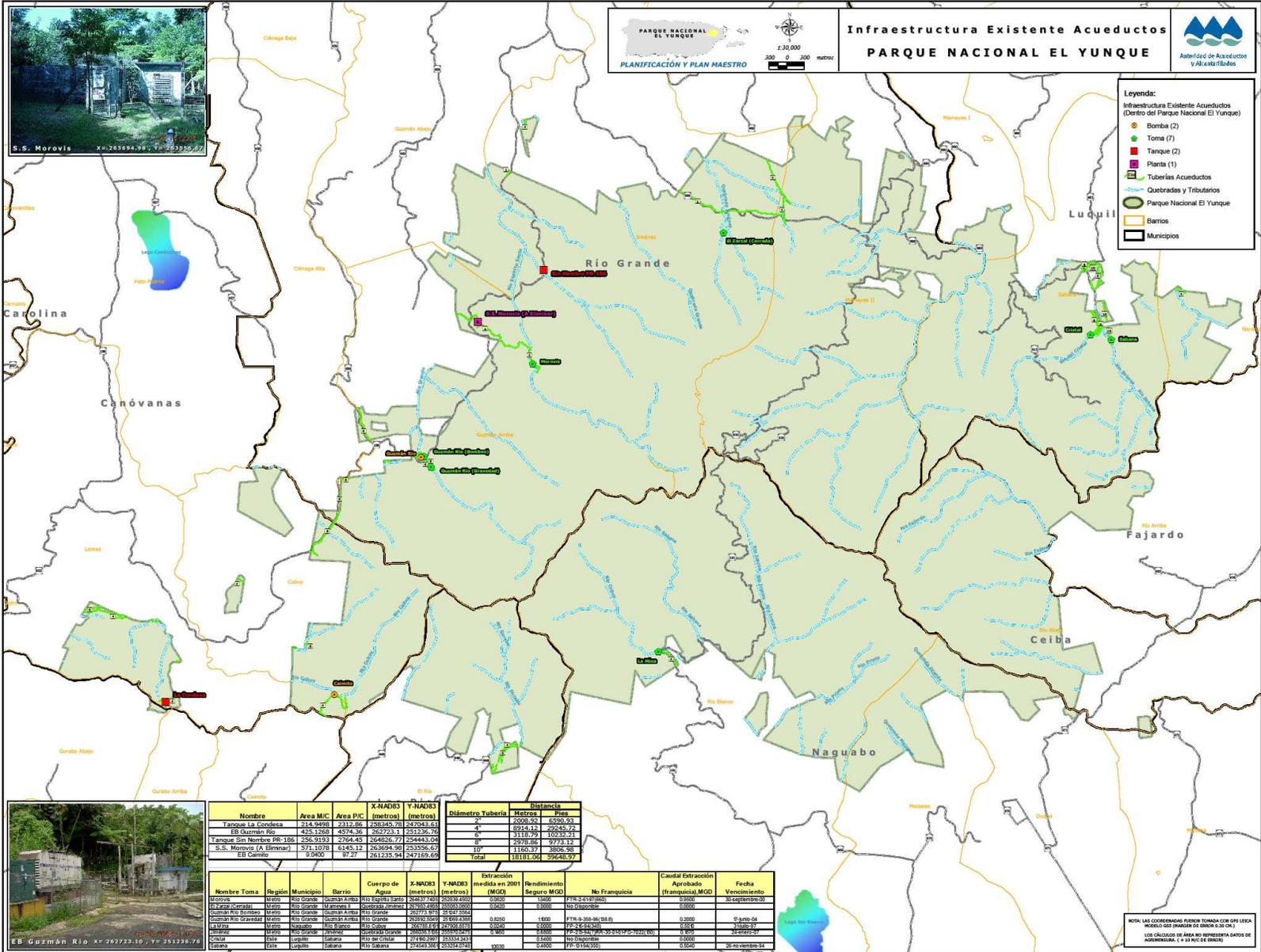
Watershed	Watershed drainage area (km ²)	Type of bedrock	Principal land use	Mean annual runoff (mm)	Mean annual fluvial sediment yield (tonnes per km ²)	Mean annual sediment concentration (kg/mm of runoff)
Mameyes	17.8	Volcaniclastic	Primary forest	2,441	227	93
Canóvanas	25.5	Volcaniclastic	Secondary forest, pasture	672	225	335
Icacos	3.3	Intrusive	Primary forest	3,193	954	299
Cayaguás	26.4	Intrusive	Pasture, secondary forest	1,111	1,163	1,047

Watershed characteristics and mean fluvial sediment yield (combined suspended and bedload sediment) for water years 1991 to 1995.



Challenges

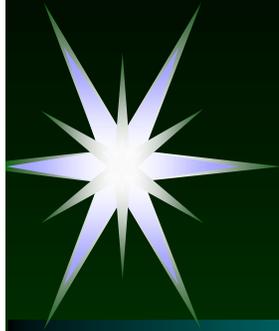
Inside the Forest



AAA Water System

Sector Arroyo





Challenges

Off - Forest

Deforested Landscapes have a 3.5 times higher sediment yield.







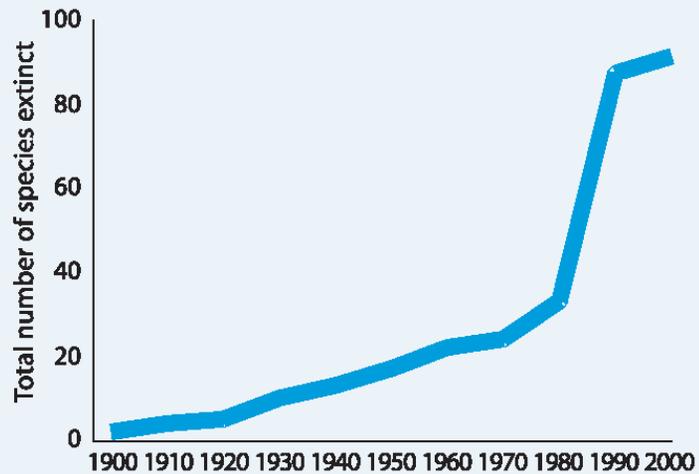
Challenges

- Erosion
- Non-point Source Pollution



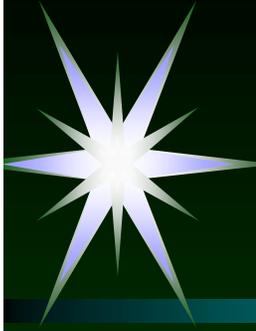
One example!

- Management Indicator Species



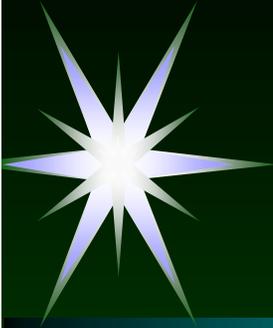
Known twentieth-century freshwater fish extinctions (cumulative)





Did we reached the objectives?

- Develop Awareness of Luquillo Mountain Range Hydrologic Function
- Use UN World Water Development Reports Data to compare global situation with El Yunque NF
- Allow you to reach conclusion if the hydrological condition is good or bad?



El Yunque National Forest

