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Yuna River Hydrologic Characterization

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Warner, A. (2005). Yuna River Hydrologic Characterization. University Park, Pennsylvania: The Nature Conservancy.

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This write-up summarizes a coarse hydrologic characterization of the Yuna River and tributaries and is to be combined with a water budget and ecological summary of the Yuna River watershed and associated Samana Bay system. These reports are being developed concurrently and will support the development of a more comprehensive site profile of the basin and bay. A description of the watershed – including its major tributaries and Samana Bay – is presented in the water budget document.

The purpose of this analysis is to provide a brief characterization of the natural patterns of river flows into Samana Bay and to assess whether or not those patterns have been substantially altered during the past four decades. This information combined with the ecological summary and the water budget will help identify relationships between river flows and important biological processes and habitat conditions, and help identify whether or not changes have occurred in ecologically important aspects of the river's flow regime and the freshwater inputs to Samana Bay.

The hydrologic characterization is presented below, following a brief description of the data used in this assessment.

Analyzed Data

This characterization considered data from six stream gage stations in the Yuna River watershed (Table 1). Three of these stations are located on the Yuna River (near Los Quemados, Villa Riva, and El Limon), with the other three stations located on the Maimon, Camu, and Payabo tributaries of the Yuna. All available data from these stations were average monthly values. While the periods of record shown in Table 1 for each station represent the starting and ending years of data, there are gaps of varying length in all of the records.

Given the primary importance to this project of freshwater inflows to Samana Bay, particular attention was given to the Villa Riva and El Limon gaging stations. These stations are both on the Yuna River, are within approximately 20 river kilometers of each other (El Limon downstream of Villa Riva), and are the lowest of all gages in the basin. El Limon is approximately 40 river kilometers up from Samana Bay. While the period of record for the Villa Riva station extends across pre- and post-dam periods (1956-1992), the data do not represent an extensive post-dam data set and are particularly spotty from 1989 through 1992. Consequently, the 25 years of data common to both Villa Riva and El Limon were compared to determine if these data sets could be combined into a single, more complete data set for the lower Yuna River (Figure 1). As can be seen from the figure, the regression line between the Villa Riva and El Limon data sets has a r^2 of 0.90 and a y-intercept of 16 cms. That is, if flow at Villa Riva equals zero, flow at El Limon would be expected to be 16 cms. Greater river discharge at the El Limon gage should be expected as it is approximately 20 river kilometers downstream and receives additional

tributary inflows (e.g., from Payaba) and likely groundwater inflow as well. The correlation of flow between the two gages is high and used as justification for combining the data sets into a single flow record extending from 1956 through 2003, referred to as the "El Limon – Enhanced" data set. This data set consists of:

1. 1956-1968: average monthly flows at Villa Riva with 16 cms added to each value to account for additional flow at El Limon; and,
2. 1969-2003: average monthly flows at El Limon.

Where these data are used in this characterization, they are referred to as "El Limon – Enhanced". Data sets from all other gage stations were not modified.

Hydrologic Characterization

The available data were analyzed in two basic ways. First, periods of record prior to the construction of Rincon and Hatillo dams (1978 and 1984, respectively; INDRI, 2001) were used to identify "natural" seasonal patterns of flow and flow variation. While there were human activities in the watershed – such as significant land cover conversion and irrigated agriculture – well prior to 1978 that may have influenced river flows, hydrologic modeling would be needed to reconstruct "natural" (unaltered by human activities) Yuna River flows. This type of modeling is beyond the scope of this project. Instead, the El Limon – Enhanced gage between 1956 and 1977 is considered relatively unimpacted and more reasonably characteristic of natural flow patterns. The more recent flow records from the gaged tributaries – which are uninfluenced by the dams – are also compared to patterns identified on the lower Yuna in the pre-dam period.

The second type of analysis presented here looks at comparisons between pre-dam (1956-1977) and post-dam (1984-2003) flows. This analysis is presented only for the El Limon – Enhanced record, as it is the only record with adequate pre- and post-dam data.

Characterization of "Natural" Flow Patterns

The general pattern of seasonal flows on the Yuna River has been noted to include a dry season that runs from December through March and a wetter period from April through November, with May-June and October-November as the most likely months for larger flows and flooding (OAS, 1969). The data from the Yuna River near El Limon (Enhanced) mostly confirm this seasonal pattern (Figure 2). There is an extended period when the Yuna River provides Samana Bay stable and low freshwater inputs, as well as two very distinct times of the year when the Yuna rises and provides large freshwater inflows to the Bay. However, the data analyzed here suggest that average flows during December are every bit as large as those experienced in October and November, and that the variability of December flows from year to year is high and very characteristic of other wet season months. Moreover, while July through September have been described as part of the wet season, flow variability from year to year during this period is low and more characteristic of dry season months.

The Camu River – the Yuna's largest tributary – exhibits the same "bimodal" seasonal pattern of wet periods as the Yuna (Figure 3), although flows during the dry January to March period are consistently higher than those experienced between July and September. Similar seasonal flow patterns are also seen further up on the Yuna (Los Quemados gage) and on the small tributary of the Maimon (Figure 4). The Payabo River – a small tributary to the Yuna draining the border between the Sanchez Ramirez, Monte Plata, and Duarte provinces – has some slight differences in its seasonal flow patterns as compared to the other tributaries (Figure 4). It has an even more pronounced December to April dry period and flows between May and November tend to remain relatively and consistently high.

Assessment of Changes in the Yuna River Flow Regime

Across a period of record for a stream gage, natural variations in climatic conditions – especially the timing and amounts of rainfall in a region – have a substantial impact on a river's flow regime. These differences can manifest as variations in the overall volume of water discharged by the river during the year, the size, time of year, and duration of floods or low flow conditions, and the frequency of these types of flow conditions within or across years. A number of human activities can change one or more of these natural characteristics of a river's flow regime, including land use conversion, construction and operation of dams, and ground water pumping or direct surface water diversions. And while humans have been present and active in the Yuna watershed for many years, two dams were built in recent decades, and the remainder of this assessment focuses on their potential to have influenced the Yuna's flow regime and consequently the freshwater inputs to Samana Bay. Summary information for these two dams (Rincon and Hatillo) is presented in Table 2 and their dates of beginning service are overlaid against the El Limon – Enhanced period of record in Figure 5.

Figure 6 compares the exceedance probability curves for the pre- and post-dam periods at the El Limon – Enhanced data. These data illustrate that the post-dam period has been generally wetter than the pre-dam period, with consistently greater average monthly flows. However, there may be some seasonal differences in how these greater flows have occurred. For example, Figure 7 compares the median, 25^{th} and 75^{th} percentiles by month for pre- and post-dam periods. Again, the plots for the two time periods exhibit similar seasonal patterns, with the largest flows observed in the months of May-June and November. However, while flows between January and March (dry season) roughly doubled over the pre-dam period, increases in flow during other months have been far less dramatic. But, while there is the possibility that the Rincon and Hatillo dams have exerted some influence on Yuna River flows and – consequently – freshwater inputs to Samana Bay, any influence of the dams are not obvious from these data and are certainly not discernable from other possible causes such as ongoing changes in land-use or irrigation, or simply differences in climate across the two periods.

References

Instituto Nacional De Recursos Hidrailicos (INDRI). Departmento De Planificacion, Programa Cultura Del Educativas. Material Basico Para Ponencias (Doc. PCA-05-01.1). Octubre 2001.

Organization of American States, Natural Resources Unit of the Department of Economic Affairs. *Survey of the Natural Resources of the Domincan Republic: Study on the Development and Planning of Natural Resources.* Washington, DC 1969.

Tables

Station Name (number)	Quad Name	Period of Record
Yuna, near Los Quemados (180001)	Bonao	1962-1979
Yuna, near Villa Riva (180003)	Villa Riva	1956-1992
Yuna, near El Limon (180004)	Cevicos	1969-2003
Maimon River (184001)	Bonao	1968-2000
Camu River (185003)	Cotui	1968-2003
Payabo River (187002)	Cevicos	1971-1995

Table 1: Gaging stations in the Yuna River watershed.

River	Dam Name	Began Service	Height (meters)	Reservoir Elevation (m.s.n.m.)	Dam Type	Reservoir Capacity (MMC)	Installed Power (MW)	Generation (GW-h/a)	Catchment Area (km2)	Irrigated Area (ha)
Yuna	Hatillo	1984	50	86.5	Tierra (earth)	375.3	8	50	1167	22,000
Jima	Rincon	1978	54	122	Gravedad (?)	60.1	10.1	30	159	7,565

Table 2: Summary information on dams in the Yuna River watershed (INDRI, 2001)

Figures

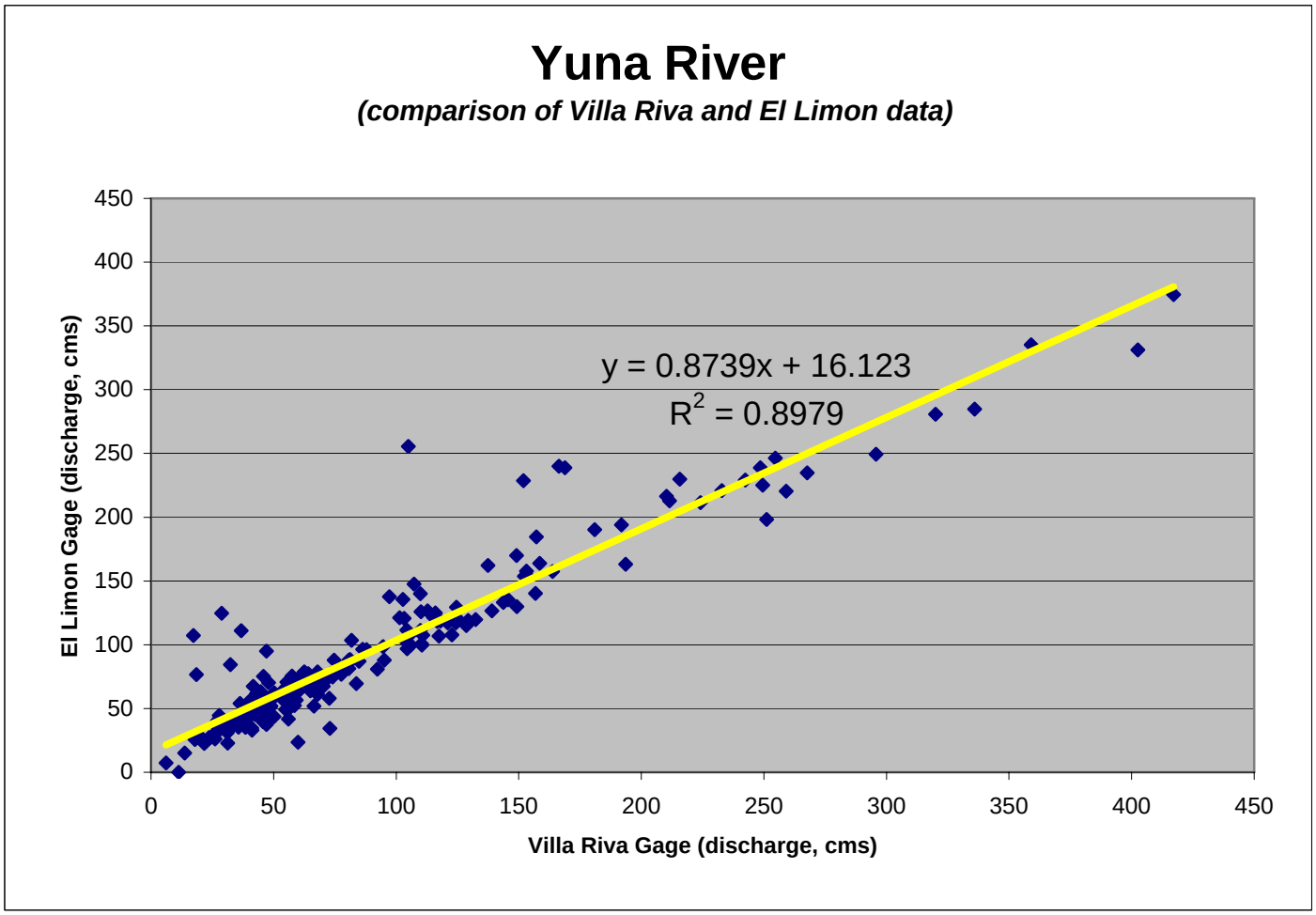


Figure 1 : Comparison of Villa Riva and El Limon gage data (1968-1992).

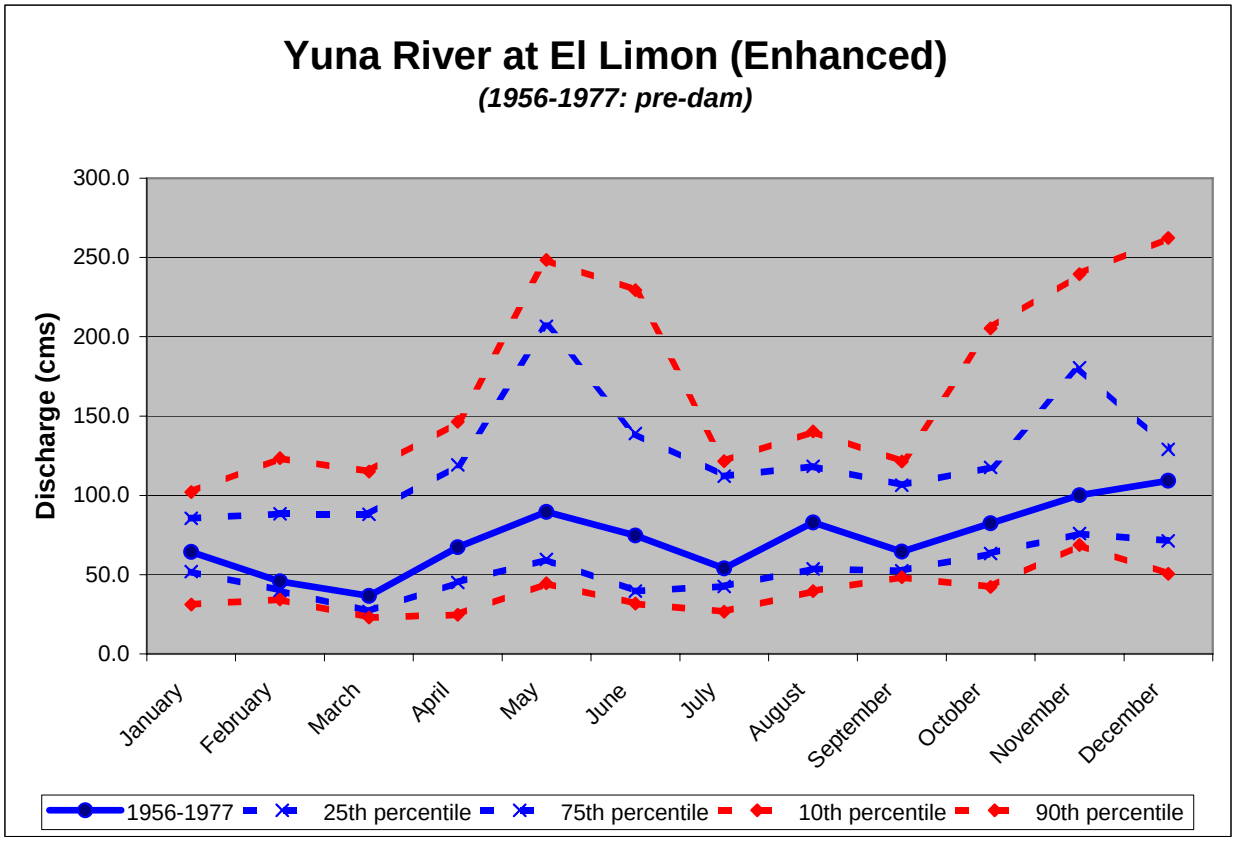


Figure 2: Yuna River, El Limon (Enhanced) gage, 1956-1977 pre-dam record.

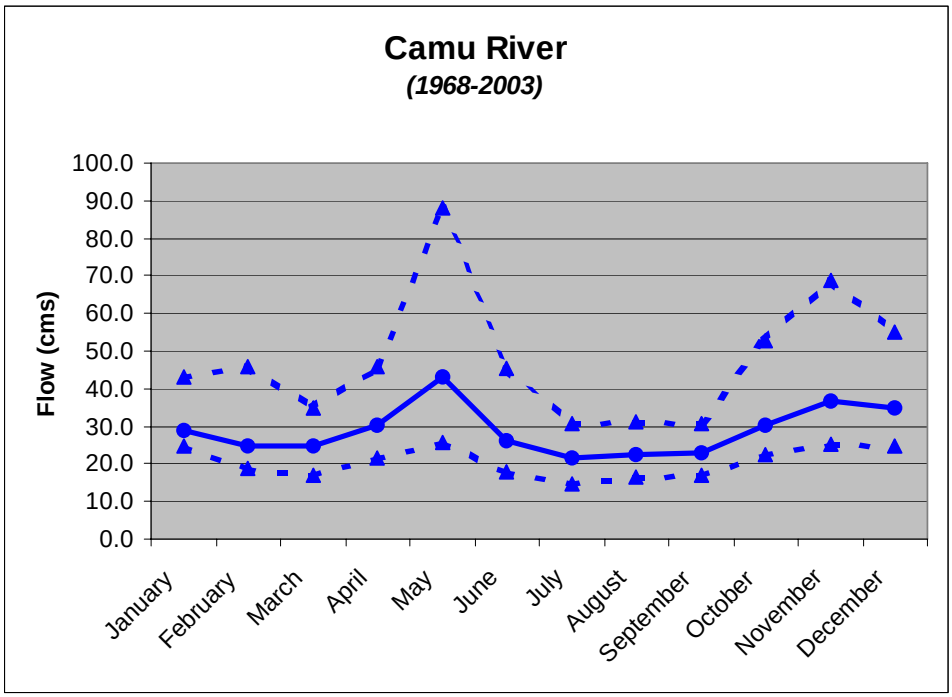
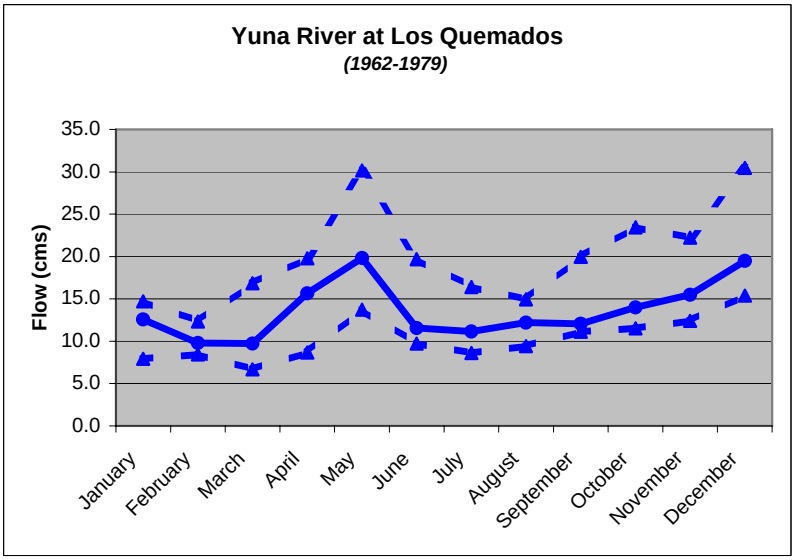
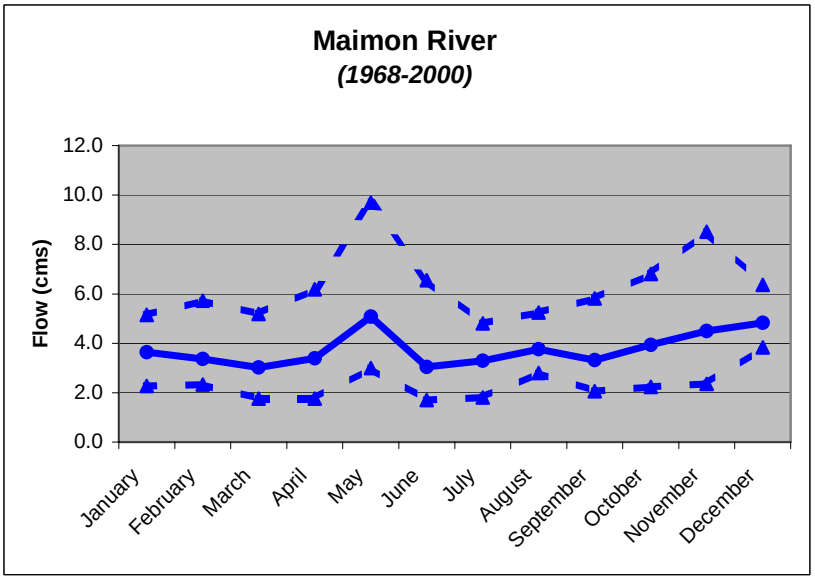


Figure 3: Camu River, Median monthly, 25th and 75th percentile flows





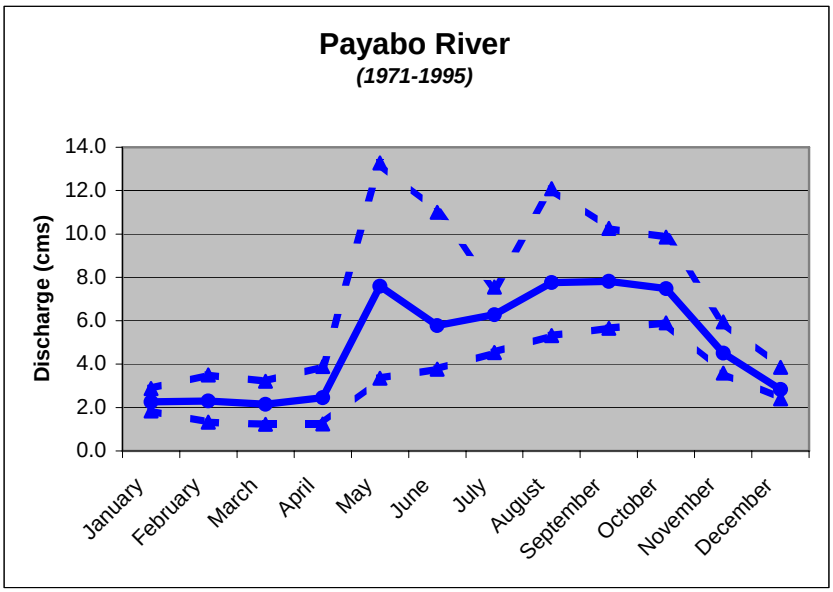


Figure 4: Yuna at Los Quemados, Maimon River, and Payabo River gage data.

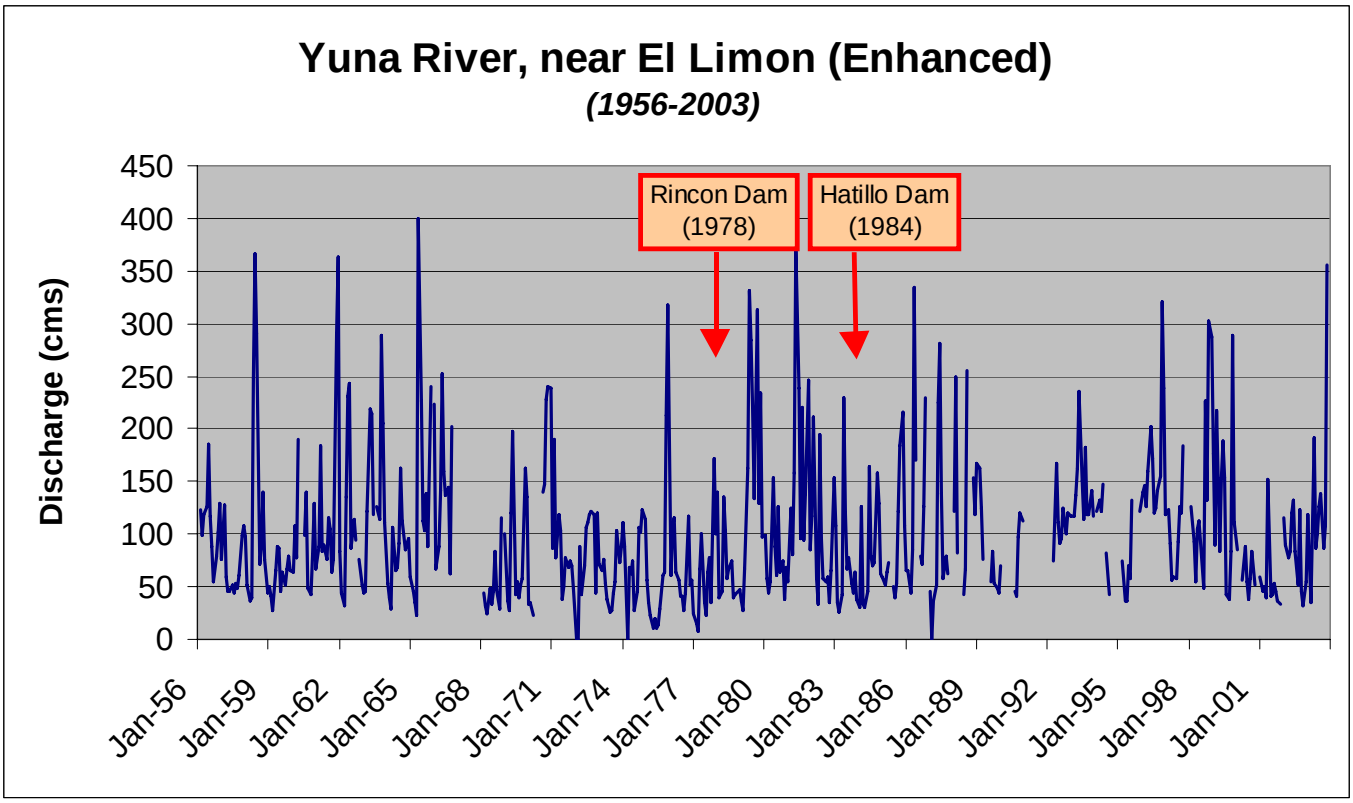


Figure 5: Yuna River, El Limon (Enhanced) period of record 1956 - 2003.

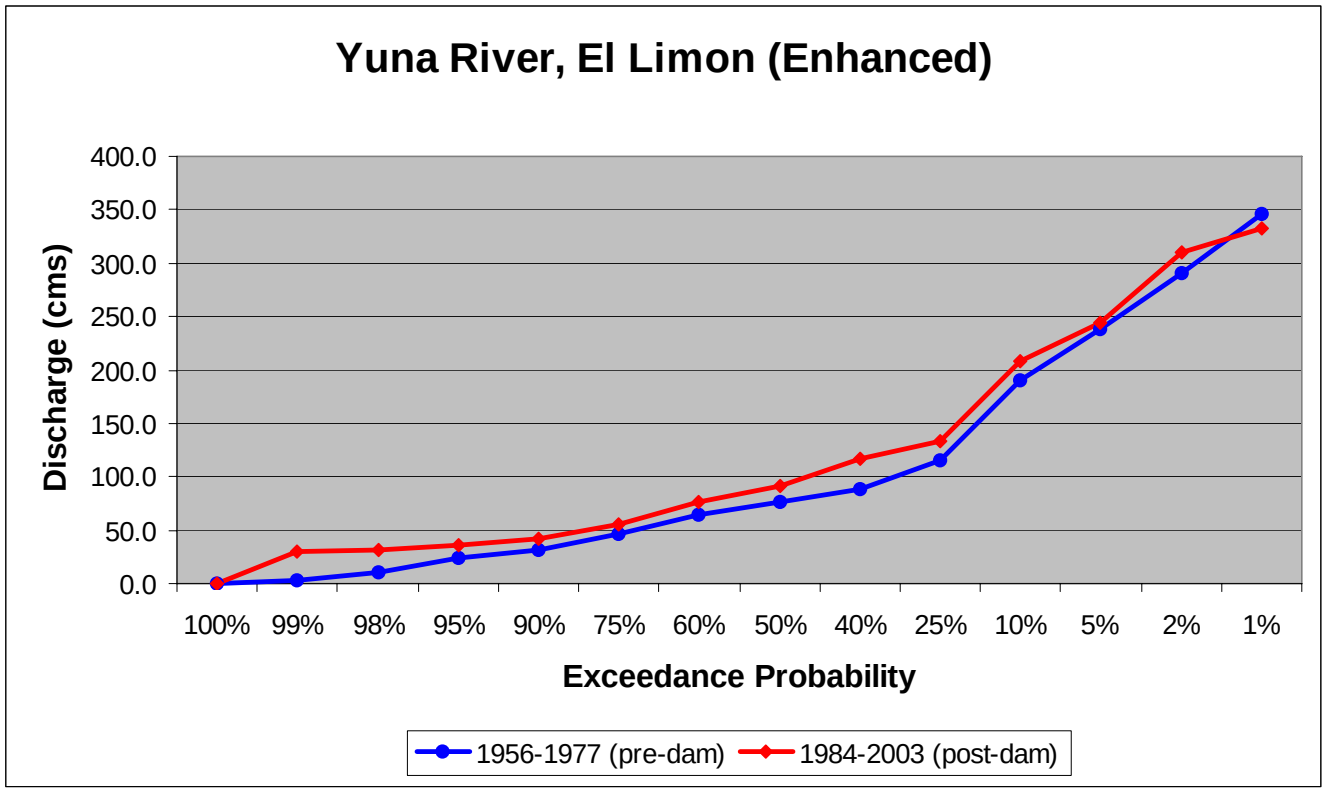


Figure 6: Eceedance probabilty curves for Yuna River (Enhanced) pre- and post-dam data periods (1956-1977 and 1984-20003).

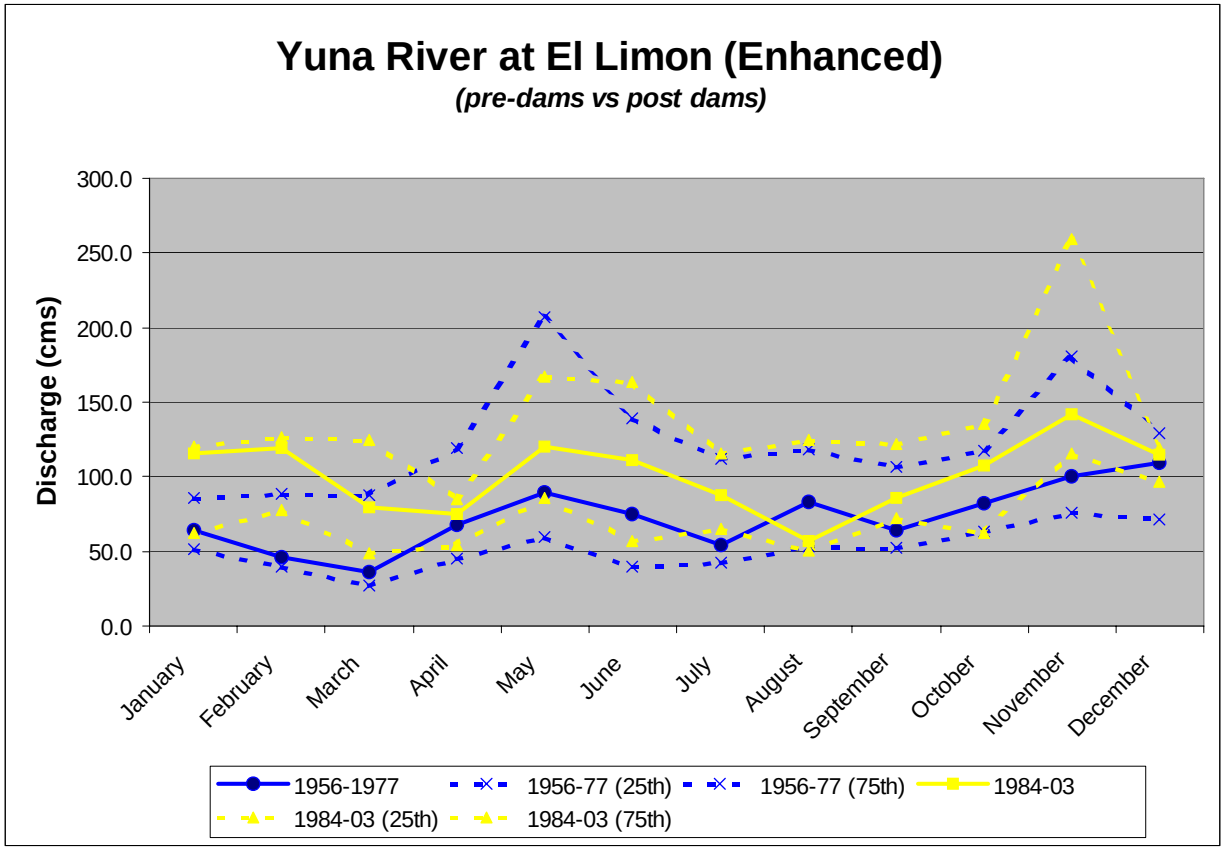


Figure 7: Yuna River, El Limon (Enhanced) median, 25th and 75th percentiles for pre- and post-dam periods.