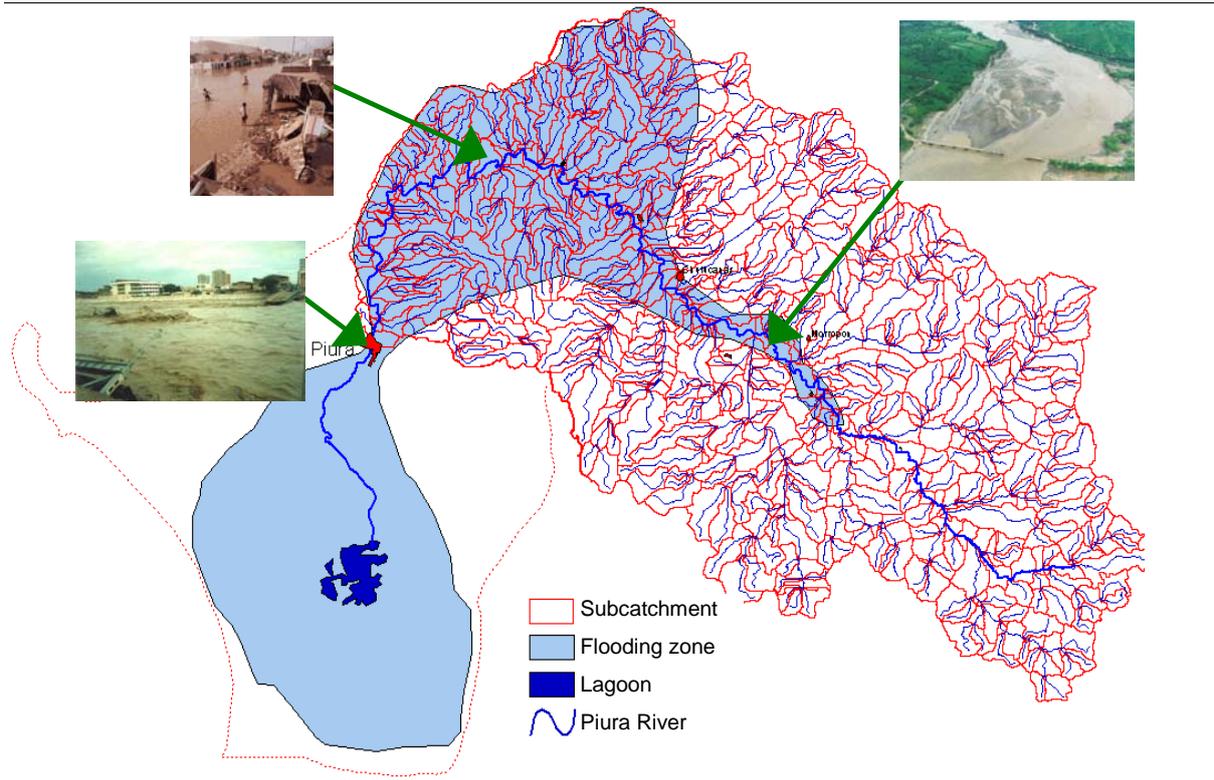




## PERU

# REGULATING STRUCTURES FLOOD PROTECTION BAJO PIURA



<b>Client</b>	Dirección Ejecutiva del Proyecto Especial Chira-Piura (DEPECHP)	<b>Scope of Services</b>
<b>Financing</b>	Worldbank	<ul style="list-style-type: none"> <li>• Morphological, hydraulic and geomechanic investigations</li> <li>• Setup of hydrologic database and GIS</li> <li>• Flood focussed hydrologic investigations</li> <li>• Design of telemetric system for observation of hydrometric parameters</li> <li>• Setup, implementation and training of hydrologic flood warning model</li> <li>• Identification of priority investments for structural/hydraulic measures</li> <li>• Final design of dykes and emergency spillway and river diversion weir</li> <li>• Preparation of tender documents</li> </ul>
<b>Duration of Services</b>	2000 - 2001	
<b>Cost of Implementation</b>	35 Mio. EUR	

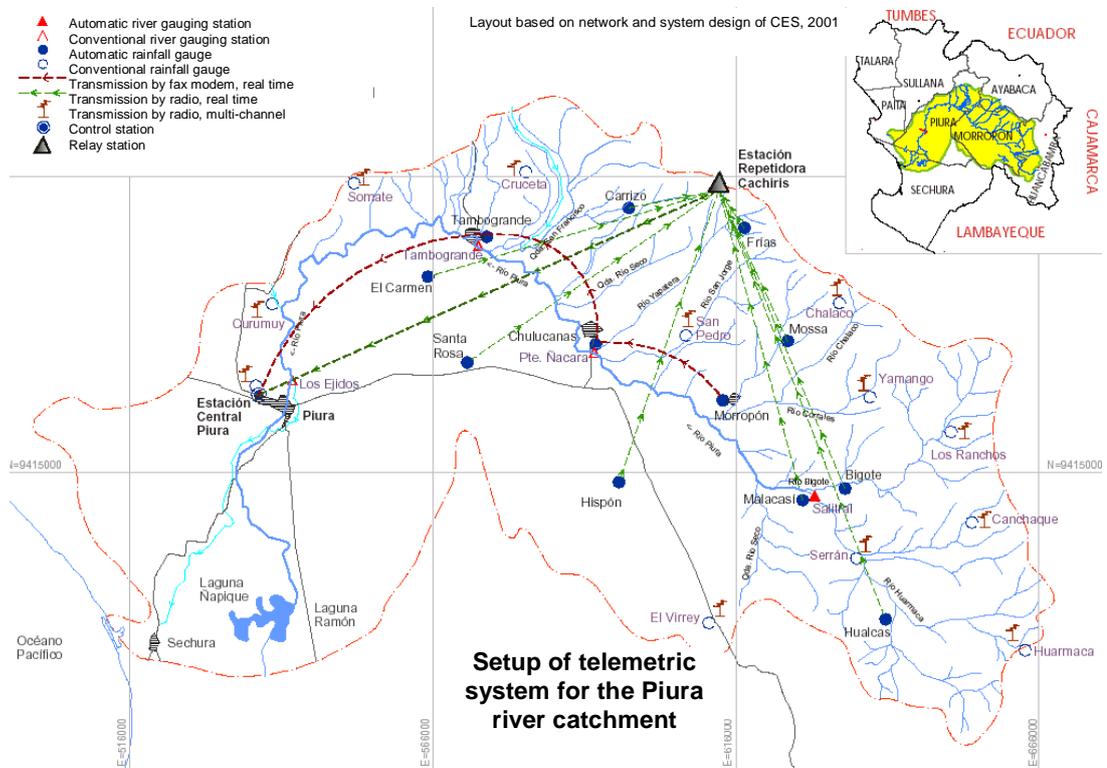
## Project Background

In the past the Piura River of northern Peru branched off and formed a network of interconnected flow channels when entering the lowlands. From the 1950s onwards the increasing need for agricultural lands led to the construction of small river training works to establish the actual river course. In 1972 first cracks were observed in the newly built dykes, in 1979 these were rehabilitated and extended to a total length of 38 km along the right bank and 25 km on the left bank. For completion a further dyke was re-established at the Ramón lagoon between 1981 and 1986.

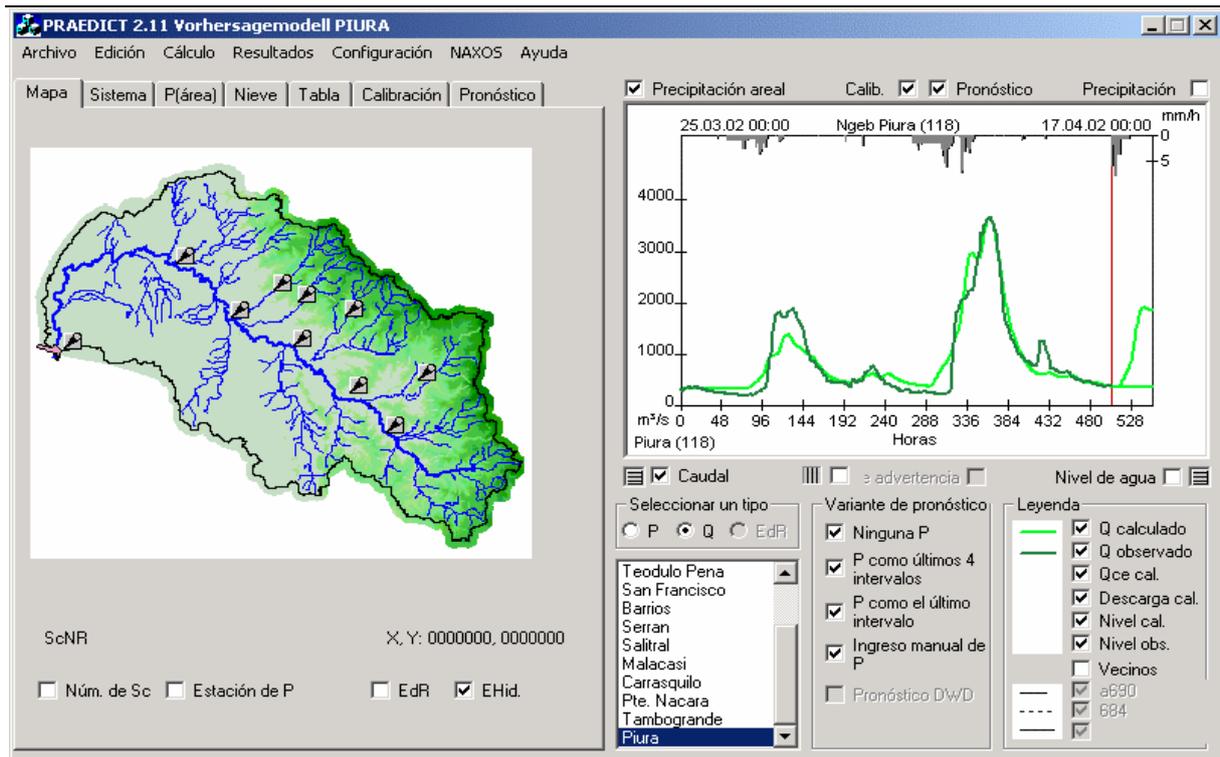
In 1983, when the diversion weir Los Ejidos was nearly finished, a devastating El Niño flood event occurred which resulted in the destruction of 15 km of dykes and of the Los Ejidos diversion weir. Riverbanks widened to later affect settlement areas and urban development of Piura. In May 1983 one dyke finally collapsed allowing the river to follow its former course. After repair works a second El Niño event of previous magnitude destroyed in 1998 dykes on the left bank and two bridges in the City of Piura. This latest event raised the demand to re-evaluate and re-design structural and instrumental/organisational flood protection measures within the framework of this Project.

## Flood Protection Measures

For the identification of sustainable flood alleviation measures the Project provided basic studies (hydrology, topography, photogrammetric and bathymetric surveys, geotechnical investigations, EIA and hydraulic evaluations) which led to the re-design of strengthened and partially raised dykes, now also providing a 1 400m<sup>3</sup>/s emergency spillway. Additionally hydraulic and stability evaluations were carried out for the 4 km upstream of Piura located Los Ejidos barrage. As an irrigation off take it is equipped with three radial gates of 60 m<sup>3</sup>/s total diversion capacity, a sand trap with 2 radial gates, and a gated spillway with seven openings with radial gates of 120 m length.



Proposed layout of telemetric network for the Piura catchment



Screenshot from the PRAEDICT version of NAXOS-Model for hydrologic flood forecast

## Flood Warning System

The latest El Niño events suggested significantly increased flood volumes evoked by higher peak flows and increased flood durations. Statistically the following floods can now be expected for given return periods as follows:

10 years	1 790 m <sup>3</sup> /s
25 years	2 500 m <sup>3</sup> /s
50 years	3 100 m <sup>3</sup> /s
100 years	3 750 m <sup>3</sup> /s

With the perception of the disastrous consequences of the recent floods the need for a flood information and warning tool became apparent. For that reason the detailed hydrological rainfall runoff model NAXOS has been developed and successfully implemented for the relevant catchment area of approx. 7 000 km<sup>2</sup>.

NAXOS is an instrument that allows the trained professional staff to analyse historic floods. This model also simulates design flows and it can be used for flood forecasts in the framework of an organised flood warning system. The detailed model was finally scaled to simulate the rainfall-runoff and flood routing processes from about 700 subcatchments with 1-minute to hourly timesteps. For detailed catchment characteristics NAXOS makes use of specific information (e.g. land use, soils, infiltration rates, and other physiographic properties, topography, river network and its morphology or digital elevation model / DEM) which are generated, stored and administered by a respective Geographic Information System (GIS). During the course of the Project the model was used to elaborate design flows for selected subcatchments. However, later floods, e.g. those of 2003 coincided fairly well with forecasted river stages.

Successful real time flood warning and catchment monitoring crucially depends on readily available and reliable hydrometric information from all parts of the watershed. However, the revision of the existing hydrometric observation system revealed the necessity for an extension and modernisation of the network to enable sound flood forecasts in the future. A respective technical proposal has been worked out for a telemetric system of rainfall and river flow stations with a control centre in the City of Piura. Here data from radio and modem connected automatic rainfall and flow recorder stations are collected, processed and integrated for the flood warning system.

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## Main Project Data

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- Objectives	Flood protection Flood warning			- New groin	right bank left bank	40 30
- Type of protection dykes	gravity earth dyke			- Slope protection	right dyke left dyke	610 m 1100 m
- Length of dykes	total length rehabilitated	total length heightened		- Telemetric system	radio / fax modem connecting automatic rainfall and river flow recorders to control station	
	right dyke. left dyke. max. heightening	38 km 25 km	25 km 12 km 2 m	- Hydrologic model	NAXOS, detailed rainfall-runoff model for flood simulation from 7 000 km <sup>2</sup> watershed and 700 subcatchments	
- Emergency spillway	Capacity Length	1400 m <sup>3</sup> /s 980 m				



Example of rehabilitated flood protection dyke upstream of PIURA