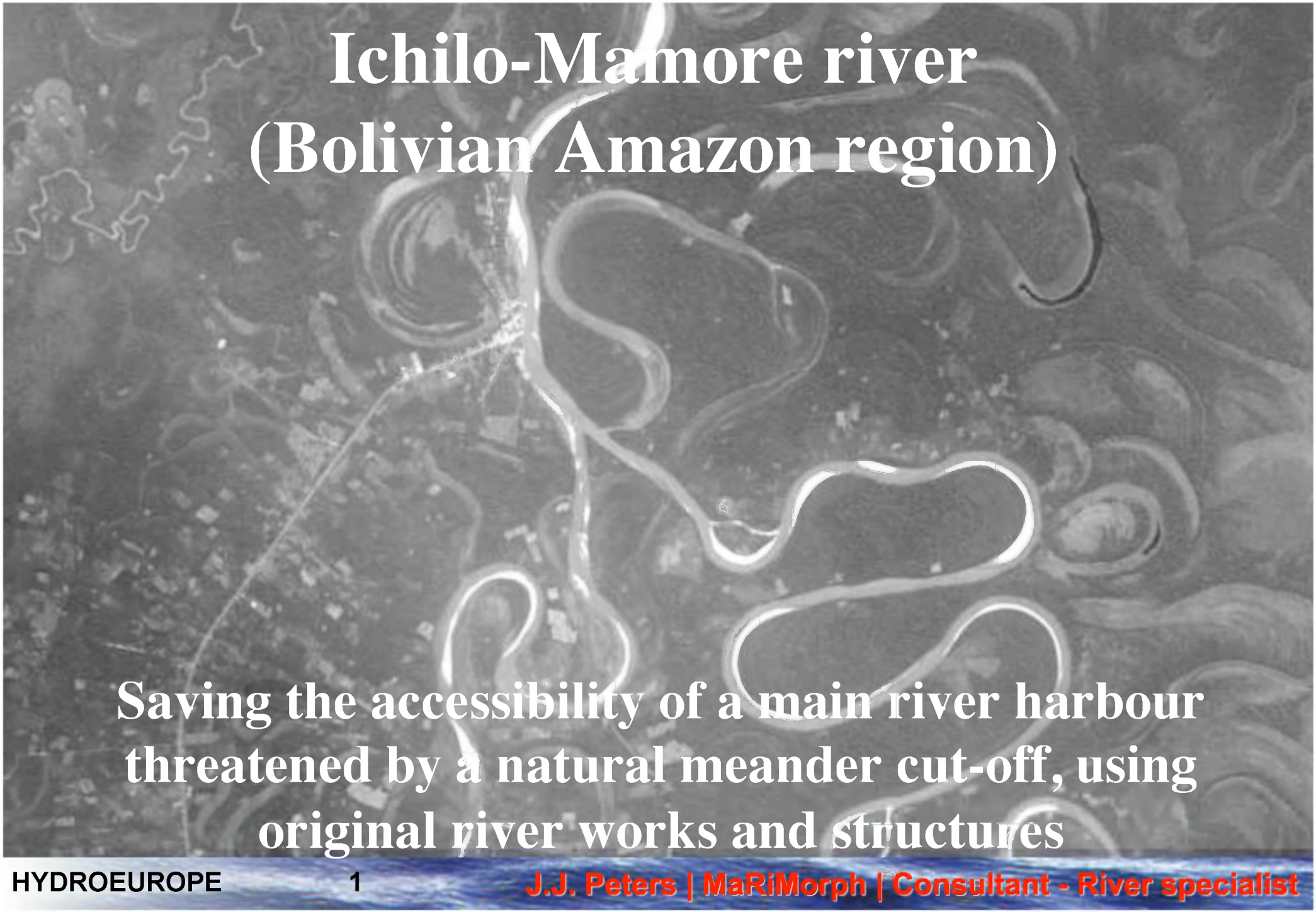
Ichilo-Mamore river (Bolivian Amazon region)



Saving the accessibility of a main river harbour threatened by a natural meander cut-off, using original river works and structures

J.J. Peters | MaRiMorph | Consultant - River specialist

SITUATION OF THE PROJECT

- Rivers are the best transport ways in the Bolivian Amazon region
- The main connection between the highlands and the border with Brazil is the Ichilo-Mamore river system between Puerto Villarroel (sometimes called Puerto Beni), about 1400 Km long
- The river has very low slopes (about 2 cm per Kilometre) and goods are transported with vessels having very shallow draft


Guayaramerin, Bolivia
1428 Km waterway
Puerto Beni, Bolivia
La Paz
Santa Cruz
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La Paz
Bolivia
Puerto Beni, Bolivia
Santa Cruz
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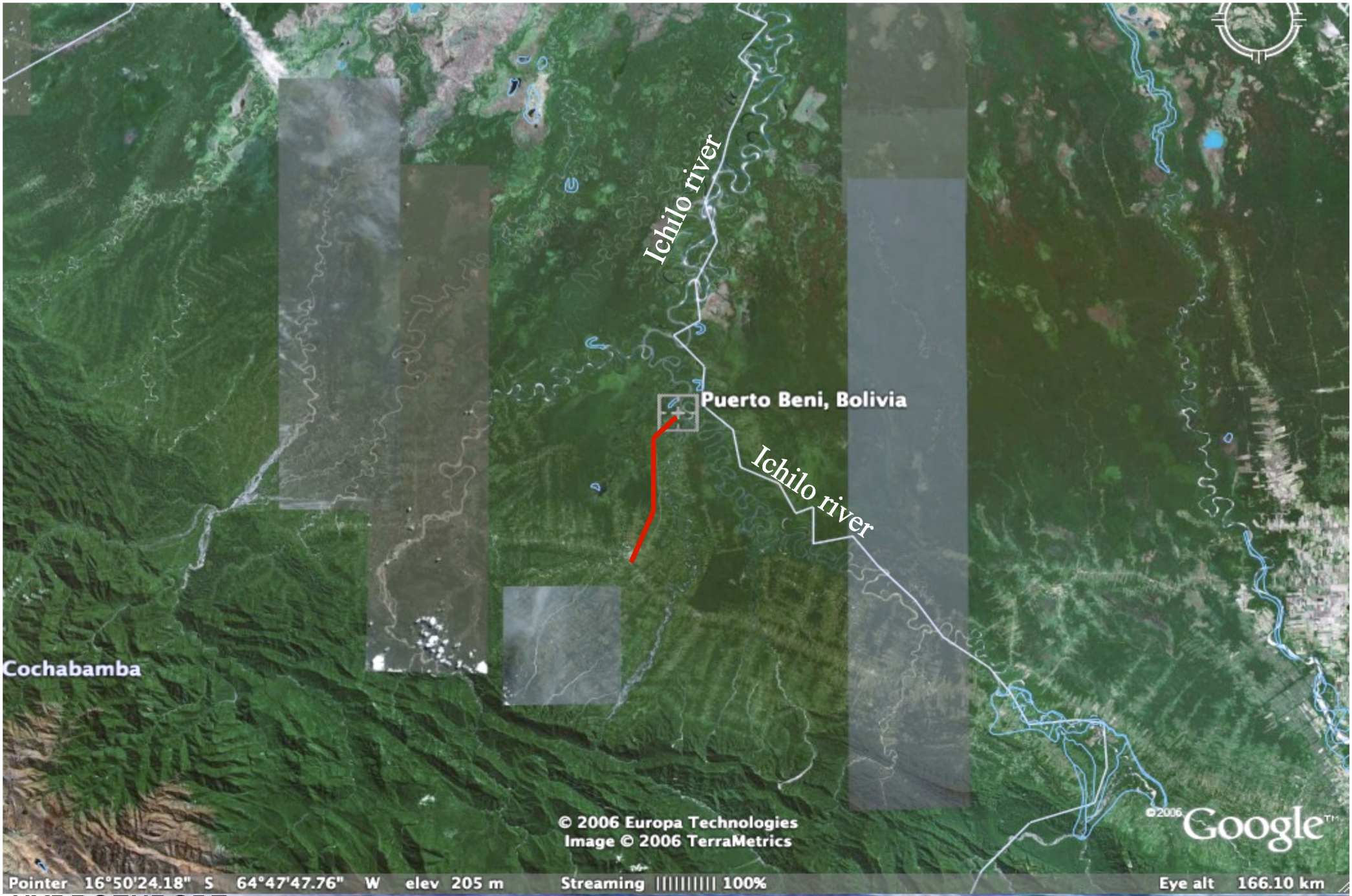
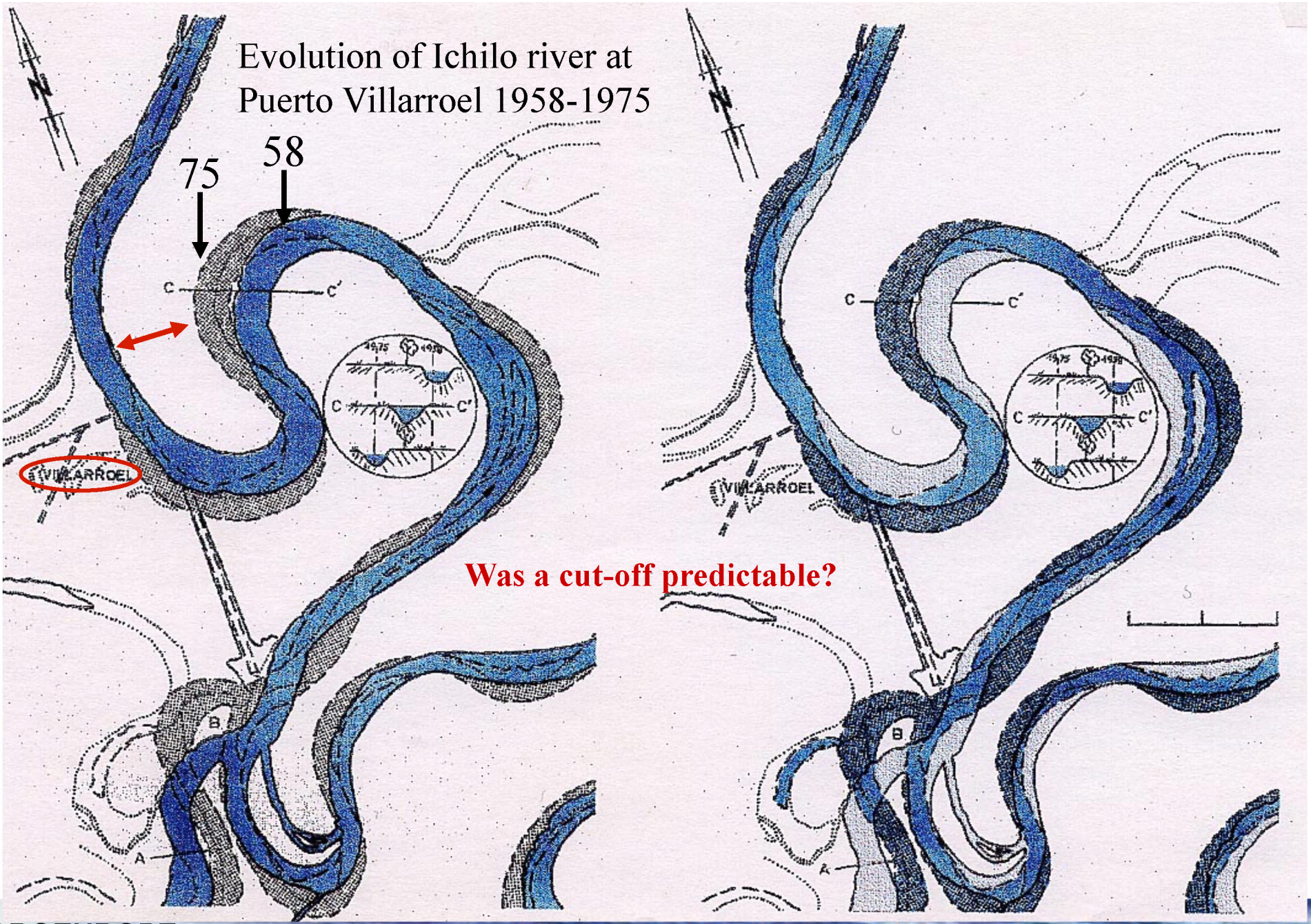
©2006 Google™
Pointer 16°50'24.18" S 64°47'47.76" W
Streaming 100%
Eye alt 1165.51 km


Ichilo river
Puerto Beni, Bolivia
Ichilo river
Cochabamba
© 2006 Europa Technologies
Image © 2006 TerraMetrics
©2006 Google™
Pointer 16°50'24.18" S 64°47'47.76" W elev 205 m
Streaming 100%
Eye alt 166.10 km

Puerto Villarroel

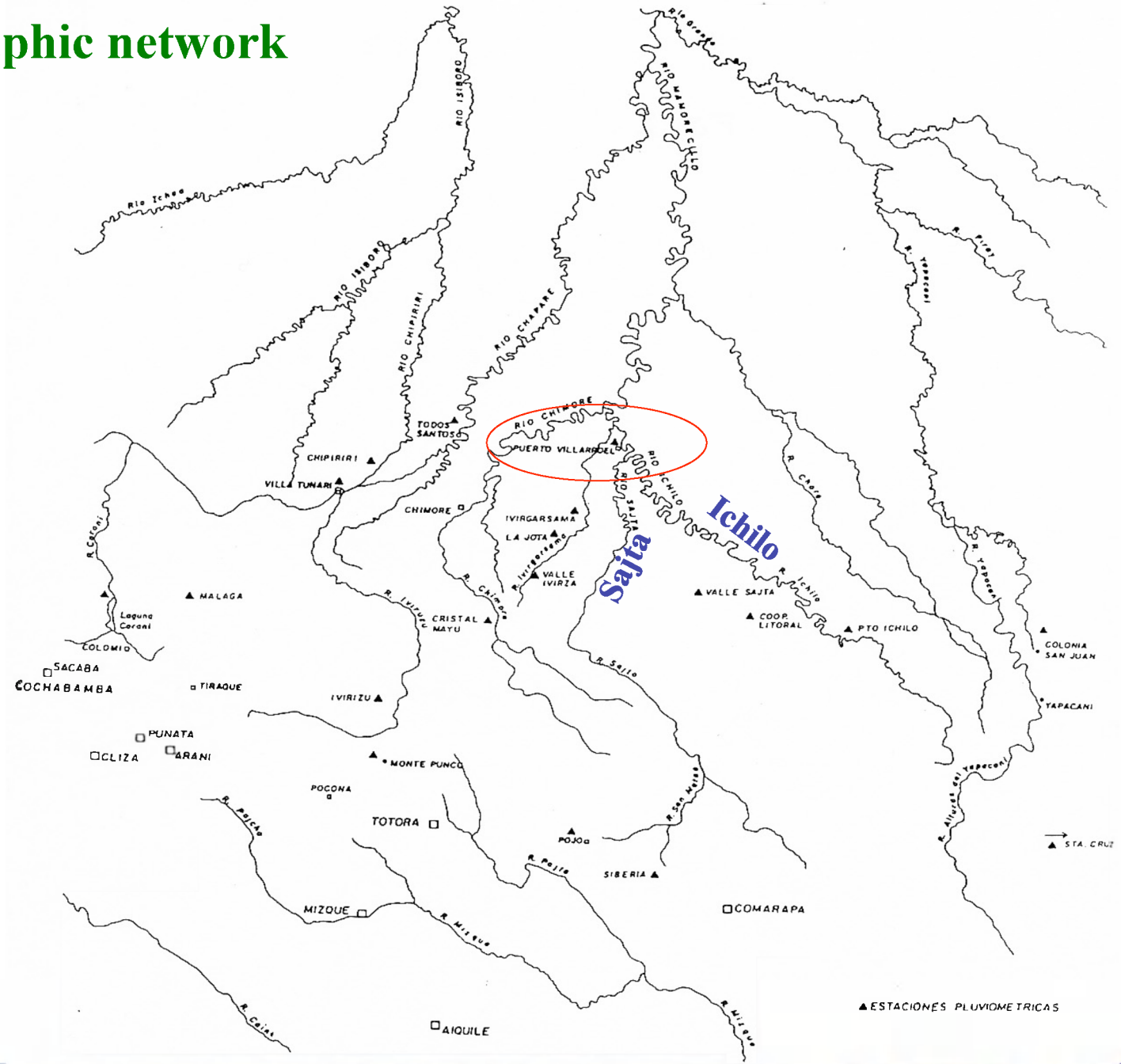
- The harbour remained for long on a stable bank of the Ichilo river, stable because of the geology
- The Belgian Cooperation decided to build a modern port, in concrete, with a crane and other facilities
- The port was designed by engineers from the Belgian Ministry of Public Works, who did not give attention to the risk of cut-off that had been identified by an expert of the same ministry …


Evolution of Ichilo river at
Puerto Villarroel 1958-1975
75
58
C
C'
VILLARROEL
Was a cut-off predictable?

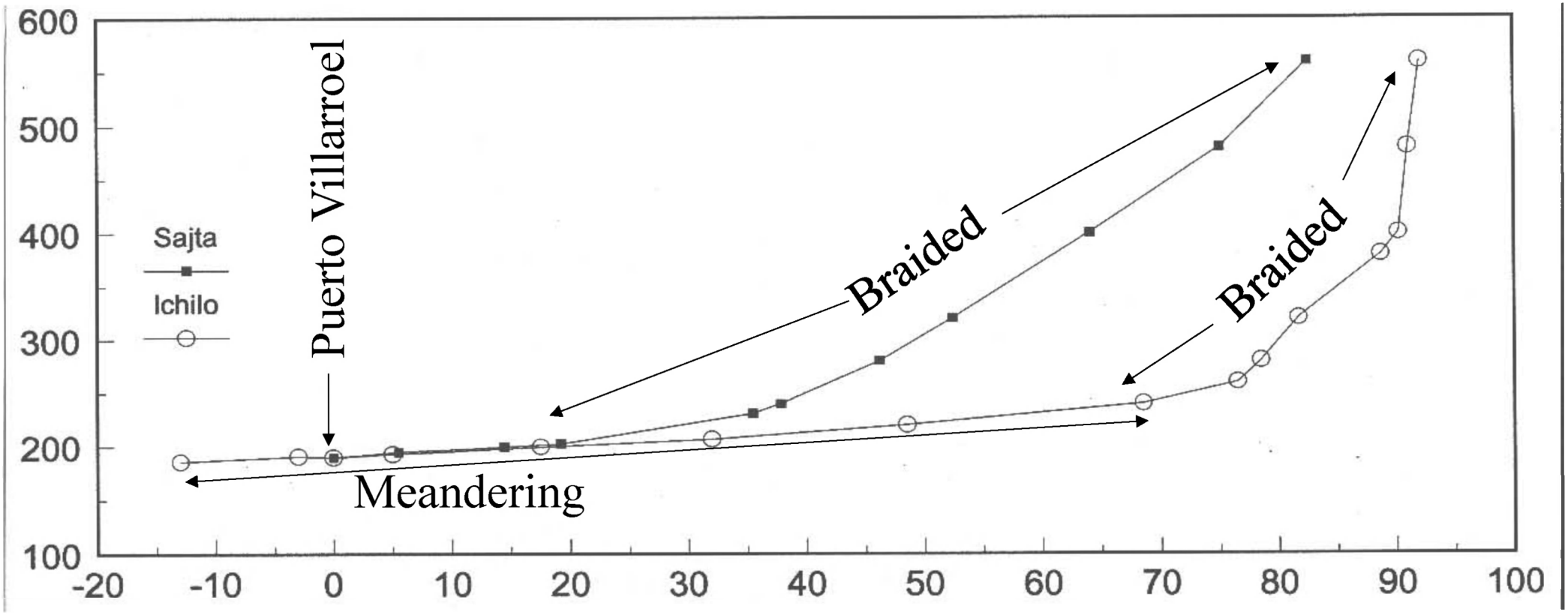
The rivers

- Puerto Villarroel lies at the confluence of the Ichilo and Sajta rivers, at the foot of the Andes
- The Ichilo river enters the Amazonian plain well before reaching Puerto Villarroel, and develops a meandering course with nice and large loops, carrying relatively fine sediments, sand, silt and clay
- The Sajta river enters the Amazonian plain close to Puerto Villarroel, bringing relatively coarser sediments, gravel and sand

Hydrographic network in Bolivia



Longitudinal profile of Ichilo and Sajta rivers



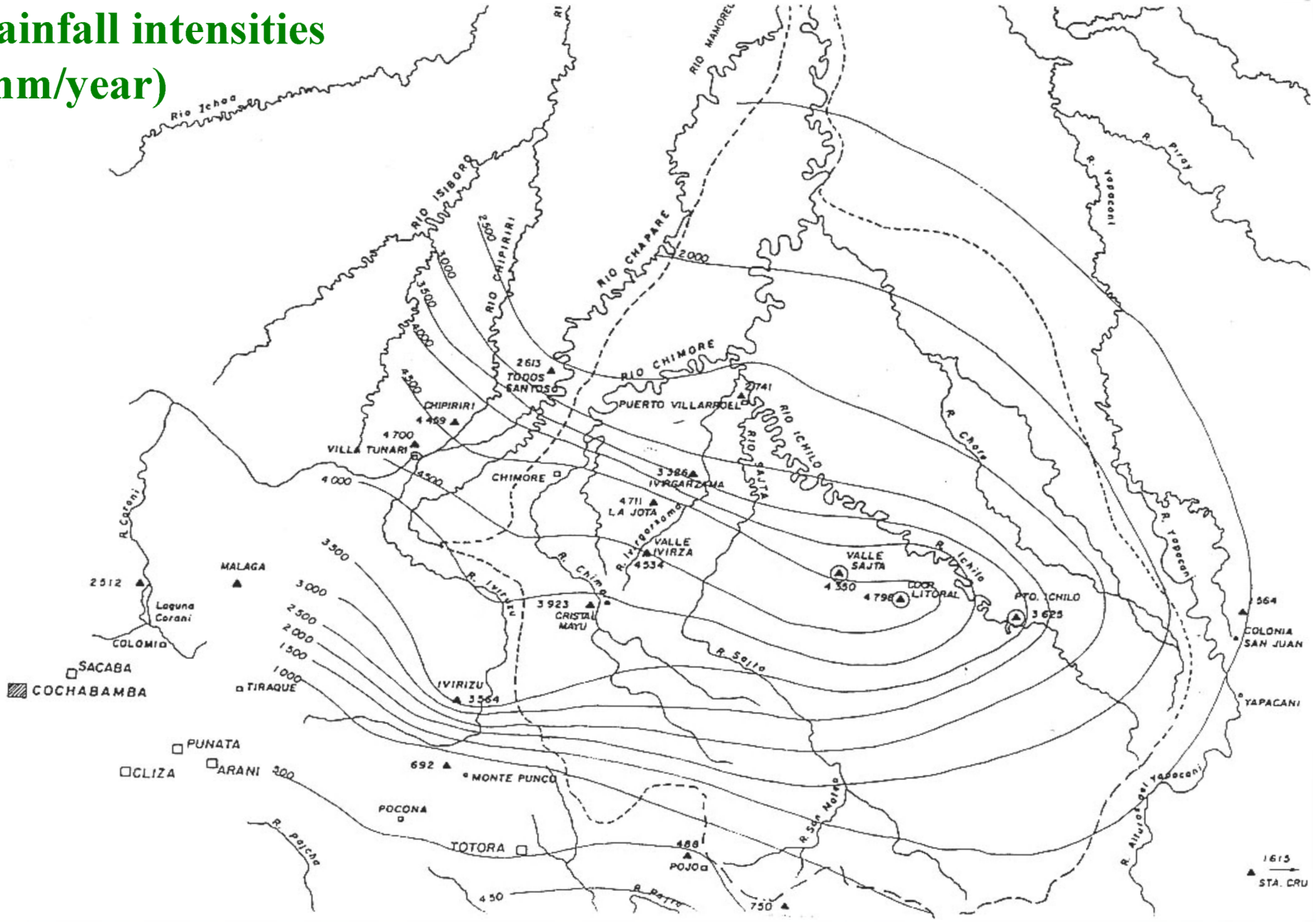
The meander loops of Ichilo river before reaching Puerto Villarroel

Braided river, an unstable affluent to Ichilo river, coarse sediments

The river's regimen

- Rain intensities in the Chapare region are very high Ichilo, up to more than 5000 mm/year
- Flash floods occur in the steep reaches, but are becoming milder when slopes reduce
- Therefore, at Puerto Villarroel, floods in the Ichilo river are rather slow as compared to those of the Sajta
- Channel migration are much slower in the Ichilo as compared to those in the Sajta

Rainfall intensities (mm/year)



Traces of abandoned channels in Ichilo and Sajta

The consultancy

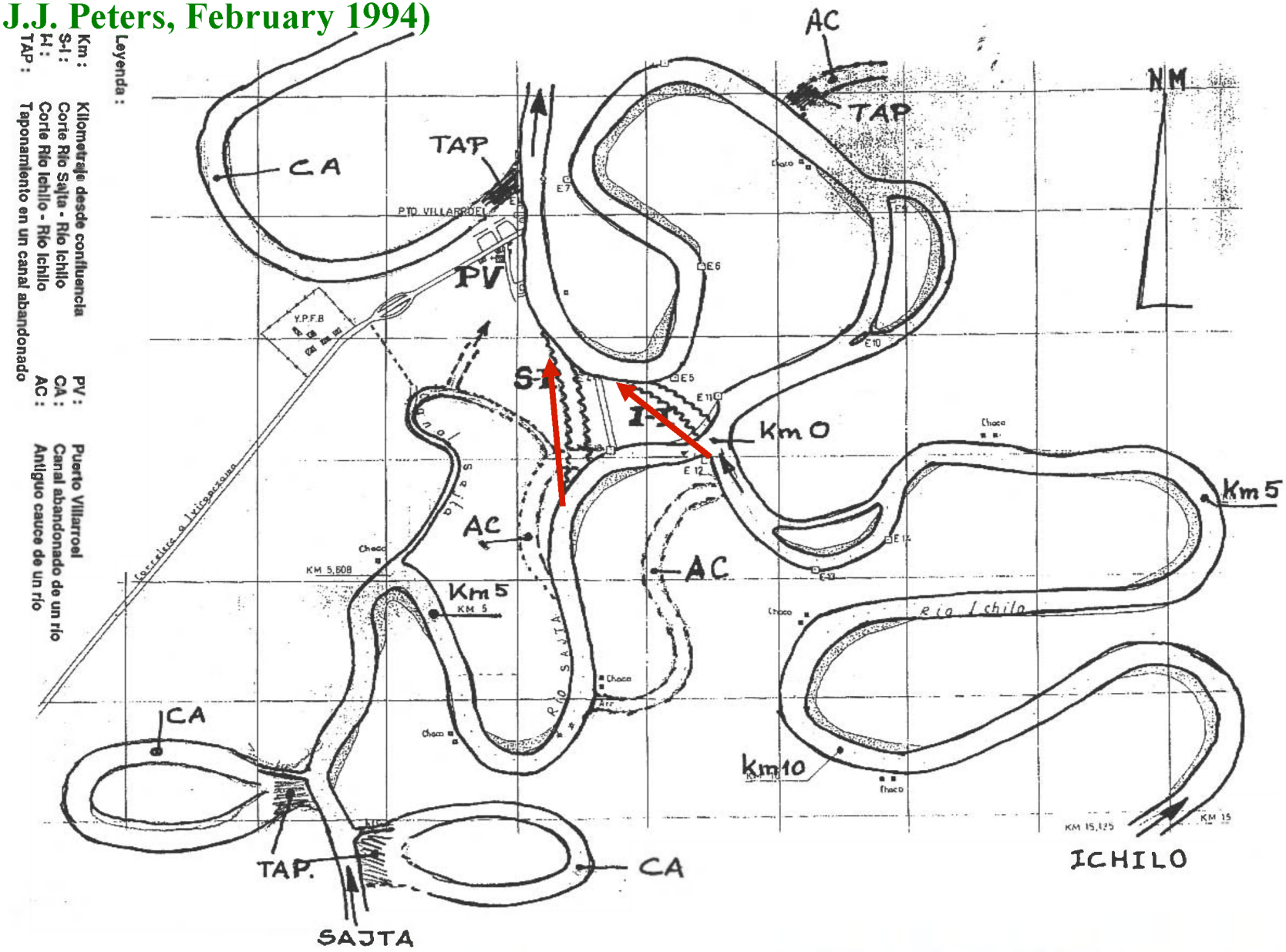
- In 1994, the Belgian Cooperation had agreed on the construction of the new harbour facilities, but the risk for cut-off had been identified that would leave the port isolated in an oxbow lake (dead branch)
- A tender was issued by the Bolivian Government for designing works to save the Port and the contract awarded
- A first mission was organised in February 1994 to make a diagnosis of the situation and propose urgent measures

In 1994 a strip of land less then 140 m was left and a natural cut-off seemed unavoidable

The diagnoses

- The importance of geology was identified, especially the resistance to bank erosion where silt and clay had recently be deposited in abandoned river branches (entrances of the oxbow lakes)
- Building bank protection was not considered as an option and a project with 2 cut-off's was designed to have a smooth confluence of the Sajta and Ichilo rivers, so that they would flow along the new port with mild bend (radius as small as possible, to avoid spiral flow and associated bank erosion)

Morphologic analyses of Ichilo-Sajta confluence and projects for artificial cut-off's S-I & I-I (Proposal J.J. Peters, February 1994)



(Works proposed in February 1994)

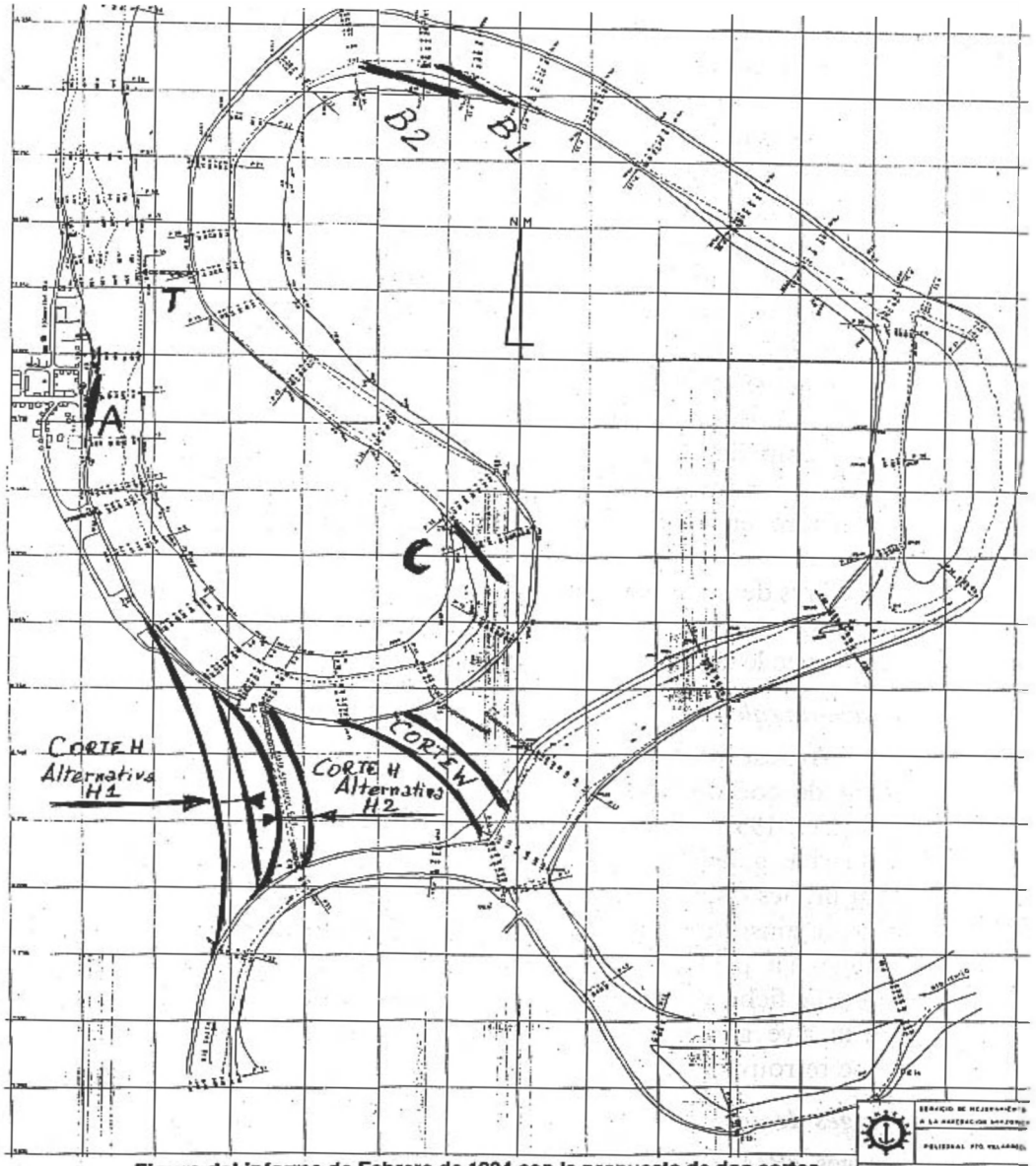


Figura del informe de Febrero de 1994 con la propuesta de dos cortes
(los cortes "H" y "W" se llaman "S-I" e "I-I" en la versión definitiva)

- As the design, tendering and contract awarding for and execution of the cut-off's would take time, it was proposed to build structures to halt the erosion at the expected natural cut-off 'T'
- Two special structures 'B1' and 'B2' were designed upstream of T to deflect the flow and reduce the bend radius there, so that bank erosion would diminish
- Another similar structure 'C' was conceived so that the radius of the flow arriving at the Port would diminish
- A retard structure 'A' was designed to reduce bank erosion at the port

Structures B1, B2 & C after construction (sedimentation and deflection of flow visible)

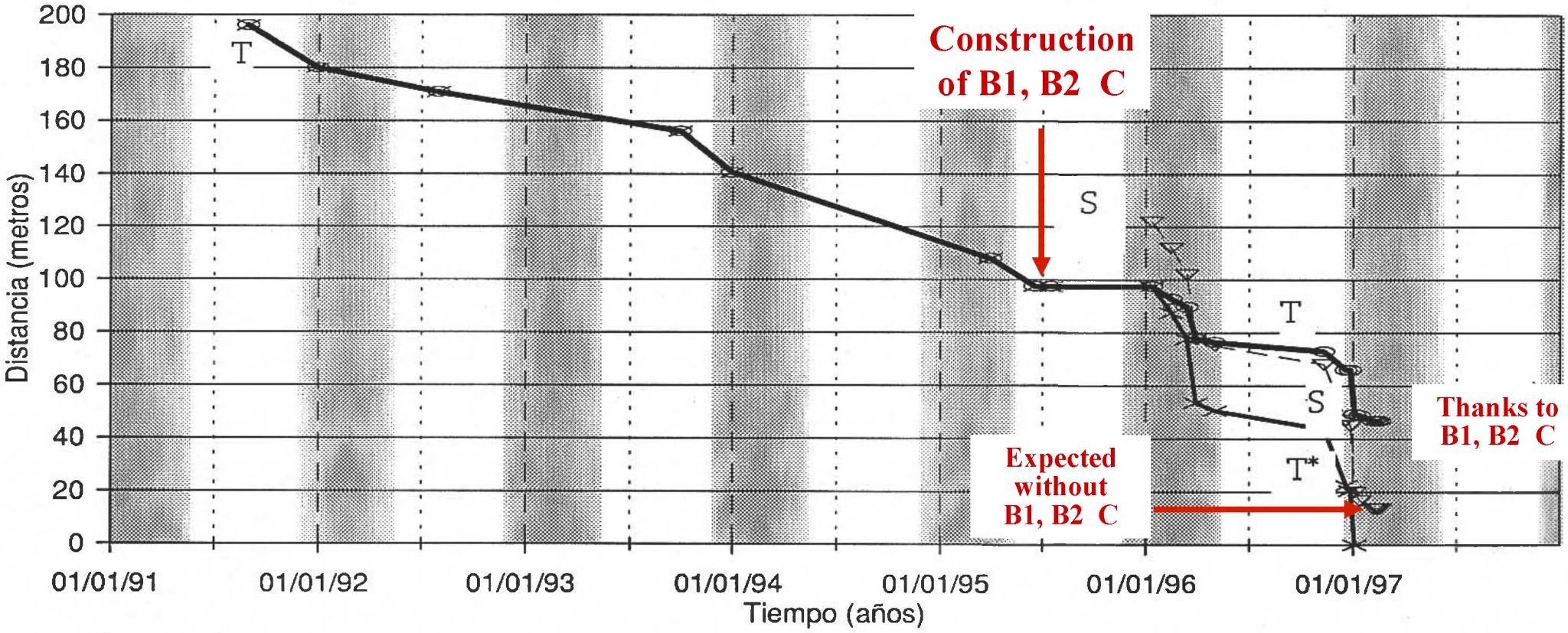
Structures B1 and B2


16 10:52

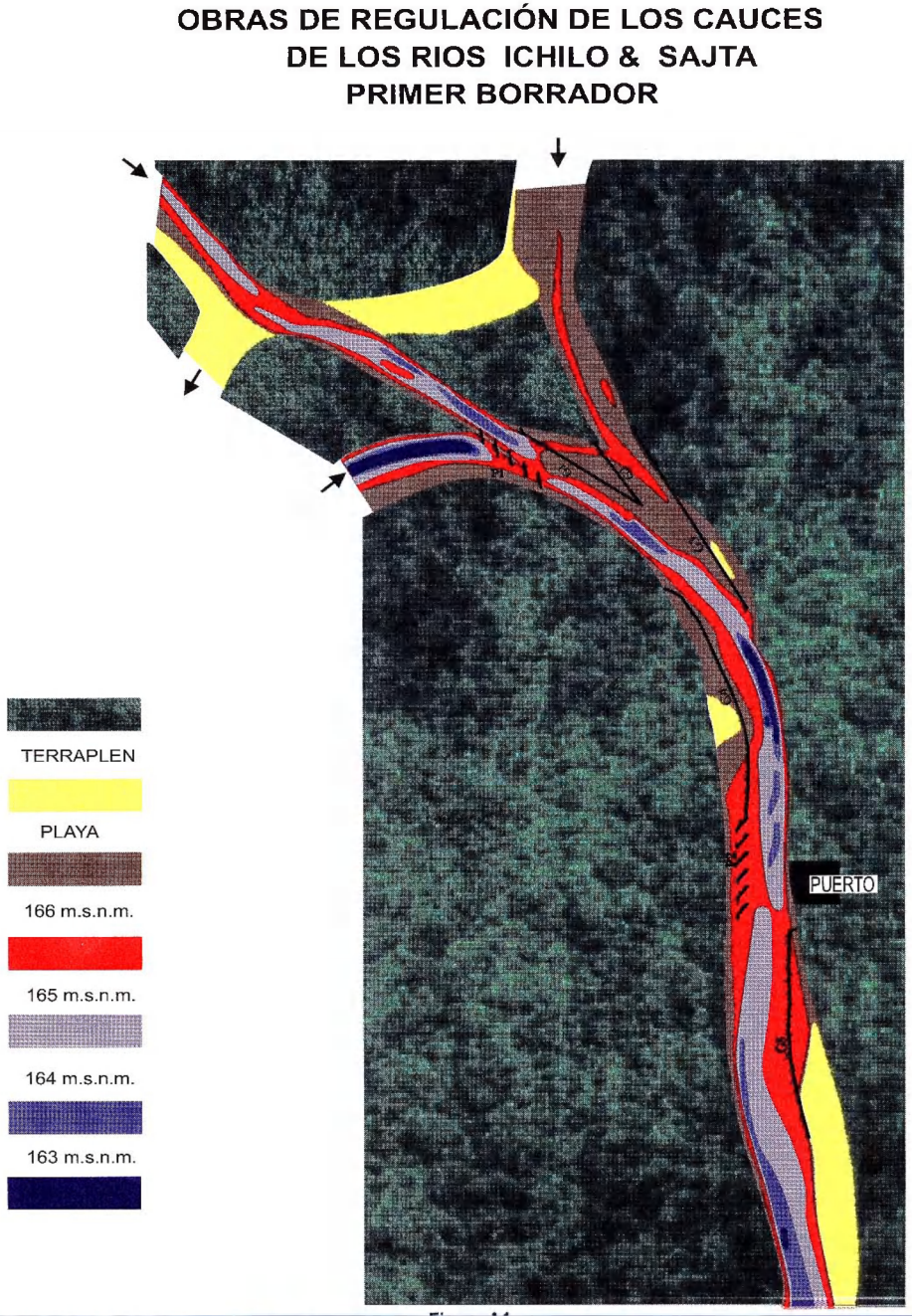
Structure B2 after a flood. It is built with local materials, wooden sticks and bamboo

Structure C: it starts from the top of the bank and follows the terrain, so that a different part of the structure works at each stage of the flood

Evolution of the land strip width remaining in T
(place of the feared natural cut-off)



After completion of cut-off's S-I and I-I



After completion of cut-off's S-I and I-I (1998)

After completion of cut-off's S-I and I-I (1998)

After completion of cut-off's S-I and I-I (1998)

And today …

What we achieved by working with nature not against it …