



Effect of exceptional hydrological events of the Solimões River on the hydrology and physico-chemistry of a floodplain-lake Part 1: Hydrology

Bonnet, MP.¹, Lamback, B², Oliveira, E.², Boaventura, G.²,
Seyler, F.³, Calmant, S.⁴, Seyler, P.¹

¹IRD – GET, UMR 5563

²IG -, Institute of Geosciences, University of Brasilia

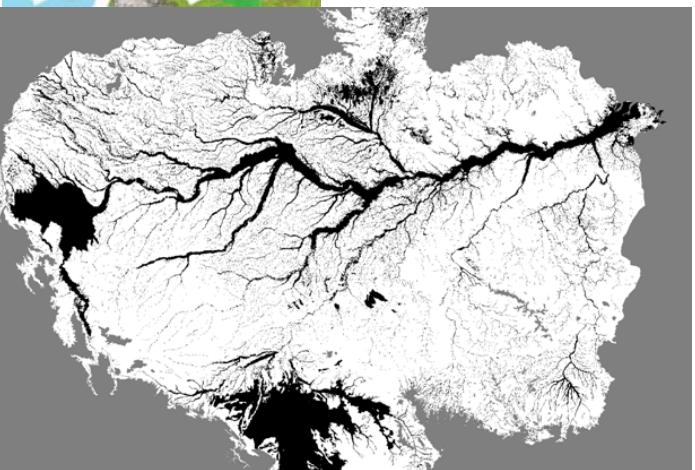
³IRD- Espace-Dec, UMR 228

⁴IRD; LEGOS, UMR 5566



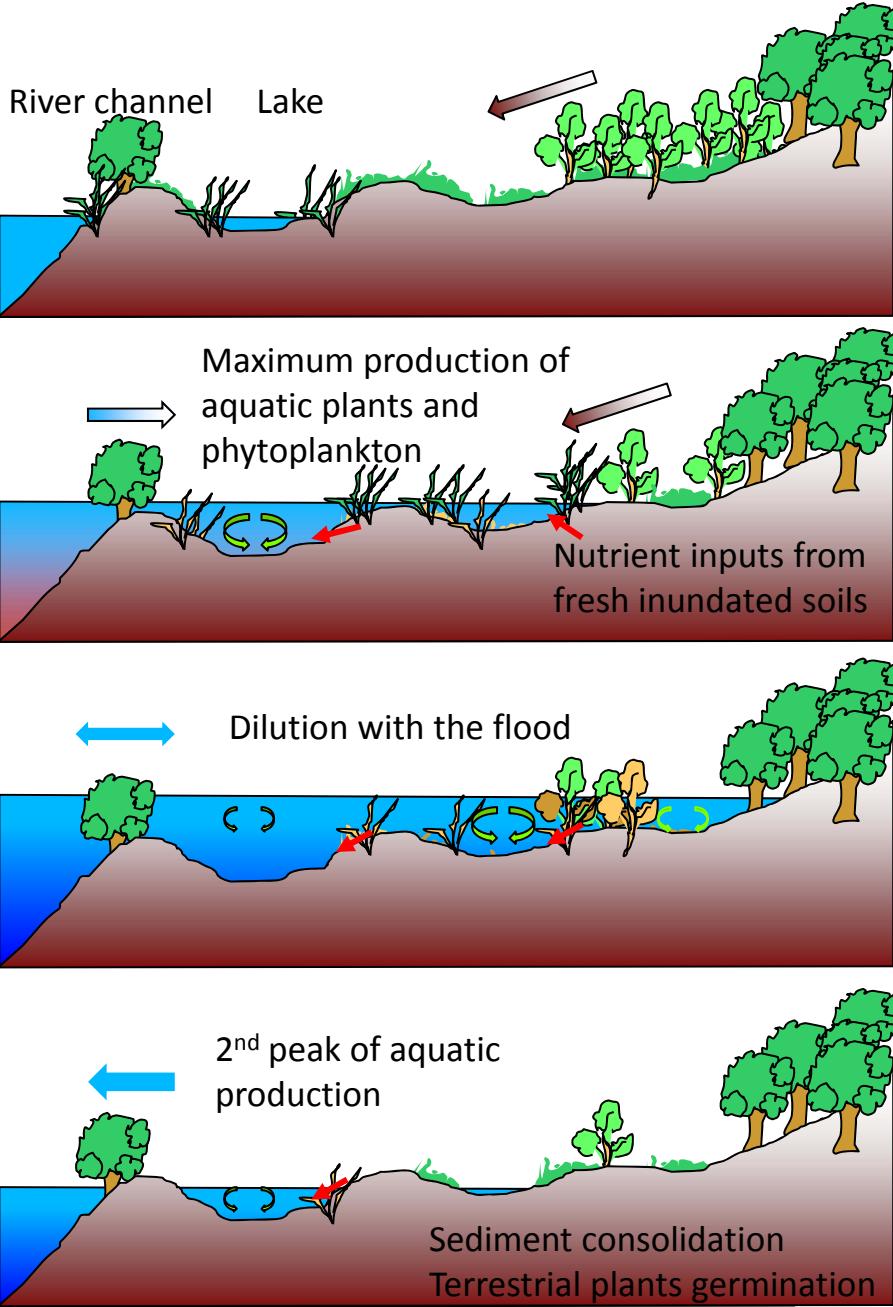
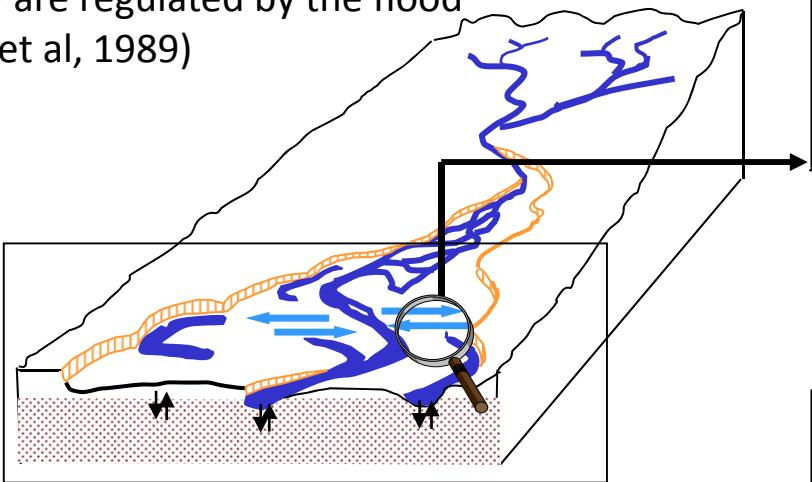
Hidrología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM



Floodplain and wetland in lowland Amazon
Basin: 800 000 km² (Melack and Hess, 2010)

Floodplain-river system
biogeochemistry, biodiversity and
productivity are regulated by the flood
pulse (Junk et al, 1989)

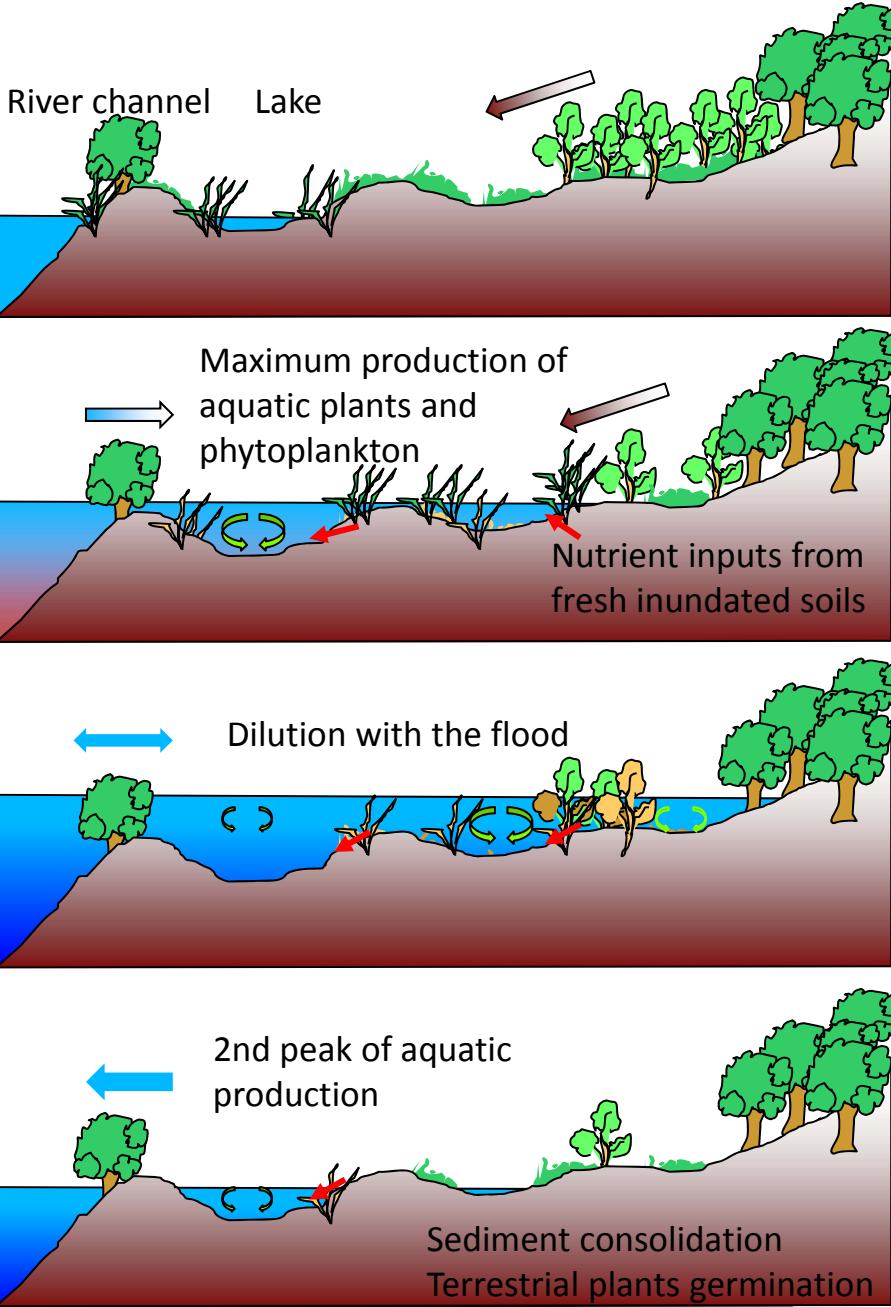




Hidroología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

Human activities regulated by the flood pulse



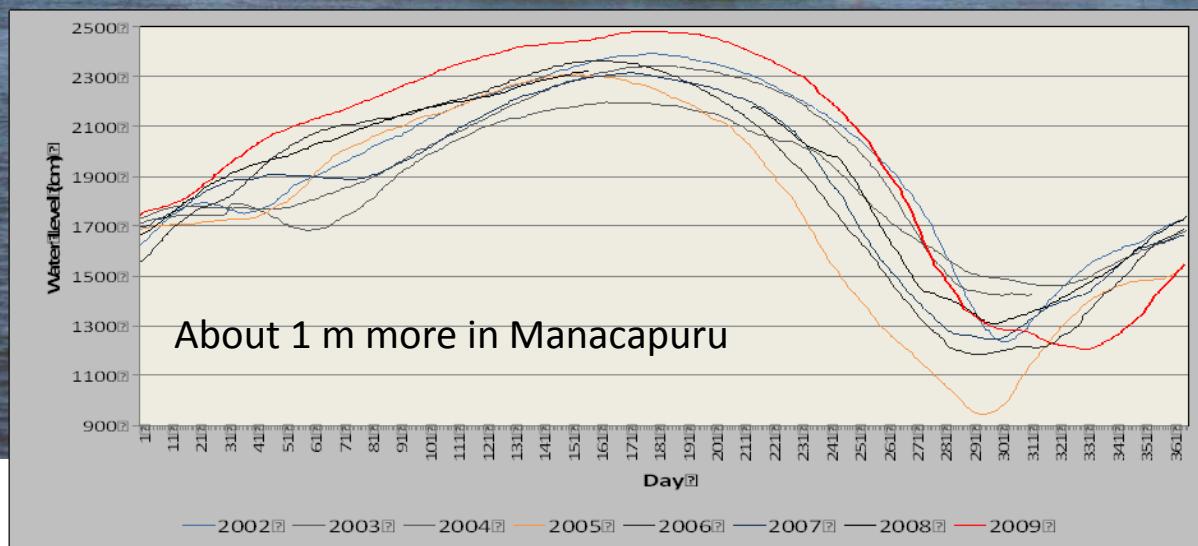


Hidrología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

What were the impacts of the 2009 Solimões flood in terms of:

- Water balance (timing of mixture and annual source contributions)
 - Water residence time



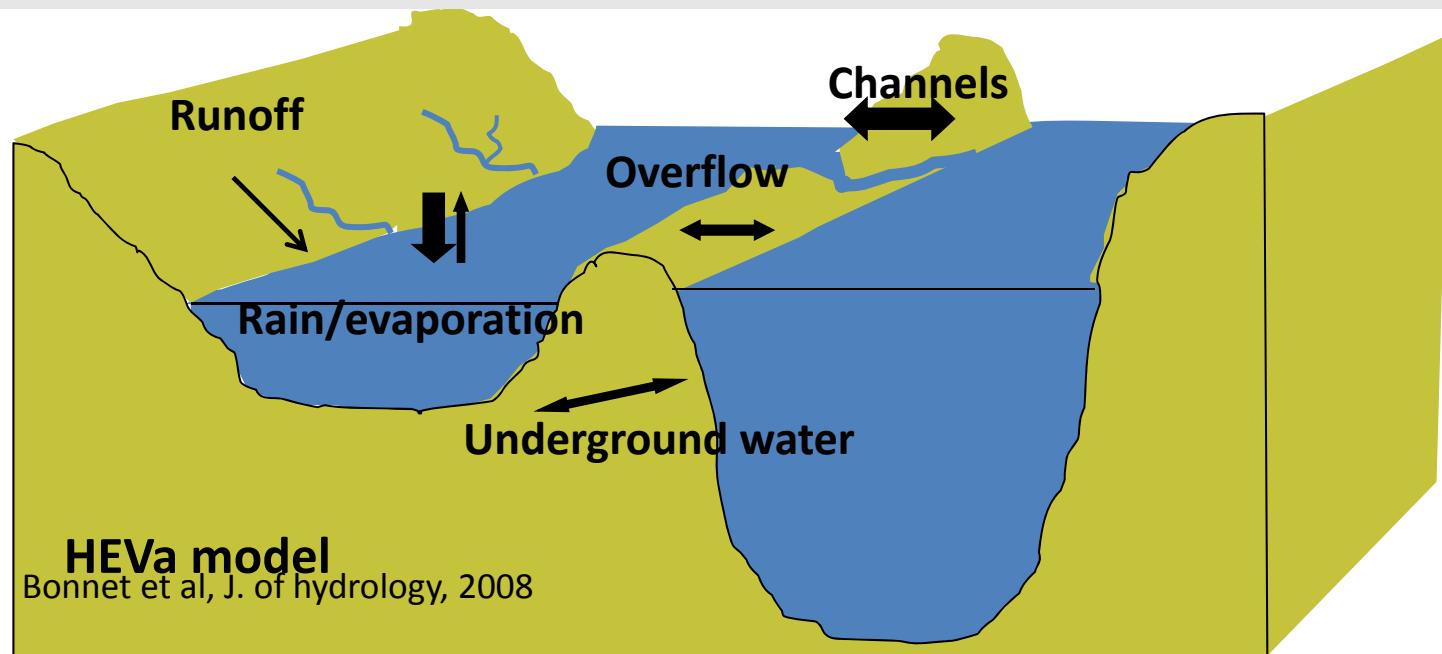


Hidrología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

A water balance model to quantify

- Spatial extension and stocked volume during hydrological cycle
- Floodplain-mainstream exchanged fluxes of water and matter
- Water residence time in floodplain
- Flooding modalities (source of water and matter)

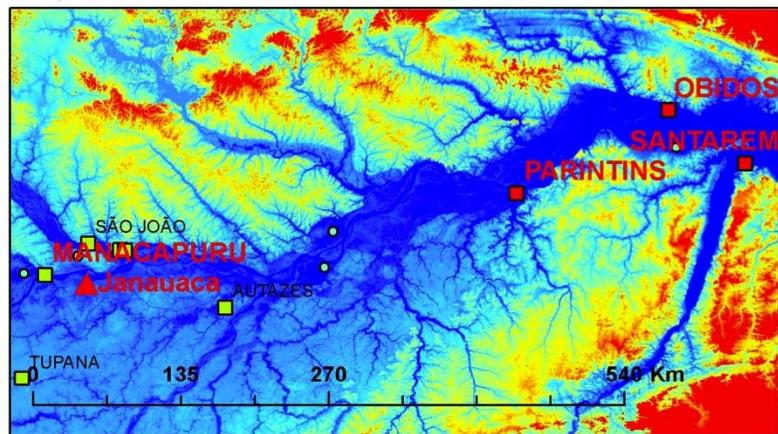
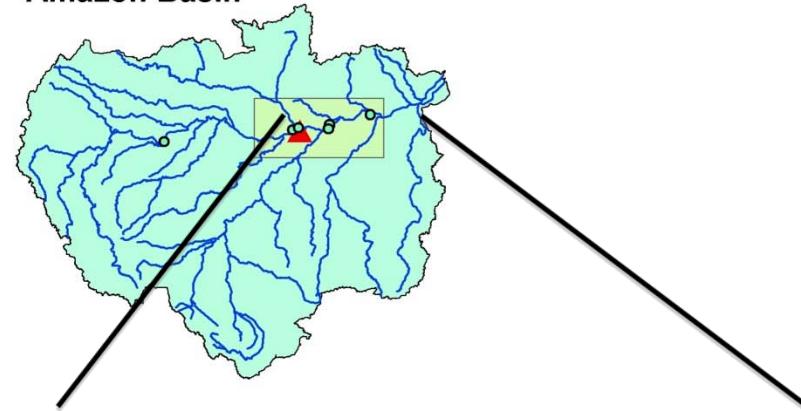




Hidrología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

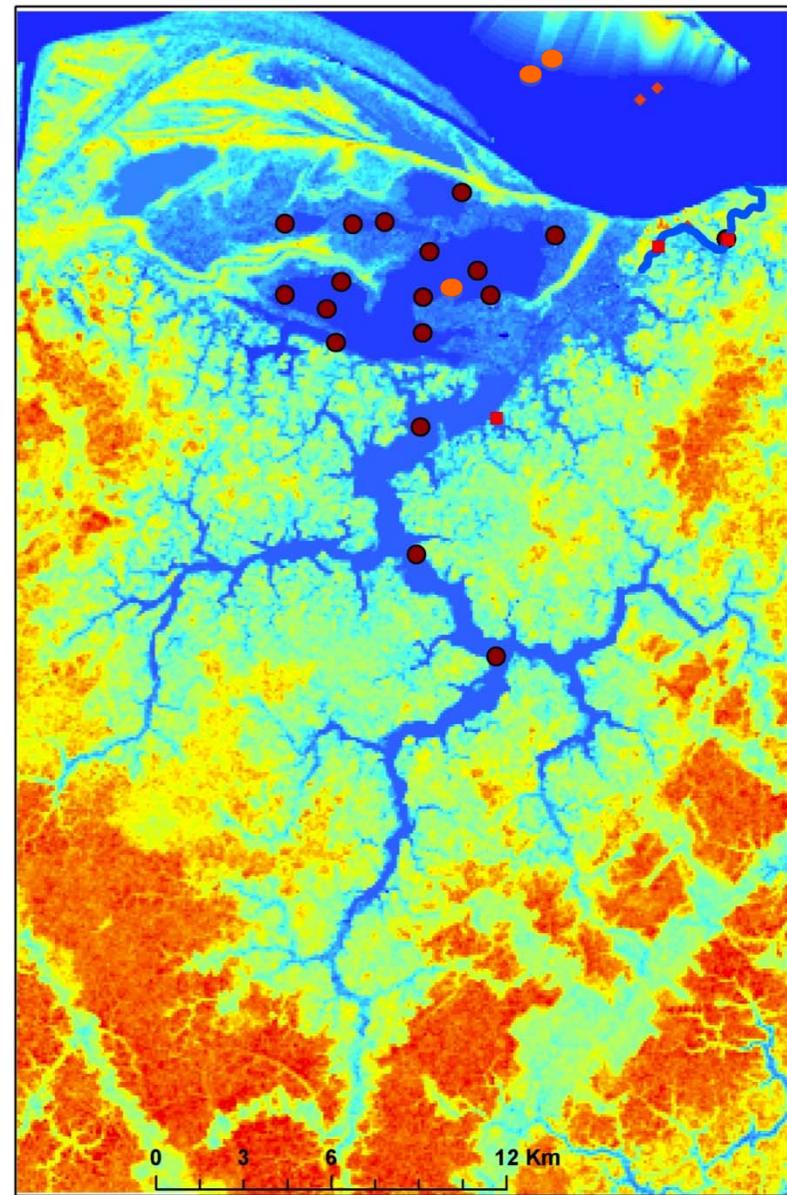
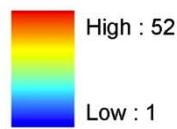
Amazon Basin



- Water level Gauges
- Rain gauges
- ◆ Virtual stations
- Water sampling stations

DEM (SRTM_V3)

Value





Hidroología y geodinámica actual de las cuencas sudamericanas

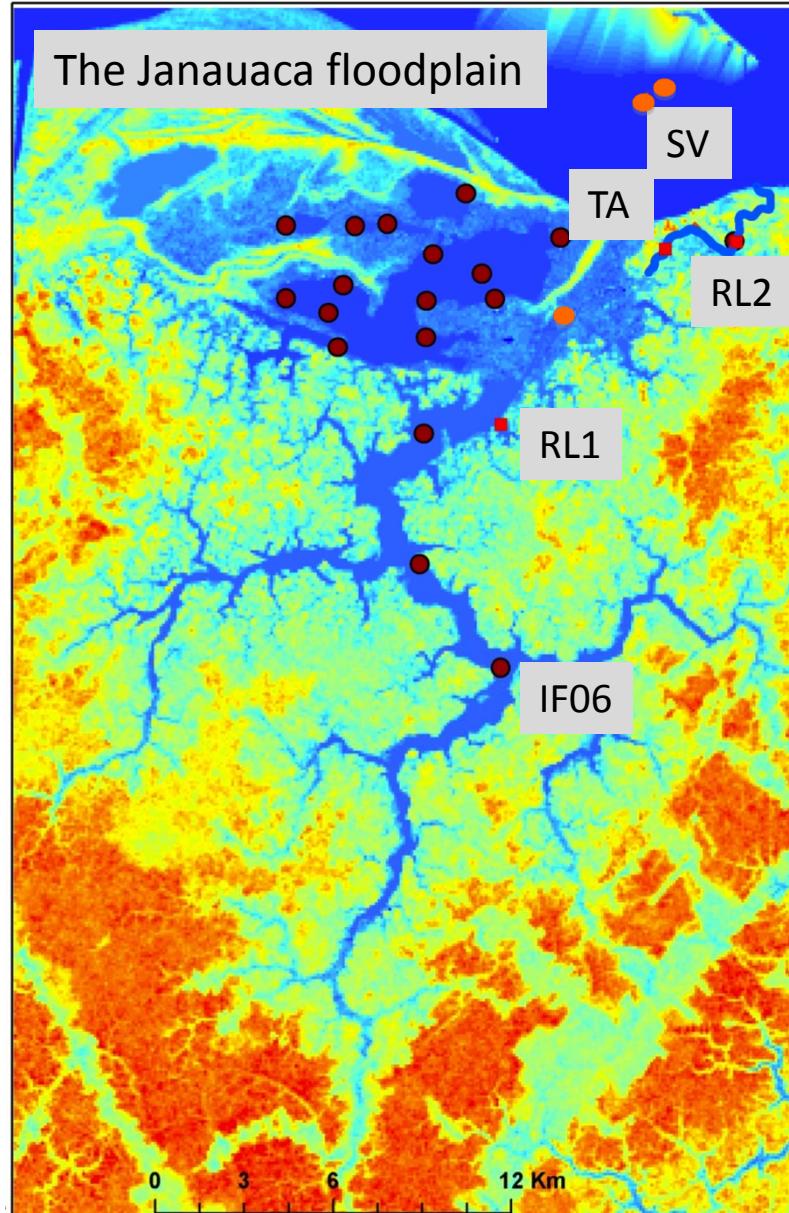
4ta reunión científica del ORE-HYBAM

Data available for the study:

- Daily water level at **RL1**, **RL2** since 08/2006
- Altimetry water level at **SV** and Manacapuru
- Discharge in **TA** and **RL2** at different periods of water year measured with ADCP
- Bathymetry from echo-sounder
- Daily rainfall at several close gauges
- Water samples at different periods of water year

Chloride and conductivity used in the study:

- Measured at **IF06** are used to characterize local watershed water
- Mean-lake water concentration and conductivity are obtained from other water samples
- Solimões chloride concentration and conductivity were deduced from an averaged year at Manacapuru from <http://www.ore-hybam.org/>
- Rainfall and groundwater were found from litterature (Honorio et al., 2009)

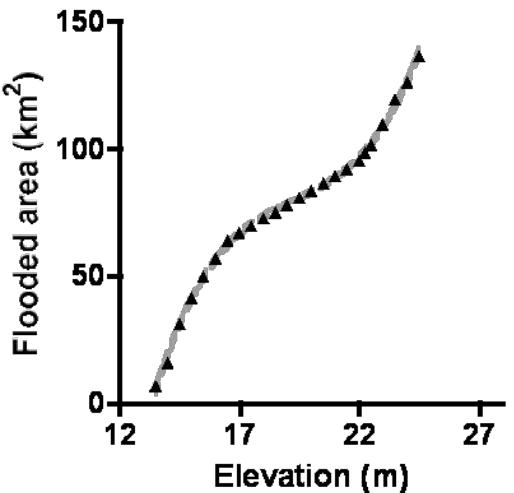




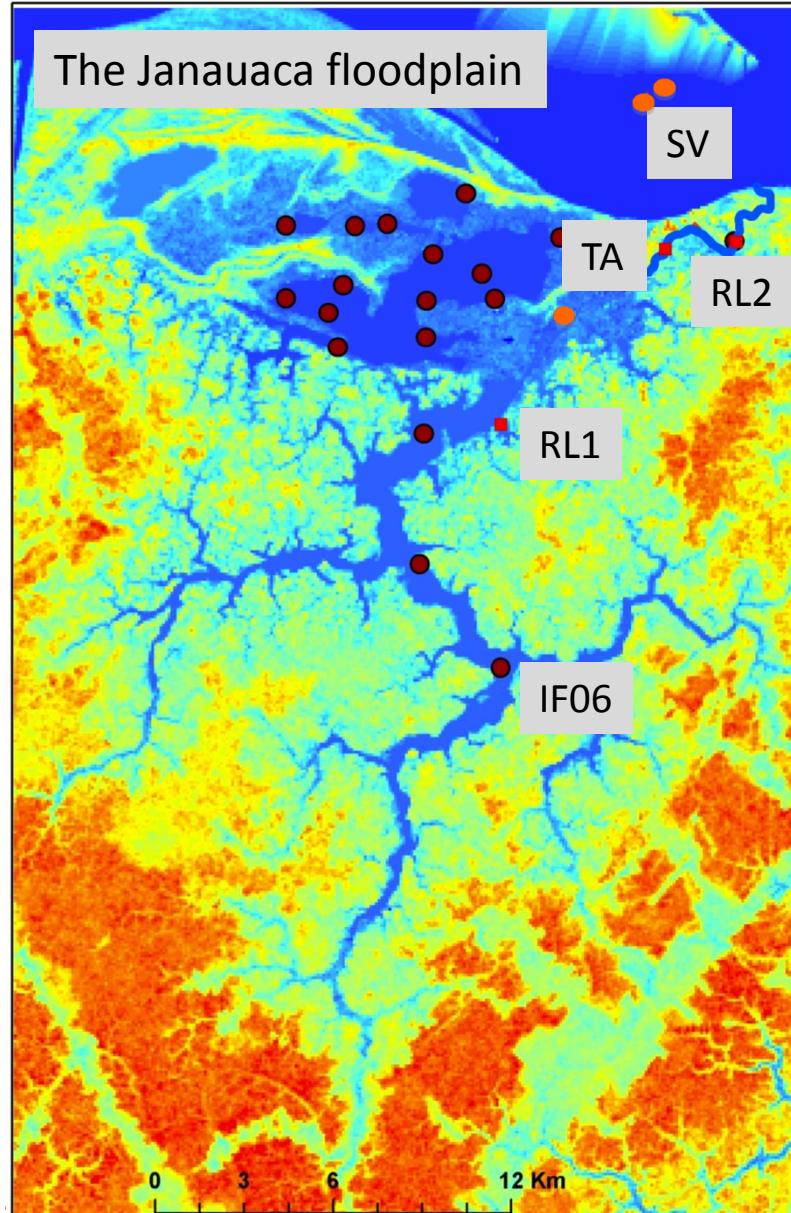
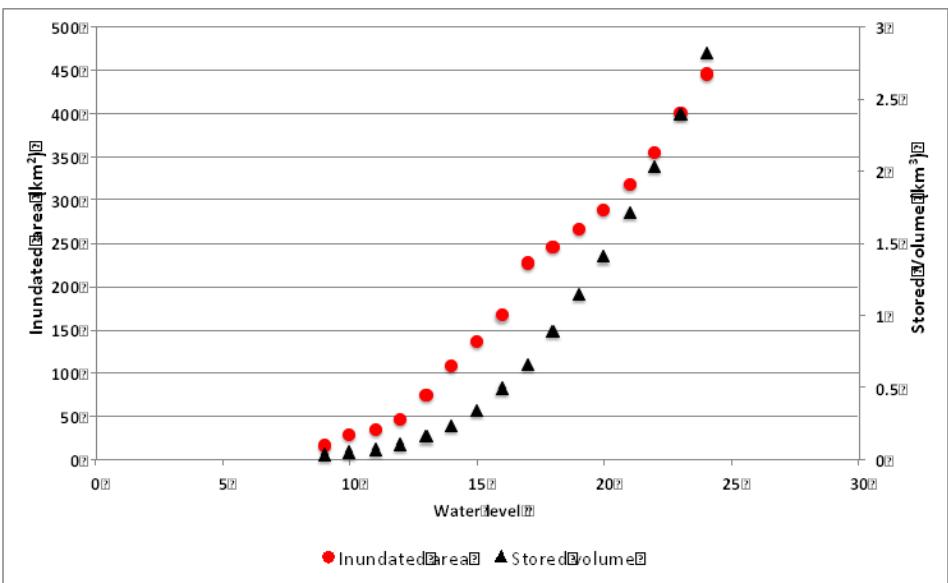
Hidroología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

Hypsometry deduced from bathymetry data



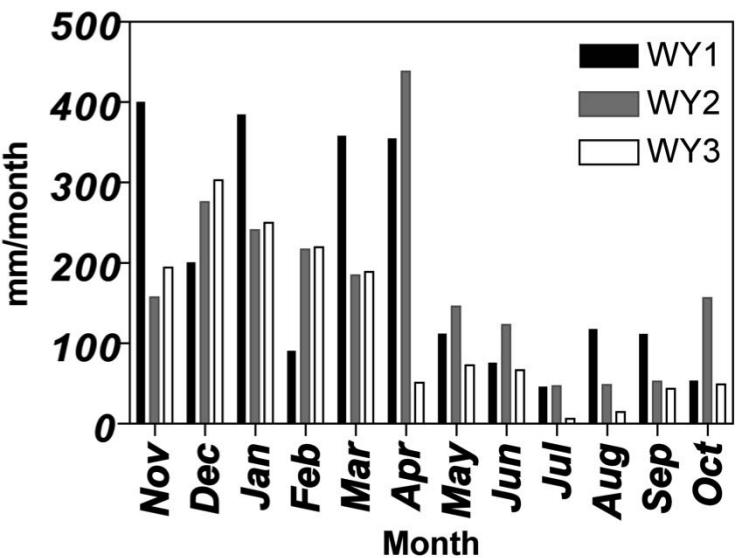
Hypsometry deduced from JERS 1 data classification





Hidrología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

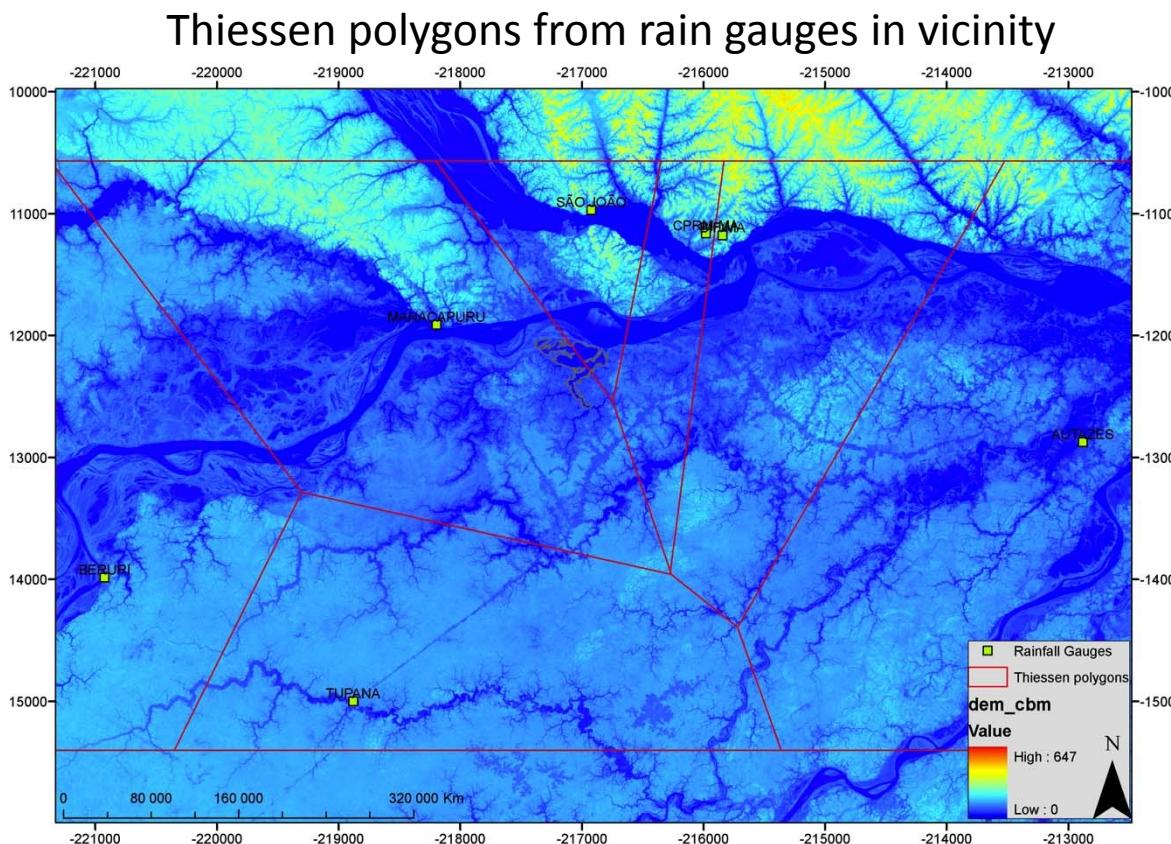


Annual amount:

WY1 (2006-2007): 2310

WY2 (2007-2008): 2090

WY3 (2008-2009): 1460



Each year, the period from November to March represented more than 70% of the annual rainfall amount.

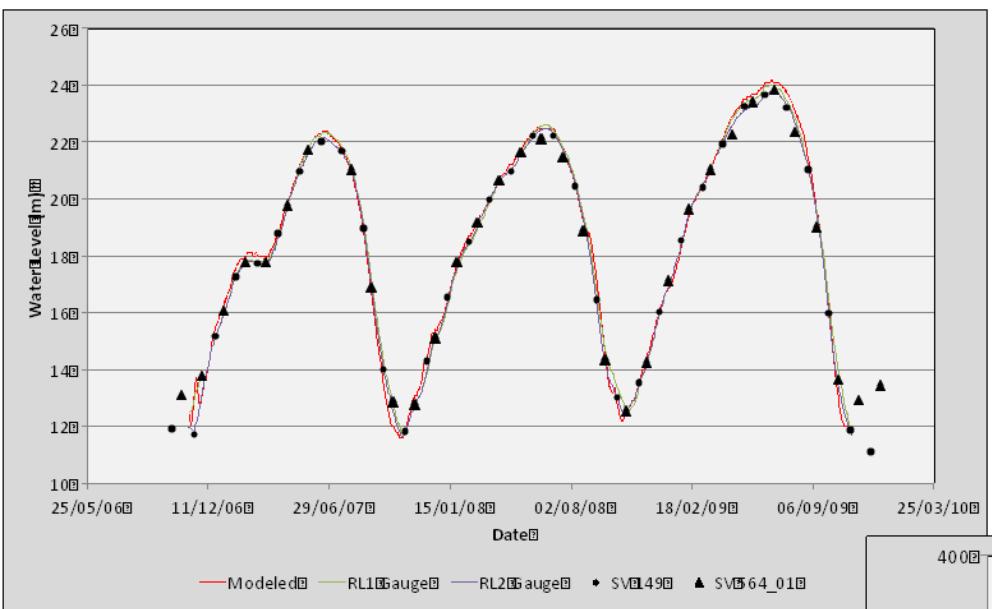
2009 is the drier year, while WY1 and WY2 can be considered as “normal”.



Hidroología y geodinámica actual de las cuencas sudamericanas

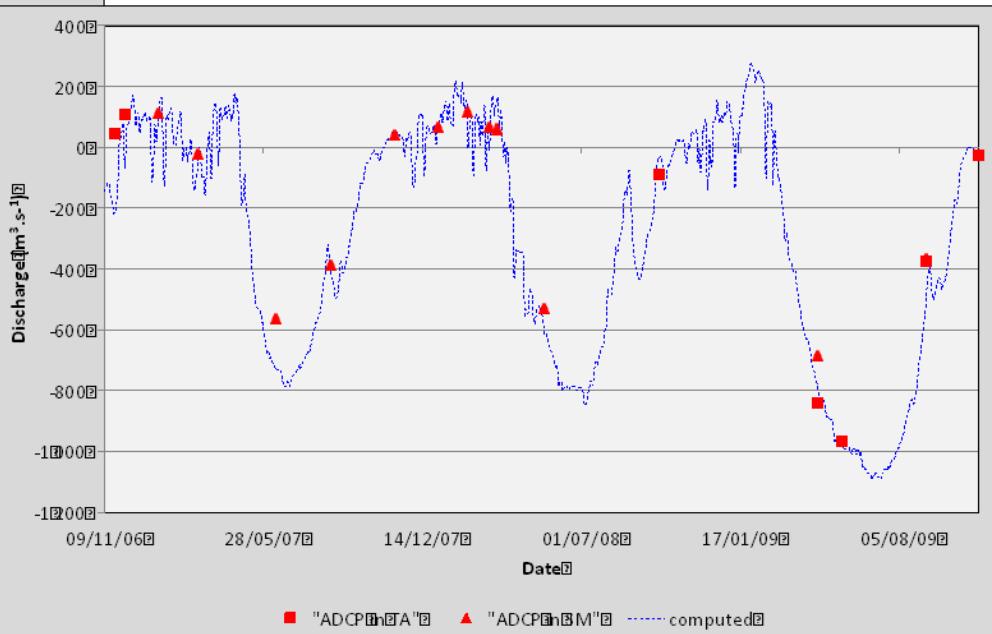
4ta reunión científica del ORE-HYBAM

Calibration and Validation of the Heva Model



Water levels computed compare well with in situ gauges and altimetry data

$$E = 1 - \frac{\sum_i (H_m^i - H_c^i)^2}{\sum_i (H_m^i - \bar{H}_m)^2} = 0,95$$



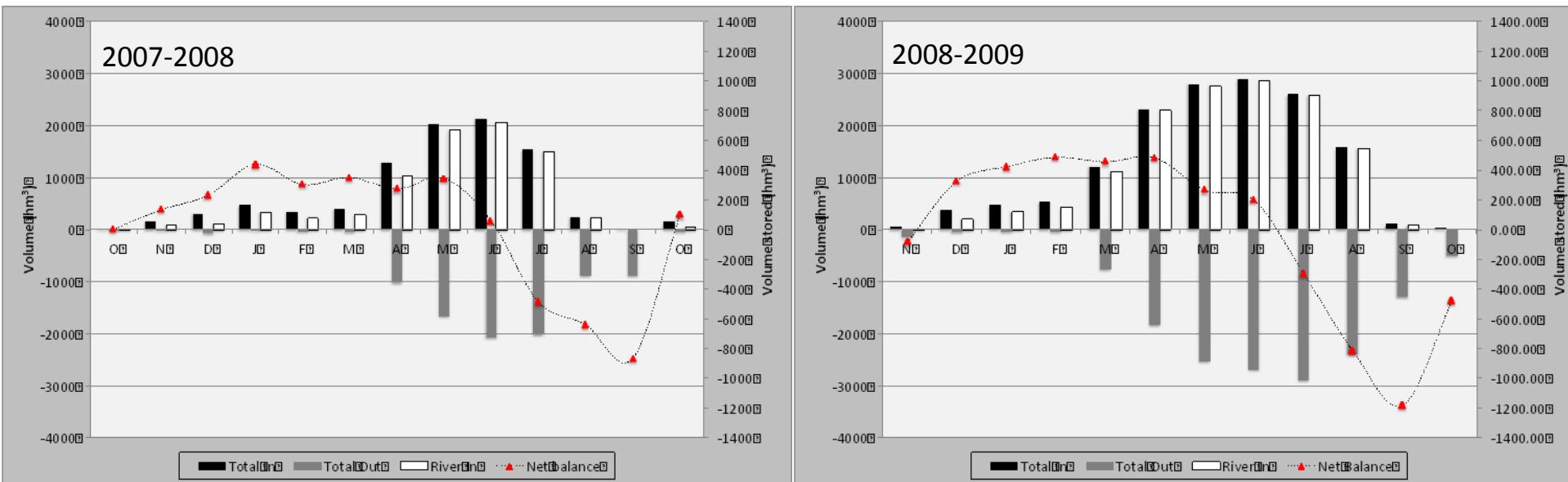
Computed discharges are satisfying



Hidrología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

Water balance and water residence time



Water year	Tot In km ³	Tot River km ³	Tot Out km ³	Res. Time days
2007-2008	9.1	7.8	-8.8	158
2008-2009	15.0	14.3	-15.2	82

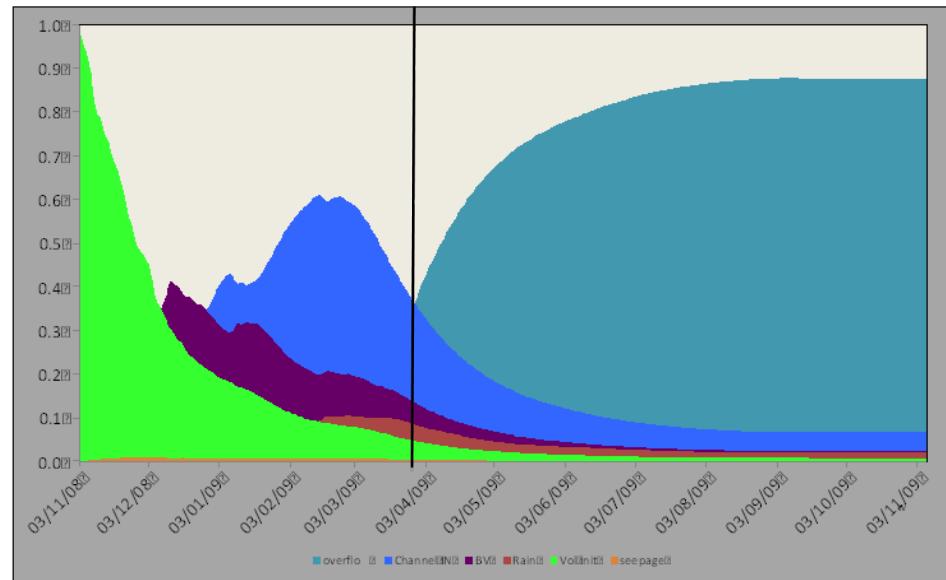
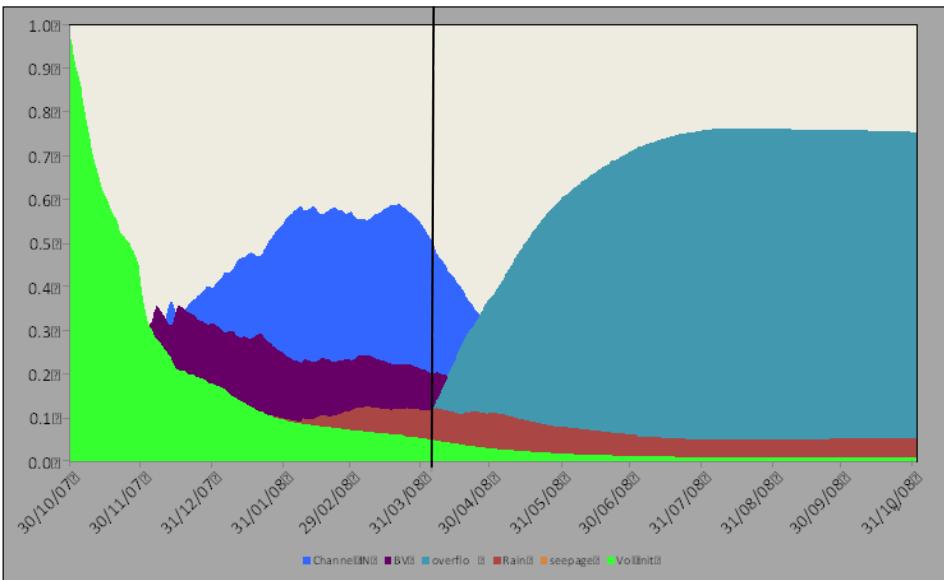
Water input from the main course is about twice in 2009 than in 2008
The water residence time was divided by about 2 between the two years



Hidrología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

Water sources contribution for WY2 and WY3



Contrasting flooding contributions between the two years

WY 2008:

- Overflow starts at the end of March
- At this time river contributed for 57% of the mixture, the watershed 22%

WY 2009:

- Overflow starts end of February
- At this time, river contributed 59% of the mixture, the watershed 20%





Hidrología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

Annual water sources contribution for WY2 and WY3

WY	Channel	Watershed	Direct rain	overflow	seepage
2007-2008	11%	7%	6%	75%	<1%
2008-2009	7%	3%	2%	88%	<1%

- The annual contribution of the local watershed is about 7% by the end of the water year
- Seepage remains weak whatever the year
- Overflow is the main source of contribution. Once initiated the connecting river-floodplain channel acts as an outlet



Hidrología y geodinámica actual de las cuencas sudamericanas

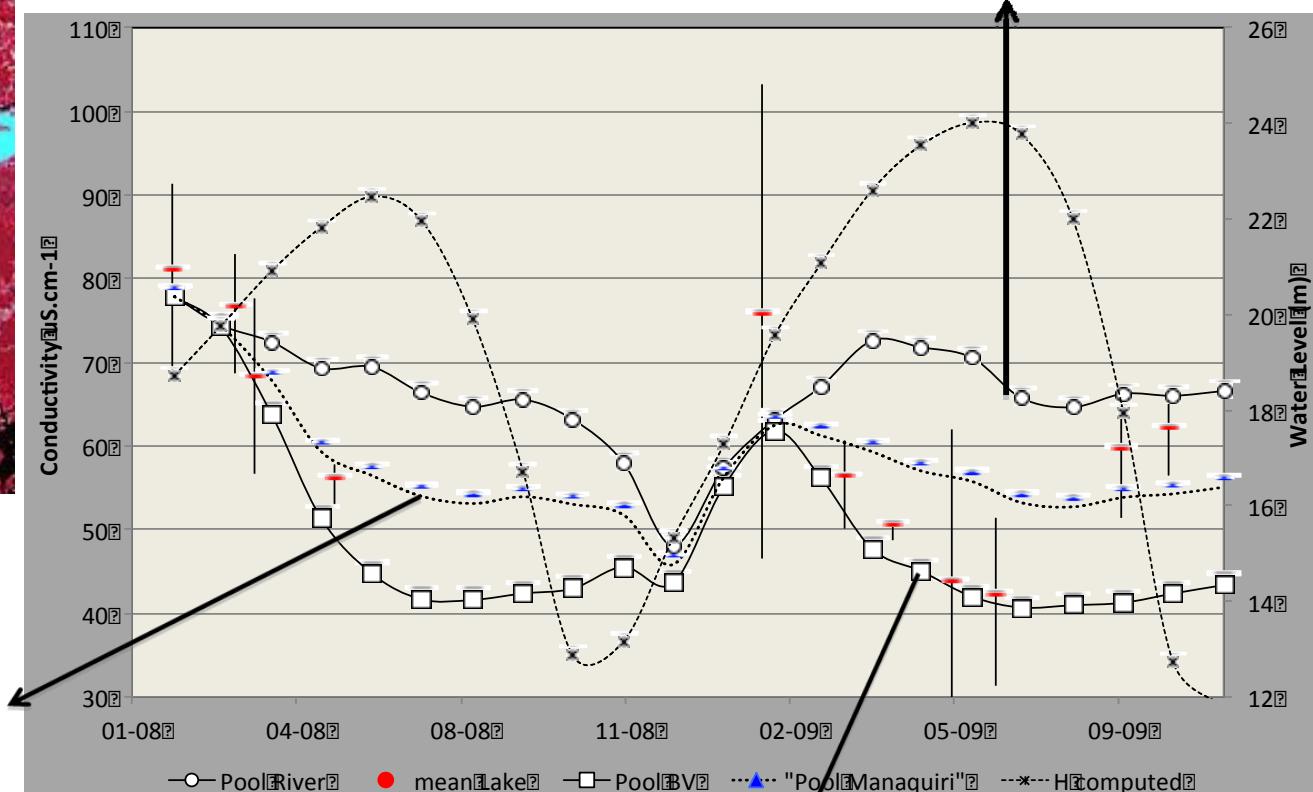
4ta reunión científica del ORE-HYBAM



Conductivity obtained assuming a pool with a conductivity similar as Manaquiri ($40 \mu\text{S}/\text{cm}$) & 50% of the total overflow

But part of the overflow may come from the Manaquiri Lake

Conductivity obtained with overflow from River



Conductivity obtained with overflow originating from a pool of same conductivity as in the south stream (BV)



Hidrología y geodinámica actual de las cuencas sudamericanas

4ta reunión científica del ORE-HYBAM

Summary

Each year the water year starts early in November and lasts until end of October.

The flooding is mainly attributed to overflow, but not only from the main course.

Direct rainfall and seepage are small contributors to water balance .

2009 exceptional flood had for consequences:

- A reduction by a factor of 2 of the water residence time
- The throughout (Influx-outflux) doubled– at the time of the flood, the floodplain is a bypass
- The watershed influence lasted for only 3 months in the water mixture