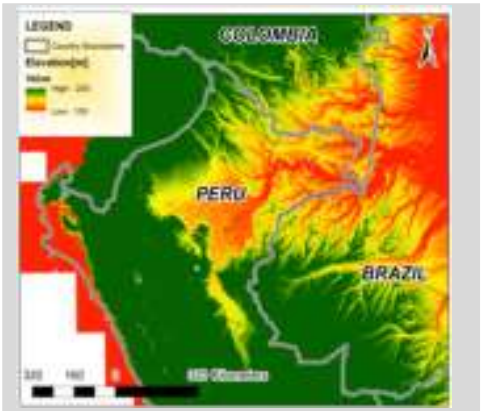

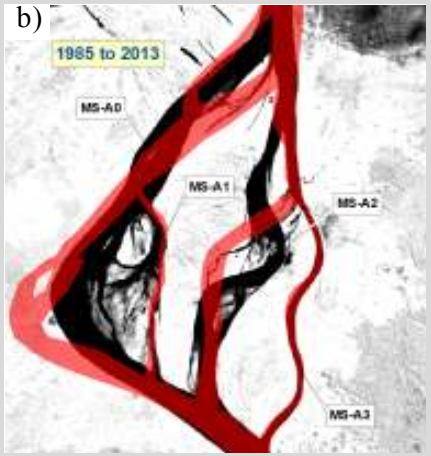

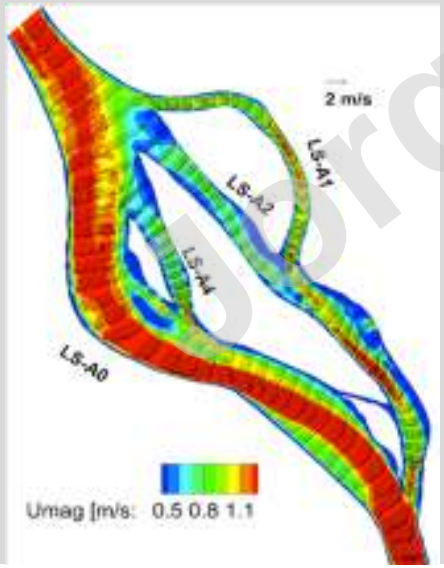

Sabemos los suficiente sobre la morfodinámica de ríos Amazónicos? Necesitamos líneas de base para el proyecto de Hidrovias?

Jorge D. Abad

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Director, CITA@UTEC (Centro de Investigaciones y Tecnología del Agua)

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Ronald Gutierrez, Jiaoli Ren, Catalina Escobar, Alejandro Mendoza, Christian Frias, Collin Ortals, Adrian Garcia, Renne Corbet (PIT)

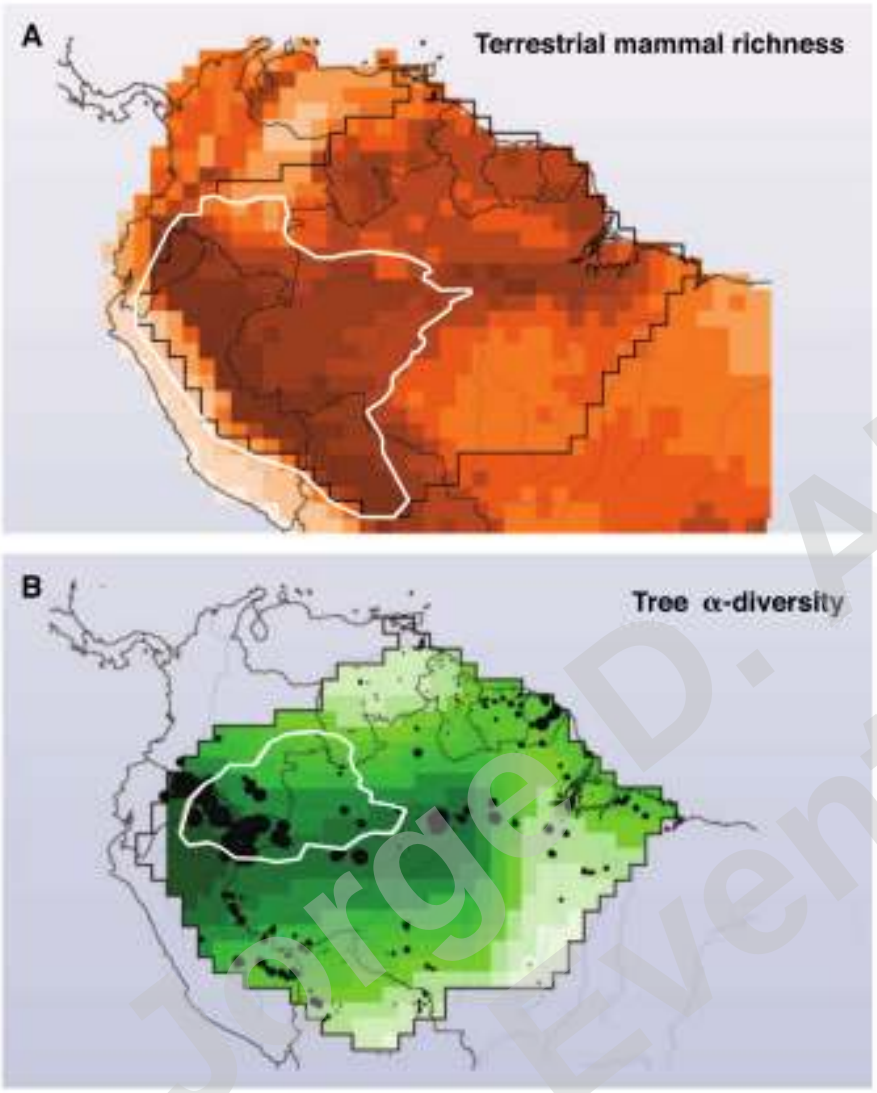
Zara Torres, Karen Garcia, Jorge Bardales, Giorly Machuca (UNAP)

Marco Paredes (SENAMHI)

The Modern Amazon Basin

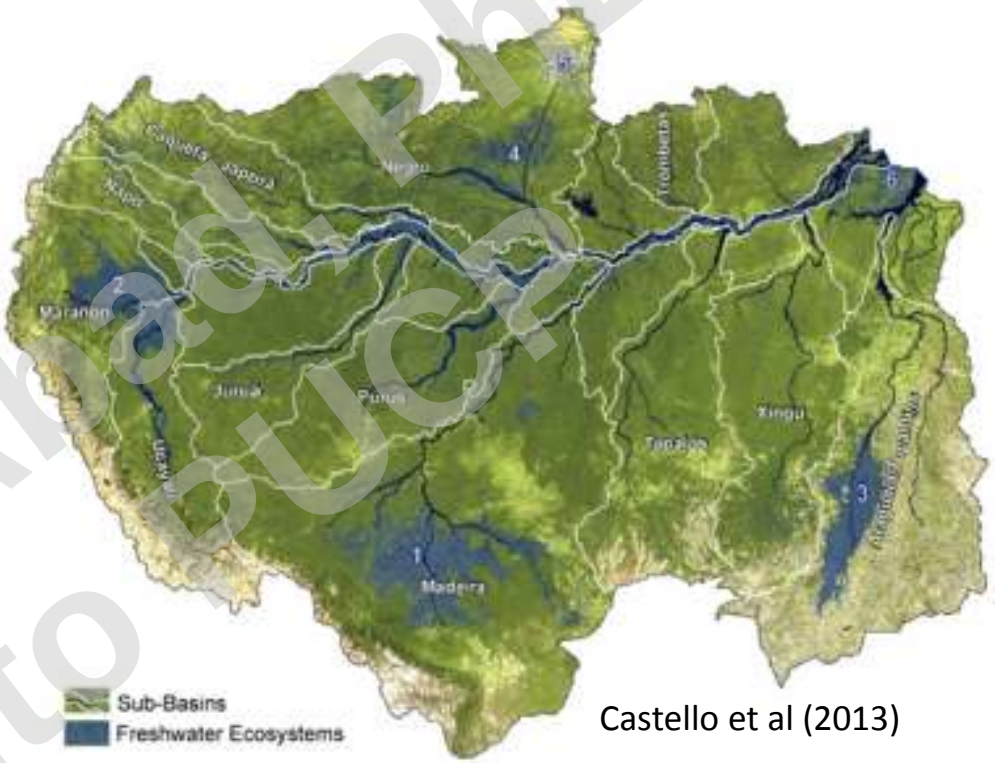
Hoorn et al. (2010)

PERU – Mayor biodiversidad que otros países amazónicos



Hoorn et al. (2010)

Drain Area: 6,915,000 km^2 (40% of South America)



Castello et al (2013)

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Transporte de sedimentos desde los Andes al Océano Atlántico

Existen zonas de captura de sedimentos, los Andes son la principal fuente de sedimentos

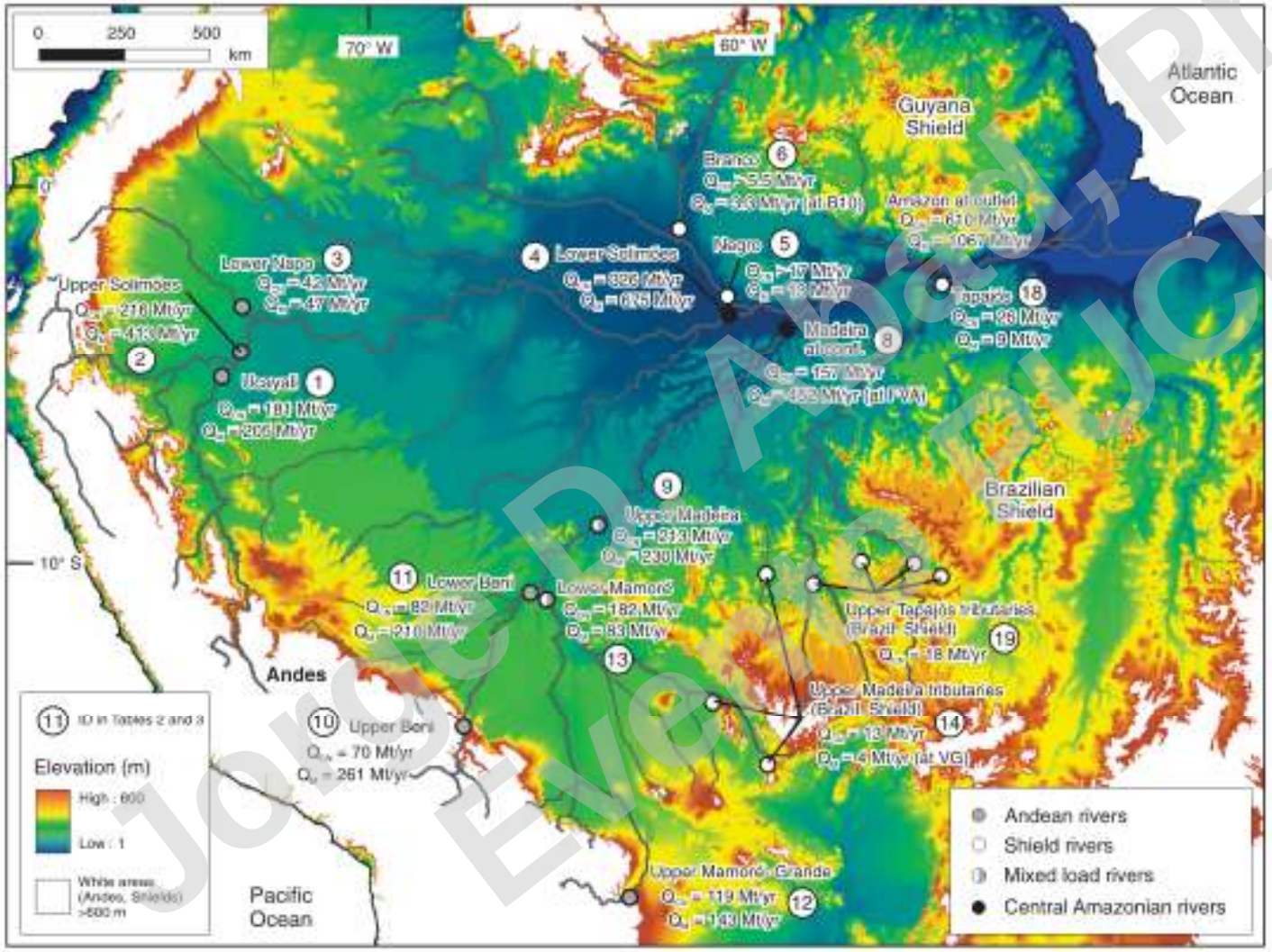

Figure 6. Sediment budget for the Amazon basin. Q_{CN} denotes sediment fluxes calculated from cosmogenic nuclides (this study), and Q_M denotes modern gauging-based fluxes from suspended and dissolved loads compiled from several different sources (see Table 2). The Q_{CN} value calculated for the Amazon outlet near Óbidos was calculated from a weighted average from IDs 4, 7, 8, 15, 16, and 17, and the Q_M value at Óbidos gives an average total load calculated from the minimum and the maximum published values at this location.

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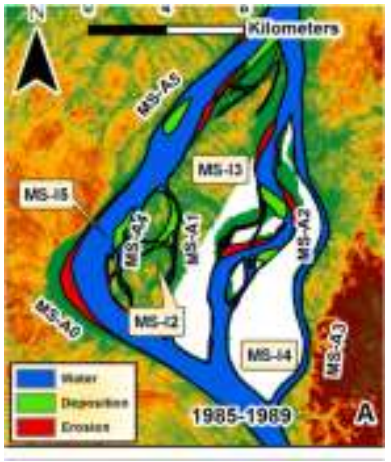
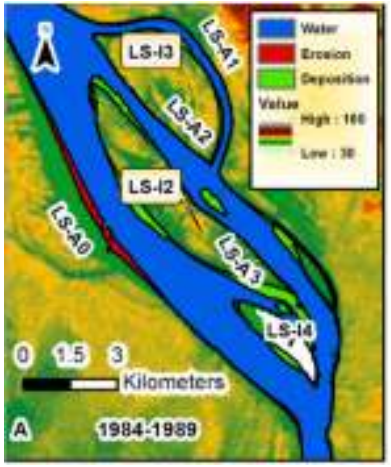
River patterns in the Amazon Basin

1) Meandering rivers (cutoffs and paleo-channels)

2) Confluence of meander trains

3) Anabranching rivers





❑ WATER DISCHARGE

Goulding et al. (2003)

❑ SEDIMENT DISCHARGE

ANTHROPOGENIC ISSUES IN THE AMAZON BASIN

❑ Water ways (IIRSA NORTE)

http://www.mtc.gob.pe/portal/logypro/Proyectos%20programados%202013.pdf

HARBORS

http://www.mtc.gob.pe/portal/logypro/proy_puertos2009.pdf

Importancia de Sedimentos de los Andes – Norte-Este

Goulding et al. (2003)

http://dams-info.org/en

Que componentes morfodinamicos existen en un rio?

Aparte de monitorear:

Flujos de agua y sedimentos (suspendidos y fondo)

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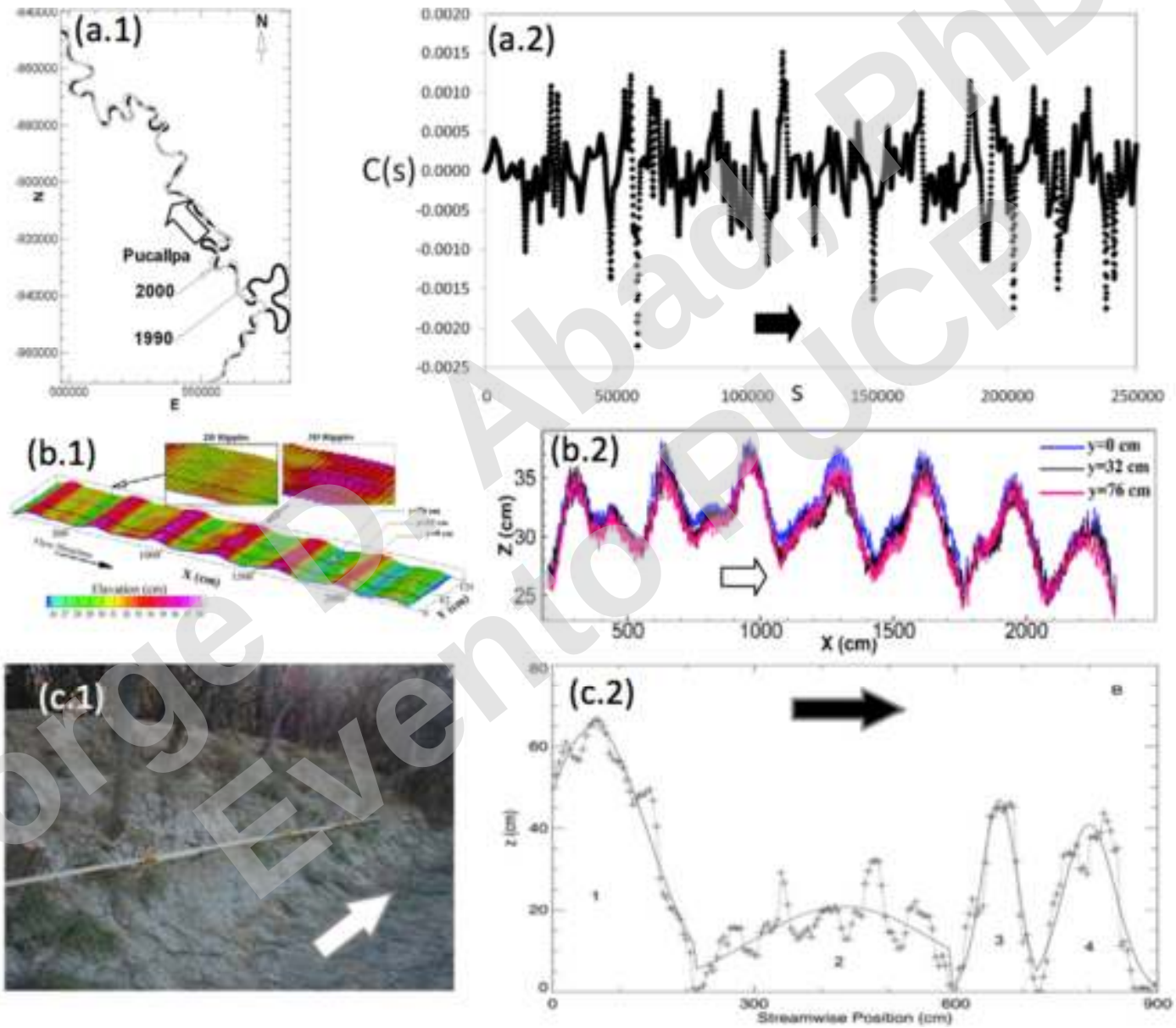
Statistical tools for morphodynamic signals



CARACTERIZAR!
CARACTERIZAR!

DINAMICA DE RIOS ES CRUCIAL!!!!!!!!!!

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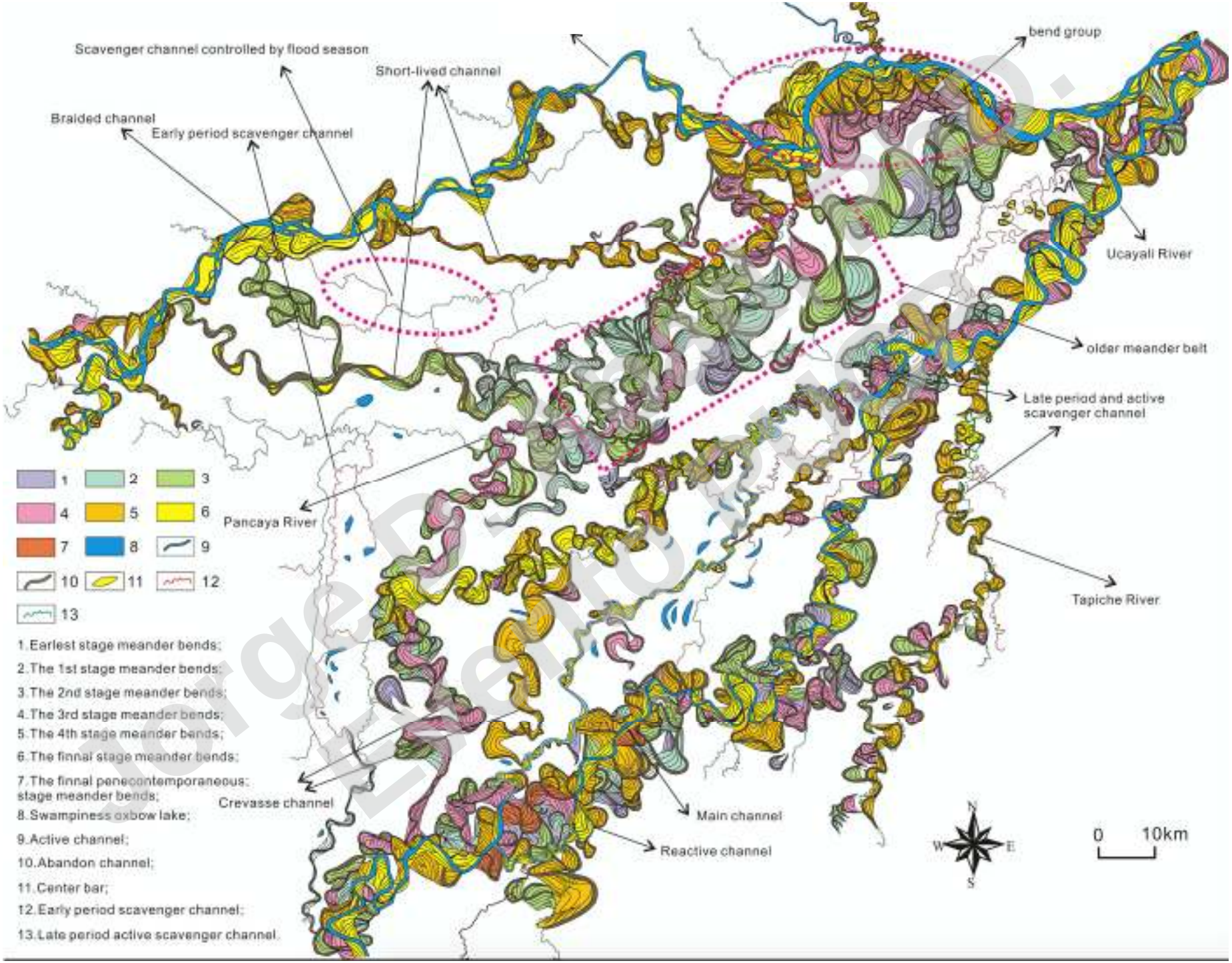
Planform evolution is important?

Gutierrez and Abad (2014, Water Resources Research)
Gutierrez and Abad. (In preparation, Geophysical Research Letters)

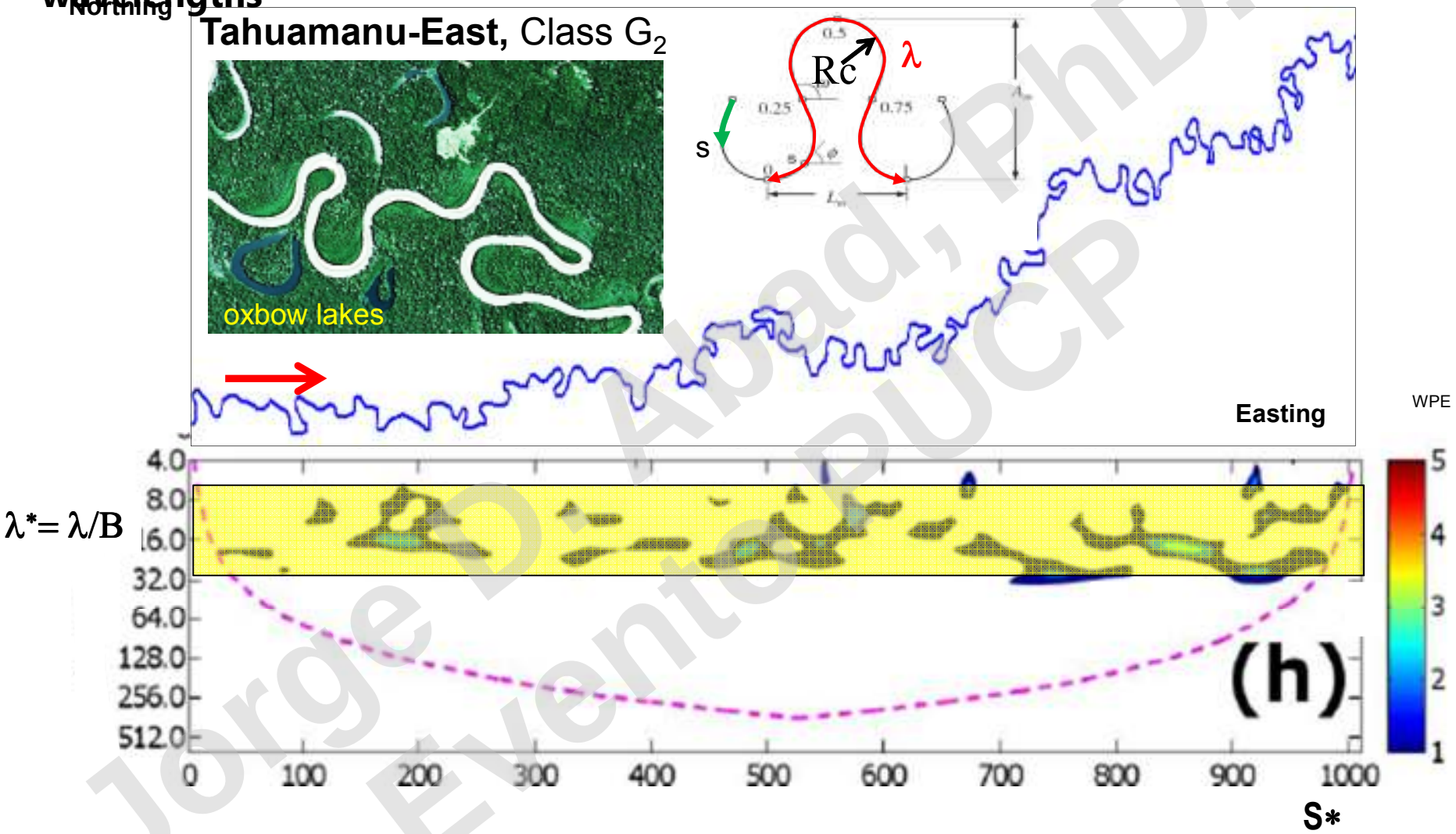

Scavenger channel controlled by flood season
Short-lived channel
bend group
Braided channel
Early period scavenger channel
Ucayali River
older meander belt
Late period and active scavenger channel
Pancaya River
Tapiche River
Crevasse channel
Main channel
Reactive channel
1
2
3
4
5
6
7
8
9
10
11
12
13
1.Earlest stage meander bends;
2.The 1st stage meander bends;
3.The 2nd stage meander bends;
4.The 3rd stage meander bends;
5.The 4th stage meander bends;
6.The finnal stage meander bends;
7.The finnal penecontemporaneous stage meander bends;
8.Swampiness oxbow lake;
9.Active channel;
10.Abandon channel;
11.Center bar;
12.Early period scavenger channel;
13.Late period active scavenger channel.
N
W
E
S
0
10km

Rivers are dynamic, but are they freely?

1) *Most linear models – freely meandering evolution*
2) *Cutoffs are produced geometrically and erased from history – No paleo-channel preservation*
3) *Geology valley is not considered*

Lancaster, 2002

❑ Spatial frequency – dynamic equilibrium conditions – arc-wavelengths



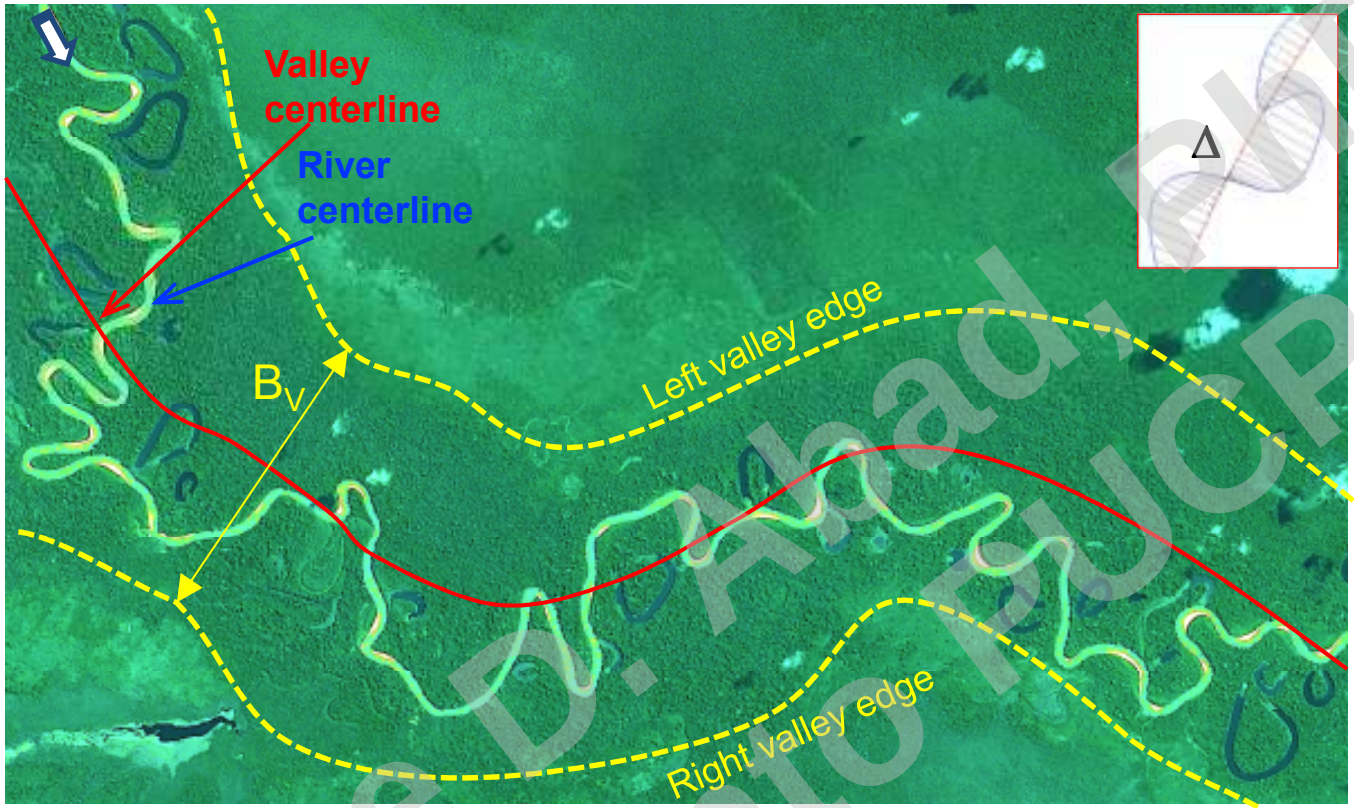
Are these dominant spatial scales constant in time?

They fluctuate around the dynamic equilibrium conditions

Gutierrez and Abad (2014, Water Resources Research)

❑ Planform amplitude – departure from valley centerline

Tahuamanu-East (Bolivia)

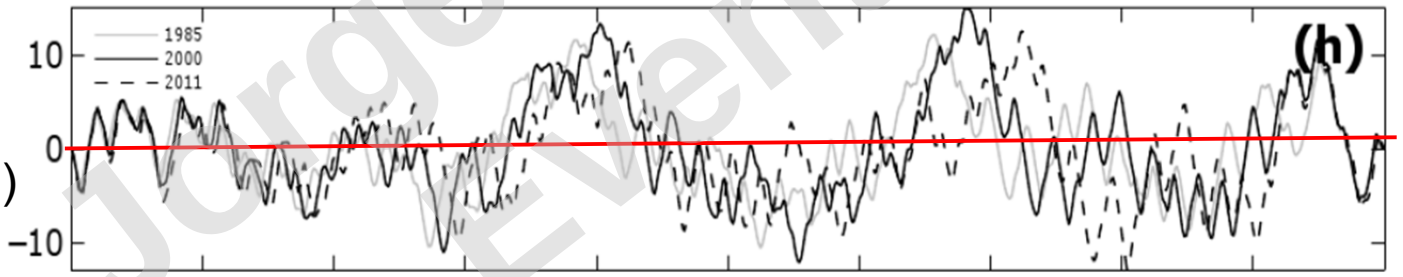


$Signal_{Vc}$

Modulation

?

$Signal_{Rc}$

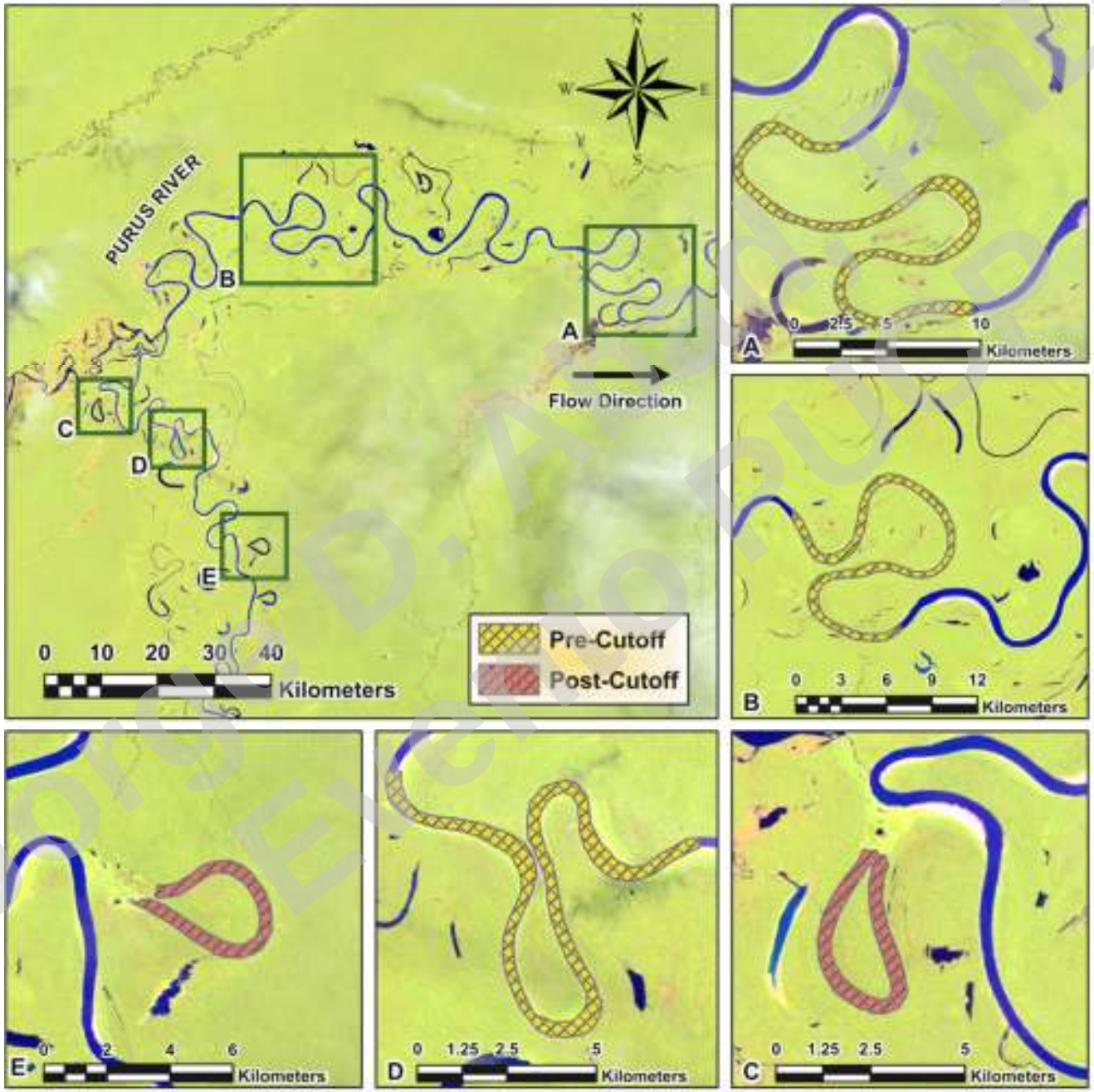


Is the planform amplitude related to degree of confinement?

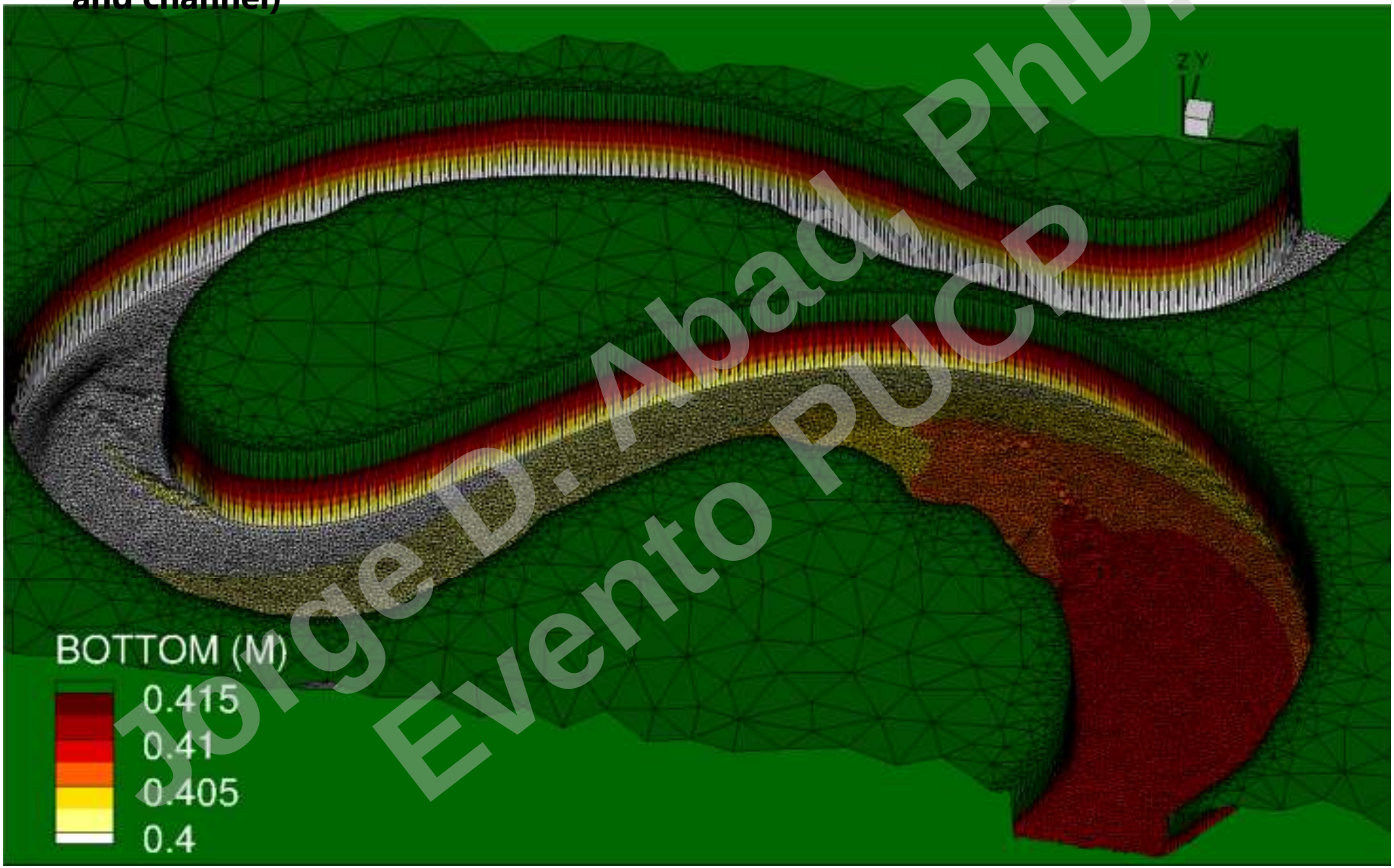
geology confinement ↓ ***occurrence of cutoffs*** ↑

Gutierrez and Abad (2014, WRR)

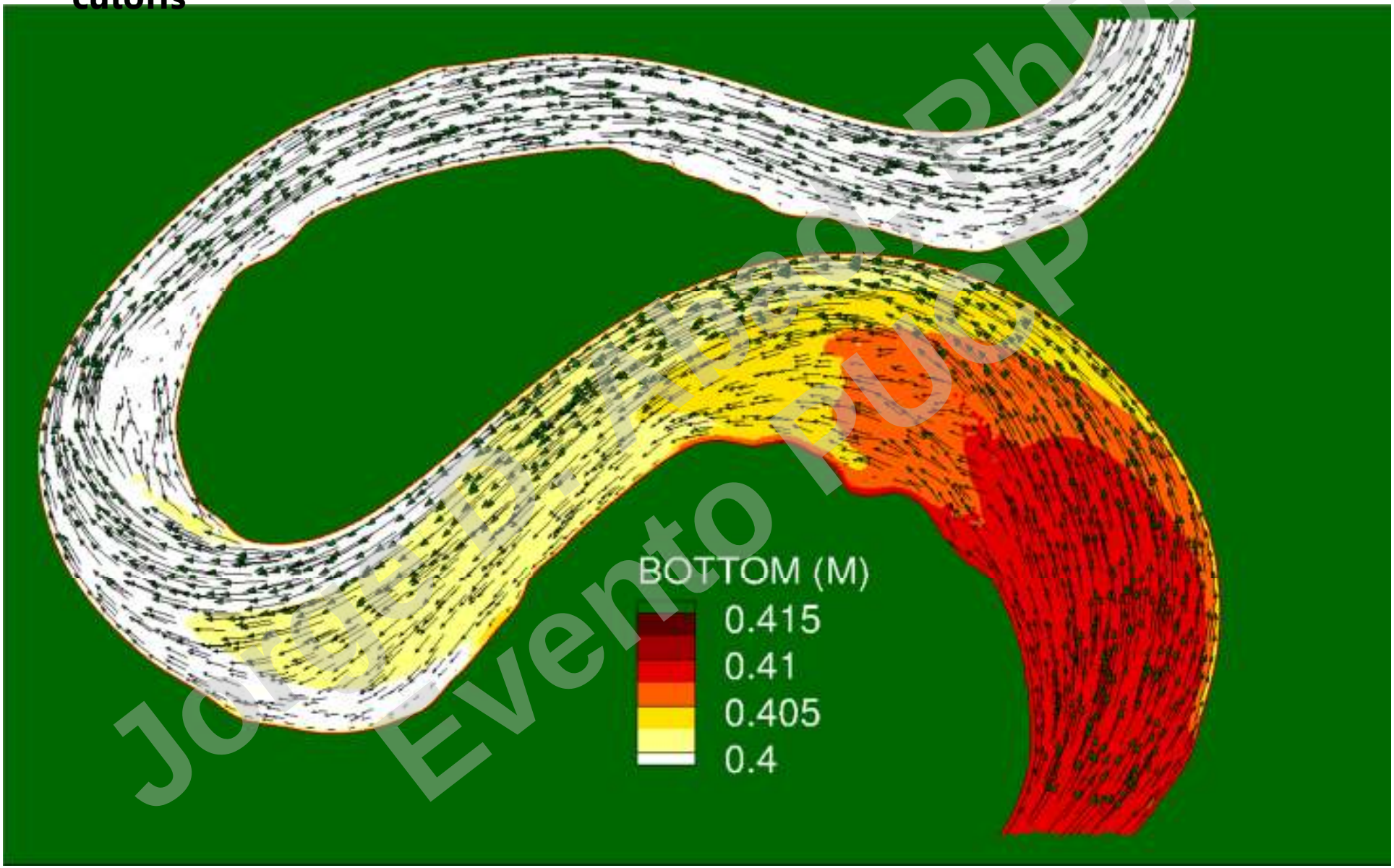
Pre- and post-cutoff metrics



- **A nonlinear model including dynamic mesh adaptation (floodplain and channel)**

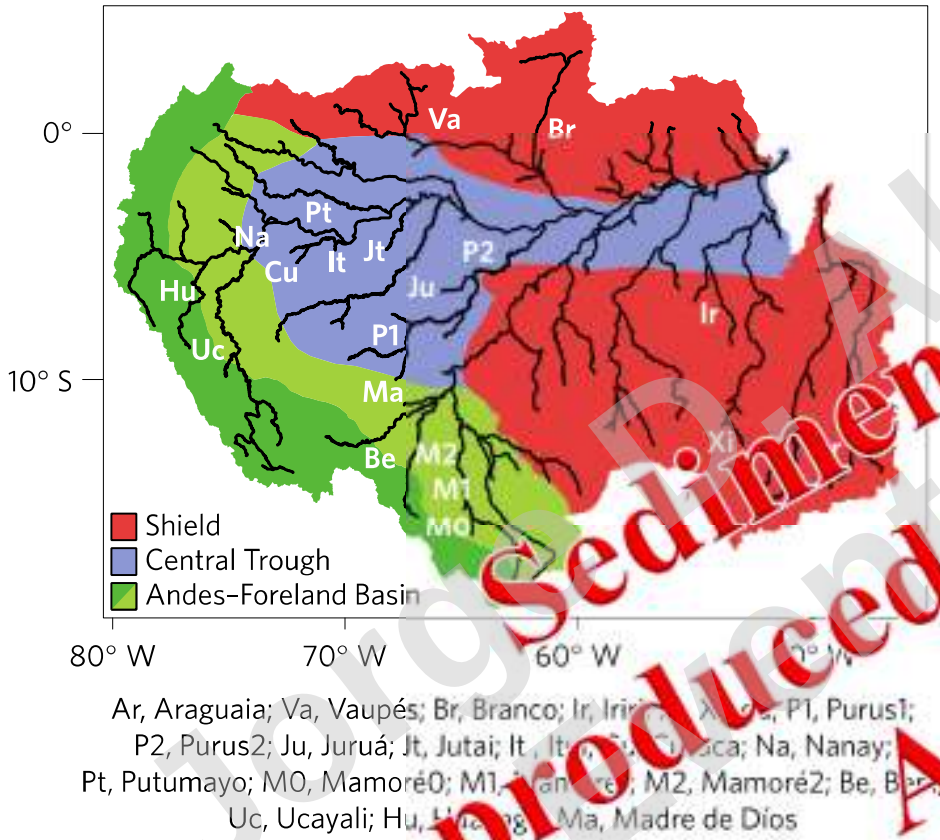


- **Flow transition during neck cutoffs**

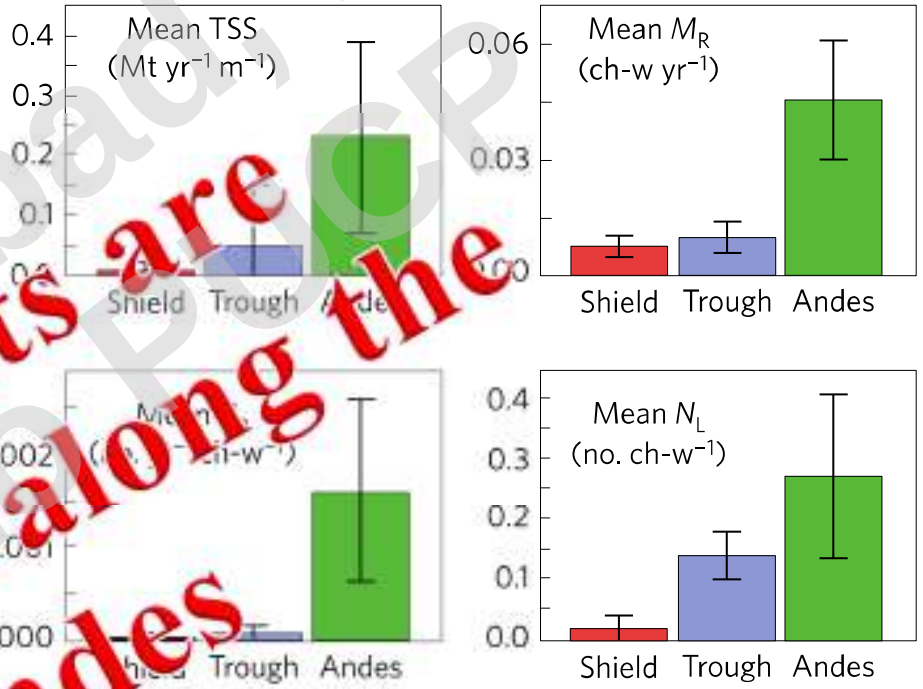


Sources for TSS (total suspended sediments)

TSS: total suspended sediments
M_R: avg. annual migration rate
C_R: avg. annual cutoff rate
N_L: total number of observable oxbow lakes



Ar, Araguaia; Va, Vaupés; Br, Branco; Ir, Iri[illegible], P1, Purus1; P2, Purus2; Ju, Juruá; Jt, Jutai; It, It[illegible]aca; Na, Nanay; Pt, Putumayo; M0, Mamoré0; M1, [illegible]; M2, Mamoré2; Be, B[illegible]; Uc, Ucayali; Hu, [illegible]; Ma, Madre de Dios

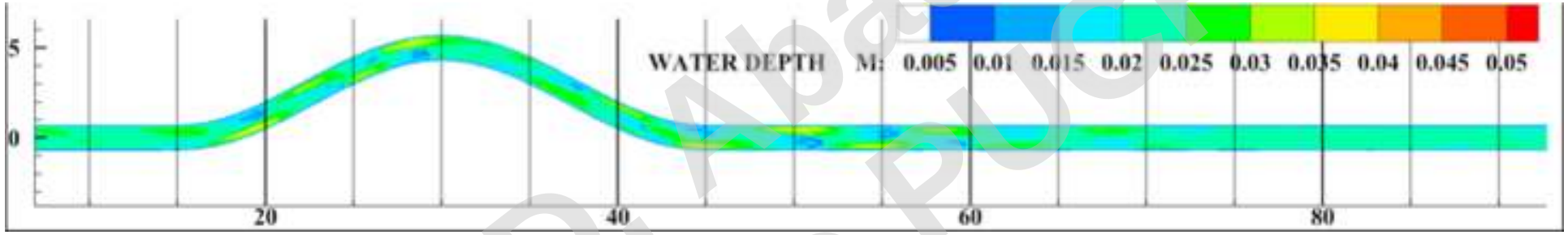


Constantine (2014)

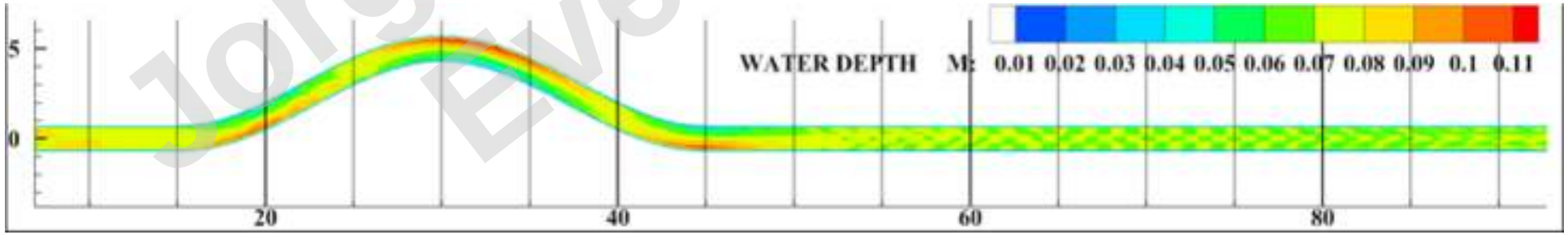
[2] Long-term modeling of meandering channels: Nonlinear model

Johannesson and Parker (1985) $k_{\max} = \frac{\sqrt{2}C_f}{h}\sqrt{A - 1 + F^2}$ $k_{\max} = 2\pi/\lambda_{\min}$

$k < k_{\max}$ Meander growth



$k > k_{\max}$ Stable meanders

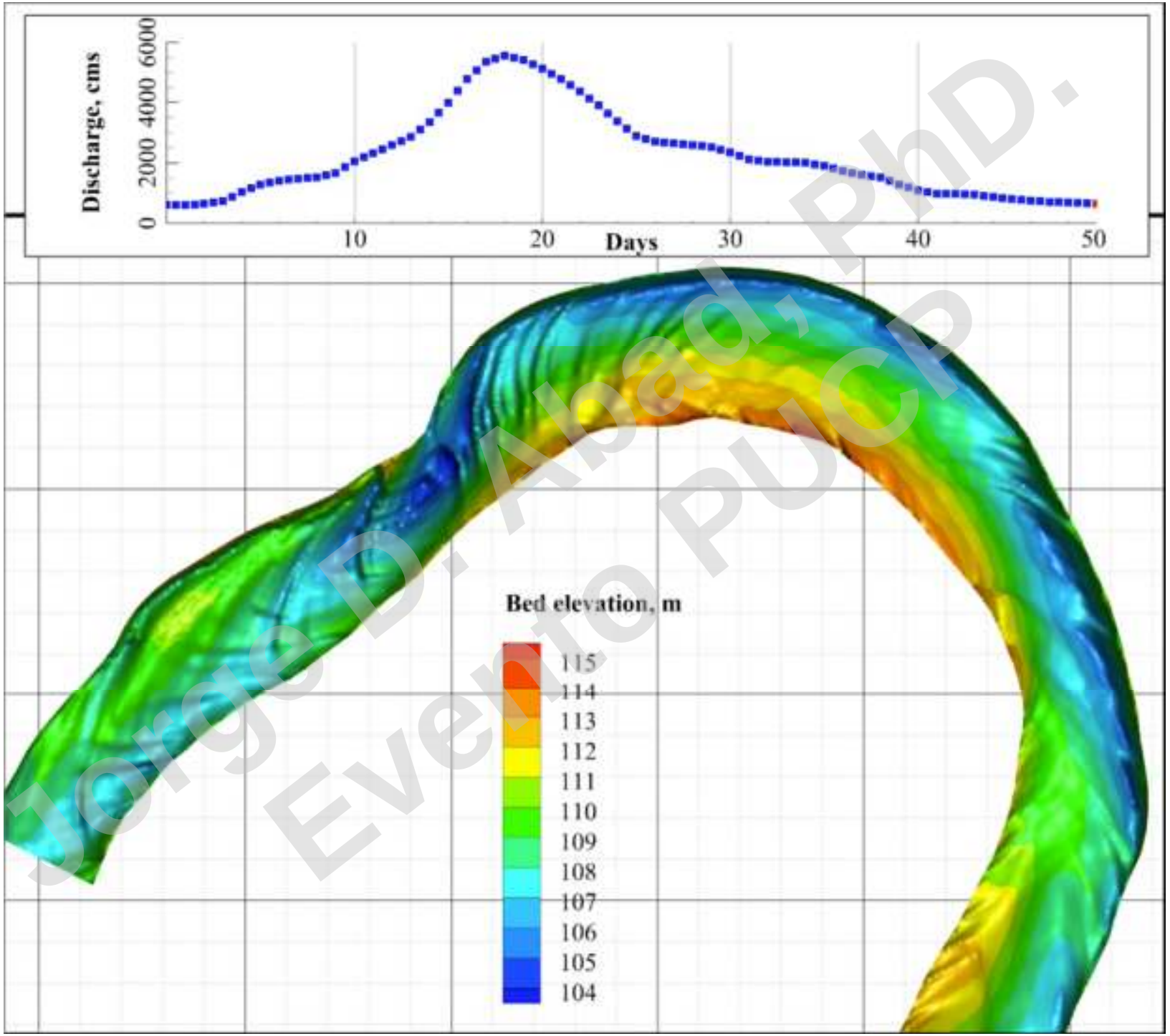


Langendoen, E., Mendoza, A., **Abad, J. D.**, Tassi, P., Wang, D., Ata, R., El Kadi Abderrezzak, K., Hervouet, J-M. (2015), Advances in Water Resources.

Bedform evolution s important?

Li, Z., Mendoza, A., Abad, J. D. et al. In review, Geophysical Research Letters

Li, Z., Abad, J. D. In preparation, Geophysical Research Letters



CARACTERIZAR NO A ESCALA LOCAL

EJEMPLO – RIO AMAZONAS PERUANO

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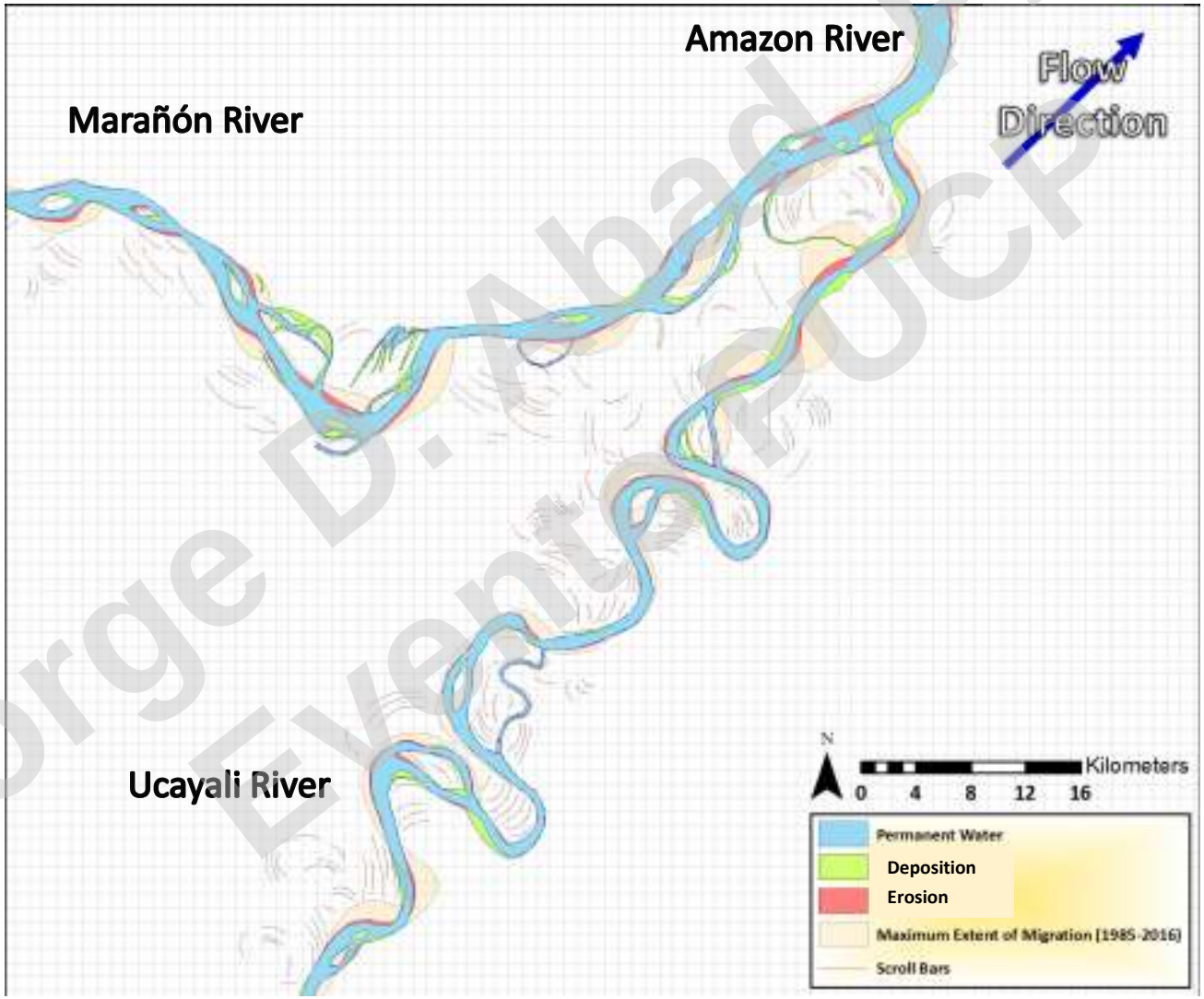
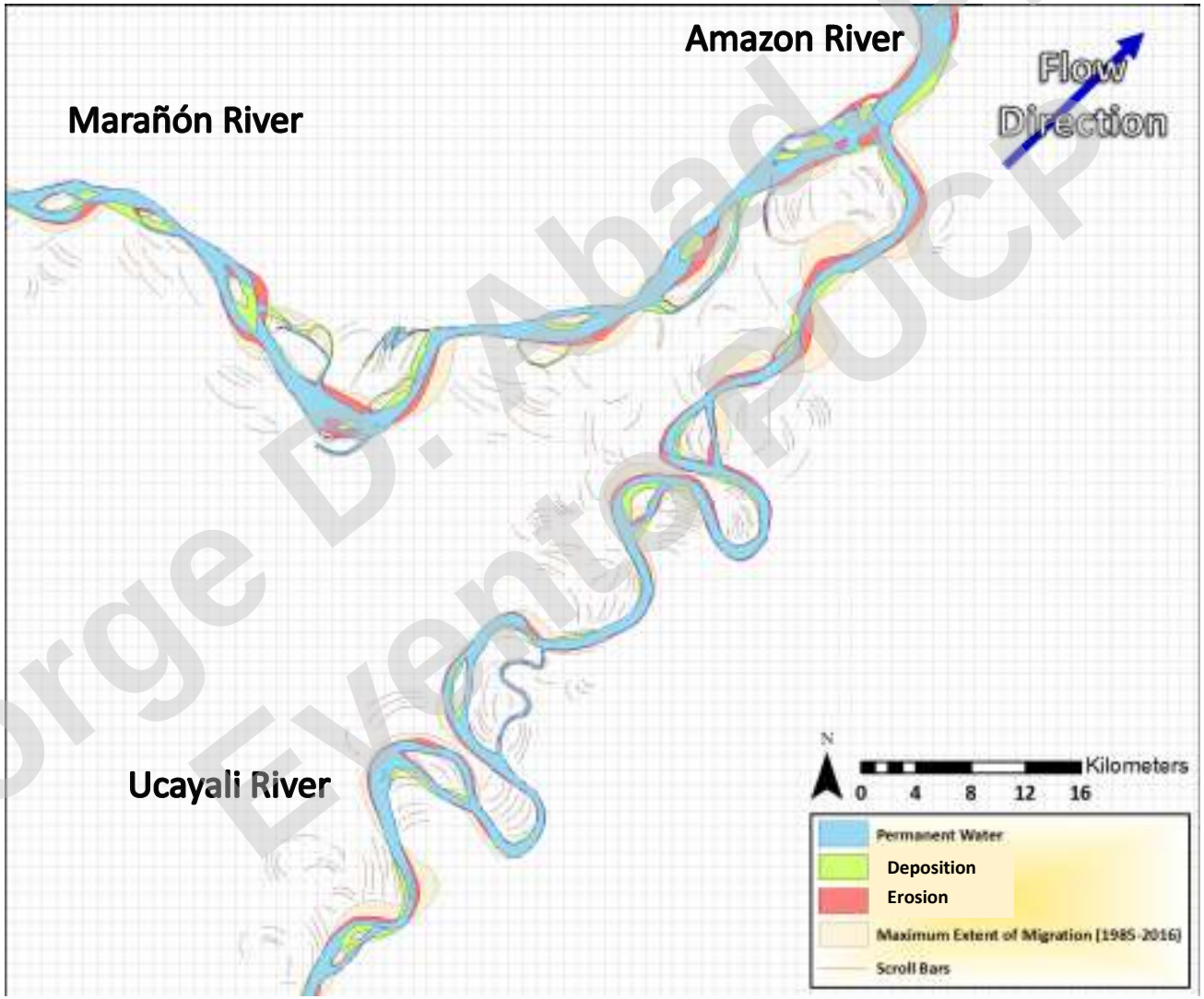
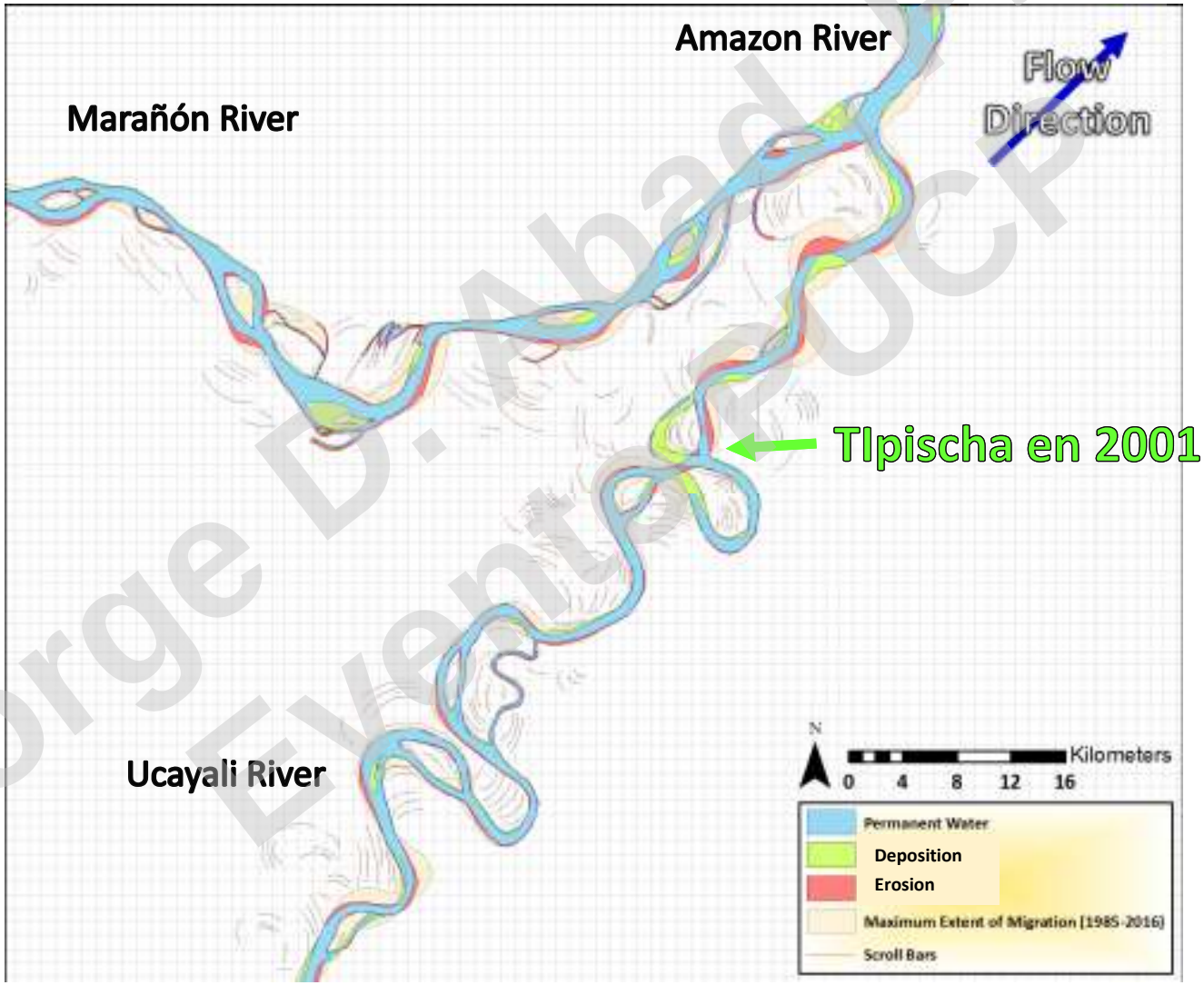
La evolución entre 1985 – 1989



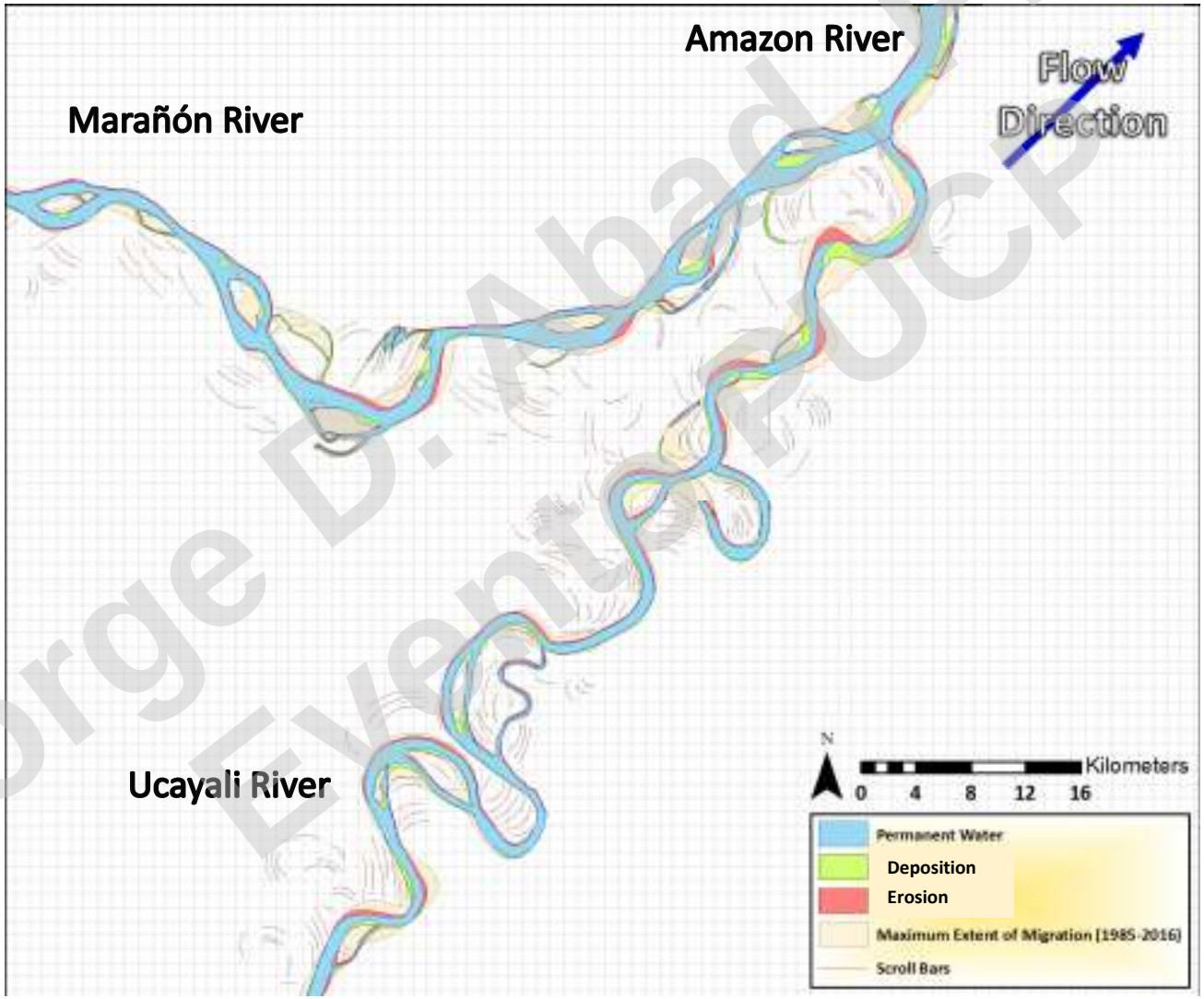
La evolución entre 1989 – 1996



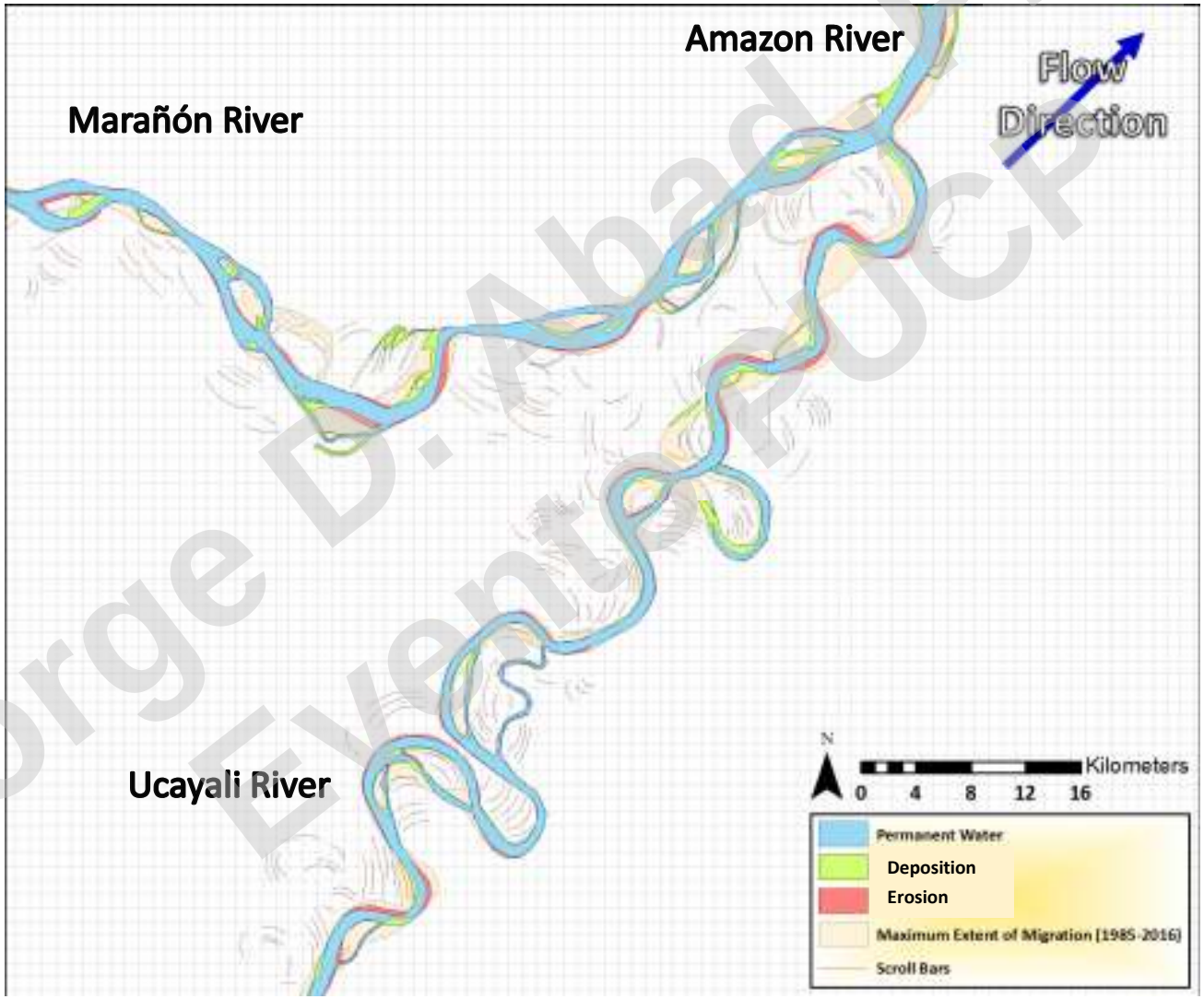
La evolución entre 1996 - 2001



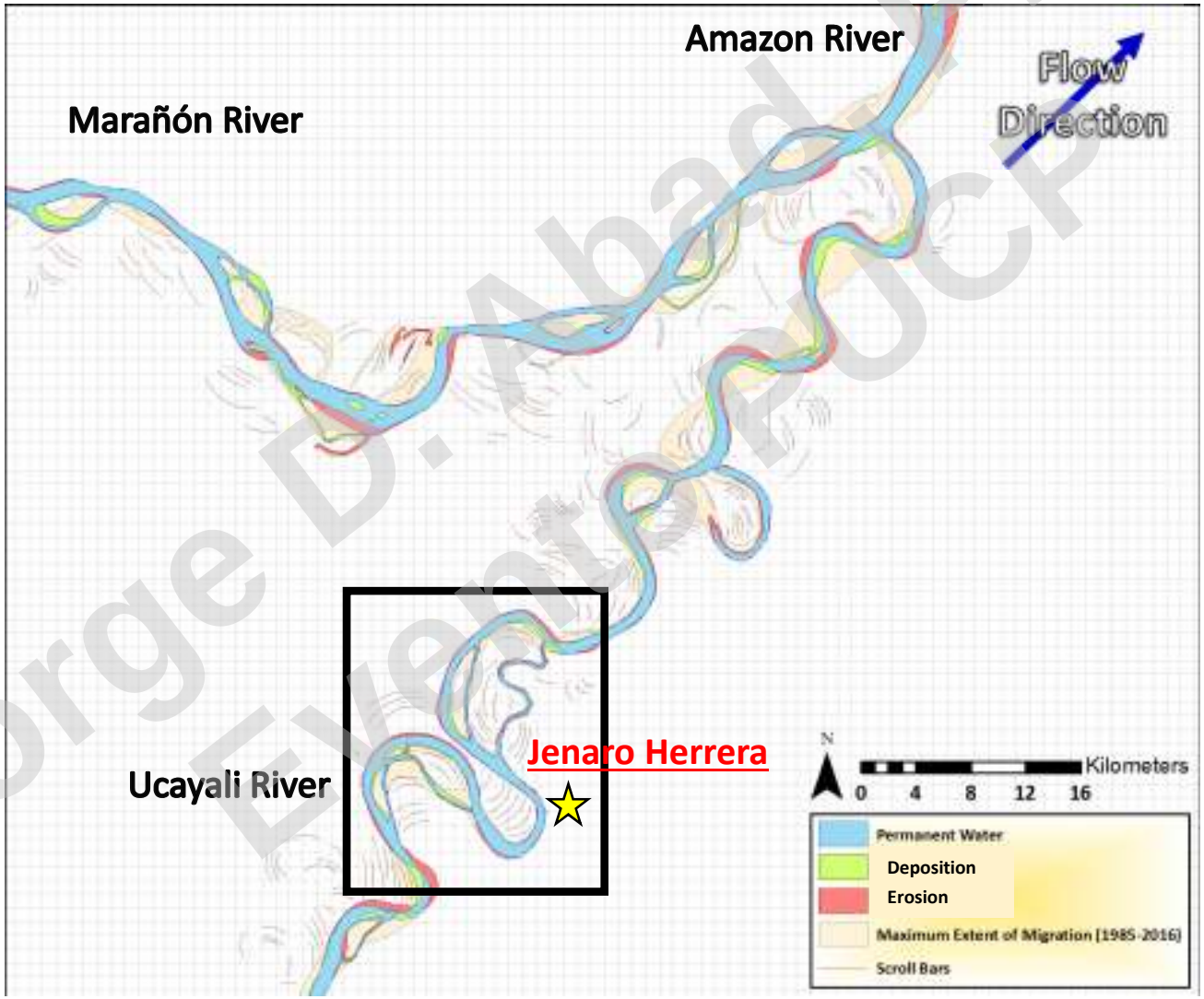
La evolución entre 2001 - 2005



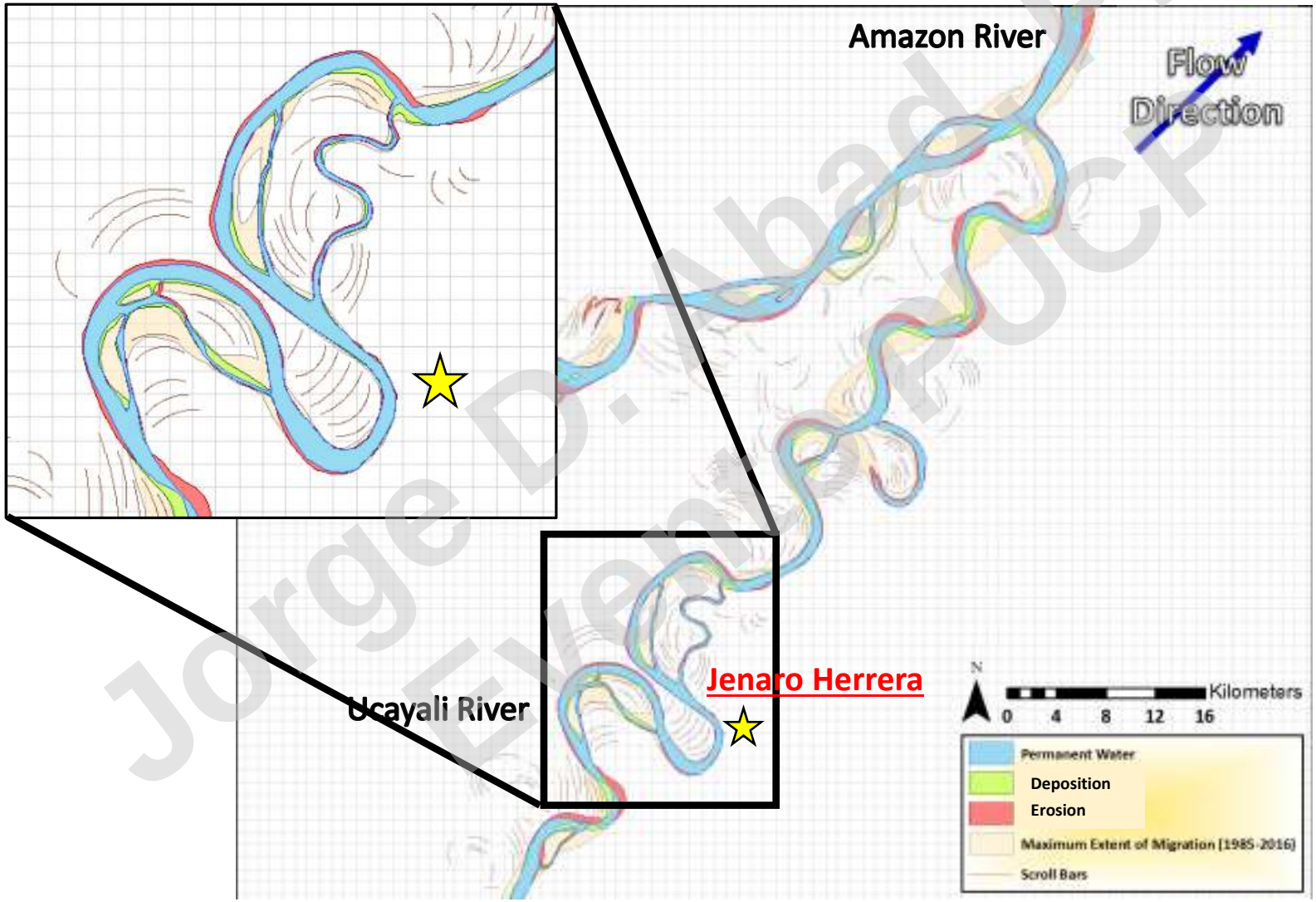
La evolución entre 2005 - 2010

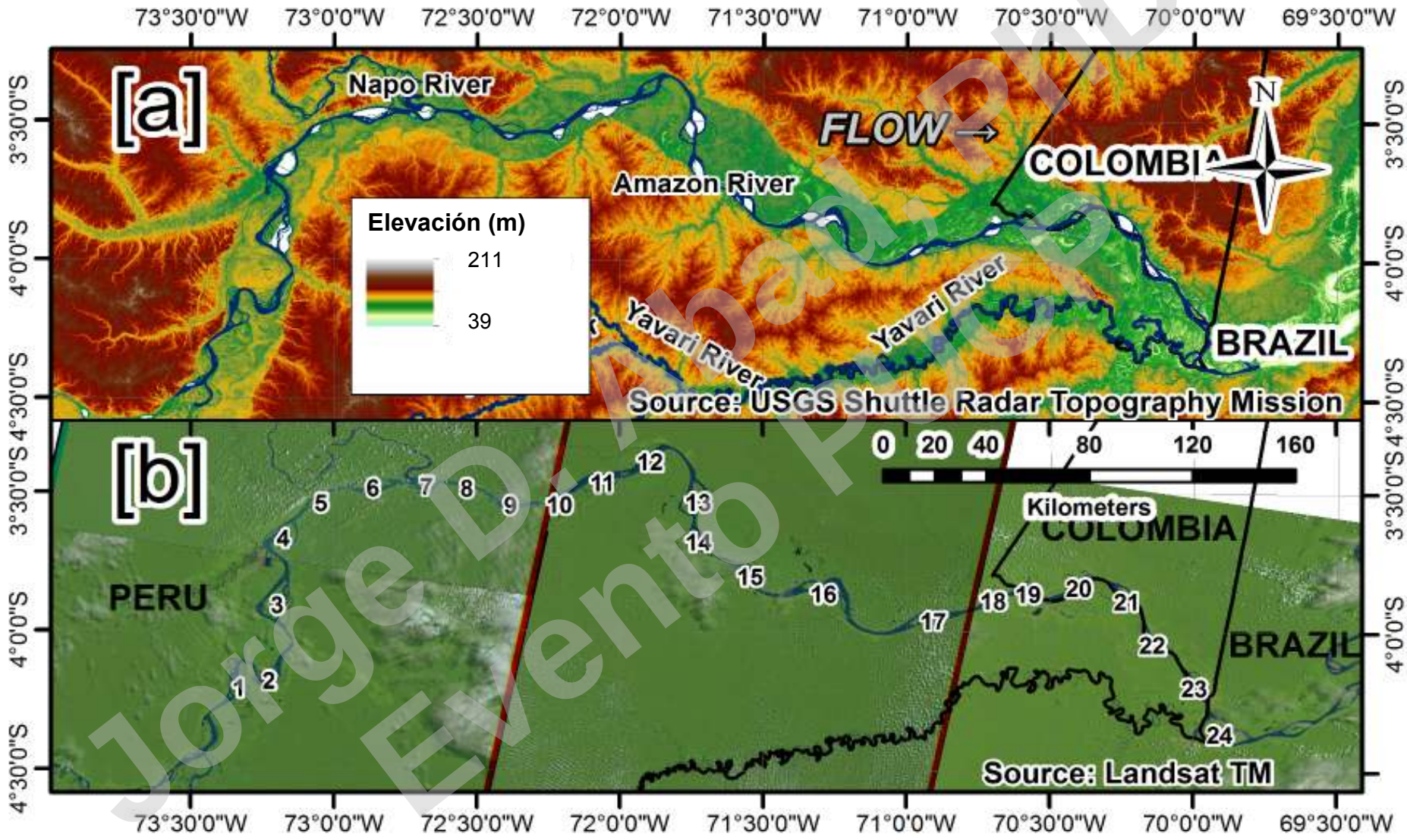


La evolución entre 2010 - 2016

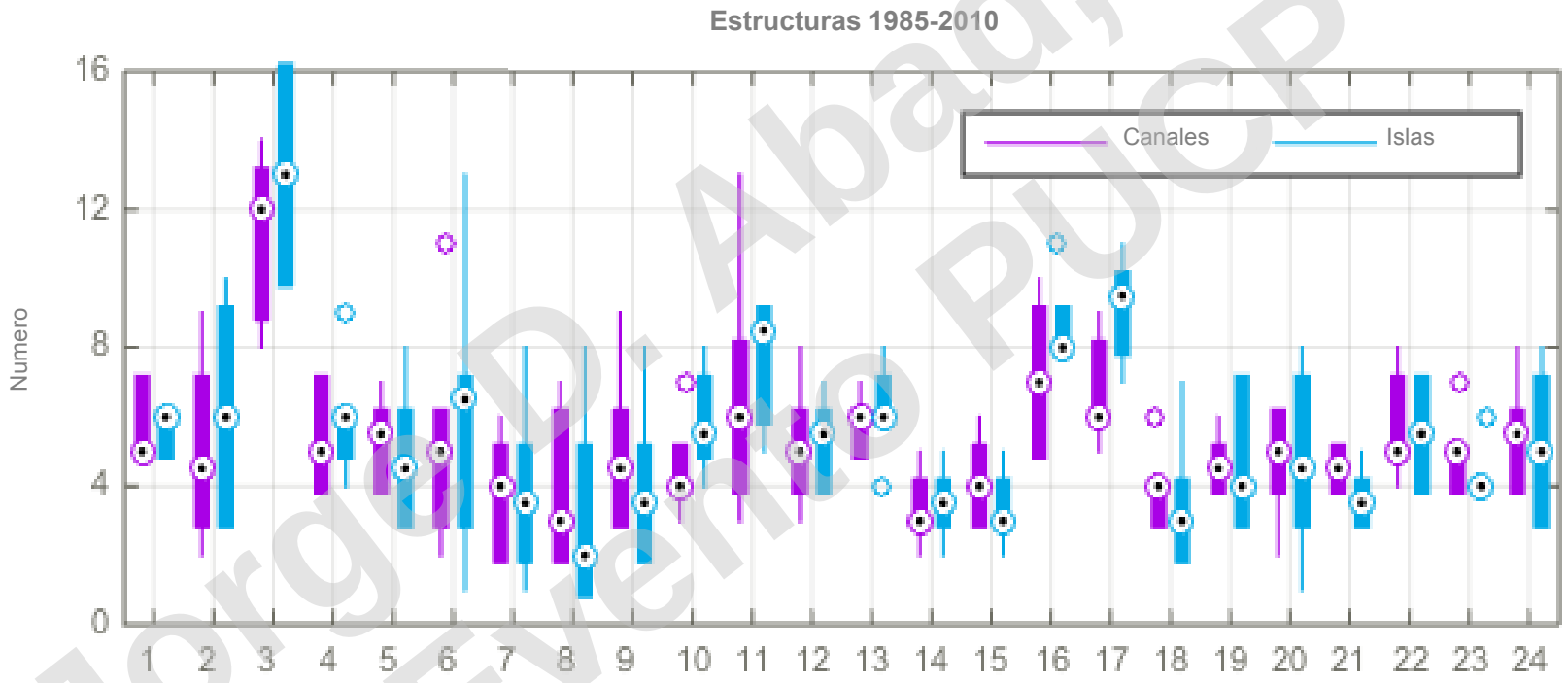


La evolución entre 2010 - 2016

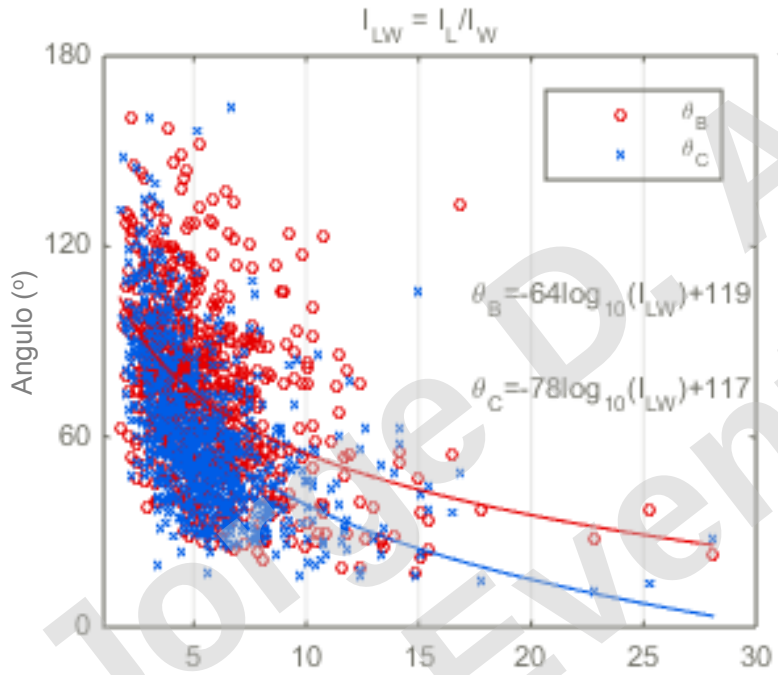


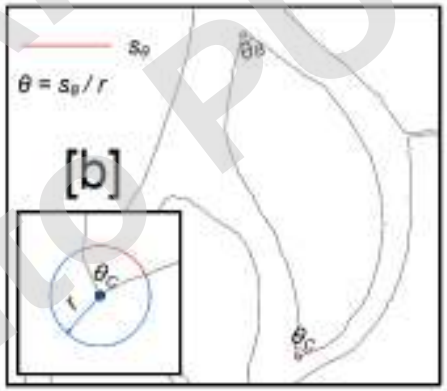


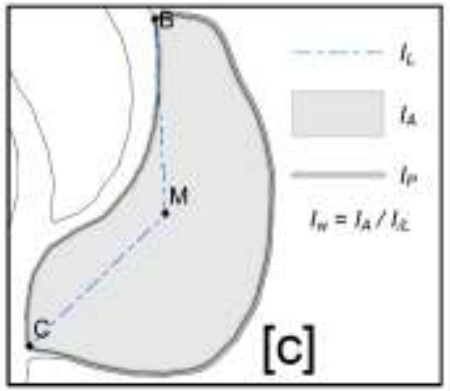
Número de canales e islas



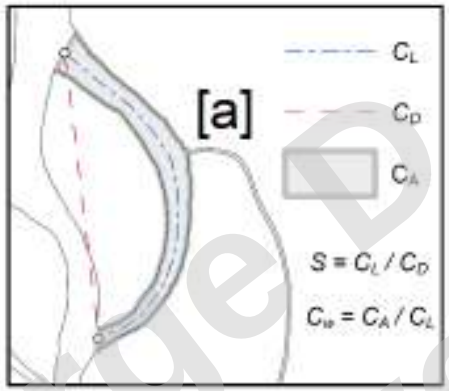
Análisis de las islas

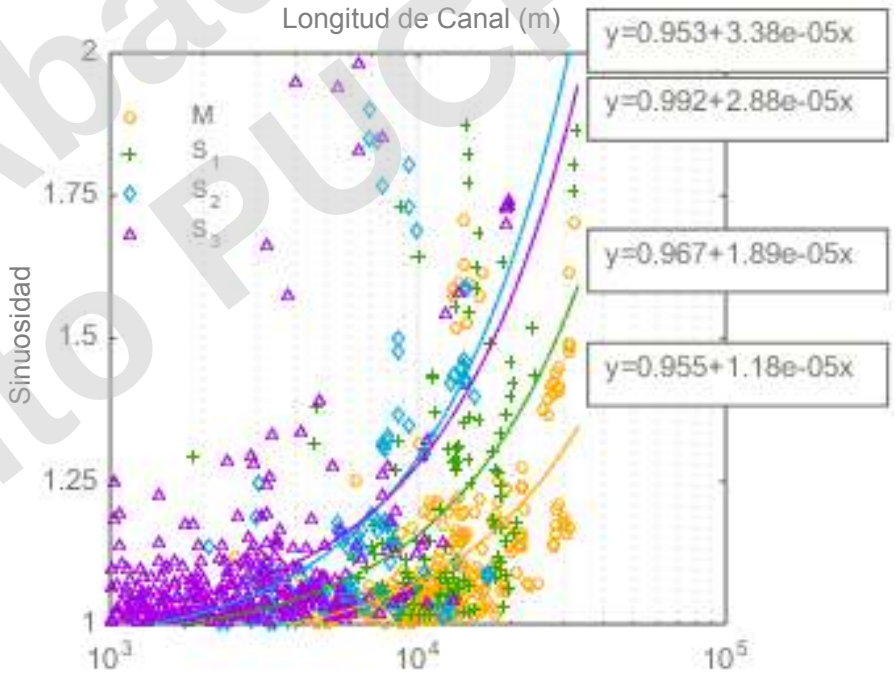




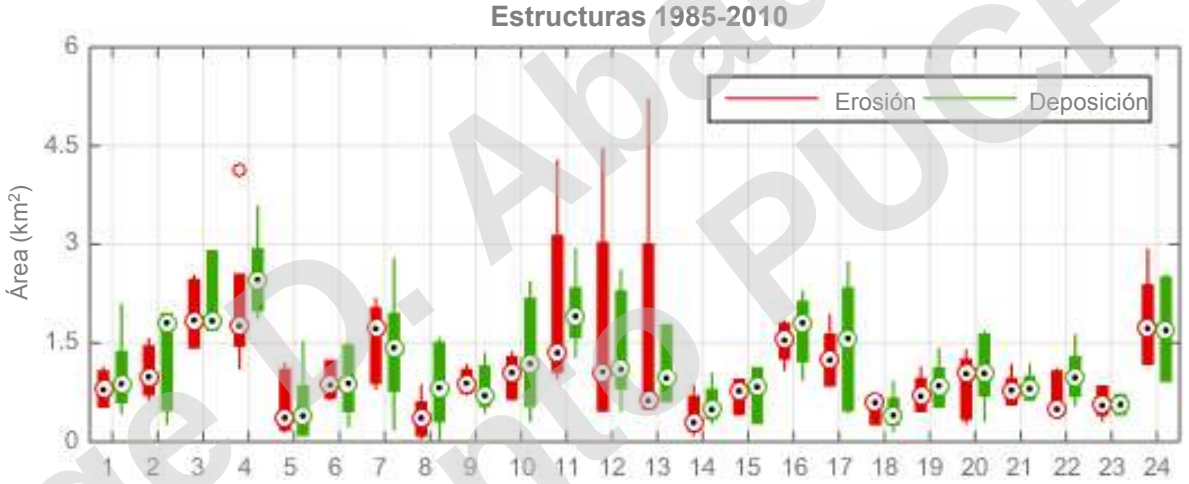


Análisis de los canales

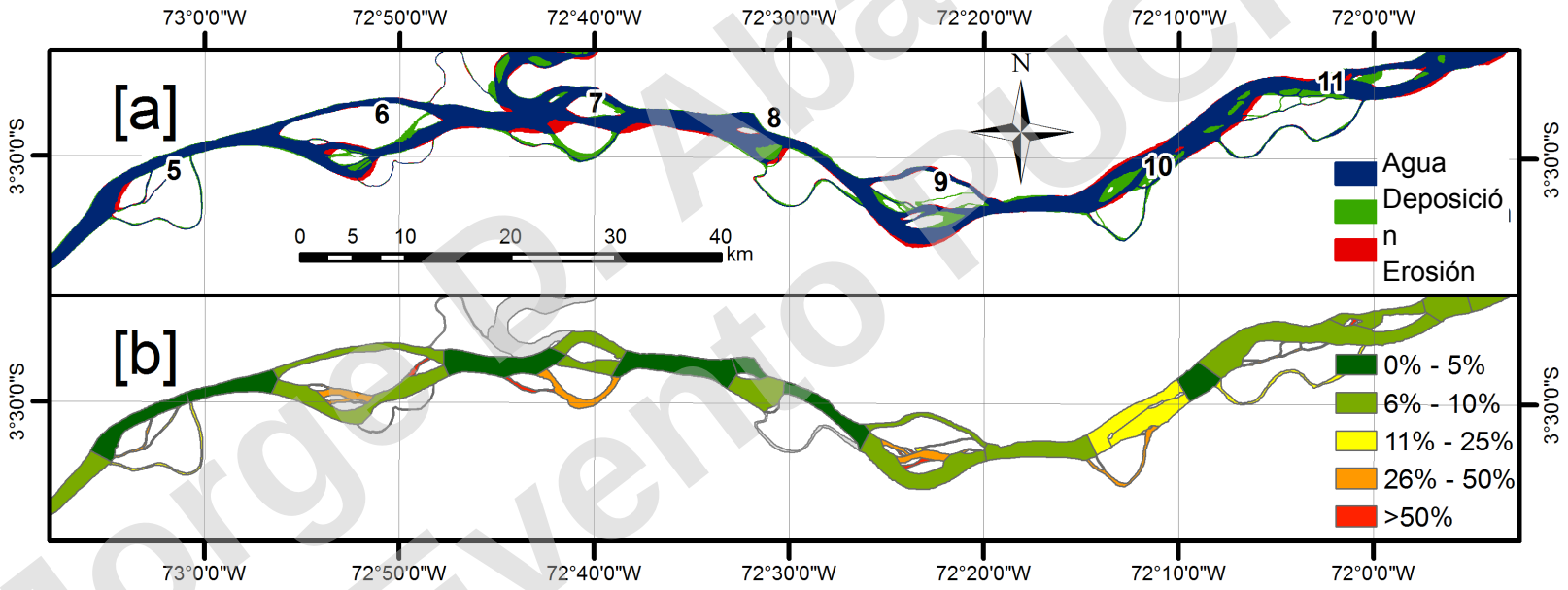




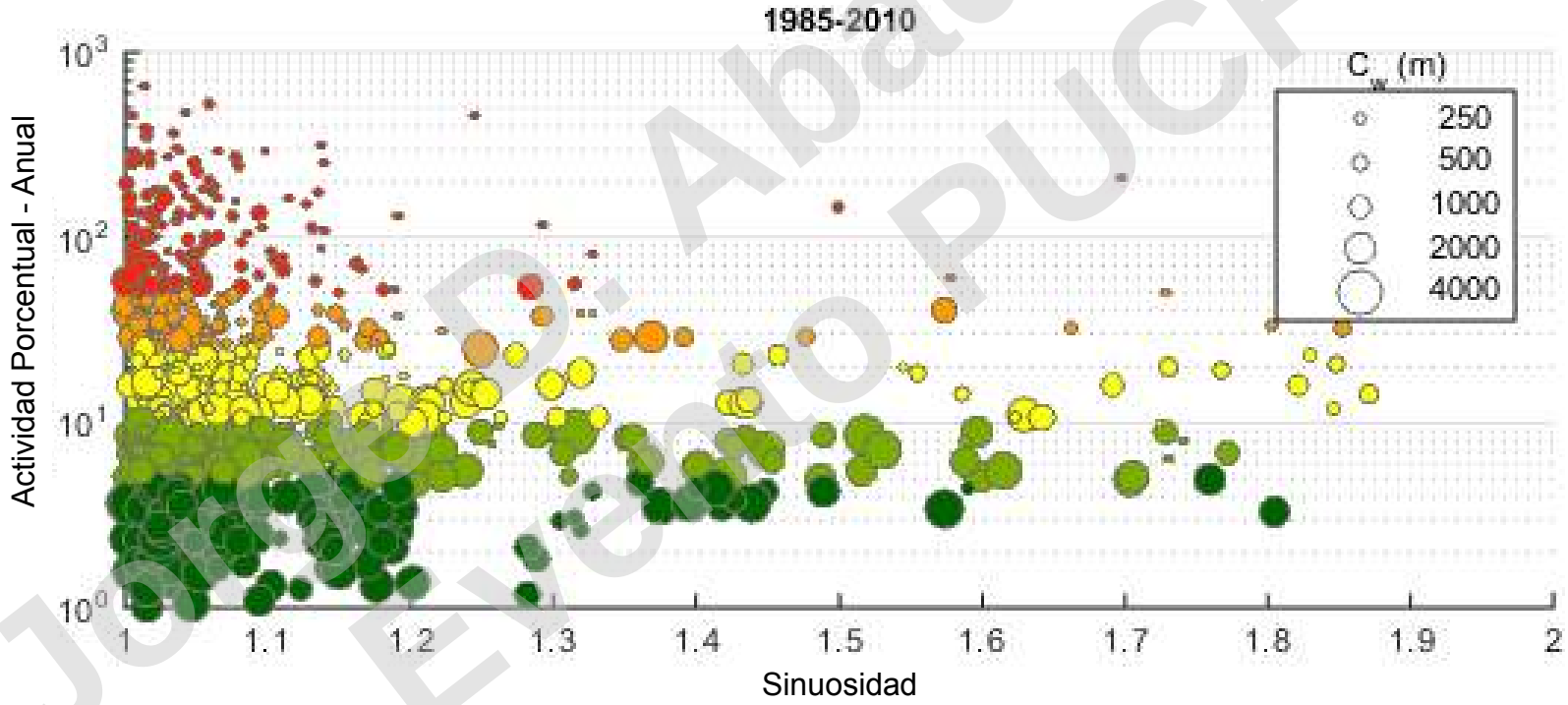
Análisis de erosión y deposición



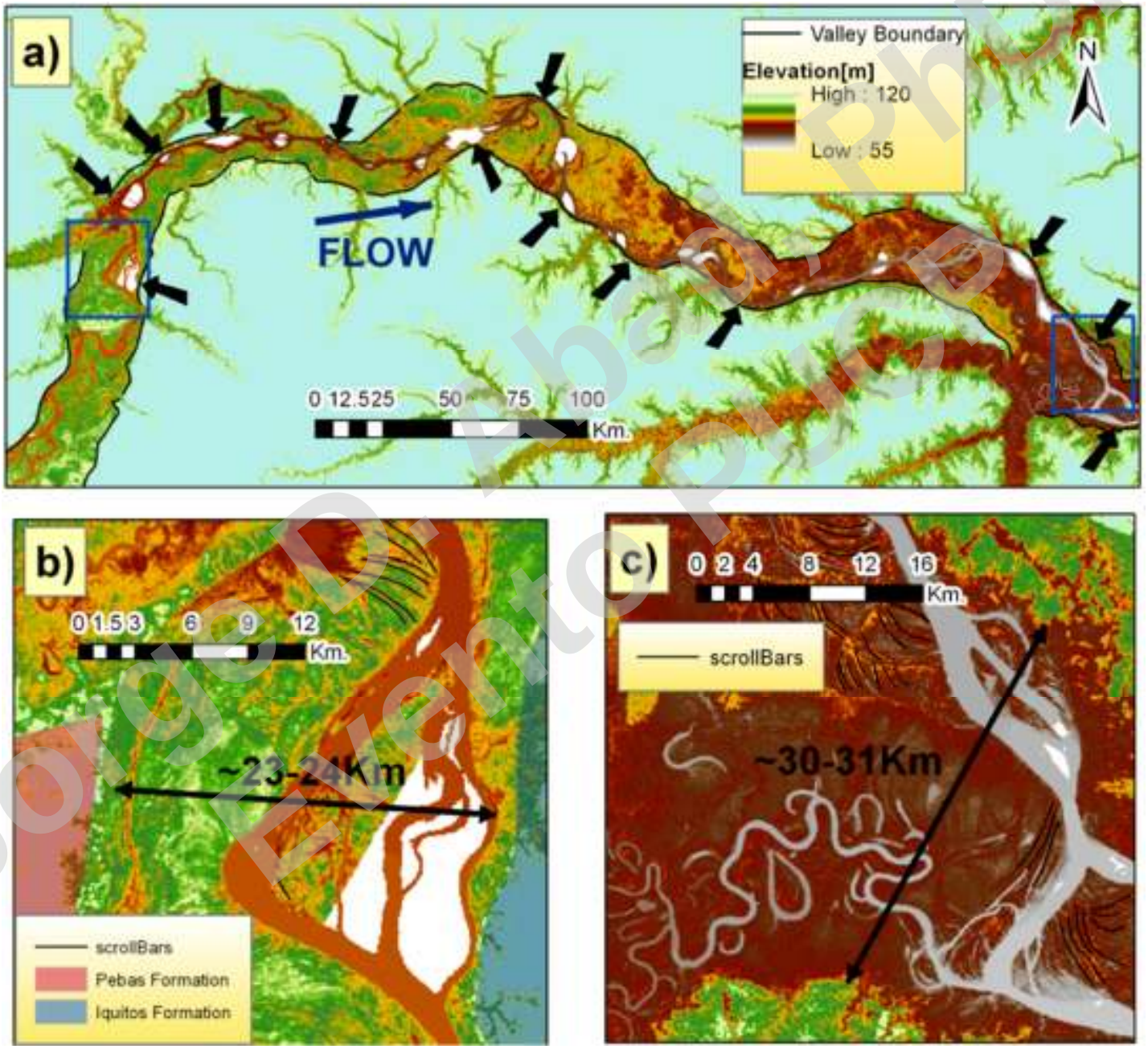
La actividad de los canales $\left(\%A = \frac{(\sum E + \sum D)}{100 A_c}\right)$



Actividad y sinuosidad de los canales

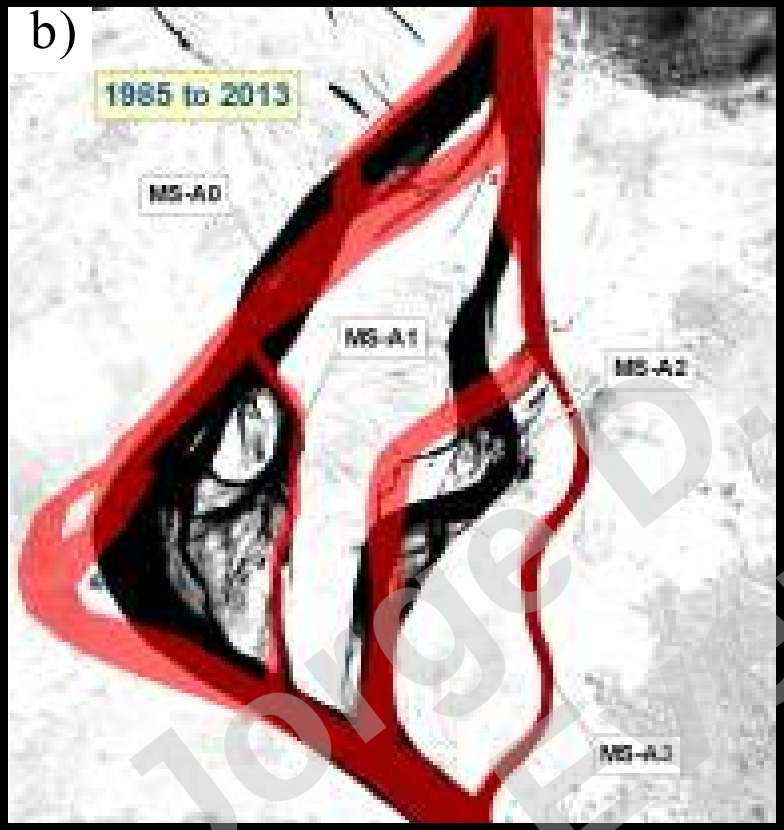


Anabranching structures along the Peruvian Amazon River

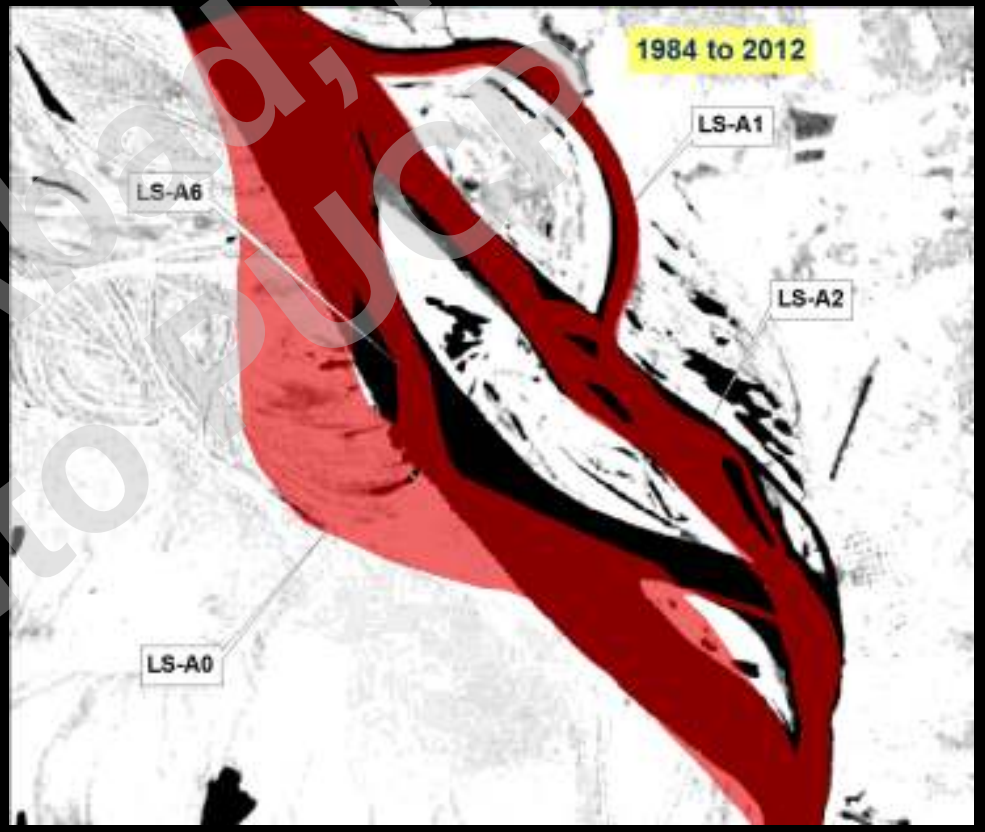


❑ Who does the reworking of the floodplain Why?

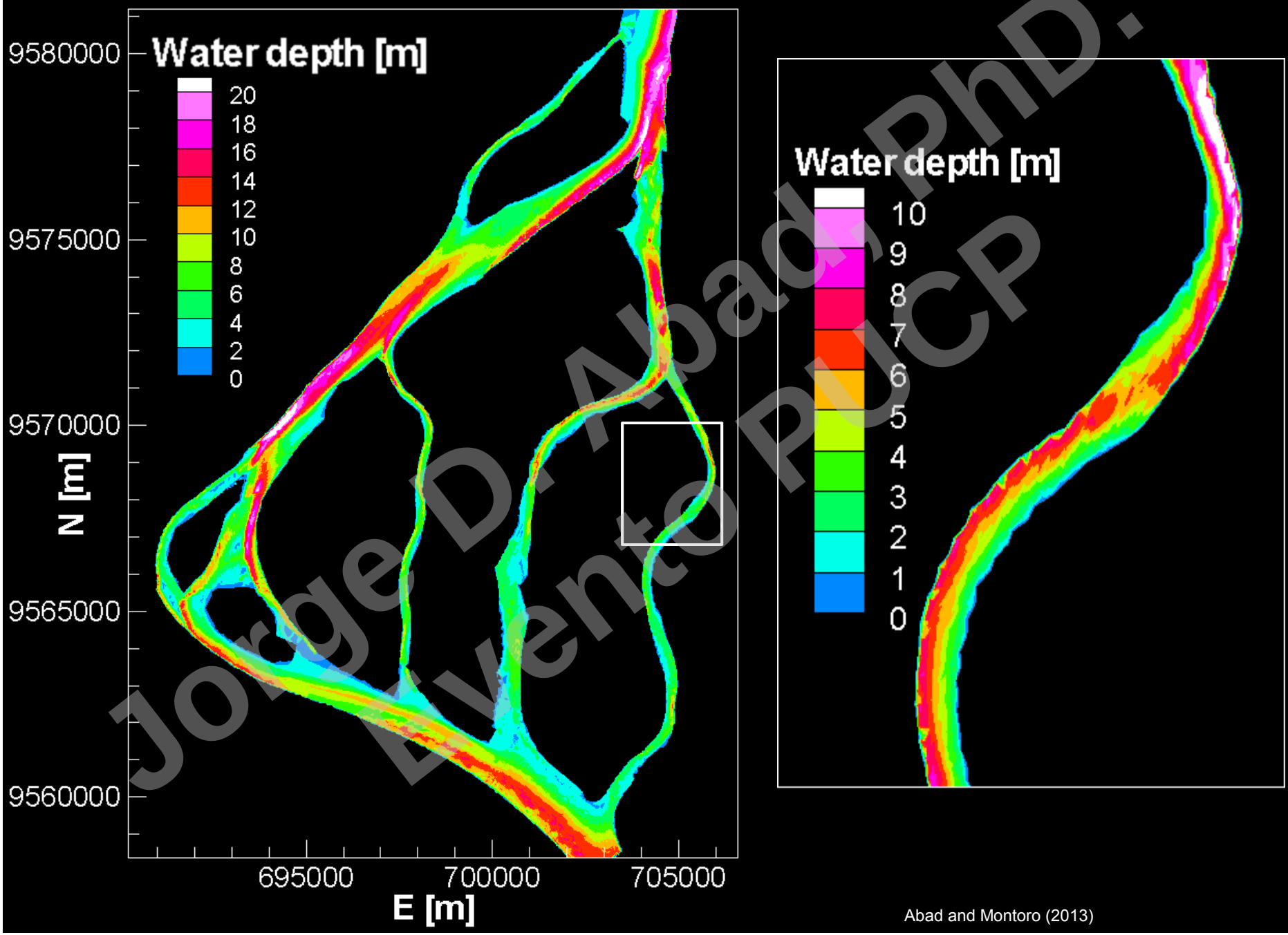
MS - Muyuy



LS – Leticia-Santa Rosa

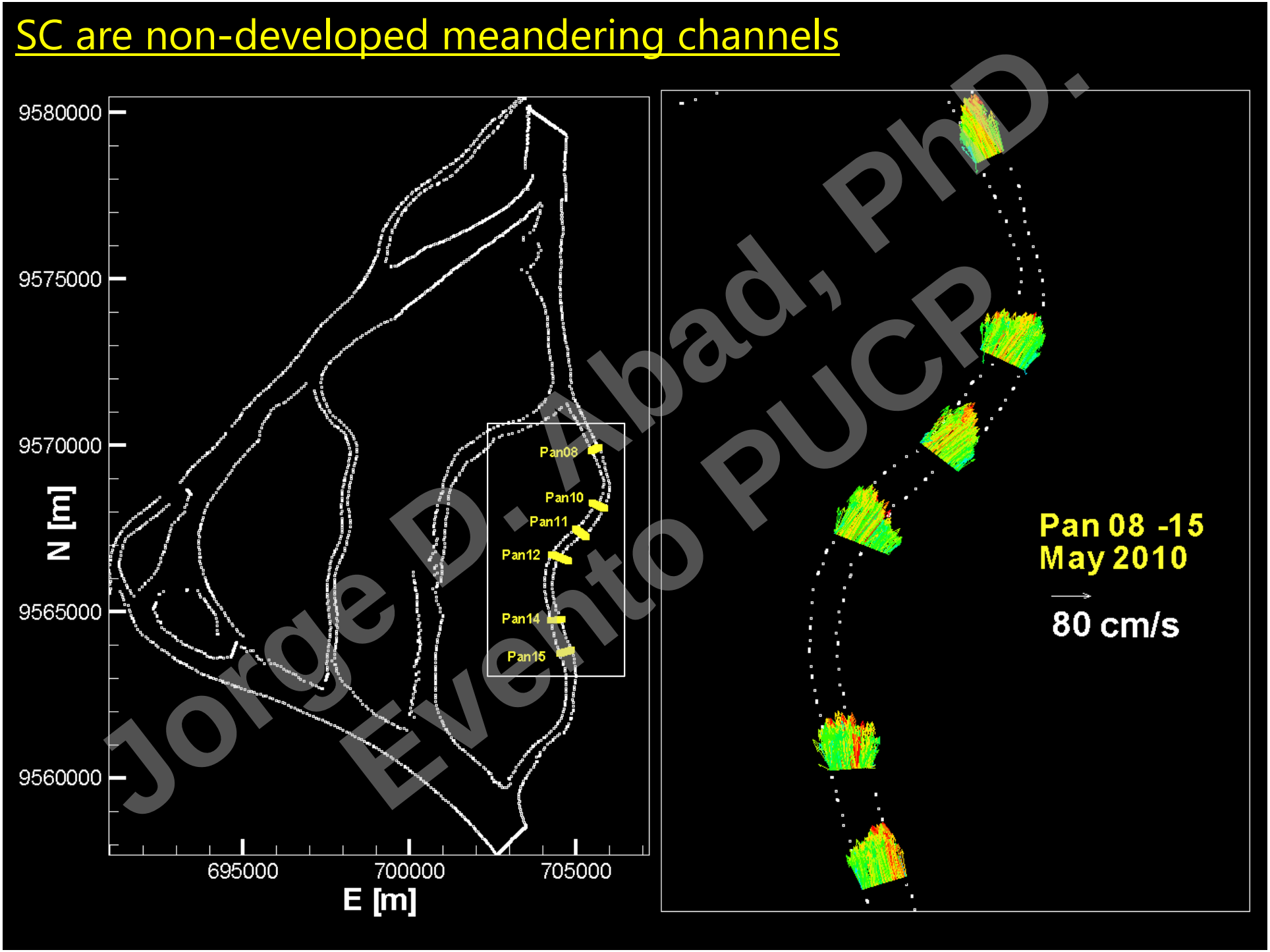


Single beam measurements (Aug 2010) – low flow



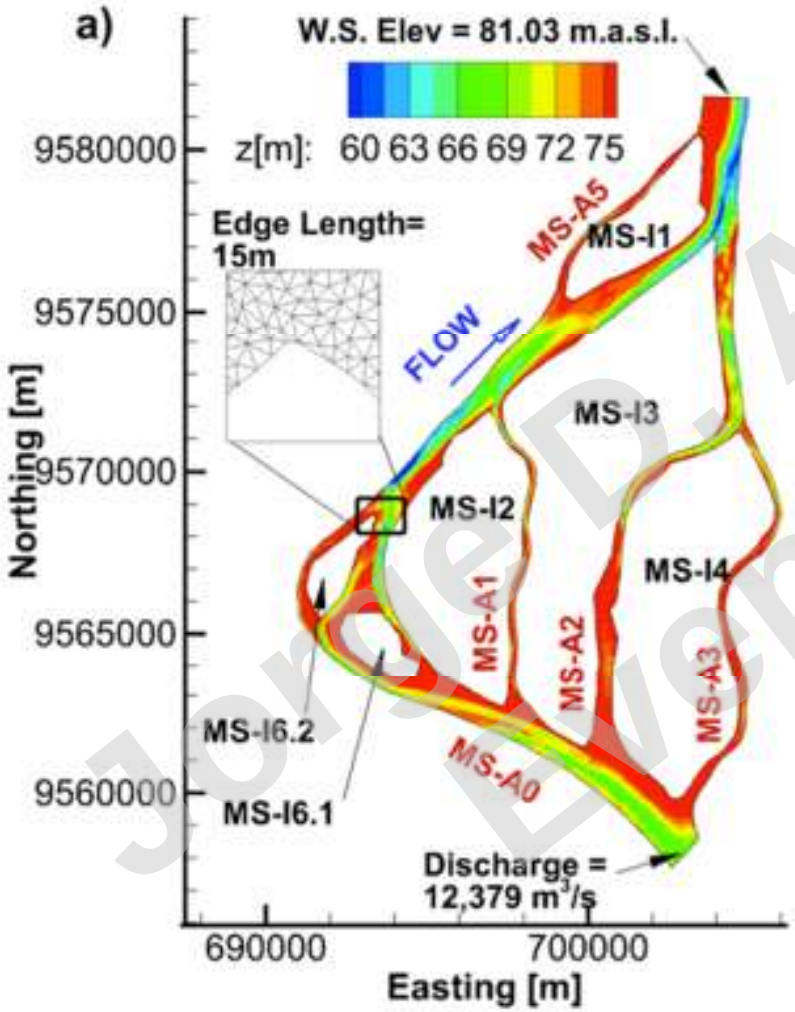
Abad and Montoro (2013)

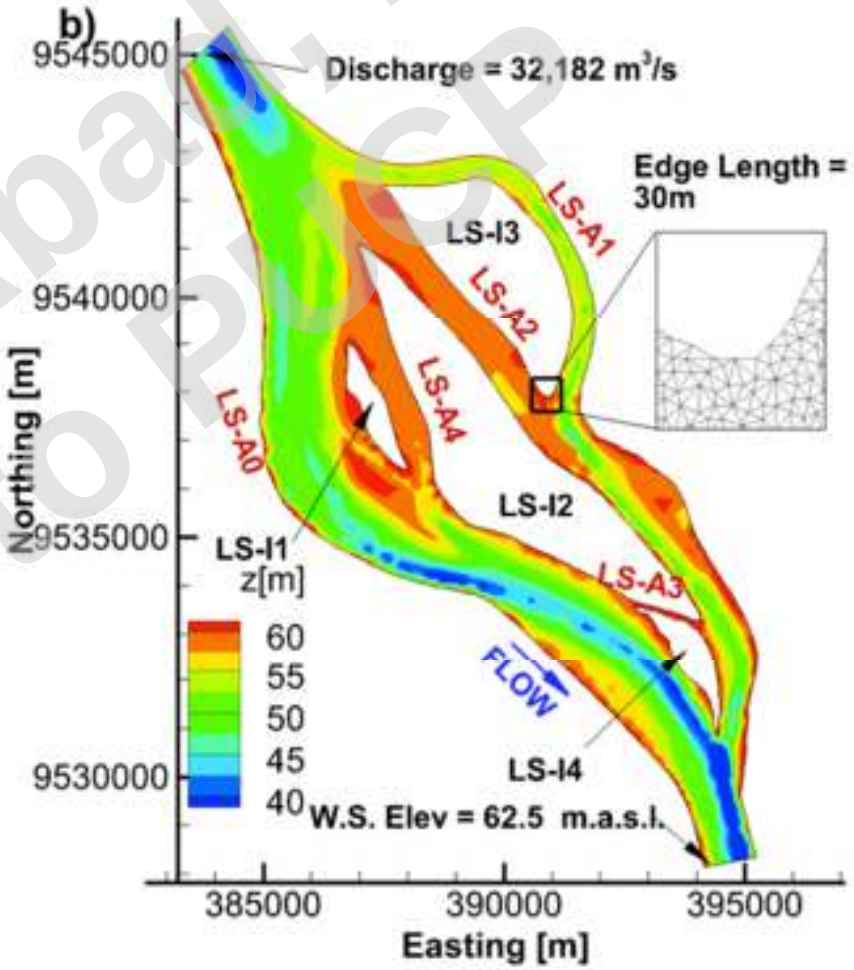
SC are non-developed meandering channels



h-l trans MS

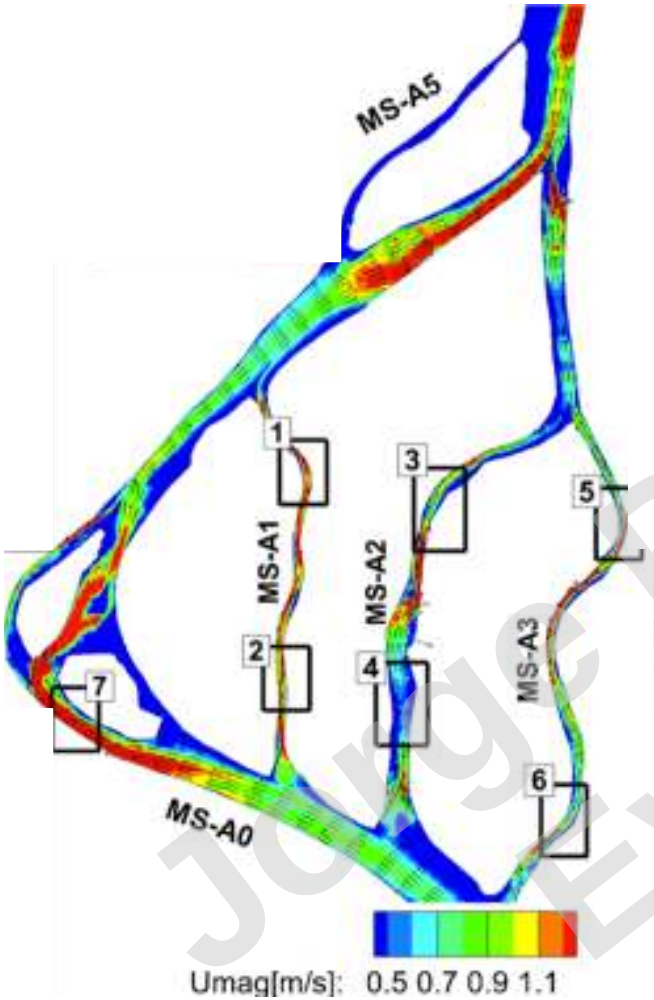
l-h trans LS



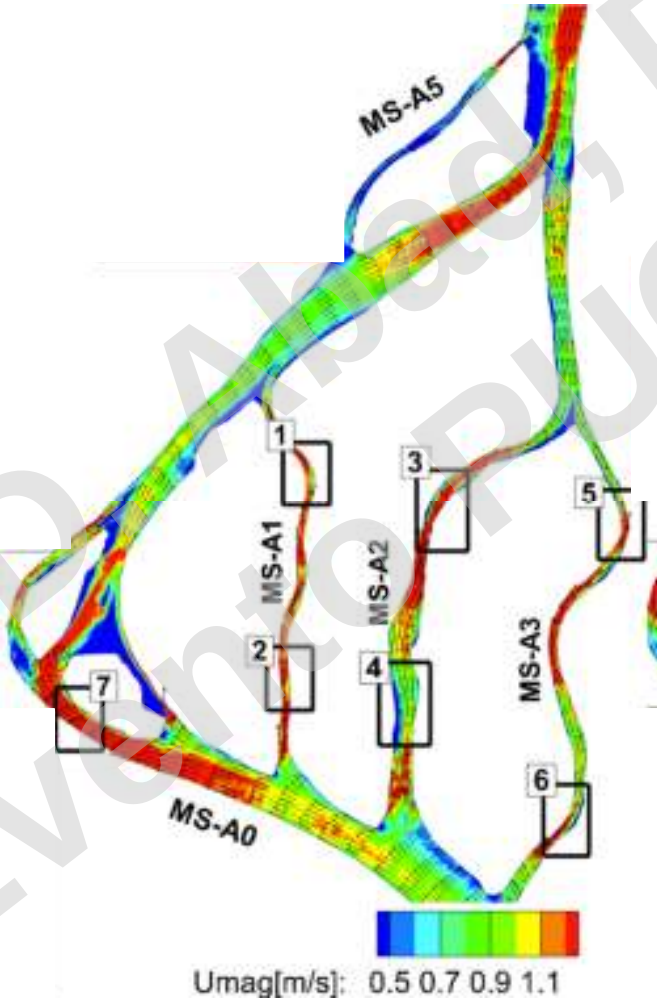


MS site

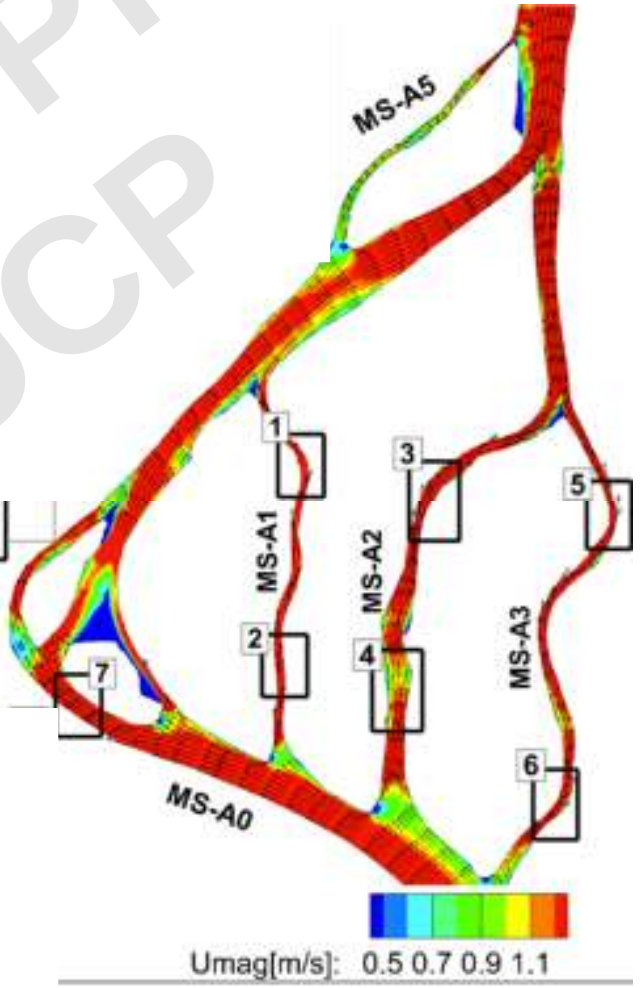
Low-flow (p)



Medium-flow (m)

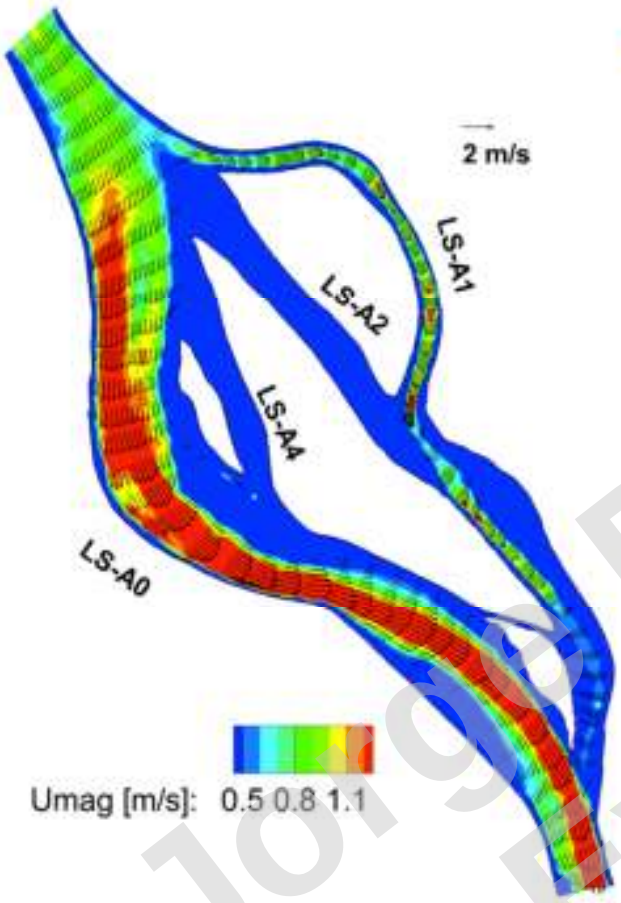


High-flow (p)



LS site

Low-flow (p)



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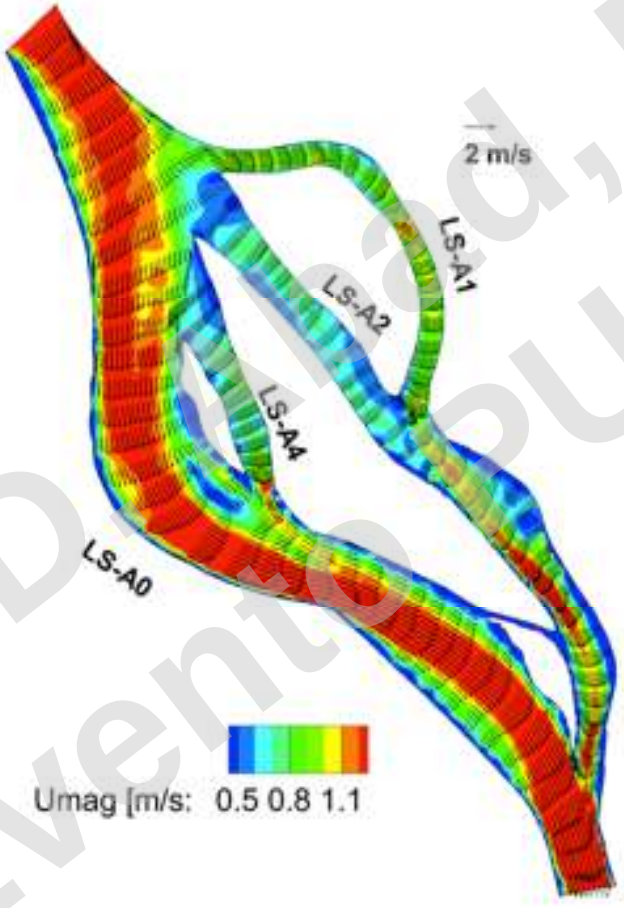
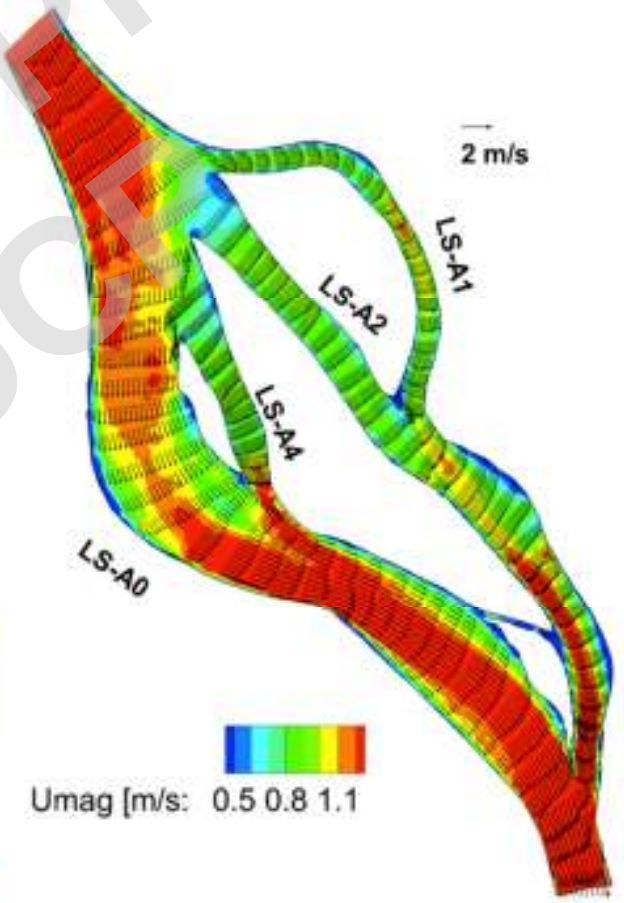
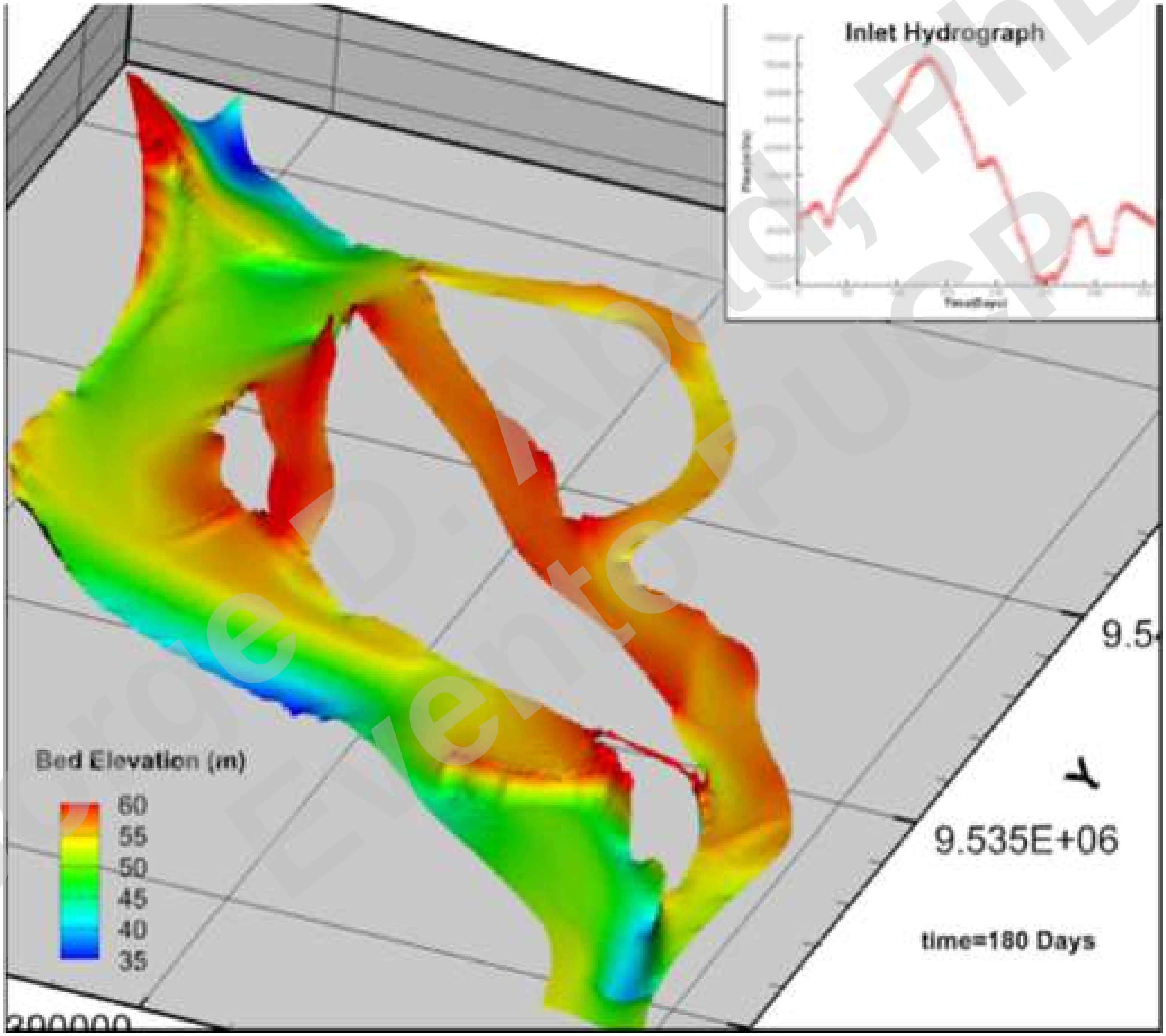


High-flow (p)



Numerical modeling at natural scale

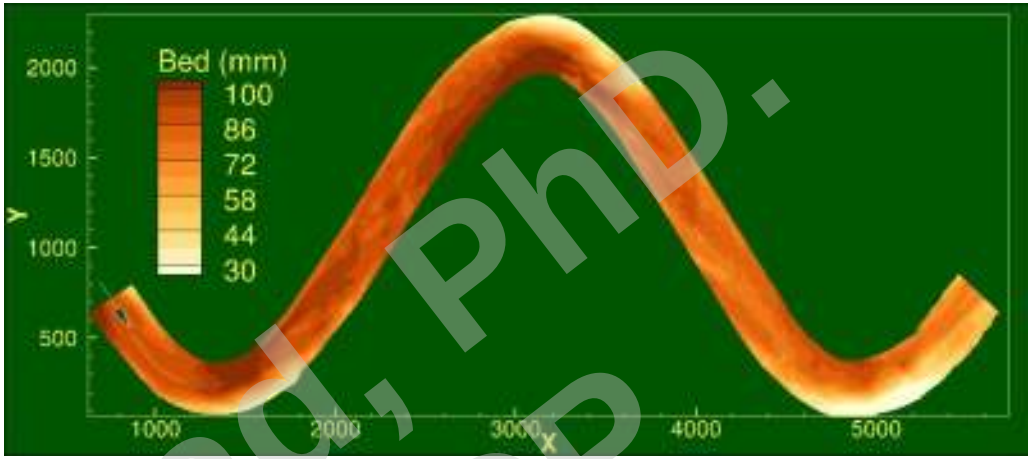


Ongoing work

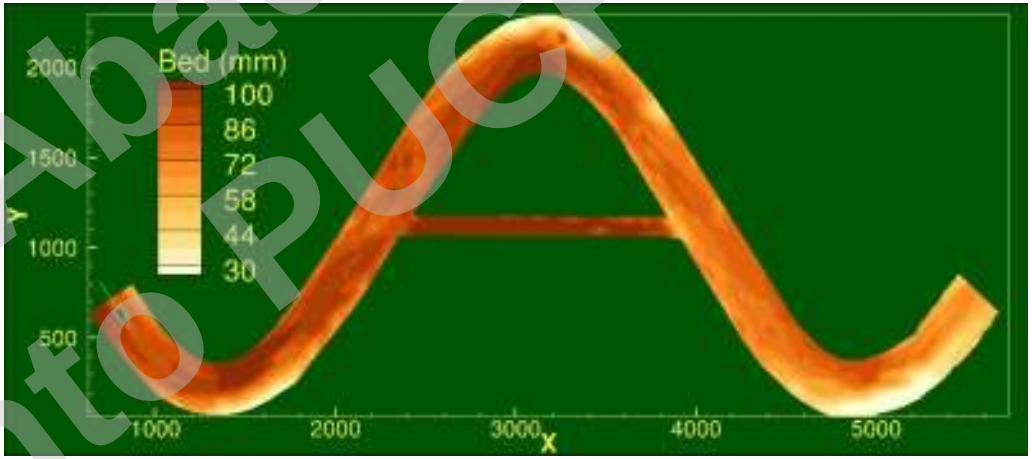
Basic Research

FIRST EXPERIMENTS

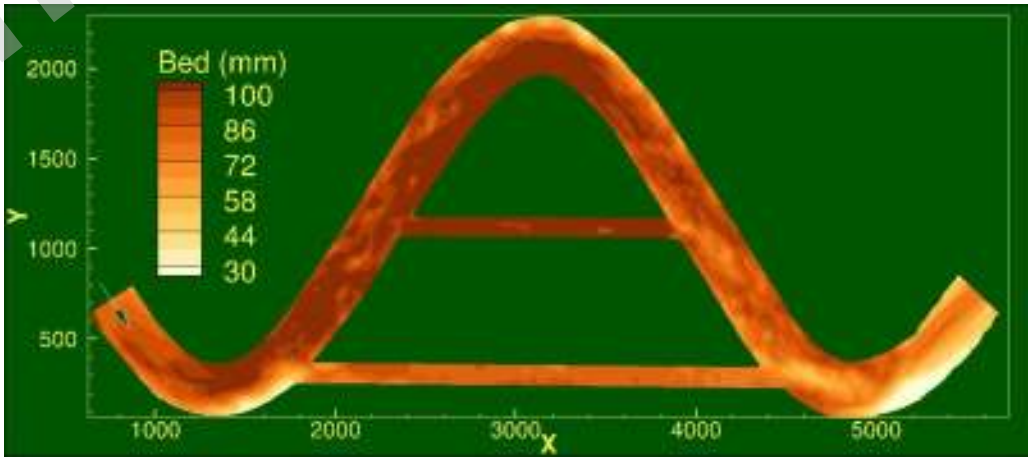
MAIN CHANNEL



MAIN CHANNEL+SECONDARY CHANNEL NEAR THE INFLECTION POINT



MAIN CHANNEL+SECONDARY CHANNELS NEAR THE INFLECTION AND APEX POINTS



PROPUESTA

- **Faltan estudios morfológicos de los ríos Amazónicos**

- **Los ríos Huallaga, Marañón, Ucayali y Amazonas influencian los demás ríos e interacción con el ecosistema**

- **Formación de grupo de trabajo**

- **Gestión del transporte acuático – Ministerio de Transportes y Comunicaciones**

- **Datos Hidrológicos – Senamhi**

- **Datos de Sedimentos, Hidrodinámicos, Morfodinámicos – SHNA**

- **Monitoreo y predicción – Estudios científicos! – Universidades peruanas**
  - **Que aseguren la funcionalidad del rio**
  - **Desarrollo de capacidades locales**

- **Dragado – Privado**

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MUCHAS GRACIAS!

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