RESTORING PROCESS IN RIVERS: 15TH ANNUAL BERKELEY RIVER RESTORATION SYMPOSIUM, 7 DECEMBER, UC BERKELEY

Revitalizing rivers: learning from a few European case-studies

Hervé Piégay

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FROM THE MYTH OF A LOST PARADISE TO TARGETED RIVER RESTORATION: FORGET NATURAL REFERENCES AND FOCUS ON HUMAN BENEFITS

SIMON DUFOUR[a*] and HERVÉ PIÉGAY[b]

RIVER RESEARCH AND APPLICATIONS

River. Res. Applic. (2009)

Published online in Wiley InterScience (www.interscience.wiley.com) DOI: 10.1002/rra.1239

The progressive emergence of concepts and terminology to design actions within the restoration / rehabilitation framework

Restoration, rehabilitation…	
The **complete structural and functional return** to a pre-disturbance state	Cairns 1991 cited by Brookes and Shields (1996)

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Restoration, rehabilitation…	
The complete structural and functional return to a pre-disturbance state	Cairns 1991 cited by Brookes and Shields (1996)
Ecological restoration is the process of **assisting the recovery** of an ecosystem that has been degraded, damaged, or destroyed to **repair ecosystem processes, productivity and services**, as well as re-establish the pre-existing biotic integrity in terms of species composition and community structure. Restoration thus consists in correcting multiple changes in various components of the ecosystem (also called rehabilitation by Aronson et al. 1993).	SER, 2004

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Restoration, rehabilitation…	
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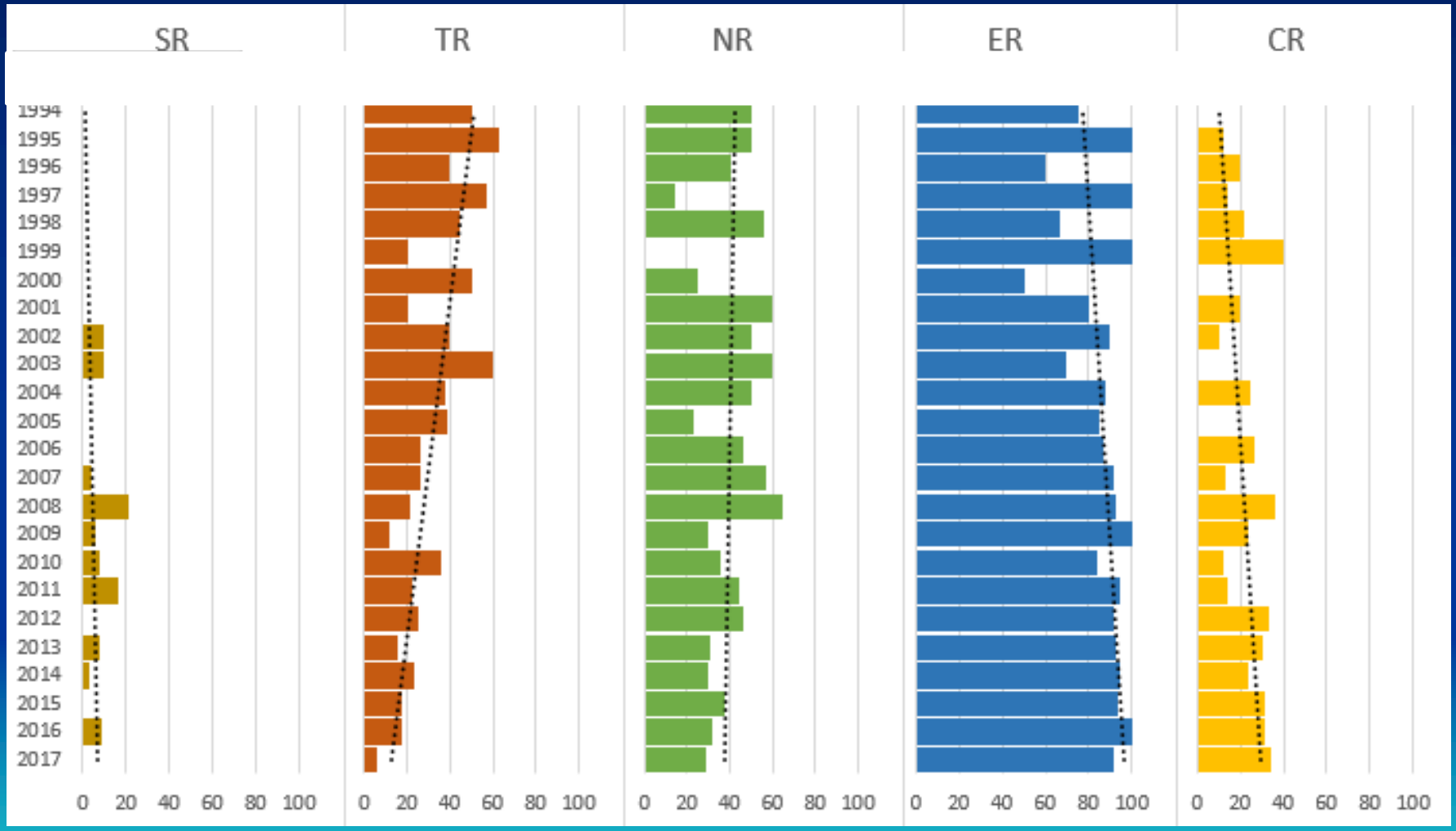
Eco eco eco esta con correcting multiple changes in various components of the ecosystem (also called rehabilitation by Aronson et al. 1993).	
Associated notions	
An environment is **healthy** when the supply of goods and services required by both human and nonhuman residents is **sustained**	Karr (1999) see also Norris and Thoms, 1999; Bunn et al., 1999; Vugteveen et al. (2006)

Fight nature to survive => Live with nature to survive

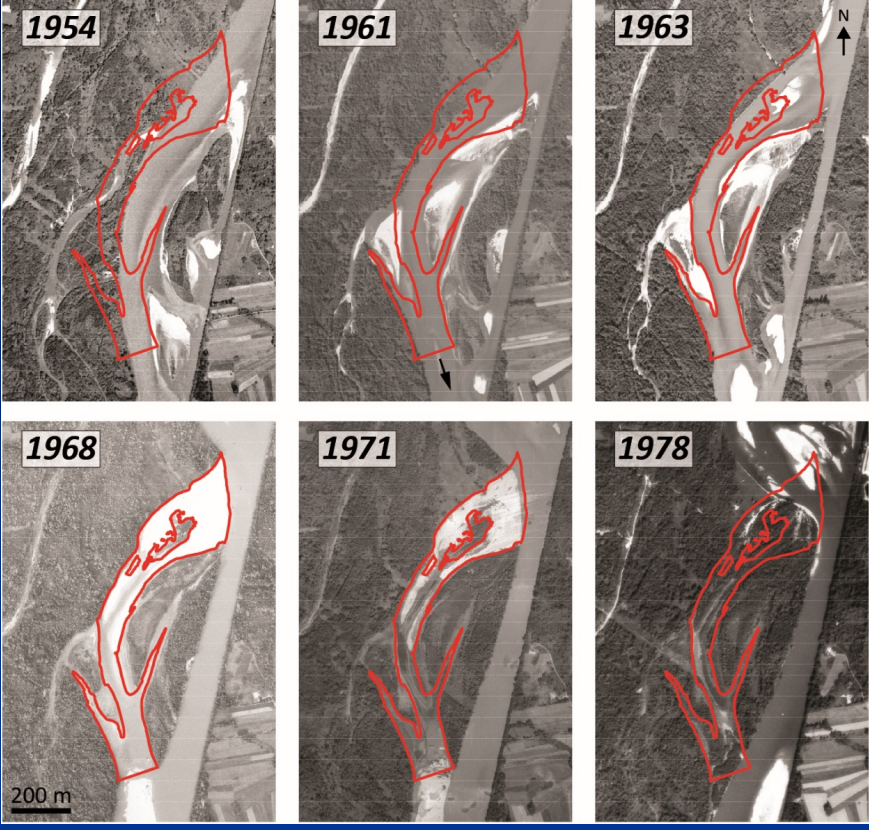
River is a natural infrastructure we need to take care

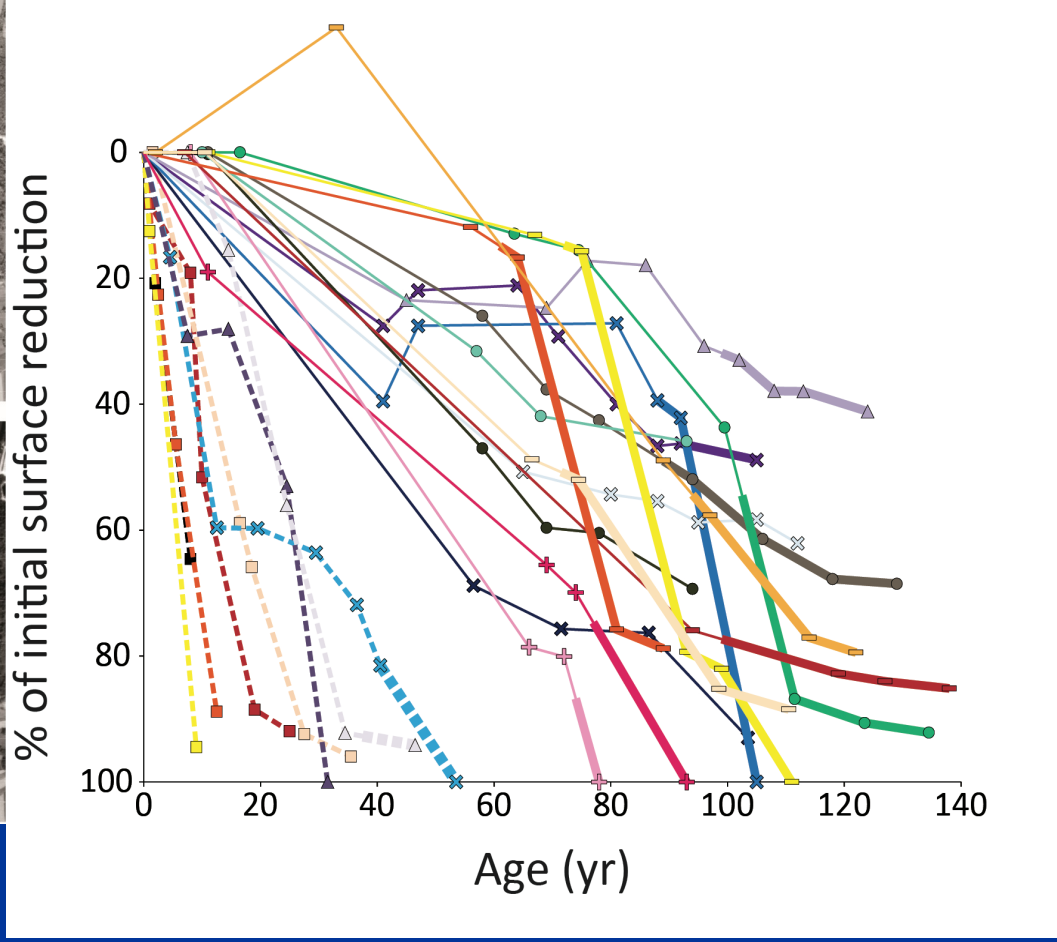
Annual % of promoted definitions using the different references

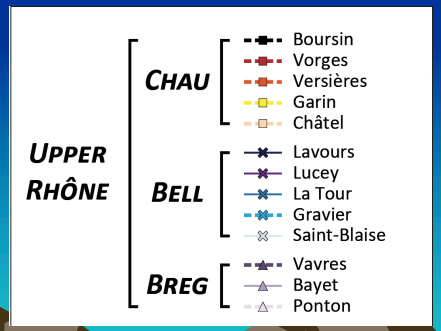


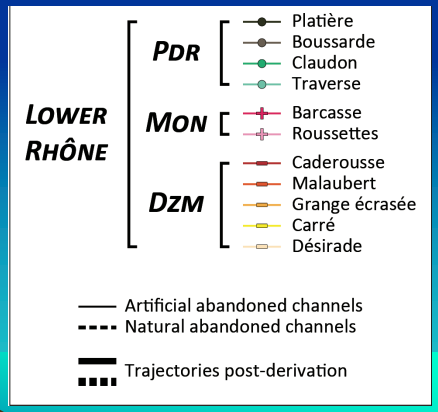
S: spatial, T: temporal, N: Natural, E: Ecological, C: Socio-economical… R… Reference

Morandi et al., in prep.









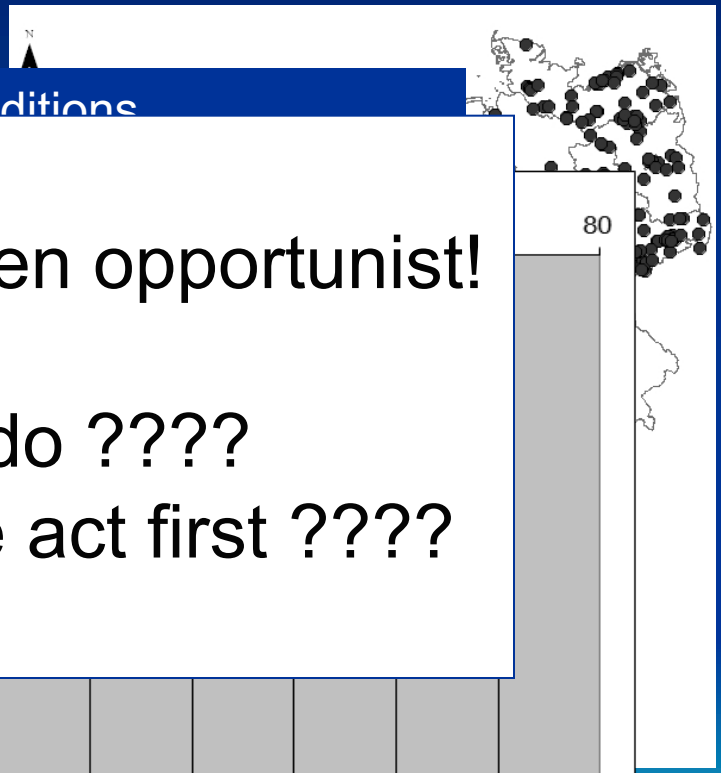
Depret et al. Geomorph. 2017

Environmental Management
November 2017, Volume 60, Issue 5, pp 931–946 | Cite as

Diverse Approaches to Implement and Monitor River Restoration: A Comparative Perspective in France and Germany

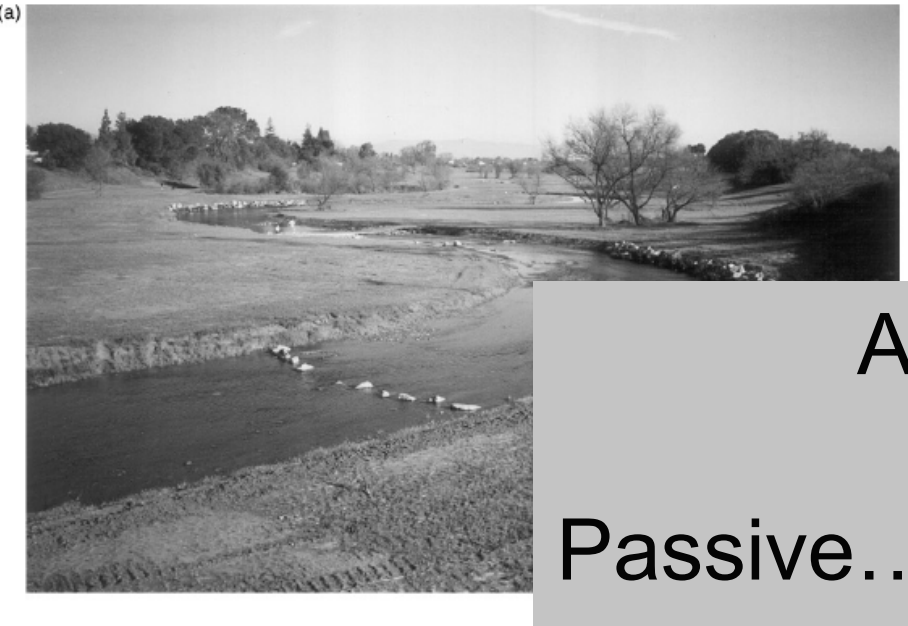
Morandi et al. 2017

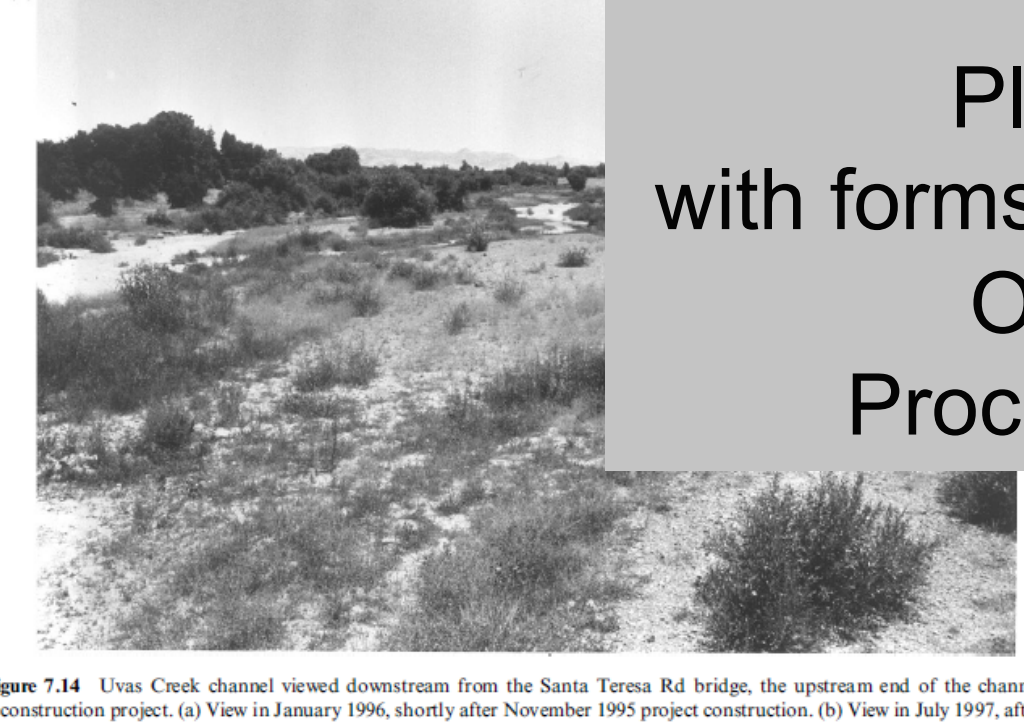
Measures class rank 1 : In-channel habitat conditions



Restoration is often opportunist!

What should we do ????
Where should we act first ????





Active
OR
Passive… restoration

Play
with forms / habitats
OR
Processes

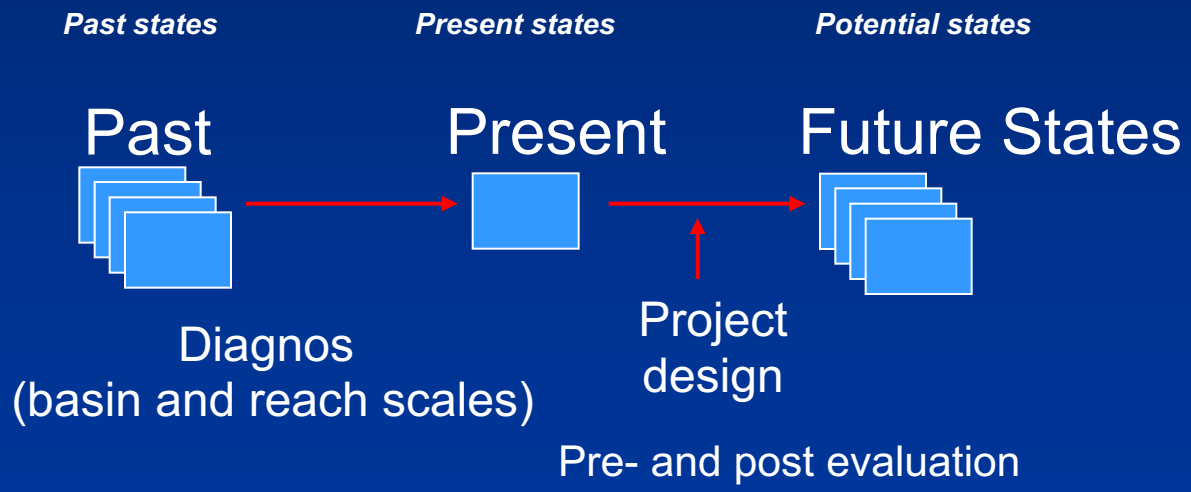
Figure 7.14 Uvas Creek channel viewed downstream from the Santa Teresa Rd bridge, the upstream end of the channel reconstruction project. (a) View in January 1996, shortly after November 1995 project construction. (b) View in July 1997, after the designed channel washed out in February 1996 and high flows in winter 1997 (from Kondolf *et al.* 2001, used by permission)

improving river management, restoration or conservation
=> wider scope in term of spatial and temporal scales

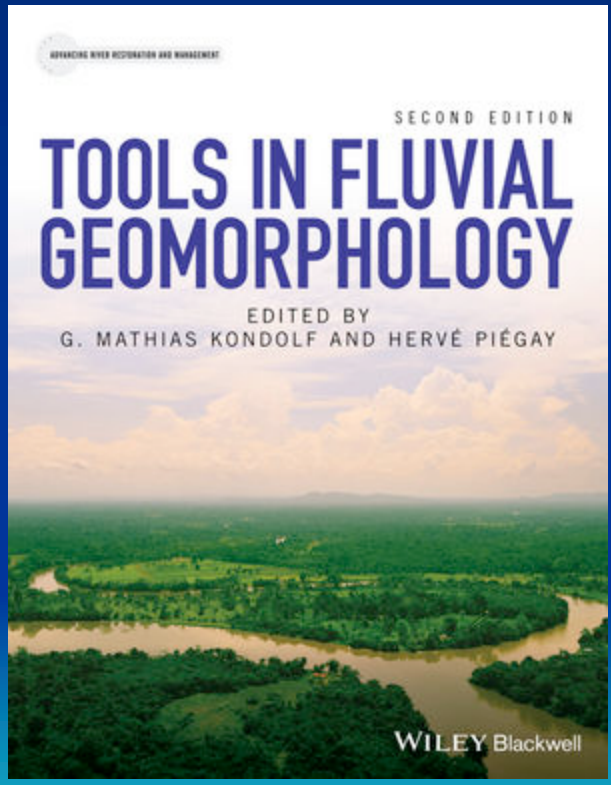
Top-down Strategy
(regional/national scale)

Planification of actions

. Evaluate and classify / target / priorise actions and reaches

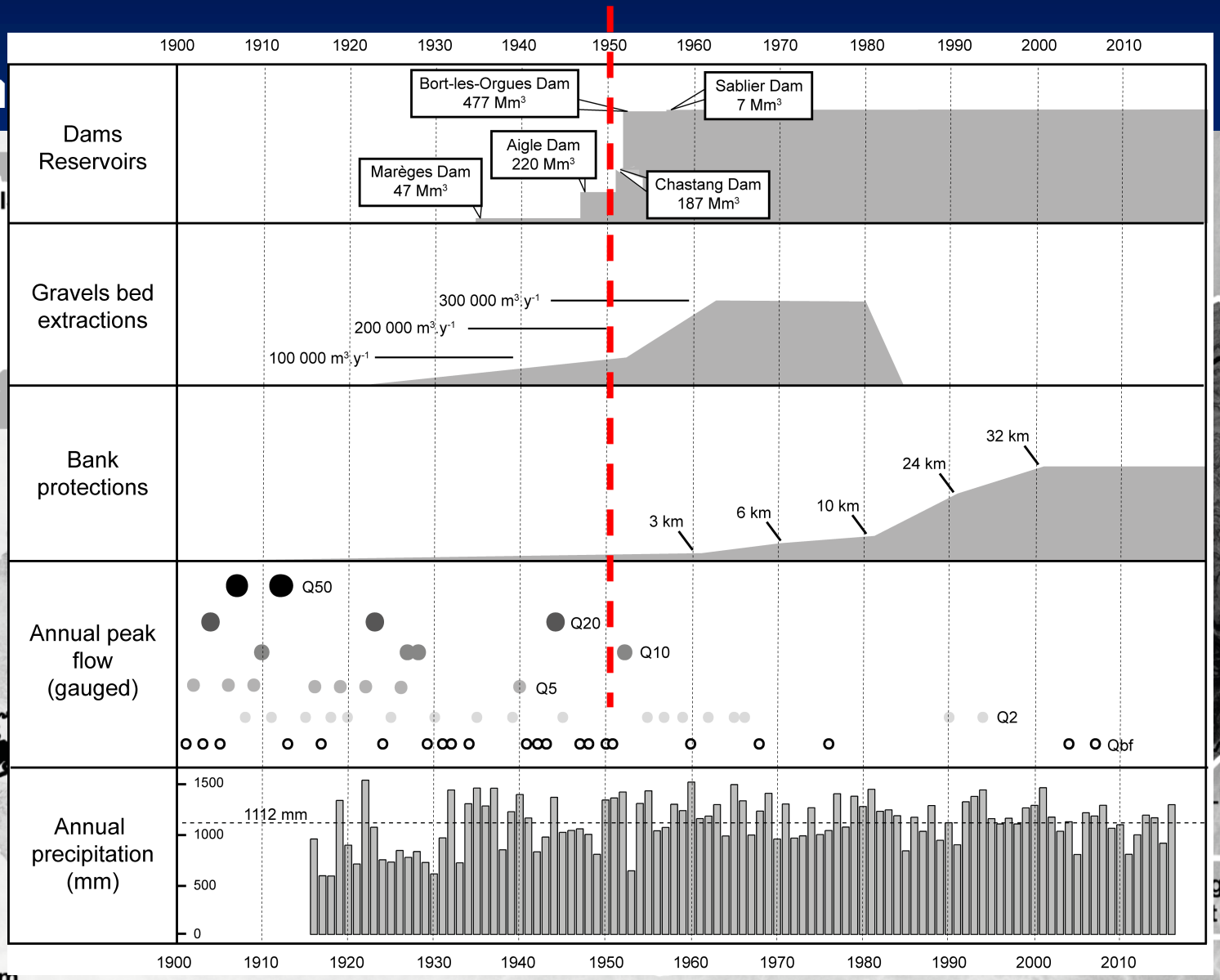


Bottom-up Strategy
(reach scale)

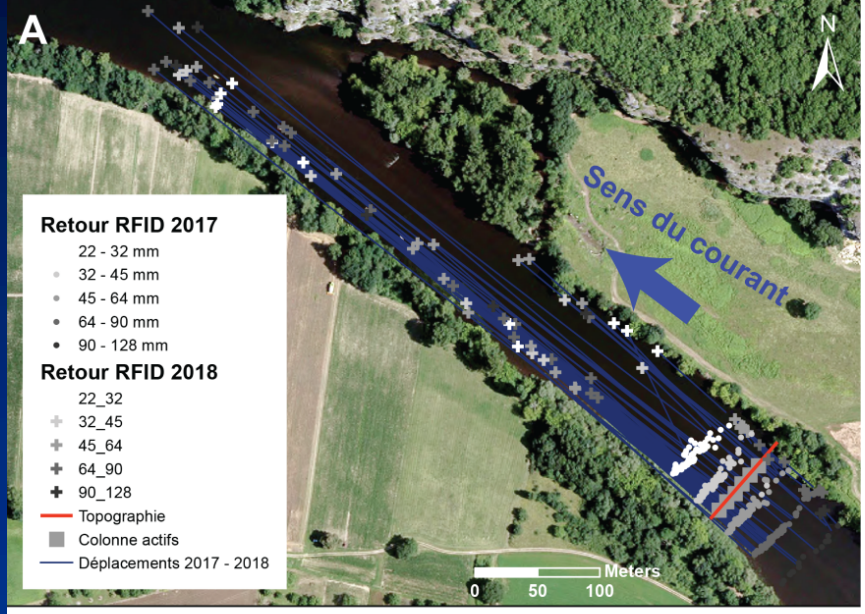


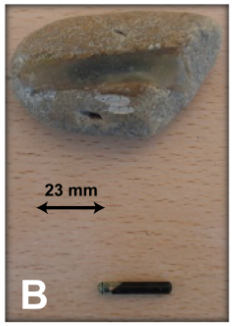
22 Integrating geomorphological tools to address practical problems in river management and restoration

Hervé Piégay, G. Mathias Kondolf and David A. Sear



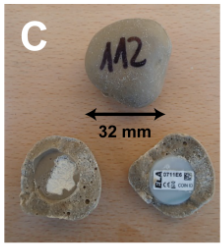
F. Boutauld, PhD, in prep.

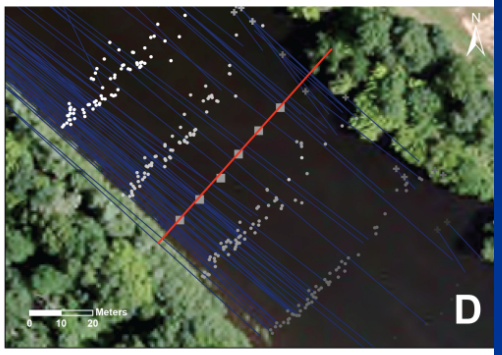




RFID passif

RFID actif





A – Trajectoire des traceurs en 2017 et 2018 sur la Dordogne (site de Meyraguet, équipé en janvier 2017) ; B – RFID passif équipé avec un tag de 23 mm ; C – galet artificiel équipé avec tag actif ; D – Disposition des colonnes de RFID actifs et E – Section au niveau des colonnes de RFID actifs avec les déplacements mesurés entre 2017 et 2018 (pour une crue biennale de deux jours, distance médiane = 268 m, épaisseur médiane couche active = 10 cm, volumes charriés = 2280 m^3).

Technical scheme

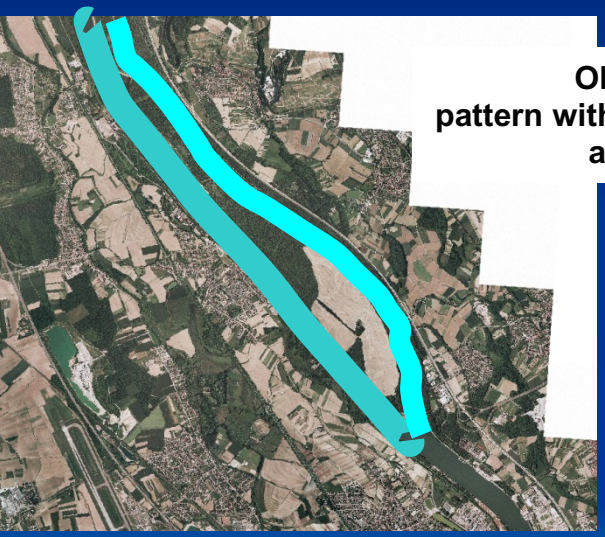
1828

By passed single-bed channel

?

Braided channel

2008



Objective : restore a pattern with multiple shifting channels and gravel islands

wider connected floodplain on the left side

Sediment availability

Option 2

Option 1

artificial recharge:
- **mechanically**

bank erosion:
- **reducing bank resistance**
- **creating new channel**

ecological benefits (fish habitat, riverine communities)

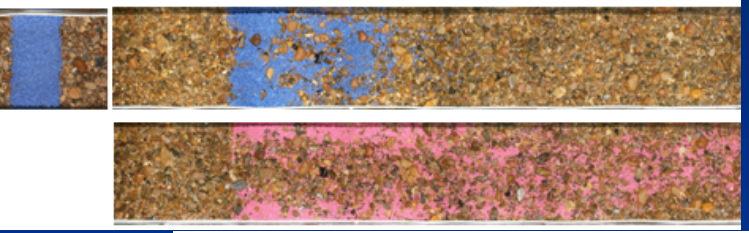
Sustainable Source (=left side?)

Risk assessment

- **Over-erosion**
- **Incision / deepening**
- **Short term downstream transfer**
- **Flooding risks following new channel geometry / right side excavation**

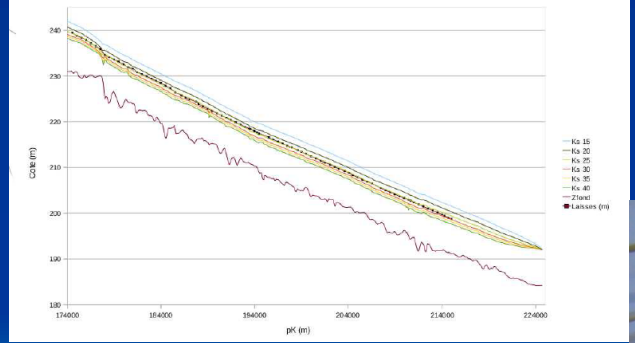
Risk assessment of proposed measures

- **Flume experiment**
- **Associated numerical modelling 1D, 2D**
  - *Controlled bank erosion*
  - *Armouring destabilisation*
  - *Downstream reservoir filling (Breisach)*
  - *Change in flood levels due to new geometries*
  - *Effects on previous restored environments*

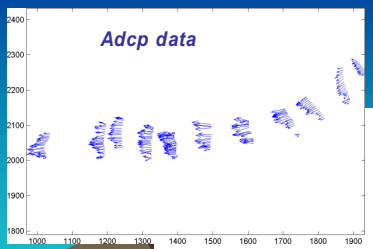


Redynamisation du Vieux Rhin
Redynamisierung des Restrheins

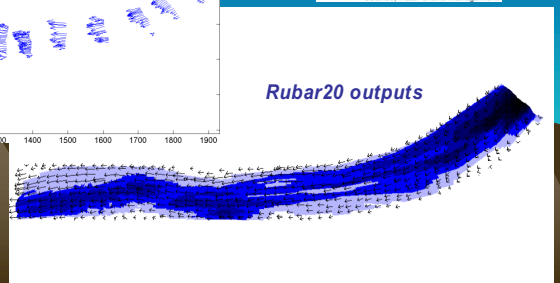
- **Model calibration (to be continued)**
  - 3020 m³/s (flood of 1995, K = 25 m$^{1/3}$/s)



eDF

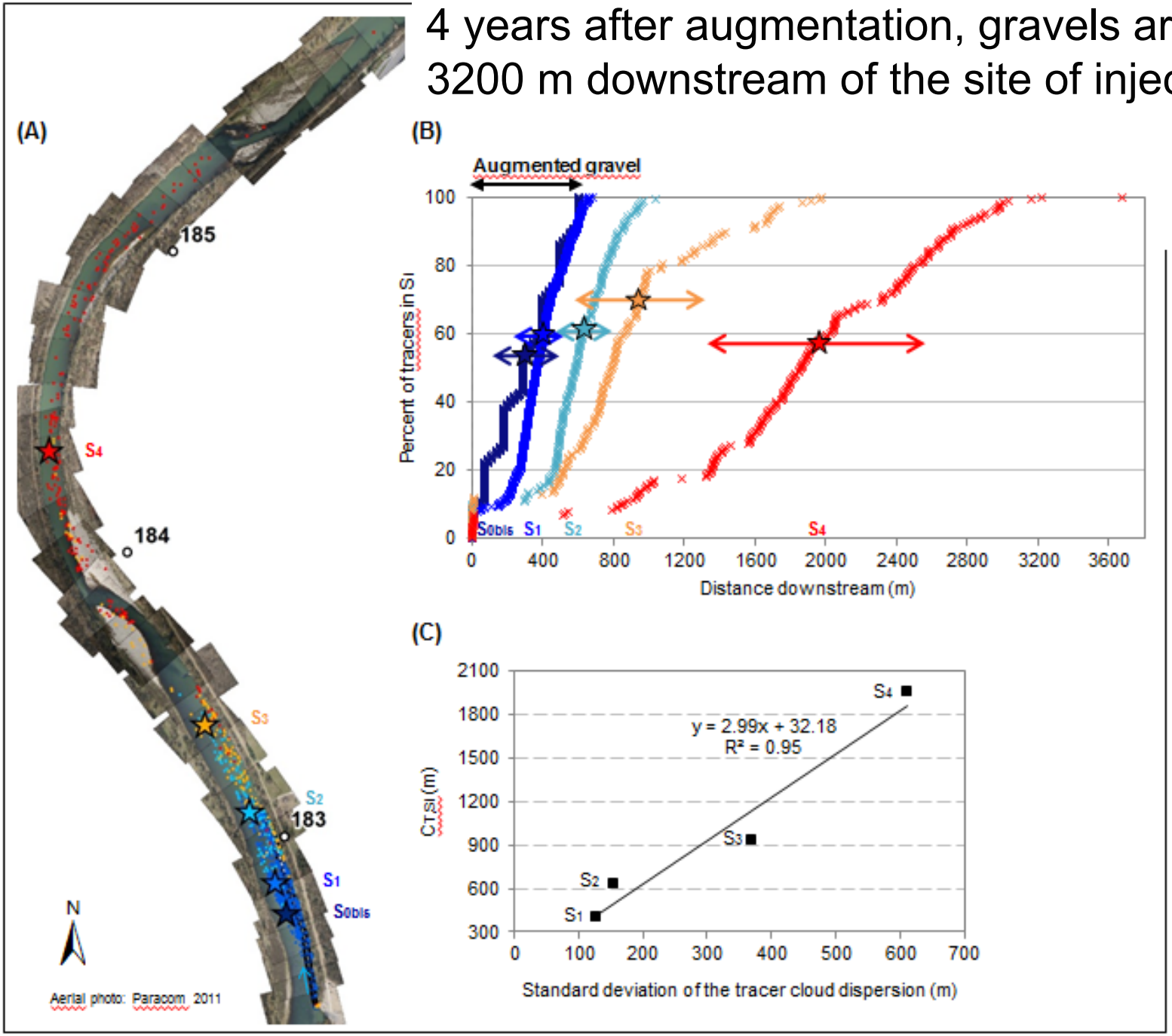


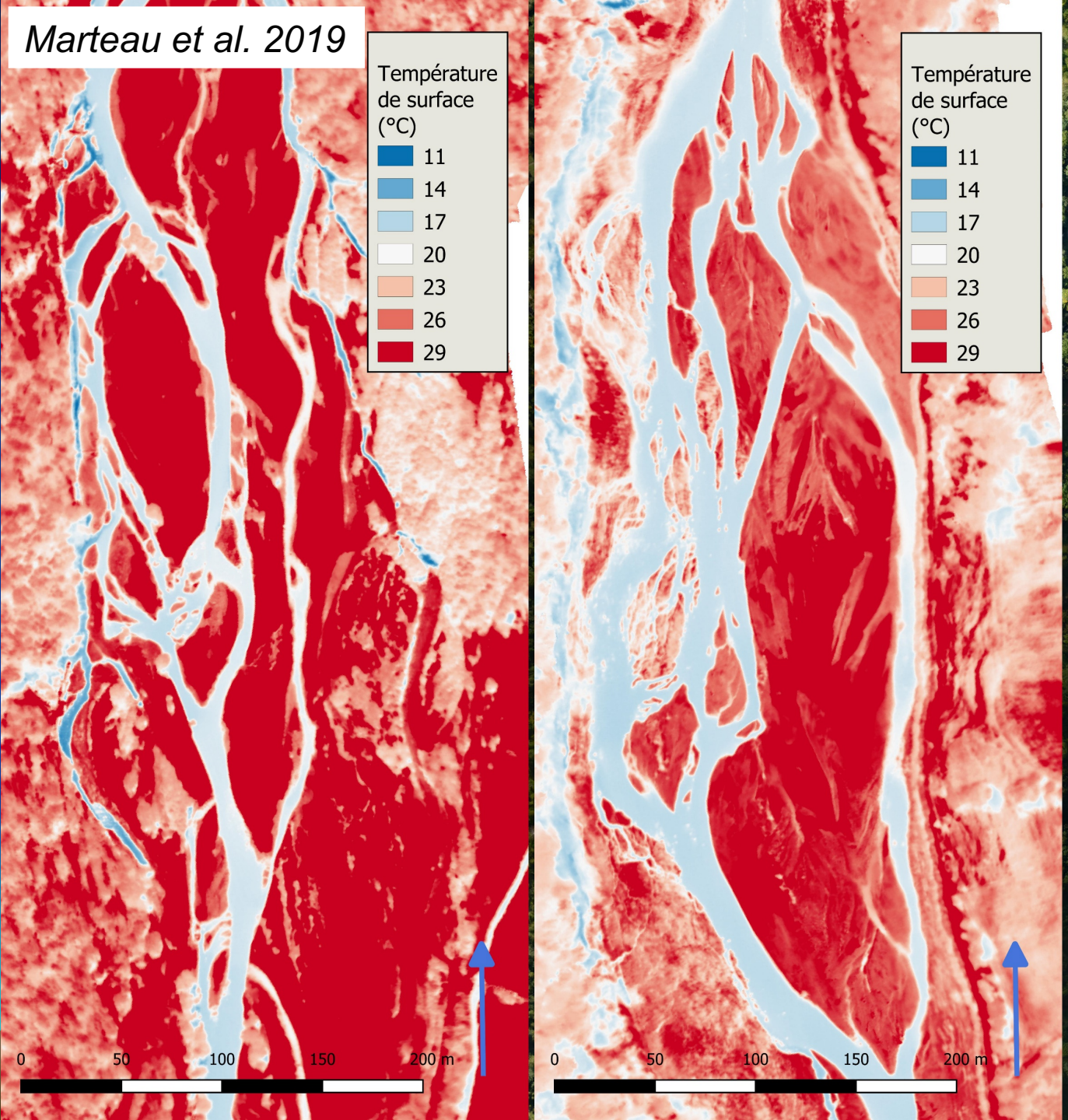
Cemagref
Science, water & land management



REDYNAMISATION
DU VIEUX RHIN
REDYNAMISIERUNG
DES RESTRHEINS

4 years after augmentation, gravels are observed 3200 m downstream of the site of injection



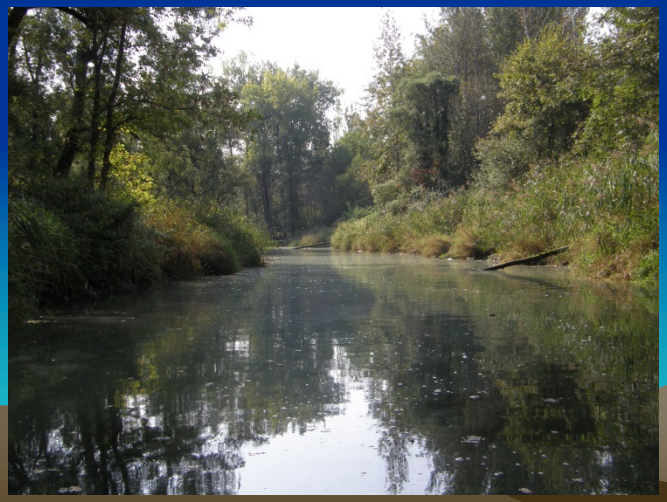

Marteau et al. 2019
Température de surface (°C)
11
14
17
20
23
26
29
0
50
100
150
200 m

Température de surface (°C)
11
14
17
20
23
26
29
0
50
100
150
200 m


Drac
Gravel augmentation
450 000 m3 of gravels
26 ha of forest cleared

Former channel restoration - Rhône

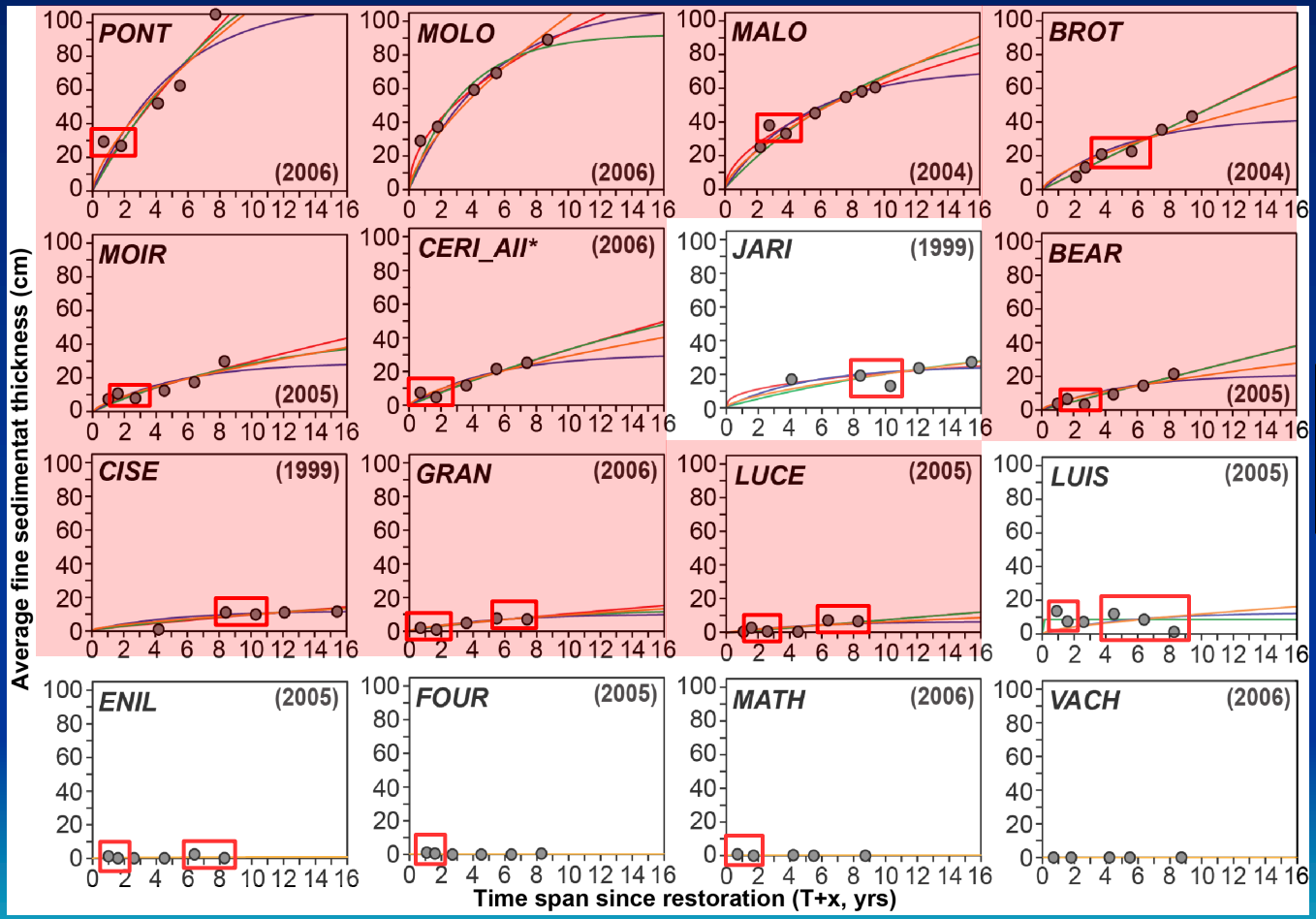
Actually
24 restored former channels (rewatered / reconnected)



Excavate and rewater former channels (1999)

Propensity of channels to accumulate fine sediment: significativity of trends

Riquier et al. Geomorphology 2017



Power fit
Exponential fit
«Classic» fixed-effects models

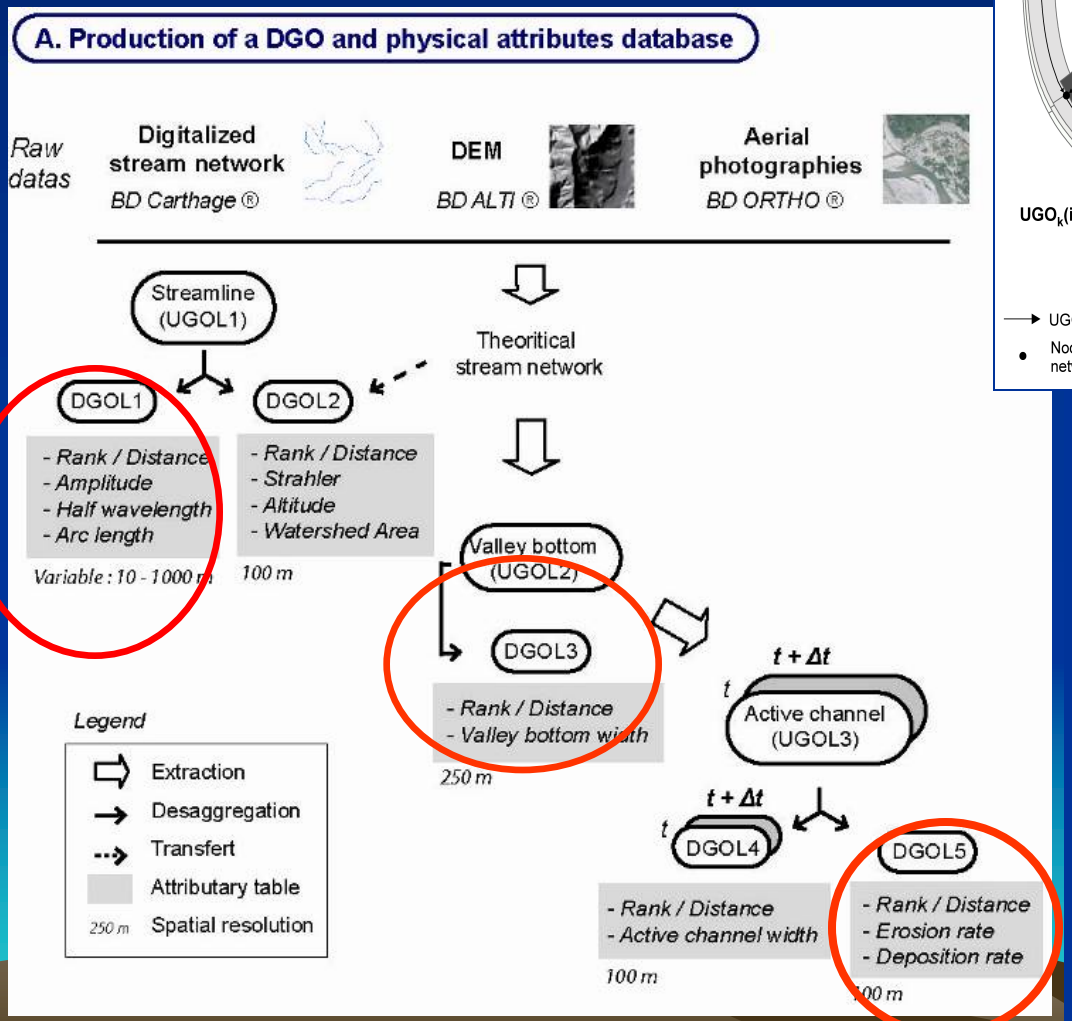
Power fit
Exponential fit
Nonlinear mixed-effects models

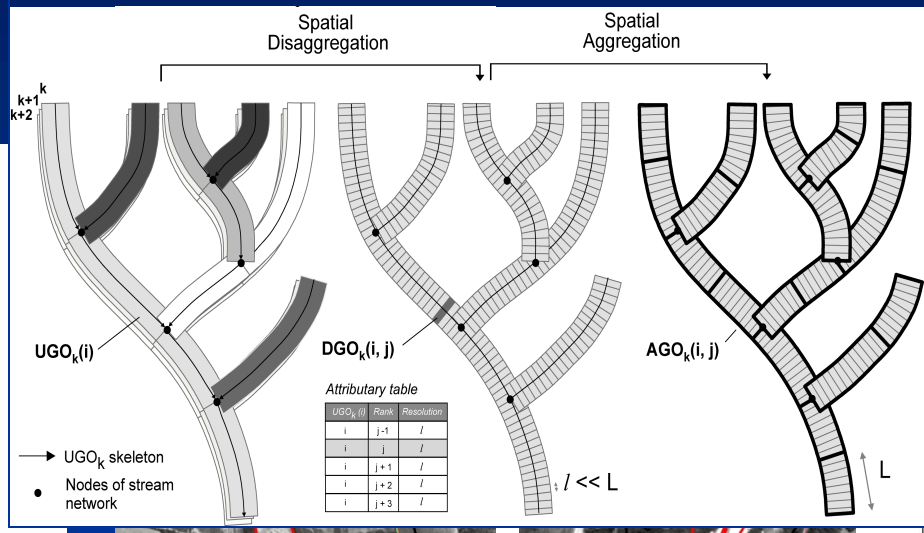
10 time-dependent channels ($P<0.05$)

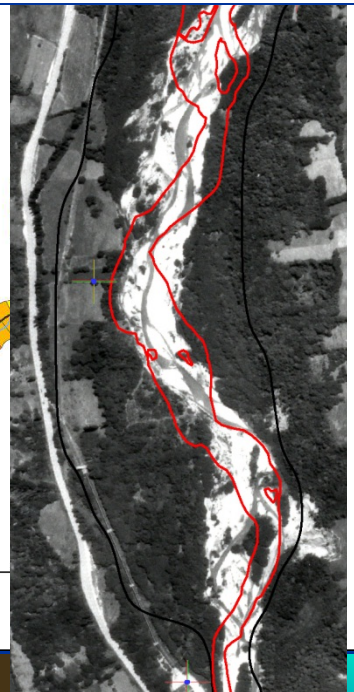
6 channels did not exhibit any significant time-dependent changes (*a priori* able to self-maintain their aquatic status over the long term)

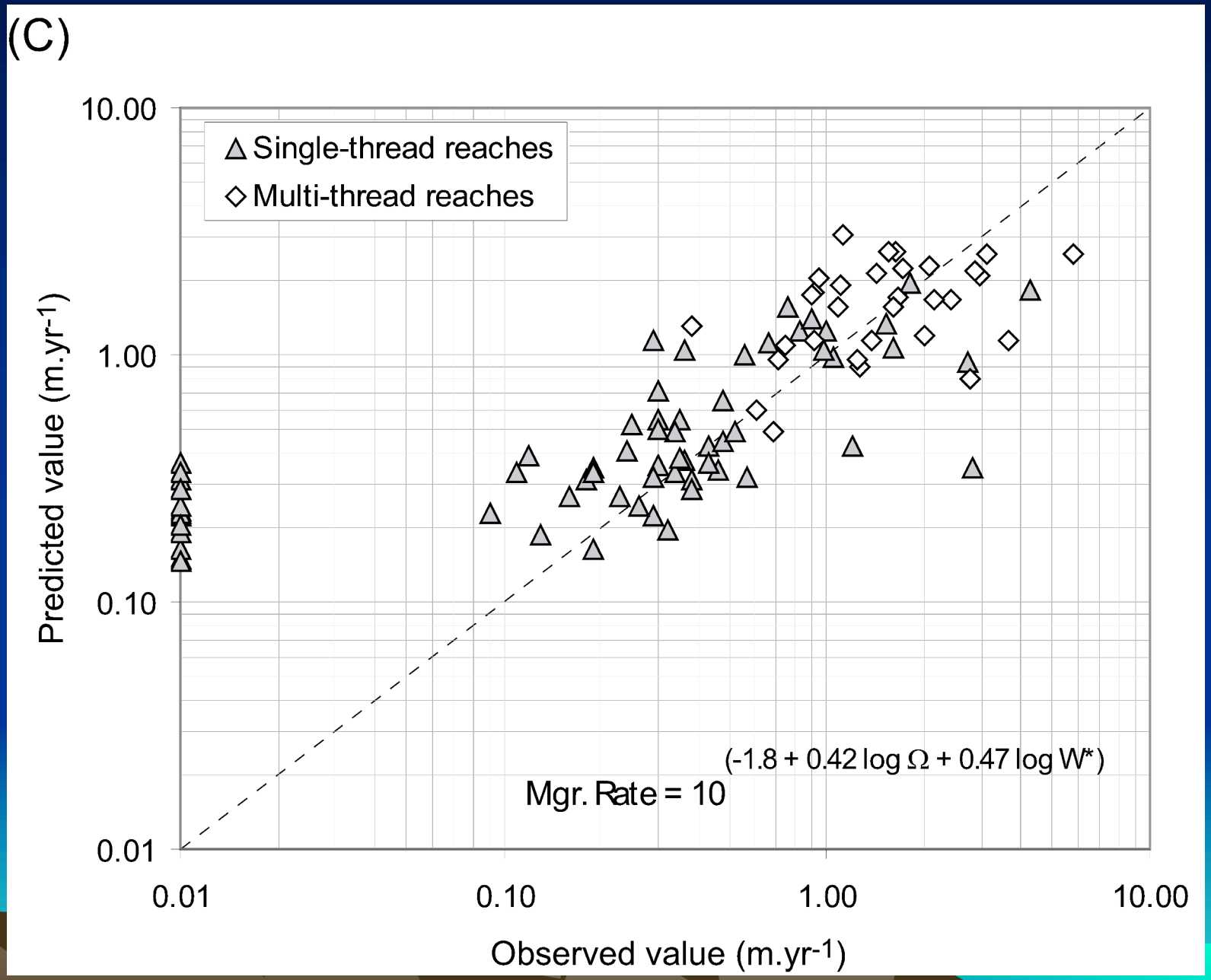
Production of a data base at the network scale (45 000 km of rivers)

- Three types de data sources: vectorial layers, DEM, orthophotographies
- GIS analysis

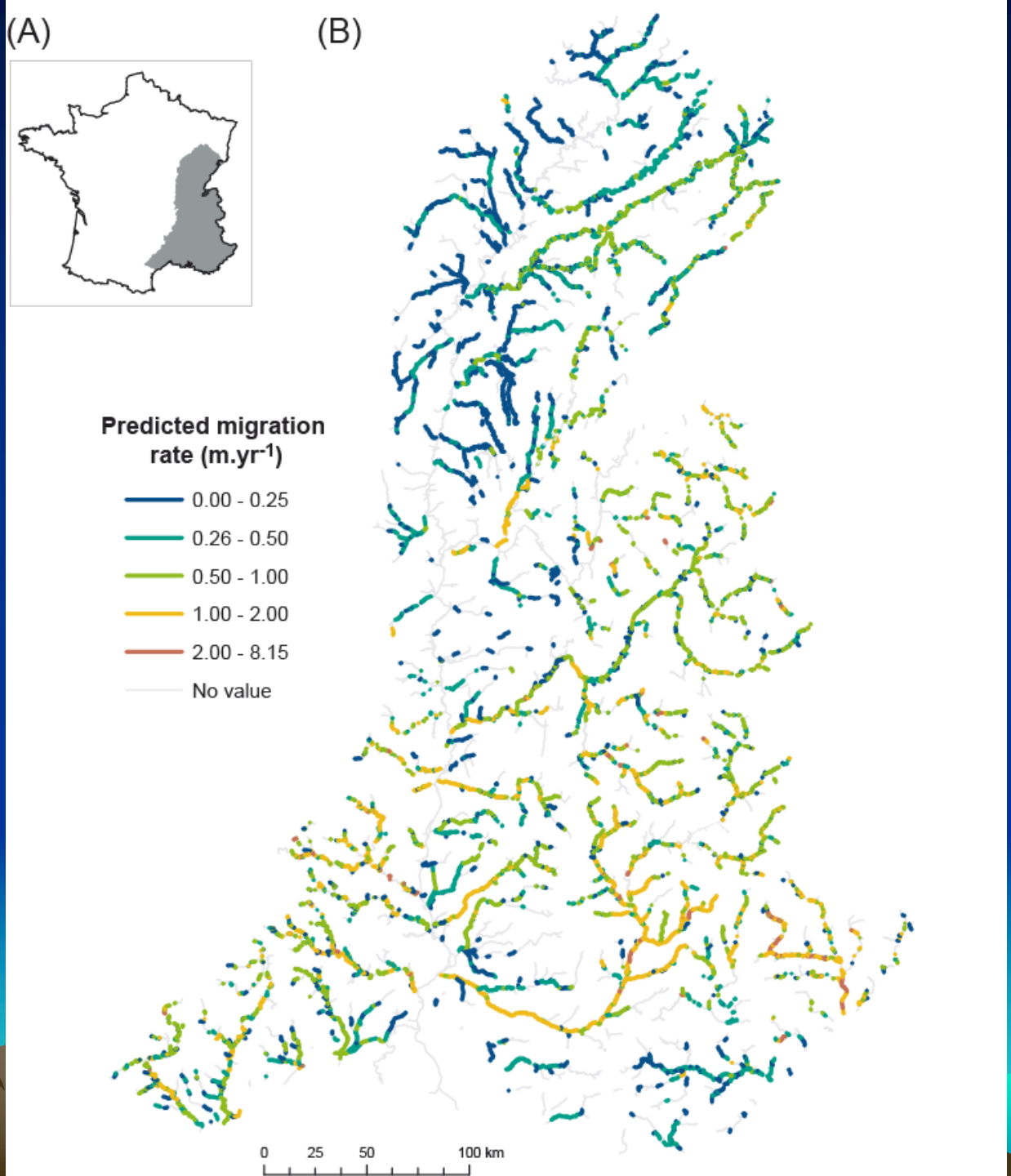








Alber et Piégay, 2017, JoEM



Alber et Piégay, 2017, JoEM

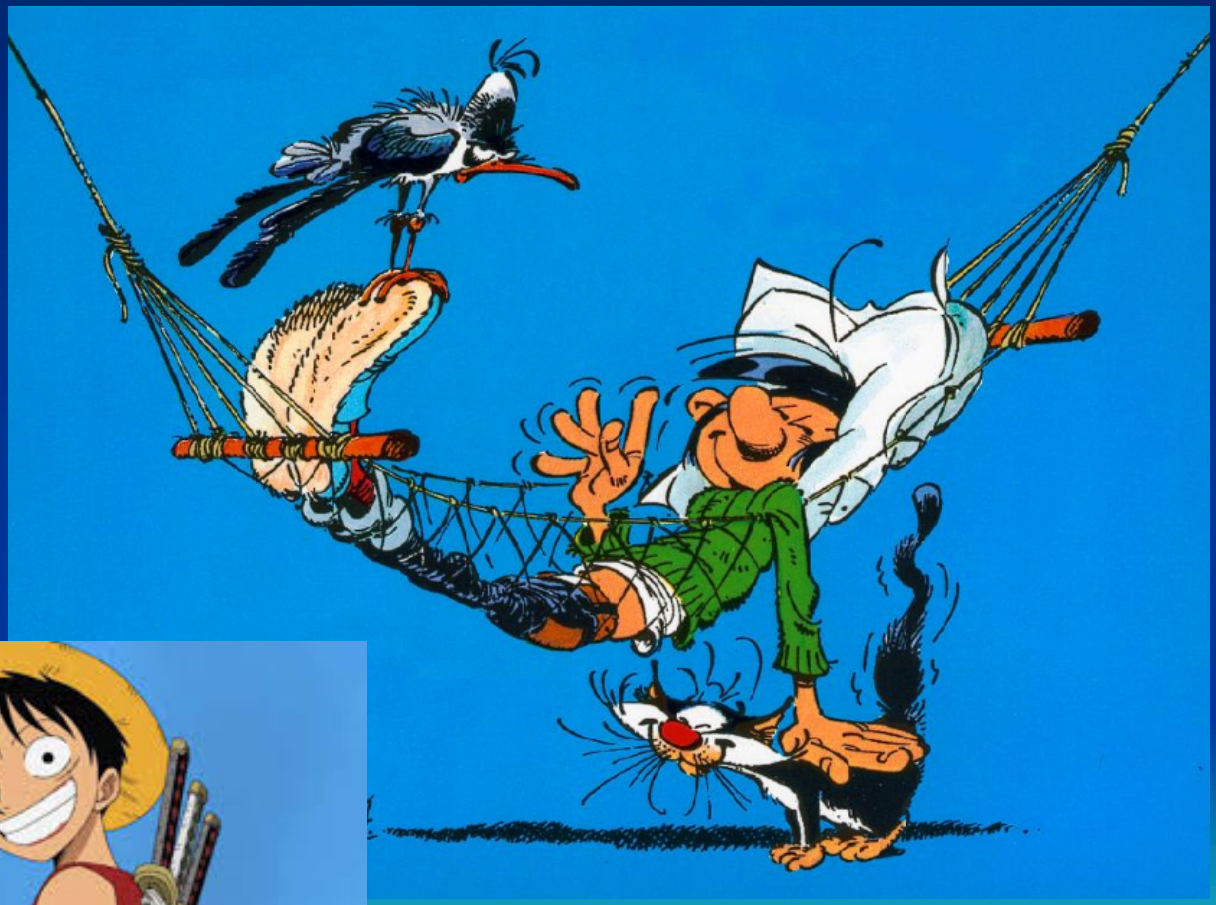
Conclusions : lessons learnt

- A restoration project is a development project
  - Need a political support (it is a social stake).
  - Integrate ecological improvement in a win-win framework considering also security / direct human benefits with participation of different stake-holders => work with nature and with society
  - Define the objectives of the development project in which ecological improvement as well as social and long term environmental management aspects must be shared.
  - Consider physical improvement for ecological purposes may generate risks to be assessed (pollutants, flooding, plant invasion, siltation in the main channel)
  - Be adaptive / integrate new knowledge in the process / manage objective changes across time (enlarge spatial scales, integrate processes)
  - Communicate on objectives, on changes related to restoration operations.
  - Time and effort to make it successful (10-15 years)

Conclusions : lessons learnt

- Improve our knowledge – Is restoration good?! Can we really repair Nature?
  - Learn from previous experiences
    - monitor because it is not evident that the measures will be ecologically efficient (what is the good timescale, the good indicators and sampling design)
    - understand stochasticity and inter-annual variability to assess ecological efficiency of measures.
  - Reduce uncertainties in potential physical/biological responses
    - Experiment, tests
    - Develop modelling approaches to provide tools for future restoration projects, anticipate biological responses prior to actions.

Thank you for your attention



It is a collective adventure

- Nicolas Lamouroux, Laurent Simon, Anne Clemens
- Carole Barthelemy, HP
- Olivier Radakowitch, Dad Roux, HP
- Jean-Michel Olivier, NL
- Christophe Douady, Sylvie Barraud, HP
- André Paquier, Nicolas Rivière

- + 150 colleagues, post-docs, PhDs, Masters, technical staff…

River Flow 2018
NINTH INTERNATIONAL CONFERENCE ON FLUVIAL HYDRAULICS

PhDs, Post-docs, Colleagues (chron.)

F. Liébault, 2003, PhD
A. Citterio,
B. S. Dufour, 2005,
B. Moulin, 2005
A.J. Rollet, 2008
Y. Le Lay, 2008
C. Simoncini, 2008
J. Lejot, 2008
M. Cossin, 2009
J. Toone, 2009
M. Michalkova, 2010
M. Cottet, 2010
L. Grospretre, 2011
A. Alber, 2012
E. Wiederjkehr, 2012
B. Belletti, 2012
F. Arnaud, 2012
V. Wawrzyniak, 2012
C. Lavaine, 2013
B. Morandi, 2014
M. Bertrand, 2014
S. Tacon, 2015
E. Parrot, 2015
J. Riquier, 2015
E. Comby, 2015
M. Bovin, 2016

A. Michez, 2016
V.Benacchio, 2017
M. Cassel 2017
B. Räpple, 2018
S. Flaminio, 2018
Z. Zhang,
G. Seignemartin
M. Spitoni
R. Loire, 2019
S. Dunesme
F. Boutault
C. Rousson
G. Lardaux
V. Chardon
H. Ghaffarian, 2019

A. Thévenet, 1998
N. Lassettre, 2004
L. Slater, 2007
R. Dunford, 2006
B. MacVicar, 2007
P. Hunter, 2008
J. Constantine
C. Gomez,
K. Dzubakova, 2011
B. Notebaert, 2011

P. Dirias, 2013
V. Ruiz, 2013
P. Lemaire, 2014
A. Senter
T. Depret, 2014
F. Arnaud, 2014
V. Wawrzyniak, 2014
A. Tena 2015
C. Dandan, 2015
H. Garcia, 2017
B. Marteau, 2018

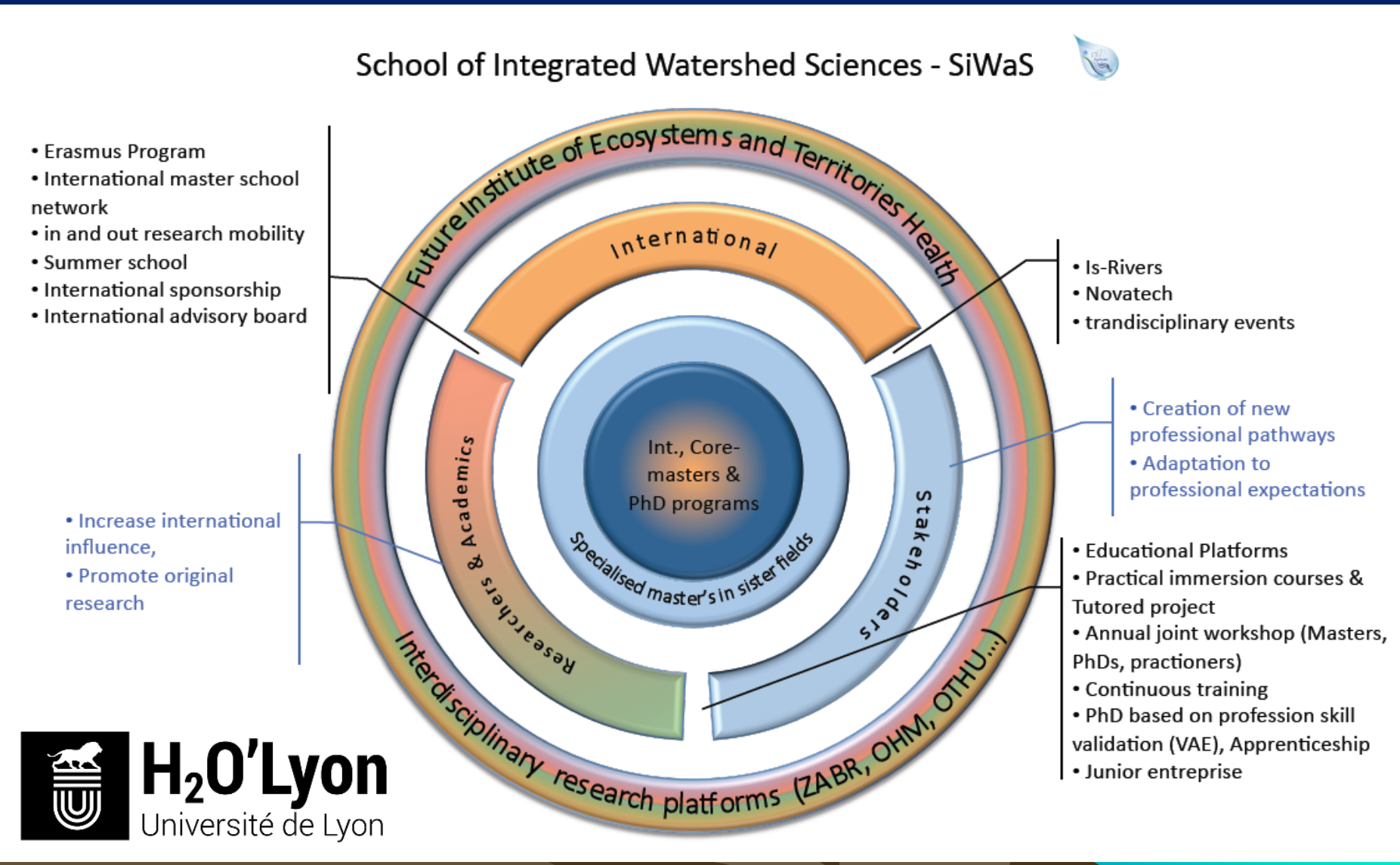
A.M. Gurnell
M.G. Kondolf
R. Marston
S. Gregory
F. Swanson
D. Walling
S. Darby
N. Surian
E. Mosselmann
K. Gregory
A. Chin
A. Elosegi
B. Wyzga
J. Zawiejska

M. Mutz
M. Rinaldi
C. Hupp
M. Daniels
E. Wohl
T. Dunne
F. Comiti
S. Rice
D. Graham
K. Holubová
J. Stella
M. Singer
J. Constantine
H. Claessens
H. Habersack
P. Carbonneau
T. Buffin-Bélanger
G. Brierley
T. Buijse
L. Demarchi
S. Bizzi
M. Stoffel
W. Lauer
G. Pasternack
J. Kail

C. Wolter
C. Weber
F. Hughes
P. Roni
M. Thoms
L. Vaudor
K. Michel
N. Landon
J.P. Bravard
G. Pautou

J.L. Peiry
B. Bornette
C. Amoros
P. Clément
E. Gautier
P.G. Salvador
L. Schmitt
C. Delacourt
P. Allemand
S. Dolédec
D. Pont
L. Tougne
A. Evette
E. Sauquet
A. Rivière-Honegger
T. Datry
N. Lamouroux
F. Moatar
J. Lavé
P Marmonier,
T Winiarski
C. Barthelemy
E; Franquet
J-N. Beisel

Promote better interactions between research and training?



H$_2$O'Lyon
Université de Lyon

REFERENCE RESTORED

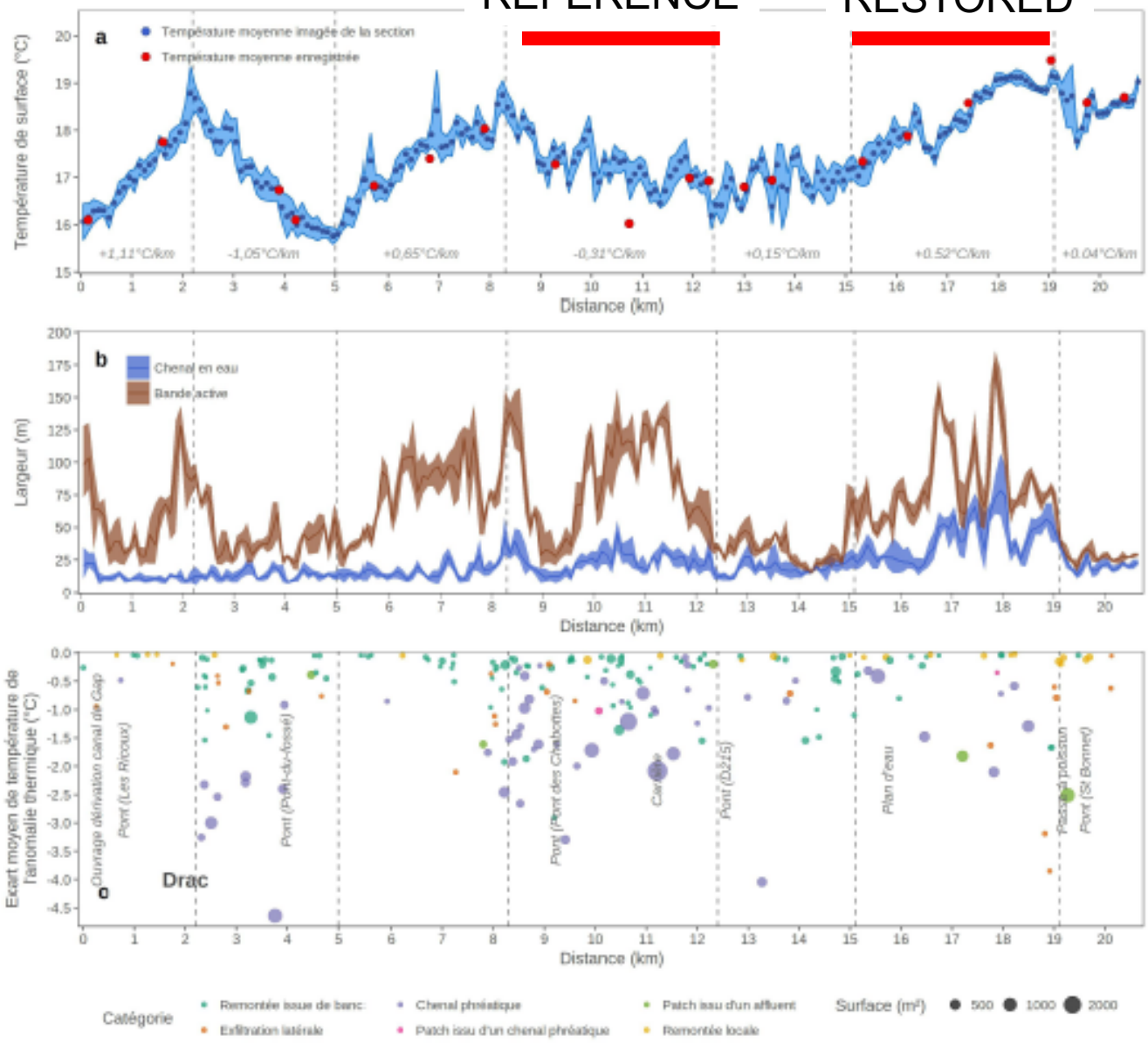


Figure 11: (a) Profil longitudinal de température de surface du Drac et gradients thermiques calculés par tronçons homogènes, (b) largeur de la bande active et du chenal en eau, et (c) illustration des anomalies thermiques observées sur le linéaire imagé.

Marteau et al. 2019