Funded by the Horizon 2020 Framework Programme of the European Union

KNOWLEDGE CONVERSION FOR ENHANCING MANAGEMENT OF EUROPEAN RIPARIAN ECOSYSTEMS AND SERVICES
Final conference, Slovak Academy of Sciences, Bratislava, Slovakia

Trajectories and stakes of riparian reafforestation along Anthropocene rivers

H. Piégay,

ENS de Lyon CNRS, France

At European scale, riparian vegetation has been replaced along long lowland reaches by agriculture…

B. Marteau

… urban areas, infrastructures…


Arve River


Agout River

… and poplar plantations as well

… but also exceptional re-afforestation along some European rivers …

Aim here :

- **Reafforestation trajectories**
- **Socio-ecological stakes**
- **Knowledge gaps**

What are the reafforestation trajectories?

Earth Surface Processes and Landforms
Earth Surf. Process. Landforms **27**, 425–444 (2002)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/esp.328

CAUSES OF 20th CENTURY CHANNEL NARROWING IN MOUNTAIN AND PIEDMONT RIVERS OF SOUTHEASTERN FRANCE

F. LIÉBAULT[a,b]* AND H. PIÉGAY[a,b]

Also, exceptional afforestation… partly spontaneous in mountain and piedmont

Earth Surface
Earth Surf. Pro
Published onli

CAUSE OUNTAIN
A CE

The Drôme R. in the Vercheny plain

Also, exceptional afforestation… partly spontaneous in mountain and piedmont

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

2021

Is afforestation a driver of change in italian rivers within the Anthropocene era?

Vittoria Scorpio [a,b,*], Hervé Piégay [a]

Legend

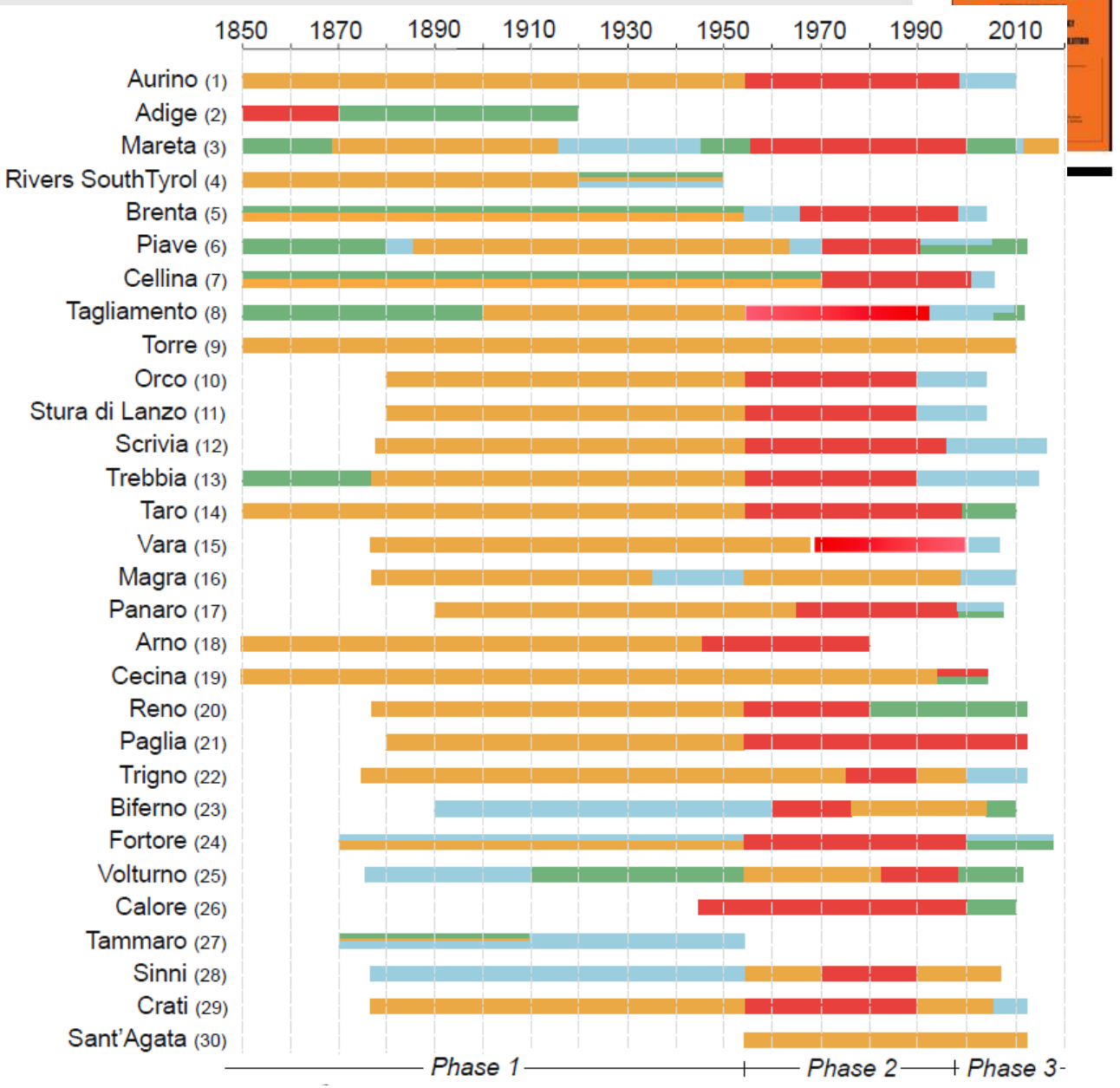
- Intense narrowing / incision
- Narrowing / incision
- Stability/ negligible adjustments
- Widening / aggradation

Contents lists available at ScienceDirect

CATENA

Is afforestation a
Anthropocene er

Vittoria Scorpio [a, b, *],

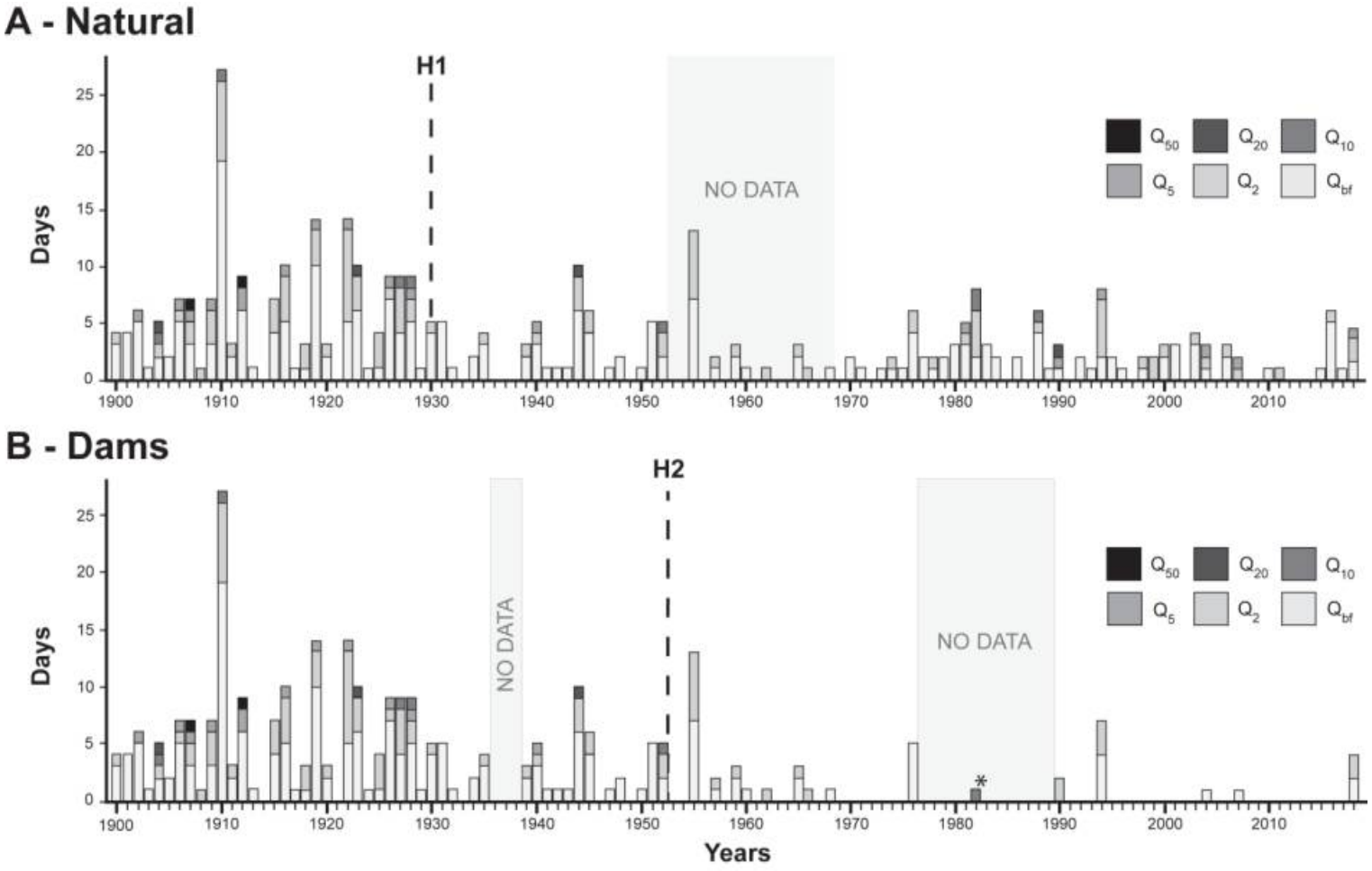


Legend

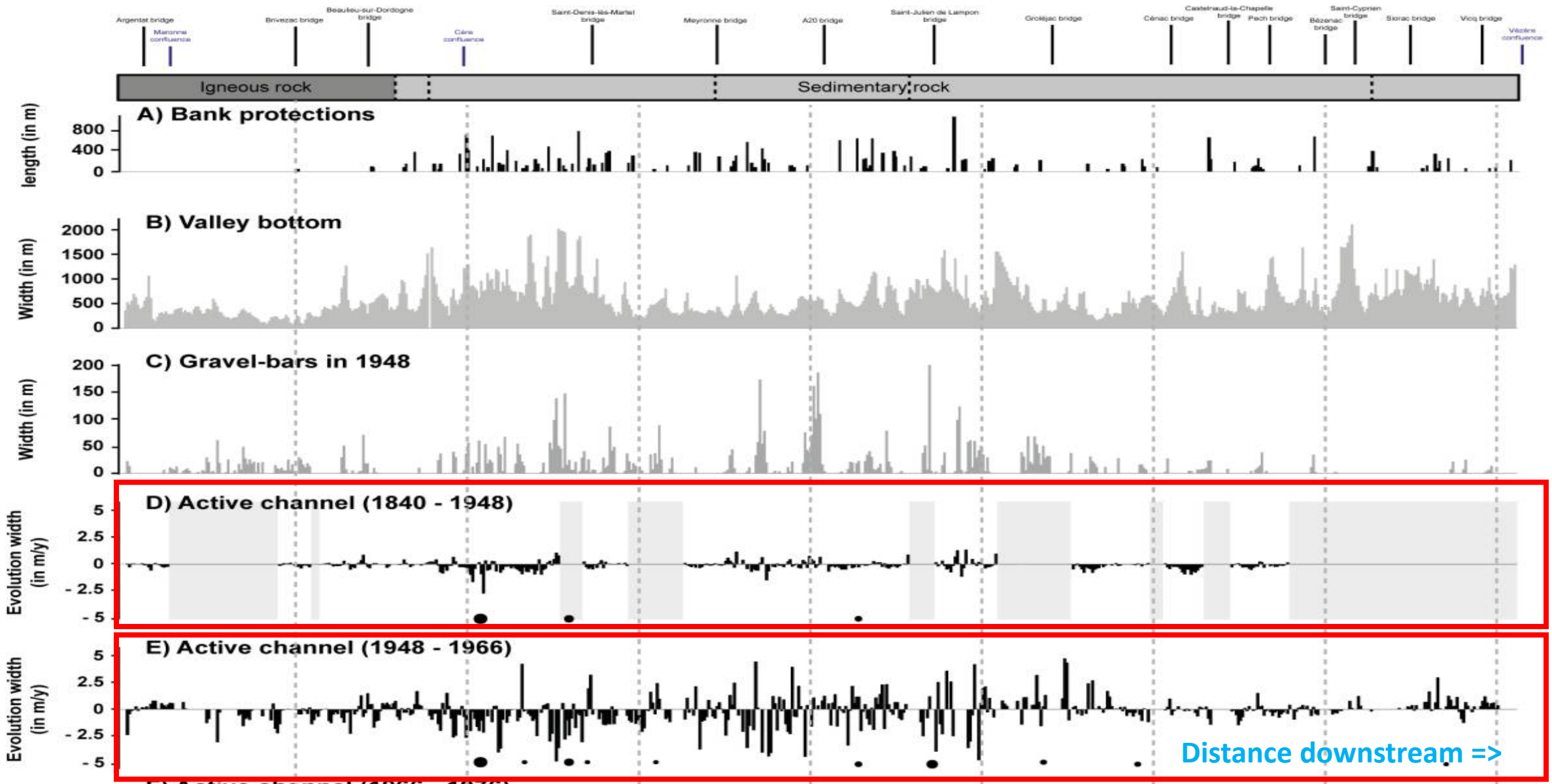
- Intense narrowing / incision
- Narrowing / incision
- Stability/ negligible adjustments
- Widening / aggradation

The Dordogne river, one of the main chain of dams in France, significantly impact peak flows

(Boutauld, 2020, PhD)



…. Favoring afforestation

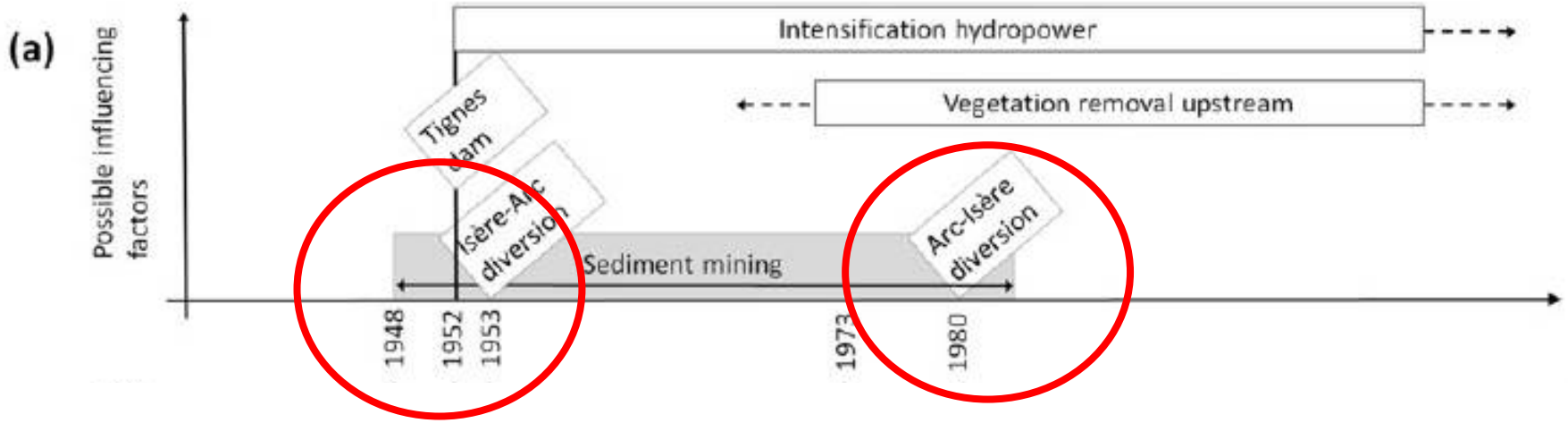


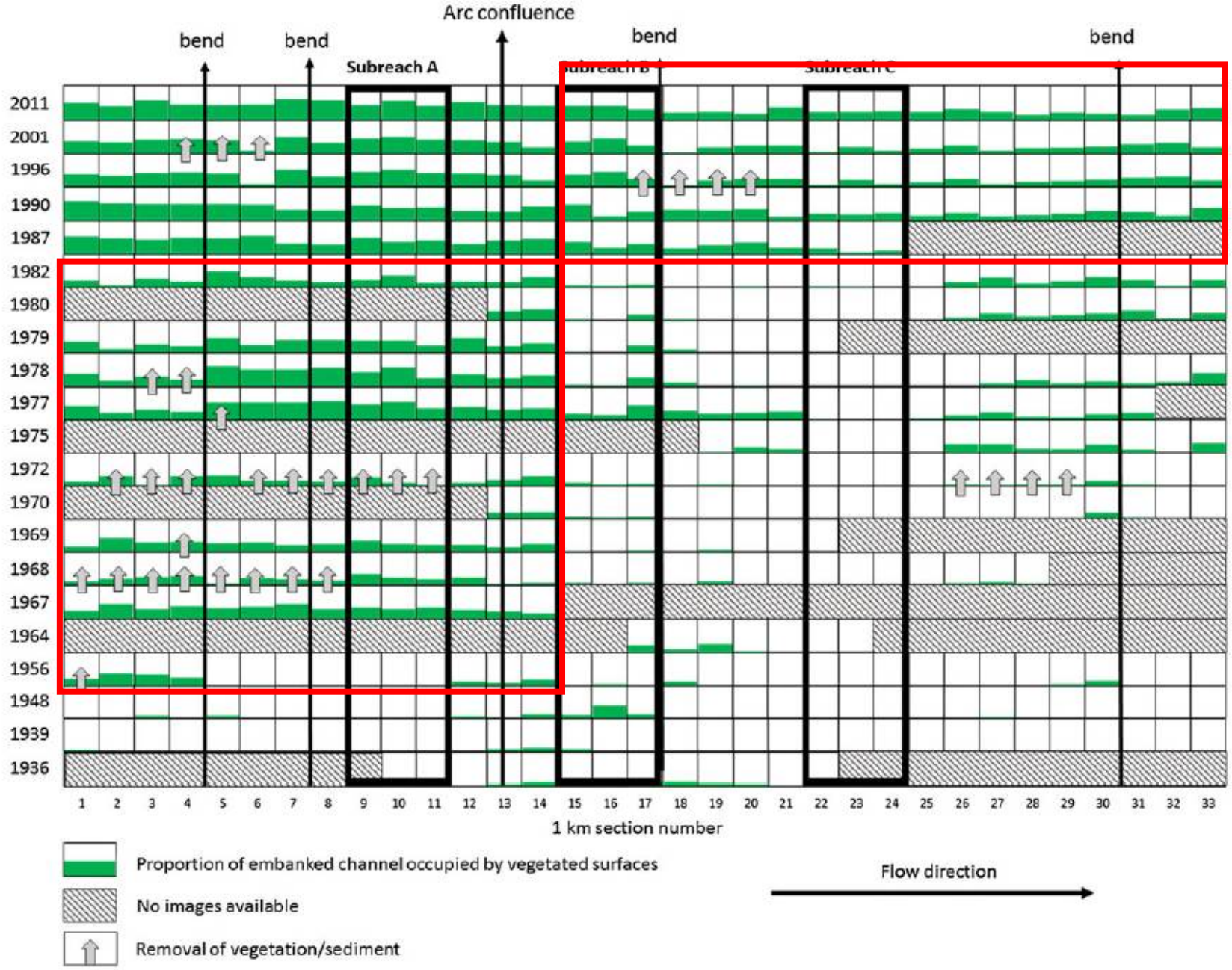
Biomorphodynamics of alternate bars in a channelized, regulated river: An integrated historical and modelling analysis

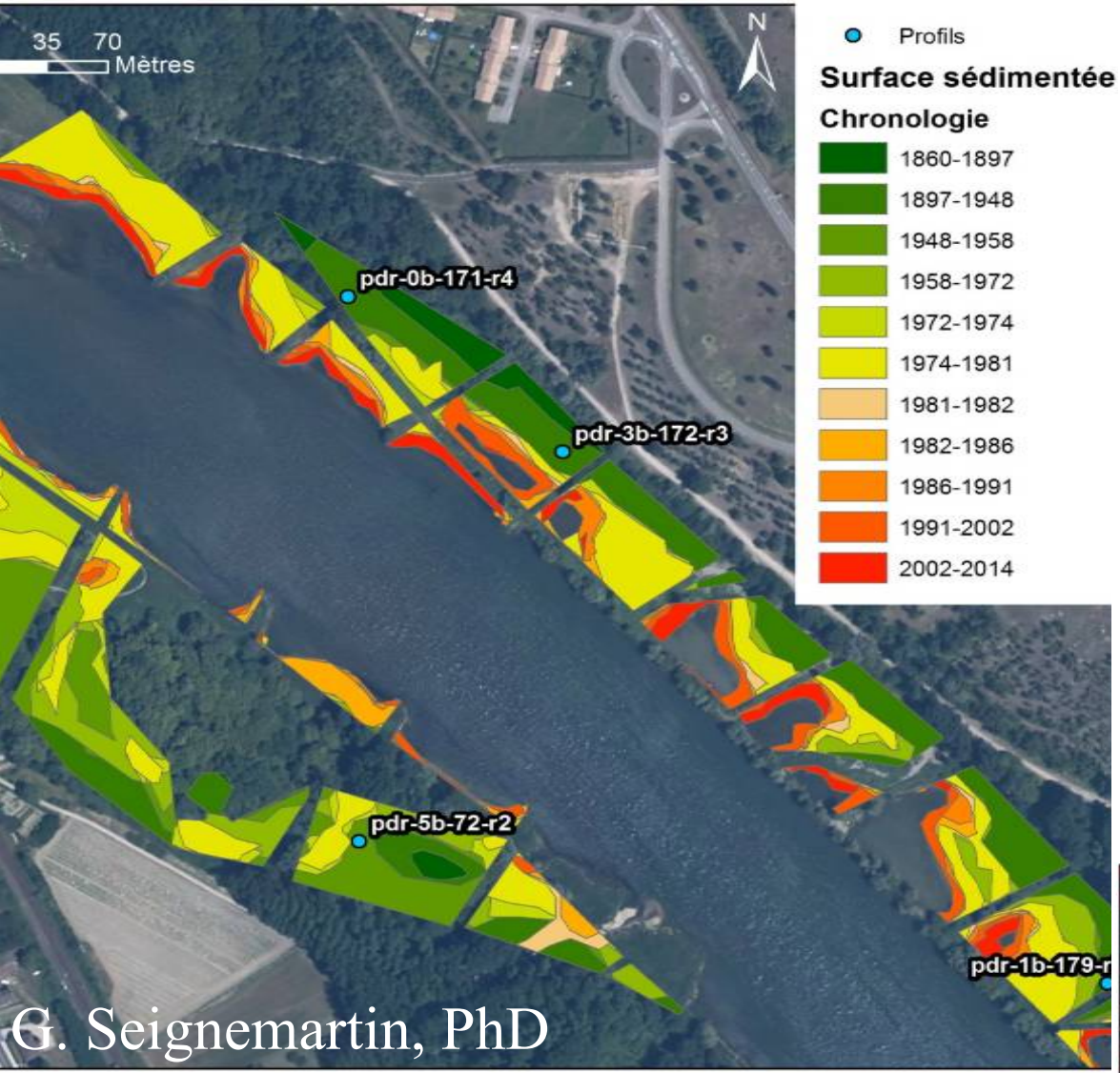
EARTH SURFACE PROCESSES AND LANDFORMS
Earth Surf. Process. Landforms **43**, 1739–1756 (2018)

Published online 7 March 2018 in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/esp.4349

Alyssa J. Serlet,[1,2*] Angela M. Gurnell,[2] Guido Zolezzi,[1] Geraldene Wharton,[2] Philippe Belleudy[3] and Camille Jourdain[3]




Arc confluence
bend
bend
bend
bend
Subreach A
2011
2001
1996
1990
1987
1982
1980
1979
1978
1977
1975
1972
1970
1969
1968
1967
1964
1956
1948
1939
1936
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
1 km section number
Proportion of embanked channel occupied by vegetated surfaces
No images available
Removal of vegetation/sediment
Flow direction

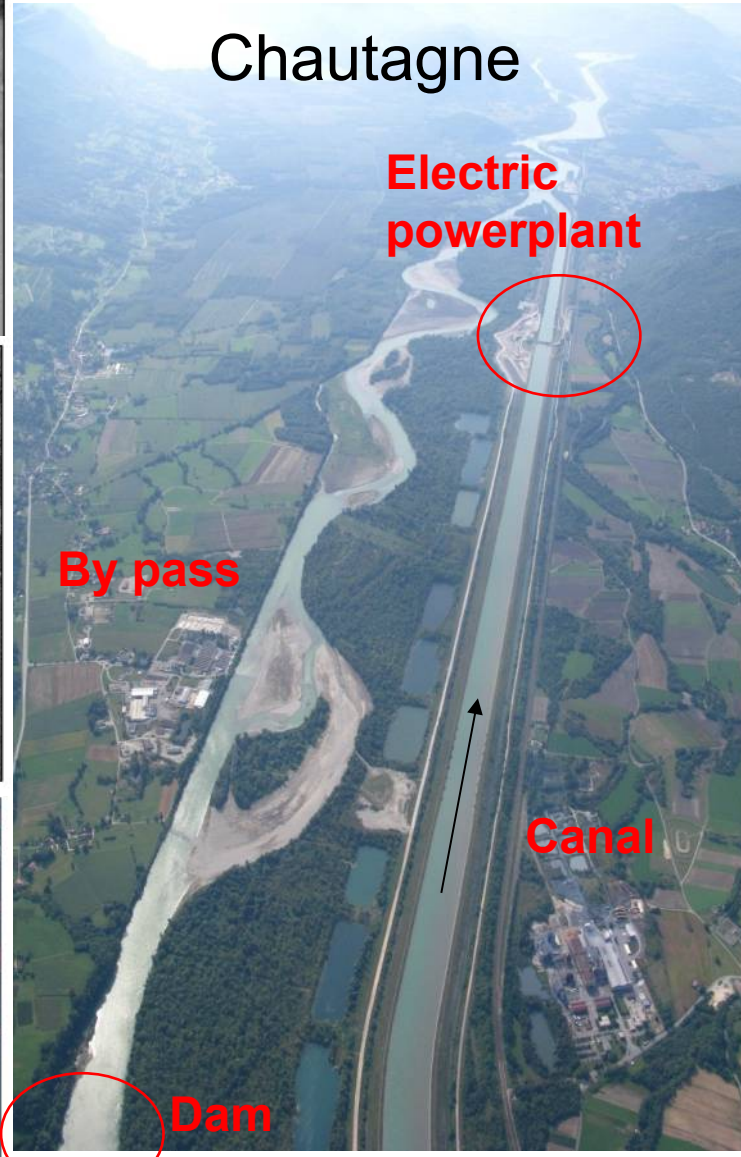


Profils

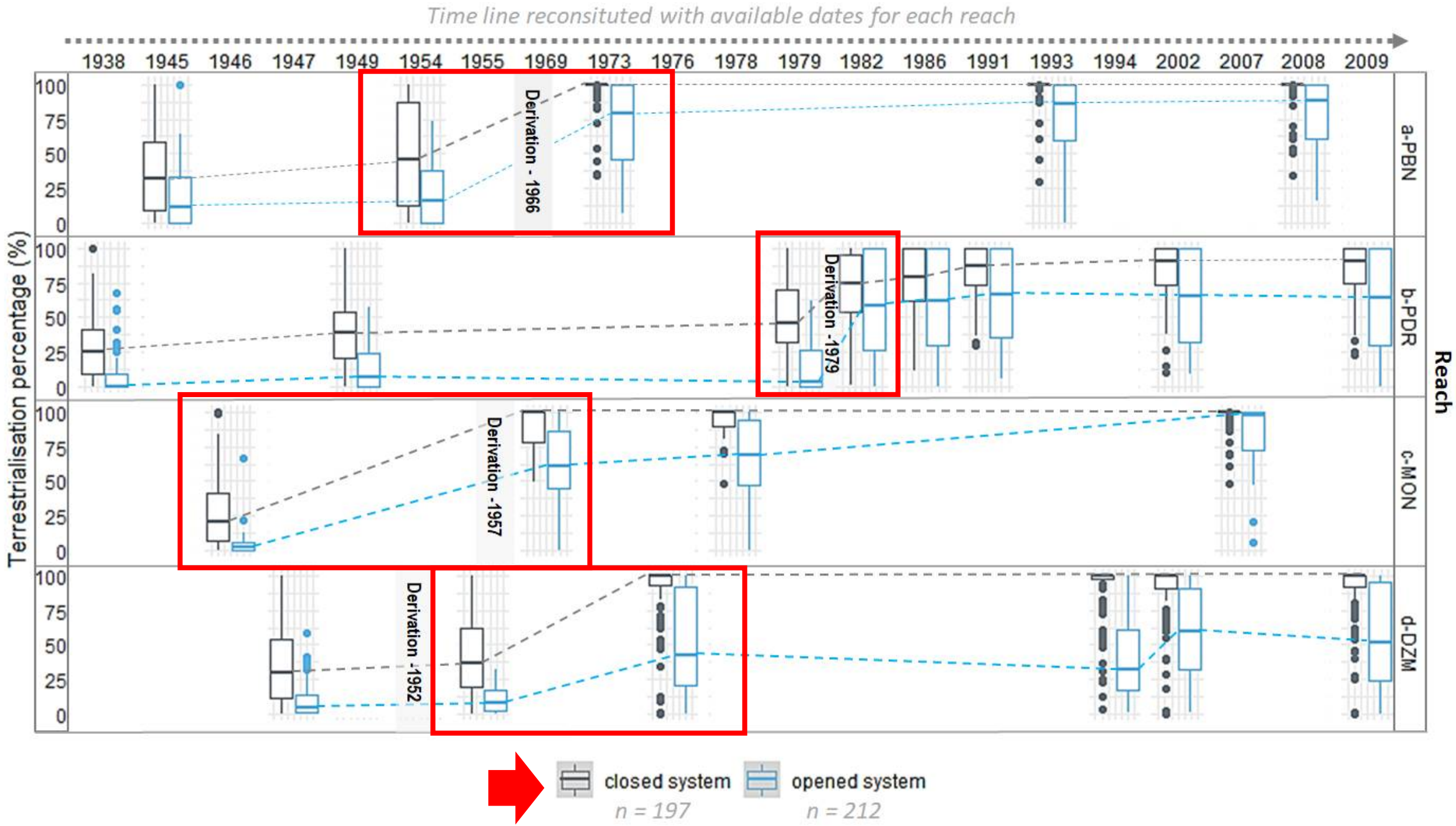
Surface sédimentée

Chronologie

- 1860-1897
- 1897-1948
- 1948-1958
- 1958-1972
- 1972-1974
- 1974-1981
- 1981-1982
- 1982-1986
- 1986-1991
- 1991-2002
- 2002-2014



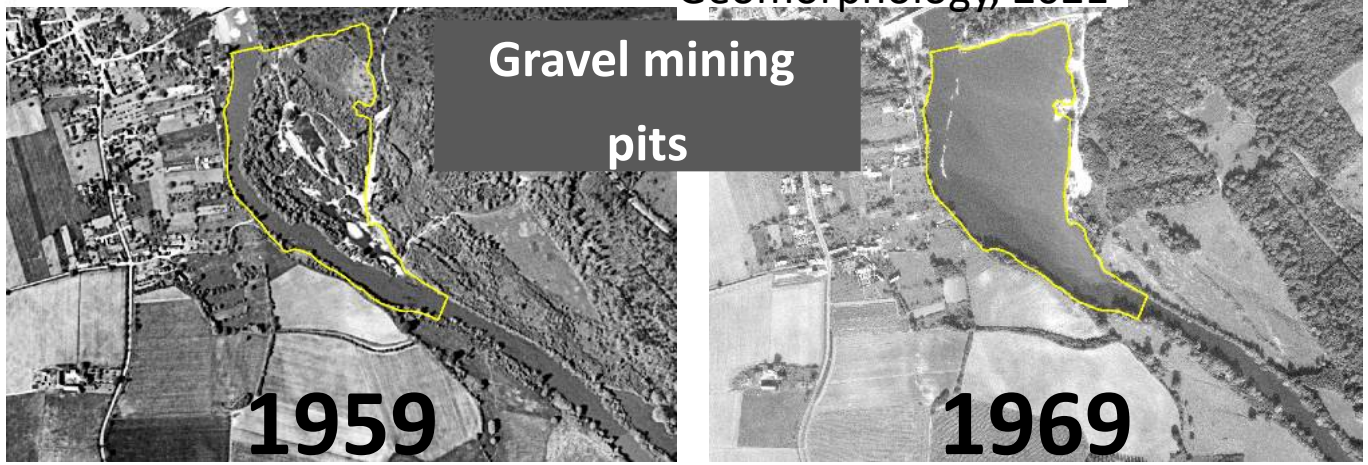
Vegetation encroachment with two phases

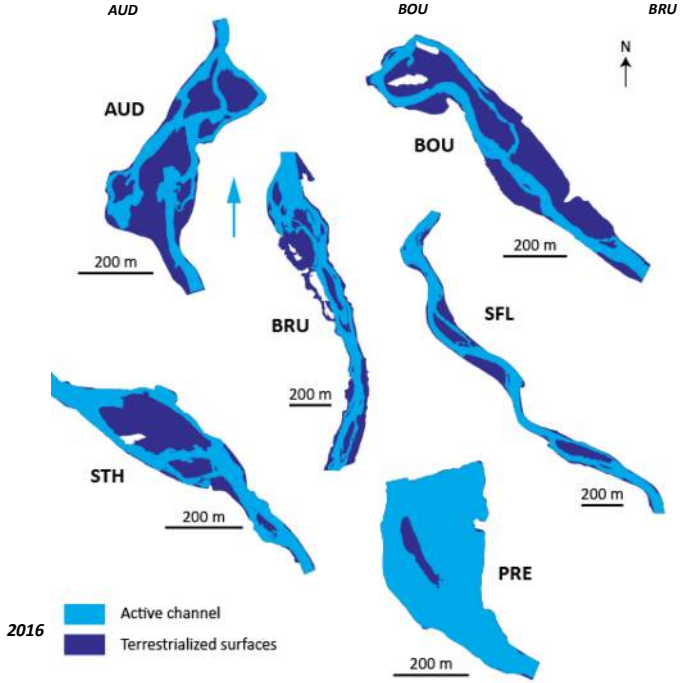

Time line reconsituted with available dates for each reach
1938
1945
1946
1947
1949
1954
1955
1969
1973
1976
1978
1979
1982
1986
1991
1993
1994
2002
2007
2008
2009
Terrestrialisation percentage (%)
100
75
50
25
0
Derivation - 1966
Derivation -1979
Derivation -1957
Derivation -1952
a-PBN
b-PDR
c-MON
d-DZM
Reach
closed system
n = 197
opened system
n = 212

Lowland gravel-bed river recovery through former mining reaches, the key role of sand

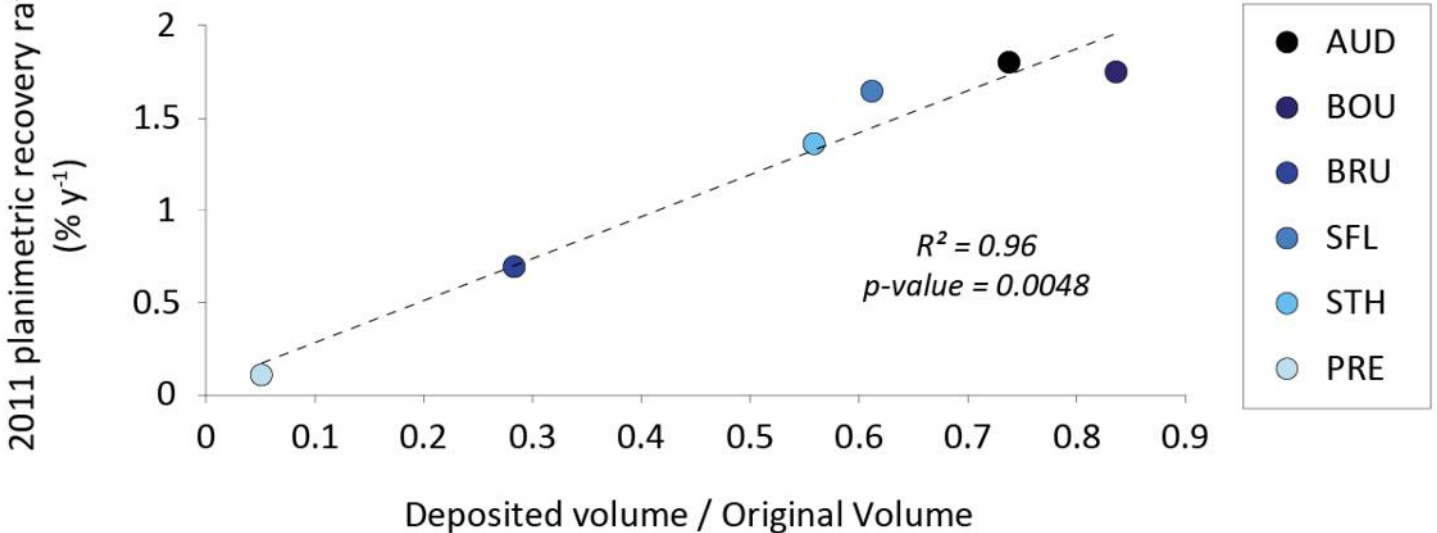
Thomas Dépret [a,*], Clément Virmoux [a], Emmanuèle Gautier [b], Hervé Piégay [c], Mariya Doncheva [b], Brian Plaisant [b], Sirine Ghamgui [b], Evan Mesmin [b], Ségolène Saulnier-Copard [a], Lucile de Milleville [d], Julien Cavero [a], Pablo Hamadouche [b]

Geomorphology, 2021





Recovery rate linked to sedimentation and initial excavated volume



Use of airborne LiDAR and historical aerial photos for characterising the history of braided river floodplain morphology and vegetation responses

S. Lallias-Tacon [a,b], F. Liébault [a,*], H. Piégay [b]

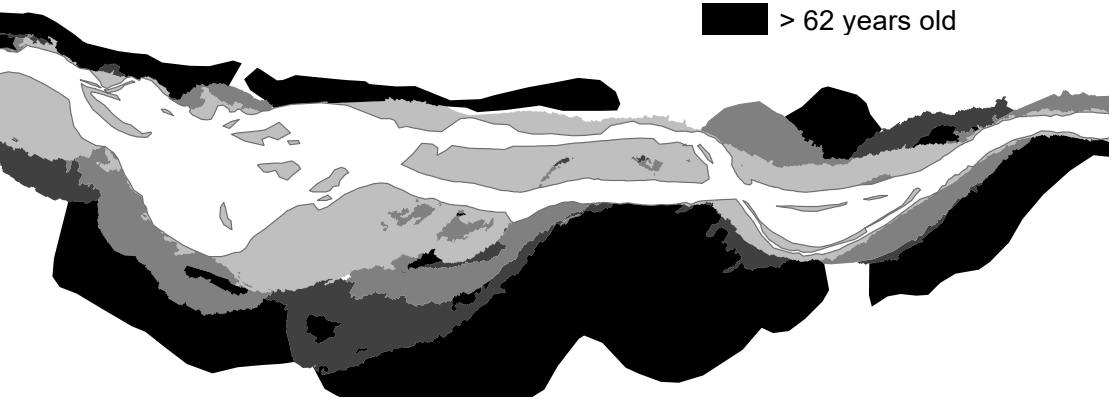
Catena 149 (2017)

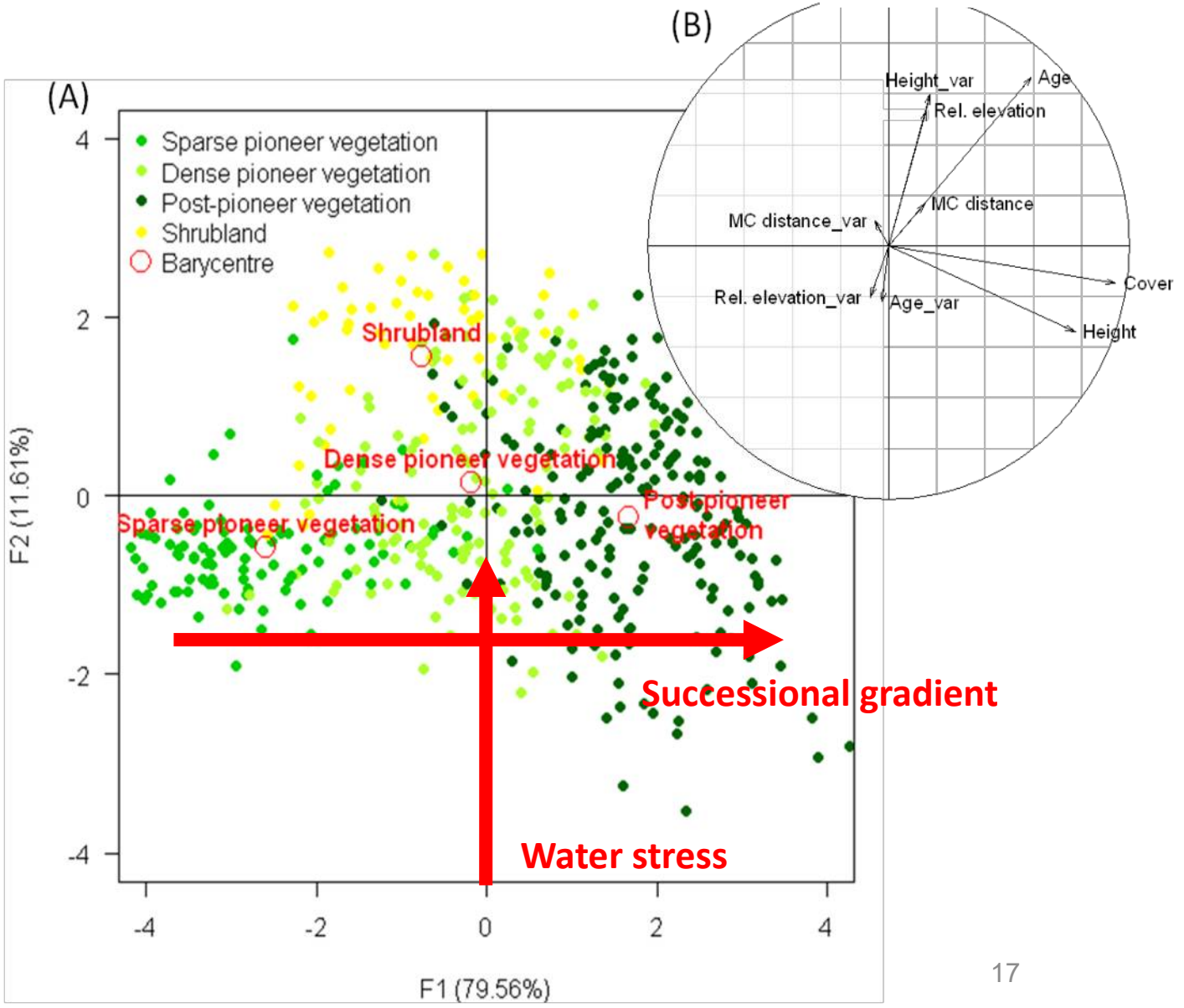
Vegetation type

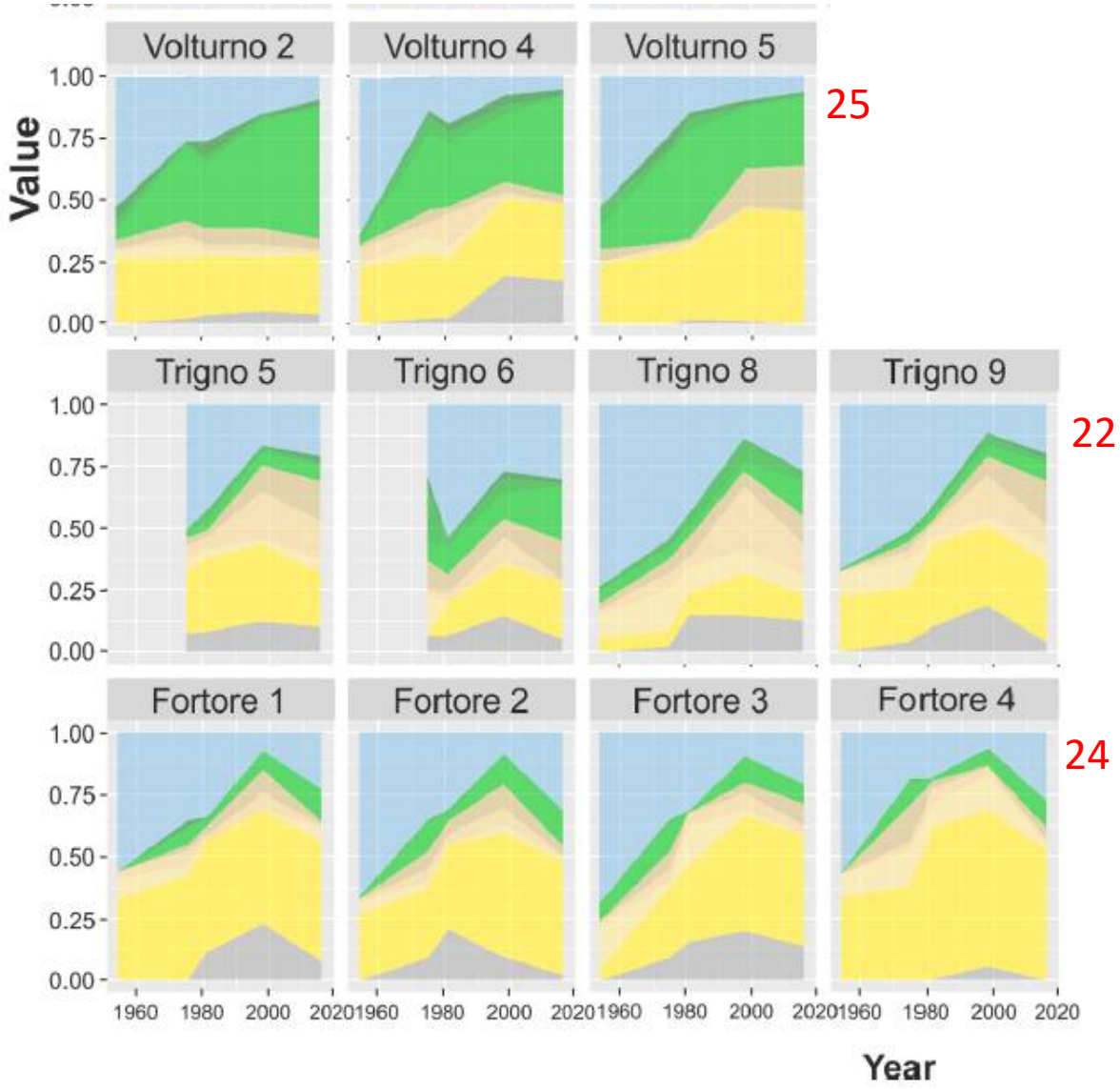
- Shrubland
- Grassland
- Shrub colonized grassland
- Sparse pioneer vegetation
- Dense pioneer vegetation
- Post-pioneer vegetation

Floodplain age classes

- Active channel of 2010
- < 20 years old
- 20-40 years old
- 40-62 years old
- > 62 years old







25

22

24

Fig. 5. Historical changes in land use trends in the corridors of the 22 selected reaches.

What are the stakes?

- Risk of deforestation, harvesting

Recevoir la lettre d'info

Reporterre
le quotidien de l'écologie

Faire un don au journal

Barnabé Binctin (Reporterre)

18 janvier 2014 à 11h25
Mis à jour le 10 mars 2015 à 09h22
Durée de lecture : 6 minutes

La centrale biomasse de Pierrelatte, l'absurde projet inutile d'AREVA

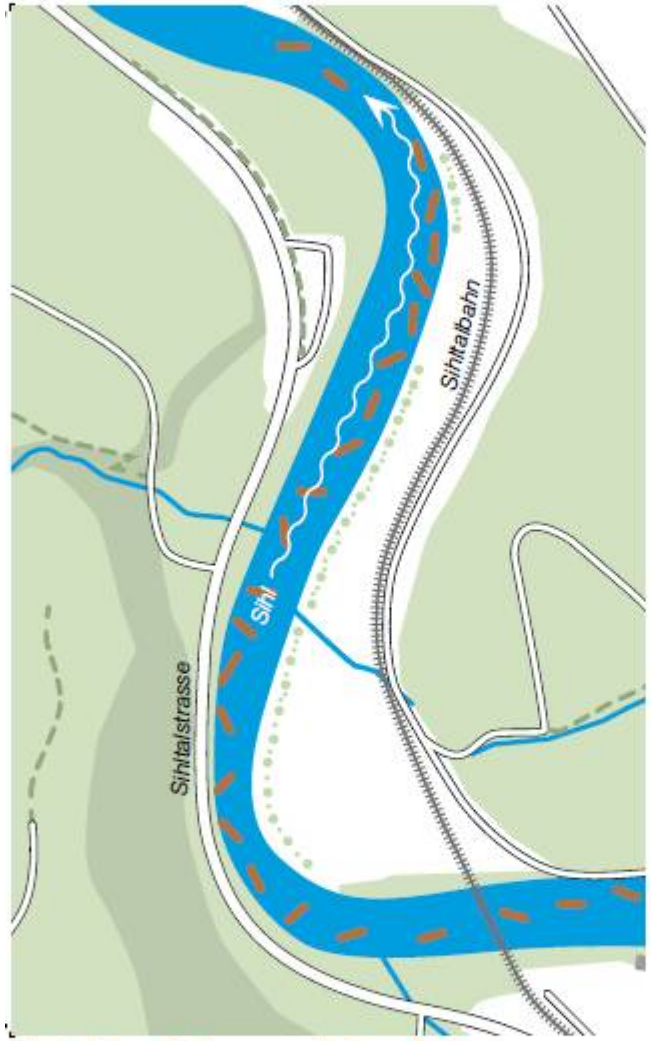
Des milliers de tonnes de bois et pourtant un mauvais fonctionnement : la centrale à biomasse de Pierrelatte a un coût environnemental très négatif. Centrale à bois ne veut pas dire « écologique ». *Reporterre* a enquêté.

What are the stakes?

- Risk of deforestation, harvesting
- Risk of flooding due to infrastructure blockage by in-channel wood

http://www.awel.zh.ch/internet/baudirektion/awel/de/wasser/hochwasserschutz/hochwasserschutz_zuerich/sihl_schwemmholzrechen.html

Grosse Teile von Zürich liegen auf dem natürlichen Schwemmkegel der Sihl. (Foto: H.J. Egger, Uster)



Heute kann Schwemmholz an kritischen Stellen zu Ausuferungen der Sihl führen.

In Zukunft treibt das Schwemmholz in den Rechen bei Langnau am Albis.

What are the stakes?

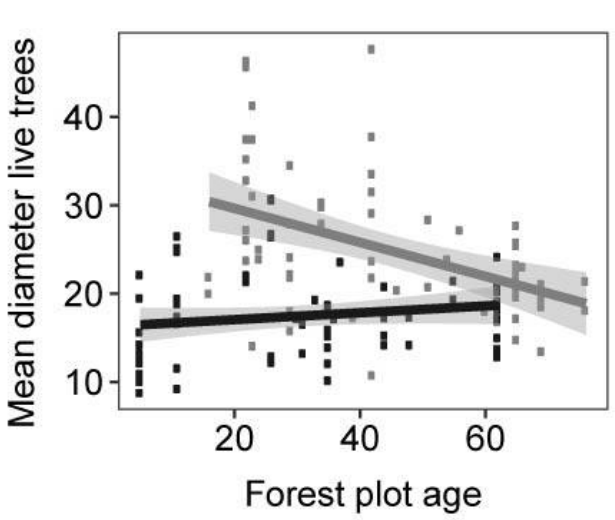
- Risk of deforestation, harvesting
- Risk of flooding
  - due to infrastructure blockage by in-channel wood
  - due to roughness increase
- Risk of eldering / drying / decline of rejuvenation dynamics due to disconnections (vertical and lateral) (dams, dikes, mining… reducing sediment delivery and flood freq.)

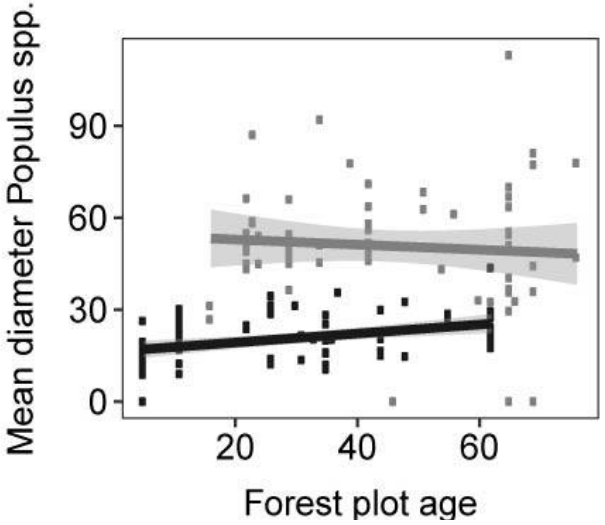
Divergence of riparian forest composition and functional traits from natural succession along a degraded river with multiple stressor legacies

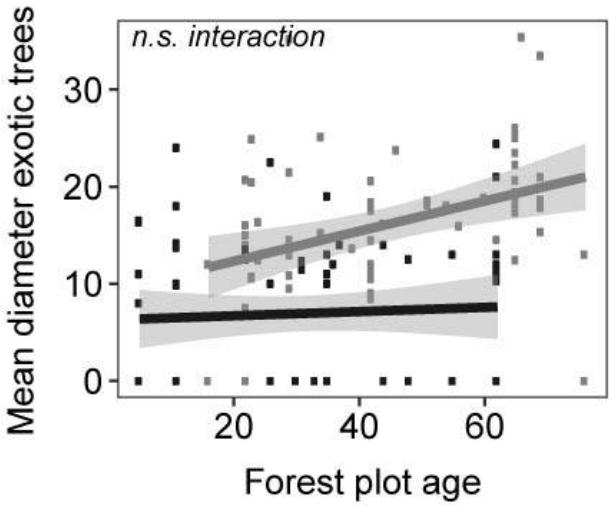
Philippe Janssen [a,b,*], John C. Stella [c], Hervé Piégay [a], Bianca Räpple [a], Bernard Pont [d], Jean-Michel Faton [d], Johannes Hans C. Cornelissen [e], André Evette [b]

Stoten, 2020

- Channelization and flow regulation => rapid terrestrial-like succession and transition to the mature successional phase;
- Resource-rich environment => establishment of exotic invasive species;
- Riparian forests could be regarded as “novel ecosystems” for which restoration thresholds are most likely exceeded;
- Alternative strategies should be developed to manage degraded riparian forests.







Rhône

Drôme

What should we do?

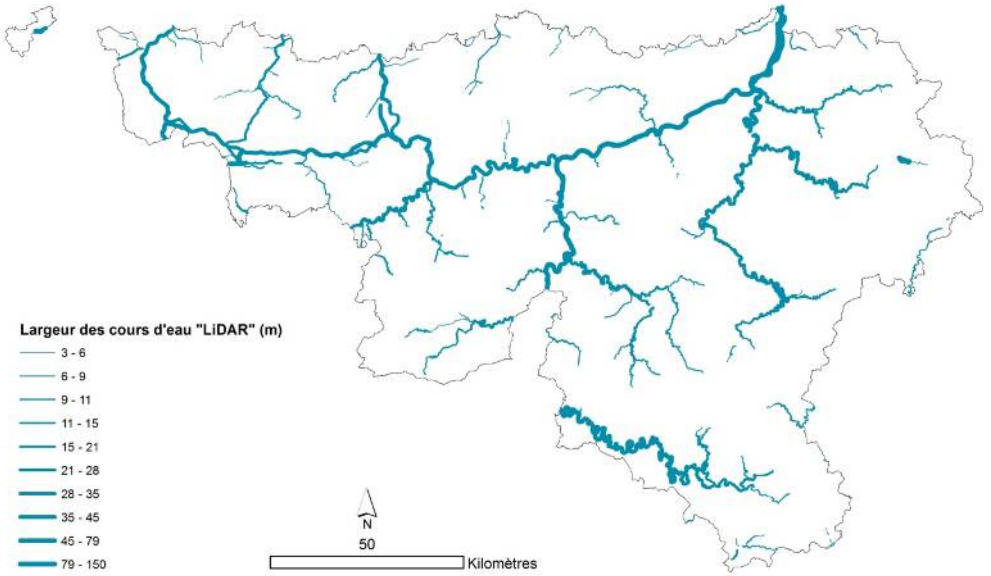
Multi-temporal monitoring of a regional riparian buffer network (>12,000 km) with LiDAR and photogrammetric point clouds

Adrien Michez [a,*], Hervé Piégay [b], Philippe Lejeune [a], Hugues Claessens [a]

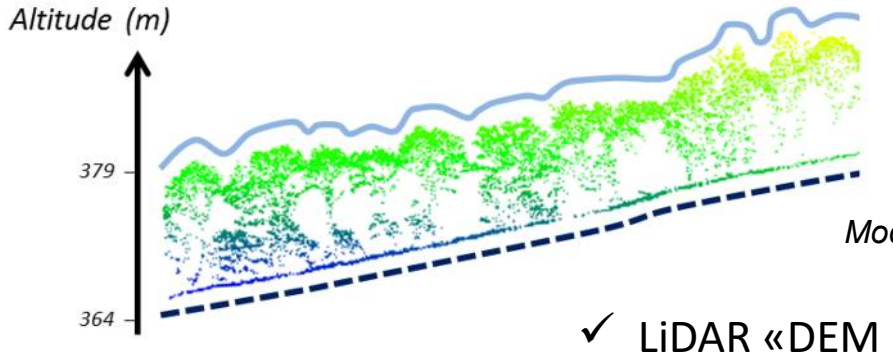
Journal of Environmental Management 202 (2017)

- Preserve the most emblematic forests, their functions and drivers
- Prevent damaging situation with regulations

=> Need large scale assessment is key for targeting / priorising actions



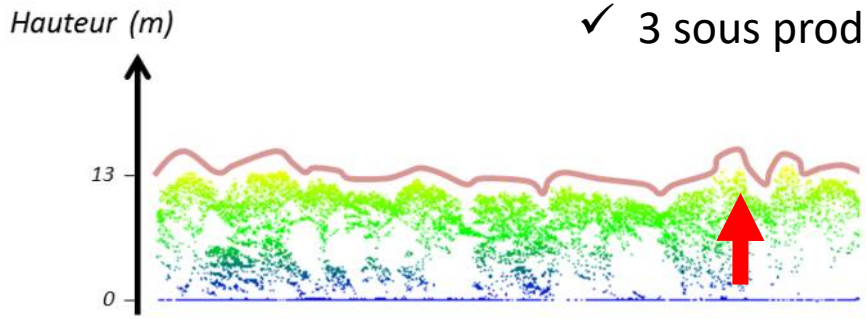
Modèle Numérique de Surface

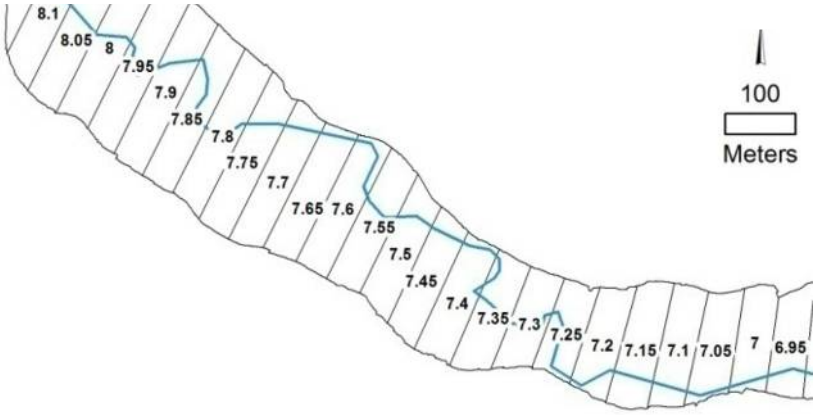


Modèle Numérique de Terrain

✓ LiDAR «DEM » ≈ 1 point / m²

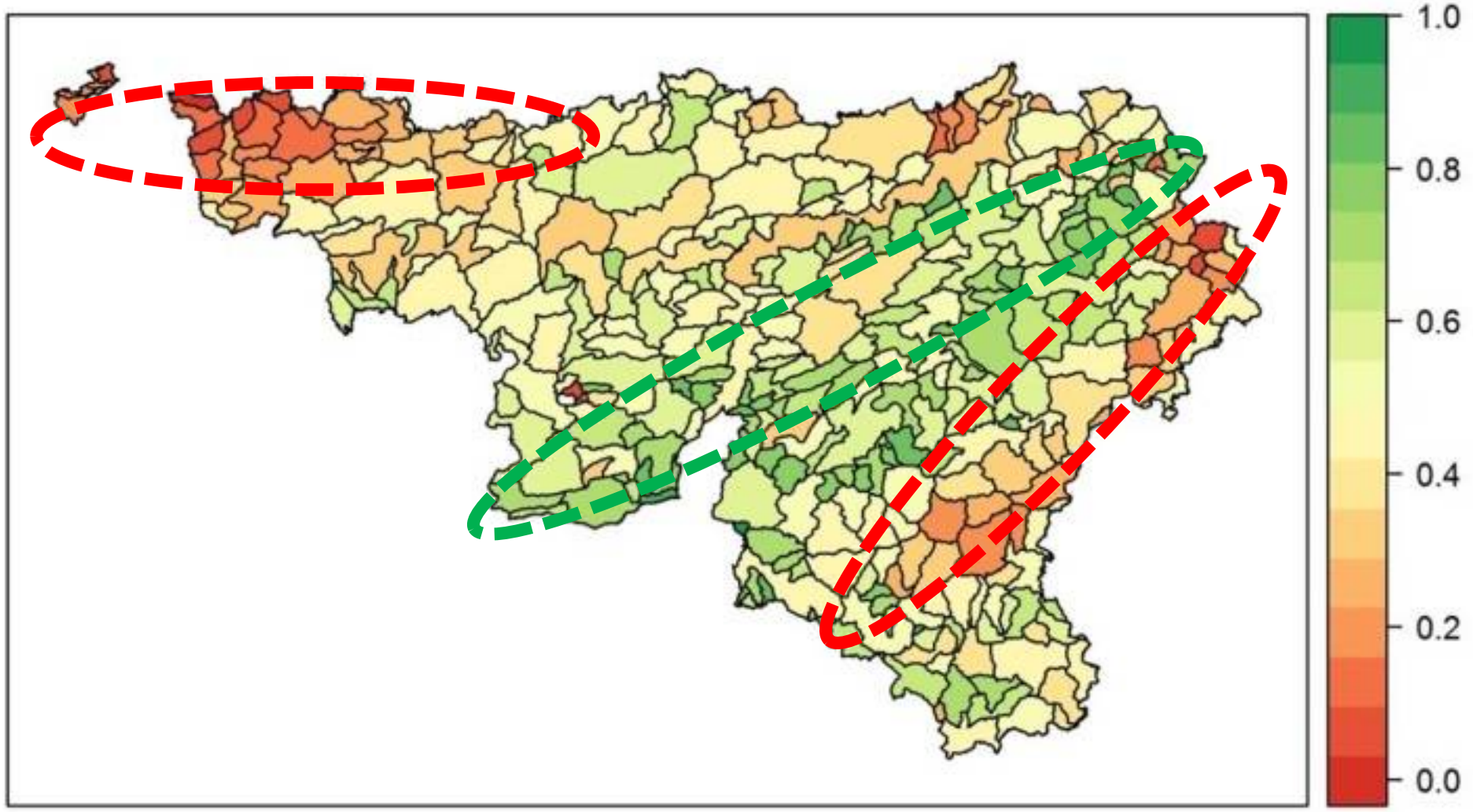
✓ 3 sous produits type : MNT / MNS / MNH





MNS - MNT : Modèle Numérique de Hauteur

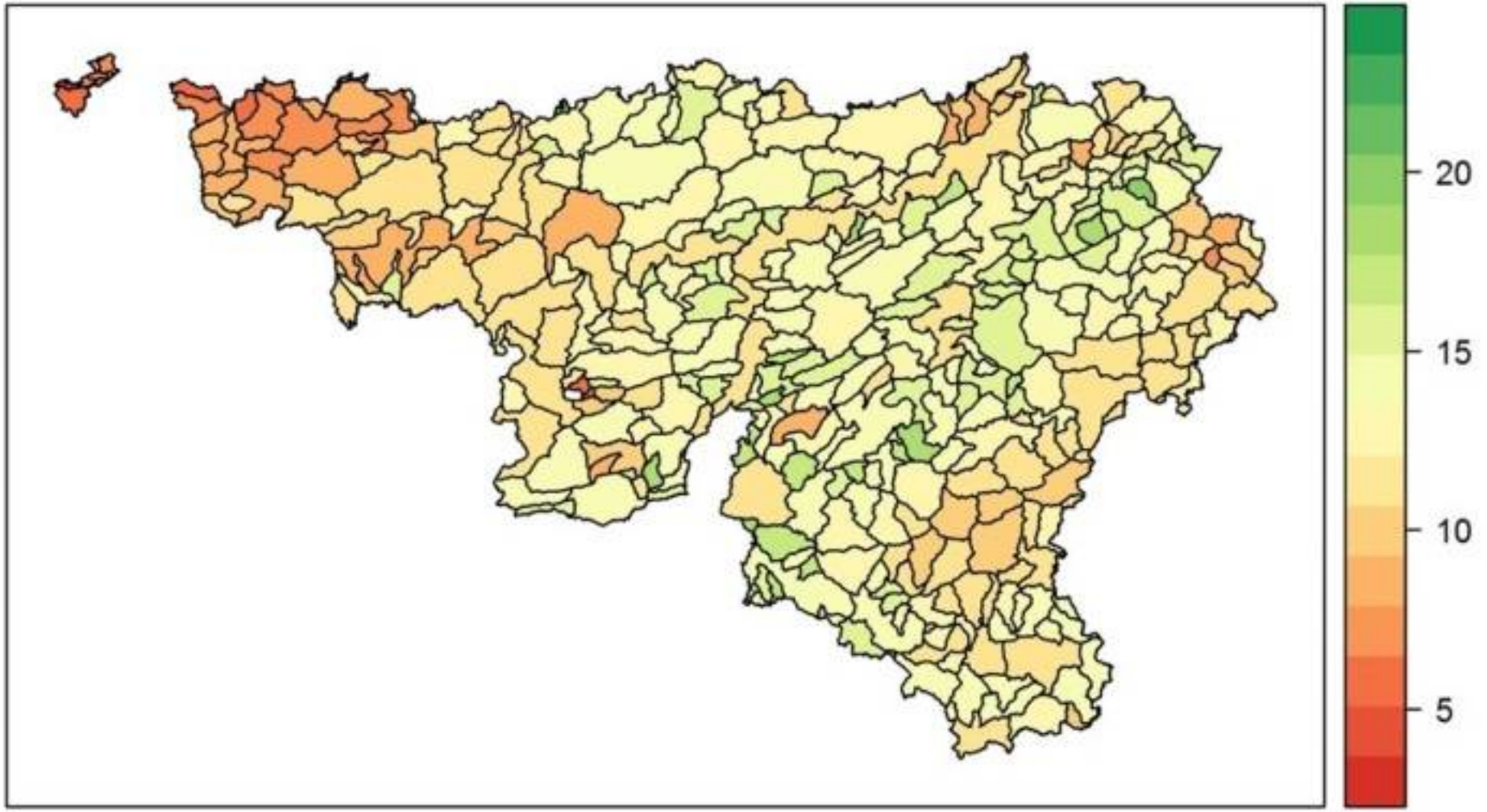
Continuous length of riparian patches along rivers (% per segment)



Représentation surfacique (masse d'eau DCE)

Michez et al.

Height of riparian forest patches (m)

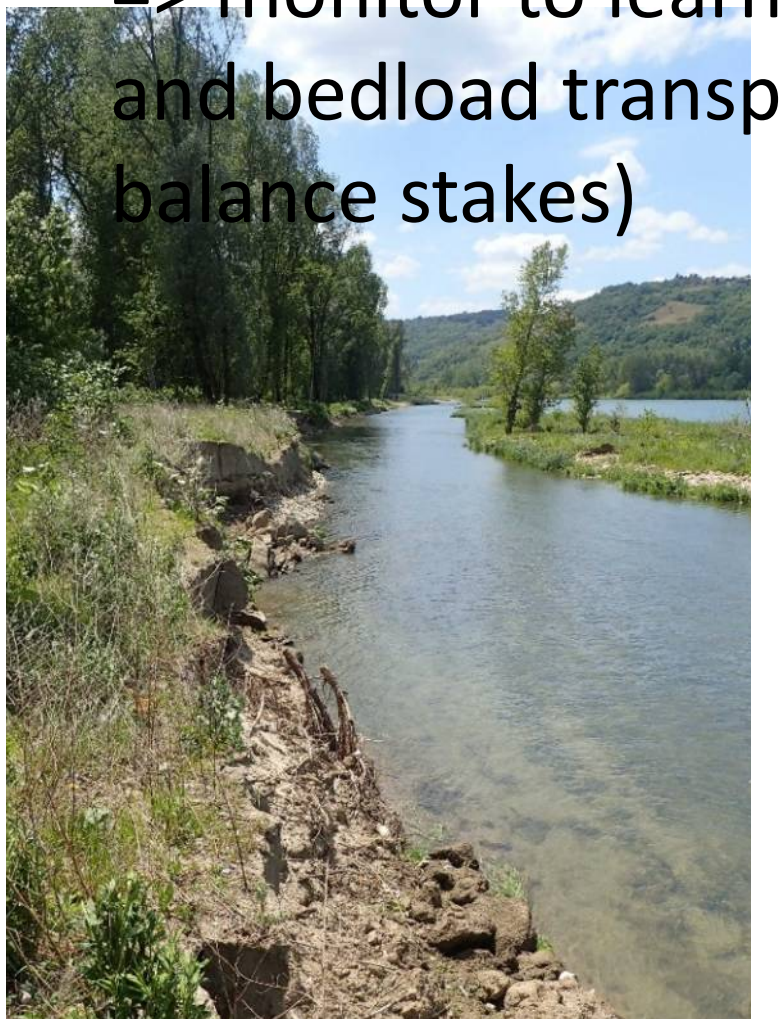


Michez et al.

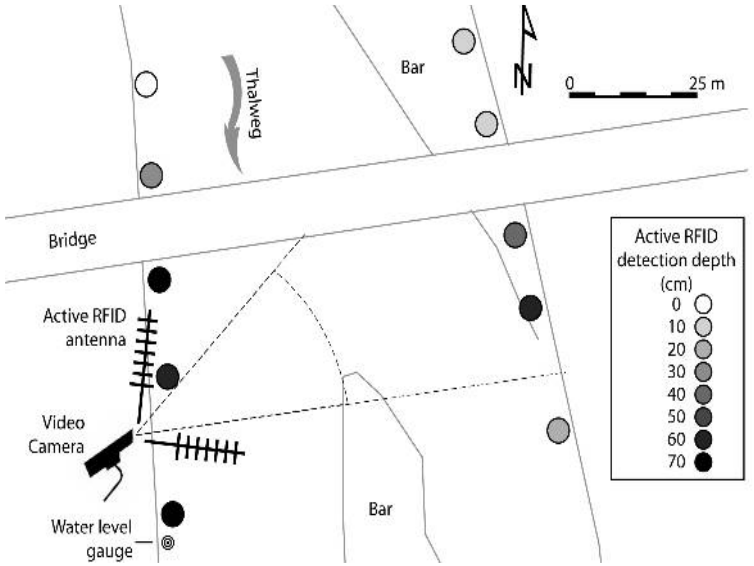
What should we do?

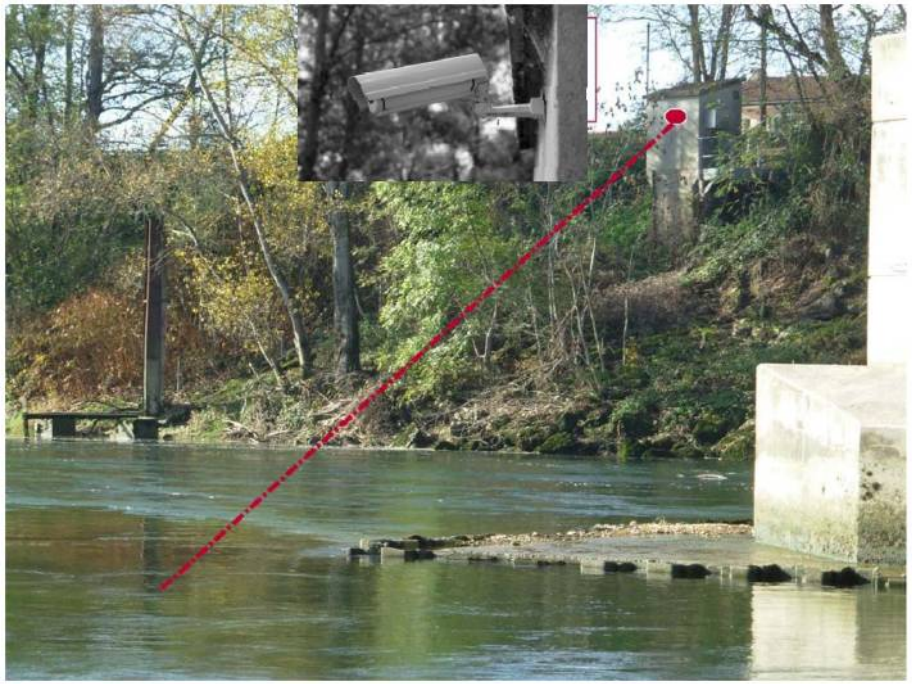
- Consider flood protection strategies incorporating forest issue
- Restore and mitigate impacts

=> monitor to learn best actions and responses (restore erosion and bedload transport; eflows; maintenance strategy to balance stakes)

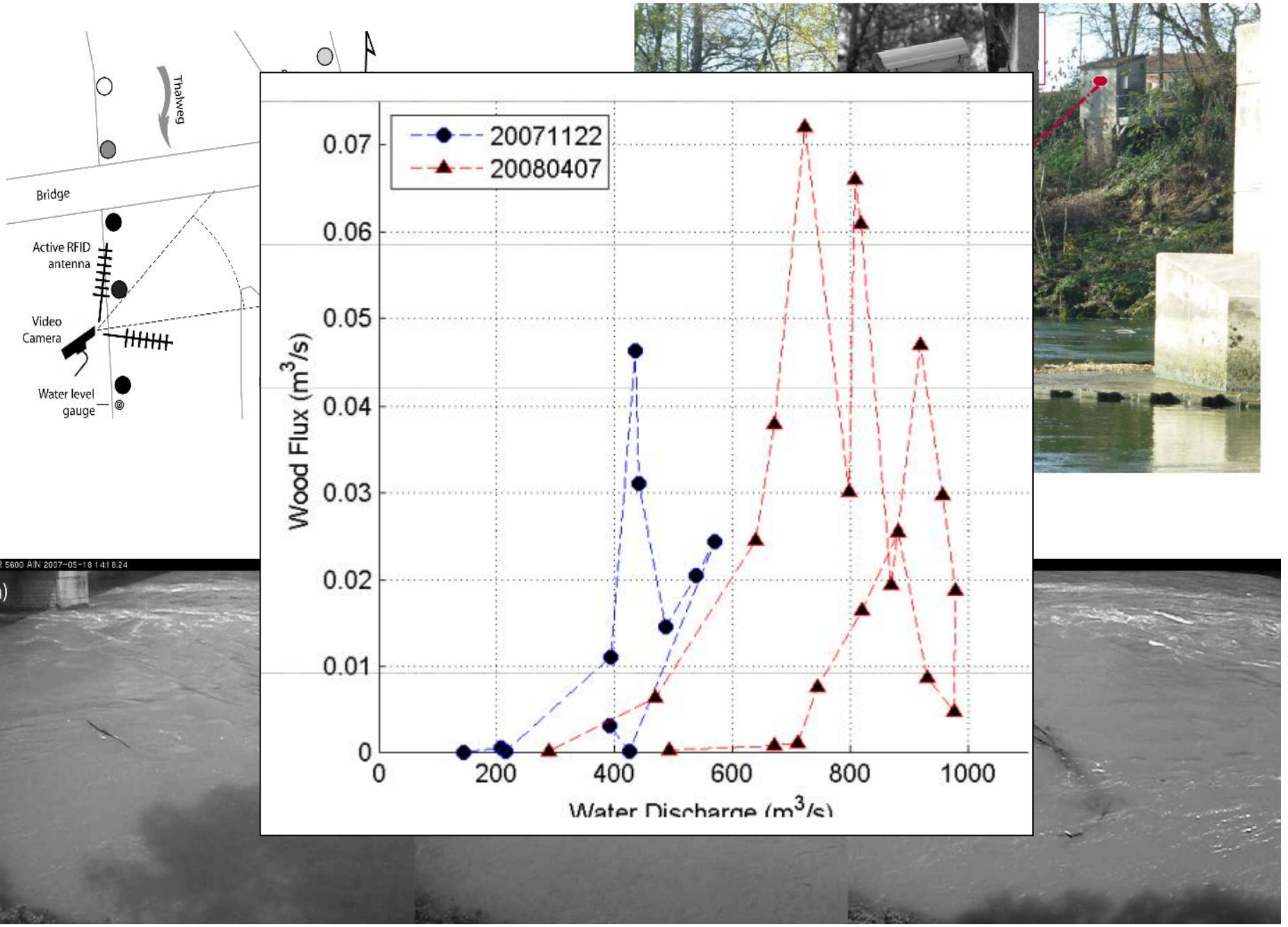


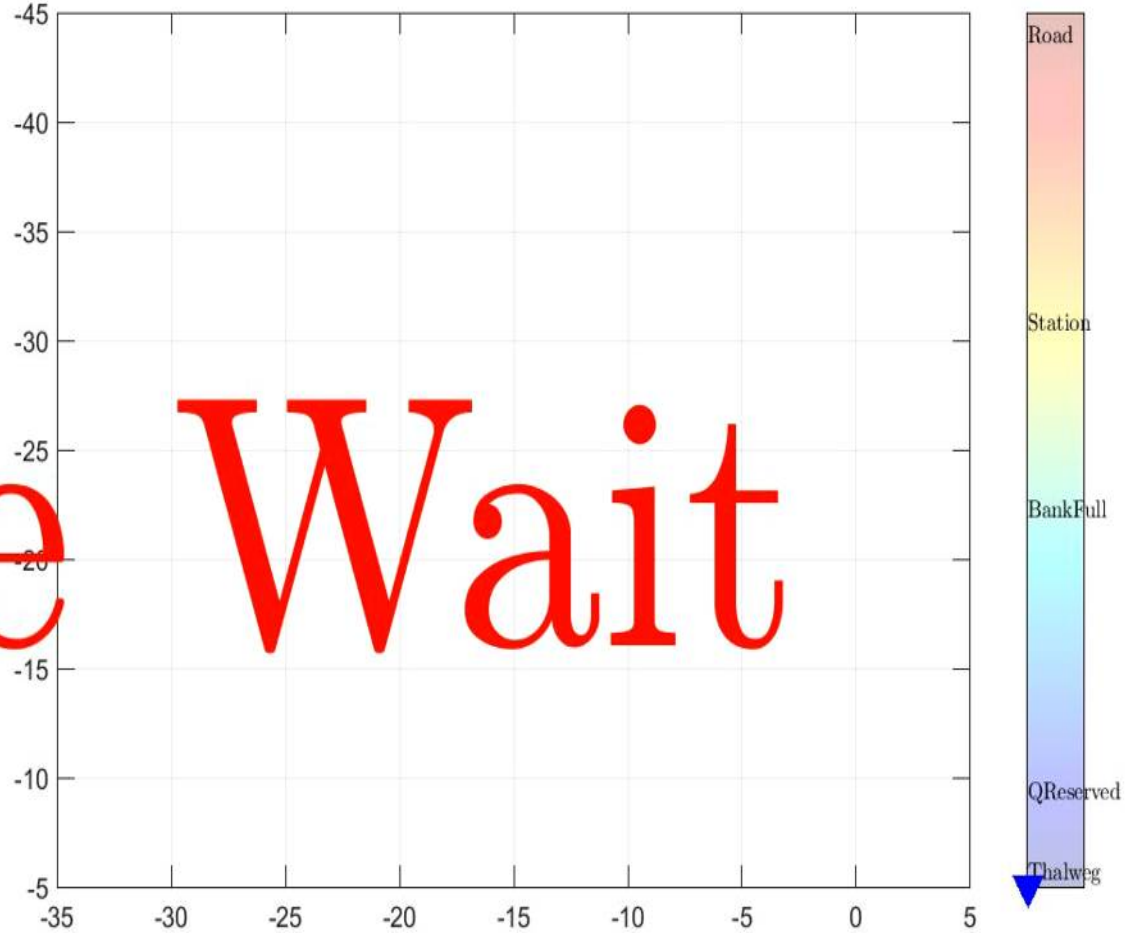
Weil-Breisach, programme [illegible] crues du Rhin - en harmonie avec la nature.

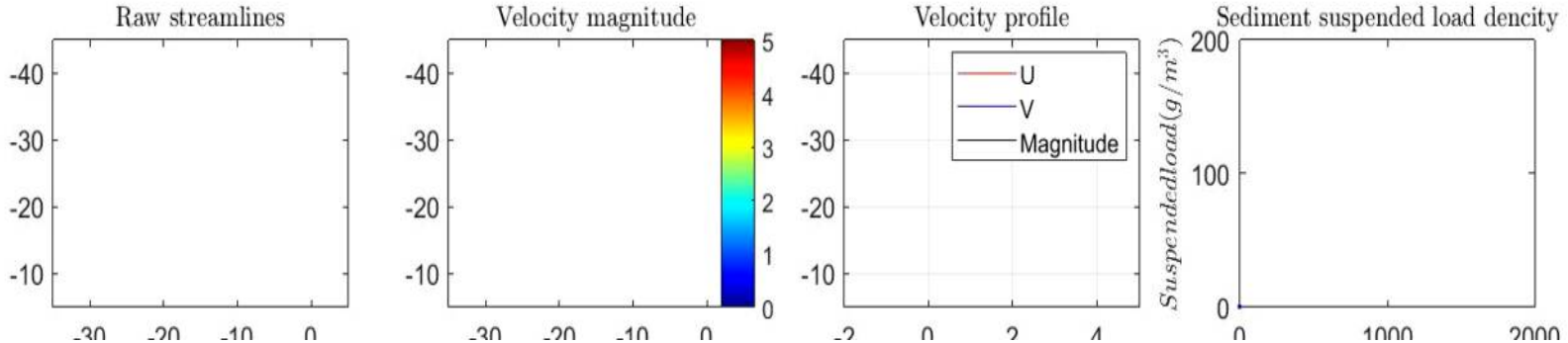

Thalweg
Bar
N
0
25 m
Bridge
Active RFID antenna
Video Camera
Water level gauge
Bar
Active RFID detection depth (cm)
0
10
20
30
40
50
60
70




UMR 5600 AIN 2007-05-18 14:16:24
a)
UMR 5600 AIN 2007-05-18 13:20:39
b)
UMR 5600 AIN 2007-05-18 12:37:57
c)


Thalweg
Bridge
Active RFID antenna
Video Camera
Water level gauge
20071122
20080407
Wood Flux (m3/s)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
200
400
600
800
1000
Water Discharge (m3/s)
a)



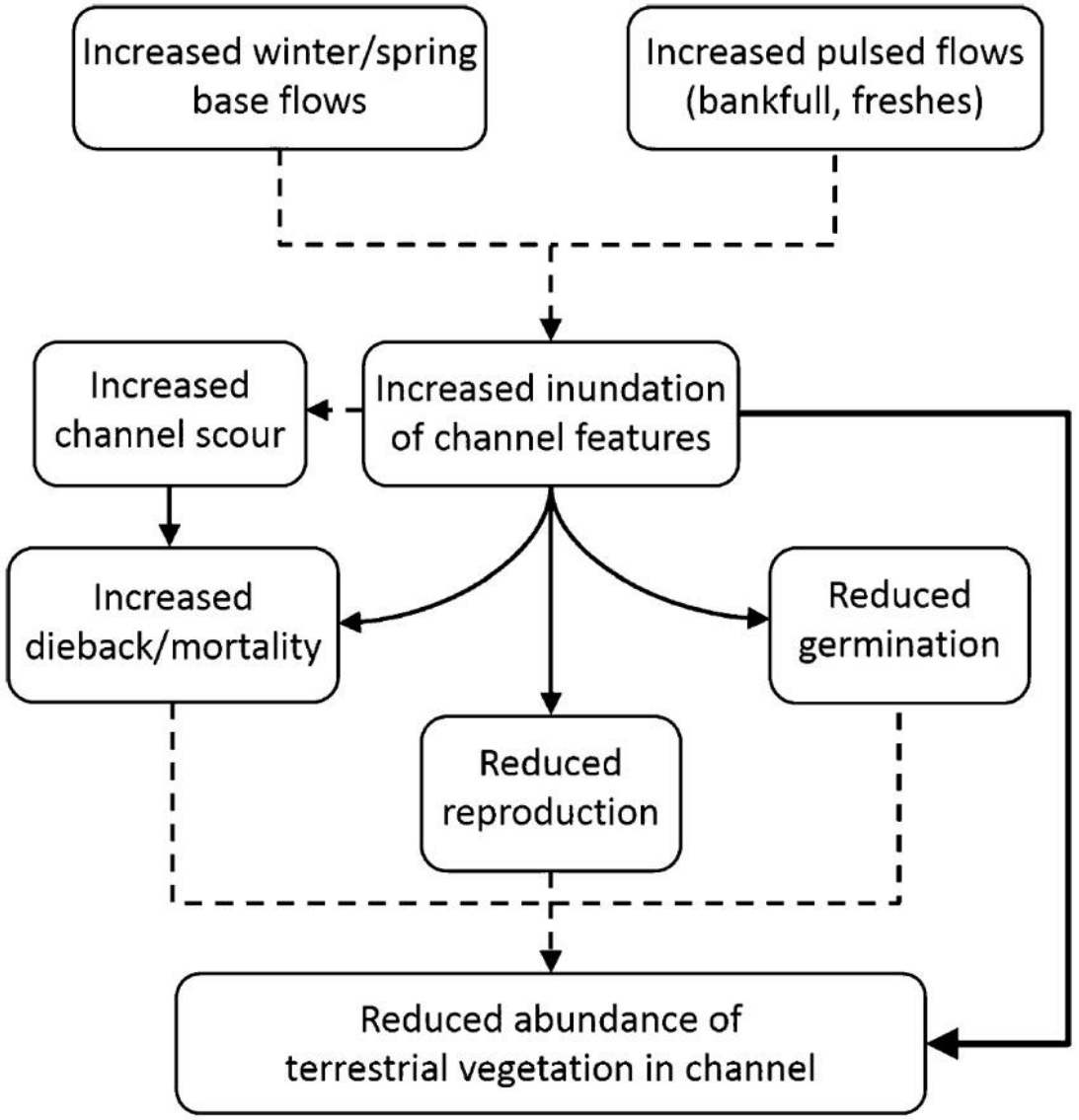


Ghaffarian et al., in prep.

What should we do?

- Improve knowledge to understand processes and promote best practices

=> ecological processes (recruitement, growth)

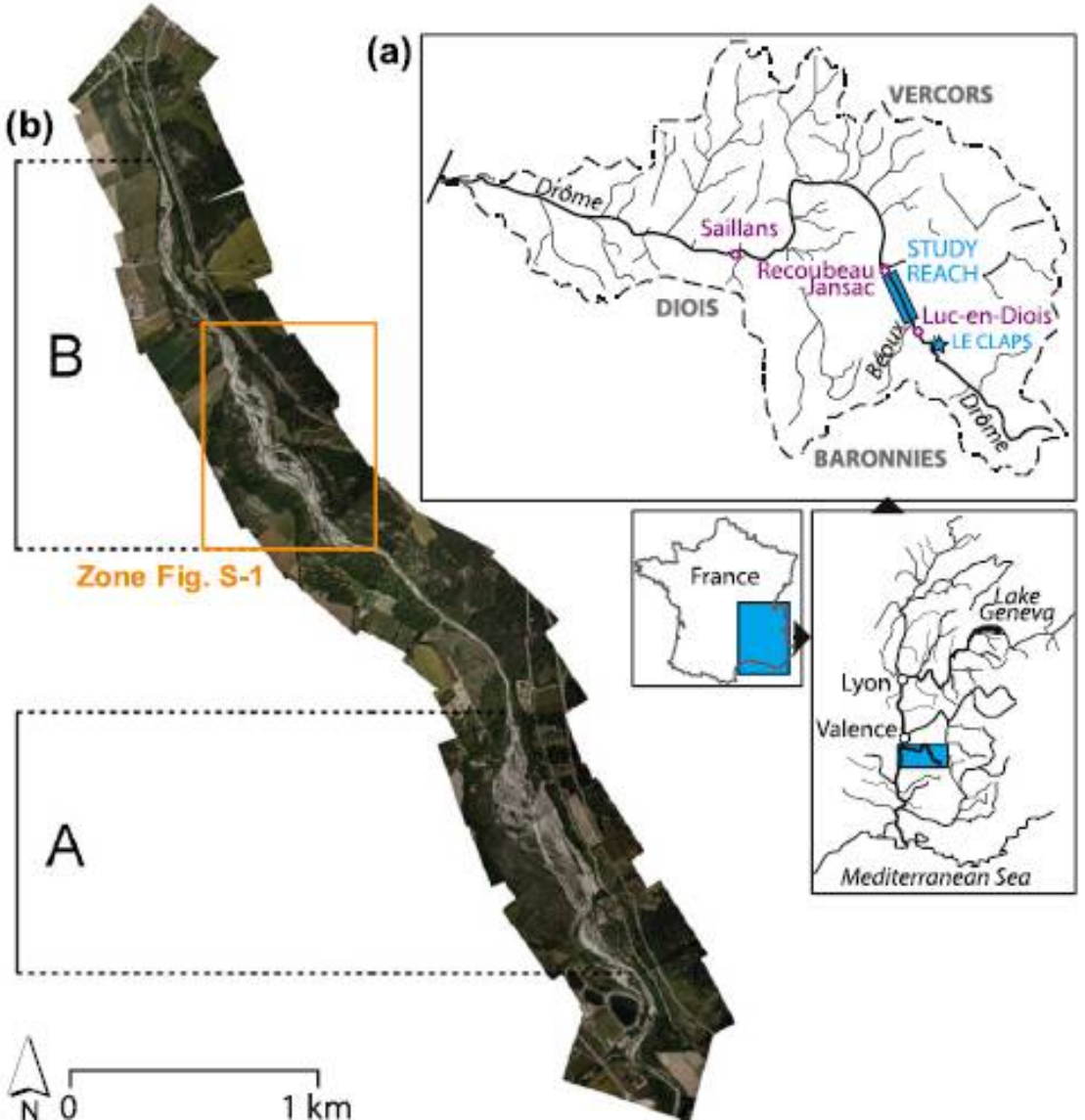


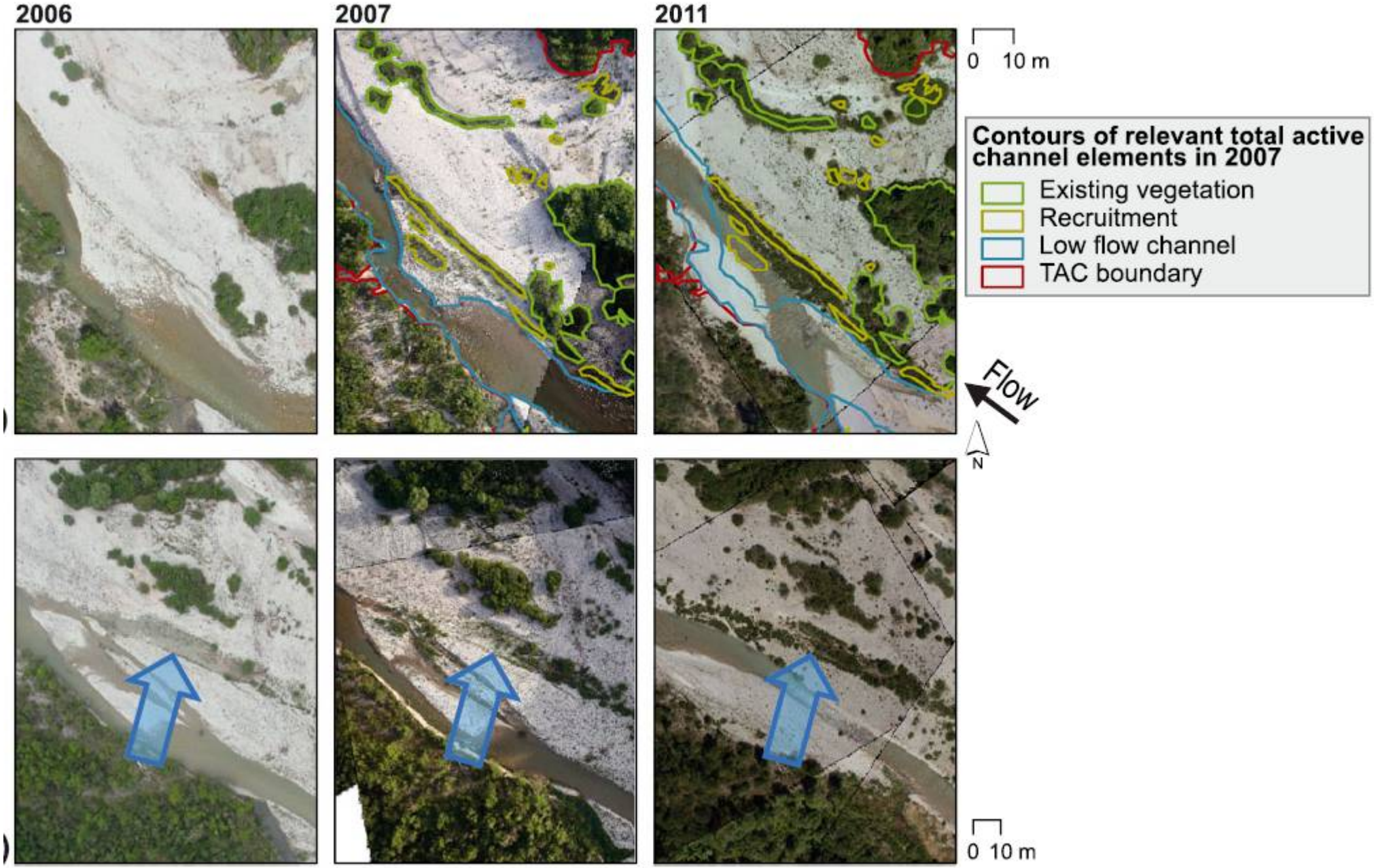
Miller et al. 2013

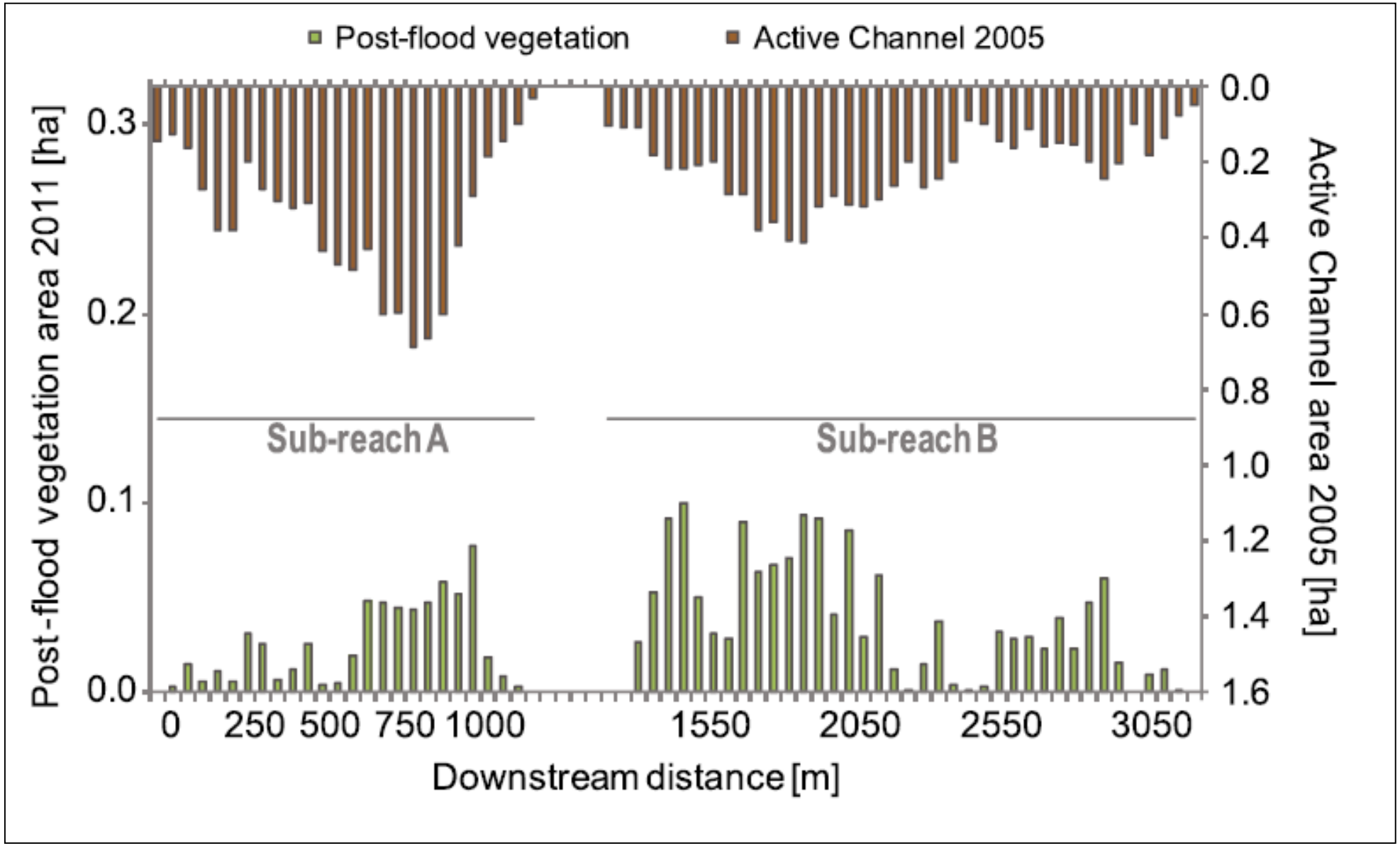
What drives riparian vegetation encroachment in braided river channels at patch to reach scales? Insights from annual airborne surveys (Drôme River, SE France, 2005–2011)

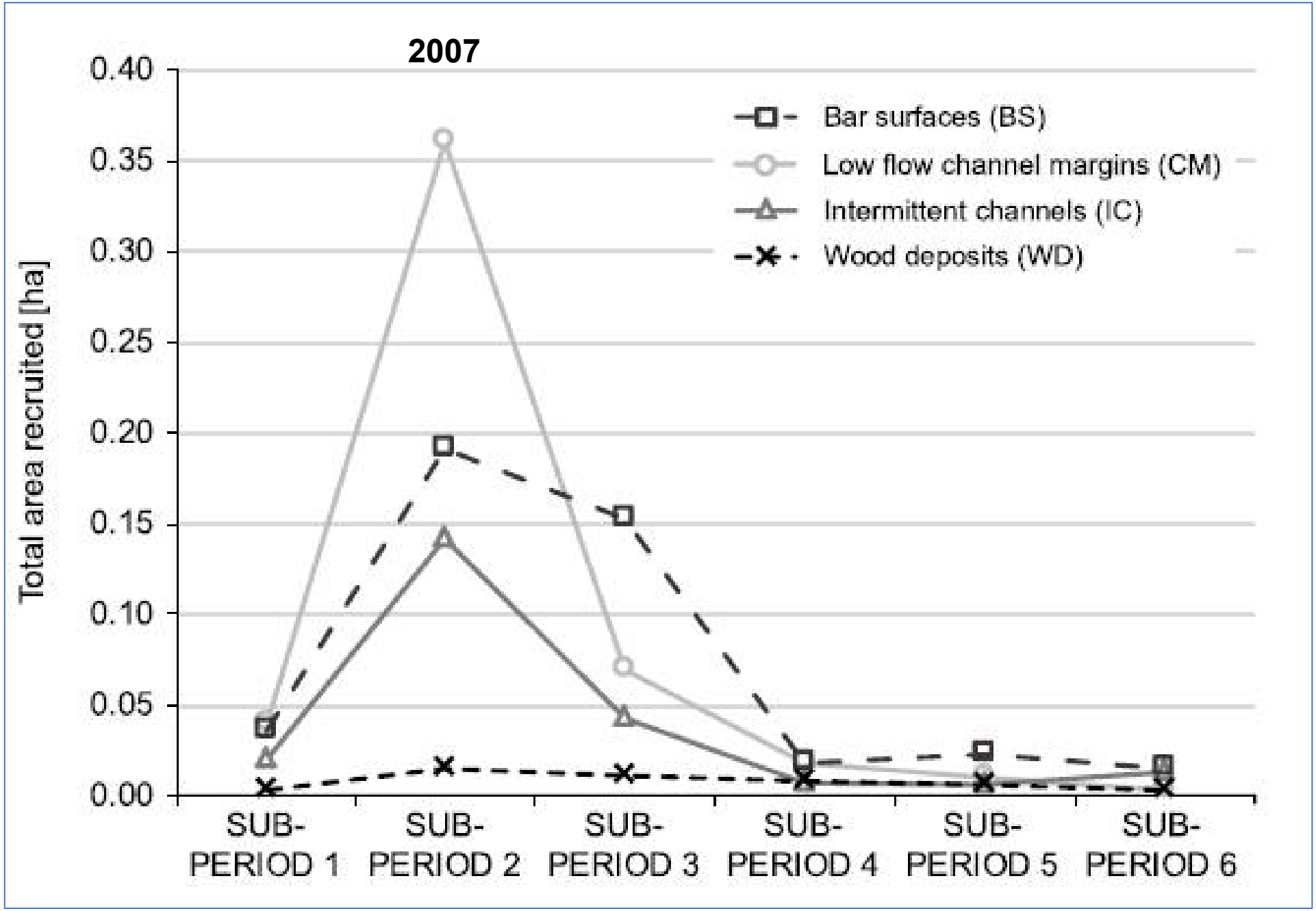
Ecohydrology, 2017

Bianca Räpple[1] | Hervé Piégay[1] | John C. Stella[2] | Dimitri Mercier[1]

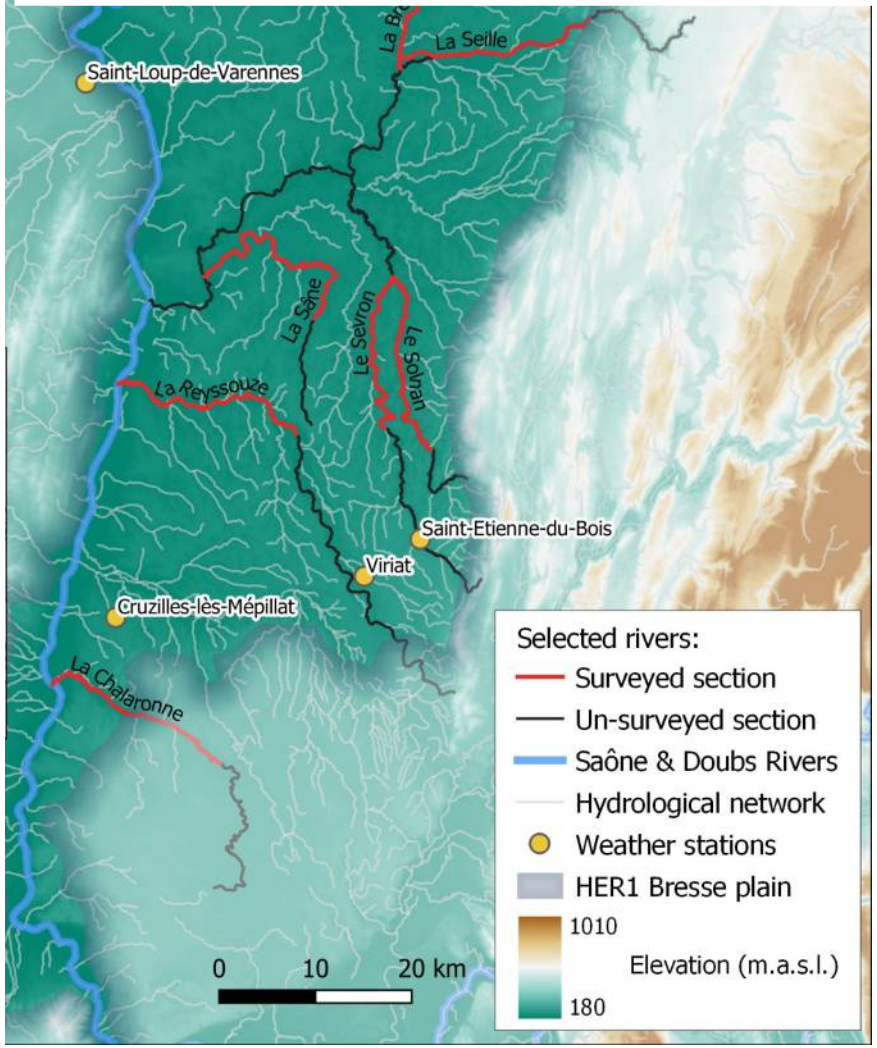


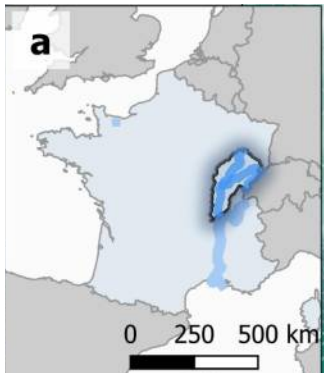

2006
2007
2011
0 10 m
Contours of relevant total active channel elements in 2007
Existing vegetation
Recruitment
Low flow channel
TAC boundary
Flow
N
0 10 m


Post-flood vegetation
Active Channel 2005
Post-flood vegetation area 2011 [ha]
Active Channel area 2005 [ha]
0.3
0.2
0.1
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Sub-reach A
Sub-reach B
0
250
500
750
1000
1550
2050
2550
3050
Downstream distance [m]

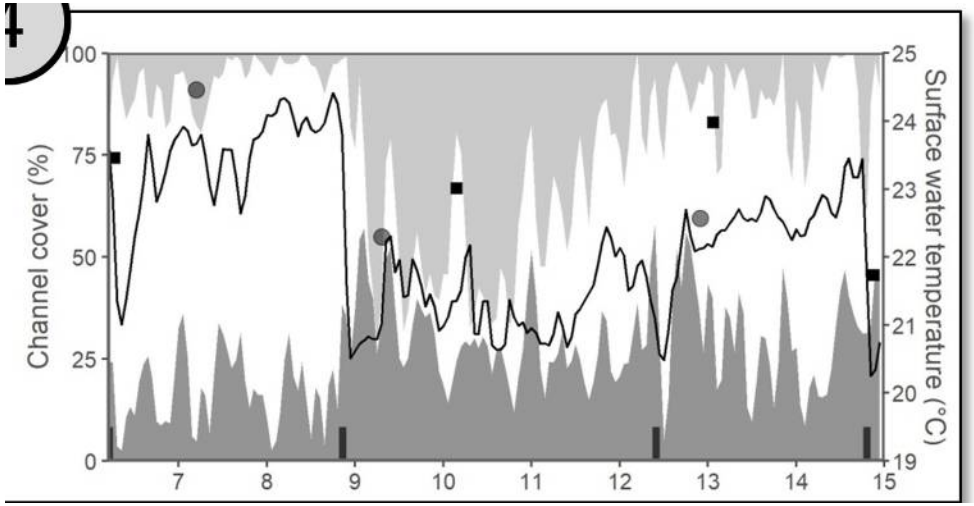

2007
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Total area recruited [ha]
Bar surfaces (BS)
Low flow channel margins (CM)
Intermittent channels (IC)
Wood deposits (WD)
SUB-PERIOD 1
SUB-PERIOD 2
SUB-PERIOD 3
SUB-PERIOD 4
SUB-PERIOD 5
SUB-PERIOD 6

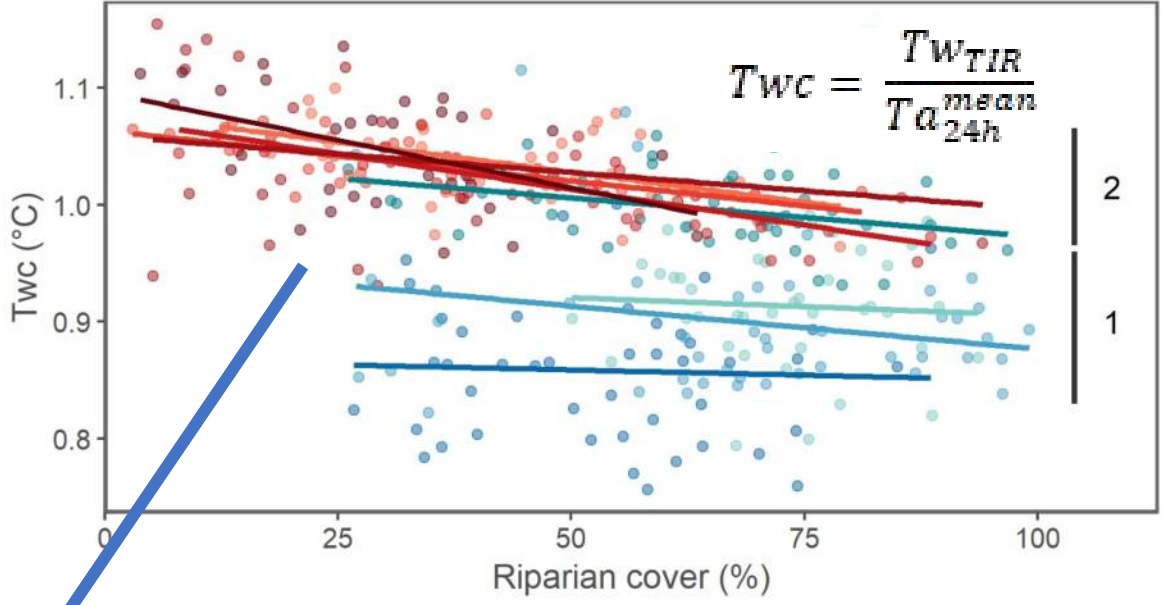
=> Temperature : Role of forests to ponderate temperature increase

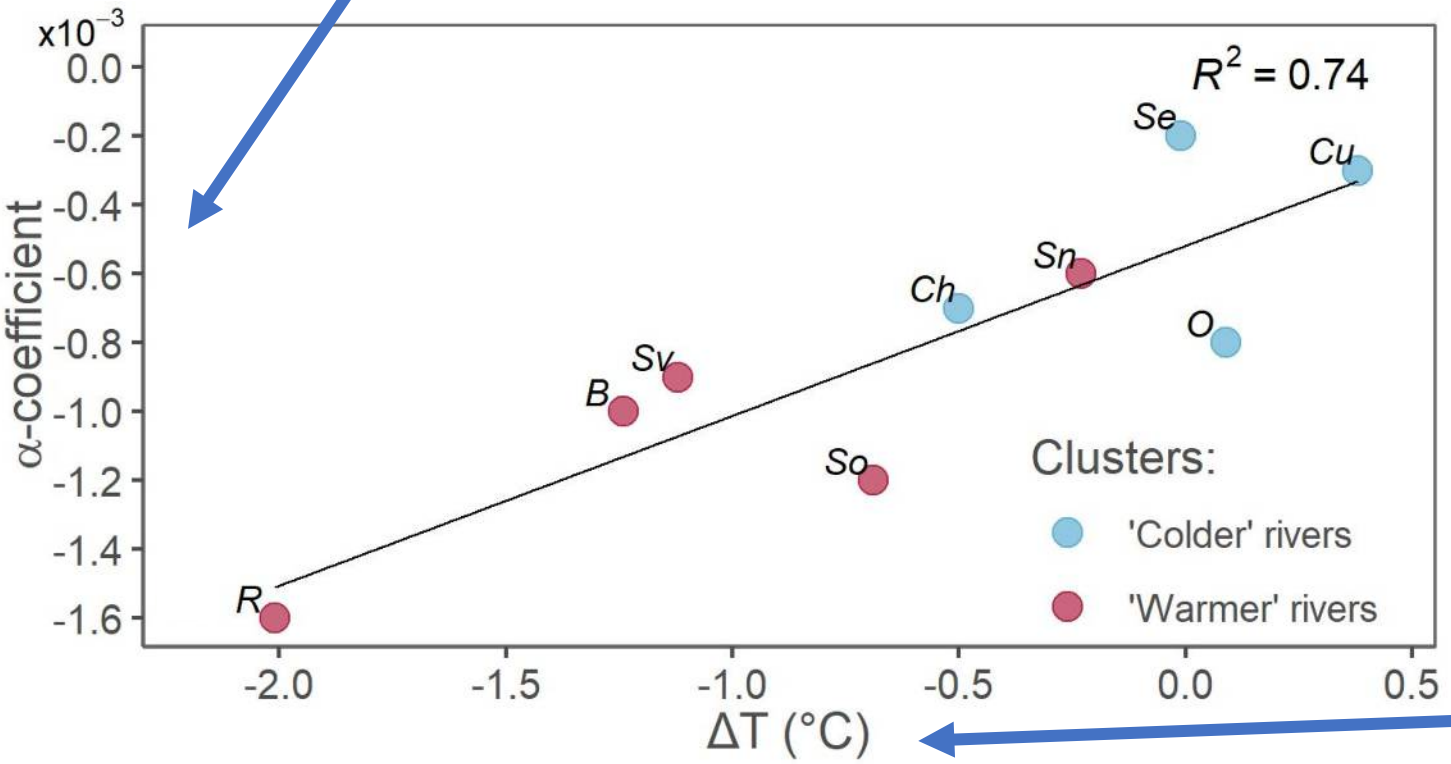


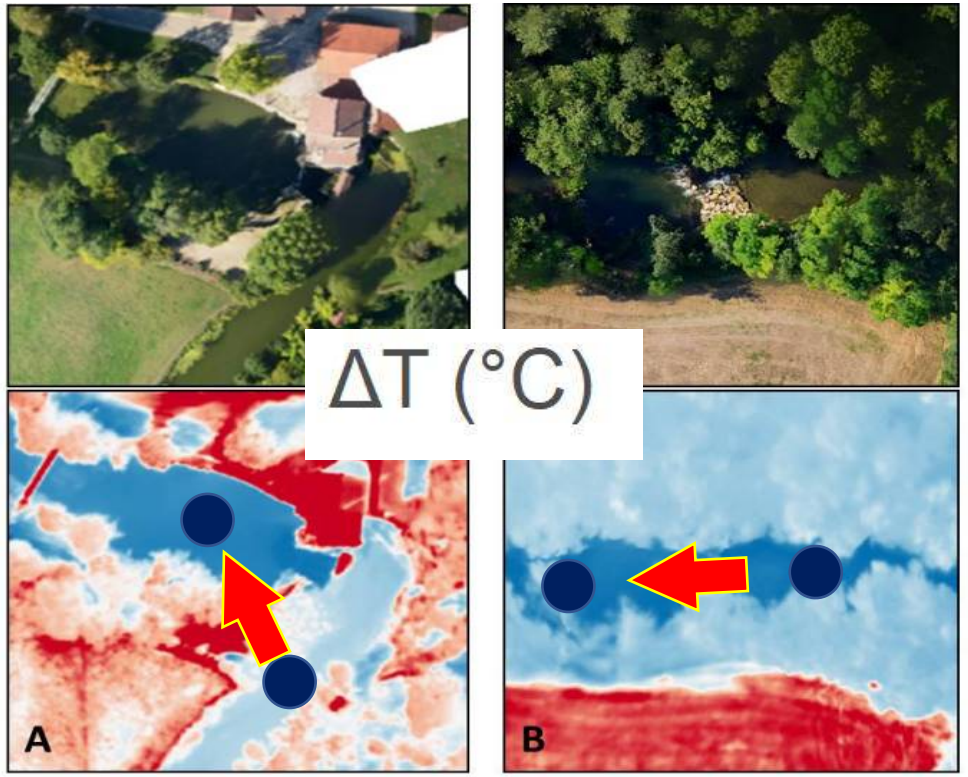


Can riparian shading mitigate water warming in impounded lowland rivers? Marteau et al. ESPL Online

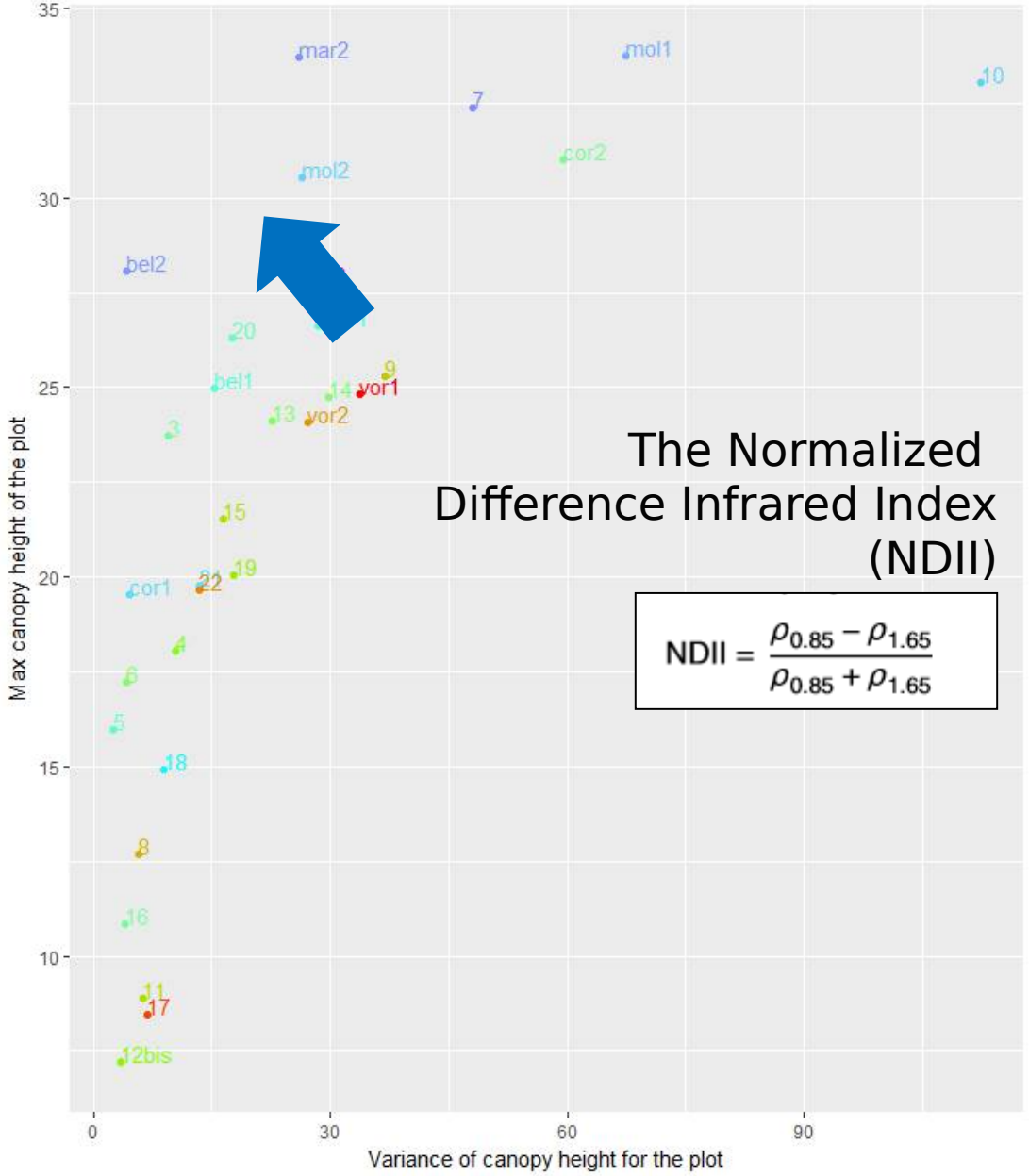



$Twc = \frac{Tw_{TIR}}{Ta_{24h}^{mean}}$
Twc (°C)
1.1
1.0
0.9
0.8
0
25
50
75
100
Riparian cover (%)
2
1


x10^{-3}
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
α-coefficient
R^2 = 0.74
Se
Cu
Sn
Ch
O
Sv
B
So
R
Clusters:
'Colder' rivers
'Warmer' rivers
-2.0
-1.5
-1.0
-0.5
0.0
0.5
ΔT (°C)

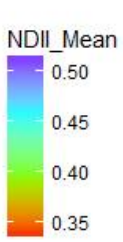

ΔT (°C)
A
B

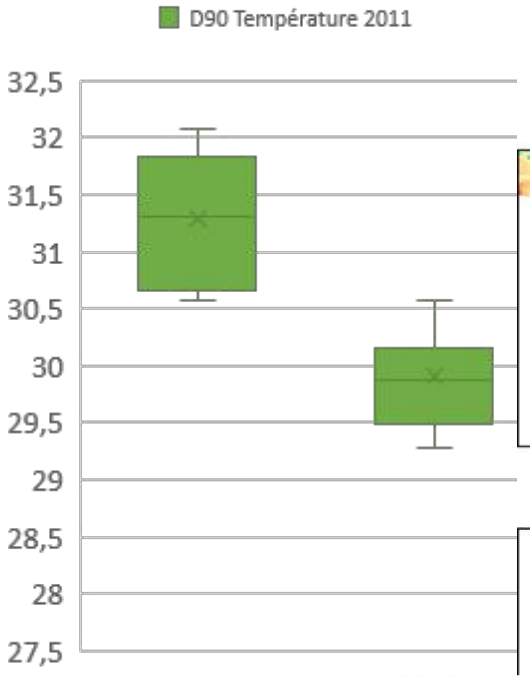
=> temperature : Effects of temperature rising on forest exacerbate existing drying due to human alterations

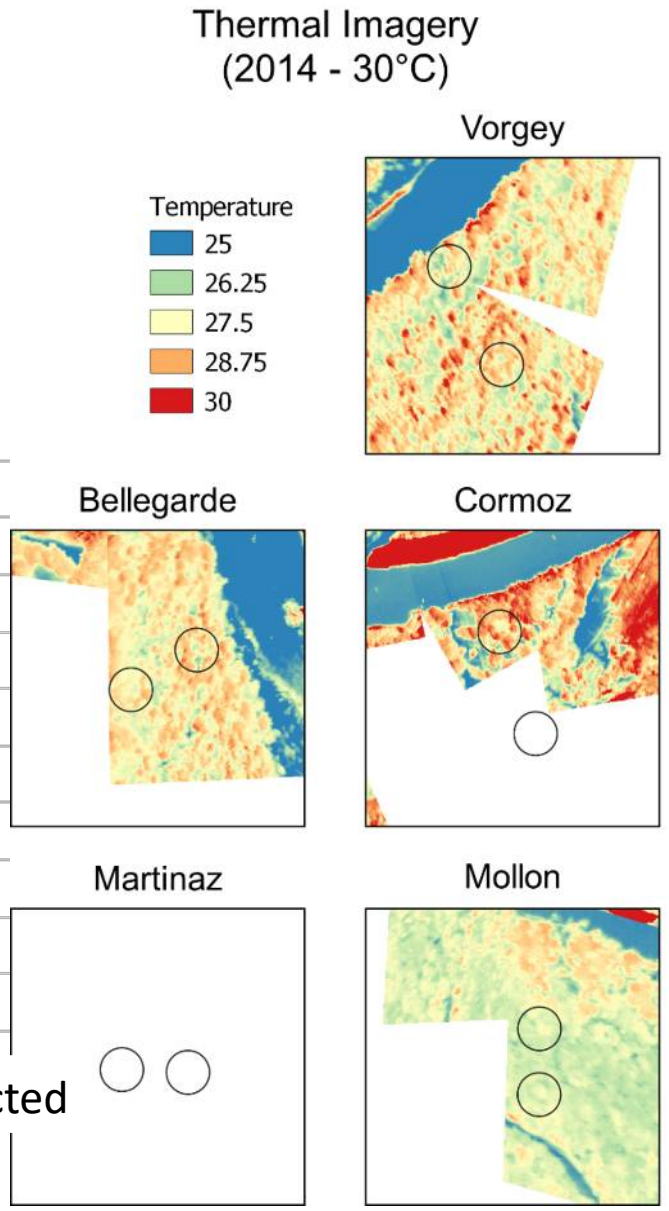


The Normalized Difference Infrared Index (NDII)

$$NDII = \frac{\rho_{0.85} - \rho_{1.65}}{\rho_{0.85} + \rho_{1.65}}$$







J. Godfroy, PhD, in prep.

Conclusions

- **Complex trajectories of afforestation due to various controls (nature, intensity, date) and hydro-bioclimatic contexts**

=> A clear biogeomorphological diagnosis considering characters, functioning and trajectory of forests and rivers is then needed to design sustainable management scenarios.
=>Managing riparian forests cannot be done without considering river processes and inversely.

- **Stakes are important (forest resource, flooding risk, aquatic and terrestrial biodiversity) and potential solutions exist to prevent problems, to improve, to preserve**

=> Clear research needs (upscaled approaches, process understanding, monitoring to assess action efficiency

A collective adventure we want to share and discuss!

- Julien Godfroy, Kristell Michel, J.Lejot, L. Demarchi
- Bianca Raepple, John Stella
- Philippe Janssen, André Evette
- Borbala Hortobagyi, Hossein Ghaffarian, Lise Vaudor,
- Virginia Ruiz-Villanueva
- Pierre Lochin, Mike Singer,
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- Adrien Michez, Vittoria Scorpio
- Sandrine Lallias-Tacon, Frederic Liebault
- Simon Dufour

Thank you for your attention


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