Towards sustainable water and sediment management in Albania,
the integration of Hydro-Morpho-Eco disciplines from Science to Management

Destil Creative Hub Tirana (AL),
October 12, 2022

Hydro-Morpho-Ecological interactions in river corridors: processes and implications for management and the environment

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University of Trento – Italy

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ITALIAN AGENCY FOR DEVELOPMENT COOPERATION

UNIVERSITÀ DI TRENTO

FONDAZIONE EDMUND MACH

C3A CENTRO AGRICOLTURA ALIMENTI AMBIENTE

UNESCO Chair in Engineering for Human and Sustainable Development

Department of Environmental, Civil and Mechanichal Engineering University of Trento

unesco Chair

CELIM

cesvi

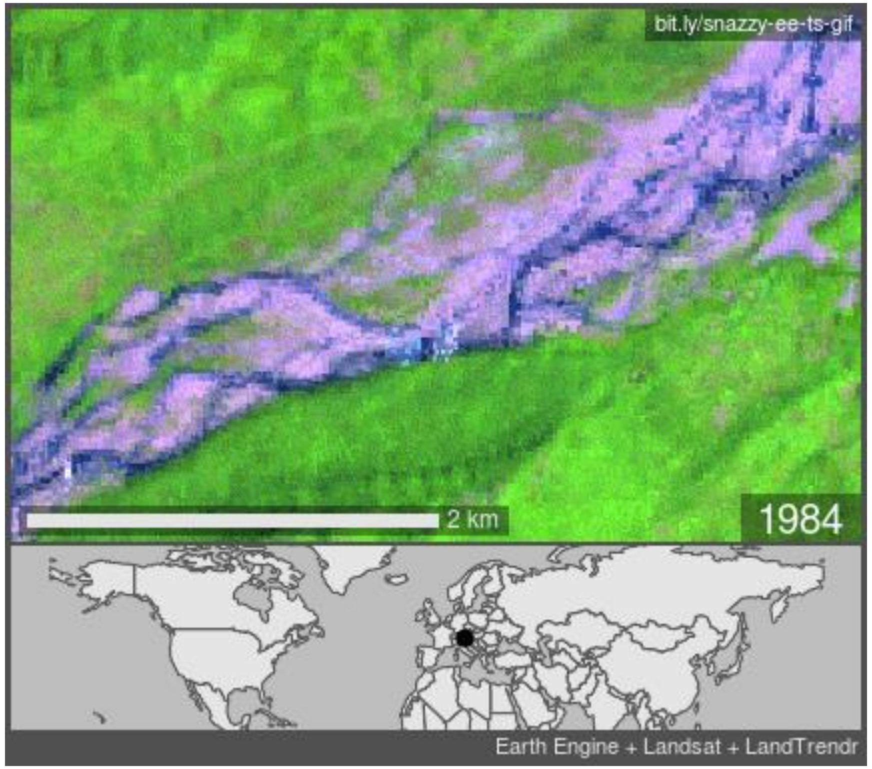
VIS ALBANIA

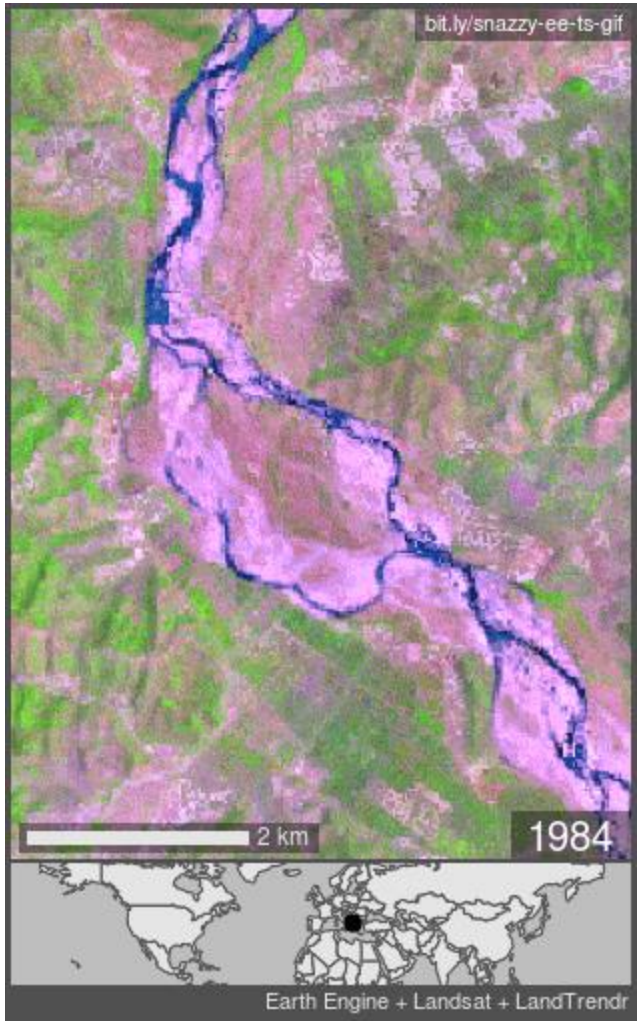
VJOSA EXPLORER

Rivers are dynamic systems ➔ they move and change their forms («morphology»)

Tagliamento (IT)

Vjosa (AL)





extraction of main riverine classes (water/sediment/vegetation) from Landsat and Sentinel-2 satellite images

M. Crivellaro, ongoing PhD thesis, Univ of Trento

The typical change of river morphology in Italy in the last 60 years

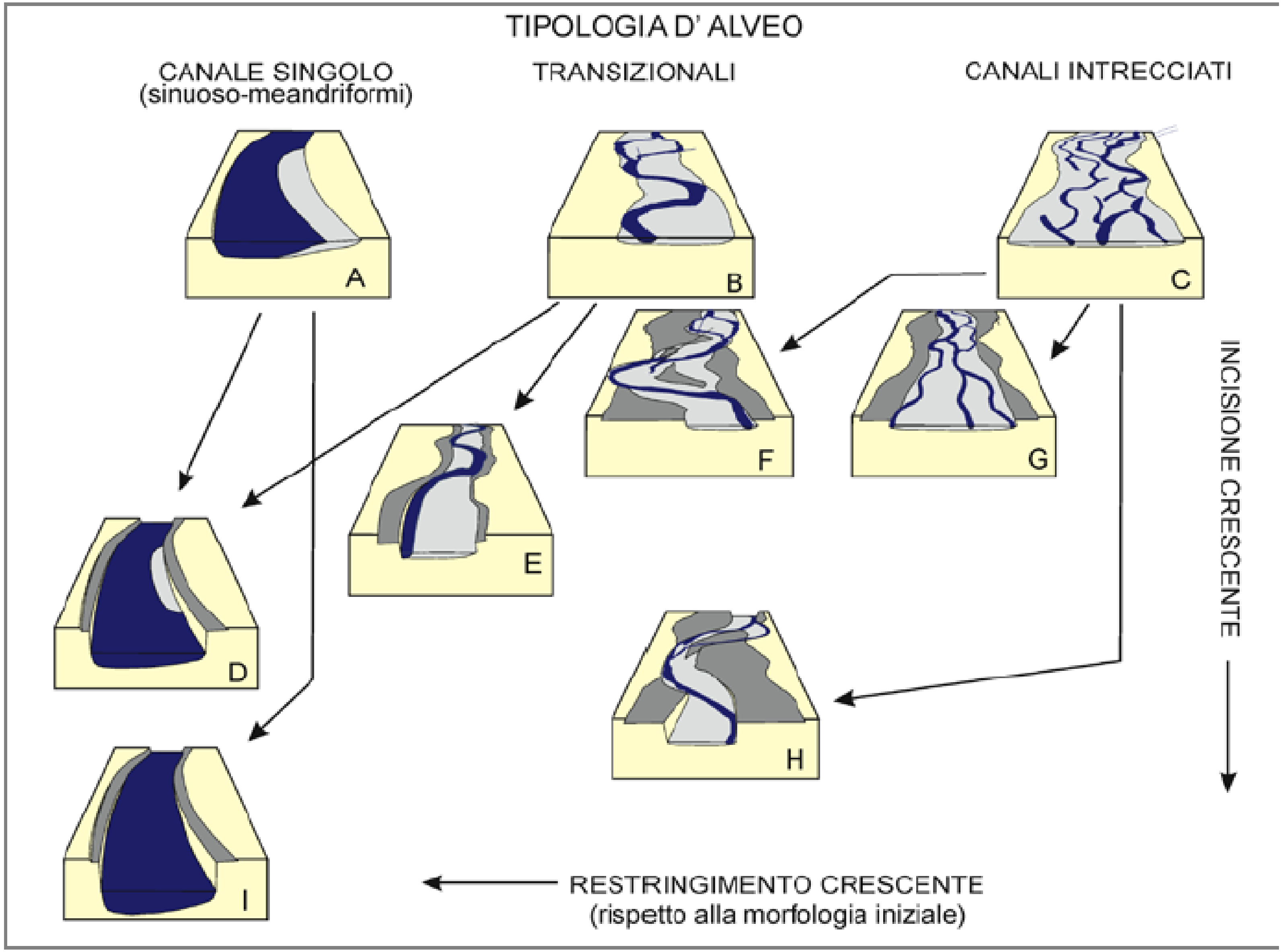
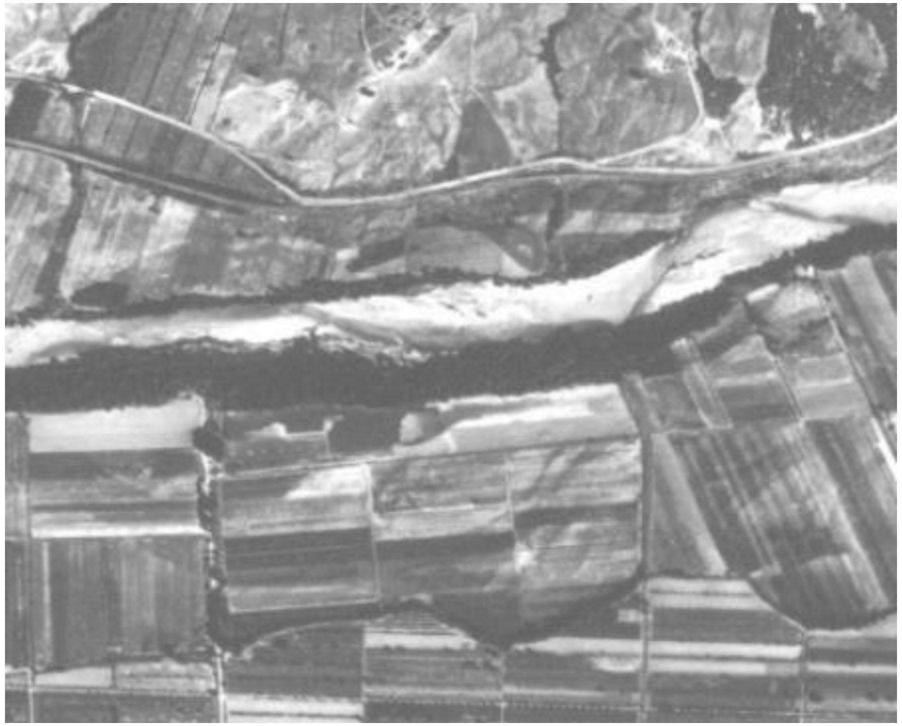


Figura 2.17 – Schema di classificazione delle variazioni morfologiche di fiumi italian (Da SURIAN & RINALDI, 2003, modificato).

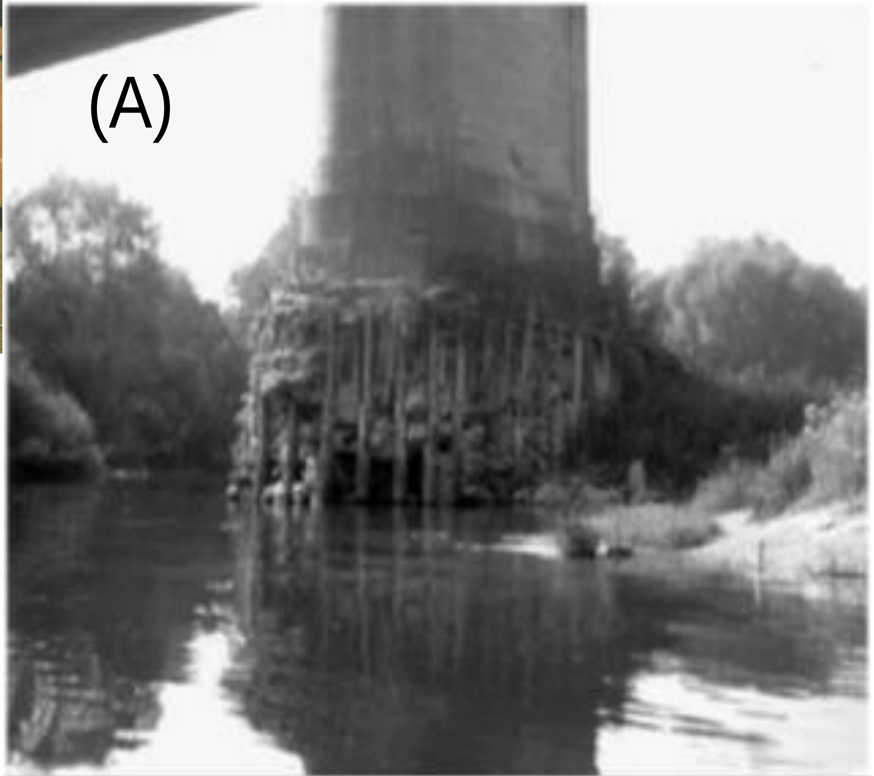
Example: Narrowing and morphological change of the Cecina River (Tuscany, IT) following gravel mining from the river

1954



2004

Rinaldi et al., (2010)
Riverflow Conference



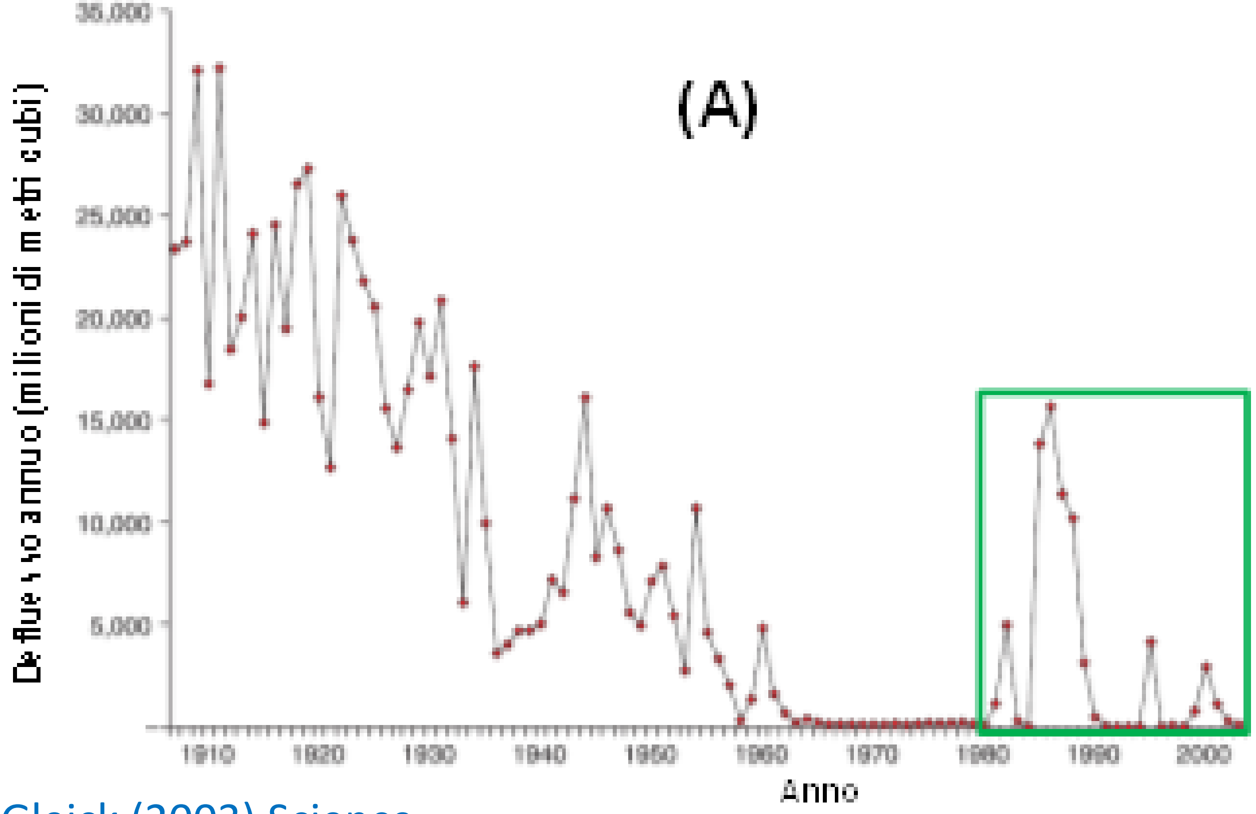
Example: nearly 4m of riverbed incision in the Arno River (Tuscany, IT)

Surian and Rinaldi (2003) Geomorhology
Rinaldi et al. IDRAIM Manual, ISPRA
Available at:
https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/idraim-sistema-di-valutazione-idromorfologica-analisi-e-monitoraggio-dei-corsi-dacqua

River trajectories ➔ WHY ??

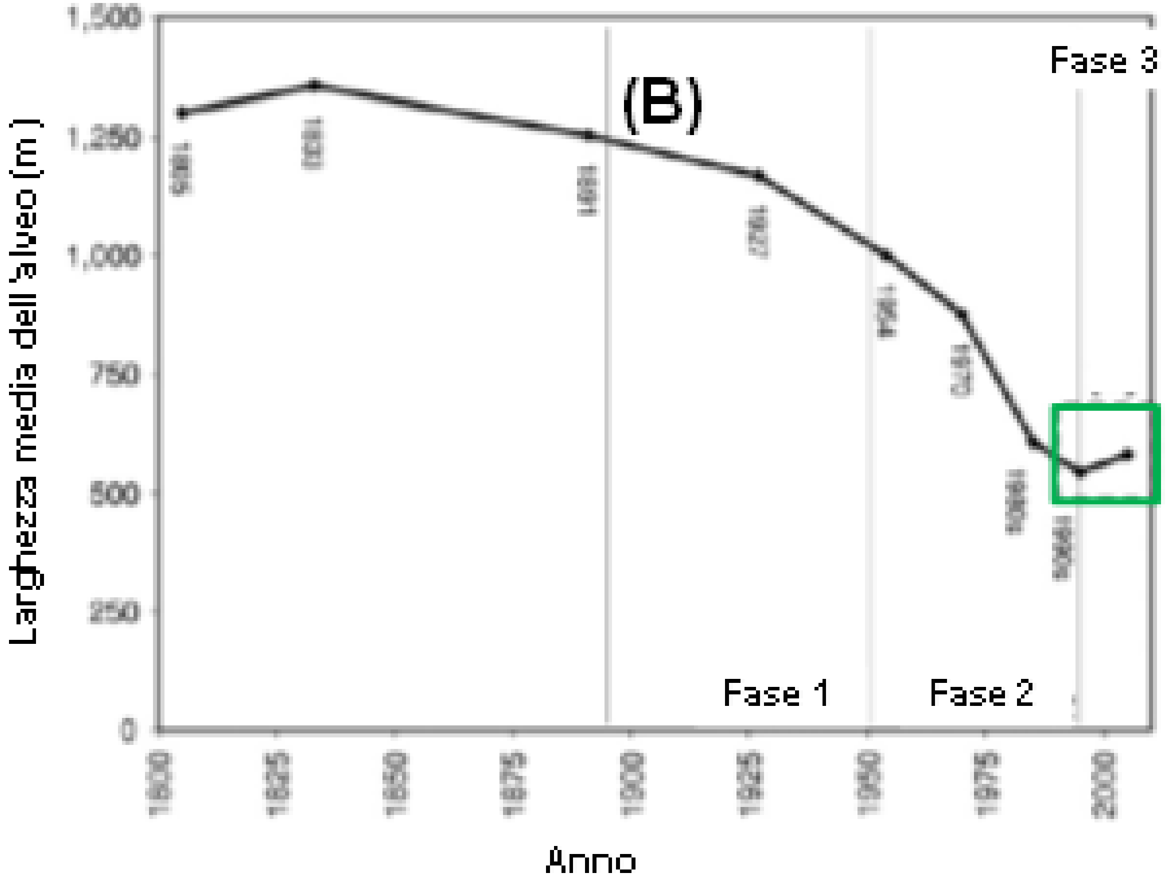
Used to measure this river „transformation“ because of human effects (ex. channel width, riverbed elevation) in time

Rinaldi et al. (2015) IDRAIM Manual



Gleick (2003) Science

Annual flows of the Colorado river



Width of the Tagliamento River (IT)

nature geoscience
REVIEW ARTICLE
https://doi.org/10.1038/s41561-018-0262-x
Corrected: Author Correction

Anthropogenic stresses on the world's big rivers

Jim Best

1) **Damming**
2) **Climate change and flooding**
3) Pollution
4) **Water withdrawal / transfers**
5) Non-native species
6) **Fragmentation; river barriers**
7) **Sediment dredging, mining and upstream catchment management**
8) Governance

Physical or "hydromorphological" stressors

Other stressors

Why do we care about rivers changing form?

PRIMARY RESEARCH ARTICLE

Global Change Biology WILEY

The global decline of freshwater megafauna

Fengzhi He[1,2,3] | Christiane Zarfl[4] | Vanessa Bremerich[1] | Jonathan N. W. David[5] | Zeb Hogan[6] | Gregor Kalinkat[1] | Klement Tockner[1,2,7] | Sonja C. Jähnig[1]

3886 WILEY Global Change Biology

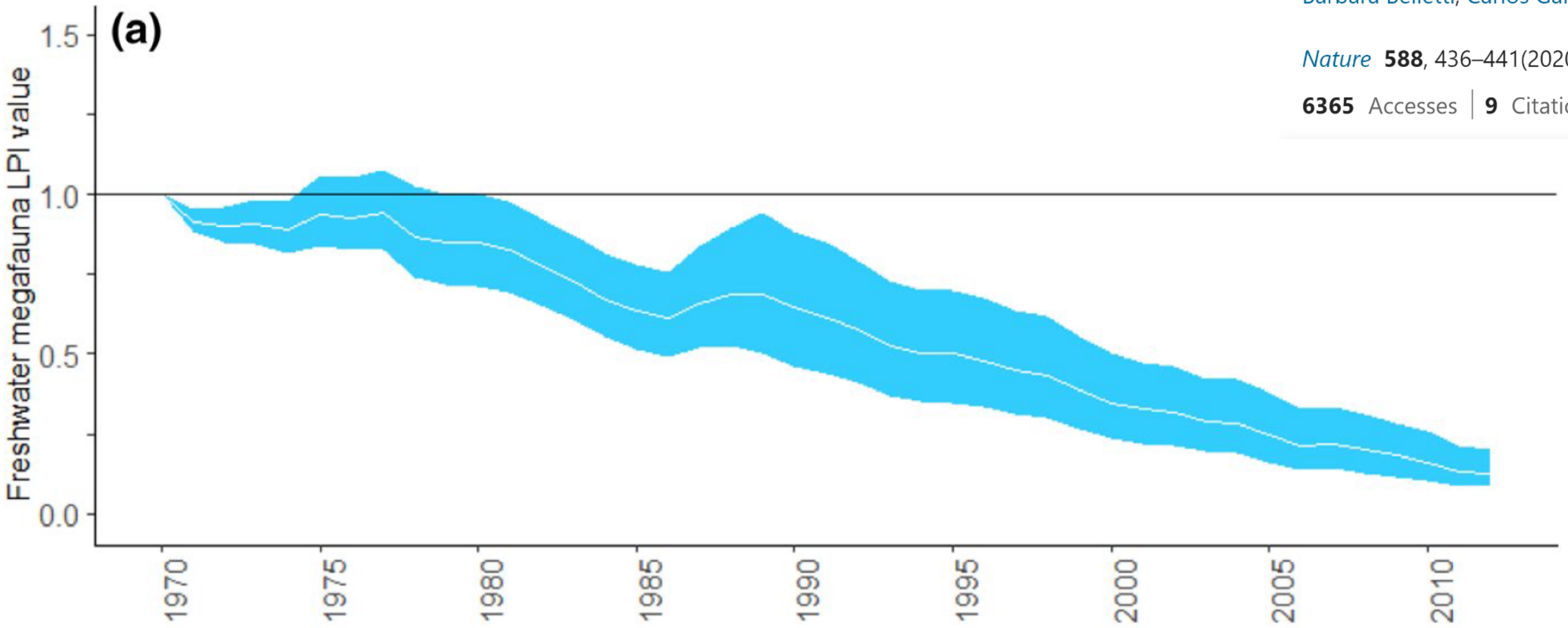


FIGURE 1 Changes in the population inventory of (a) global freshwater megafauna (126 species; 639 time series) and (b) mega-fish species (81 species; 404 time series) from 1970 to 2012. The value of the Living Planet Index (LPI) was set to 1 in the reference year 1970 [Colour figure can be viewed at wileyonlinelibrary.com]

nature

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nature › articles › article

Article | Published: 16 December 2020

More than one million barriers fragment Europe's rivers

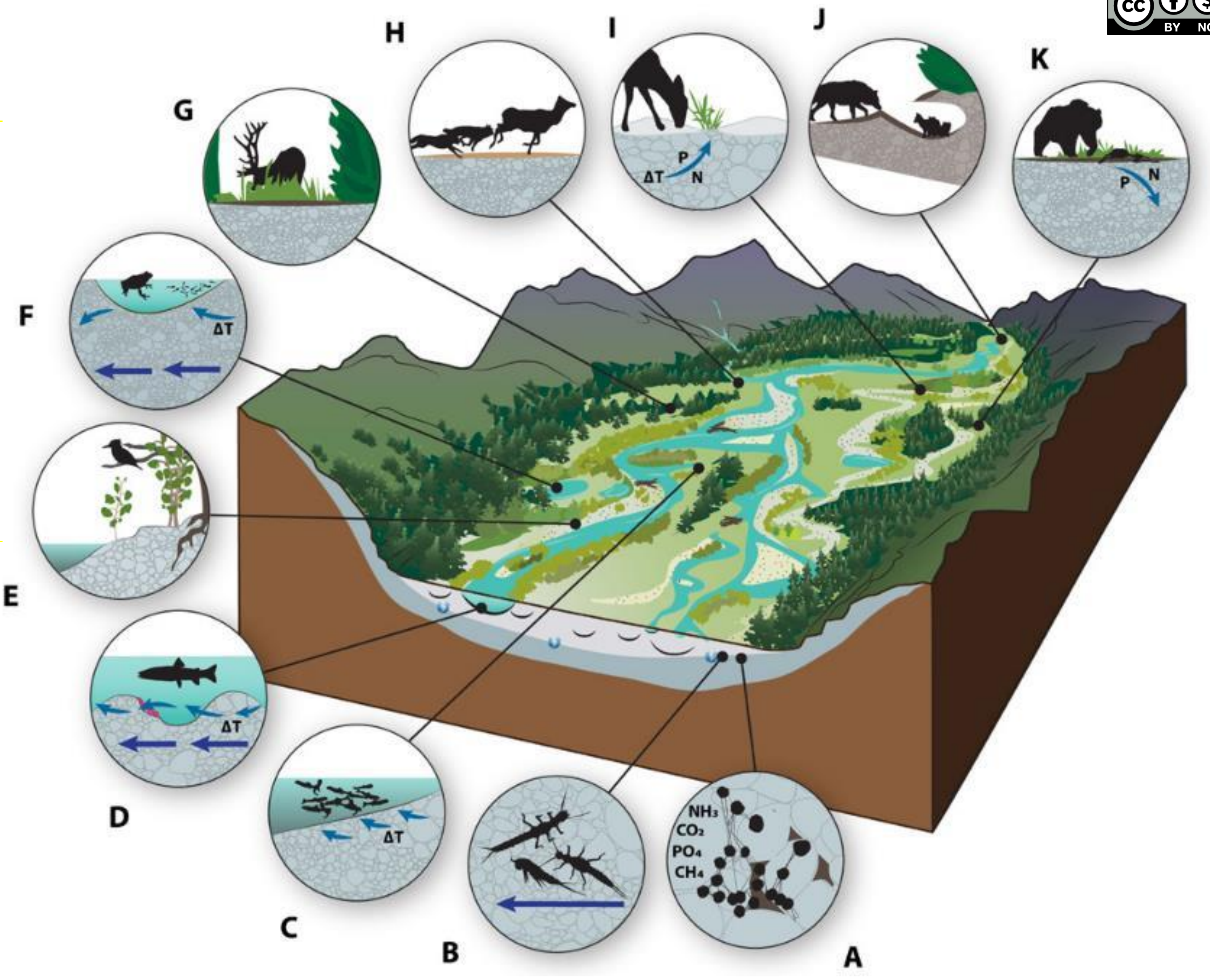
Barbara Belletti, Carlos Garcia de Leaniz, [...] Maciej Zalewski

Nature **588**, 436–441(2020) | Cite this article

6365 Accesses | **9** Citations | **554** Altmetric | Metrics

Diversity of the morphological «*mosaic*» and variability of the flow regime imply biodiversity

➔ Habitat diversity



Hauer et al., 2016

Natural Flow Regime: riverine communities are adapted to the natural variability of the streamflow

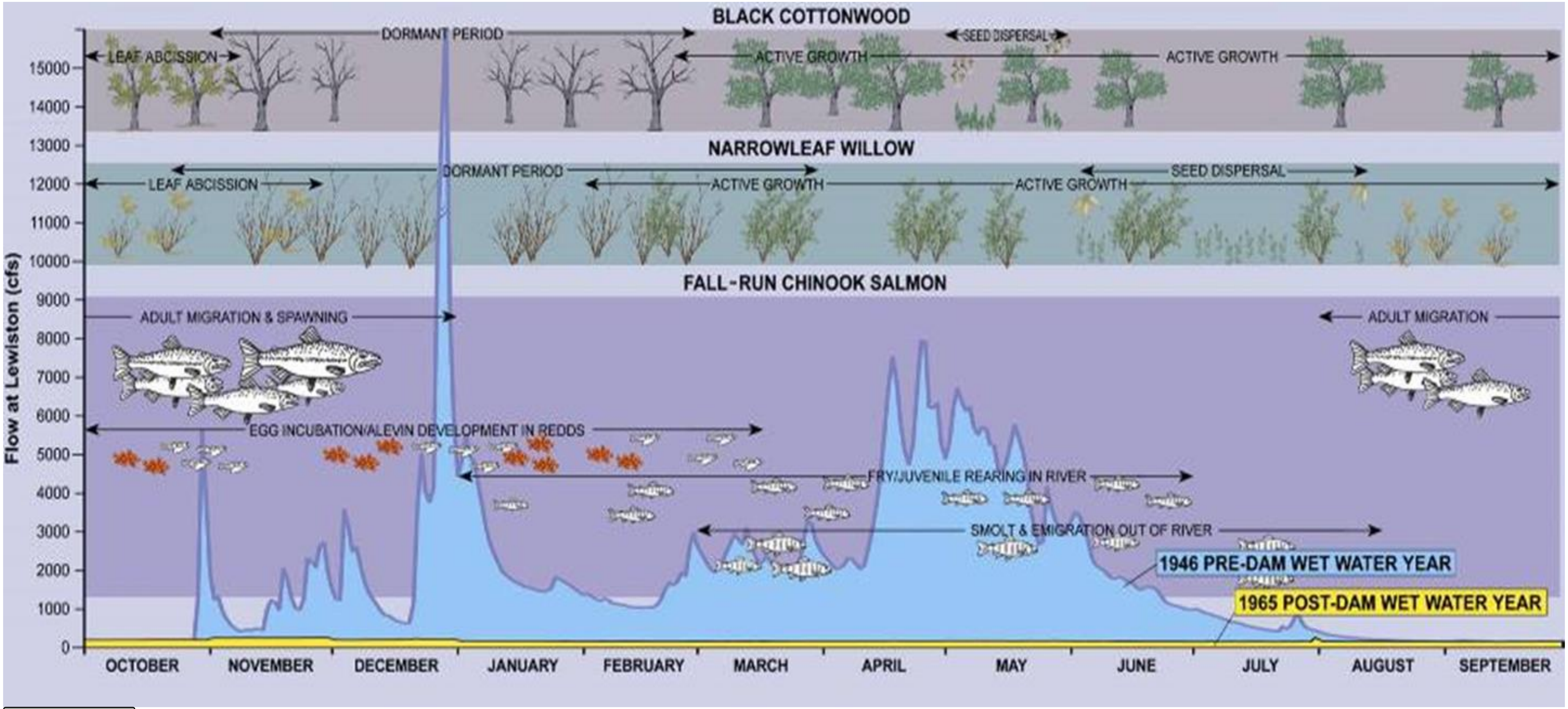
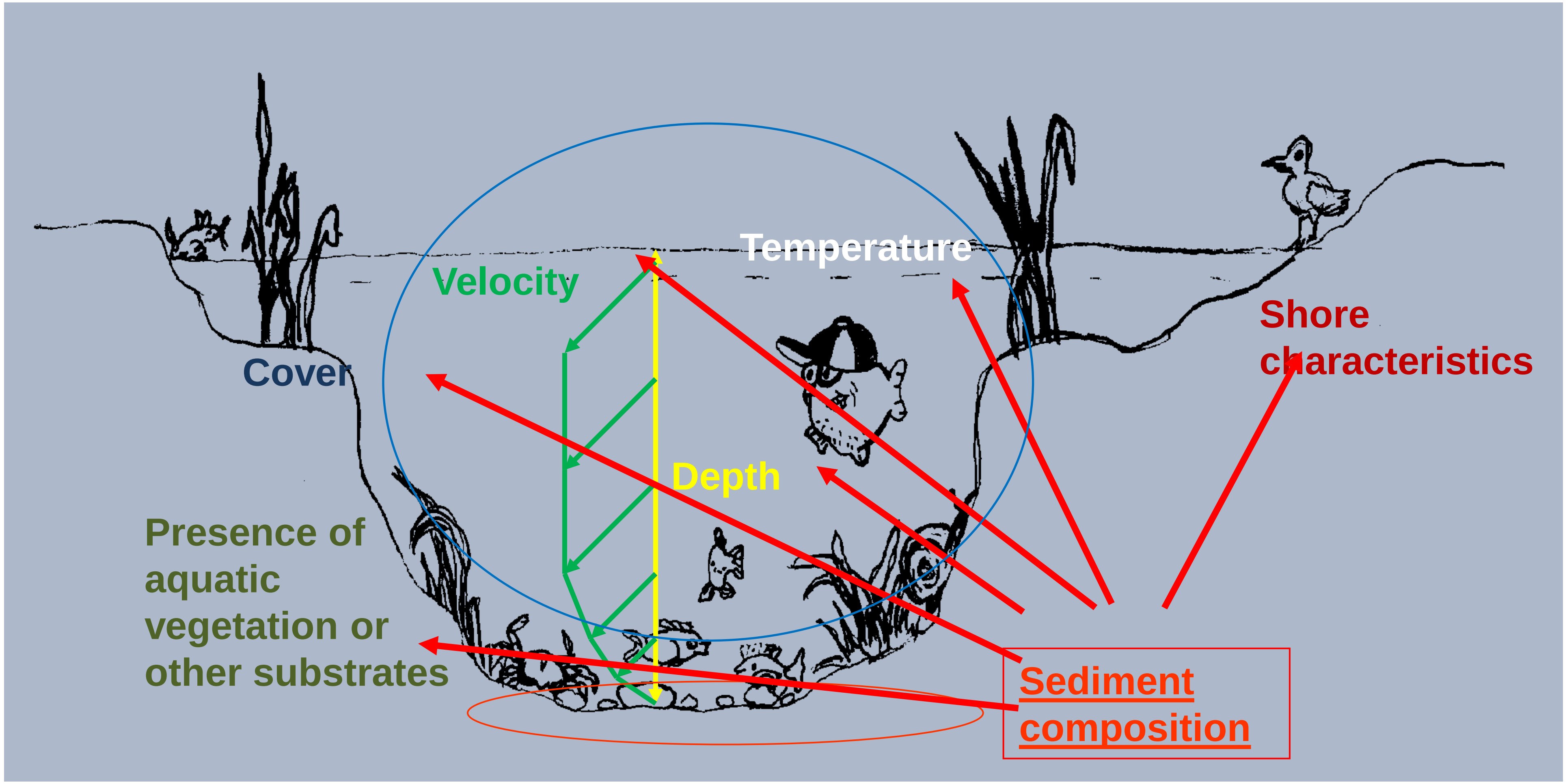


Image Courtesy S. McBain

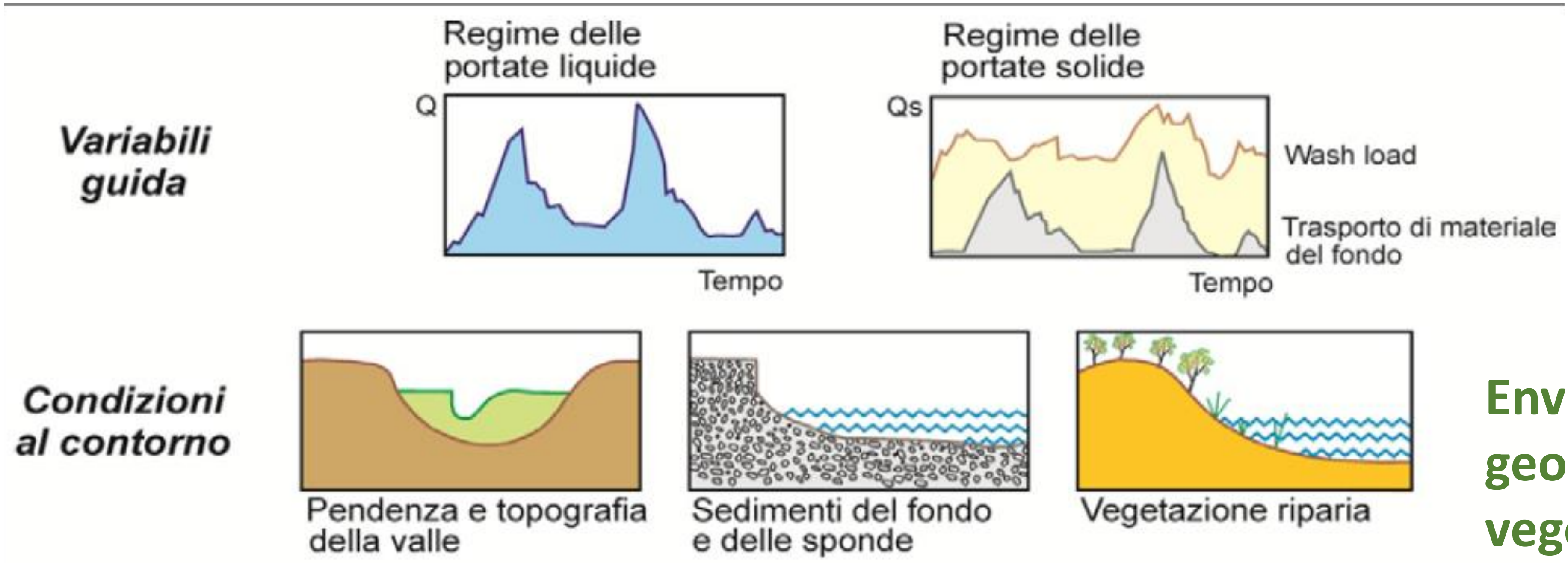
Biological species and communities have specific habitat preferences
And habitat is closely related to rriver morphology

If morphology changes ➔ habitat changes !!



What determines the morphology of a river?

The «guiding variables» the flow and sediment supply regimes



Can be modified by river management

Environmental conditions: geology and riparian vegetation

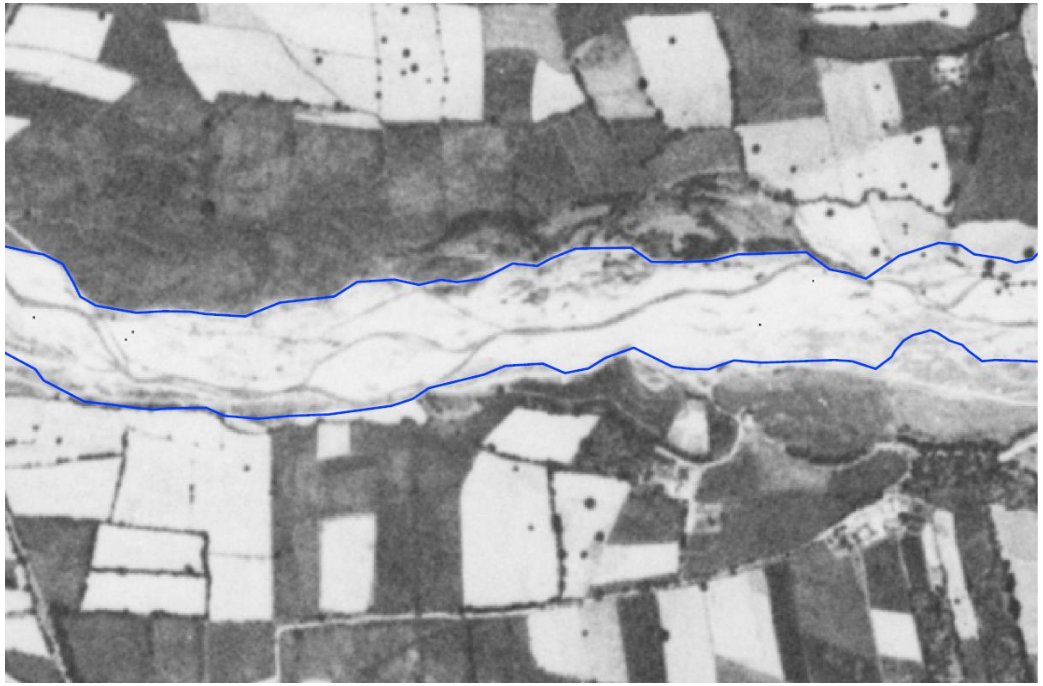
Rinaldi et al. (2015) IDRAIM Manual

Why does the river morphology changes?
➔ Human effects on the flow and sediment transport regime

Channel narrowing, vegetation stabilization and change in morphology following sediment mining

Lumbardhi i Pejës 1968 – 2007 (Kosovo)

M. Paderno (2008). MSc thesis, University of Trento



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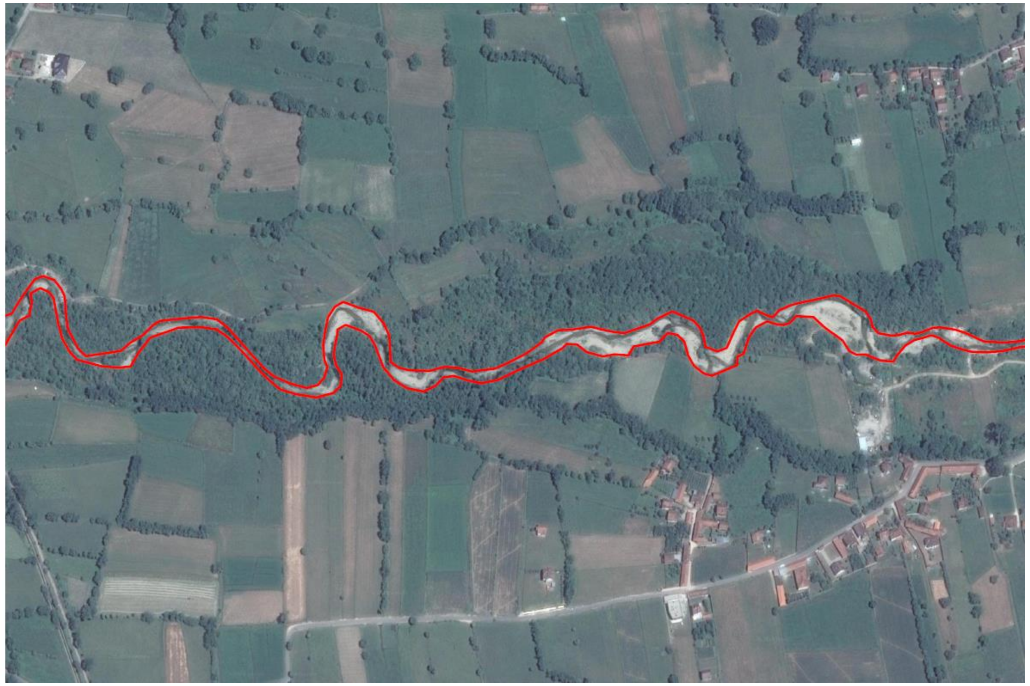
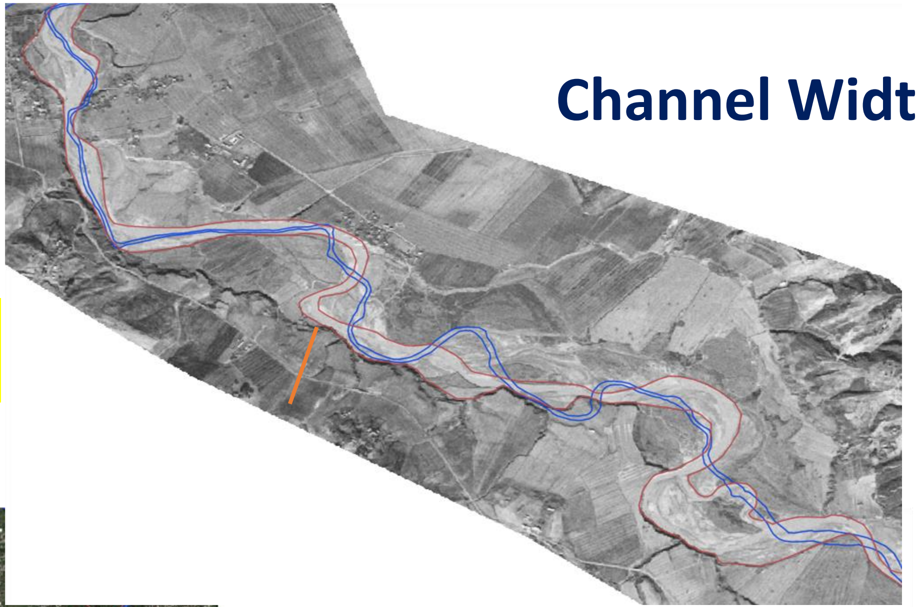


➔ **Dramatic reduction in river channel habitat area!**

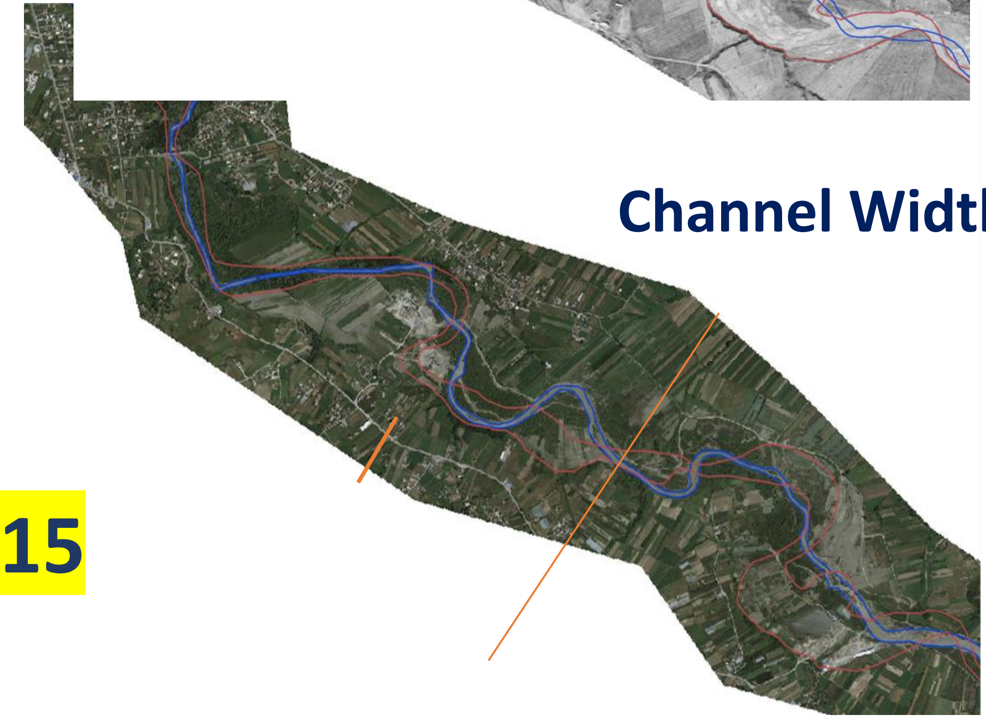
Narrowing of the Erzen river (intense sediment mining)

1994



Channel Width = 137 m

2015



Channel Width = 22 m

B. Cekrezi, ongoing Ph.D thesis, University of Trento

Location: Hardhishte

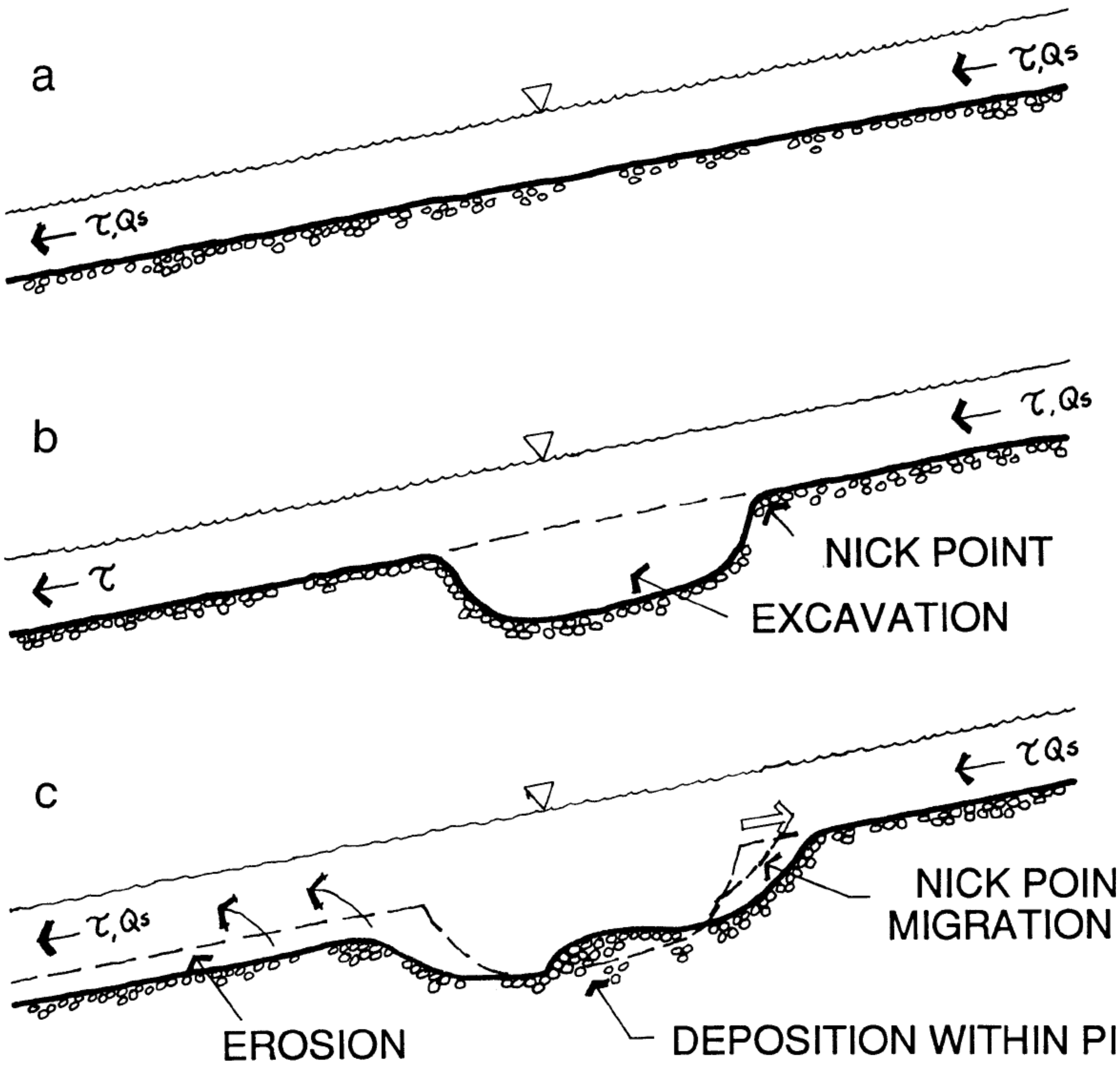
Also: incision in the Erzen River (AL)

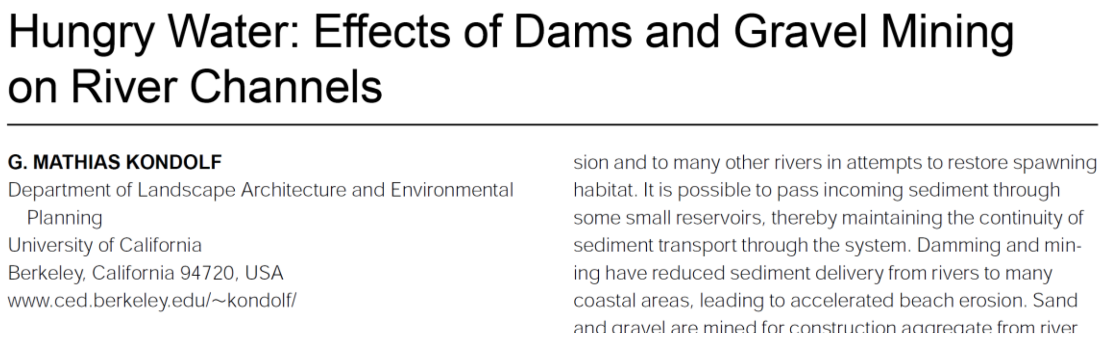
Nearly 4-5 m mean riverbed incision in the lowland single-thread reach

B. Cekrezi, ongoing Ph.D thesis, University of Trento

What happened?

← the dynamics of riverbed incision following sediment excavation in riverbeds



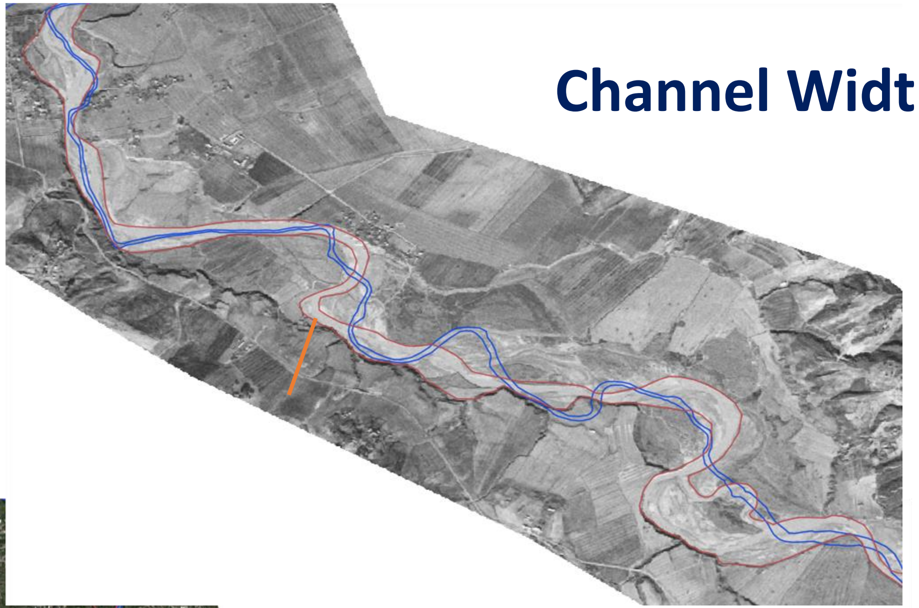


Environmental Management Vol. 21, No. 4, pp. 533–551

Figure 9. Incision produced by instream gravel mining. **a:** The initial, preextraction condition, in which the river's sediment load (Q_s) and the shear stress (τ) available to transport sediment are continuous through the reach. **b:** The excavation creates a nickpoint on its upstream end and traps sediment, interrupting the transport of sediment through the reach. Downstream, the river still has the capacity to transport sediment (τ) but no sediment load. **c:** The nickpoint migrates upstream, and hungry water erodes the bed downstream, causing incision upstream and downstream. (Reprinted from Kondolf 1994, with kind permission of Elsevier Science-NL.)

Incision ➔ less frequent inundation ➔ forest establishment

1994



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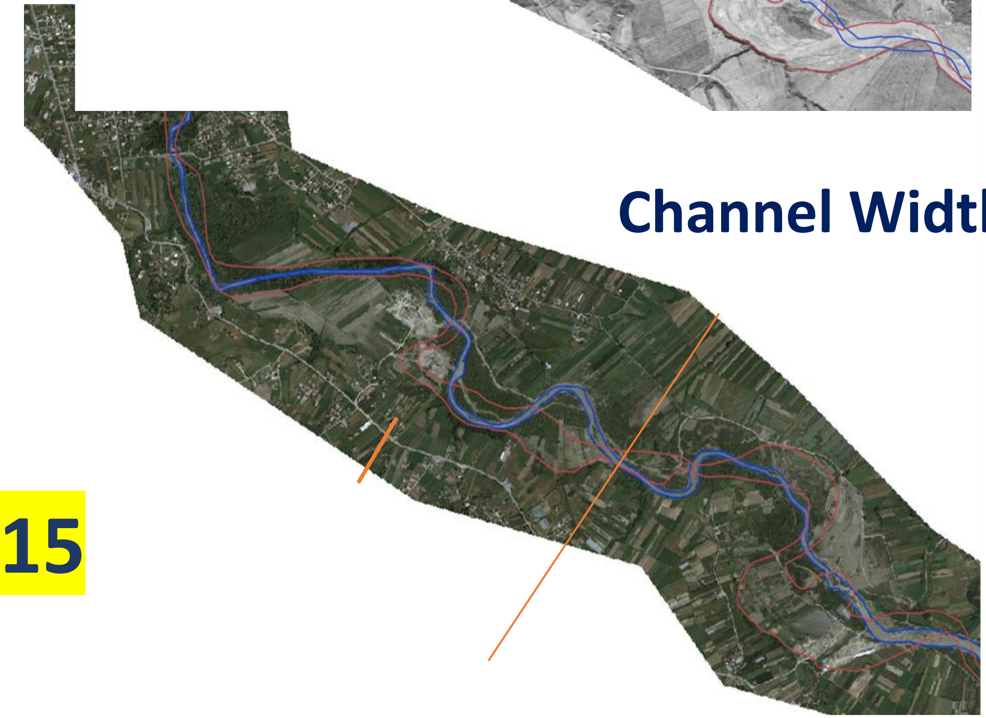
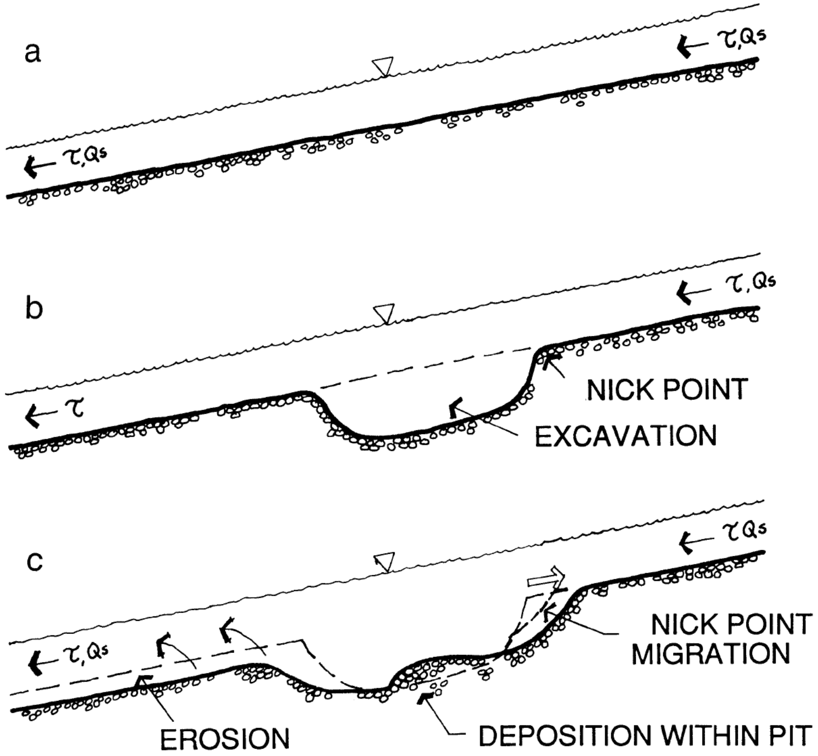
2015



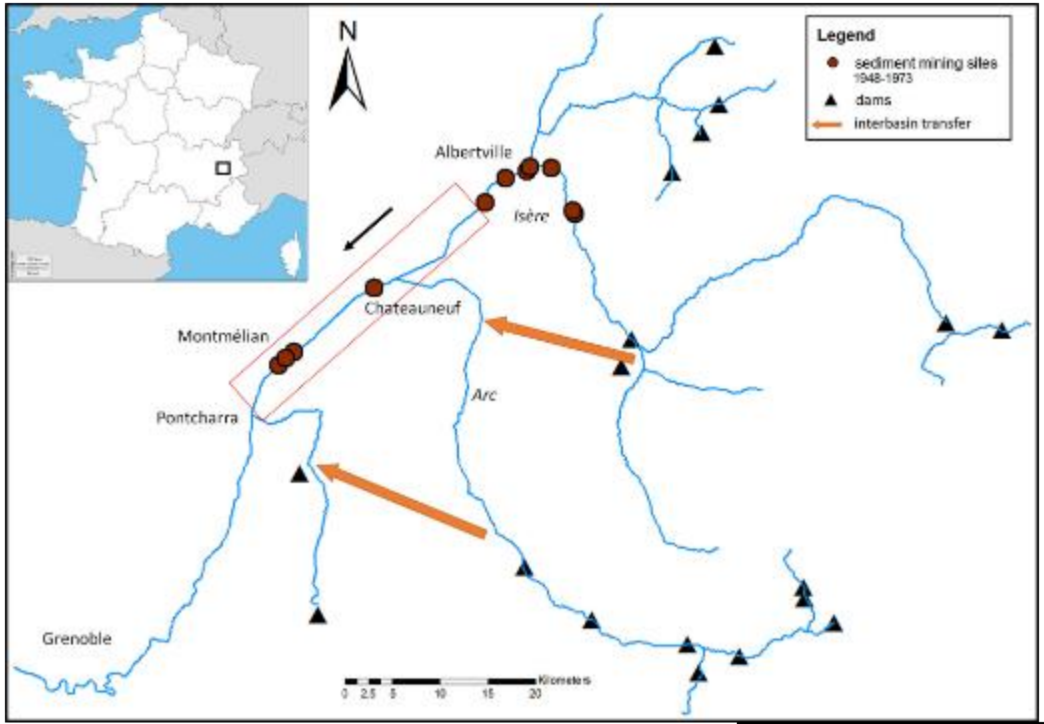
Channel Width = 22 m



Location: Hardhishte

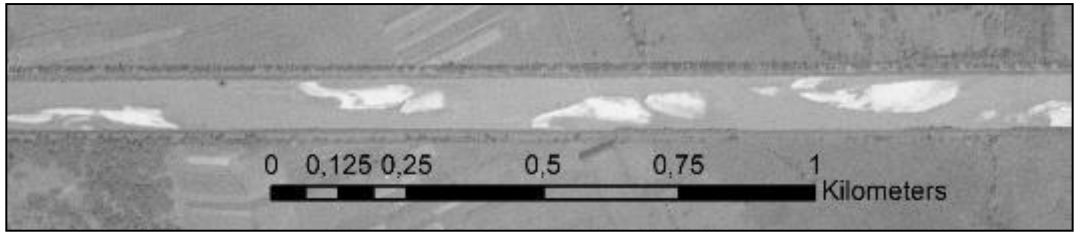
B. Cekrezi, ongoing Ph.D thesis, University of Trento

Channel transformation of the Isere River, SE France



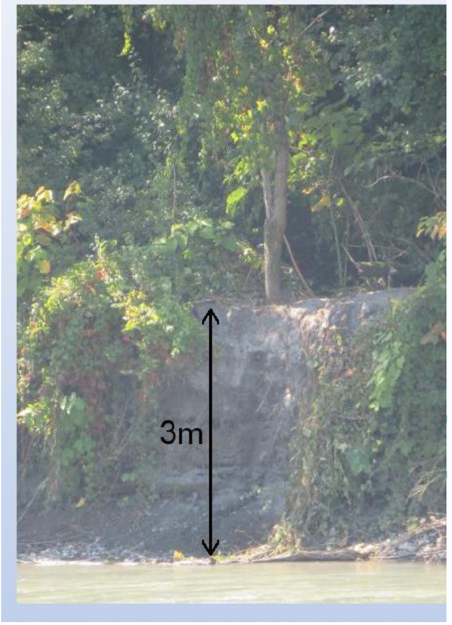
Legend
- sediment mining sites 1948-1973
- dams
- interbasin transfer

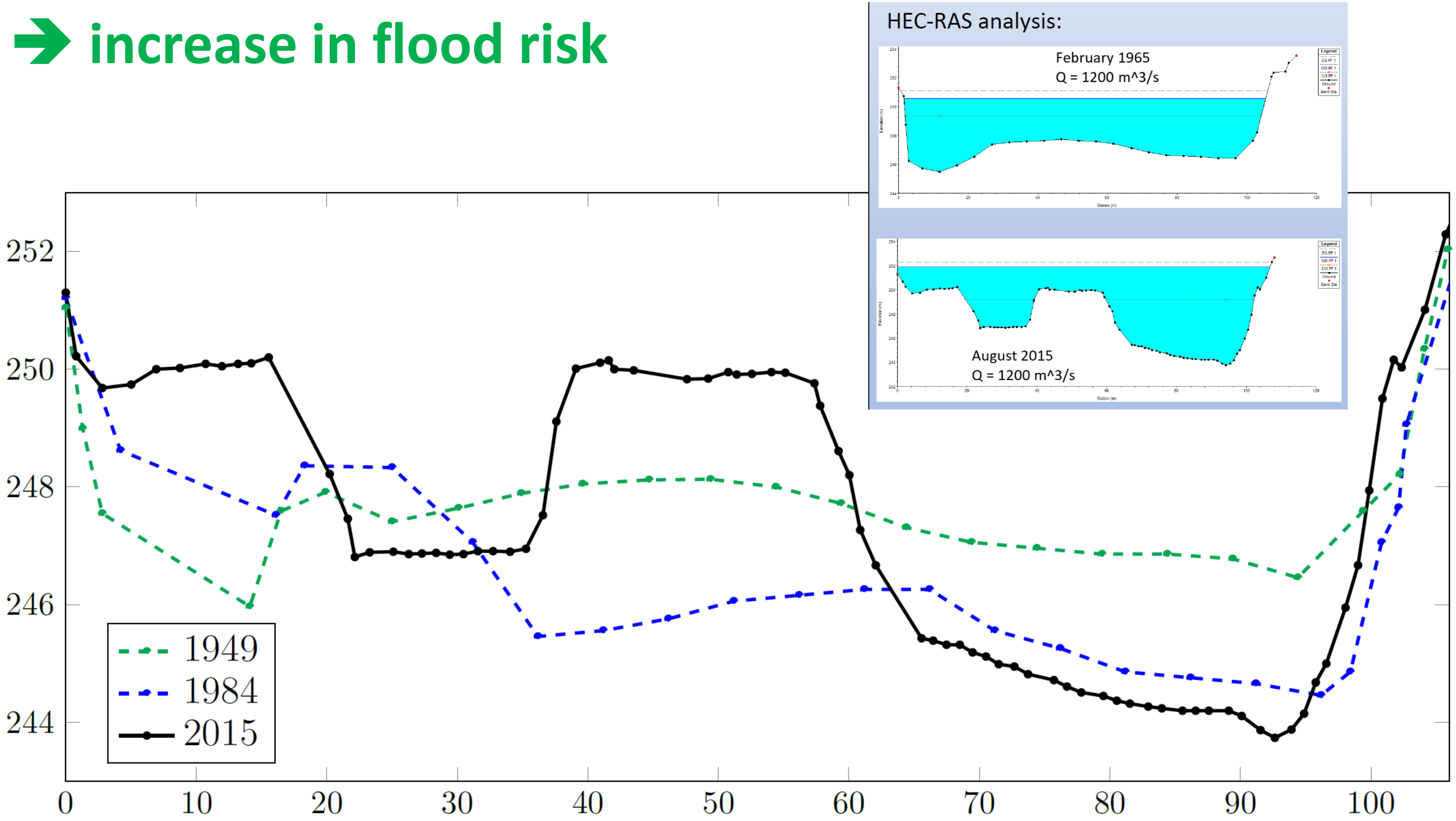
Alcayaga et al. (2013)



Serlet et al. (2018), Earth Surf Proc. and Landforms

Isere: vegetation caused 3m of fine sediments accumulation on each bar in 20 years ➔ increase in flood risk

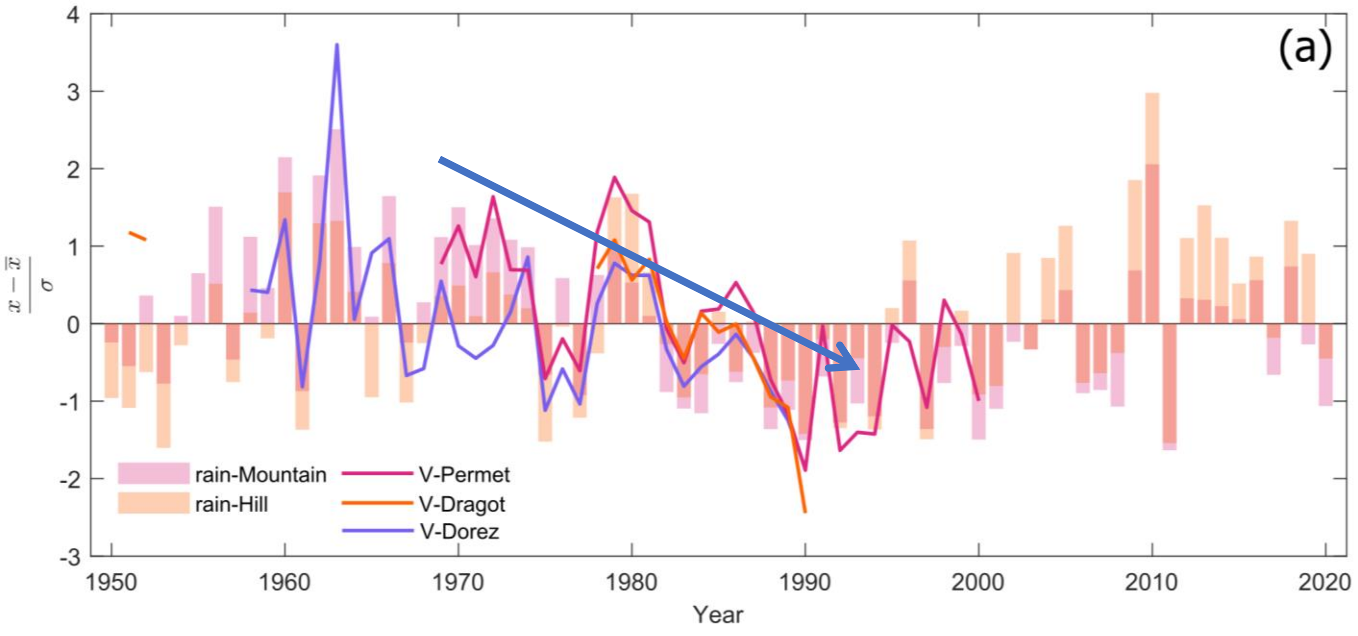




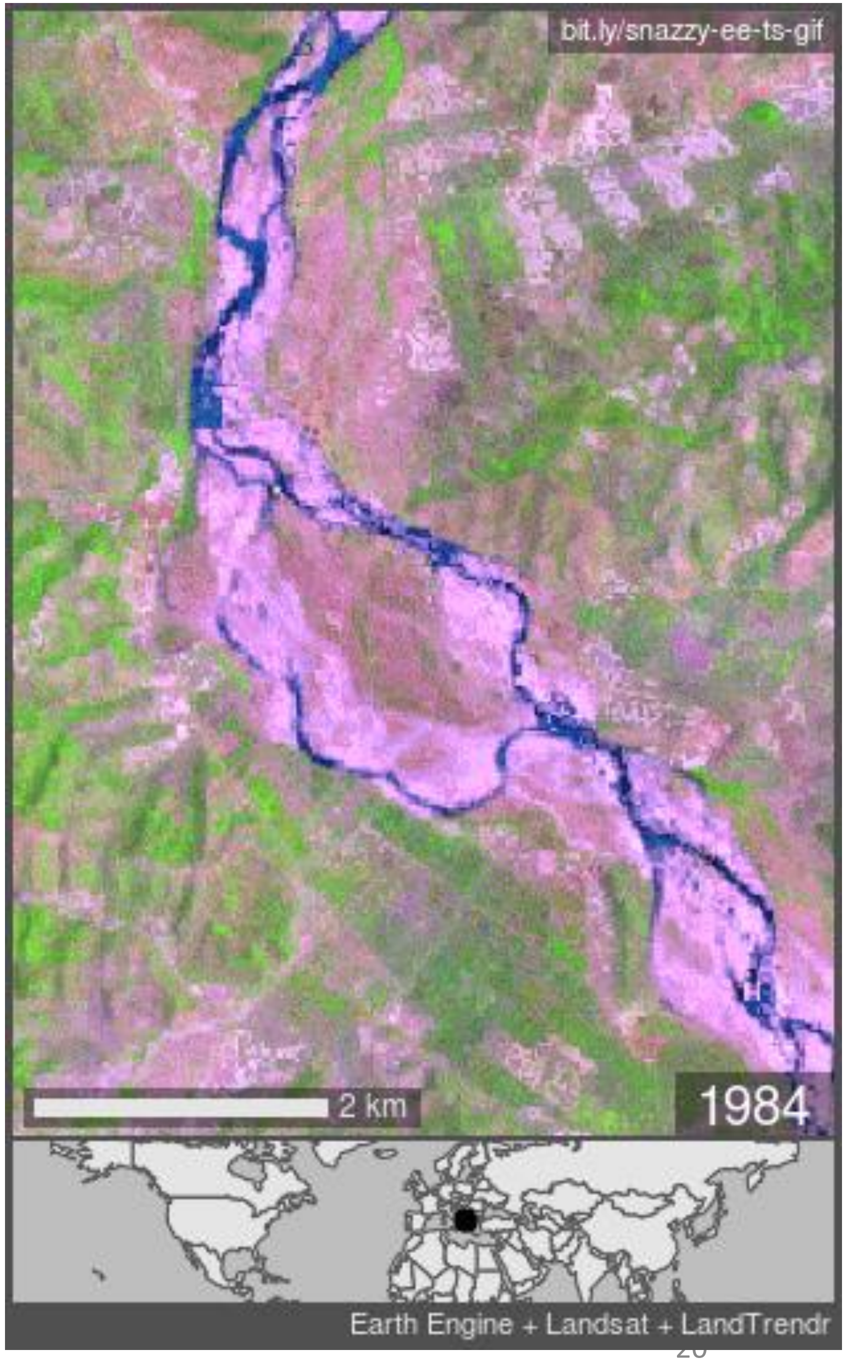
M. Combatti, ongoing Ph.D thesis, University of Trento

Also "near-natural" rivers change over decades

Narrowing of Kuta reach, Vjosa river
➔ climatic variability?



Crivellaro et al., under review



Also "near-natural" rivers change over decades

Narrowing of Kuta reach, Vjosa river

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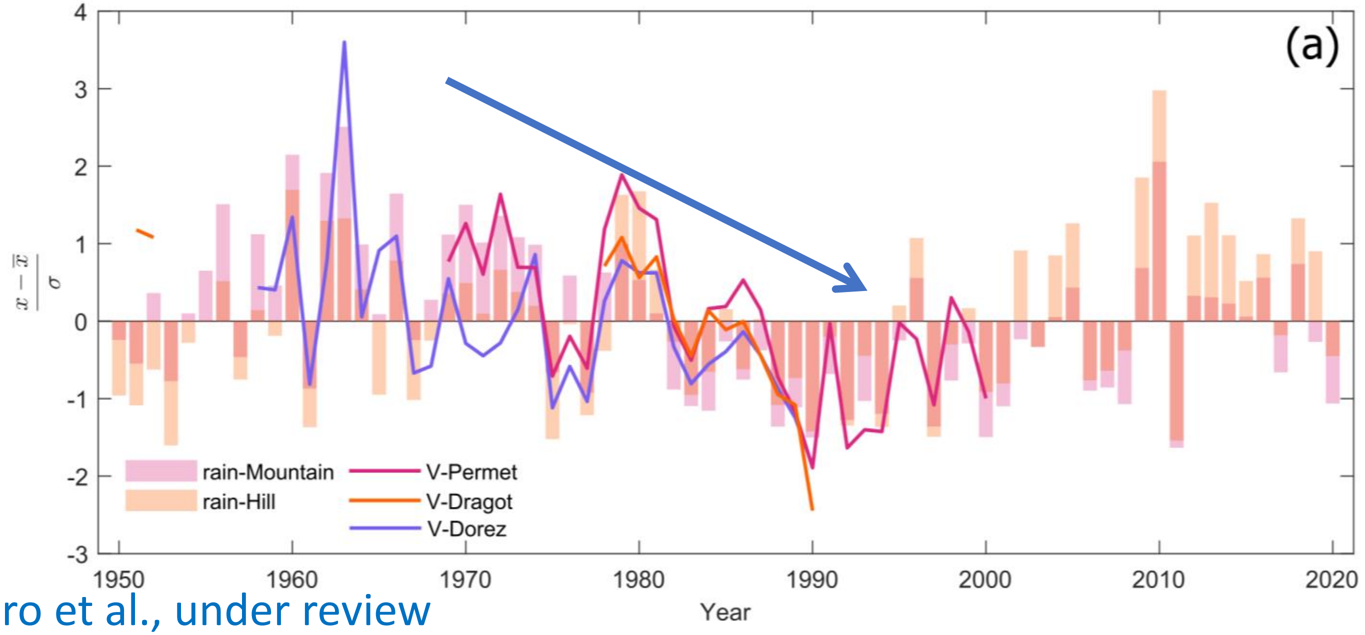
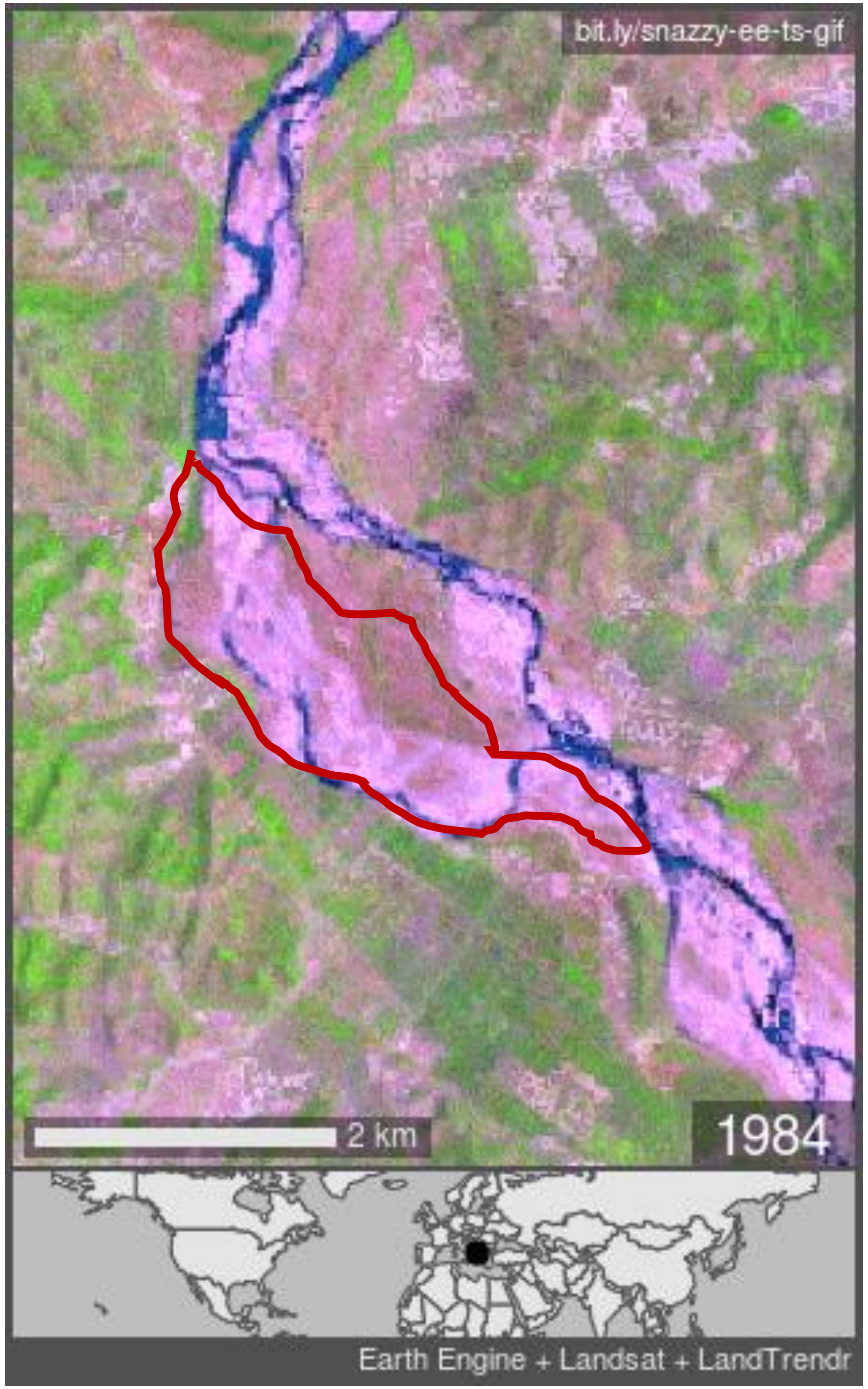


Crivellaro et al., under review



What can we do?

1. Monitoring the river environment – ex. Discharge data in rivers
2. Assessing the «hydro-morphological quality of rivers»
3. Quantifying how much habitat is available for target species,
4. Restore degraded river reaches through nature-based solutions
    1. Dynamic ecological flow releases (mimic the natural flow regime)
    2. Restore sediment connectivity (sediment agumentation/ barrier removal or reduction)
5. Planning: Determine «no-go» highly valuable areas where anthropic interventions should not be allowed

1) Measure discharge and make data easily available for management and research

Naturalbania project: installation of a water level sensor in the Vjosa River - Permet

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1951 1991 UPT

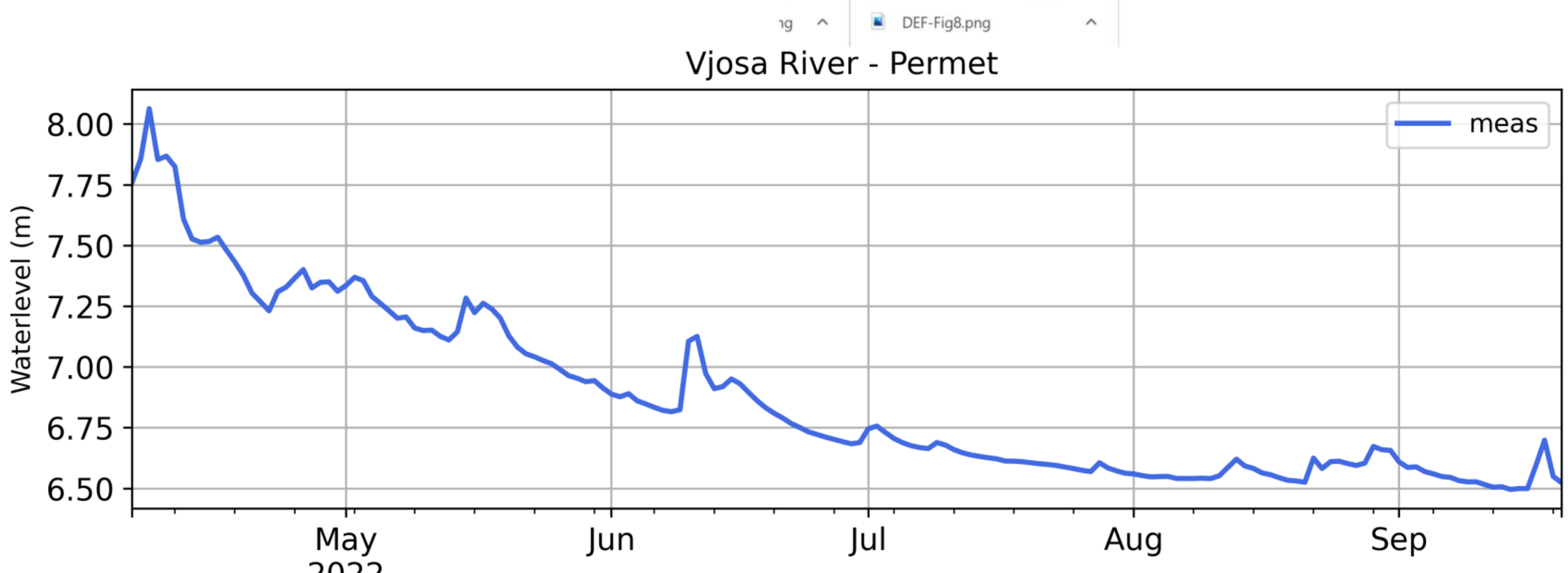
cesvi

1) Measure discharge and make data easily available for management and research

Permet Hydrometer

Narta Lagoon Hydrometer

www.hydrovjosa.eu



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1951 1991 UPT

cesvi

Università di Genova

DICCA DIPARTIMENTO DI INGEGNERIA CIVILE, CHIMICA E AMBIENTALE

2) Assessing the «hydromorphological quality» at the reach scale

The WFD 2000/60 MQI (Morphological Quality Index

Vjosa River basin – entire main stem

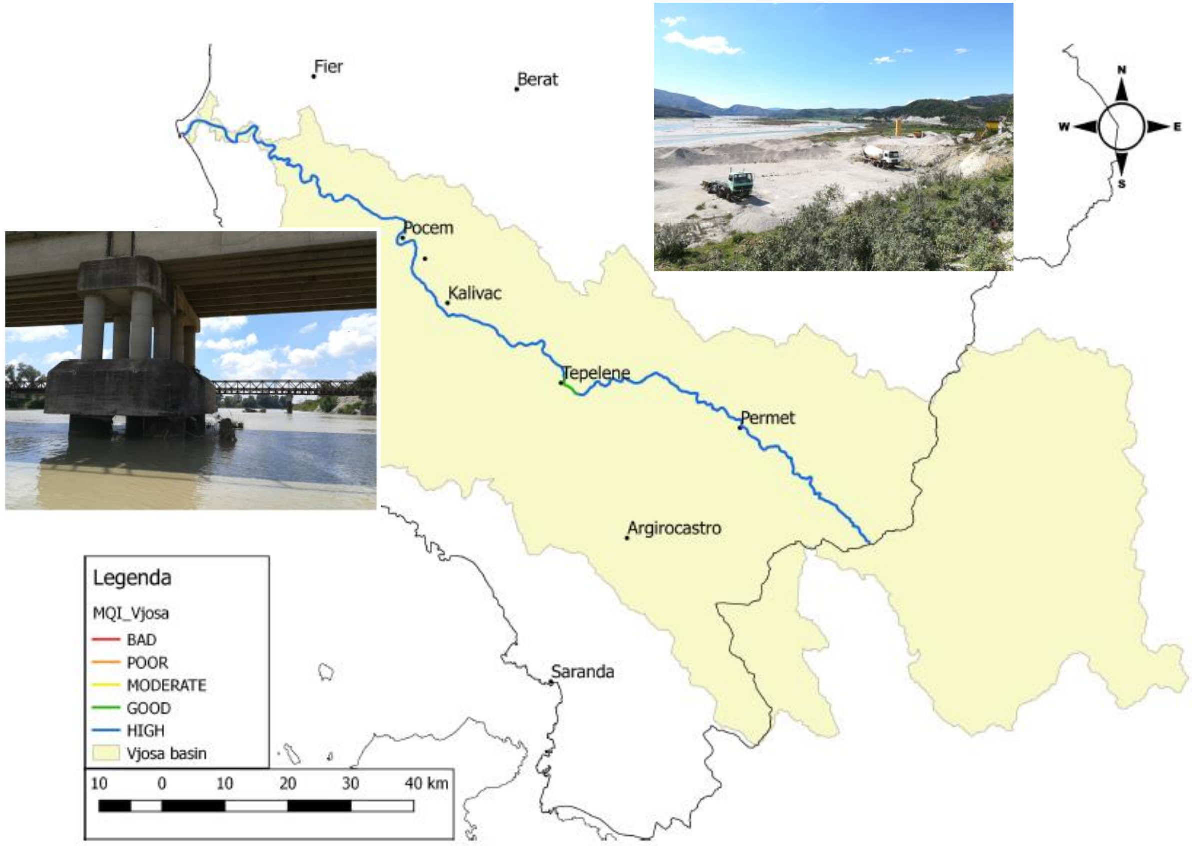


Figure 5.4: Morphological quality map of the Vjosa river.

MSc thesis of G. Laghetto, 2018, University of Trento

Upper Drin basin, Kosovo –

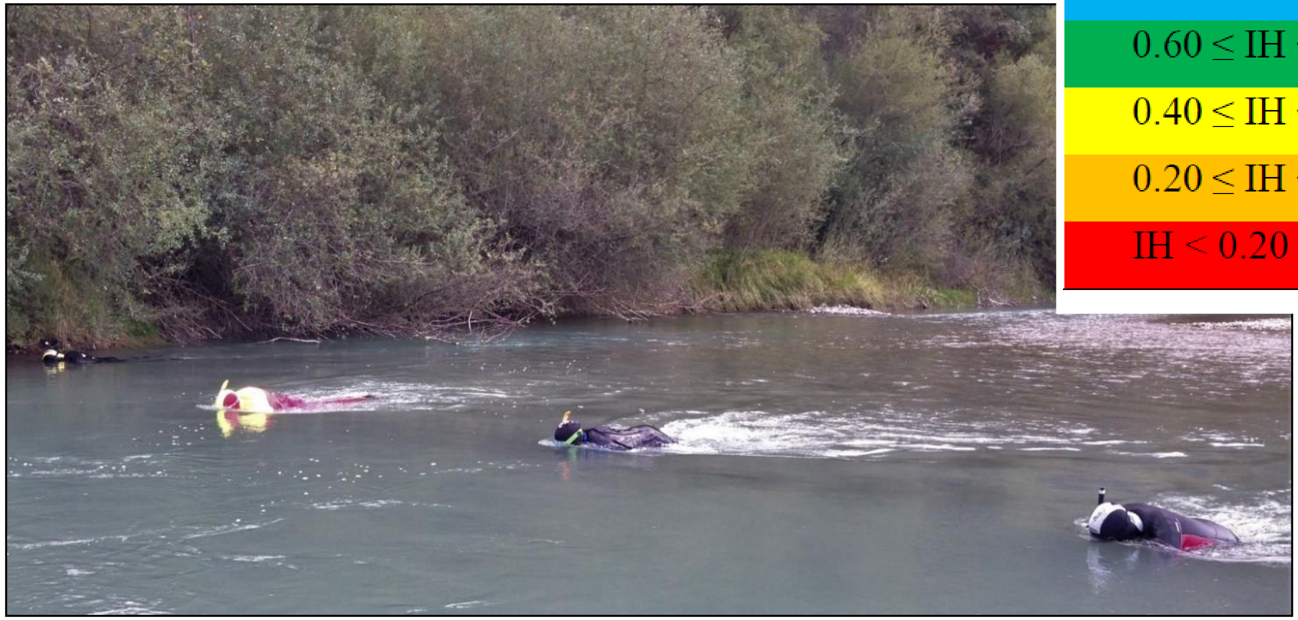
MSc thesis of M. Paderno, 2018, University of Trento

3) Quantify the availability of river habitat for target species / communities

➔ **Habitat Integrity index** (Vezza et al., 2015)

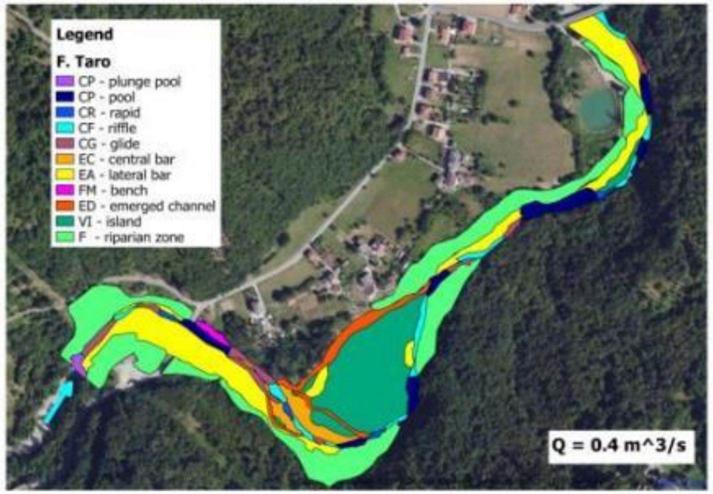
➔ **quantitative predictive tool for dynamic ecological flows**

IH	Classe
$IH \geq 0.80$	High
$0.60 \leq IH < 0.80$	Good
$0.40 \leq IH < 0.60$	Moderate
$0.20 \leq IH < 0.40$	Poor
$IH < 0.20$	Bad

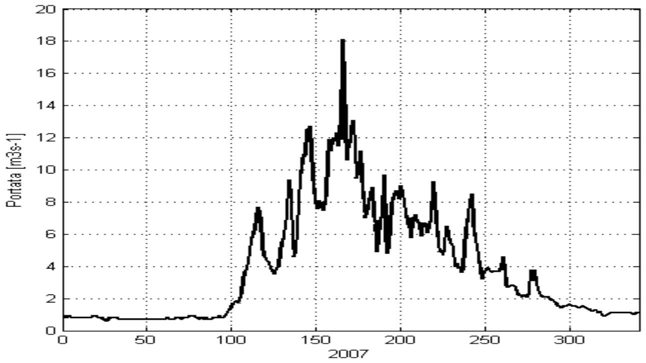


Habitat modelling: integrating ecology, geomorph., hydraulics, hydrology

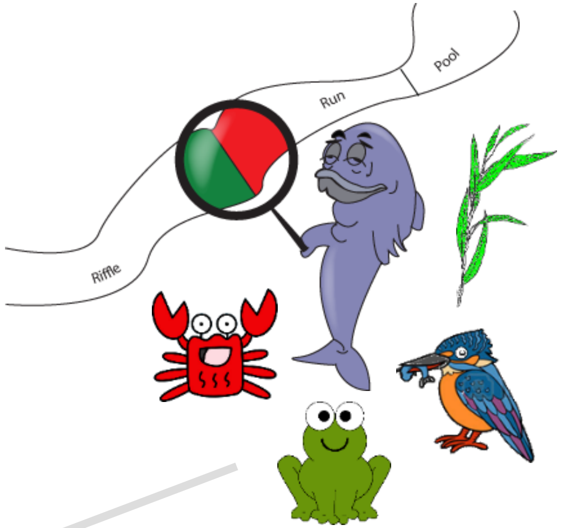
Hydro-morphological habitat mapping



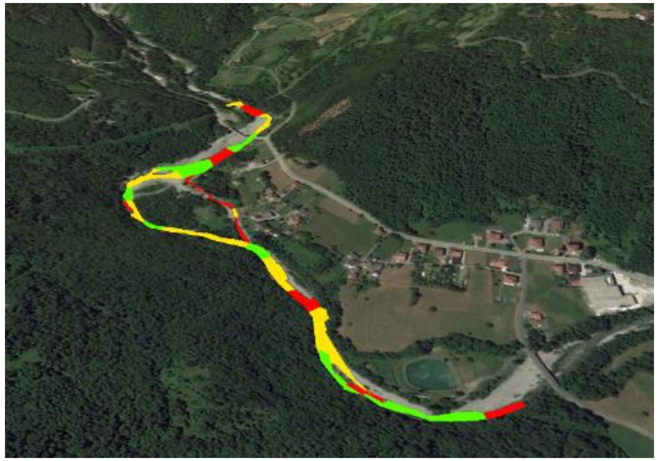
Scearios of natural and altered flow regimes



Habitat preferences of target species



Space – time hiabitat variabilty



Habitat Integrity Index

IH	Classe
IH ≥ 0.80	High
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0.20 ≤ IH < 0.40	Poor
IH < 0.20	Bad

3) Design Dynamic Ecological Flows

Italian national / EU legislation – Water Framework Directive
D.D. 29 e 30, febbraio 2017

m_amte.STA.DEC STA.REGISTRAZIONE.Prot.0000408.03-08-2016

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE
Direzione Generale per la Salvaguardia del Territorio e delle Acque

DEC STA - REGISTRAZIONE
Prot. 0000408/STA del 03/08/2016

Ministero dell'Ambiente e della Tutela del Territorio e del Mare

DIREZIONE GENERALE
PER LA SALVAGUARDIA DEL TERRITORIO E DELLE ACQUE

VISTA la Direttiva 2000/60/CE del 23 ottobre 2000, che istituisce un quadro per l'azione comunitaria in materia di acque;

VISTO il Decreto legislativo 152 del 3 aprile 2006 e ss.mm.ii, ed in particolare la Parte Terza "Norme in materia di difesa del suolo e lotta alla desertificazione, di tutela delle acque dall'inquinamento e di gestione delle risorse idriche";

VISTO in particolare l'art. 95, comma 4, del predetto Decreto legislativo, il quale prevede che, con apposito decreto del Ministro dell'Ambiente e della Tutela del Territorio e del Mare, vengano adottati i criteri volti a garantire il minimo deflusso vitale nei corpi idrici;

VISTO il Decreto del Ministro dell'Ambiente 28 luglio 2004, recante "*Linee guida per la predisposizione del bilancio idrico di bacino, comprensive dei criteri per il censimento delle utilizzazioni in atto e per la definizione del minimo deflusso vitale, di cui all'articolo 22, comma 4, del decreto legislativo 11 maggio 1999, n. 152*";

VISTO il CIS *Guidance Document* n°31/2015 "*Ecological flows in the implementation of the Water Framework Directive*", nel quale sono fornite indicazioni, condivise a livello comunitario, per la determinazione del deflusso ecologico e per la definizione delle misure necessarie all'applicazione del deflusso stesso;

CONSIDERATA la necessità di assicurare che l'applicazione del deflusso ecologico avvenga, su tutto il territorio nazionale, secondo metodologie condivise e scientificamente avanzate, tenuto conto delle differenze orografiche, idrologiche, geologiche ed ecosistemiche esistenti tra i vari distretti;

VISTO il caso EU PILOT 7304/15/ENVI avviato dalla Commissione Europea sull'attuazione Direttiva "Acque" 2000/60/CE in Italia;

VISTO il caso EU PILOT 6011/14/ENVI avviato dalla Commissione Europea sugli impianti per la produzione di energia idroelettrica localizzati nel territorio nazionale, in merito alla corretta applicazione della Direttiva "Acque" 2000/60/CE, della Direttiva "Habitat" 92/43/CEE e della Direttiva "VIA" 2011/92/UE;

VISTE le risultanze del dialogo avviato dalla Direzione generale per la salvaguardia del territorio e delle acque con i competenti Uffici con la Commissione Europea in merito allo situazione della Pianificazione di bacino sui distretti italiani;

CONSIDERATI in particolare gli esiti della riunione bilaterale Italia/Commissione Europea del 12 febbraio 2016, ed in particolare gli impegni assunti nel corso della stessa, tra i quali vi è quello di adottare una specifica normativa tecnica di settore che fornisca alle Autorità di bacino distrettuali le linee guida per la corretta applicazione del deflusso ecologico sui corsi d'acqua appartenenti ai vari distretti;

VISTO il Decreto Direttoriale 00357/STA del 23 giugno 2016, con il quale è stato costituito, sulla base delle designazioni delle Autorità di bacino nazionali e degli Enti pubblici di ricerca interessati, un gruppo di lavoro di elevato profilo tecnico, con il compito di predisporre una proposta per le suddette linee guida, ai fini della successiva adozione delle stesse con Decreto del Ministro dell'Ambiente e della Tutela del Territorio e del Mare;

CONSIDERATO che, nel corso della prima riunione del gruppo di lavoro, avvenuta il 4 luglio 2016, è stata sottolineata l'opportunità di prevedere che il gruppo di lavoro suddetto sia opportunamente integrato con i rappresentanti della Regione Sardegna, dell'Autorità di bacino del Fiume Serchio e con alcuni esperti di settore, anche in relazione alla predisposizione di alcuni capitoli tematici della proposta di linee guida;

CONSIDERATO che, per mero errore materiale, nel precedente Decreto Direttoriale 00357/STA del 23 giugno 2016 il nominativo dell'Ing. Emanuele Romano è riportato in maniera erronea, per cui è necessario provvedere alla correzione;

Guidance on Environmental Flows

Integrating E-flow Science with Fluvial Geomorpho[...] Maintain Ecosystem Services

2019 edition

WORLD METEOROLOGICAL ORGANIZATION

WMO-No. 1235

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

SUM
Sistema di rilevar[...] classificazione de[...] morfologiche dei [...] d'acqua

122 / 2015

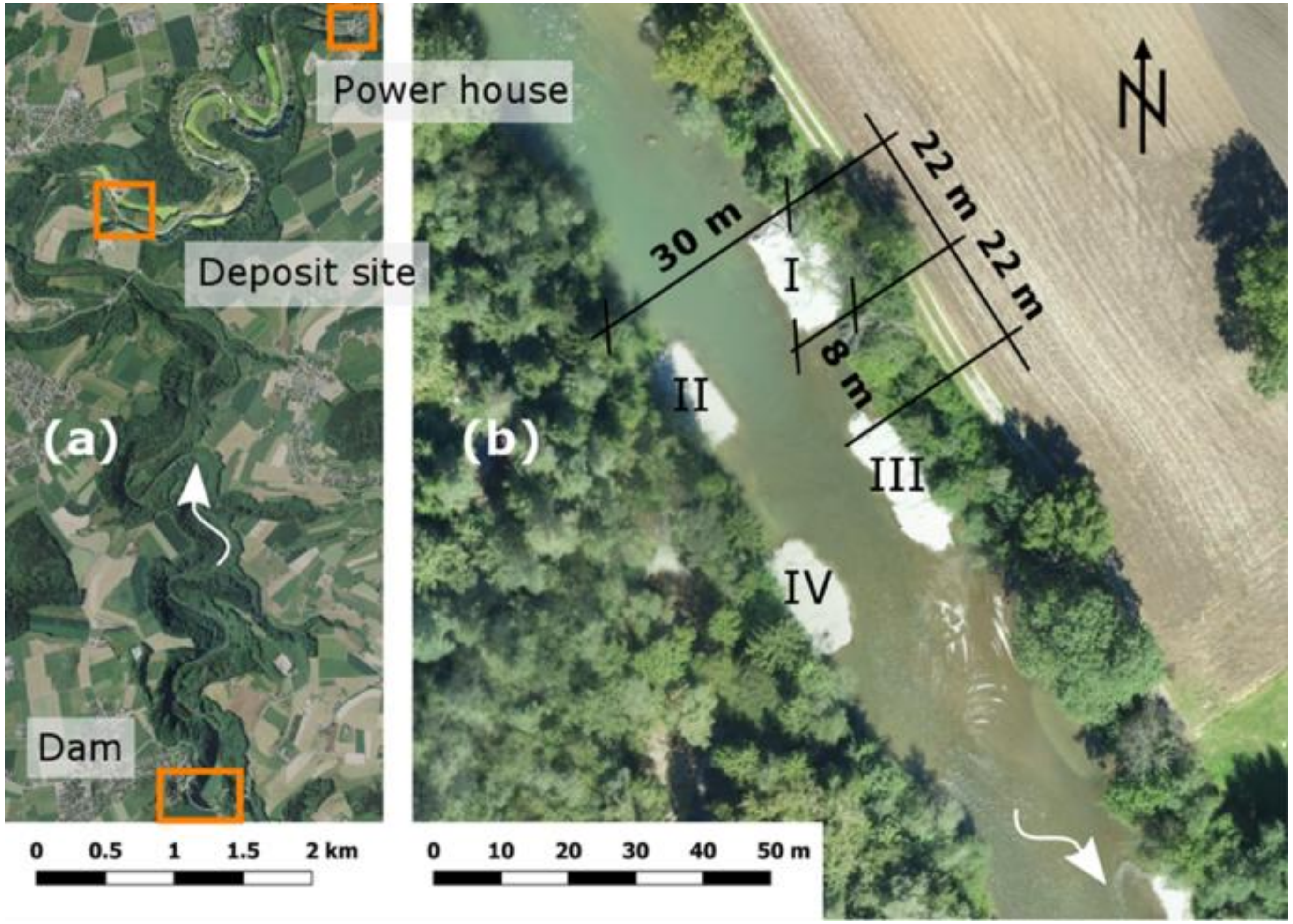
ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

Manuale tecnico-operativo
per la modellazione e la valutazione
dell'integrità dell'habitat fluviale

154/2017

MANUALI E LINEE GUIDA

4) River restoration through sediment reinjection



Sarine River (CH), Stahli et al., 2019

What can we do?

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2. Assessing the «hydro-morphological quality of rivers»
3. Quantifying how much habitat is available for target species,
4. Restore degraded river reaches through nature-based solutions
    1. Dynamic ecological flow releases (mimic the natural flow regime)
    2. Restore sediment connectivity (sediment agumentation/ barrier removal or reduction)
5. Planning: Determine «no-go» highly valuable areas where anthropic interventions should not be allowed

➔ INTEGRATION OF ECOLOGY – GEOMORPHOLOGY – HYDRAULICS/HYDROLOGY IS CRUCIAL FOR SUSTAINABLE MANAGEMENT

Thanks for your attention

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