RIVER MANAGEMENT: RIVER RESTORATION AND FLOOD HAZARD

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Introduction

Most of the rivers (at least in Europe) are managed
River management…a geomorphic perspective

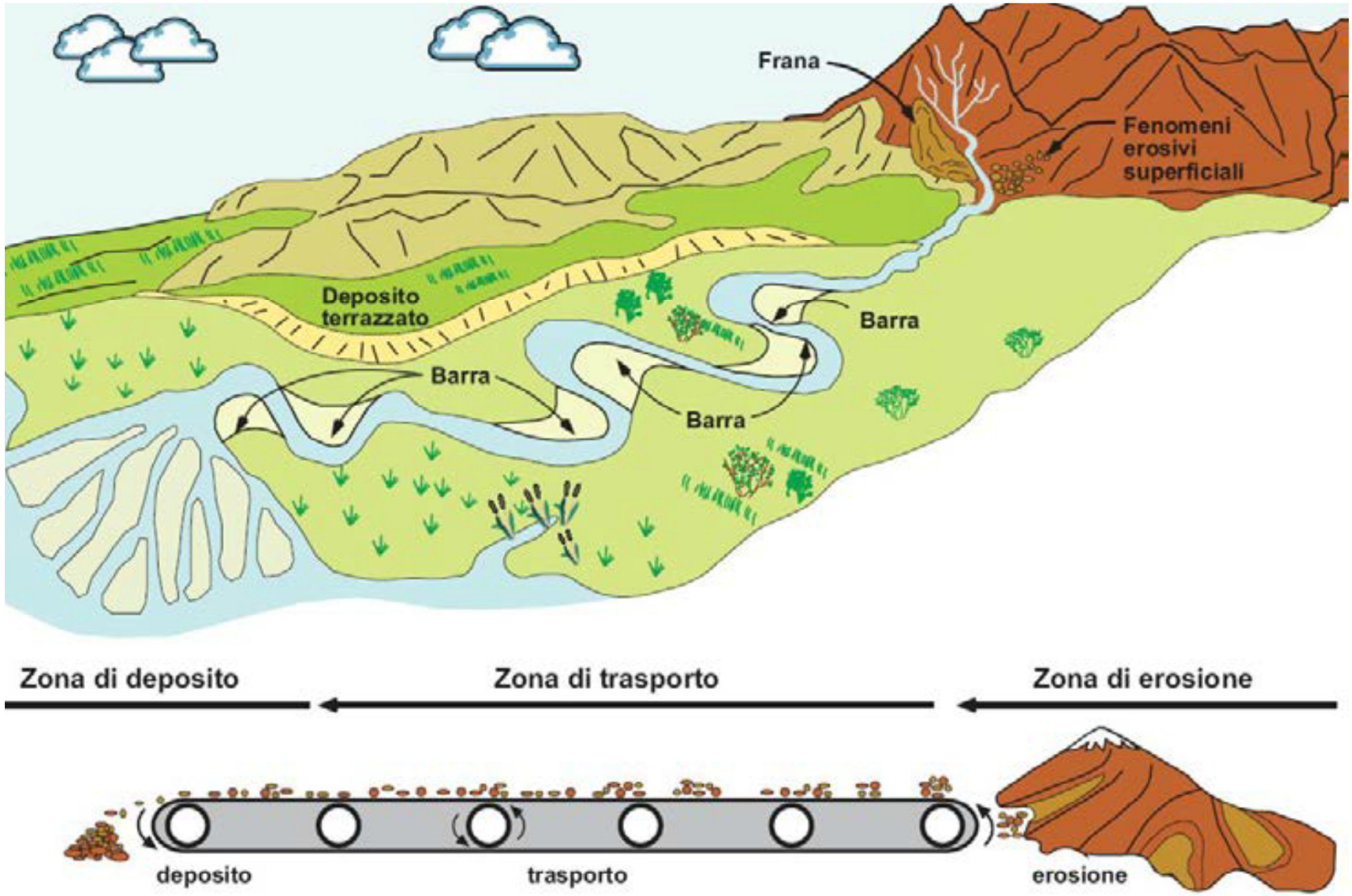
Content and aims of this lecture

1. River management: key concepts
2. River management in Europe
3. The role of fluvial geomorphology in river management

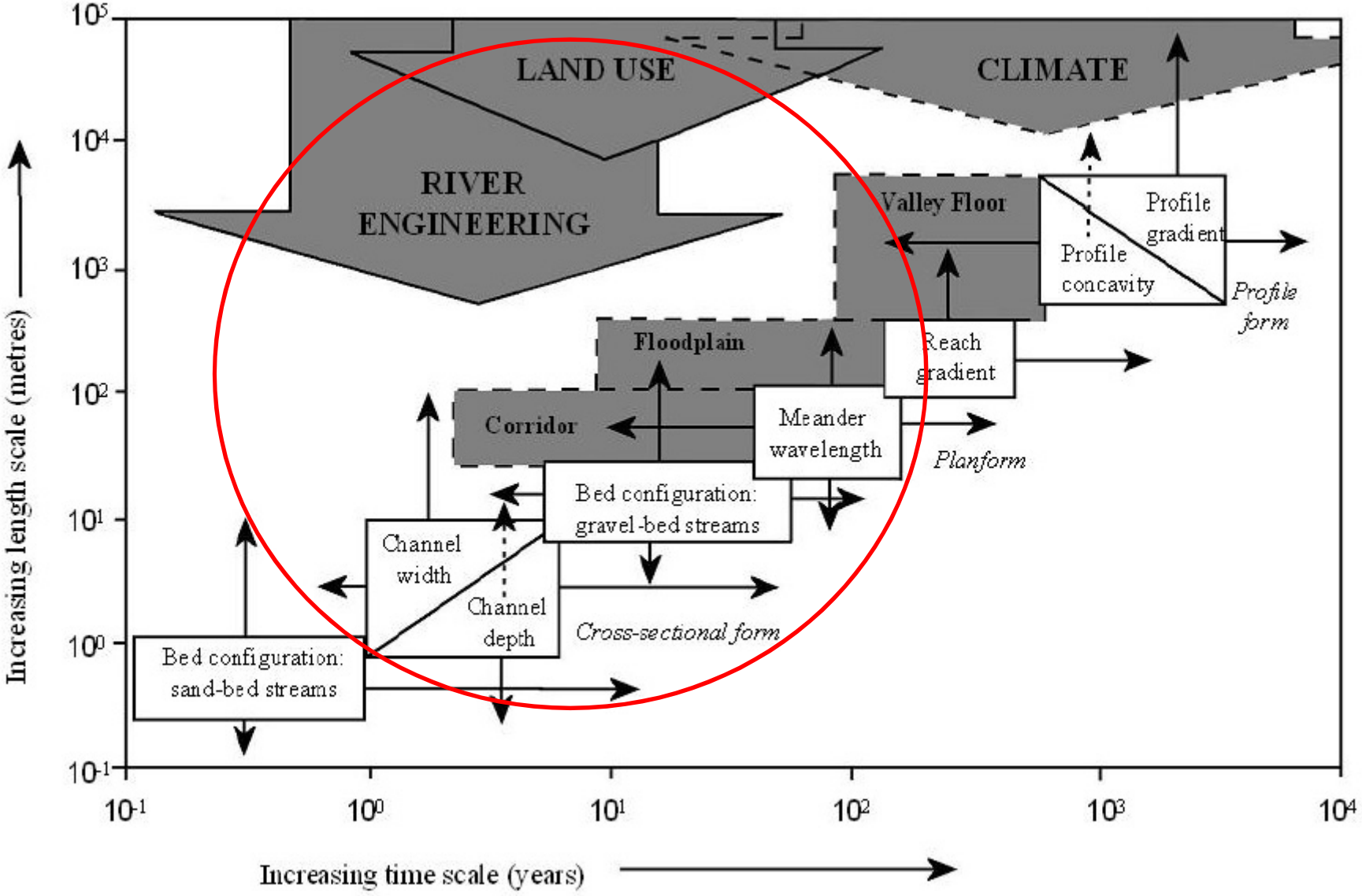
River management: key concepts

- ✓ Managing the river…and its catchment
- ✓ A complex system: natural processes and human activities
- ✓ What is river management (e.g. small and large scale interventions)?
- ✓ Who manages the river?

THE FLUVIAL SYSTEM



Temporal scales



(from Newson and Sear, 1993)

A complex system: natural processes and human activities

Main uses of rivers:

- ✓ Agriculture
- ✓ Navigation
- ✓ Production of energy
- ✓ Drinking water
- ✓ Recreation activities

…and flood protection

Channelization

Dams

Bank protection

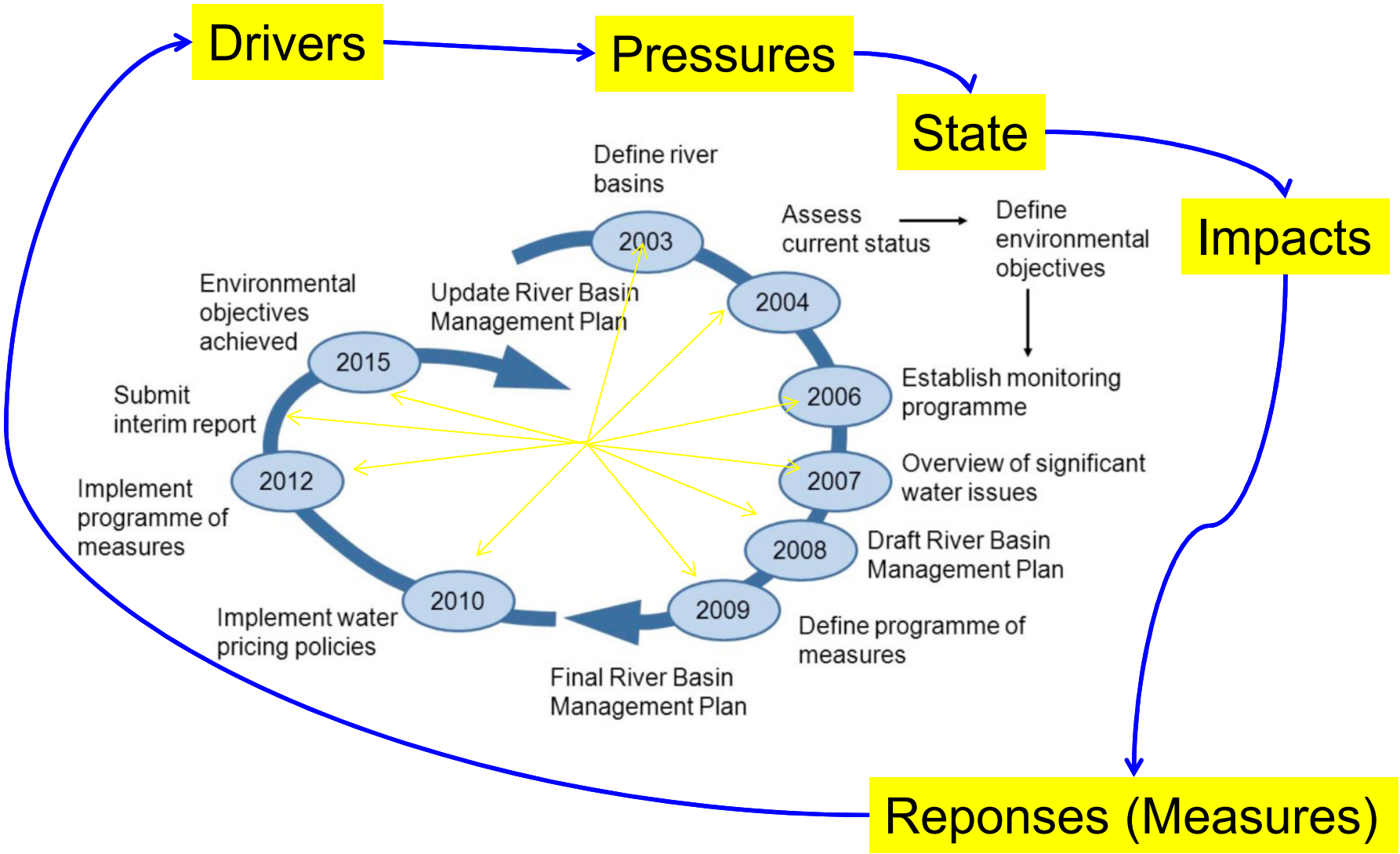
Sediment mining

Who manages the river or play a role in river management?

River management in Europe

- ✓ Water Framework Directive (2000/60/CE): to improve ecological quality of rivers
- ✓ Flood Directive (2007/60/CE): mitigation of flood risk
- ✓ «Integrated river management»

Water Framework Directive (WFD)?



Ecological condition of rivers

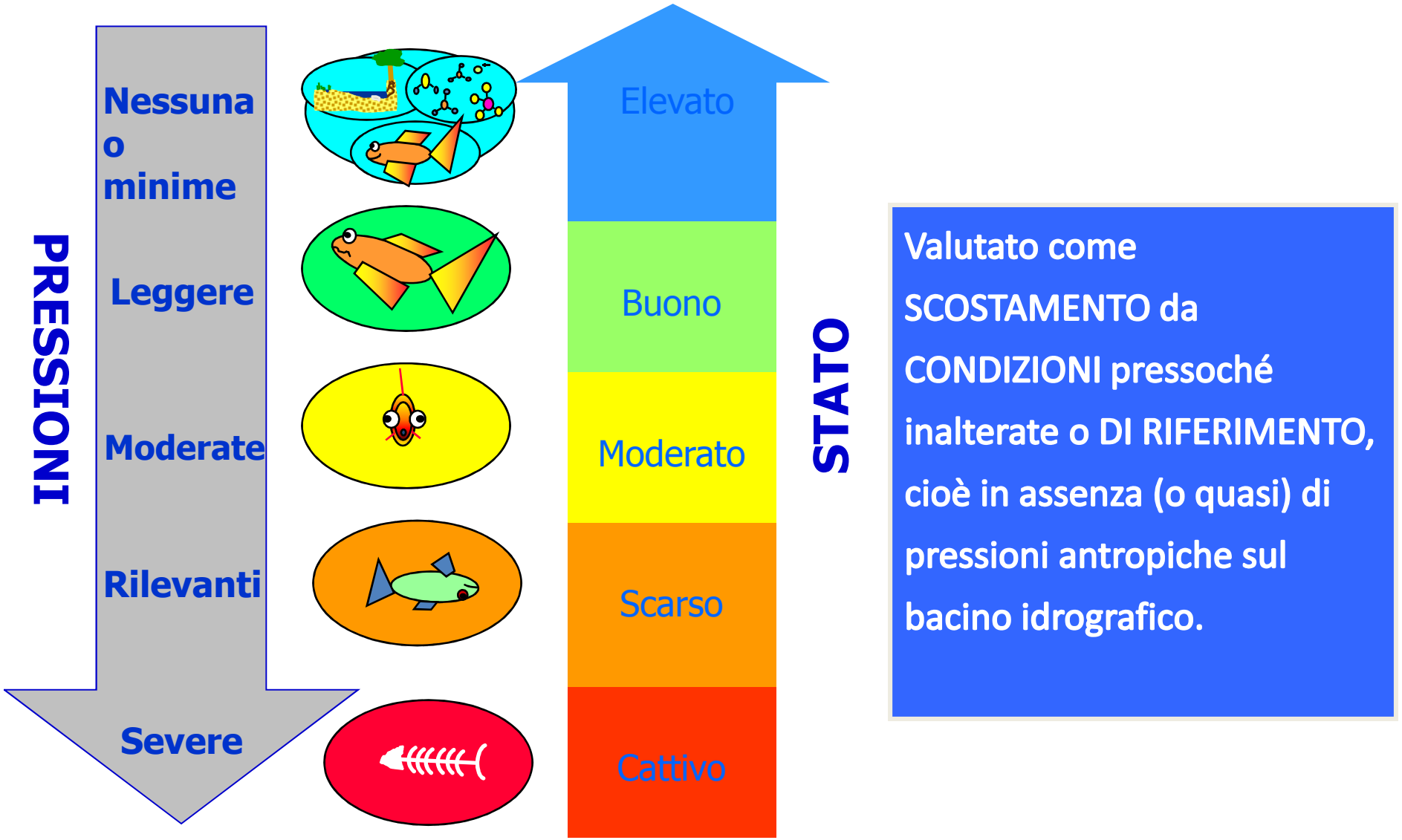
E’ DATO DALLA COMBINAZIONE DELLO STATO DI:

1.Elementi biologici

2. Elementi chimico-fisici (generali, inquinanti specifici)

3. Elementi **idromorfologici**: regime idrologico, continuità fluviale, condizioni morfologiche

Ecological condition of rivers



Valutato come SCOSTAMENTO da CONDIZIONI pressoché inalterate o DI RIFERIMENTO, cioè in assenza (o quasi) di pressioni antropiche sul bacino idrografico.

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

MANUALI E LINEE GUIDA

IDRAIM
Sistema di valutazione idromorfologica, analisi e monitoraggio dei corsi d'acqua

113 / 2014

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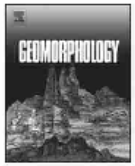
Geomorphology

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



A method for the assessment and analysis of the hydromorphological condition of Italian streams: The Morphological Quality Index (MQI)

M. Rinaldi [a,*], N. Surian [b], F. Comiti [c], M. Bussettini [d]

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The role of fluvial geomorphology in river management

An historical perspective: traditional approach (manly an engineering approach) and modern approach (including also geomorphology and ecology)

From «control of nature» to «work with nature»

Key physical processes that should be taken into account:

- ✓ Fluvial processes
- ✓ Appropriate spatial and temporal scales

Bank erosion

Classe A: frequenti sponde in arretramento, soprattutto sul lato esterno delle curve (frecce rosse nella foto a sinistra).

F4	Processi di arretramento delle sponde		
A	Presenza di frequenti sponde in arretramento soprattutto sul lato esterno delle curve	0	
B	Sponde in arretramento poco frequenti in quanto impedite da opere e/o scarsa dinamica alveo	2	
C	Completa assenza oppure presenza diffusa di sponde instabili per movimenti di massa	3	

Non si valuta in caso di alvei rettilinei, sinuosi o anabranching a bassa energia (bassa pianura, basse pendenze e/o basso trasporto solido al fondo) e nel caso di corsi d'acqua di risorgiva

Bank erosion

Classe C: completa assenza o presenza molto trascurabile (erosioni molto localizzate) di sponde in erosione per presenza di interventi di protezione e/o dinamica dell'alveo assente.

F4	Processi di arretramento delle sponde		
A	Presenza di frequenti sponde in arretramento soprattutto sul lato esterno delle curve	0	
B	Sponde in arretramento poco frequenti in quanto impedite da opere e/o scarsa dinamica alveo	2	
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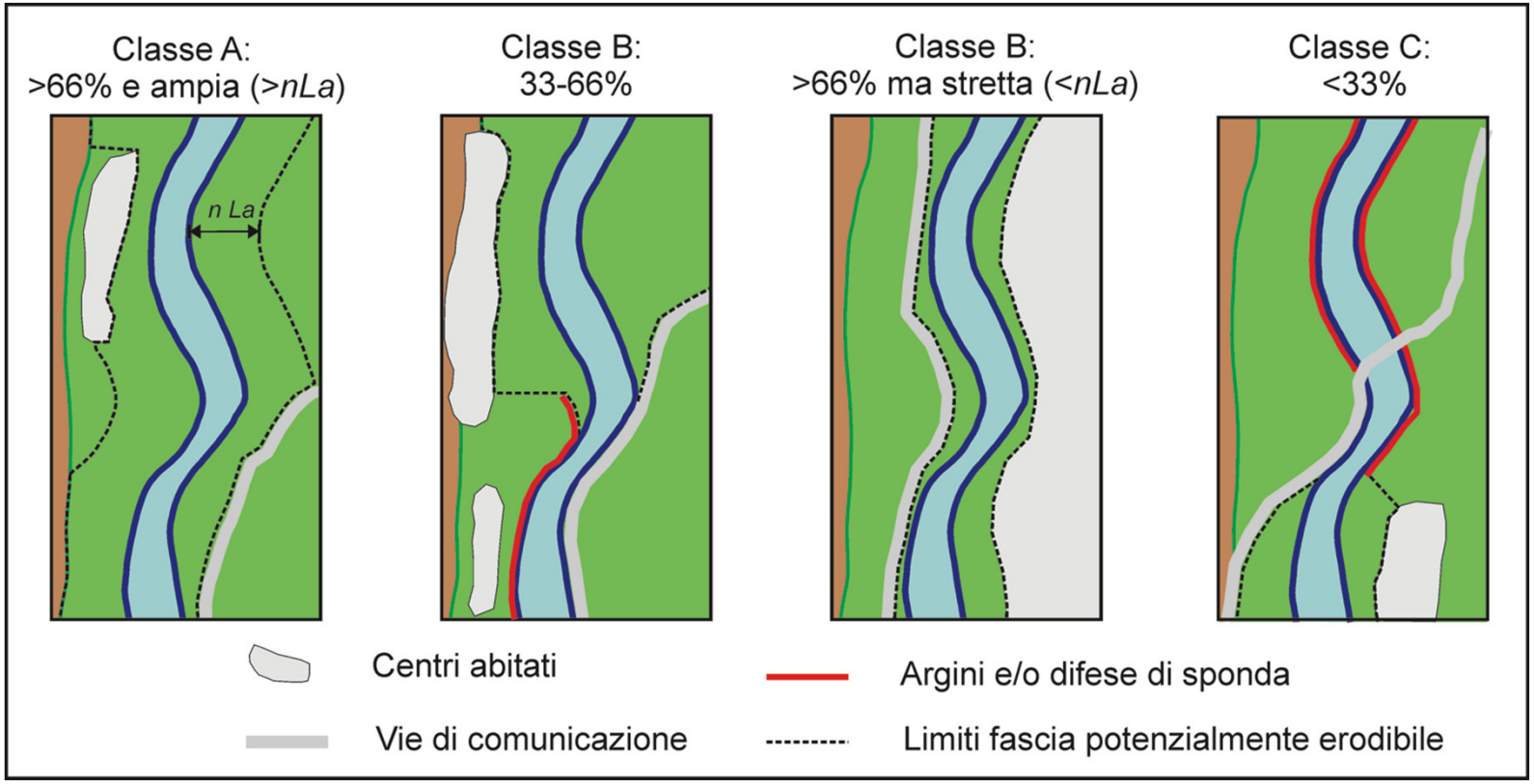
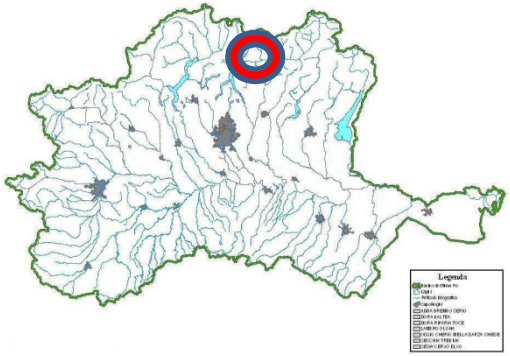
Erodible corridor



Classe A: nonostante il centro abitato e la strada, è presente una fascia potenzialmente erodibile continua e sufficientemente ampia. Classe B: la fascia erodibile presenta media continuità (33÷66%) e qualunque ampiezza (seconda figura da sinistra), oppure è continua (>66%) ma non sufficientemente ampia (larghezza media <*nLa*) (terza figura da sinistra). Classe C: è presente una fascia potenzialmente erodibile (di qualunque ampiezza) per <33% del tratto.

Sediment mining

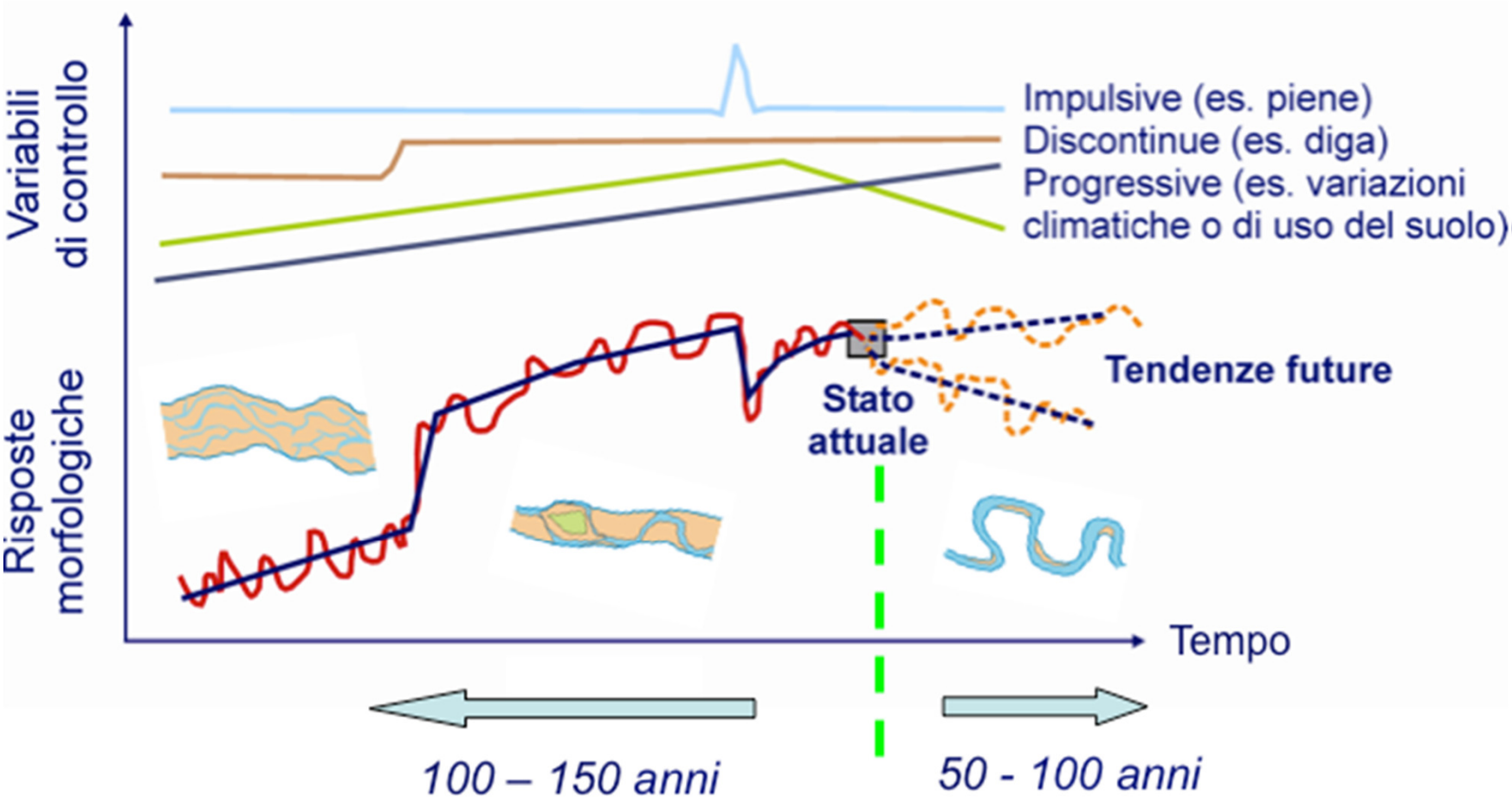


Channel changes: why the need for evolutionary trajectories

When did changes start to occurr ?

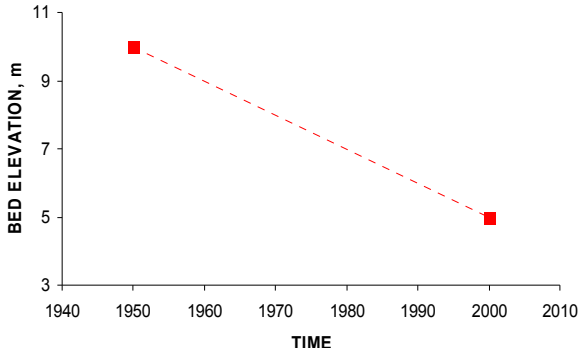
Are these changes still on-going ?

Reconstruction of morphological changes: the concept of evolutionary trajectory

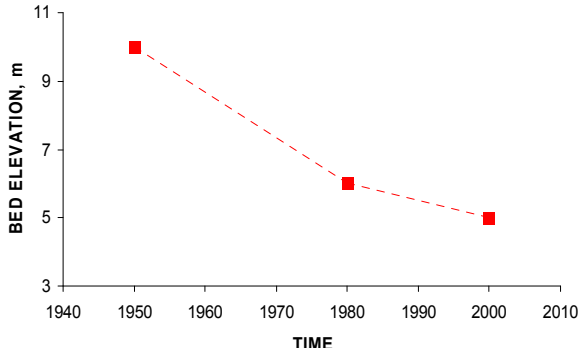


Trajectories of channel evolution

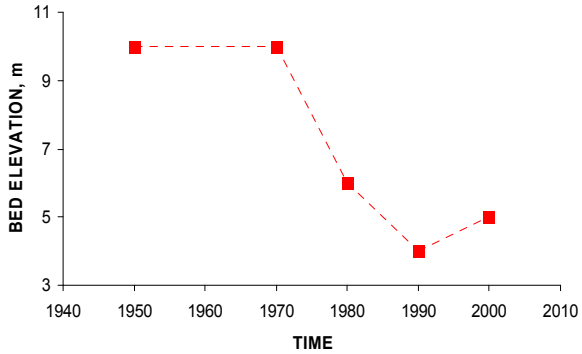
A

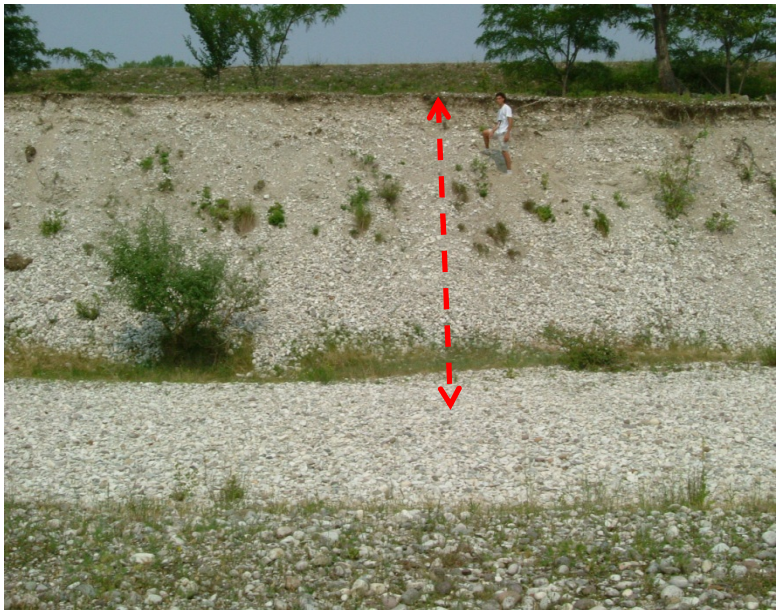


B



C

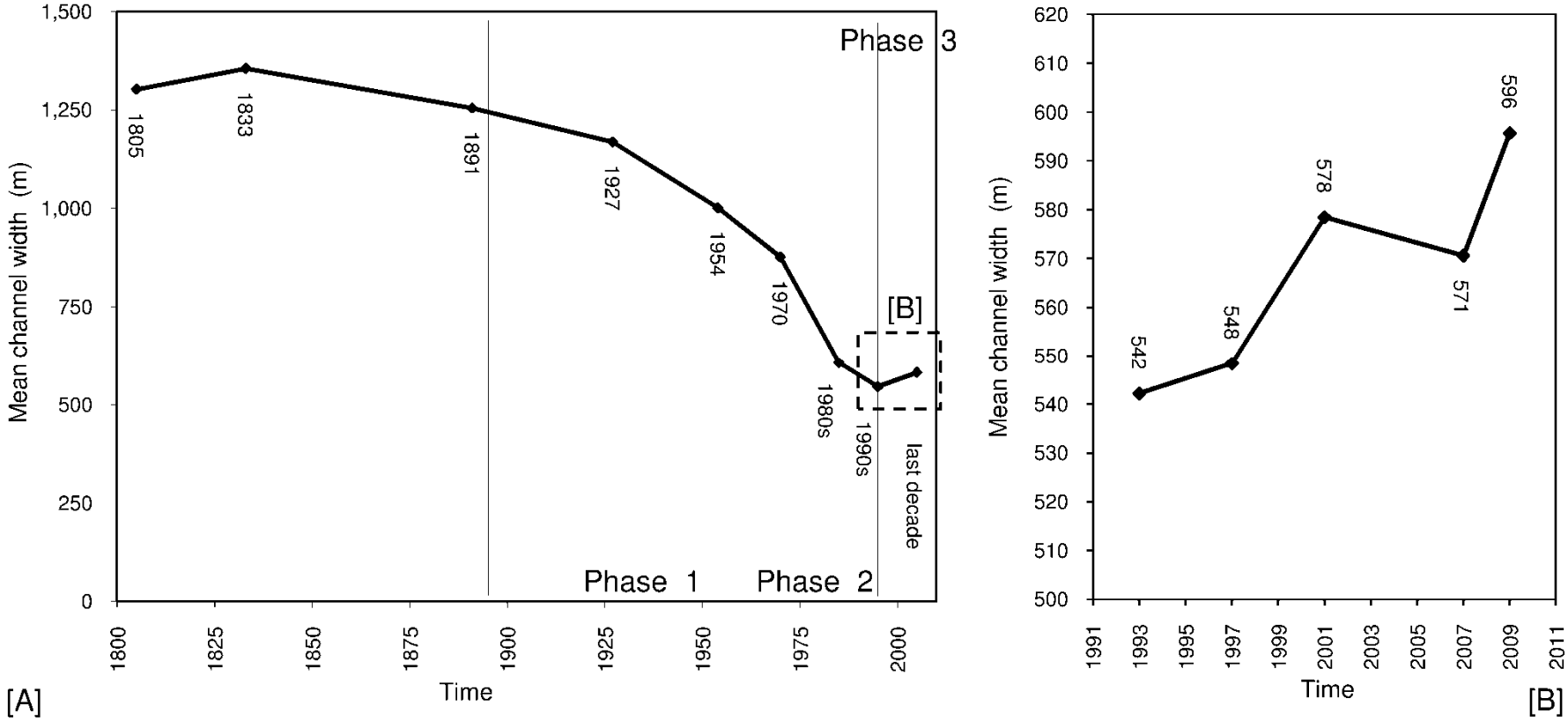




"The pathway along which a reach adjusts following disturbance" (Brierley and Fryirs, 2005)

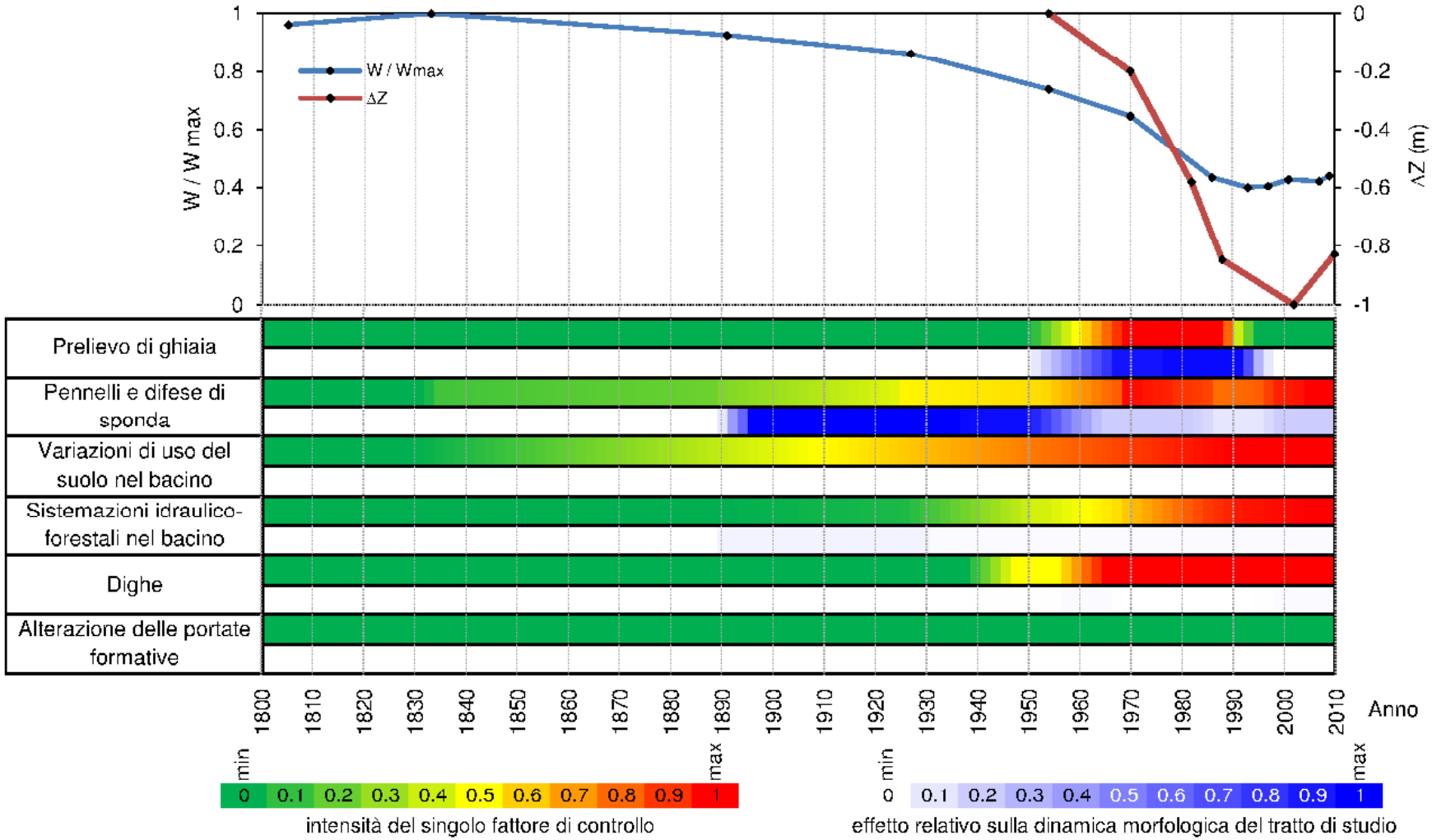

DOLOMITES
Cellina R.
Tagliamento R.
Piave R.
VENETIAN-FRIULIAN PLAIN
Brenta R.
Venice
ADRIATIC SEA
0
20 km

Tagliamento River



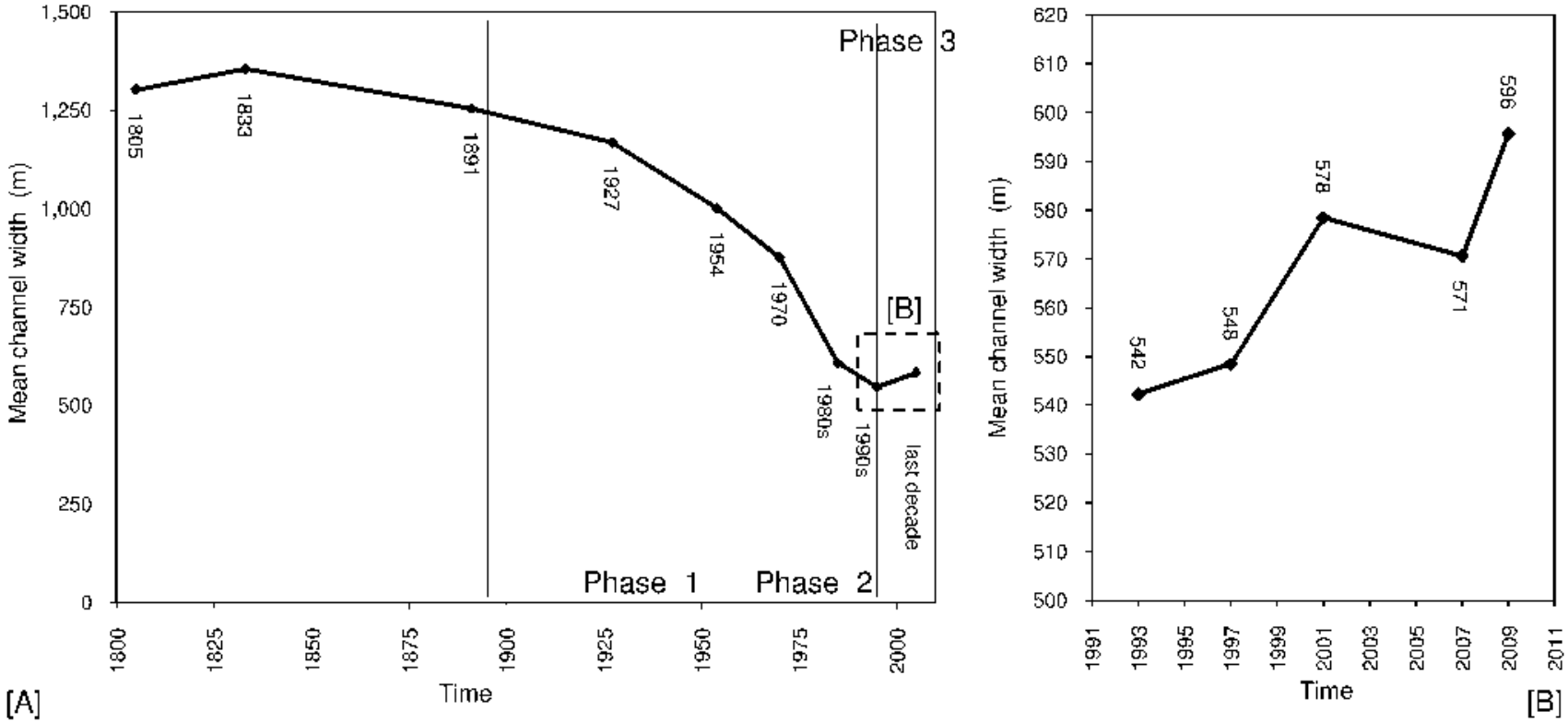
Evolutionary trajectory: channel width

Ziliani & Surian, Geomorphology, 2012



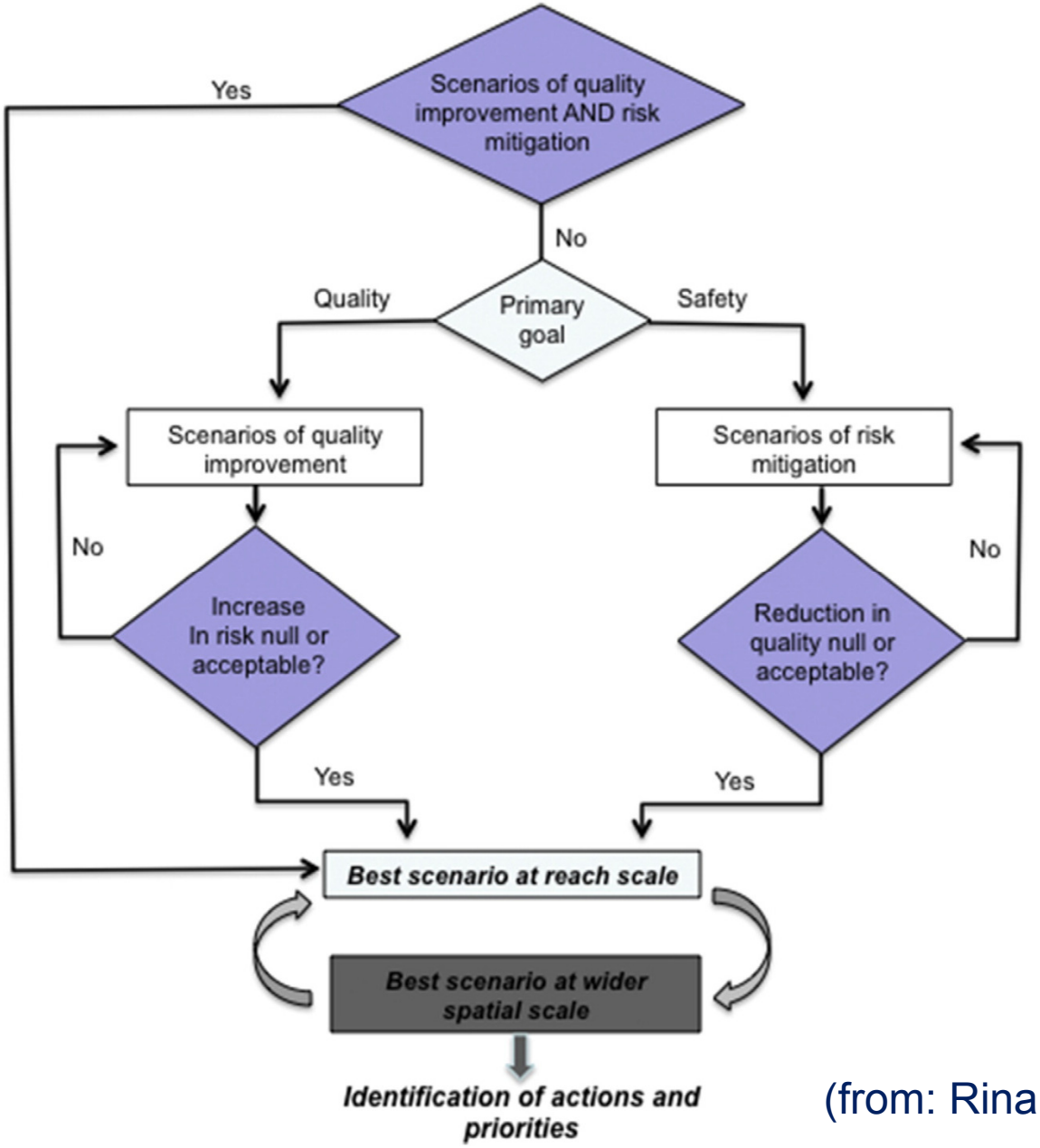
Evolutionary trajectory and controlling factors

Management perspective: future trajectories



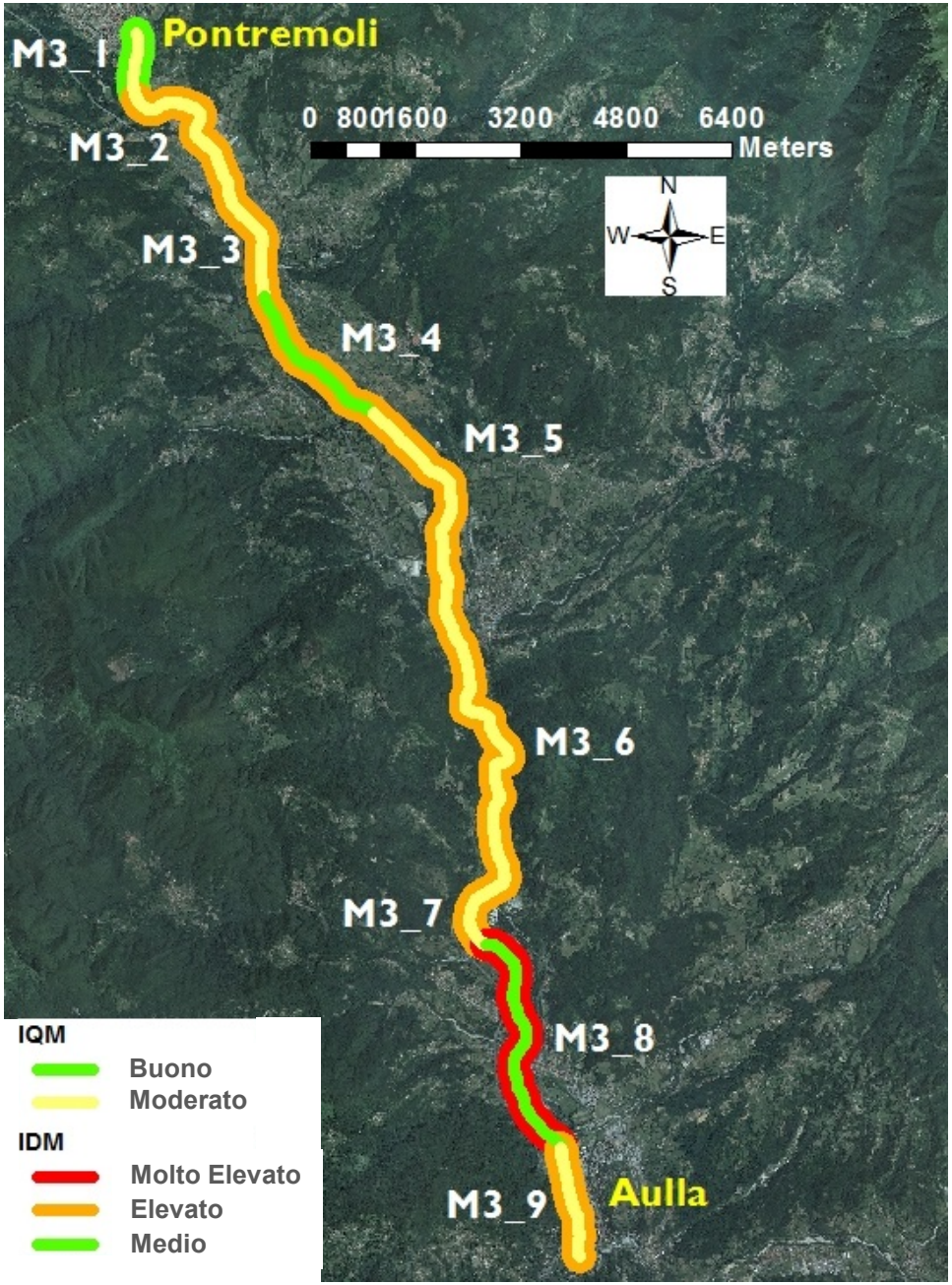
Is present trajectory what we want for that river reach ?
Can this trajectory be modified and to what extent ?

Decision-making framework

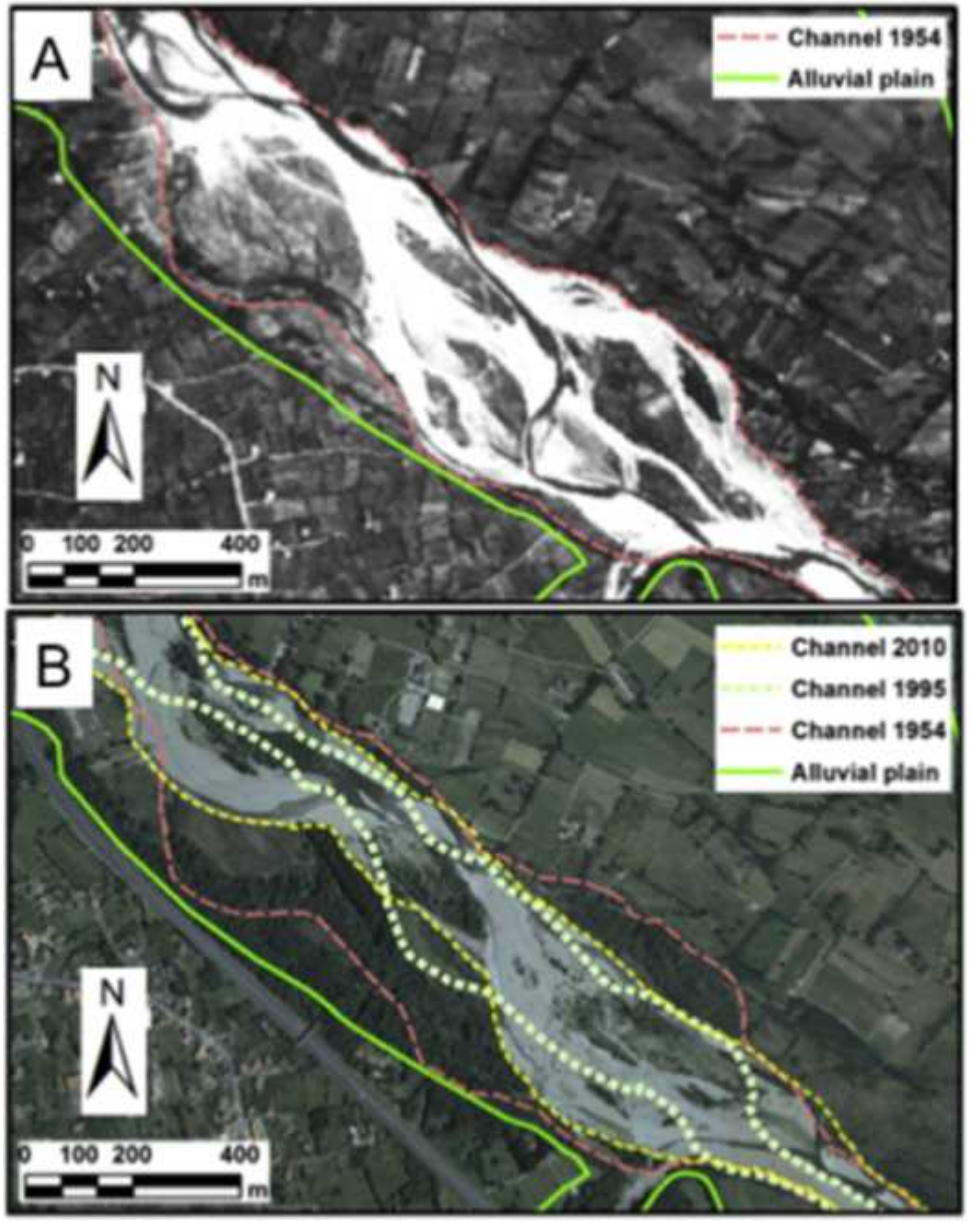


(from: Rinaldi et al., 2015)

Magra River


Pontremoli
M3_1
M3_2
M3_3
M3_4
M3_5
M3_6
M3_7
M3_8
M3_9
Aulla
0 800 1600 3200 4800 6400
Meters
N
W
E
S
IQM
Buono
Moderato
IDM
Molto Elevato
Elevato
Medio

Magra River


A
Channel 1954
Alluvial plain
N
0 100 200 400
m
B
Channel 2010
Channel 1995
Channel 1954
Alluvial plain
N
0 100 200 400
m

Magra River: management scenarios

Example of application of the general decision-making framework to a reach of the Magra River: management scenarios and potential impacts.

Management scenarios	Description	Possible reach-scale effect	Possible effects at wider scale
1. Morphodynamic corridors	No direct interventions, delimitation of morphodynamic corridors, definition of policy and planning regulations, possible relocation of some exposed elements, no need to maintain existing bank protections	*Morphological dynamics and risk*: no measurable impact on *MDI* and *EDC*, but mitigation of risk in the long term by reducing exposed elements *Morphological quality*: channel mobility would enhance morphological functionality, thus an overall increase of morphological quality is expected	Morphodynamic corridors may reduce flood peak within the reach and downstream by increasing retention of flood volumes
2. Bank protection	Increase of bank protections from 33% to 60% of total bank length	*Morphological dynamics and risk*: significant reduction of channel dynamics (*MDI* from 0.77 to 0.71 and reduction of *EDC* to class "medium") and consequent mitigation of risk related to bank erosion *Morphological quality*: deterioration (*MQI* from 0.78 to 0.71)	Increased bank protection may reduce sediment supply for downstream reaches, with potential positive effects for risk mitigation and adverse impact on morphological quality
3. Reduction of sediment supply to the reach and channel maintenance	Construction of check dams along most relevant tributaries; partial sediment and vegetation removal within the reach	*Morphological dynamics and risk*: reduction of channel dynamics (*MDI* from 0.77 to 0.73 but no effects on *EDC*) because of reduced aggradation, and possible mitigation of inundation hazard *Morphological quality*: significant deterioration (*MQI* from 0.78 to 0.71)	Reduced sediment supply to downstream reaches, with potential positive effects for risk mitigation and adverse impact on morphological quality

Concluding remarks

- ✓ Work with nature: a more sustainable approach (i.e. less costs and less negative effects)
- ✓ Integrated river management
- ✓ River management is not just a «technical» issue and should include other issues (e.g. socio-economical; cultural)