Centro Italiano per la Riqualificazione Fluviale
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# River Restoration: basic concepts

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# RESTORATION:

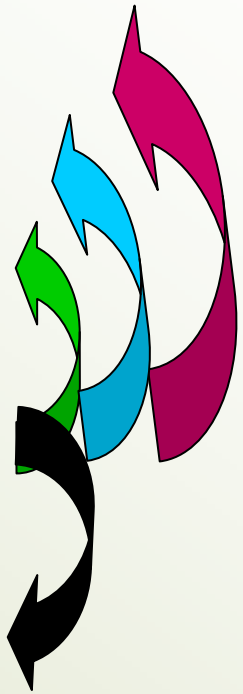
## objective and means

- more safety
- allow anthropic activities
- satisfy recreation, aesthetics & identity

RR

- **improve rivers (existence value)**

- reduce costs (investm.&management)
- enhance landscape and increase urban asset value



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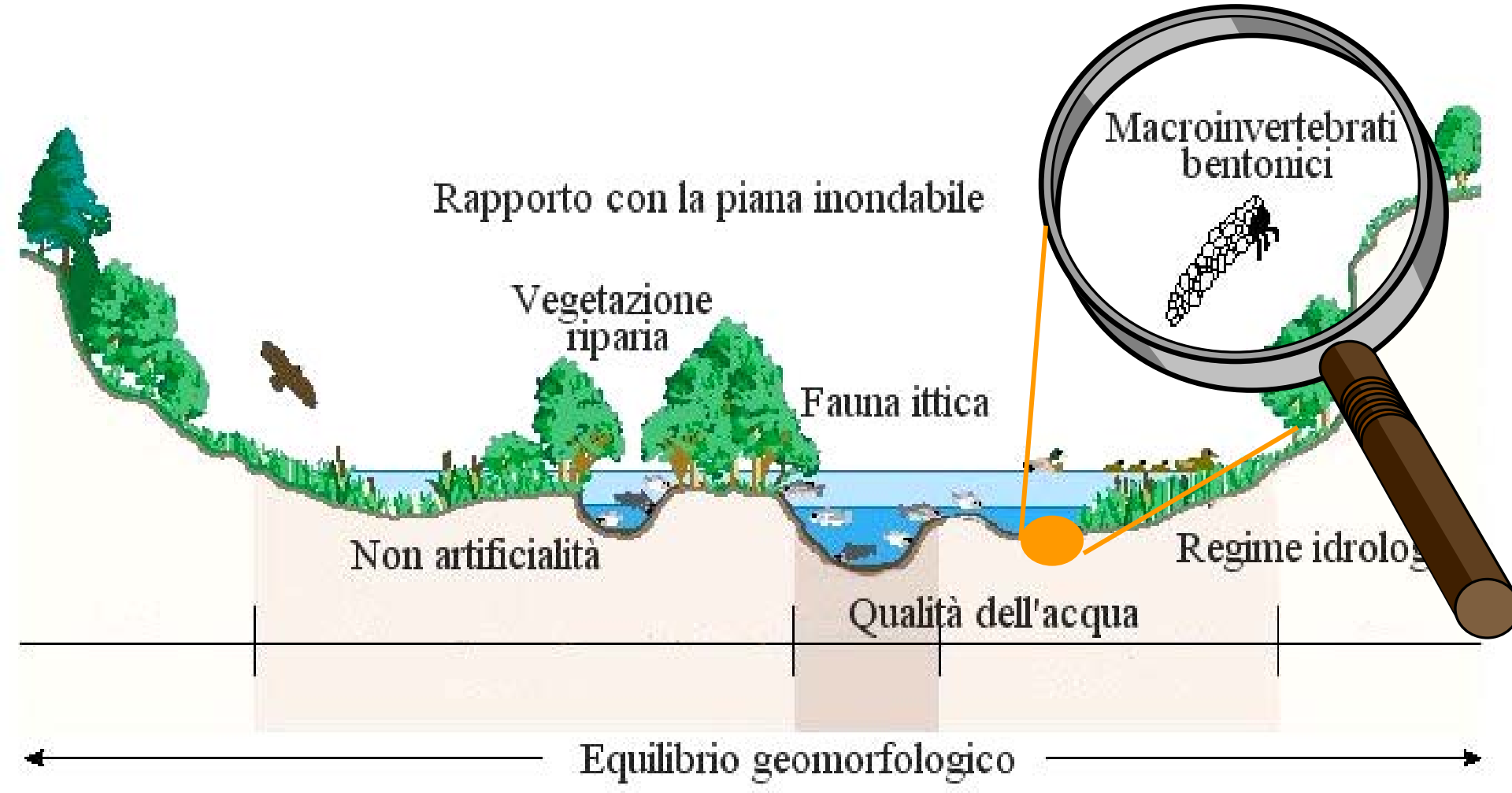
# OBJECTIVE
# river "HEALTH"



# Hydraulic RISK

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# RISK: classic hydraulic approach and its effects

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# RISK: classic hydraulic approach and its effects

**Increase efficiency, confine flow:**

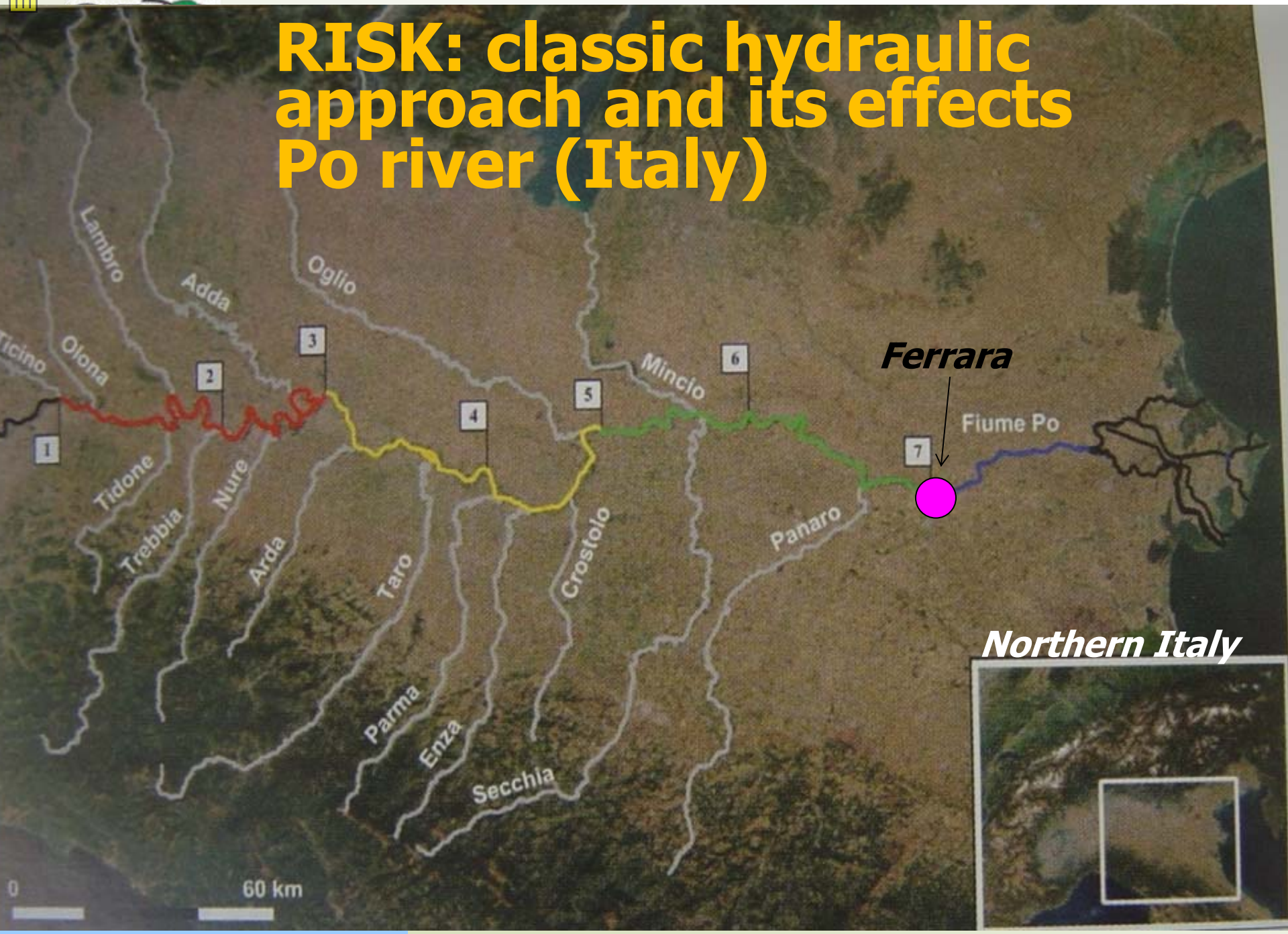
$\Rightarrow$ **levees, canalization**

**+ protects against events with:**

$T \leq T^*$ **(200)**

**- BUT..... less space to river: accelerated flow, increased peak, lower energy dissipation**

# RISK: classic hydraulic approach and its effects Po river (Italy)



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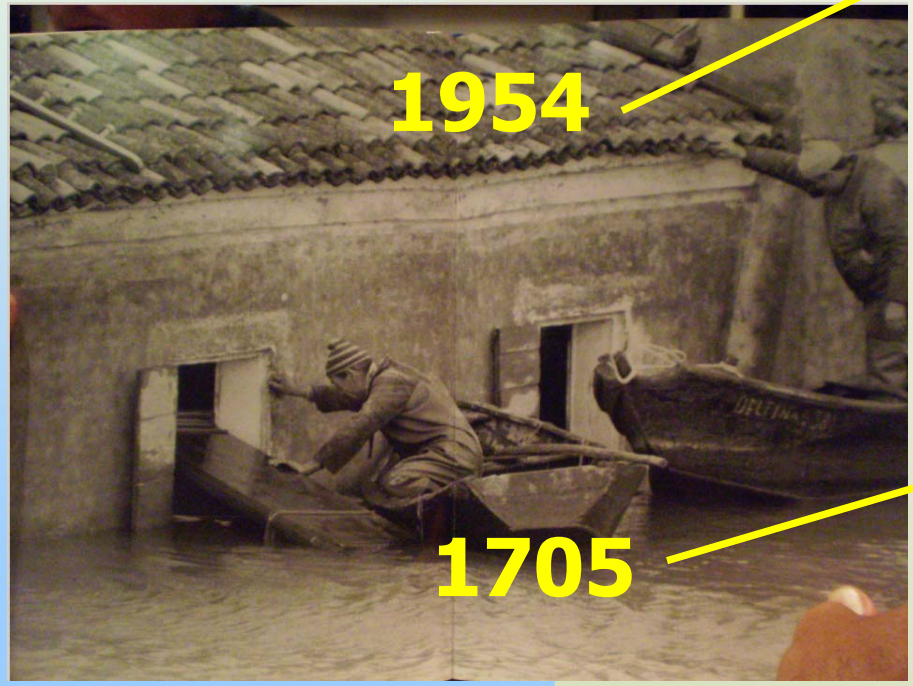
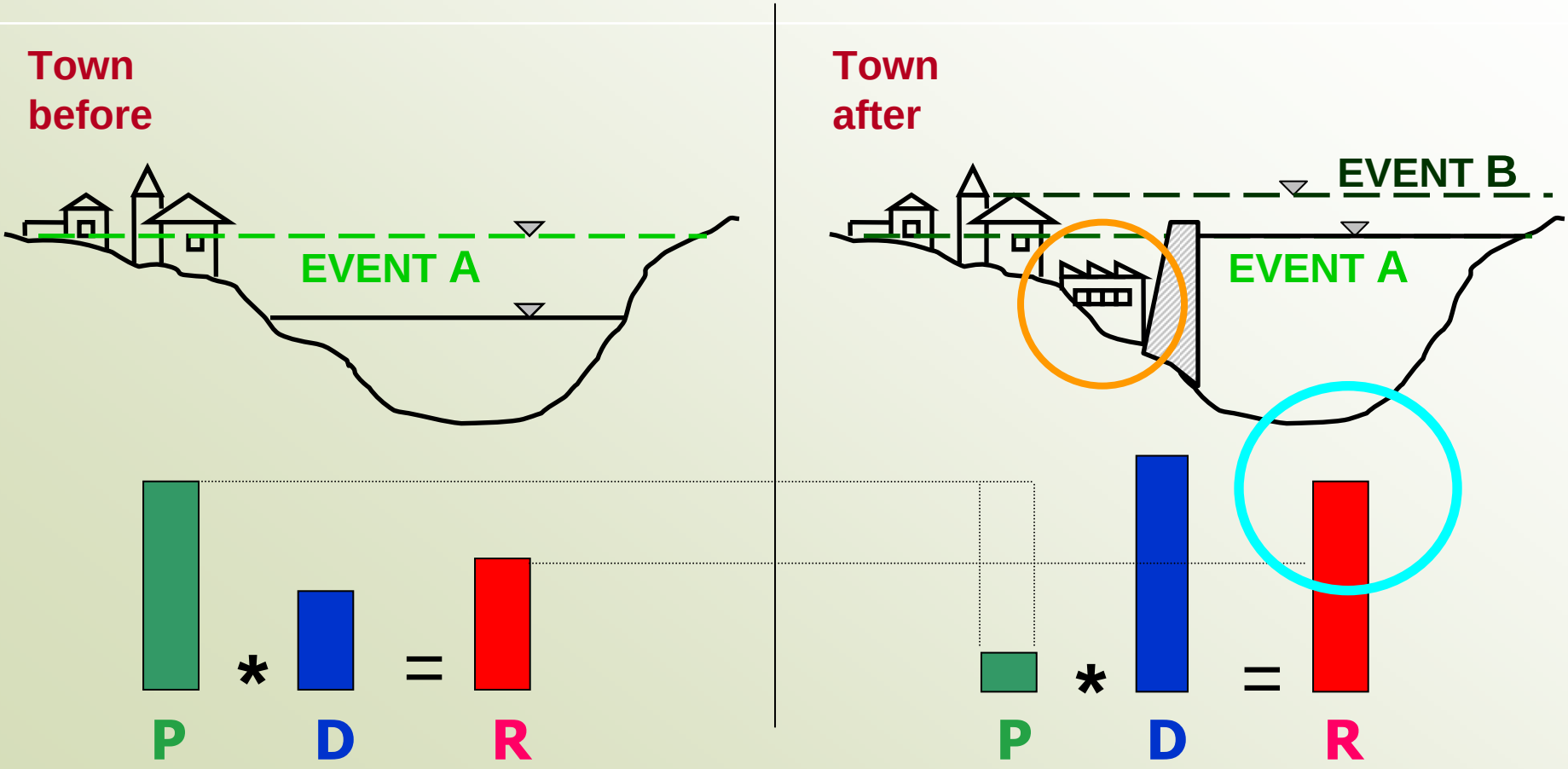
# Po river (Italy): result

today…




# The “safe conditions” paradox




⇒ **the risk increased !!**

**In addition, climate change …**

# Urban planning?

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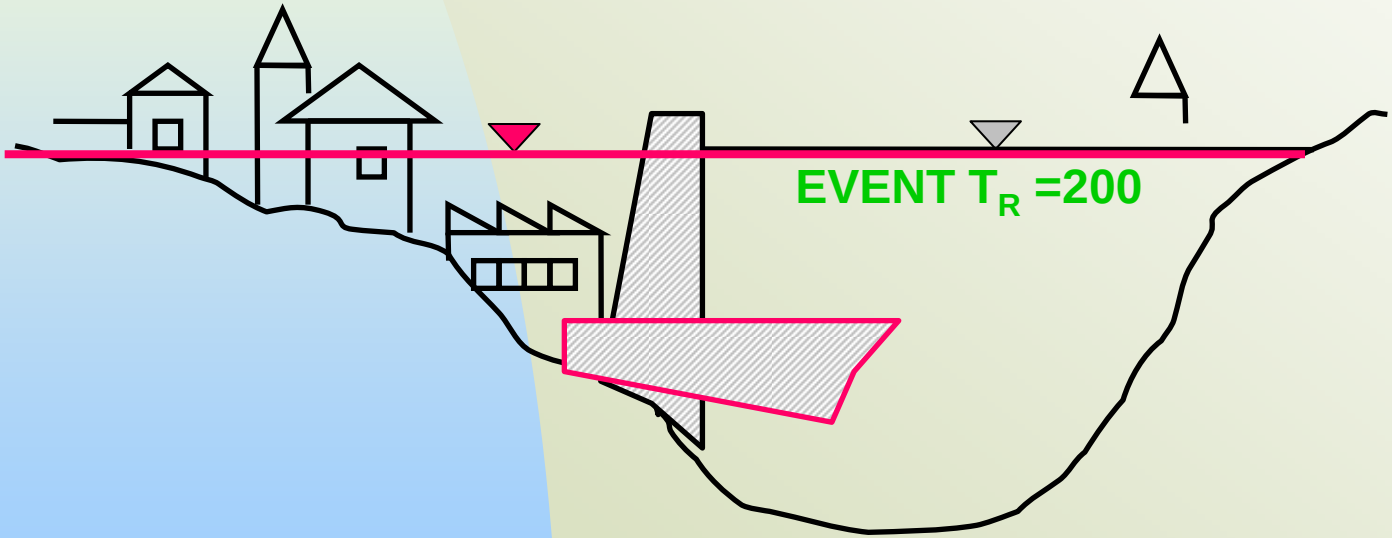
# Levees for or against safety?? … *FRAGILITY*!

**RISK:** $R_{200} = 0$ ?

**RISK:** $R_T > 0$ !

$R_T(\infty) >> 0$ !!




⇒ *FRAGILITY* HIGH….!!!

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# An approach really "CLASSIC" !

## A touch *of history*

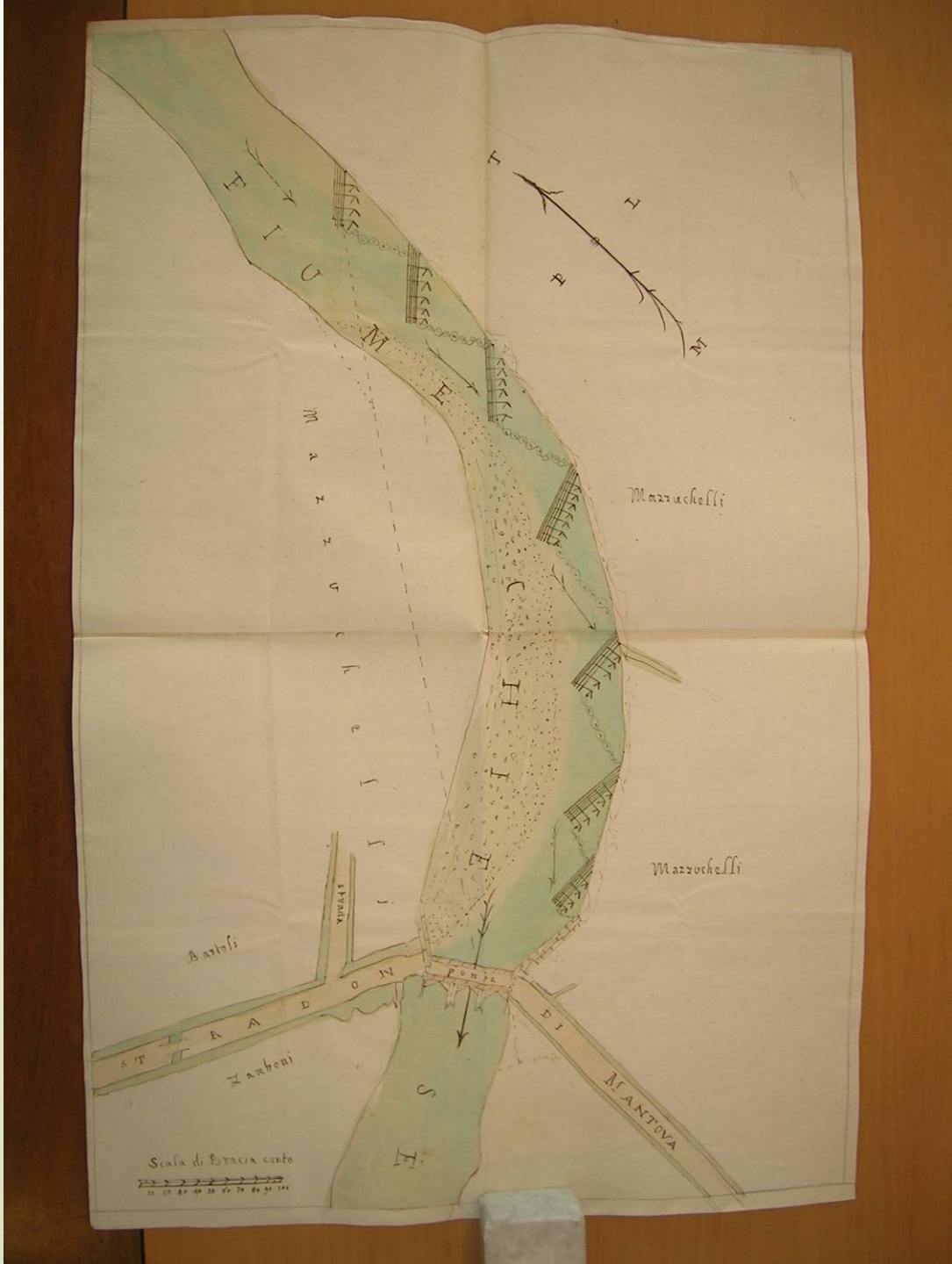
**Montichiari**

**1805**

**(Archivio Stato MI)**

**← 1500**

**← 1300**



# Hydraulic approch: who pays!?

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**infrastructuring =**

**Taxes in biberon!**

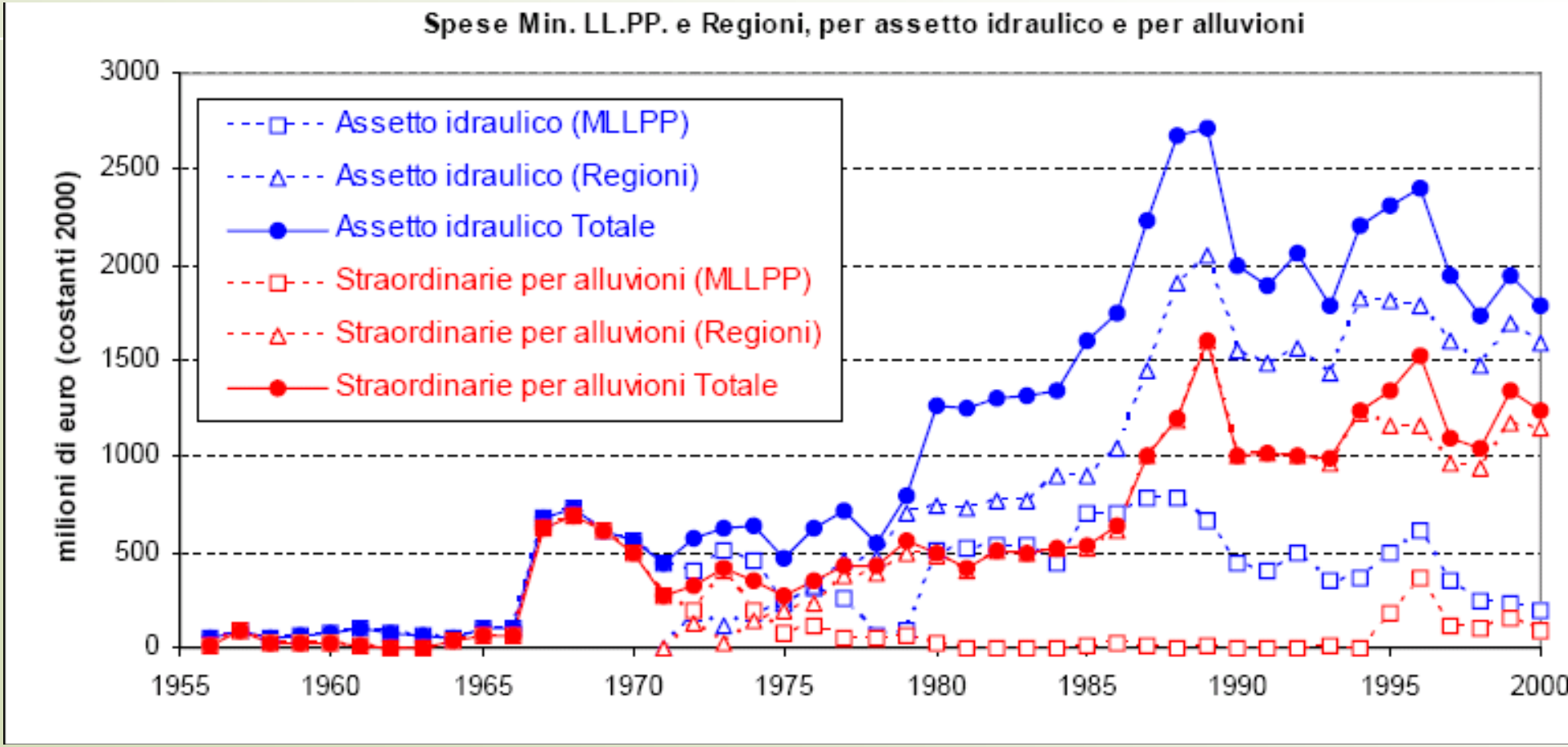

Ministero delle Finanze

*Carissimo neonato, benvenuto in questo mondo! Ecco la tua prima cartella delle tasse sui fiumi*

| | | |
|---|---|---|
| argini | € | 25,00 |
| difese spondali | € | 17,00 |
| briglie | € | 9,80 |
| dighe | € | 7,50 |
| taglio vegetazione | € | 4,30 |
| rimozione sedimenti | € | 4,30 |
| pulizia tombamenti | € | 2,50 |
| derivazioni | € | 3,80 |
| canalizzazioni | € | 13,00 |
| bonifiche | € | 15,50 |
| fognature | € | 9,00 |
| acquedotto | € | 9,00 |
| depurazione | € | 5,60 |
| pennelli e scogliere | € | 13,80 |
| ripascimenti | € | 12,00 |
| ponti | € | 6,50 |
| stabilizzazione frane | € | 18,00 |
| danni alluvionali | € | 15,70 |
| Protezione civile | € | 9,75 |

ecc., ecc.

# Po river: results



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# Hydraulic approch: summary

**PUT in SAFE conditions… r… cally**

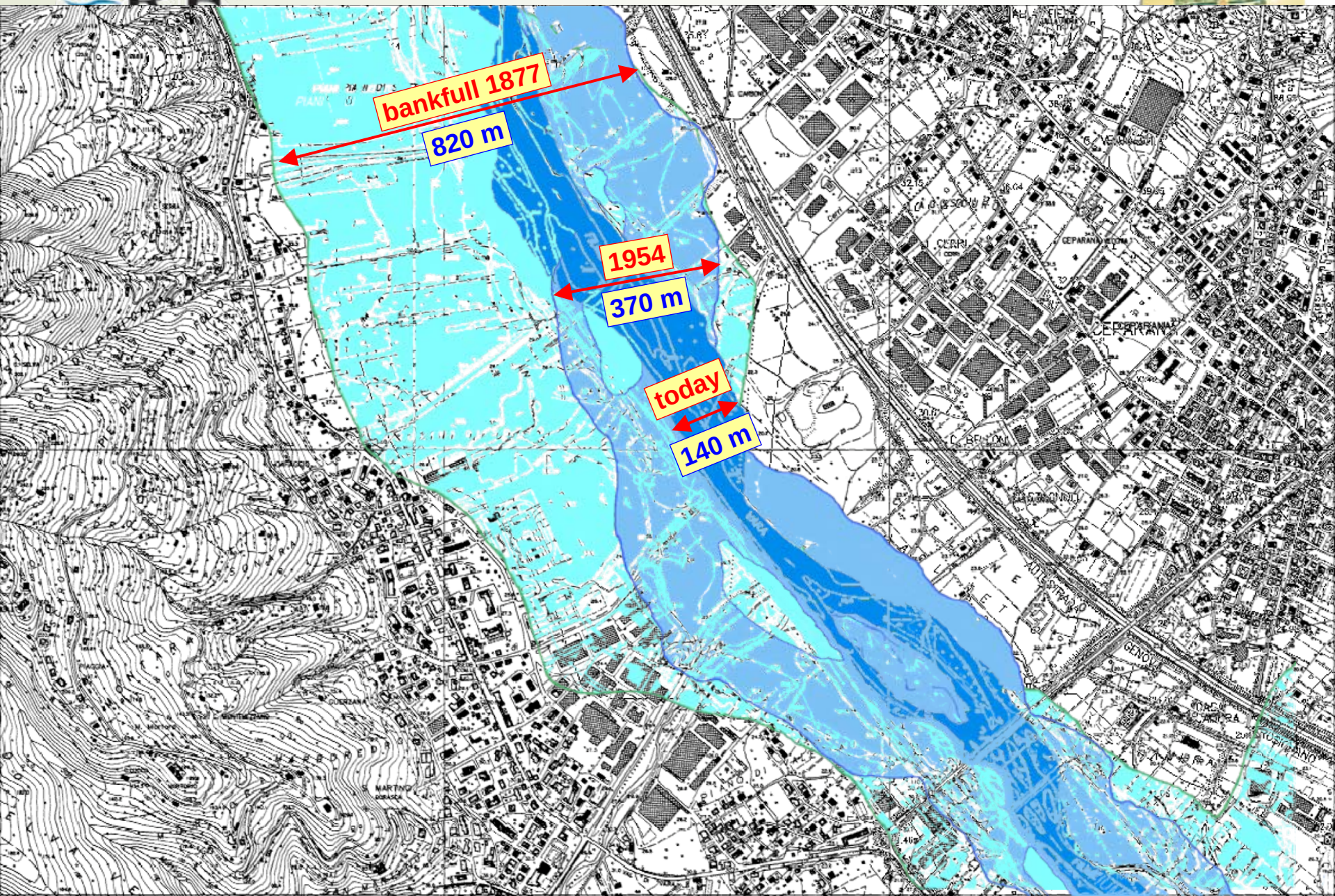
**…increases risk**

- **Exports hazards elsew…**
- **Induces fake saf… se potential damage**
- **Increases … ILITY**

- **m… is VERY COSTLY and increasingly**
- **and dumps costs on future generations: which sustainability??**

**NOT SOLVED !!!**

# ….River incides and narrows



# → bridges break down

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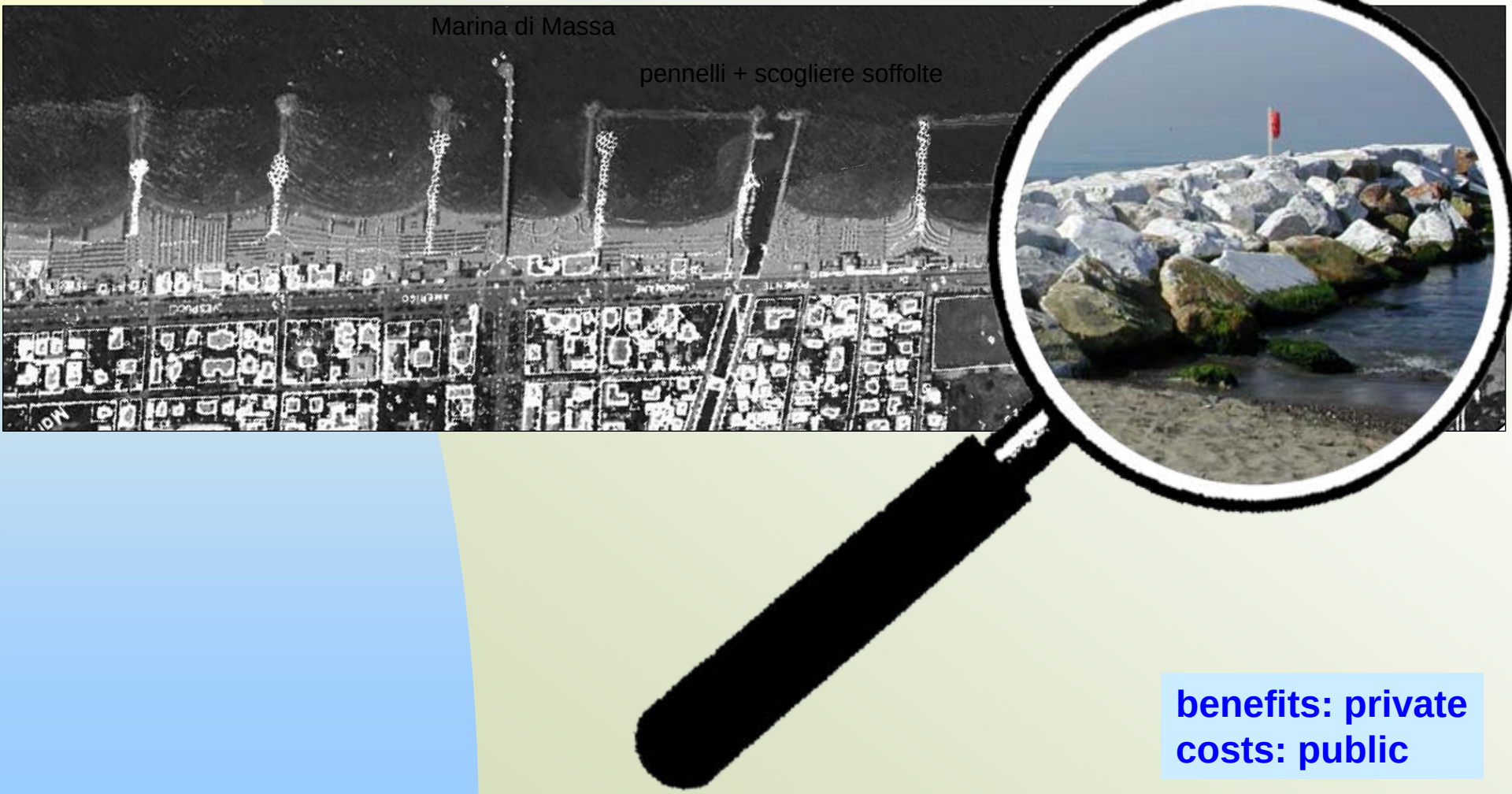
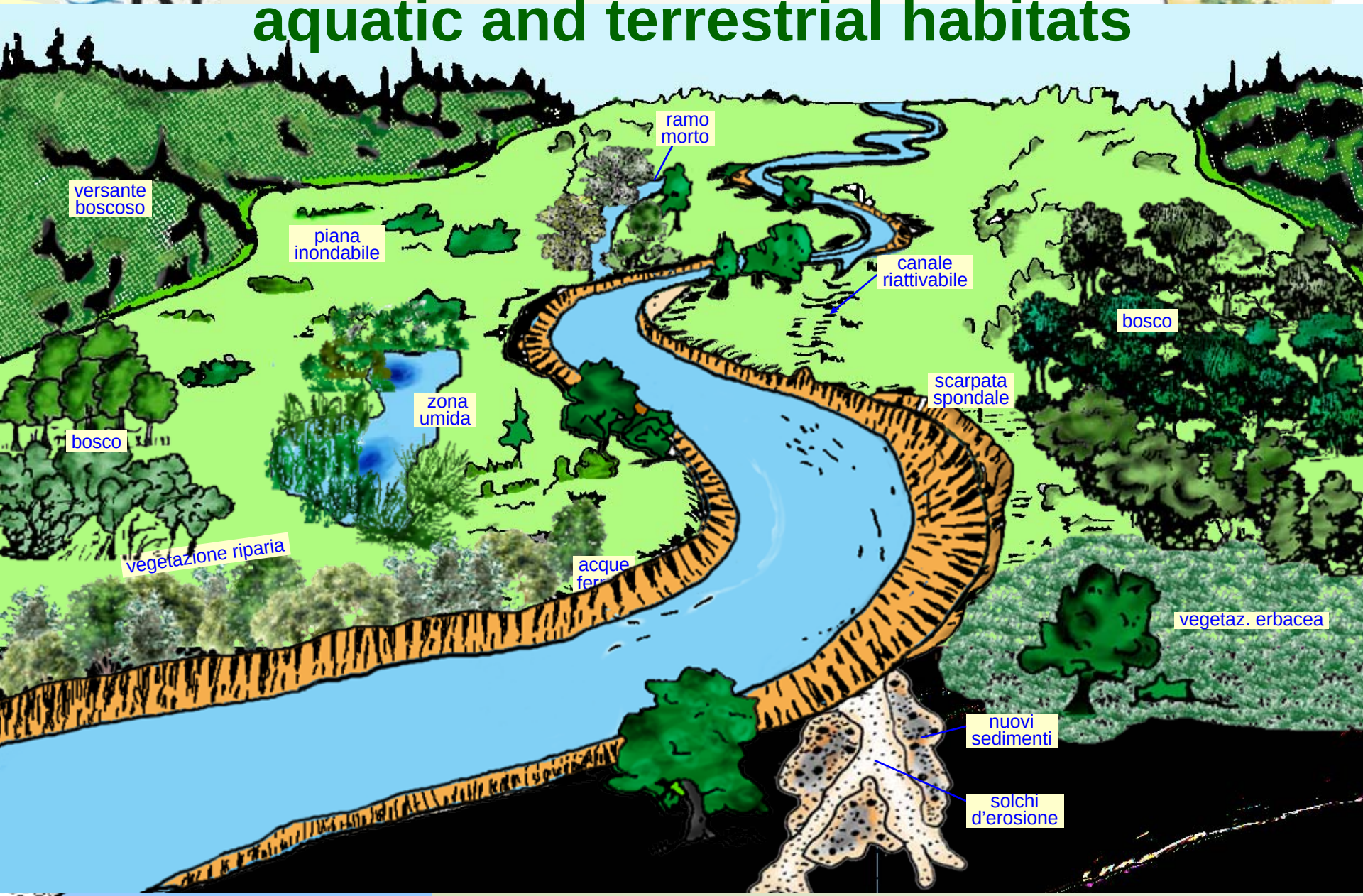
# ...reduction of solid flow → coastal erosion




**benefits: private**
**costs: public**

# …canalization effect → loss of aquatic and terrestrial habitats



# RR trends

ECRR

# EUROPEAN CENTRE FOR RIVER RESTORATION

## www.ecrr.org




- **www.restorerivers.eu**

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# WHAT IS CIRF

**CIRF is a private, independent, cultural, technical-scientific, and non-profit organisation**

**founded in 1999 by 10 "technicians" with the MISSION of:**

**promoting river restoration to**

**improve the state of water courses**

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# MAIN ACTIVITIES

- EDUCATION
- INFORMATION
- AWARENESS RISING
- RESEARCH
- INT. COOPERATION

- Courses
- Study trips
- Opinion documents
- Guidelines
- Meetings/Seminars

- Pilot Projects
- Studies

CIRF
CENTRO ITALIANO PER LA RIQUALIFICAZIONE FLUVIALE

AUTONOME PROVINZ BOZEN SÜDTIROL
PROVINCIA AUTONOMA DI BOLZANO ALTO ADIGE
Abteilung Wasserschutzbauten
Ripartizione Opere Idrauliche

FREIE UNIVERSITÄT BOZEN
LIBERA UNIVERSITÀ DI BOLZANO
FREE UNIVERSITY OF BOZEN - BOLZANO
Fakultät für Naturwissenschaften und Technik
Facoltà di Scienze e Tecnologie
Faculty of Science and Technology

Bolzano 5-8 Novembre 2012

# PROGRAMMA PRELIMINARE

## 2° Convegno italiano sulla riqualificazione fluviale

# RIQUALIFICAZIONE FLUVIALE E GESTIONE DEL TERRITORIO

# VALURI: saving money through RR, even addressing flood risk

## A general evaluation approach applied to Chiese river (Po river basin, Italy)

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**Partners: Autorità di bacino del Po; Università di Udine**

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# OBJECTIVEs

- is restoring rivers really DESIRABLE also to face RISK in MEDITERRANEAN countries?
- how to EVALUATE in an integral fashion alternatives -even daring (RR)- able to address hydraulic RISK (flooding, bank erosion,..)

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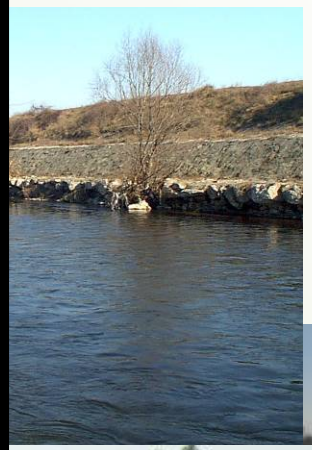
# MESSAGE

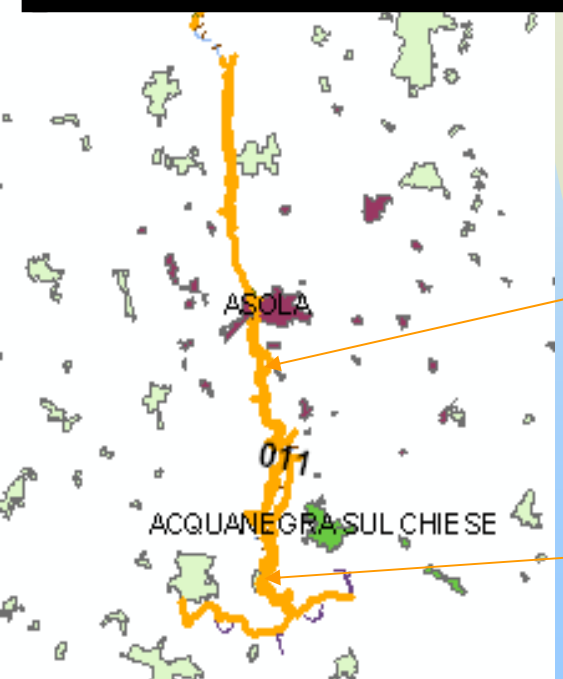
- RR in many cases is the best way to address efficiently the hydro-morphological risk ALSO in Mediterranean countries, where flooding is generally associated with fluvial dynamic and débris flows impacts (not just flooding)
- There is URGENT need to implement a network of RIVER CORRIDORS as the best preventive measure, before land use change will enormously increase potential damages
- Urban development can take advantage of conserving water courses, both avoiding flood risk and increasing the welfare of citizens (recreation, aesthetics, asset value...)
- Evaluating river setting alternatives in an integral, structured fashion can greately help to make informed decisions

# Case study on river CHIESE (TN, BS, MN)


# River CHIESE (TN, BS, MN)

- catchment area: 1400 km$^2$
- lenght: 180 km
- studied reach: 80 km
- average flow: 33 m$^3$/s
- Q flood (Tr=200): 750 m$^3$/s
- Vol. lake Idro: TOT 747 Mm$^3$
  NET 75.5 Mm$^3$

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ACQUANEGRA SUL CHIESE

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# SOLUTIONS: toolbox of POSSIBLE OPTIONS

- Works (costruction + OMR): dismantel; not implement; implement (already foreseen or not –"environmentalized")
- Morpho modifications of river bed, rehabilitation of hydraulic annexes, ...etc
- Reduction of vulnerability: adapting buildings and behaviours (....warning)
- Delocalization
- Changing land use suitability
- Management mechanisms (indemnization, insurance, incentives, community fund.....,)

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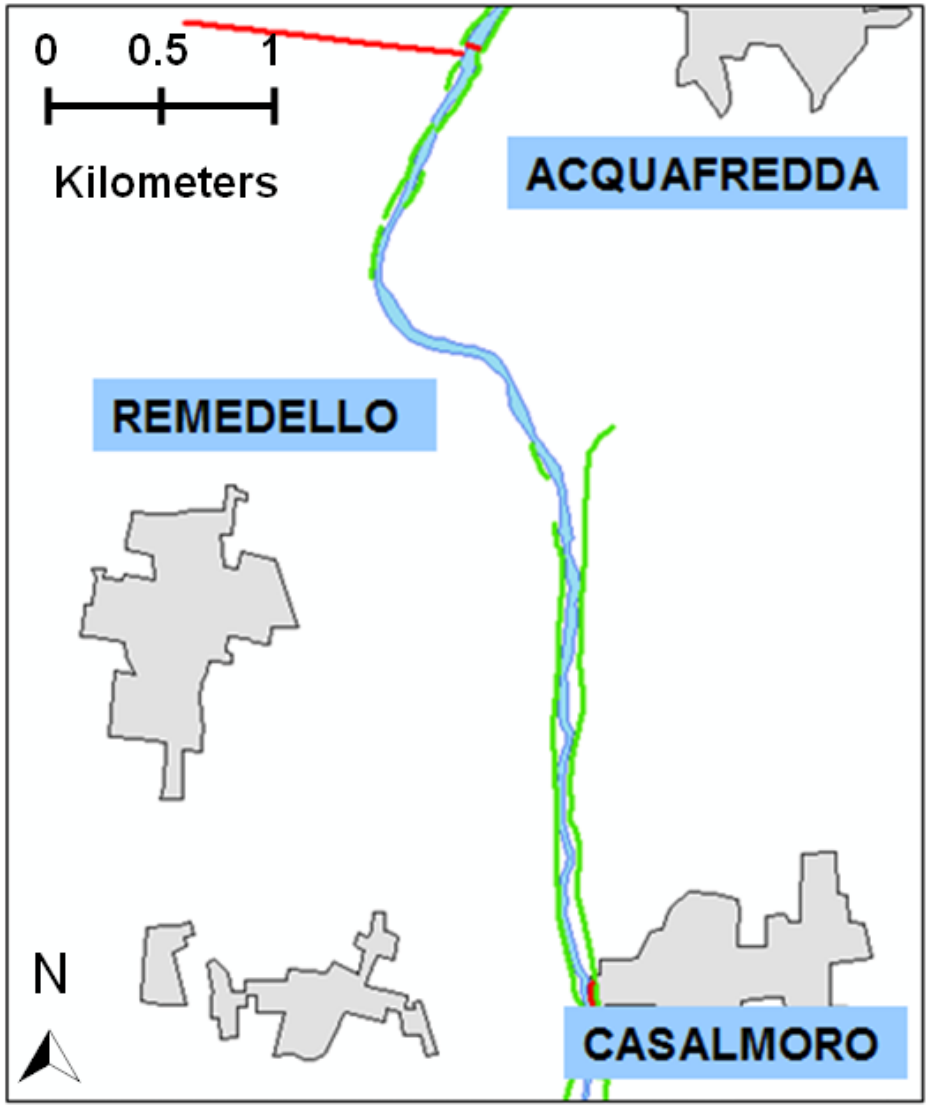
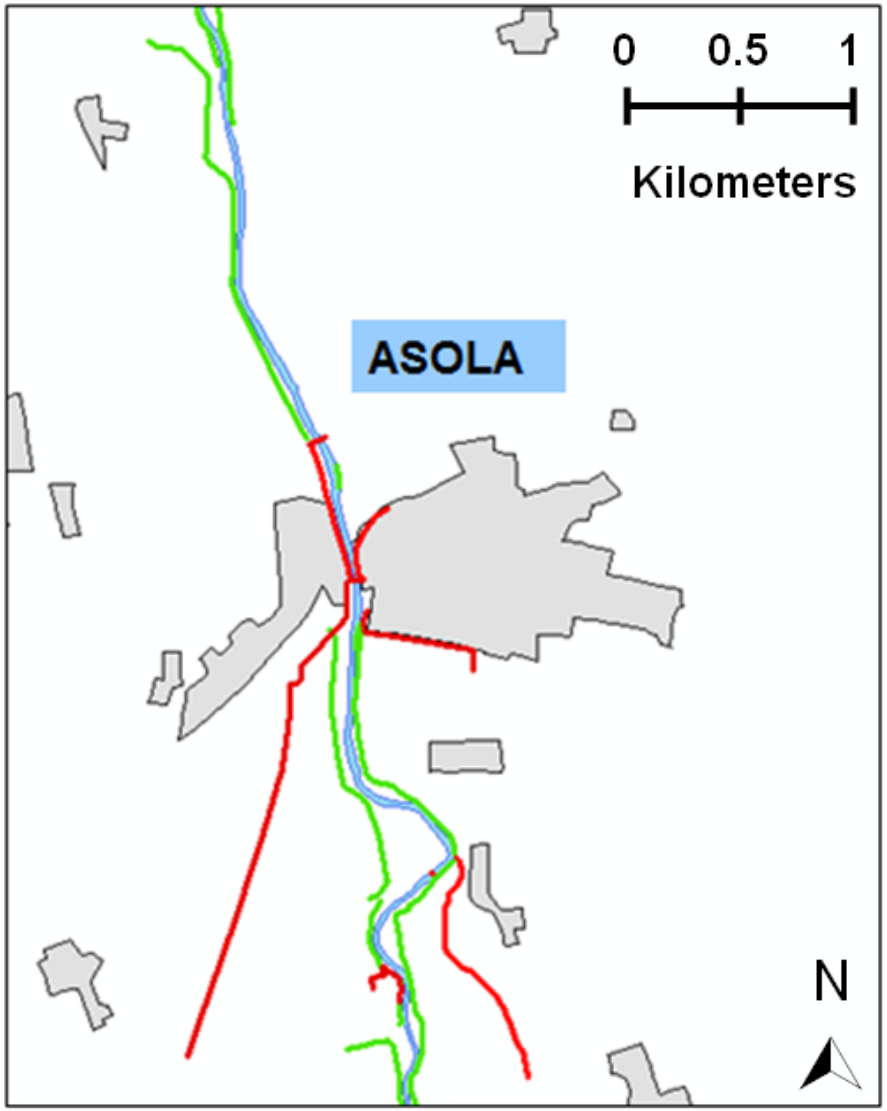
# DEFINITION of the ALTERNATIVEs: ALT_Base*



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# DEFINITION of the ALTERNATIVEs CHIESE

- *ALT-zero* (current state kept but ADAPTING critical points)
- *ALT-SdF*: put in “safe conditions”, keeping current land and water uses
- *ALT-base*: try to minimize OMR cost of works, but with minimum disturbance to urban and agricultural setting, while improving nature → protect urban settlements; allow agricultural flooding; mobilize partly river bed avoiding dismission of weirs; switch needed longitud. defenses with bio-engineering; keep weirs below bridges
- *ALT-daring*: as ALT-base, but more nature: eliminates also longitud. defences not impacting urban (→ dismantels also some diversion weirs); keep weirs below bridges; dismiss also main levees in front of Oglio river

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# PARADIGMS to addres

A) Put in safe conditions($Q_{200}$)

B) Min TOT Risk

C) Max net Benefit (or total Cost)

D) Max Quality of Life (L)

$$\max_{u} [\, L(u) \,]$$

$$\cong \max_{u} [\, N(u),\ -R_T(u),\ -C(u) \,]$$

Under the constraint:

- $u \in U$

A) Und

B) I
- of
-

C) M

D) Max Quality

✓ ***Approach d) multiobjective (QoL)***: integrated, three-stage evaluation, based on the Quality of Life (*QoL*) concept:

✓ *Stage iii) Strategic evaluation :*

*QoL criteria:*

- ✓ - synthesis of stakeholders' satisfaction (from *Stage ii*)
- ✓ - satisfaction of the "outer world":
  - ✓ - flood peaks propagation
  - ✓ - altered solid transport flux exported downstream
  - - ....

*Justice criteria*:

- - equity of distribution of pros and cons on stakeholders
- ✓ - conservation of natural capital (*N*) for future generations
- - ...

*Stage ii) Conflict management evaluation*: assessment of stakeholders' satisfaction according to their own perception and multicriteria negotiation

✓ *Stage i) Technical evaluation*: assessment of multiple declared key objectives: Nature (river ecological status *N*), investment and management Costs (*C*), total Risk (*R*), Social disturbance (*S*), etc...

✓ ***Approach c) – Net benefit $B_N$ maximization (ECBA)***: synthesis of (at least) tangible benefits (risk reduction) and costs → min ($R_\infty + C$)

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# EVALUATION : RESULTS CBA ALT_Base*

| *ITEM* | BENEFIT | COST |
|---|---|---|
| OMR savings from works to dismiss (OMR) and (OMR+invest.) of works not being implemented | 185.27 | |
| Investment and OMR of new works to be made | | 65.84 |
| Δ Maintenance of river bed | 17.72 | |
| Δ Flooding risk | | 22.16 |
| Δ Land loss risk because of erosion and wandering | 7.09 | |
| Δ Land-use value from irrigated to dry agriculture | | 1.26 |
| Loss from hydropower production because of modification of weirs or river elevation | | 0.00 |
| **TOT** | 211.45 | 89.25 |
| **122.2 (M Euro)** | | |

**Evaluation horizon T = 50 years; discount rate = 5%; OMR: "CIRF"**

✓ ***Approach d) multiobjective (QoL)***: integrated, three-stage evaluation, based on the Quality of Life (*QoL*) concept:

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- ...

*Stage ii) Conflict management evaluation*: assessment of stakeholders' satisfaction according to their own perception and [illegible] negotiation

✓ *Stage i) Technical evaluation*: assessment of multiple declared key objectives: Nature (river ecological status *N*), investment and management Costs (*C*), total Risk (*R*), Social disturbance (*S*), etc...

✓ ***Approach c) – Net benefit $B_N$ maximization (ECBA)***: synthesis of (at least) tangible benefits (risk reduction) and costs → min ($R_\infty + C$)

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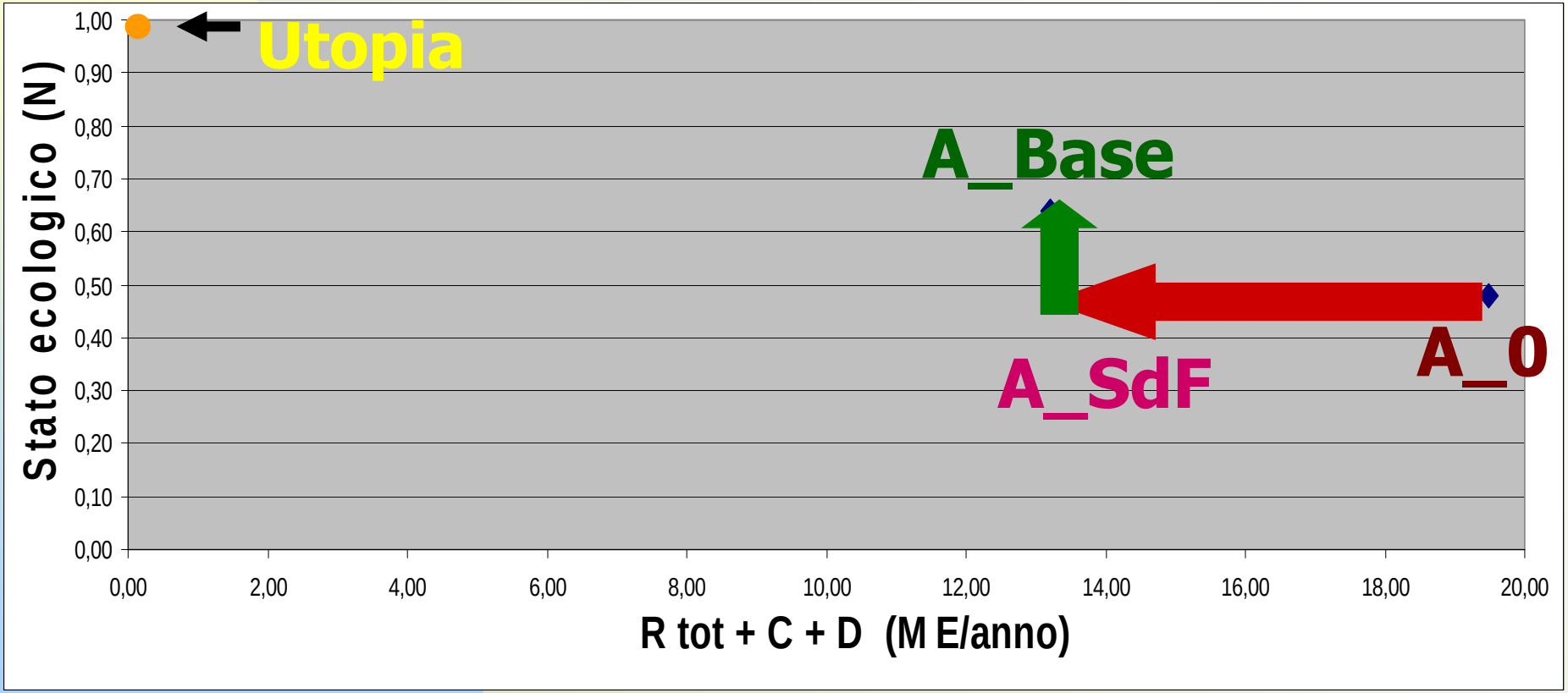
# EVALUATION : apprach: MULTI-OBJECTIVE: Level I: C+F+D, N: AGGREGATION




Orizzonte T = 50 anni; tasso sconto r= 5% ; OMR: “CIRF”

✓ ***Approach d) [illegible] objective (QoL)***: integrated, [illegible] evaluation, based on the Quality of Life (*QoL*) concept:

*Stage iii) Strategic evaluation :*

*QoL criteria:*

- ✓ - synthesis of stakeholders' satisfaction (from *Stage ii*)
- ✓ - satisfaction of the "outer world":
  - ✓ - flood peaks propagation
  - ✓ - altered solid transport flux exported downstream
  - - ....

*Justice criteria*:

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- - ...

*Stage ii) Co[illegible]agement evaluation*: assessment of [illegible]olders' satisfaction according to their own perception and multicriteria negotiation

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# EVALUATION : results pseudo Level III

| | | | | ALT_0 | ALT_SdF | ALT_Base* |
|---|---|---|---|---|---|---|
| QoL stakeholders | $R_T^F + R_M$ | total RISK (hydraulic $R_T^F$ + morphological $R_M$) | ME/year | 2.52 | 2.11 | 3.30 |
| | $R_{failure}^F$ | fragility (residual risk) | - | 2.06 | 1.68 | 0.85 |
| | $S_{agro\text{-}sett.}$ | social disturbance: land-value loss | ME/year | | 0.00 | 0.07 |
| | $S_{water\ use}$ | social disturbance: hydropower loss | ME/year | | 0.00 | 0.00 |
| QoL outer | $C$ | financial sustainability: total cost (invest.+OMR) | ME/year | 16.95 | 17.05 | 9.83 |
| | $B_N$ | economic efficiency: net benefit | ME/year | | 0.33 | 6.35 |
| | | externalities out of basin | - | 3 peak reduction 1 solid flow | 1 peak reduction 0 solid flow | 3 peak reduction 3 solid flow |
| Justice | $N$ | Nature conservation (ecosystem status) | - | 0.48 | 0.48 | 0.64 |

Orizzonte T = 50 anni; tasso sconto r= 5% ; OMR: “CIRF”

ASSUMPTIONS and LIMITATIONS:

- Flooded zones affected by: i) scheme quasi-2D (lateral flood channels); ii) expert-based method to correct for works effect, after spatial extrapolation
- Dismission of works @ no cost (just triggering); future Morphology at the equilibrium (no transition phase considered); ...

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# PROJECT CONCLUSIONS

- Assumptions and uncertainties; but at least the Thesis is not discarded and seems to hold →

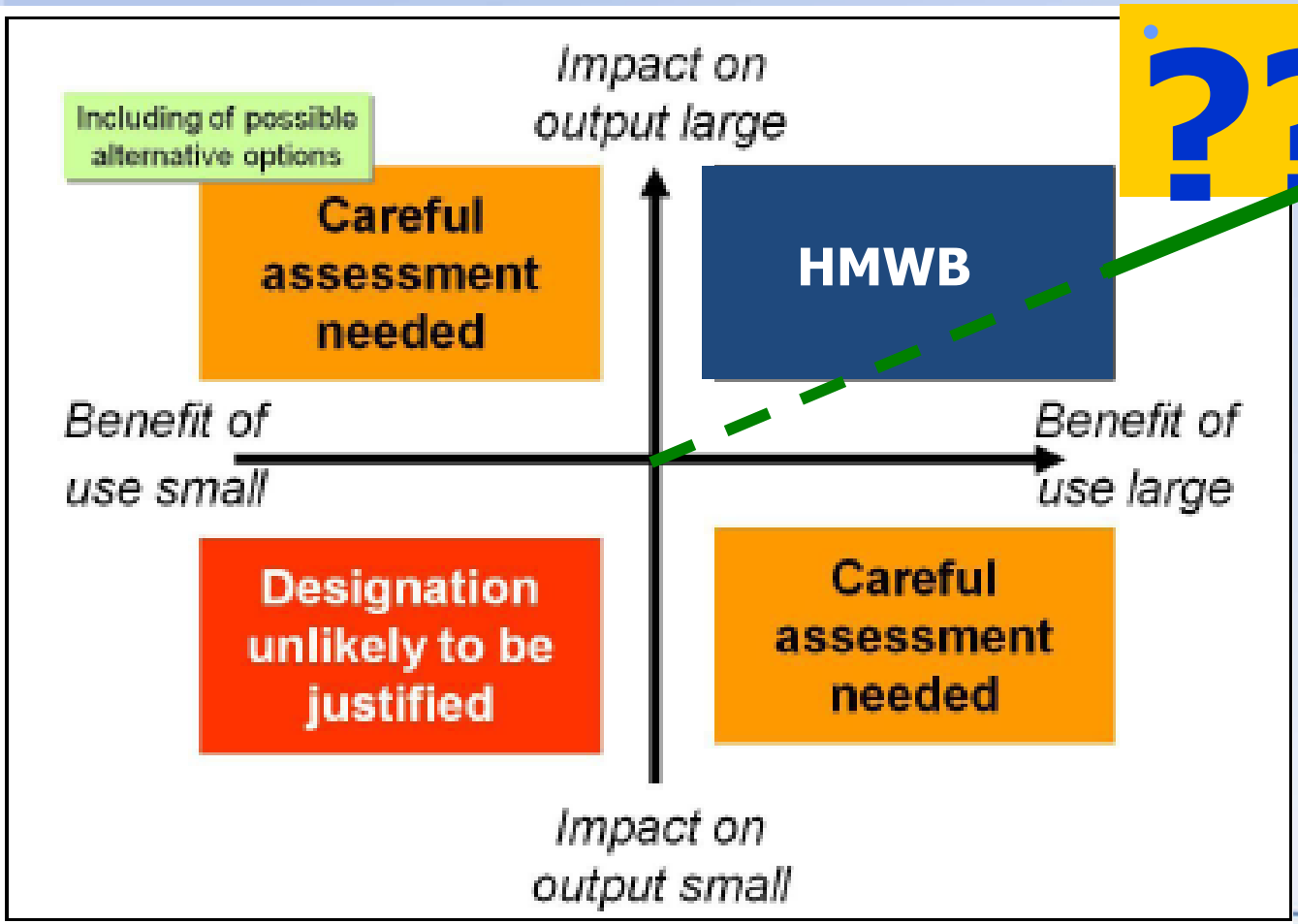
  there is space for GREEN/BLUE revolution → significant savings and better environment, while managing risk!
- Methodology captures the many factes of evaluation and is applicable
- HMWB (Heavily Modified Water Bodies) → this label should be reviewed in several cases if all benefits are considered!
- Does better than the "put in safe condition" criterion: protect only what *"…is flooded often, it's highly worth and vulnerable…seen in a system view; and protect the target asset rather than separating the river"*
- Cost Benefit analysis: powerful tool to guide the design of more efficient ALTernatives → give meaning to the WFD effort of valuating the risk R

NEED for:

- Participation and negotiation (Level II) : perceived risk ≠ objective risk /WHO bears damages?
- Administrative-financial tools to manage the change

# OPPORTUNITY to coordinate WFD e FLOOD directives:

## HMWB



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- Nardini A. and S. Pavan (2012). What river morphology after restoration? The methodology VALURI. *Journal of River Basin Management*. Taylor & Francis (UK). Vol.10, n.1, pp.29-47.



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