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## VALURI

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**VALURI: development of an approach/methodology for the *integrated eVALUation* to support the design of hydraulic-morphological river setting that be efficient, sustainable and environmental compatible to combat hydraulic **RIsk****

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Project summary May 27, 2010



### Location:

- Methodology: sufficiently general for mediterranean regions
- river Chiese (a second order tributary of river Po) downstream Lake Idro (hence within the Province of Brescia and Mantova –Regione Lombardia- with approx 80 km of river stretch)

### Partners

- CIRF: (Italian Center for River Restoration – [www.cirf.org](http://www.cirf.org)) promoter of the project, conceptualization of methodology, coordinator
- Università di Udine (Antonio MASSARUTTO e Alessandro DE CARLI)
- Autorità di bacino del Po (Parma) (Po River Basin Authority)

### Funding

Fondazione Cariplo : open call 2008 - *Tutelare la qualità delle acque*

Co-funding: CIRF, U. Udine e Autorità di Bacino del Po

Value: 144,000 Euro

### Duration:

start: March 2009-12-21

end: mid May 2010

### Contact

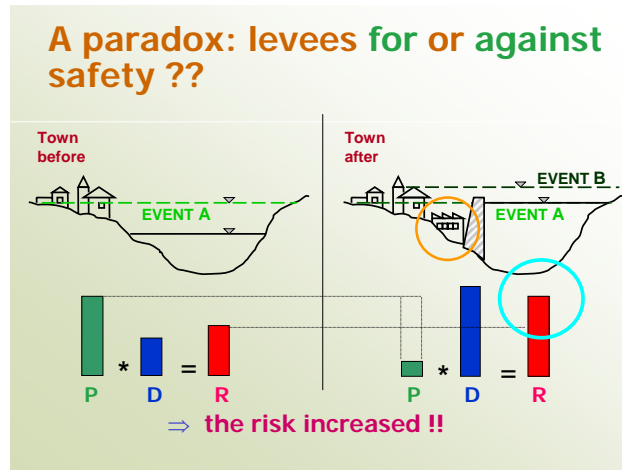
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### Project documentation (available to project partners):

- General report Word on the project
- Two PowerPoint presentations , one with the conceptual position of the problem faced and the proposed methodology , another with the Chiese case study development
- Several Excel sheets amongst which: 0) synoptic framework of the river (elevations, sections, etc.); i) geomorphological prediction for each Alternative; ii) economic parametrization and AIPO expenses record; iii) evaluation of alternatives (Synthesizer application)
- Several GIS shapefiles

## Rationale and scope

The Italian Center for River Restoration (CIRF), since its foundation, promoted the idea that “more natural rivers” are desirable not only for environmental reasons, but also for economic reasons, even when flood and erosion risks are at stake.



Demonstrating this thesis is however far from being an easy task. But it is essential, because still today rivers are continuously artificialized with defence works for the sake of achieving the dream of a “safe territory”, safe from flood and geomorphic disruption.

To give ground to such a thesis, we explored whether by dismissing a number of defence works in a river basin, total investment and operation costs would drop significantly more than the corresponding likely increase in flood and geomorphic disruption, so to ensure a positive balance that would prove a better river setting solution does exist. The analysis is further integrated by incorporating at least qualitatively environmental concepts, like in particular the improvement of the ecological status (according to the European Water Framework Directive) and the export of externalities to the downstream river basin. Also, disturbance to people because of a modified setting is included. Legal-administrative-financial mechanisms (reimbursements, payment for environmental services,...) would ensure that the additional benefit could be spread so to leave every one better off. Cost-Benefit Analysis is hence the core, but is just one piece within a multicriteria framework suited to address interest conflicts in a participatory fashion.

This project aimed at defining a methodology refined enough to achieve meaningful and convincing results, but sufficiently simple to be applied in several cases.

A case study on the highly artificialized river Chiese (a second order tributary of river Po) downstream Lake Idro (hence within the Province of Brescia and Mantova with approx 80 km of river stretch) has been developed to test in several ways the methodology.



## **Activities developed**

### General:

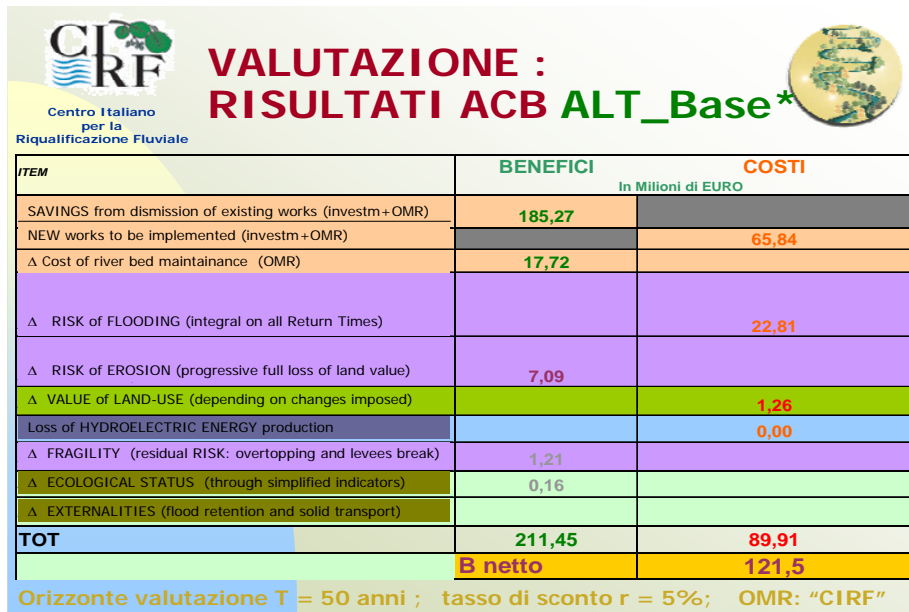
- Synthetic review of methodologies and experiences on the evaluation of river setting alternatives
- definition of a suitable evaluation methodology, capitalizing such experiences
- development of a methodology for the prediction of the future river morphology consequent a modification of the physical setting (particularly presence or absence of defence and exploitation works), and implementation of an Excel support sheet to apply it
- design and implementation of an informatic support to synthesize the economic evaluations suitable for automation (the “Synthesizer”): it is an Excel sheet equipped with VisualBasic “Macros”, able to acquire and elaborate the information related to the characterization of the river setting Alternatives considered (works and Land-use), their hydraulic behaviour (flood zones with different occurrence times) and geomorphological behaviour (erodable zones), the economic features (parametric investment and maintenance costs of works and land-use value for each category) and the parameters governing the computation of costs and benefits (including the risk assessment); the Synthesizer supplies as an output a social Cost-Benefit analysis of the Alternatives together with a set of evaluation indices suitable to perform a multicriteria evaluation.
- Several meetings with project partners and Fondazione Cariplo (funding subject)
- reporting

### Case study:

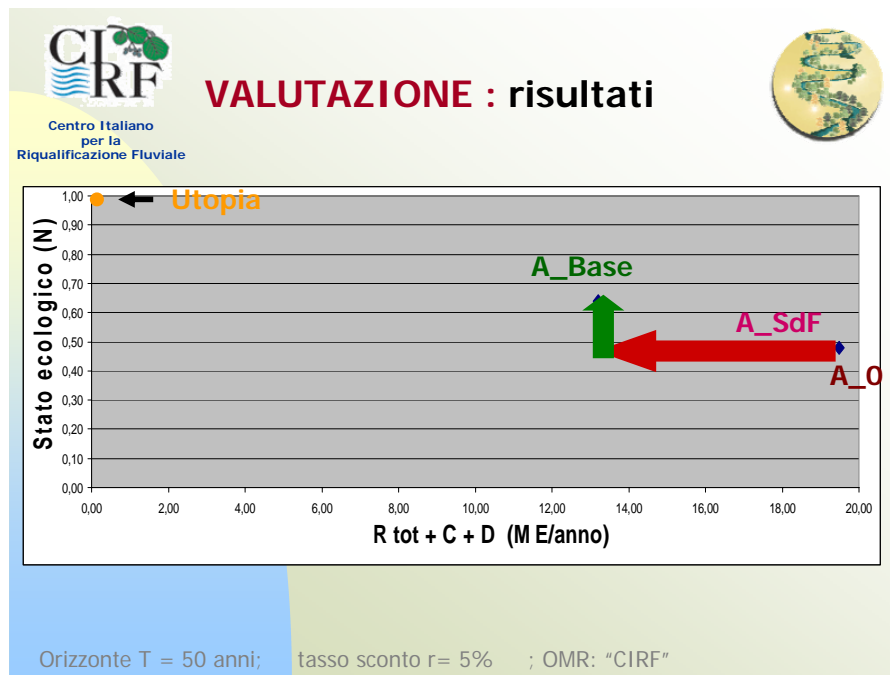
- homogenization and fixing of the cartographic data base mainly derived from an existing “feasibility study of the hydraulic setting” (of the Autorità di bacino del Po, Parma – referred to as “SdF”) and creation of dedicated GIS project
- data collection at several info sources
- analysis of historical records (state archives of Brescia, Milano, Mantova, Venezia) to investigate on the history of the river and in particular on the interventions implemented in the past
- definition of the economic parametrization (land-use value, vulnerability,...; ordinary and extraordinary management costs of works based on real expenses data from AIPO)
- definition, in terms of set of works (more than 200 elements present in current situation) of the different (5) ALternatives of river setting candidate for evaluation
- definition of hydrology scenarios to execute simulations (peak flows and hydrograms for several return times: 2, 5, 10, 20, 50, 200, 500)
- application of the methodology and of the support tool for the geomorphological prediction
- elaboration of the required GIS shapefile (new bankfull, erodable zones)
- preparation of a modelling tool (Mike 11) for the hydraulic simulation, which implied defining a procedure to load the modified geometries in a comparable fashion for the different alternatives, and execution of simulation
- elaboration of the relevant GIS shapefile (flooded zones for all return time for each Alternative)
- loading obtained data within the Synthesizer
- Cost-Benefit and Multicriteria evaluation and sensitivity analysis
- Meeting with key stakeholders and experts (irrigation associations geomorphological experts)
- Field surveys to know the river, check and complete the information available and solve some doubts

## **Findings**

The methodology proved to work well. The CBA approach greatly improves the design of Alternatives (as opposed to the classic “putting in safe conditions with respect to a reference event, usually 200 Return time). The thesis has been demonstrated, at least for the case study: RR is more desirable and rewarding.



It is a differential cost benefit analysis; Δ means difference with respect to the “business as usual Alternative” (Alt\_0)



Monetized criteria (Rtot: flood+erosion risk; C: total cost of works; D: total Disturbance to community in terms of value lost after land-use change and loss of hydroelectric production) are aggregated into one (horizontal axis); even by looking at just the river ecological status (vertical axes N), while disregarding the remaining environmental criteria, the multicriteria evaluation shows that the RR Alternative “ALT\_Base” dominates both ALT\_0 and ALT\_SdF: less total costs and more “nature”!

Synthetically the conclusions are as follows:

Case study:

- evidence of inefficiency (costs exceeding benefits) and ineffectiveness (residual risk -particularly from geomorphic disruption- and bad status of works because of lack of maintenance), of current river setting → need for intervention
- lack of maintenance → the capital “works health” is being depleted
- heavy influence of OMR cost of works in the evaluation, as assumed
- scarce weight of risk, until urban areas are not touched, as expected

- broad margin for optimization of river setting (and hence of ALternatives) by modifying works (ex. Lowering weirs, inserting bank protections somewhere, while removing many others,..), or by modifying Land use (and strong potential of equalization administrative-financial instruments)
- complexity of analysis which still deserves more insight

→ although with limitations, we can state that at least for this case study there are vast margins for river restoration that is economically rewarding, even when risk is considered!

#### *Methodology:*

- the methodology captures the key issues while it is still applicable in many cases → project goal reached
- the Thesis is demonstrated → vast margins for a “green/blue revolution” = significant saving AND better environment
- the Heavily Modified Water Bodies classifications should be explored through this methodology: Chiese (case study) would certainly be classified as HMWB a priori, but not after this analysis
- the integrated evaluation shows to be quite superior to the classic criterion of achieving safe conditions (with respect to a reference event) : need to protect only what has a very high value at stake, high vulnerability and is exposed to high flood and geomorphic hazard, while keeping a river basin view
- CBA is a powerful tool to guide in the design of river setting to create smarter ALternatives
- Appropriate administrative-financial-legal tools to allow people to live with a higher risk (but lower global costs and additional benefits) need to be put in place
- The analysis calls for the support from a dedicated Decision Support System

### **Limitations**

The key assumptions are:

- river has already achieved a new geomorphic dynamic equilibrium after the interventions foreseen in each ALternative and hydraulic analysis is performed accordingly (no transition process is considered)
- cost of dismissal of works is negligible (just inputs are to be given)

Although these assumptions need to be investigated, in our opinion they do not change the conclusions.

### **Methodology and innovations**

1) general: the aim of the project was defining and testing a methodology to explore the thesis that "River Restoration is rewarding, even economically " through an integrated evaluation, multiobjective, but lying on a sound economic basis: we reached it by producing something that pulls together in a coordinated, innovative and complete fashion several approaches and methodologies, and clarifies a thorough procedure. This is possibly the main innovation brought in.

The proposed approach, in essence, constitutes a step forward with respect to the approach of “achieving safe conditions” because can guide in the identification of the most critical situations –those were a high value is at stake under heavy flooding or erosion hazard and with high vulnerability- and in the design of the interventions that show the highest net social benefit, while keeping a system view (transfer of effects internally in the basin or externally).

As a side product, the methodology allows also to support clearly the denomination of Heavily Modified Water Bodies as required by the WFD.

And allows to face conflicting objectives/interests through a really integrated evaluation.

2) Specific innovations: the key components of the methodology are:

- i)** the *integrated evaluation* (organized on three levels, while merging the multicriteria, environmental and economic approaches);
- ii)** the *geomorphological prediction* and its translation into river bed geometry for hydraulic simulation;
- iii)** the *quantitative assessment of flooding and geomorphic risk*;
- iv)** the *economic parametrization* to specify potential damages based on land use categories and the costs of defence works

In particular, the geomorphological prediction includes elements of innovation; while it is still fragile as it requires a broad experimental testing and verification, it opens a very promising window about how to respond to the general question (usually skipped by both hydraulic engineers, because of ignorance of the issues involved, and geomorphologists, because of prudence about a very uncertain domain) "what will the new river morphology be if certain interventions are implemented now (and/or if some control variables are modified)?" It is a mix of knowledge about past behaviour of the river, engineer-mechanistic reasoning, analytic support from fluvial engineering and applied geomorphology and common sense.

We developed an Excel with Visual Basic macros support tool to synthesize the large amount of different pieces of information required to achieve an economic evaluation and some key elements of the multicriteria evaluation. Such a tool proved indispensable, but also revealed the need for a true Decision Support System to really achieve an operational level (currently, many manual steps are required where it is easy to make mistakes).

3) case study: its aim was to test whether the methodology was applicable and how. The test was successful, although not all the involved issues were touched because of the heavy burden of the required elaborations and of the energies spent in data collection).

## **Future developments**

We foresee two major lines:

- a) General: influence legal framework and planning framework in order to include such evaluations in the planning of river setting according to Dir. 2000/60 (WFD) and 2006/60 (Flood Directive). A dissemination effort needs to be undertaken.
- b) Specific for Chiese river: the analysis and evaluation performed, although conducted with a level of insight probably sufficient for a real planning and design of alternative river setting, all respond to the need of comparability with the current main proposal of setting coming from Studio di Fattibilità of the River Basin Authority of Po river. This study assumes in particular that the upstream lake Idro is regulated in a way particularly favorable to floods reduction; but reality is quite different as the lake is multipurpose and there is a strong social push to maintain levels high as it also touches a significant nature aquatic conservation site. A real planning process should hence embed the problem of multiobjective management of lake Idro and should include all interests involved, both upstream and downstream. Some data should be updated, like land-use, status of works, river morphology. A participatory process should be organized and professionally conducted. Discussions with Regione Lombardia are being developed to explore possible developments.