

River Restoration International Symposium  
Madrid, 19-21 September 2006

Rehabilitation of Urban Rivers - Opportunities and Constraints  
From aesthetics to an integrated evaluation?



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## Summary

1. General overview on urban rehabilitation opportunities and constraints
2. The URBEM project: objectives, structure and scope
3. Evaluating aesthetic values
4. Criteria and indicators for post-implementation assessment
5. Case study evaluation
6. Conclusions

**Examples of urban river rehabilitation and improvement**



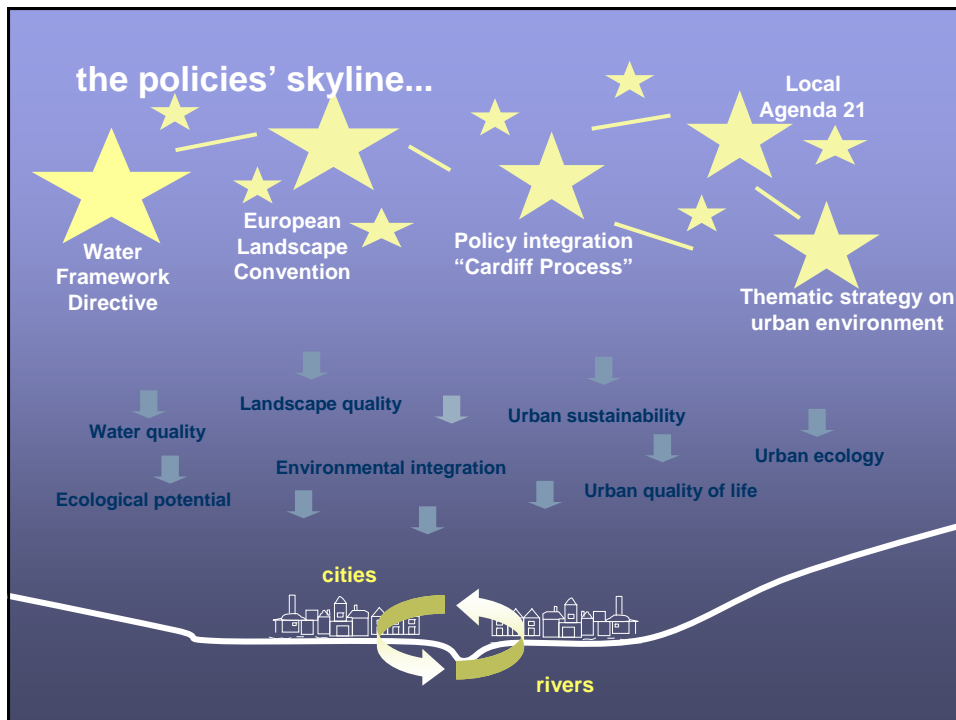
Stream daylighting in Leipzig, Germany



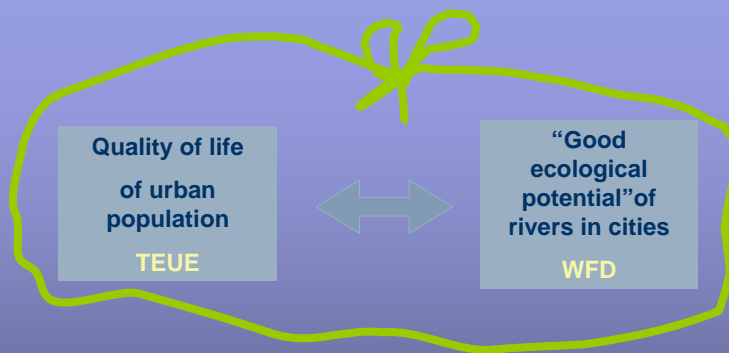
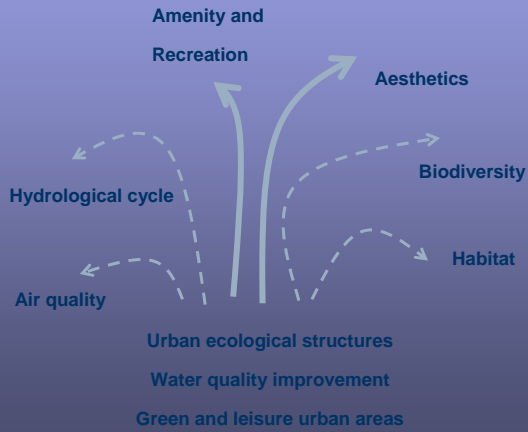
Santa Rosa Creek, CA, USA



Rehabilitation of urban creeks, Gaia, Portugal



## Rehabilitation of urban rivers - new opportunities



- Beside ecological issues in urban areas there are cultural constraints for water rehabilitation.
- Social, economic and aesthetic requirements have to be considered as additional aspects.
- The principles of sustainability - a balancing of all aims is needed.
- The ecological concerns are of special weight due to the relatively high guidance levels of the WFD

## Integration of several dimensions of sustainability

Paradigm  
SUSTAINABILITY

### DIMENSIONS (3A+2)

Ecological Dimension

Economic Dimension

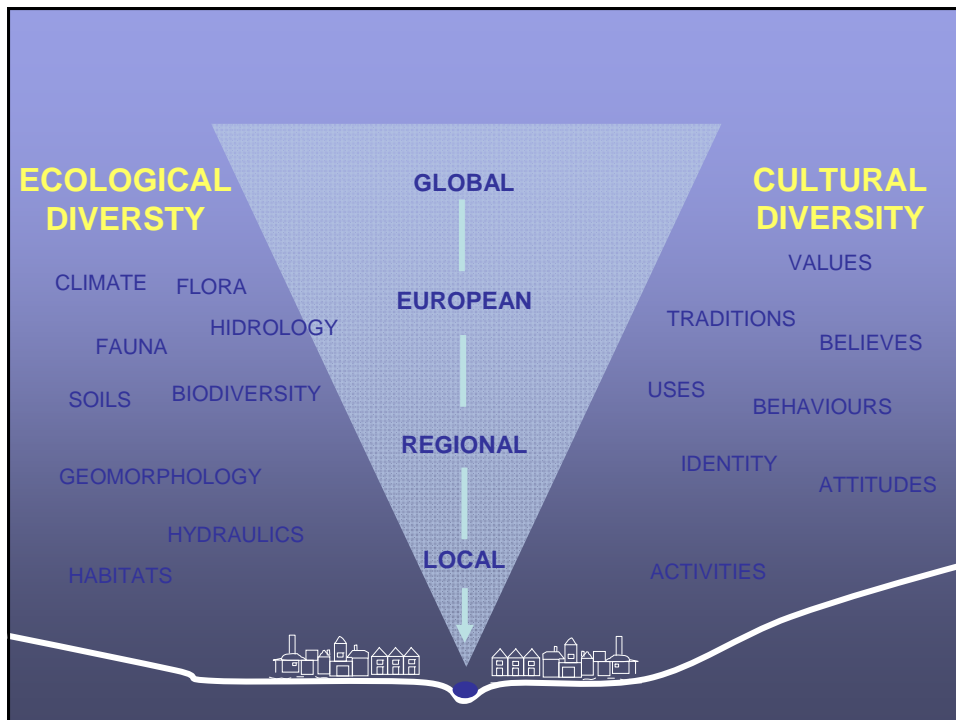
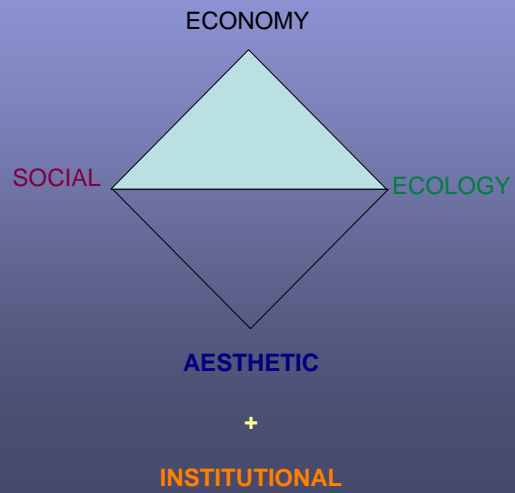
Social Dimension

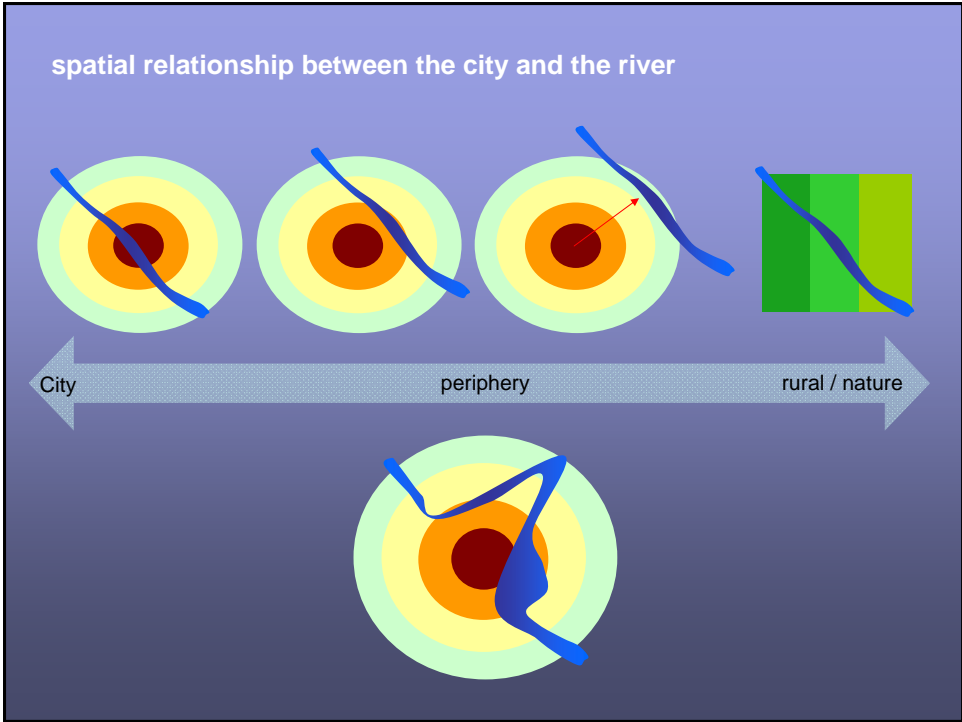
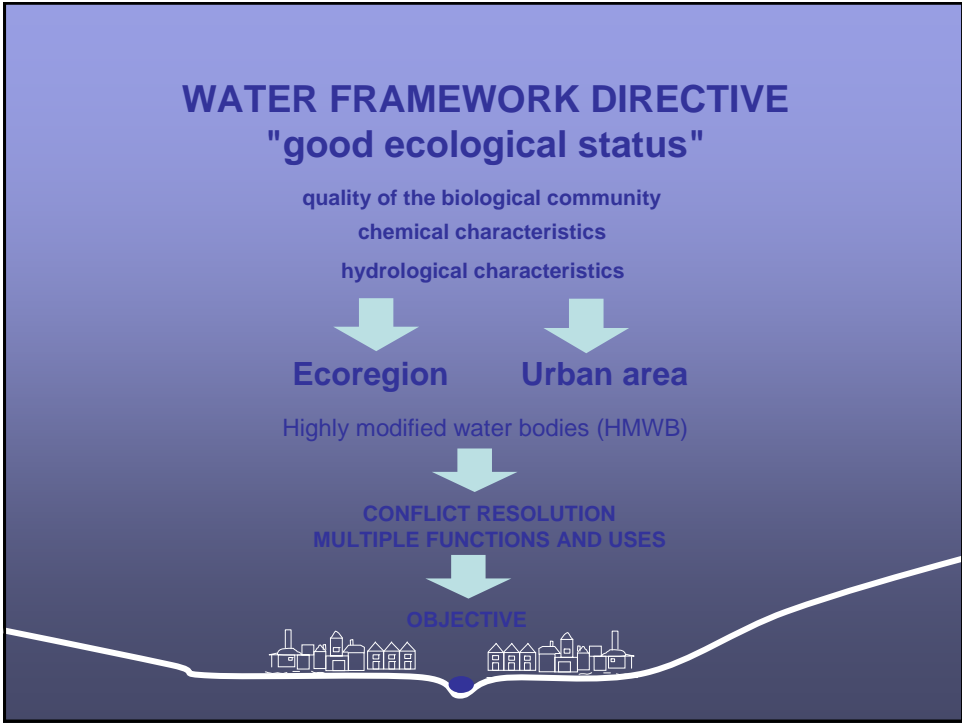
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Aesthetic Dimension

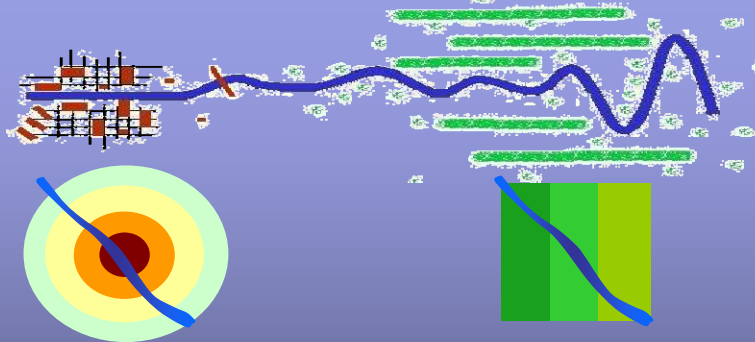
+

Institutional Dimension





## spatial relationship between the city and the river



More people

More uses  
More pressure  
More conflicts

Less space

Less people

Some uses  
Some pressure  
Some conflicts

More space

## Scopes of action on rivers

(depending on specific site conditions)

**Restoration** is directed towards *recreating the **pristine** physical, chemical and biological state* of rivers. In its purest sense it means a full structural and functional return to a pre-disturbance state (Wade et al. 1998, p. 2).

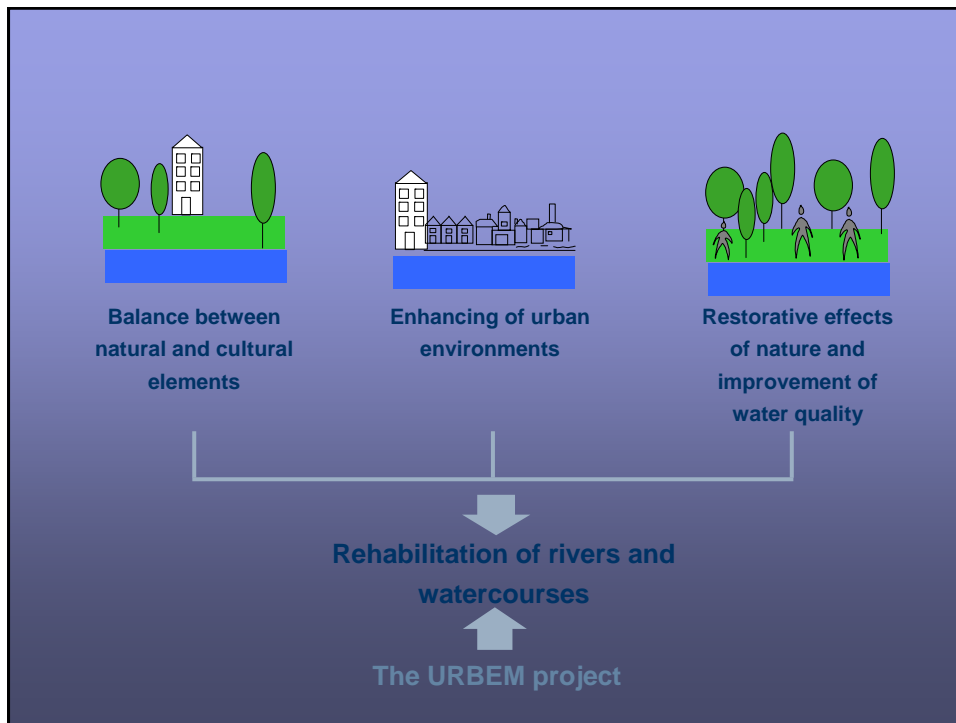
**Renaturalisation or naturalisation** describes the *naturalistic* way of bringing a (river-) ecosystem back to a **natural state** but without targeting the really pristine, pre-disturbance state (cp. Mendiondo 1999).

**Rehabilitation** indicates a process which can be defined as the *partial functional and/or structural return* to a former or pre-degradation condition of rivers or putting them **back to good working order** (Wade et al. 1998, p. 2). It is dedicated to the ecologic state (biological, hydromorphological and physico-chemical) by structural and partly non-structural measures.

**Enhancement** means an *improvement* of the current state of rivers and its surroundings. It aims at a general valorisation of the ecological, social, economic and aesthetic properties.

Urban rivers

Schanze et al., 2004



**Urban River Basin Enhancement Methods  
2002-2005**

5th European Framework Programme  
Energy, Environment and Sustainable Development Programme

**Objectives**

- To provide a comprehensive framework to facilitate urban water course rehabilitation taking into account regional variations in modification and use of urban rivers across Europe
- To develop new tools to assess the potential for enhancement and rehabilitation of urban watercourses

**Partners**

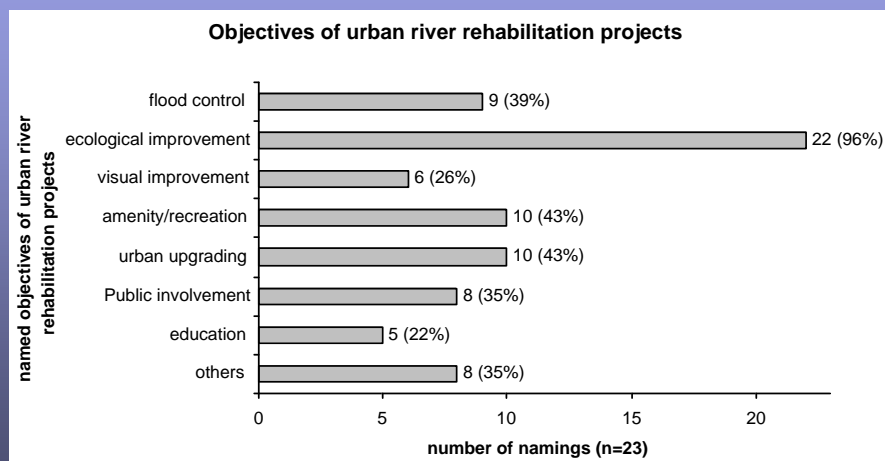
- Hydraulic Research Wallingford, UK
- New Economics Foundation, UK
- Institut für Ökologische Raumordnung, D
- Technische Universität Dresden, D
- University of Newcastle, UK
- Newcastle City Council, UK
- LNEC, P
- CESUR, IST, P
- CEMAGREF, F
- Centre for Urban Waters Network, UK
- University of Ljubljana, SL
- JP Vodovod-Kanalizacija Ljubljana, SL
- Universität für Bodenkultur, Vienna, A

Contract N° EVK4-CT-2002-  
[www.urbem.net](http://www.urbem.net)

## Structure

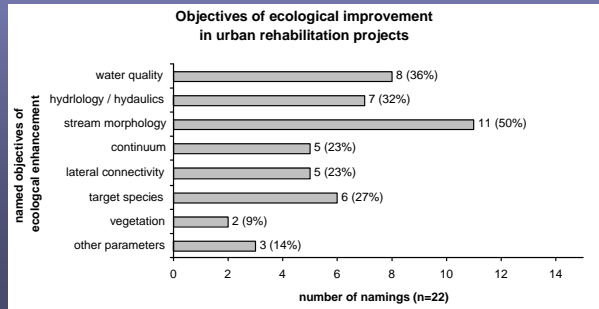
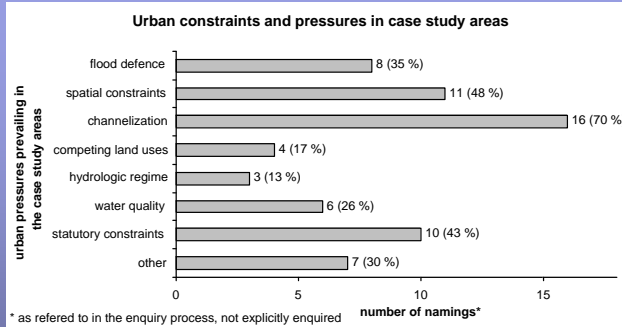
Themes	Work packages	Objectives
T1. Project integration, co-ordination and delivery	WP1 -Project integration and coordination WP2 -Case study evaluation WP3 -Study site monitoring	Improve water quality Reduce risk to human health Incorporate safety issues
T2. Existing case study selection		
T3. New tools to assess the potential for UW rehabilitation	WP4- Aesthetic evaluation	Enhance aesthetic values and raise its perception
T4. Social appraisal tool	WP5 -Development of tool to assess WP6 -Implementation and review of the new assessment technique	Improve community links with UW
T5. Innovative rehabilitation techniques	WP7 -Development of new social appraisal tool	Enhance bio-diversity
T6. Decision making support methodologies	WP8 -Innovative techniques for UR rehabilitation WP9 -Decision making methodologies	Improve tools and methods of sustainable development
T7. Indicators of success (ex post evaluation)	WP10 -Development of indicators of success WP11 .Training and dissemination	Methodologies for planning and managing rehabilitation of urban watercourses Promotion of UW rehabilitation

URBEM WP2 Survey on existing Urban River Rehabilitation Schemes,  
Schanze *et al.*, 2004



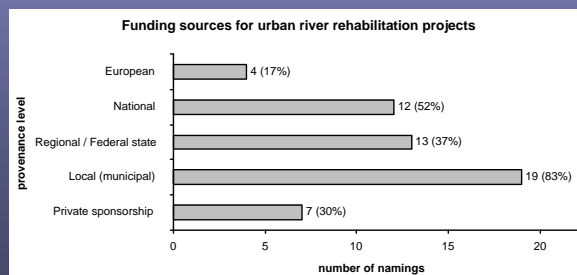
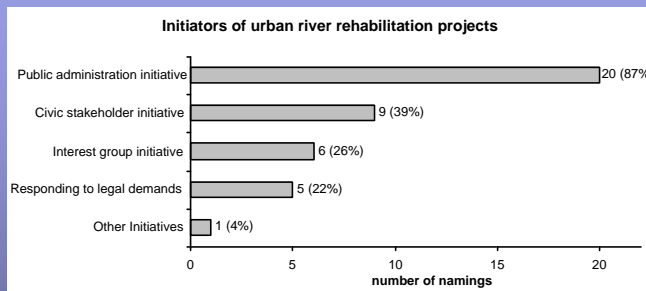


Schanze *et al.*, 2004 ecologic context



Schanze *et al.*, 2004

Institutional and economic context



## URBEM-WP2 results

- ✓ River rehabilitation is seen as an **opportunity for urban renewal**
- ✓ Found emerging urban renewal projects to contain a strong component of river rehabilitation (e.g. Emscher, Quaggy, Saône)
- ✓ More than 40% of the cases had some form of **public involvement**
- ✓ **Initiation** of project planning and implementation was mostly done by city councils – about half jointly with citizen groups (e.g. Don River)
- ✓ **Organization**: forms of interdisciplinary, interagency coop.
- ✓ **Funding** –  $\frac{3}{4}$  of the schemes are based on multi-budget sources;  $\frac{1}{3}$  had private sponsorships

## WP4 AESTHETICAL EVALUATION

### TEAM

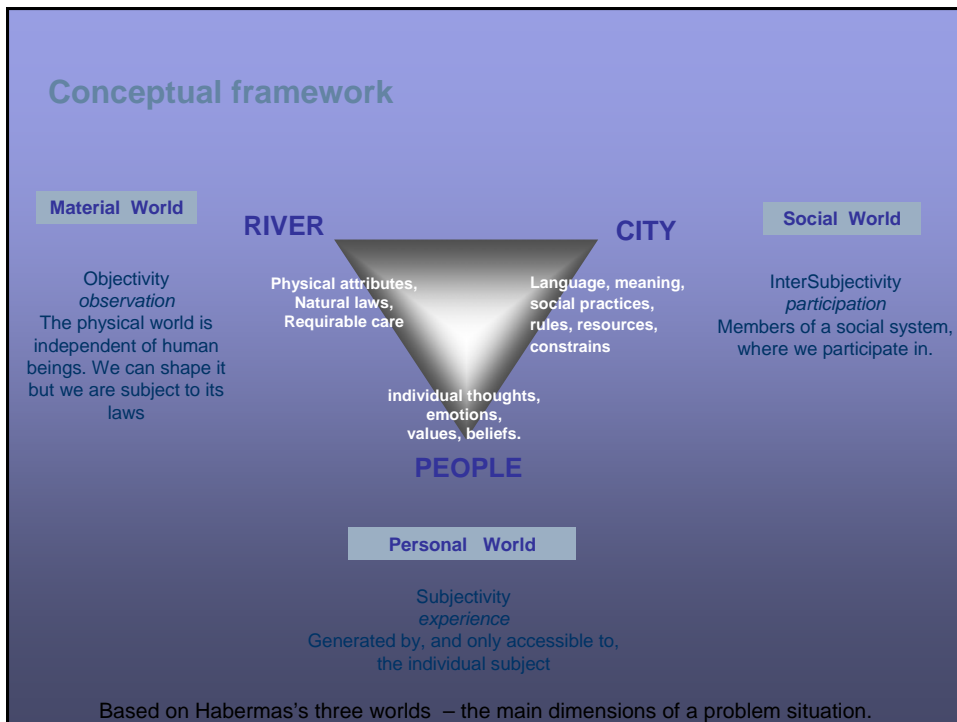
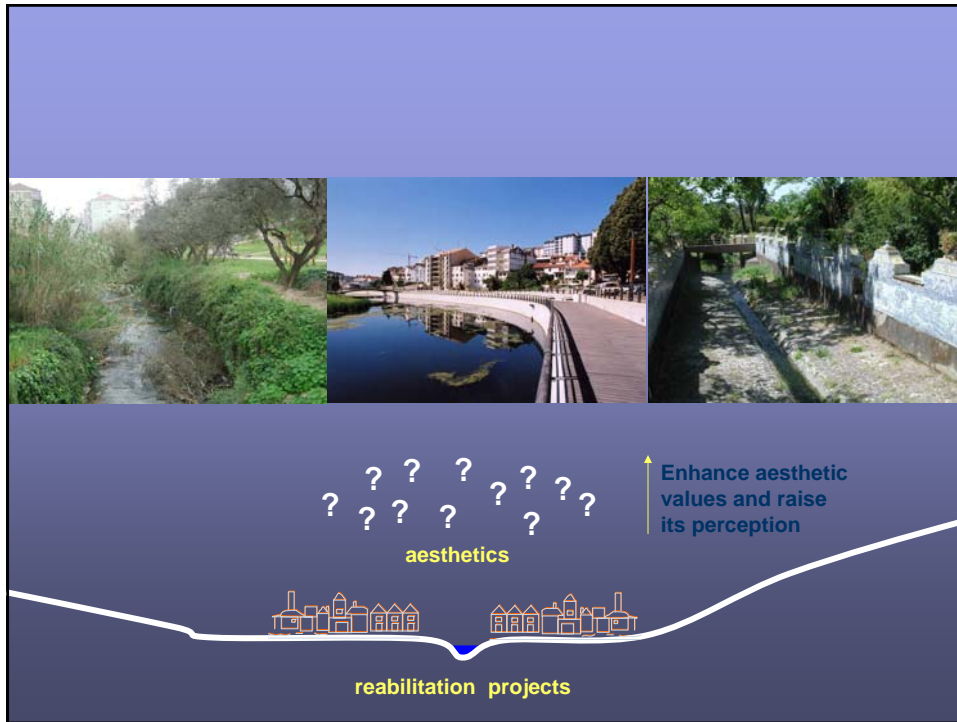


CESUR  
IST  
UTL  
FA  
UE



Centre for Urban and Regional Systems  
Technical Institute of Lisbon  
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- Jorge Silva, **professor, planner**, CESUR/IST, UTL
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- Isabel Ramos, **PhD student, landscape architect**, CESUR/IST, UTL
- Fátima Bernardo, **assistant professor, psychologist**, UE
- > Lúgia Vaz, **MSc. student, landscape architect**, CESUR/IST, UTL



## Structuring “Post it” Session: Expert Panel

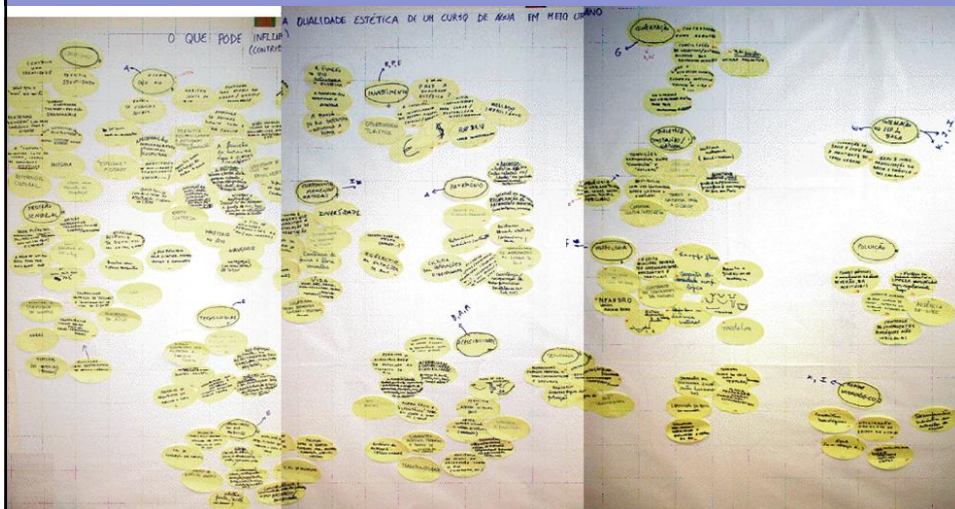
*“What can influence the aesthetical quality of watercourses in cities ?”*

- (3) Hydraulic Engineers
- (1) Environmental Engineer
- (1) Geomorphologist
- (2) Architects
- (3) Landscape Architects
- (1) Environmental Psychologist
- (1) Biologist
- (2) Planners
- (1) Economist

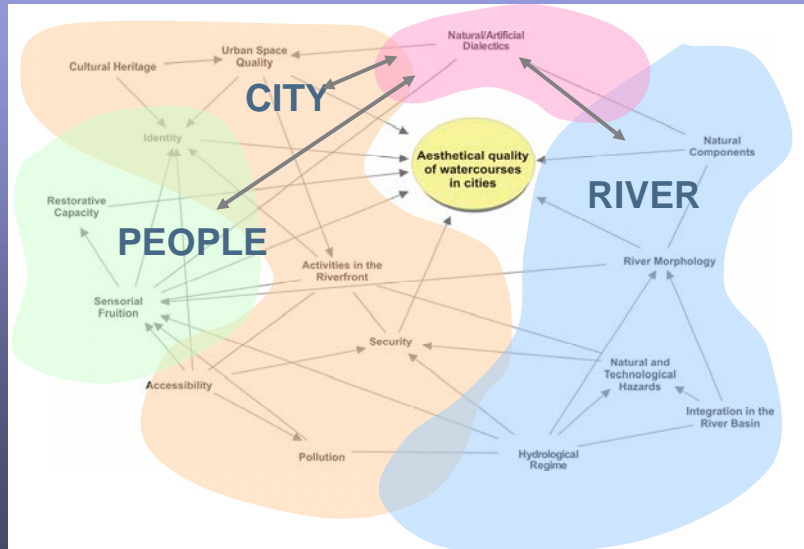


## The network of concepts

*“What can influence the aesthetical quality of watercourses in cities ?”*

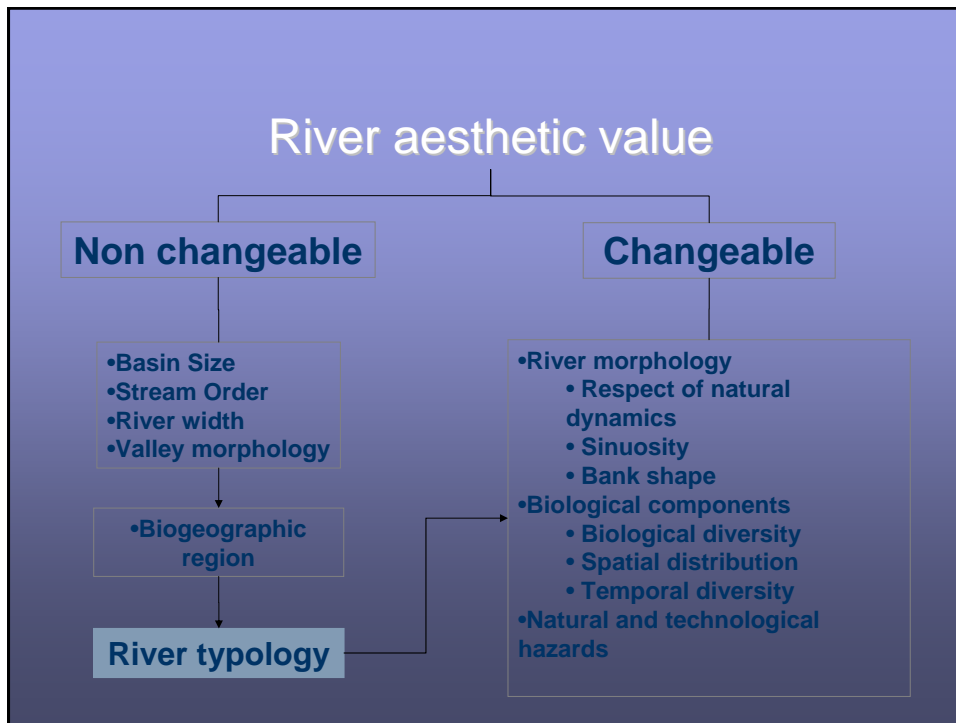


## Minimal network of factors



## Natural features in the landscape – the RIVER

	Fundamental viewpoint	Elementary viewpoint
	<b>River Typology</b>	Basin size Stream order River width Valley morphology
	<b>River Morphology</b>	Degree of disturbance of the natural dynamics Sinuosity Bank Shape Presence of elements in the channel
	<b>Biological Components</b>	Biological diversity Presence of riparian vegetation in river banks Width of riparian vegetation Presence of different type of vegetation species
	<b>Natural and Technological Hazards</b>	Flood vulnerability Bank erosion or landslide risk




## River width

The **width** of a watercourse is determined by several aspects:

- Size of the basin
- Stream order
- Flow discharge
- Climate
- Profile of the valley
- Hydrological regime
- ...

and influences several factors :

- Visual contact with opposite margin
- Number of bridges
- Potential uses in the river
- Visual basin
- Traffic of boats, ferries,...
- ...



## Viewpoint **River width**

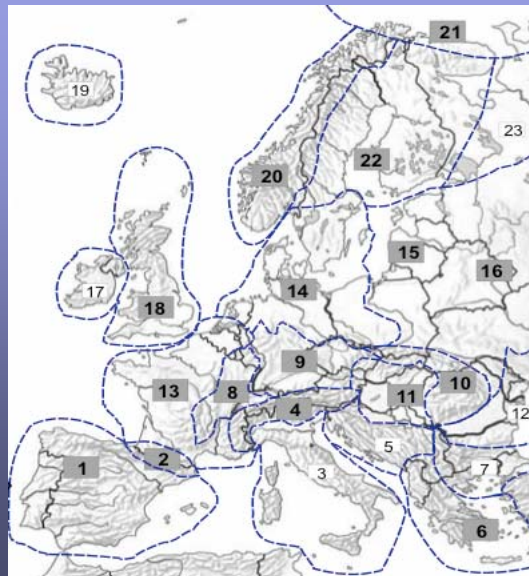
1. Non existent (culverted)
2. narrow (0 – 5m)
3. medium (5-20m)
4. large (20 – 200m)
5. very large (more than 200 m)



## Water Framework Directive (2000) ANNEX XI **Biogeographic region** System A: Ecoregions for rivers and lakes

### WFD - ECOREGIONS

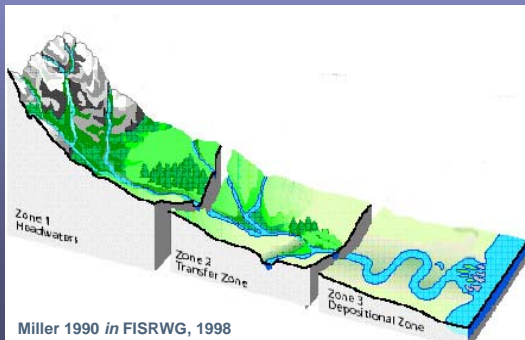
1. Iberic-Macaronesian region
2. Pyrenees
3. Italy, Corsica and Malta
4. Alps
5. Dinaric western Balkan
6. Hellenic western Balkan
7. Eastern Balkan
8. Western highlands
9. Central highlands
10. The Carpathians
11. Hungarian lowlands
12. Pontic province
13. Western plains
14. Central plains
15. Baltic province
16. Eastern plains
17. Ireland and Northern Ireland
18. Great Britain
19. Iceland
20. Borealic uplands
21. Tundra
22. Fenno-Scandian shield
23. Taiga
24. The Caucasus
25. Caspic depression



## Viewpoint Stream Order

Strahler stream ordering system

1. 1st and 2nd order
2. 3rd and 4th order
3. >4th order



## Viewpoint Valley morphology

1. V-shaped



2. U-shaped



3. Asymmetric



4. Large, broad floodplain








## Viewpoint

## River morphology

Descriptor: Respect of natural dynamics






Indicator: Degree of disturbance

1. Highly disturbed	Very artificial Channelized Concrete bed and banks	
2. Moderately disturbed	Artificial Channelized or concrete bed or banks	
3. Undisturbed	Close to natural conditions	

## Viewpoint

## River morphology

Descriptor: Bank shape

4. Class 1	 Culvert d watercourse
3. Class 2	 Vertical banks (walls)  Trapezoidal watercourse
2. Class 3	 Asymmetric banks (wall and levee)
1. Class 4	 Natural banks (earth)



River banks typology (Saraiva et al., 2001)

## Viewpoint **River morphology**

Descriptor: Sinuosity

1. Straight ( $SI < 1.05$ )
2. Sinuous ( $SI$  between  $1.05 - 1.5$ )
3. Meandering ( $SI > 1.5$ ).



(Mount, 1995)

## Viewpoint **Biological Components**

Descriptor: Spatial distribution of vegetation - Vertical

Indicator: Presence of riparian vegetation in river banks

1. Presence of well developed and continuous riparian vegetation in one or in both margins
2. Presence of sparse trees in one or in both margins
3. Presence of herbaceous vegetation
4. Absence of vegetation



## Viewpoint

## Biological Components

Descriptor: Spatial distribution of vegetation - Horizontal  
Indicator: Width of riparian vegetation

1. Large (>20 meters)
2. Medium (12 – 20 meters)
3. Narrow (0-12 meters)
4. Absence of vegetation



## Viewpoint

## Biological Components

Descriptor: Biological Diversity  
Indicator: Ecological status of river corridor (rc)

1. Undisturbed and with highly biological interest
2. Moderately disturbed
3. RC highly disturbed or artificial

ECOLOGICAL STATUS is calculate trough a set of parameters:

- Biological quality (BMPW' index)
- Exotic fish species
- Autochthonous fish species
- Riparian vegetation
- Exotic and invasive flora

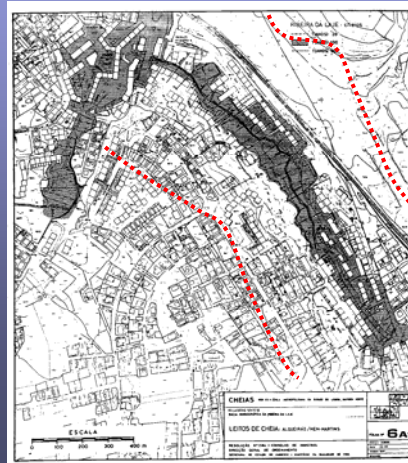
(Moreira *et al.*, 2002)

Viewpoint

## Natural and technological hazards

Descriptor: Flood vulnerability

Indicator: % of the river corridor located within the areas of the 100 year flood event



Viewpoint

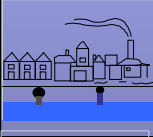


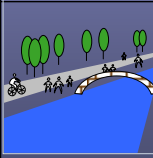
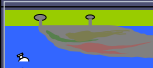
## Natural and technological hazards

Descriptor: Bank erosion or landslide

Indicator: % of the length of banks with potential erosion or landslides



## Urban environment in the landscape – the CITY

	Fundamental viewpoint	Elementary viewpoint
	<b>Urban space quality</b>	Visual permeability: - Visual contact - Depth of views - Width of views  Density of landmarks Built space quality Public utility of riverfront Intensity of construction
	<b>Cultural heritage</b>	Cultural heritage
	<b>Activities</b>	Diversity of uses Attractiveness of riverfront
	<b>Accessibility</b>	River crossing: - Existence of bridges - Use of bridges  Surface of parking Public transport Walkways and bikeways Level of disruption Anchorage places Use of river by boats
	<b>Pollution</b>	Pollution

### Viewpoint

### Urban Space Quality

#### Visual permeability

Perspectives on the river  
 Deepness of views  
 Wideness of perspectives –  
 panoramic views, belvederes, public terraces...  
 Influence of urban morphology  
 Equity of visual access from buildings  
 Contact with water (near/close/over the water)



#### Indicators:

- Linear density of visual intersections
- Average length of visual axes with the river
- Number of belvederes or focal points

Viewpoint **Urban Space Quality**



**Indicators:**  
Density of Landmarks / reference points in the landscape (River Corridor)  
(Kevin Lynch)

Viewpoint **Urban Space Quality**

Public utility of river watersides

Public access – private access  
State of conservation

Balance between public open areas  
(in good conditions) and private open areas  
in both watersides of river



**Indicator:**  
Public open areas (in good conditions) of river watersides / private open areas  
in riverfront

## Viewpoint

## Urban Space Quality

### □ Intensity of construction in riverfront

High intensity of construction is generally not advisable in riverfront



URBAN AREA



RURAL AREA

London – Thames river

### Indicator:

**Gross floor area of construction / net surface of riverfront**

(in urbanized riverfront areas)

## Viewpoint

## Cultural heritage

### □ Public interest of present CH values

**Values:** Historical  
Cultural  
Natural Ecologic  
Industrial Arqueologic  
Arquitectural  
Social ...

Collective memories  
Social representativeness of those memories

Monumental buildings (physically perceptible)  
or more natural landscapes

Historical sites

Creating collective values – new cultural heritage

### Indicator:

**Amount of classified CH units**

**with official recognized public interest** (in Rivercorridor)



Tagus river - Lisbon

Viewpoint **Accessibility**

From city to river... From river to city...

Crossing the river

- Access in public transport in RC
- Access in soft modes: walking and biking
- Urban / river disruption caused by major roads or railways located close to the margin
- Parking on the margin

Viewpoint **Accessibility**

- Urban / river disruption caused by major roads or railways located close to the margin

Estoril - Lisbon

Lisbon

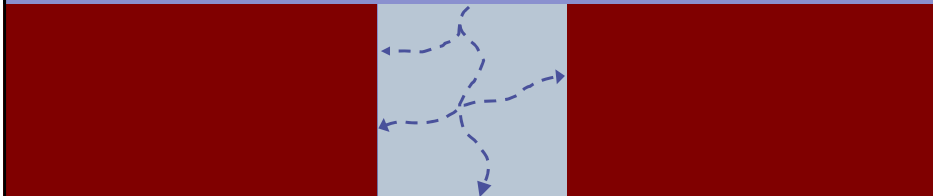
**Indicator:**  
 Length of non-sustainable disruptive major roads / Total length of the river within city (km)



Viewpoint

Accessibility

From river to city...



- Transport function
- Usefulness / vividness of the watercourse

Viewpoint

Accessibility

- Transport function



Tagus river - Alcochete



Tagus river - Cacilhas

Jardas stream  
is actually non  
navigable

Indicator:  
Linear density of anchorage places (along the river in both margins)  
(docks, floating pier, etc)

Viewpoint

## Accessibility

- Usefulness / vividness of the watercourse



Veneza

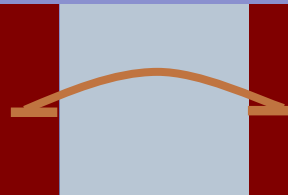
Indicator:  
Daily average density of boats in the river (whatever the purpose)

Vietname

Viewpoint

## Accessibility

Crossing the river

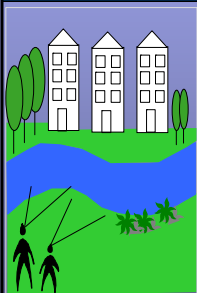




- Physical connectivity
- Relationship with river when crossing



Claude Monet

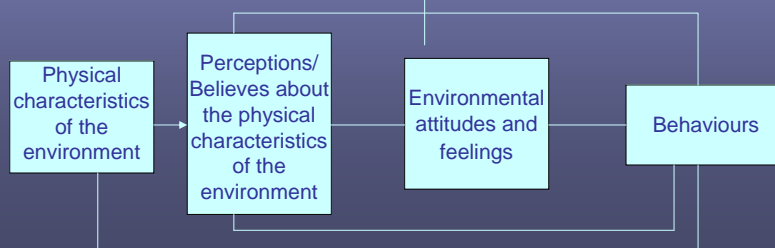
## Human Perception of the Landscape – the PEOPLE

	Fundamental viewpoint	Elementary viewpoint
	<b>Public perception</b>	In relation to the River <ul style="list-style-type: none"> <li>- Aesthetic</li> <li>- Water</li> <li>- Biodiversity</li> <li>- Risk (perception of flood risk)</li> <li>- Pollution</li> </ul> In relation to the City <ul style="list-style-type: none"> <li>- Urban quality</li> <li>- Accessibilities</li> <li>- Security Infrastructures</li> </ul> People relationship with the river <ul style="list-style-type: none"> <li>- Relax</li> <li>- Attachment</li> </ul>
	<b>Place Identity</b>	Continuity Self-esteem Self-efficacy Distinctiveness
	<b>Restorative Capacity</b>	Being away Fascination Extent Compatibility

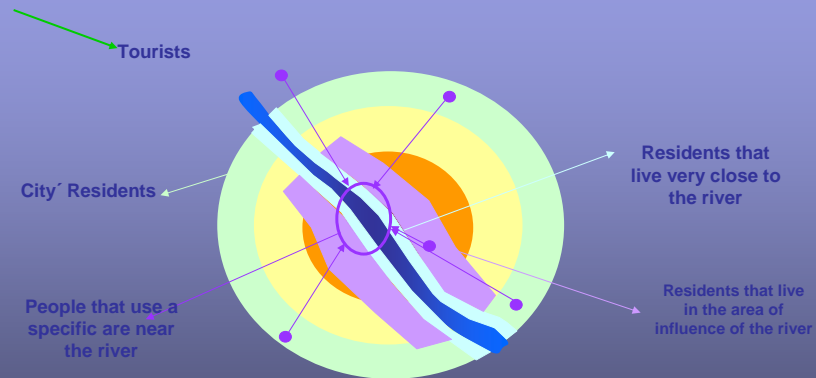
## MAIN QUESTION

- In Aesthetic evaluation is it important to include **Public** Perception ????

### USERS



## Who are the Users ?



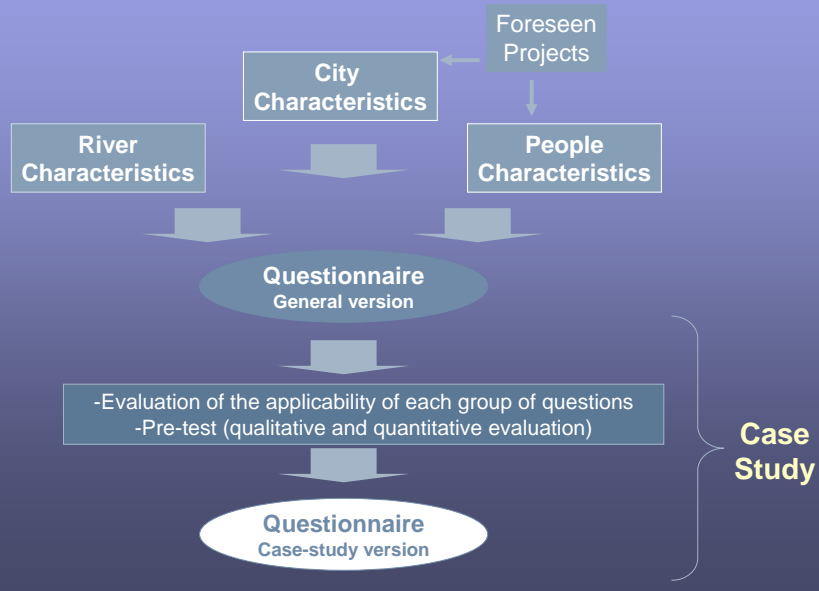
Related with the project objective ....

## Question?

It is possible to evaluate the Restorative capacity of any River?  
It is possible that any river contribute to the place identity of the residents in this area?



## Design and construction of the Questionnaire



## QUESTIONNAIRE STRUCTURE

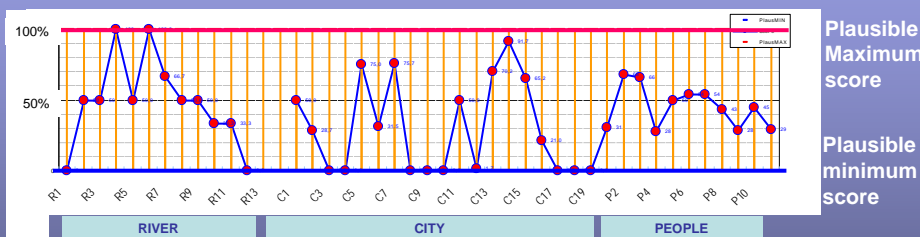
- General questions
  - Activities in the river area
  - River perception
  - Preferences for the Future
  - Identity
  - Restorative Capacity
  - Background
- Information to future river restorations

## QUESTIONNAIRE: Identity

Elementary viewpoint	Questionnaire	Scale (likert scale of 5 points)				
		1 Not agree	2	3	4	5 Agree complete
Continuity	e.g.: "My main memories are connected with this city"					
Self-esteem	e.g.: "I am proud in living near this river"					
Self-efficacy	e.g.: "Living next to the river provides me a feeling of tranquillity"					
Distinctiveness	e.g.: "I like better to live in this city than in the others"					

## Methodology

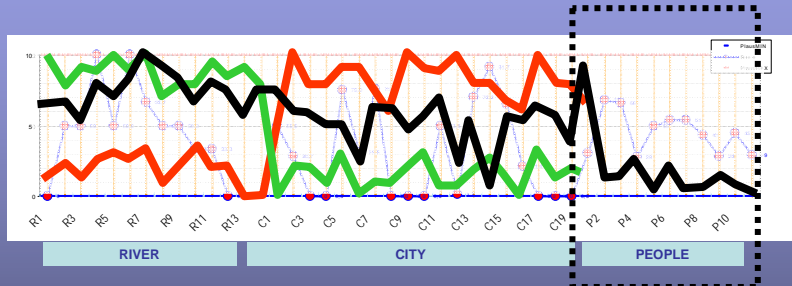
Indicators, descriptors, criteria and evaluation scores



### Profile of Aesthetical Performance

(Jardas Stream, Cacém-Portugal)





## Discussion of the aesthetic evaluation methodology

- **Aesthetics is multidimensional**

- **Deals with common/ collective sense and also with individual perceptions**

- **Use of multimethodologies**

- **Use flexible methods, considering the characteristics of each river – balance between more “natural” or “urban” watercourse;**

- **The role and search for interdisciplinarity**

- **Combination of expert approaches with public involvement ( several “publics” – residents, visitors, planners, decision makers, etc.)**

- **Exploring the rehabilitation potential of urban watercourses**

- **Help in defining priorities for urban river rehabilitation**

**Contribution for aesthetic landscape appreciation and evaluation**

**Indicators of Success for  
Urban River Post Implementation Assessment (URPIA)  
URBEM WP 10**

Dresden University of Technology (TU Dresden) - Joachim T. Tourbier, Ines Gersdorf  
Leibniz Institute of Ecological and Regional Development, Dresden (IOER) - Jochen Schanze, Alfred Olfert  
2005

**“ URPIA reflects the three components of sustainability, expanding the assessment of rehabilitation of river ecology to also consider social and economic aspects. Socio-economic components including spatial planning and aesthetics especially applied to urban settings, where rivers have a role in shaping the quality of life for the city of tomorrow ”**

- Context Indicators**  
**41 Ecological Indicators (WFD)**  
**43 Social Indicators**  
**7 Economic Indicators**

**Examples:**

Ecological Indicators	Social/Aesthetic Indicators	Economic Indicators
Biological water quality (WFD)	N° of parking lots	Median property value
Hydromorphological conditions (WFD)	Soft mode access barriers	Unemployment
Acidification status	Access points for soft modes	Activities to create income
Inundability	Water contact zones	Maintenance costs
Structure and condition of riparian zone	Recreational facilities and paths	Replacement costs for flood damage
River depth and width variation	River crossings	Replacement costs related to vandalism
Connection to groundwaters	Vandalism	Potential flood damage cost
Continuity of river for river sediments	Carrying capacity of public open space	
Quantity and dynamics of river flow	Visitor frequency	
Nutrient conditions	Cultural events	
Concentration of hazardous substances	Viewpoints	
Self-cleaning capacity	Landmarks	
Nature conservation value	Integration of cultural heritage and cultural assets	



## Urban rehabilitation in Portugal POLIS programme



## Urban quality of life



## Case Study: Polis Programme in Braga

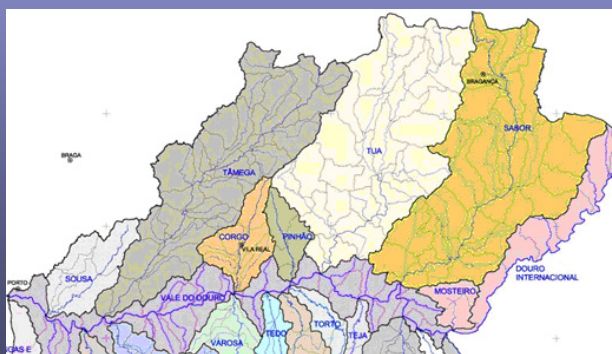
### Rehabilitation of Fervença river



Fig1 – Location of Braga in a national and regional context



Fig2 – Tourist map of Braga



River basin of Sabor river and Fervença river

River basin areas:  
Fervença river-206 km<sup>2</sup>  
Sabor river - 4.000km<sup>2</sup>  
Douro river - 99.000km<sup>2</sup>

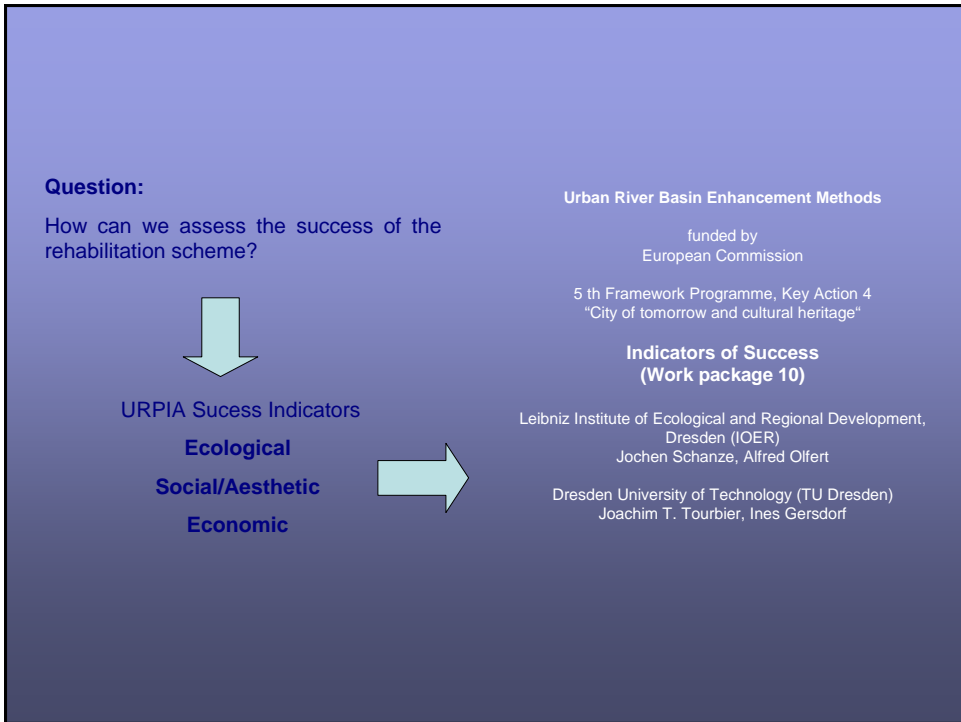
## Rehabilitation Project of Fervença river



PROGRAMA POLIS BRAGANÇA – Intervention area

### SPECIFIC OBJECTIVES

- Return river Fervença to the city enhancing its character;
- Creation of a “green corridor” (strategy of environmental landscape integration of the city);
- Enhancement of the natural and architectural heritage;
- Rehabilitation of disqualified urban zones (construction of a quality public space)
- Restructuring of the network road, encouraging the reduction of the traffic car and establishing a pedestrian and cycle paths linking the Historical core to the river.



Indicators of Success		Contribution to achieve objectives	Applicability	Measurability		
				scale 0-5 *1	scale 0-5 *2	min
Ecological	River depth and width variation	4	4	0	8 m	-
	Acidification status	4	2	-	-	-
	Inundability	4	3	-	-	-
	Percentage of stream length with riparian vegetation	5	2	0	3,2%	100%
	Storm water recycling	3	1	-	-	-
	Ground water level	2	2	-	-	-
	River continuum	2	4	0	0	-
	Width of riparian fringe	4	2	12	5 m	>20
	Parking lots	1	4	0	40	-
Social	Public Transportation Stops	1	4	0	0	-
	Access Points for Soft modes	5	4	0	3	8
	Water contact zones	5	2	0	27%	50%
	Anchorage Points	not applicable	4	-	-	-
	River crossings	5	4	0	3,5*	5
	Public Utility of river site	5	4	0	18%	100%
	Landmarks	4	2	0	9	-
	Viewpoints	4	1	0	6,5*	-
	Recreational Facilities	5	4	0	3,5*	-
	Recreational Paths	5	4	0	3,06	-
	Cultural Events	4	4	0	3	-
	Integration of Cultural Heritage and Cultural Assets	4	4	-	-	-
	Self-esteem	5	1	qualitative		
	Fascination	5	1	qualitative		
	Economics	Median property value	3	4	-	-
Unemployment		2	4	-	-	-
Activities to create income		4	4	0	0	-

\* Number/Km

**2 Applicability Scale**

**0** Not Available or very difficult to obtain

Acquisition of data required and complex process of modeling or calculation

**1** Acquisition of data required and simply process of modeling or calculation

**2** Data available and complex process of modeling or calculation

**3** Data available and simply process of modeling or calculation

**4** Official statistics available

**5** Official statistics available

### FROM SPECIFIC OBJECTIVES TO EX-POST ASSESSMENT

#### Objective Polis Programme

#### 1. ENHANCEMENT AND REHABILITATION OF FERVENÇA'S RIVER BY THE CREATION OF A GREEN CORRIDOR

##### Applicable Indicators

-% of stream length with riparian vegetation



-Presence of riparian vegetation in margins



- Width of riparian fringe



##### Results





FROM SPECIFIC OBJECTIVES TO *EX-POST* ASSESSMENT

Objective Polis Programme

2. LINKING AGAIN FERVENÇA RIVER TO THE CITY

Applicable Indicators

Results

- Pollution sources	
- Chemical and physical water quality	
- River depth and width variation	
- Inundability	

FROM SPECIFIC OBJECTIVES TO *EX-POST* ASSESSMENT

Objective Polis Programme

3. REHABILITATION OF DISQUALIFIED URBAN AREAS, WITH THE IMPROVEMENT OF QUALITY PUBLIC SPACE

Applicable Indicators

Results

- Public utility of the river site	
- Recreational facilities	
- Recreational paths	
- Cultural events	

FROM SPECIFIC OBJECTIVES TO *EX-POST* ASSESSMENT

Objective Polis Programme

4. REESTRUCTURING THE NETWORK TRAFFIC, ENCOURAGING THE REDUCTION OF CAR TRAFFIC AND ESTABLISHING PEDESTRIAN AND CYCLE PATHS

Applicable Indicators

- Parking lots
- Public transportation stops
- Access points for soft modes
- River crossings
- Recreational paths

Results



FROM SPECIFIC OBJECTIVES TO *EX-POST* ASSESSMENT

Objective Polis Programme

5. ENHANCEMENT OF THE NATURAL AND CULTURAL HERITAGE

Applicable Indicators

- Water contact zones
- Landmarks
- Viewpoints
- Integration of cultural heritage and cultural assets

Results



**FROM SPECIFIC OBJECTIVES TO *EX-POST* ASSESSMENT- CONCLUSIONS**  
EMPHASIS ON THE SOCIAL AND CULTURAL OBJECTIVES



THERE IS THE NEED OF HIGHER INTEGRATION  
OF ECOLOGICAL AND ENVIRONMENTAL OBJECTIVES...