



Urban River Basin Enhancement Methods

**URBEM Training and Dissemination
Journal Publications, Conference Papers and
Dissemination Activities
Work Package 11**

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1. OVERVIEW

There have been a variety of dissemination activities carried out on the URBEM project that involve producing written papers for conferences, journals and information for stakeholders. In addition to the documented material prepared, all the URBEM project partners have been involved in oral presentations and hosting of workshops at URBEM meetings, the URBEM final conference and additional conferences.

A book of proceedings was produced for the final URBEM conference, containing extended abstracts of papers presented by the URBEM partners and by researchers and consultants external to the URBEM project.

In addition to the activities presented here, several of the URBEM partners have formed a consortium to produce a book detailing some of the research that has been carried out on the URBEM project. It is expected that this book will go into production one year following the end of the URBEM project.

The following sections provide an overview of these activities and the Appendices of this report give most of the material produced for dissemination purposes.

2. CONFERENCE PAPERS

This section lists the main conference papers that have been produced for the URBEM project.

See Appendix 1 for the following:

Bain, V., Bettess, R., Schanze, J., Olfert, A., Tourbier, J., Gersdorf, I. (2005) International Approaches to Achieving Ecological Objectives of Urban River Basin Enhancement. *River Restoration Centre UK Conference, Hatfield, April 2005.*

See Appendix 2 for the following:

Bernardo, F., Saraiva, M.G., Ramos, I., Silva, J.B. (2005) Landscape Ecology in the Mediterranean: Inside and Outside Approaches. *European IALE Congress 2005.*

Bettess, R., Bain, V. (2005) Assessing and Managing River Rehabilitation. *Urban River Rehabilitation Conference. Dresden 21 – 23 September 2005.*

Gersdorf, I., Tourbier, J., Olfert, A., Schanze, J. (2005) Indicator-based Post Implementation Assessment (PIA) for Urban River Rehabilitation. *Urban River Rehabilitation Conference. Dresden 21 – 23 September 2005.*

Lafont, M., Vivier, A., Namour, P., Breil, P., Perrin, J. (2005) Conceptual Approaches for the Study of Urbanized Watercourses: Proposals for Short

and Long term Applied Researches. *Urban River Rehabilitation Conference. Dresden 21 – 23 September 2005.*

See Appendix 3 for the following:

Maksimovic, C. (2005) Urban Stream Rehabilitation – Lessons to be Learned From URBEM Project. Seoul, South Korea, 8-16 September 2005.

Rocha, J., Alves, E. (2005) Rehabilitation and Creation in Urban Rivers – Objectives and Techniques. *Urban River Rehabilitation Conference. Dresden 21 – 23 September 2005.*

See Appendix 4 for the following:

Saraiva, M.G., Silva, J.B., Ramos, I.L., Bernardo, F. (2004) Rehabilitation of river landscapes in the urban context – evaluating aesthetics for decision making process. *International Conference “From Knowledge of Landscapes to Landscaping Action”. Bordeaux, 2-4 December 2004.*

Schanze J, Olfert A, Tourbier J T and Gersdorf I (2005), Urban River Rehabilitation in Europe: A Case Study Analysis. In: Tourbier J T and Schanze J (eds) Urban River Rehabilitation. Leibniz Institute of Ecological and Regional Development (IOER), Dresden, pp 5-13.

Gersdorf I, Tourbier J T, Olfert A and Schanze J (2005), Indicator-based Post Implementation Assessment (PIA) for Urban River Rehabilitation. In: Tourbier J T and Schanze J (eds.) Urban River Rehabilitation. Leibniz Institute of Ecological and Regional Development (IOER), Dresden, pp 142-152.

See Appendix 5 for the following.

Silva, J.B., Saraiva, M.G., Ramos, I.L, Bernardo, F. (2005) Methodology of aesthetic evaluation of rivers in urban context. *Urban River Rehabilitation Conference. Dresden 21 – 23 September 2005.*

Tellier, S, Amezaga, J, Baker, L., Percy, C. (2005) Application of the URBEM Toolkit for Watercourse Rehabilitation in the River Ouseburn, Newcastle upon Tyne. *Urban River Rehabilitation Conference. Dresden 21 – 23 September 2005.*

3. OTHER DISSEMINATION ACTIVITIES

Presentations at Final URBEM Conference Workshops.

Presentations at six-monthly meetings for the URBEM project team.

Presentation at stakeholder meeting for the WWF in Trento, Italy.
See Appendix 6 for the presentation material.

Notes produced for informing stakeholders:

See Appendix 7 for the following:

Brilly, M. (2005) *How to Take Action for River Restoration*. UL FGG Report.

See Appendix 8 for the following:

Brilly, M. (2005) *Monitoring the Impacts of Urban Environment on River Water Bodies and Importance of Volume of the Water Body – Case Study..* UL FGG Report.

See Appendix 9 for the following:

Brilly, M. (2005) *The Study Site Monitoring of the Gradascica Catchment*. UL FGG Report.

Appendix 1

International Approaches to Achieving Ecological Objectives of Urban River Basin Enhancement

Valerie Bain¹, Roger Bettess¹, Jochen Schanze², Alfred Olfert², Joachim Tourbier³ and Ines Gersdorf³

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It is common for urban river enhancement to focus on improving the aesthetic quality of the river since this results in the most visible benefit for improving the quality of life for people living and working in the urban environment close to the river. However, rehabilitating the landscape alone will not necessarily result in any improvement of the river ecology, which in urban rivers has frequently been highly degraded. With the advent of the European Water Framework Directive (WFD), there is significant motivation for EC states to improve the ecology of their urban rivers in order to comply with the legislation.

This presentation will describe case studies of river rehabilitation from around Europe and the rest of the World, identifying methods that have been used to improve the ecology of urban rivers. The research has been carried out under the URBEM (Urban River Basin Enhancement Methods) Project, which is part of the EC Fifth Framework Programme and started in November 2002 and will finish October 2005. The work on existing river rehabilitation schemes supports other work packages which develop methods for identifying rehabilitation potential and carrying out rehabilitation projects.

The case studies demonstrate that urban planners and river managers are often aiming to satisfy a number of objectives when carrying out river rehabilitation. For example, the objective of ecological improvement cannot, in many cases, compromise flood control. This places constraints on the techniques available for implementation. In addition, there are constraints on the rehabilitation project due to the fact that it is being carried out in an urban setting, for example, there is often restricted space along the river corridor and urban rivers are commonly channelised. Information on successful approaches to improving urban river ecology within these constraints is, therefore, of great use to river managers and planners.

The presentation will discuss the ways in which both hydromorphological and water quality elements can be improved and will explore the relationship between these parameters and the river ecology. The analysis of the case studies will examine the ecological impacts of rehabilitation in terms of WFD classes. The case studies will be used to establish current best practice, defining a bench mark on which the science of river rehabilitation must build.

Appendix 2

European IALE Congress 2005
Landscape Ecology in the Mediterranean
Inside and outside approaches
Faro, March 29 – April, 2, 2005

Abstract

Rivers in urban landscape: values, perceptions and contributions to urban identity
Bernardo, F. ; Saraiva, M.G. ; Ramos, I. ; Silva, J.B.

The main objective of this study is to understand the social role of rivers in urban landscapes. Rivers are important features in urban environments, not only due to its ecological and environmental functions, but also for its contribution to urban quality of life. In this context, public perception of rivers, as well as its contribution to urban identity and to restorative effects, were evaluated. This study was developed in the context of the European Research Project (URBEM - Urban River Basin Enhancement Methods).

Two rivers of different typologies were evaluated and compared: the Tagus River that borders Lisbon, with a strong historical connection to the city, and a small river, Jardas, a highly modified by urban encroachment, in the periphery of Lisbon, crossing the town of Cacem.

In the context of this project, a questionnaire was developed to evaluate public perception and uses of the river and its banks. The questionnaire was structured into four sections: public perception of river landscape, place identity, restorative capacity and activities in river corridor. Comparison of the river physical characteristics and of the morphological urban context were also carried out.

About 120 residents, living near each river, with the same demographic characteristics, were interviewed. The results obtained help to understand the importance of some river characteristics in the urban settings as well as the role of landscape perception to identify its social value. The results also show that the river can play an important role in the place identity of the residents, and can contribute to restore from the stress of the daily urban life.

The awareness of the social role of rivers along with its ecological values may contribute to more sustainable programmes for rivers, to be integrated in environmental design, planning, and decision-making.

Appendix 3



Centre for Urban Water*

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** more than water, more from water*

Prof. Čedo Maksimović

Report on the visit to the **Cheonggyecheon (Chongechon)**
River Restoration project and lecturing in the Special
Seminar 5 on Stream Restoration Principles, Practice and
Monitoring / Assessment

Seoul, South Korea 8-16 September 2005

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Introduction

As a part of dissemination of the results of the URBEM project, it has been agreed with EU and project management team to pay the visit to Seoul, Korea in the period 8-19 in order to disseminate the results of the project, collect the information on the technical features and socio-economical implications of the Chonggechon project and to look for the follow-up activities in which further cooperation with Korean partners would be pursued. The mission took place as planned, all planned activities have been performed and the follow-up activities agreed upon. The report presents the results of the mission. It is structured so that the main report provides basic information and more detailed information can be found in the annexes.

The goal of the mission

According to the agreement with the EU and the project management team the mission had the following goals:

- a. To establish direct contacts with the professionals involved in the Chonggechon urban stream rehabilitation project in order to collect the information on the technical features and socio-economical implications of the project.
- b. To disseminate the results of the URBEM project by delivering an invited lecture – keynote paper at the specialty seminar on **Stream Restoration - Principle, Practice and Monitoring / Assessment – focused on the Monsoon and Typhoon- affected Regions** on Sept. 16, 2005 in Seoul
- c. To explore the possibilities for the follow-up activities in which the results of the URBEM would be implemented in Korea and in the third countries.

Activities performed

The mission to Seoul, South Korea took place between 8-16 September 2005. In this period the following activities have been performed:

- a. Direct contact has been established with the following individuals and institutions:
 - a.1 Planning department of the Seoul municipality
 - a.2 Korean Institute of Construction Technology which was involved in the planning and supervision of the project
 - a.3 Construction branch of Hyundai company which was involved in construction of one third of the Chonggechon river. Relevant technical documents have been acquired and studied. Selected slides are attached to this report.
- b. Invited paper entitled **Urban Stream Rehabilitation – Lessons (to be) learned from URBEM project** has been

delivered at the Session3: Monitoring and Assessment of the Specialty Seminar **Stream Restoration - Principle, Practice and Monitoring / Assessment – focused on the Monsoon and Typhoon- affected Regions** on Sept. 16, 2005 in Seoul. The Seminar was organised as one of the “added value” events concurrent to the XXXIst Congress of the International Association for Hydraulic Research-IAHR. In the presentation use has been made of the results of the URBEM project. The Seminar was organised by Dr Hyoseop Woo, director of the Koran Institute of Construction Technology. Detailed programme of the Seminar is presented in the Annex 1. The paper presented (Extended Abstract) is enclosed in the Annex 2.

- c. Field trip to the Congechong rehabilitation project. Photographs from the visit are enclosed in the Appendix 4.
- d. Field trip to Shihwa lake

Follow-up

Based on the successful presentation of the URBEM project outputs, and after the consultation with the management of the Korean Institute of Construction Technology, Dr Hyoseop Woo, its director has decided to invite Prof. Maksimovic to a consultation meeting together with 3 other leading international experts from US, Japan, and Holland. The meeting is to assist the host country to formulate its research and development agenda in the area of urban stream rehabilitation and to discuss the cooperation possibilities . The meeting will take place in the early 2006 at the time that is yet to be agreed among the invitees.

Conclusions

The mission has fulfilled all its goals. The dissemination of the URBEM results has been performed satisfactorily, and furthermore has opened possibility for the future cooperation based on the achievements of the URBEM project.

Appendix 1 Programme of the Specialty Seminar

Time Schedule for Special Seminar SS-5 on Sept. 16, 2005
 Stream Restoration - Principle, Practice and Monitoring/Assessment
 – focused on the Monsoon and Typhoon- affected Regions
 (Organizer: Hyoseop Woo, Korea)

Time	Presentations	Country
09:00-09:05	Introductory remark by <i>Hyoseop Woo, Chairman</i>	Korea
09:05-09:30	- (Keynote Address) Scientific Support to Ecosystem Conservation in Stream Restoration in Monsoon Asia by <i>T. Tsujimoto</i>	Japan
09:30-10:30	<i>Session 1 Principle and Research</i> chaired by <i>H. Woo, Korea</i> - (Invited Paper) Basics on the Interaction of "Flow, Vegetation and Sediment" by <i>Andreas Dittrich, Germany</i> - CFD Modeling Vegetated Channel Flows: The State of the Art Review by <i>S.-U. Choi, Korea</i> (4) - Research on Changes of Topographical Features and Vegetation on a Sand Bar due to Floods by <i>Satoru Sugio, Japan</i> - Ecological Researches for River Restoration Projects Using Experimental Stream in Japan by <i>Yuichi Kayaba, Japan</i>	Korea Germany
10:30-10:40	<i>Coffee Break</i>	
10:40-11:55	<i>Session 2 Practice</i> chaired by <i>T. Tsujimoto, Japan</i> - (Invited Paper) Application of Aquatic Habitat Improvement Techniques at Ta-Chia River in Taiwan by <i>S. Marko Hsu, Taiwan</i> - Cheonggyecheon Restoration Project and Hydrological Cycle Analysis by <i>H. J. Kim, Korea</i> - Effects of River Discharge on Growth of Periphyton in Sand River by <i>Yuji Toda, Japan</i> - Landscape Characteristics of Riffles in Middle Reaches of River by <i>Takeyoshi Chibana, Japan</i> (5) - Improving Habitat of Formosan Landlocked Salmon by Dam Removal by <i>Chao-Hsien Yeh, Taiwan</i>	Japan Taiwan
11:55-12:05	<i>Coffee Break</i>	
12:05-13:05	<i>Session3 Monitoring/Assessment</i> chaired by <i>S. Marko Hsu, Taiwan</i> - (Invited Paper) Urban Stream Rehabilitation - Lessons learned from URBEM project by <i>C. Maksimovic, England</i> - KI Ecological Response of Rivers on Treatment under Different Management Regime by <i>C. S. Lee, Korea</i> - Model of Comprehensive Assessment of Ecological Riparian Zone by <i>Jihong Xia, China</i> (4) - The Results of Monitoring of Adopted Trees, Flora and Fauna on the Han River Flood Plain by <i>C. W. Kim, Korea</i>	Taiwan England China
13:05-13:15	Wrap-up by <i>T. Tsujimoto, Japan</i>	

Appendix 2: Extended abstract of the paper

URBAN STREAM REHABILITATION – LESSONS (TO BE) LEARNED FROM URBEM PROJECT¹

ČEDO MAKSIMOVIĆ

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One of the most important aspects in the urban development of the modern world is that the urban streams and rivers are modified to meet the needs of the urban population and the small ones often act as conduits for wastewaters. Throughout historic development urban watercourses have gradually been converted from natural river beds to confined narrow river corridors with the channels canalised in concrete and other man-made materials forming both the bed and banks of the river. In many cases they have been culverted and converted into covered combined sewers.

Management and control of urban watercourse are used to prevent or reduce bank erosion, flooding and increased pollutant loads, but may also be used for the protection of the natural hydraulic conditions and urban aquatic habitats. The urban communities expect protection from floods and preservation of public health and aesthetic or amenity value. Resolving the conflicts over watercourse functions is particularly complex in urban areas, and urban watercourses are seen as an important element in an integrated urban water management cycle (Maksimović & Tejada-Guibert, 2001)

Modification of watercourses is recognised in European legislation through the Water Framework Directive (WFD), which defines a “heavily modified water body” as a “body of surface water, which as a result of physical alterations by human activity is substantially changed in character”. The WFD provides the basis for long-term, sustainable development, enhancement and planning of European rivers with an emphasis on natural ecosystems, and intrinsic wildlife value. Improvement of the river systems through urban areas in terms of quality, ecology, aesthetics and amenity values is vital in the movement towards an environmentally sustainable future for cities in Europe.

The URBEM project (<http://www.urbem.net/theproject.html>) investigated various aspects of new techniques and materials for bringing rivers back to urban streams in order to provide long term sustainable solutions and to enhance the visual and

ecological values. The approach of URBEM is based on the belief that the whole river corridor and its interactions with the urban environment are an integral part of the system (Gardiner, 1992).

This paper (and the lecture that follows) present the educational – capacity building component of the project. The educational tool (Training Module – TM) that will be developed at the end of the project, is an overarching framework which integrates the educational elements of the other 10 work packages and presents them in the form suitable for running various forms of training – capacity building of the three defined target groups: (a) top level decision makers, (b) water and environmental specialists and urban planners and (c) general public.

The main objective of the Training Module (TM) is to enhance the awareness of the general public and develop the capabilities to public, professional and environmental authorities about how to plan, implement and maintain an urban rehabilitation scheme.

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The TM is designed so that it can be tailored to suit the three selected target groups of audience with a different level of interest and understanding: top level decision maker (that includes high level ministerial officers, chief city planners and alike), professionals (water and environmental planners, developers and designers) and other stakeholders and general public. In addition to the conventional material (books, reports etc.) the TM includes guidelines for preparation and running training programs are series of Power Point slides sorted out in accordance with project deliverables and supported by written material. It is anticipated that those involved in the presentations will have an understanding of the subject area and the technical knowledge to undertake the training programme in the first place and than to get involved in rehabilitation project hopefully on the project developed paradigm.

The TM is provided on a CD with adequate number of folders and art designed slides (about 350). It can be used directly from the CD or copied on a hard drive and used from there. The slides provided are as follows: (a) individual, simple graphs and photos, (b) animated slides, consisting of several sequential images and (c) slides with buttons for more information about specific subject. presented in Power Point presentation (Fig 1):

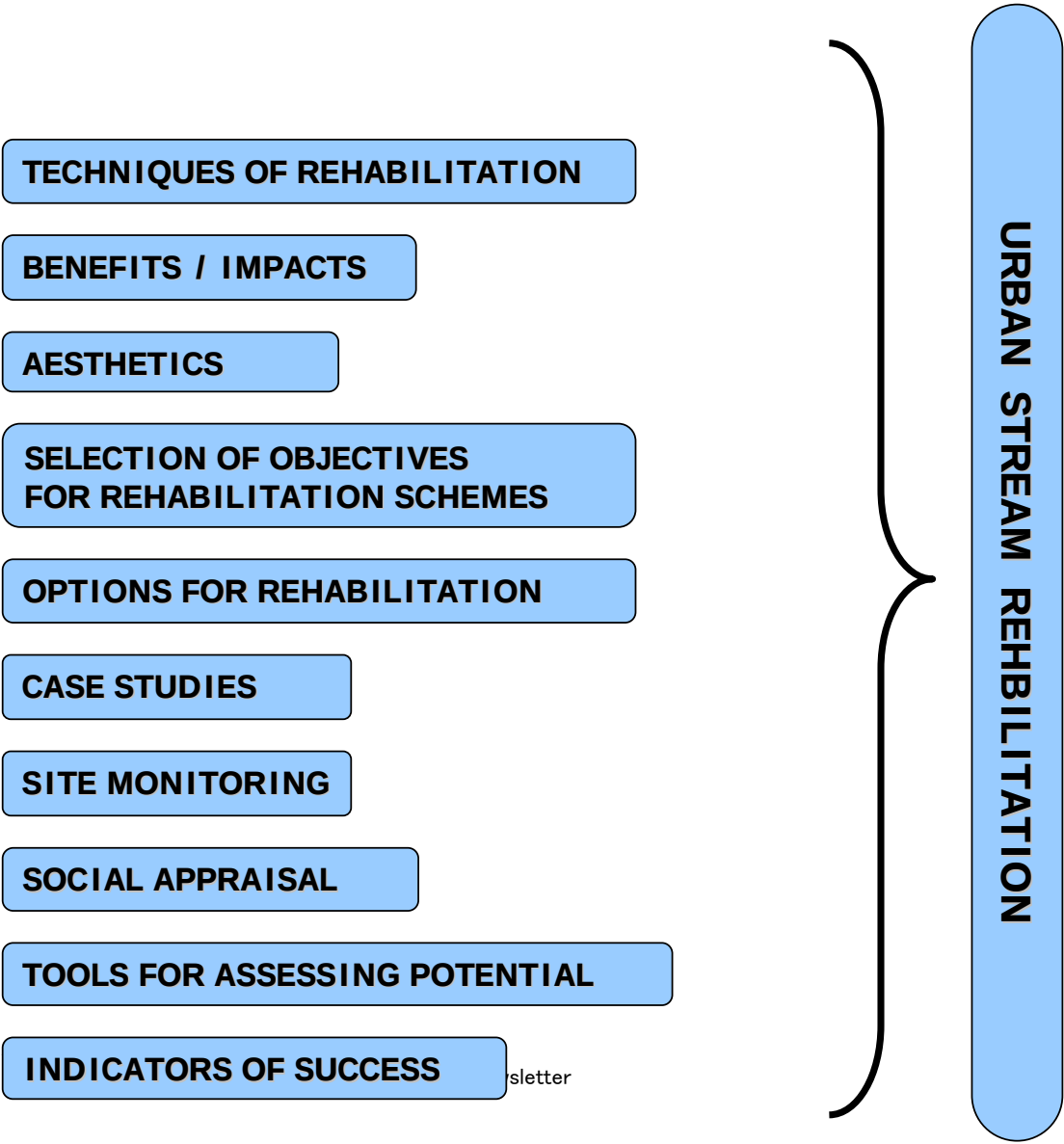
Although each of the training blocks presents a self-contained unit is makes sense to refer to that other blocks when running the class with individual target group on a particular topic.

The principles of modern graphics design are used, and the slides are meant to be easy to understand to master their essence

The Training Module has been developed so that further updates and upgrades can easily be made. Separate modules can be specifically designed for various regions, written in the appropriate language and adapted to the local culture. Detailed

examples and case studies can also be included. Its translation into various languages would make it available to an even wider audience, and should enhance the process of creating additional local modules.

Fig 1. depicts the blocks of units used in the presentation



Appendix 3: Excerpts form the JWF Newsletter on Chongechon River Restoration project

Chongechon River Restored in the Centre of Metropolitan Seoul - a New Landmark in World History

At the beginning of this newsletter, although I know that I should refer to the Japan Water Forum first, I would like to mention the great Chongechon River Restoration Project,. This is because I am deeply impressed by the grand project, and regard it as a new monument in world history. It is equivalent to the Appian Way and the aqueducts of Rome, which are also known as great monuments in world history. The Chongechon River Restoration Project will be preserved as glorious heritage for thousands of years. It will go down in history as a landmark that changed the basic direction of urban development. I am happy to have been able to witness such a historic moment.

The Chongechon River Restoration Project, which required more than 4200 sessions of hard negotiations with local citizens about how to remove the paved roads and the overpass above the river, was completed at long last on October 1st. Though a formal celebration hosted by the mayor of Seoul and attended by the Korean president was held, it was what happened after the ceremony that deeply impressed me. There were more than 300,000 citizens of Seoul strolling along the river. Some one thousand of them suddenly walked into the river with great exuberance. Young and old, parents and children, and lovers were hand in hand, playing joyfully in the water. It was nearly 10 o'clock at night. Some people were walking downstream. The moment I saw this sight, I realized that it was unnecessary to discuss why we had to restore rivers in cities. In the past, we had covered over rivers and used them as roads or parks in order to improve efficiency. Such an era had finally come to an end.

Thanks to the trial flow of the Chongechon River, the wind became 1.5 times stronger in Seoul and the temperature along the river was unexpectedly 3 degrees lower compared to last year. Although there are still some problems such as traffic congestion, these problems are moving toward resolution by sagacious policies aimed at developing the city for the next generation.

This project was an outstanding achievement resulting from the collaboration of the Seoul government, which believed in the "invisible hand", and the wise citizens of Seoul. They intend to change their means of transportation from private cars to buses and subways. As a result, the movement of road traffic along the Chongechon River has become smoother. The Chongechon River Restoration Project has triggered a change in the entire transportation system in Seoul and has spurred a new approach to urban development in the new millennium by combining both hardware and software. I would like to congratulate the mayor and citizens of Seoul on their accomplishment of the grand project.

We have put the plan of the Japan Water Forum Fund, which we promised at the establishment of JWF, into effect. We have decided to allocate 3% of the membership fees to the support of water-related grassroots activities.

Though this was the first year of the Fund, we received as many as 156 applications from 34 countries. Following discreet screenings, we have decided on 19 recipients. We intend to deliver the grants to each recipient before the end of this year.

In consideration of the purpose of the Fund, we believe it is preferable to hand the grant directly to each recipient through a concerned person. If there are any JWF members who would like to volunteer to be mediators between JWF and the recipients, please contact us. It is a great honour for us to be able to develop not only information exchanges, but also face-to-face contacts with people who are working hard in the field.

Regional meetings for the 4th World Water Forum have gained momentum.

Following the Southeast Asia sub-regional meeting, the Oceania/Pacific sub-regional meeting was held. For details, please refer to the following report.

The Chongchon River Restoration project has completely captivated my heart these days.

Appendix 4: Photographs from the field trip to Congechong river rehabilitation project



Appendix 4

International Conference

“FROM KNOWLEDGE OF LANDSCAPES TO LANDSCAPING ACTION”

Bordeaux, 2-4 December 2004

Theme – The place of the landscape in urban policies

Title - Rehabilitation of river landscapes in the urban context - evaluating aesthetics for decision making process.

Tittre - Réhabilitation de paysages fluviaux en contexte urbain – evaluation esthétique pour un process decisionnel.

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Abstract

This work refers to the establishment of a methodology to evaluate urban river aesthetic quality, in order to integrate this evaluation into a decision making process for river rehabilitation. It has been undertaken through an European research project called URBEM (Urban River Basin Enhancement Methods), (www.urbem.net). This project has the objective of providing a comprehensive framework to facilitate urban watercourse rehabilitation that takes into account the regional variations in modification and use of watercourse across Europe.

Within the project framework, the team developed a methodology for river aesthetics evaluation, based on a research that looked deeply on the topic of landscape quality perception and evaluation, including both expert assessments and public surveys.

This research was designed based on a three-dimensional approach – the river, the city and the people, as the main poles of the conceptual framework for aesthetical evaluation.

The methodology was based on several steps, such as problem identification and structuring, through the generation of ideas and aspects considered relevant to the evaluation of aesthetic quality of urban rivers; establishment of a network of viewpoints considered more relevant to the aesthetical classification of urban watercourses, and model building, through designing a process of evaluation, comparison and weighting of the scores assigned to the selected viewpoints, leading to the establishment of an aesthetic profile of an urban watercourse.

The overall aim is to integrate this methodology in a decision support system, allowing understanding the different dimensions and characteristics that can be improved in a river rehabilitation scheme. This work may contribute to the opportunity to rehabilitate or

create new urban landscapes, where nature can be more present in cities, based on criteria recognized as relevant for a wide aesthetic appreciation. More pleasant aesthetic environments and increased public participation are recognized as critical issues when considering sustainability as a target for urban rehabilitation.

Resumé

Ce travail se centre sur l'établissement d'une méthodologie pour évaluer la qualité esthétique des fleuves urbains, avec le but d'intégrer cette évaluation dans un processus d'aide à la décision pour la réhabilitation des fleuves. Cette méthodologie a été développée au cours du projet de recherche Européen URBEM (Urban River Basin Enhancement Methods), (www.urbem.net). Ce projet a comme but établir un cadre intégré pour permettre la réhabilitation des fleuves urbains, permettant de tenir en compte les variations régionales des usages et modifications des fleuves à travers l'Europe.

Dans le cadre du projet, l'équipe a développé une méthodologie pour l'évaluation de la qualité esthétique des fleuves urbains, ayant comme base la recherche sur la perception et évaluation de la qualité du paysage, incluant les avis des experts et les enquêtes au public.

Cette recherche a été établie sur une approche tri-dimensionnelle – le fleuve, la ville et les personnes –, comme les principaux pôles du cadre conceptuel pour l'évaluation esthétique. La méthodologie s'établit sur plusieurs étapes, comme l'identification et structuration des questions de recherche, à travers de la génération des aspects importants pour l'évaluation de la qualité esthétique des fleuves urbains; l'établissement d'un réseau de « points de vue » considérés plus importants pour la classification esthétique des fleuves urbains, et la construction du modèle, par l'établissement d'un processus d'évaluation, comparaison et pondération des points de vue choisis, ayant pour but l'établissement d'un profil esthétique d'un fleuve urbain.

L'objectif global est l'intégration de cette méthodologie dans un système d'aide à la décision, pour permettre comprendre les différentes dimensions et caractéristiques qui peuvent être améliorées dans un projet de réhabilitation fluviale. Ce travail peut contribuer pour réhabiliter ou créer de nouveaux paysages urbains, où la nature peut devenir plus présente, tenant en compte des critères reconnus comme importants pour une appréciation esthétique élargée. Des ambiances plus plaisantes et une croissante participation publique sont reconnues comme des questions clé quand on envisage le développement durable comme un but pour la réhabilitation urbaine.

1. Introduction

The role of landscape studies in urban policies shows a raising concern and appeals to interdisciplinary research. Urban issues and territorial and environmental problems are actually under the scope of the search of sustainability. Urban sustainability tends to be a framework for the long and medium term visions for planning and management in cities in the 21st century. The need to assess the path and progress towards a more sustainable development for urban areas requires a special commitment towards the urban environment by decision makers and local managers.

Urban sustainability is a broad concept that involves several complex dimensions, related with quality of life, environmental objectives, economic efficiency, equity and shared governance and public participation, among other issues¹. The context and meanings of urban landscapes adds to those dimensions the aesthetic component, which brings more complexity and subjectivity to the decision making process.

In our point of view, aesthetic quality in the urban environment can be considered as a complementary dimension of sustainability, which should be achieved together with other components of sustainable development, referred above. This assumption means that landscape aesthetic quality and appreciation should be considered beyond its visual appearance, in combination with other dimensions of the urban environment.

Landscape aesthetic appreciation and evaluation is actually an important concern in the field of environmental planning. The balance between natural and cultural environments has always been a concern for human societies, in a search for beauty, delight and balance of human works and their environmental relationship. Thus, environmental aesthetics is actually a relevant interdisciplinary field of research, crossing disciplines so diverse such as geography, planning, landscape architecture, architecture, psychology, and philosophy, amongst others. This recognition shows that aesthetic evaluation is a raising issue, as an important complement area of research such as sustainable development, planning and resource management².

Aesthetic values can be assessed through different approaches and motivations. The existent and wide literature comprises several approaches, from the expert or professional point of view, concerning technical aims and the integration in the planning process. Other approaches come from the social sciences framework, namely from the fields of environmental psychology, integrating behavioural studies related with public perceptions and preferences for scenic and aesthetic values³. Phenomenological approaches are more concerned with the intangible, sensorial and emotional aspects of landscape appreciation.

Several policy documents encourage including the assessment of environmental values in the planning process. Among those, the Landscape European Convention states the need for integration of landscape into regional and town planning policies. Other policy documents and programs, related with the urban environment, recommend the integration of targets, objectives, measures and instruments where landscape plays an important role, calling for strategies where landscape perception, assessment and evaluation are critical aspects. The work described in this paper intends to establish and discuss a methodology for evaluating the aesthetic value of rivers and riverfronts in cities, as a contribution for the management and rehabilitation of urban rivers across Europe.

2. Natural features in the urban landscape. Urban river rehabilitation

In the context of urban landscapes, a better balance between natural elements and the built environment is seen as an important target for urban development, related with a

¹ (White, 2001)

² (Berleant, 1997)

³ (Kaplan and Kaplan, 1989)

better human quality of life and to the restorative effects of nature and of natural elements in the city⁴.

Water is a key natural resource concerning sustainability and plays an important role in the urban environmental quality. The relationship city/water is a complex and demanding issue, requiring special tools and procedures affecting all the levels of urban management.

The presence and crossing of rivers in cities bring additional concerns to the urban environment. Beyond the historical, geographical and morphological contexts of its relationship, several specific aspects can be considered, such as water quality, flood vulnerability, accessibility, increased aesthetic and landscape value, and contribution to urban attractiveness, identity, among others⁵. Among these characteristics, water quality improvement is one of the more demanding, in terms of achieving environmental targets, due to the obligations of the Water Framework Directive⁶, in terms of restoring surface water quality.

This task, together with an increasing environmental concern on the rehabilitation and restoration of fluvial ecosystems, are responsible for an emergent trend on river rehabilitation and restoration programmes, all around the world⁷. The specific cases of urban rivers is highly demanding, due to its complexity in terms of uses, density, population, institutional framework, degree of pollution, public involvement, among others. On the other hand, urban riverfront areas can show an enormous potential for recovery and rehabilitation, bringing together programmes of urban regeneration with environmental, socioeconomic and aesthetic improvement⁸.

The research on policies for rehabilitation of urban rivers and watersheds is the aim of a European research project called URBEM (Urban River Basin Enhancement Methods) (www.urbem.net), under the Energy, Environment and Sustainable Development Programme. This project has an overall objective to provide a comprehensive framework to facilitate urban watercourse rehabilitation that takes into account the regional variations in modification and use of rivers across Europe. Within this project, the authors developed a methodology for the evaluation of the aesthetic value of an urban river, considering its potential for rehabilitation, with the aim of building a methodology to be incorporated in the overall assessment process towards urban river rehabilitation⁵.

3. Methodology – An interdisciplinary approach

Within the project framework, the team developed a methodology for urban rivers aesthetic evaluation, based on a research that looked deeply on the topic of landscape quality perception and evaluation, including both expert assessments and public surveys.

⁴ (Hough, 1998 ; Kaplan, 1995)

⁵ (Silva and al., 2003a)

⁶ (EC, 2000)

⁷ (Boon and al., 2000 ; FISRWG, 1998 ; Saraiva, 1999 ; Ureña, 1999)

⁸ (Petts and al., 2002 ; Riley, 1998)

The overall aim is to integrate this methodology in a decision support system, allowing to understand the different dimensions and characteristics that can be improved in a river rehabilitation scheme, compare performances and analyze their scores based on reference values.

The methodology was based on several steps described below:

- A. Design of the conceptual framework - This research was designed based on a three-dimensional approach – the *River*, the *City* and the *People* – that was inspired by the three Worlds of Habermas⁹. In this context the River can perform the material and “natural” world, the City can be viewed as the Social and “humanized” world and the People can perform the place of subjectivity, of individual emotions and perceptions (figure 1). Those three dimensions were viewed as the fundamental poles related with the several attributes that can influence the aesthetic quality of an urban watercourse

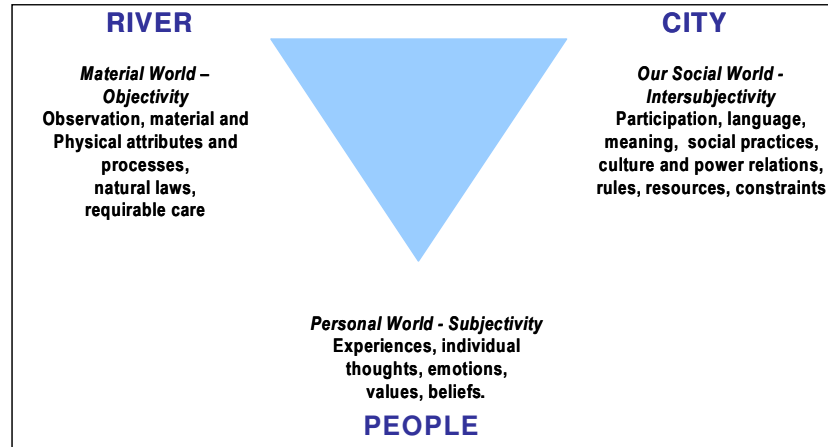


Figure 1– River-City-People framework

- B. Problem identification and structuring – This step lead to the generation of ideas and aspects considered relevant to the evaluation of aesthetic quality of urban rivers; it was conducted through an expert panel using a “post-it” technique. 15 experts from different and institutional background were brought together for a session where they have been exposed to the question: “What can influence the aesthetical quality of a watercourse in cities?”. A large number of concepts and ideas have been generated, leading to several statements that described the answers given by the different experts;
- C. Analysis of the concepts and their relationships raised from the expert panel which led to a cognitive map modeled with the help of Decision Explorer software¹⁰;

⁹ (in Mingers, 2001: 290)

¹⁰ is a software developed by Banxia Software Ld^a (www.banxia.com)

- D. Establishment of a network of viewpoints considered more relevant to the aesthetical evaluation process of urban watercourses, according to the three main dimensions previously identified– river, city and people (figure 2). This network has been organized, for each dimension, as a set of fundamental viewpoints and elementary viewpoints.

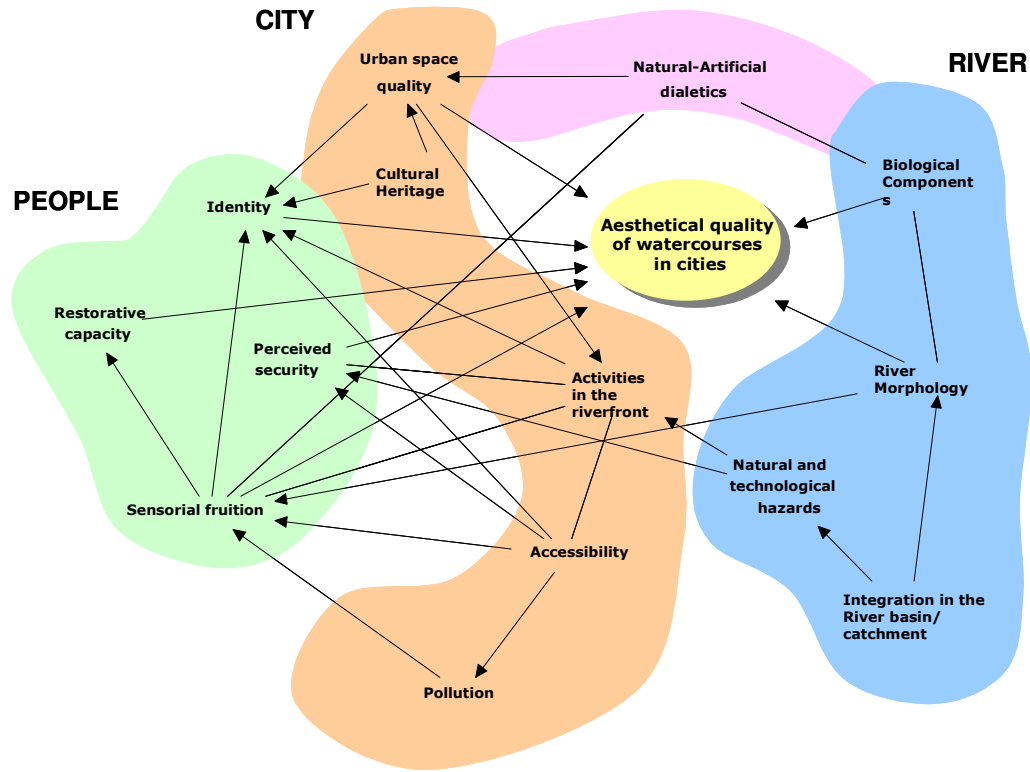


Figure 2 - Minimal network expressing the relationships between fundamental viewpoints

- E. Model building, through designing a process of evaluation / comparison of the scores assigned to the selected viewpoints, leading to the establishment of an aesthetic profile of an urban watercourse.

4. Dimensions of evaluation

The list of viewpoints obtained has been organized according to the three conceptual dimensions (River-City-People), producing a first draft of structure. Following the application of a case study (Jardas stream within the city of Cacém in the Metropolitan Area of Lisbon) a refined set of viewpoints to assess the aesthetical value of an urban watercourse was established. In the following sections, the fundamental viewpoints used in each dimension considered are briefly described.

4.1 Natural features in the landscape – the River

Among the set of 113 concepts that emerged from the expert panel session, 29 were related to characteristics of the river as a natural feature. These concepts were aggregated into 4 viewpoints, including other elementary viewpoints:

- a) River typology
- b) River morphology
- c) Biological components
- d) Natural and technological hazards

Figure 3 shows the set of attributes considered for the assessment of the dimension “river”.

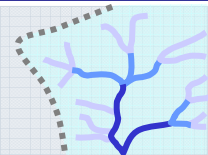
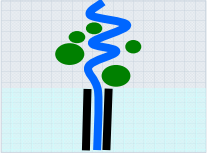
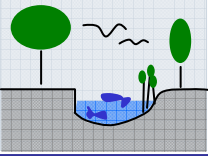
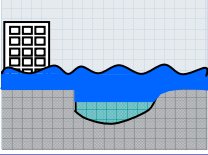
	Fundamental viewpoint	Elementary viewpoint
	River Typology	Basin size Stream order River width Valley morphology
	River Morphology	Degree of disturbance of the natural dynamics Sinuosity Bank Shape Presence of elements in the channel
	Biological Components	Biological diversity Presence of riparian vegetation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

Figure 3 – River - set and structure of fundamental and elementary viewpoints

The ecological value of a river, and in this context, its contribution to its aesthetic value, is associated to the ecological region where the river is located. The spatial framework of eco-regions, as presented in the WFD (2000), has been used to frame the viewpoint “**river typology**” and define thresholds for values measuring the natural performance of urban rivers. Each river is strongly related with the territory that generates runoff and sediment transport, which is conducted by the water movement that reaches the fluvial system. So, the spatial concern with the integration in the basin shows a strong relevance when dealing with rivers and watercourses, even in the urban context. Some

characteristics influence aesthetic appearance of an urban watercourse as the basin size, the stream order where it is located, the river width and the morphology of the valley.

River systems are natural dynamic elements, which have specific behaviours and patterns, influenced by geology, geomorphology and climate. Thus “**River morphology**” reflects a balance of forces and processes that operate through it and upon it. In natural systems, the movement of energy and matter shows the tendency to attempt a dynamic equilibrium with the discharge and sediment load provided by its basin or watershed. This dynamics of the river system is the result of complex interactions between the geometric properties of a river, the landscape where it flows and the energy and forces that act on it. The aesthetic appearance of a river can also depend upon a balance between a “natural” morphology and a “man-made” one, due to regulation, channelization or other modifications of the channel, where, for instance, sinuosity can play an important role, increasing view depth, mystery, focal points and other aesthetic attributes.

The viewpoint “**Biological components**” is associated with the biological features of the river system. In the context of urban environment, the degree of naturalism of rivers is considered one of the major contributions for its aesthetic quality. The presence and diversity of vegetation along the river corridor is a representative criterion of quality of the river ecosystems as well as one of the major factors for its aesthetic quality (Fig. 4). Diversity is generally accepted to be with more valued than uniformity in river corridors and its aesthetic quality augments in function of variety of species, vegetation stages and contrast with land uses.

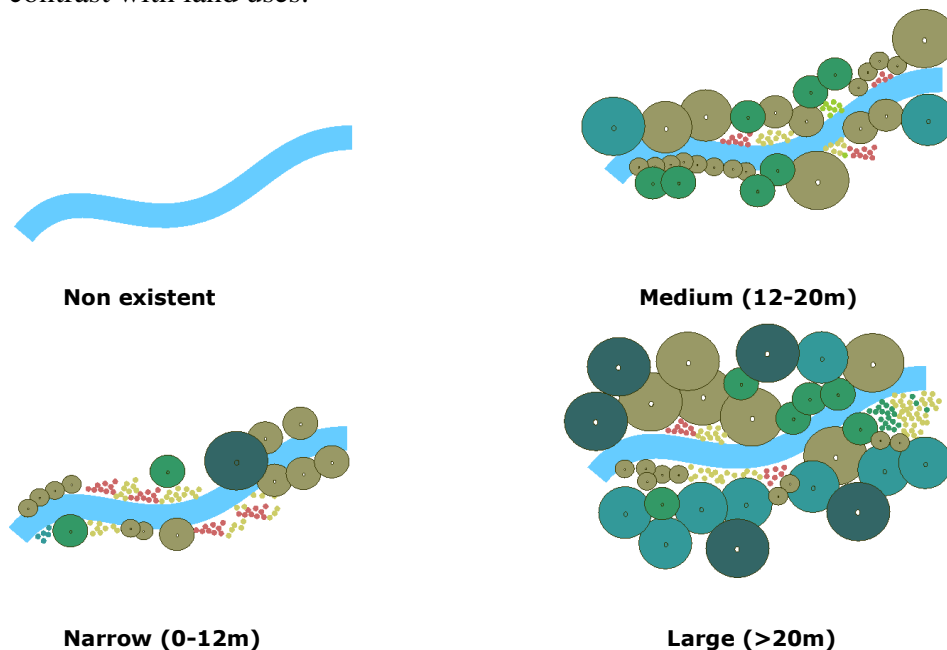


Fig. 4 – Variation in presence of vegetation along the river

“**Natural hazards**” on the river corridor are mostly associated with floods and massif soil erosion processes, both in form of bank erosion or landslides. The risk associated to these hazards highly depends on the natural characteristics, as geological structure and

hydrological regimen. Nevertheless the risk might be increased, or even induced, by human behaviours, as improper land uses, for instance, turning it into a technological hazard. Therefore increasingly it is spread the idea of using the concept of semi-natural hazards in order to reflect this independence. It is recognized that the perception of risk and feelings of insecurity may influence aesthetical appreciation of rivers.

4.2 Urban environment in the landscape – the City

Within the structuring process five fundamental viewpoints were identified as being the main issues that envelopes a wide variety of elementary aspects that can describe and influence the aesthetic value of city-river landscape. Figure 5 shows the set of viewpoints selected for the “city” dimension.

- a) Urban space quality
- b) Cultural heritage
- c) Activities on riverfront
- d) Accessibility
- e) Pollution

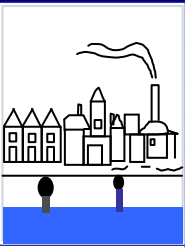
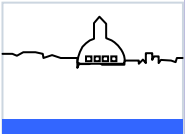
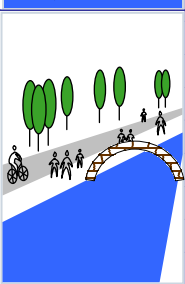
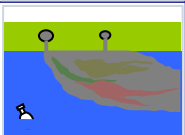
	Fundamental viewpoint	Elementary viewpoint
	Urban space quality	Visual permeability Visual contact Depth of views Width of views Density of landmarks Built space quality Public utility of riverfront Intensity of construction
	Cultural heritage	Cultural heritage
	Activities	Diversity of uses Attractiveness of riverfront
	Accessibility	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
	Pollution	Pollution

Figure 5 – City - set and structure of fundamental and elementary viewpoints

The “**Urban Space Quality**” can be evaluated through a set of five elementary viewpoints. Visual Permeability regards the existence of river perspectives and their wideness and contact points with water, which will be strongly influenced by urban morphology and variety of visual access from buildings. Landmarks or reference points in the landscape explains the presence of remarkable points in the river corridor (the well known method of Kevin Lynch(1960) can be adopted) specially those that are physically perceptible in the landscape. The Quality of Built Space in the river-corridor regards the quality of construction, its state of conservation healthy conditions and the existence of basic infrastructures. The Public Utility given to both river watersides concerns the equity of access to the aesthetic values of the river. The balance between public open areas in good condition and private open areas can reveal the importance given by society and its political representatives to this issue. It was also considered that low Intensity of Construction on the river margins would have better consequences in the aesthetical performance of the river.

“**Cultural Heritage**” (CH) of city-river landscape regards its public interest – the amount of collective memories and its social representation – and regards the level of attractiveness of existent CH values which can be influenced by several factors, namely the state of conservation, the level of free access, etc.

It is also important to consider the “**Human Activities in the Riverfront**” – where the human contact with the river is more intense, which increases the potential of interaction between the people and the river.

Diversity of uses enriches the urban landscape trough the interrelation between urbanized areas – more artificialized, full of human life and agitation - and natural areas – less stressed and offering quiet places to stay, enjoy and interact with nature and water. The attractiveness of these activities also influences indirectly the aesthetics through their distinctiveness, the presence of leisure and tourist activities, occasional or regular public events, the presence of relevant economic activities or special commercial units.

Many towns and cities owe their existence to water, developing around a port or being located at a major crossing point. “**Accessibility**” is an indirect factor that makes more or less possible the people enjoyment of aesthetic values of urban waterfront. Also, the way in which people access the river has great importance. In most urban watercourses, bridges are in fact the common way to cross the water, having two fundamental functions: Linking function and Contact zones¹¹ The majority of the existent bridges allow all kinds of traffic to cross but others are exclusively to pedestrians or bikes. In fact the so-called soft modes of transportation – walk or bike - are the ones that promote a more close contact with the water, the sight and the landscape. Accessibility is relevant in what concerns the relationship of the people with the river and what concerns the development of a collective aesthetical notion related with a daily contact with water.

¹¹ (Manning, 1997)



Figure 6 – Different kinds of river crossings.

Looking from the river to the city, the traditional transportation function or **navigability** arises also as an important factor promoting the movement of people and goods by water transport, having aesthetical significance to some port cities. The water transport adds color, movement and life to the urban watercourses that should be seized and balanced by retaining and developing public and private water transport. Also, the leisure activities, associated with the regeneration of disused water frontages, are becoming popular and appealing for users and tourists. *Looking from the city to the river*, the access to riversides is a prerequisite to promote the use by people, which should be well balanced in terms of nature and landscape preservation and in terms of the transportation modes used. Problems derived from the use and abuse of private car can create environmental impacts that should be mitigated and minimized.

For the purpose of aesthetic assessment of urban rivers, more adequate sustainable transport solutions exist. **Public Transport Systems** and **Soft Modes** are actually considered a better sustainable alternative to access riverfront in central urban areas in spite of using the private car. If the river is also considered an important focus and generator of events, we must mention the problem of valleys that have become a corridor for major urban roads or railways. Manning (1997:79) mentions this as the **disruption effect** that may be devastating.



Figure 7 – Increasing effect of disruption in the valley of Alcântara Stream, Lisbon (XVIII and XXI century) and in the riverfront of Tagus River in Lisbon.

4.3 Human Perception of the Landscape – The People

From the expert panel session a set on concepts emerged connected with the relation of people with rivers. These concepts were aggregated into three fundamental viewpoints (Figure 8):

- a) river landscape public perception,
- b) place identity
- c) restorative capacity.

Fundamental viewpoint	Elementary viewpoint	
Public perception	In relation to the River	Aesthetic Water Biodiversity Risk related with the perception of flood risk Pollution
	In relation to the City	Urban quality Accessibilities Security Infrastructures
	The dimensions identified with the people relationship with the river	Relax Attachment
Place Identity	Continuity Self-esteem Self-efficacy Distinctiveness	
Restorative Capacity	Being away Fascination Extent Compatibility	

Figure 8 – People - set and structure of fundamental and elementary viewpoints

The viewpoint “**public river landscape perception**” is related to the process of extracting meaning from complex stimuli encountered in river landscapes. There is evidence that environmental perception depends on physical elements in the scene and their spatial arrangement. But also personal, cultural and training factors are relevant.

Therefore, it is possible to say that public perception suffers from a lack of objectivity. Nevertheless, public perception of a specific landscape gives important information about people's preferences and their behaviour in the landscape.

Environmental perception is connected with the attitudes towards the environment, and it reflects conflicts between positive and negative characteristics of the environment. In order to understand “**public river landscape perception**”, it is necessary to identify cognitions, feelings and behaviours of its users. Literature on public perception of the riverine areas in urban context identifies several dimensions. Dimensions related with the river itself as biophysical feature (e.g.: perception of quality of water, pollution, and biodiversity and risk perception); dimensions related with the city surrounding the river (e.g.: perception of urban quality, accessibilities, infrastructures or perception of security); and dimensions that reveals people's relationship with space as individual (e.g.: relax, attachment).

The second view point considered is “**place identity**” which commonly refers to “*those dimensions of the self that define the individual's personal identity in relation to the physical environment by means of a complex pattern of conscious and unconscious ideas, beliefs, preferences, feelings, values, goals, and behavioural tendencies and skills relevant to this environment*”¹².

Some studies show that place identity can play an important role in the perception of environmental changes, in the perception of environmental problems and perception of public areas. There is evidence that a positive and strong place identity reduces the negative perception of some environmental problems or increases the positive perception of some environmental aspect.

In relation to the “**restorative capacity**”, empirical research strongly suggests that viewing natural scenes (like visiting natural places, or even viewing photographs of natural scenes) may have a restorative effect, contributing, for instance, to reduce stress and to promote positive moods and feelings¹³. So, natural spaces in urban areas, and notably those with presence of water³, can promote a positive view of the place. Natural environments can be restorative because they stimulate the involuntary attention, that requires little efforts because it allows cognitive freedom, meaning that it allows the subject only to concentrate on the environmental aspects that they choose and escape from the daily activities, in the sense that natural environments provide freedom of rules and obligations. In the context of this research, it was used the Kaplan and Kaplan' conceptualisation (1989, 1995) that considers four interrelated characteristics of restorative experiences: *being away, fascination, extent, and compatibility*.

Understanding of restorative environment can be useful in environmental design, planning, and policy¹⁴ and the measurement of restorative qualities of person-environment transactions can help in applying such understandings¹⁵

¹² (Proshansky, 1978:155)

¹³ (Ulrich and al., 1991)

¹⁴ (Kaplan and Kaplan, 1989 ; Ulrich and al., 1991)

¹⁵ (Hartig and al. 1996)

Even though there may be different approaches to the understanding people's perception of a specific river in the urban context, asking them directly proves to be the most reliable way of gaining information. Therefore, for each viewpoint of the "people component" a questionnaire was developed based on the concepts previously presented.

Since this research aims to develop a methodology, it was constructed a questionnaire that should set a basis for assessing these viewpoints. Nevertheless, this general version of the questionnaire has each time to be adapted to the characteristics of the river, to the specific urban context, and to the social background present in the case studies. Otherwise the results may not prove to be reliable.

The integration of information on public perception in aesthetic evaluation is relevant in setting guidelines for river rehabilitation processes, because it informs about potential users expectations and desires towards the future of these landscapes. In this way the rehabilitation process may contribute to increase the users attachment and identity with the place and promote, as well as, environmental conservation behaviour.

5. Evaluation process

A multicriteria approach was used to model and making operational the evaluation process. The partial performances following each elementary viewpoint have been measured through a set of chosen indicators and descriptors. The resulting measurement scales have been standardized to a cardinal common scale of performance, using simple linear functions, varying from 0 (the worst plausible level) to 100 (the best plausible level). Figure 9 shows the profile of aesthetic values obtained for Jardas stream, the case study used within the project, showing the all set of criteria performance¹⁶.

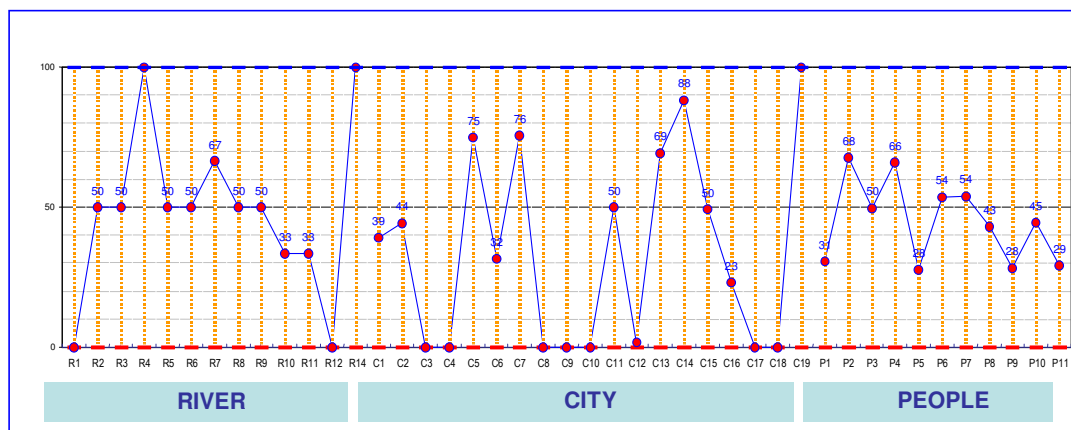


Figure 9 – Profile of aesthetical performance for Jardas Stream

This profile is a useful manner of showing the aesthetical performance of a watercourse, in the sense that all the scales have bounds (0-100) which express the local plausible achievements, allowing comparability between criteria; also, the profile do not express

¹⁶ (Silva and al., 2003b)

the preference system of decision makers, in the sense that only linear functions have been used and without considering weights. However, value functions and weights can be introduced to include value judgments from decision makers or other actors, in the decision making process.

In the profile, the upper and lower limits are useful bounds in order to perceive the meaning of those partial performances, how distant is a particular river or case study from these levels and to support the selection of criteria where the best improvements can be made in a rehabilitation scheme.

6. Discussion

The methodology used was based on several steps and approaches and, in fact, can be viewed as a multimethodology using the arguments referred by Mingers (2001:289). In fact, a multimethodology is necessary to deal effectively with the full richness of the real world, especially with aesthetical aspects, which are inevitably multidimensional. Otherwise, combining different methods and approaches may well yield better results. This means reinforcing interdisciplinarity and using several approaches, from expert evaluation procedures to other involving public surveys and enquiries, that can include several “publics”, such as residents and users of city riverfronts, decision makers, planners, etc.

Using this process, we avoided giving a unique “score” for aesthetical quality of an urban river, but to look to a set of partial performances of each situation, following each viewpoint selected in our approach.

The approach described shows some advantages, as following:

- revealing the diversity of characteristics of each urban watercourse. Some could be more related with social and cultural context, other with a more “natural” landscape or even a specific geographic context;
- allowing perceiving and better understanding the different dimensions that can be improved in a river rehabilitation process and compare performances between rivers in different contexts.

We believe that this procedure can help to establish conclusions and comparisons about profiles of aesthetical characteristics of urban watercourses, helping also in defining priorities in urban rehabilitation processes and policies, taking into account landscape aesthetic values, which try to include not only expert procedures, but also some inputs from public surveys and human values assessment.

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Raumentwicklung e V Dresden, Germany, University of Newcastle-Upon-Tyne, UK, Newcastle City Council, UK, Cemagref, France, Centre for Urban Waters, UK, University of Ljubljana, Slovenia, Javno podjetje Vodovod-Kanalizacija, Slovenia, Department for Water Management, Hydrology and Hydraulic Engineering, University of Agricultural Sciences, Vienna, Austria and Laboratorio Nacional de Engenharia Civil (LNEC), Portugal, are the organizations participating in the project, which provided interesting exchange of views and scientific contributions. This research work is part of the WP4 of the project, on the aesthetic evaluation of urban rivers and watercourses, led by CESUR, a research center from Instituto Superior Técnico of the Technical University of Lisbon. Acknowledgements are due also to Filipa Monteiro and Cristina Câmara for the involvement in previous research and production of graphic information.

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Appendix 5

Methodology of aesthetic evaluation of rivers in urban context

Prof. Jorge Batista e Silva, Prof. Maria Graça Saraiva, Isabel Loupa Ramos, Fátima Bernardo

1. Introduction

Landscape aesthetic appreciation and evaluation is actually an important concern in relevant interdisciplinary fields of research, crossing disciplines so diverse such as geography, planning, landscape architecture, architecture, psychology, and philosophy among others and a raising issue in sustainable development, planning and resource management (Berleant, 1997).

Aesthetic values can be assessed through different approaches and motivations, namely from expert or professional point of view, from the social sciences framework like environmental psychology (Kaplan and Kaplan, 1989) or through phenomenological approaches, more concerned with the intangible, sensorial and emotional aspects of landscape appreciation.

Several policy documents encourage the inclusion of assessment procedures in the planning process. Also, the Landscape European Convention states the need for integration of landscape into regional and town planning policies. Water is also a key natural resource concerning sustainability - the presence and crossing of rivers in cities, water quality, flood vulnerability, accessibility, increased aesthetic and landscape value, and contribution to urban attractiveness, identity, among others (Silva and al., 2003a). Water quality improvement is one of the more demanding due to the obligations of the Water Framework Directive (EC, 2000). This task, together with an increasing environmental concern on the rehabilitation and restoration of fluvial ecosystems, are responsible for an emergent trend on river rehabilitation and restoration programmes, all around the world (Boon and al., 2000 ; FISRWG, 1998 ; Saraiva, 1999 ; Ureña, 1999). The specific cases of urban rivers is highly demanding, due to its complexity in terms of uses, density, population, institutional framework, degree of pollution, public involvement, among others. On the other hand, urban riverfront areas can show an enormous potential for recovery and rehabilitation, bringing together programmes of urban regeneration with environmental, socioeconomic and aesthetic improvement (Petts and al., 2002 ; Riley, 1998).

This project has an overall objective to provide a comprehensive framework to facilitate urban watercourse rehabilitation that takes into account the regional variations in modification and use of rivers across Europe. Within the European research project URBEM (Urban River Basin Enhancement Methods) (www.urbem.net), the authors developed a methodology for the evaluation of the aesthetic performance of an urban river, considering its potential for the urban river rehabilitation.

2. The Methodology

The overall aim was to develop and integrate in a decision support system a methodology of aesthetic evaluation of rivers in urban context, allowing better understanding about different dimensions and characteristics that can be improved in a river rehabilitation scheme, compare performances and analyze their scores based on reference values. The methodology includes both expert assessments and public surveys and is inspired on Multi Criteria Decision Analysis procedures (Belton, 2002). The methodology follows three main steps described below:

- ☐ Exploring
- ☐ Structuring
- ☐ Modelling

2.1. Exploring

This first important step leads to the generation of ideas that are considered relevant to the evaluation of aesthetic quality of an urban river. It can be conducted through an expert panel using a “post-it” technique (Eden, 1989). During a case-study application 15 experts, from different and institutional background, were brought together for a session where they have been exposed to the question: “What can influence the aesthetical quality of a watercourse in cities?”. A large number of concepts and ideas have been posted, through an interactive process of generating knowledge and enlarging the field of common understanding about aesthetics.

2.2. Structuring

The analysis of these concepts and their relationships, emerged from the expert panel, lead to a cognitive map that can be modelled with the help of Decision Explorer software¹. The complex network of concepts obtained will be then structured and organized considering their relevancy to the aesthetical evaluation process of urban watercourses. A set of fundamental viewpoints and elementary viewpoints can be obtained through a hierarchic representation.

2.3. Modelling

The modelling stage is based on a designing process that leads to the evaluation and comparison of performances of alternatives, the urban watercourses that are supposed to be evaluated, assigned to the selected viewpoints and leading to the establishment of a profile of aesthetic performances.

3. A three dimensional approach

¹ is a software developed by Banxia Software Ld^a (www.banxia.com)

The research has revealed, mainly in the *exploring* and *structuring* stages, three main types of evaluative dimensions or viewpoints – viewpoints related with the *River*, with the *City* and with the *People*. This three dimensional approach has strong similarities with the three Worlds of Habermas (*in* Mingers, 2001: 290).

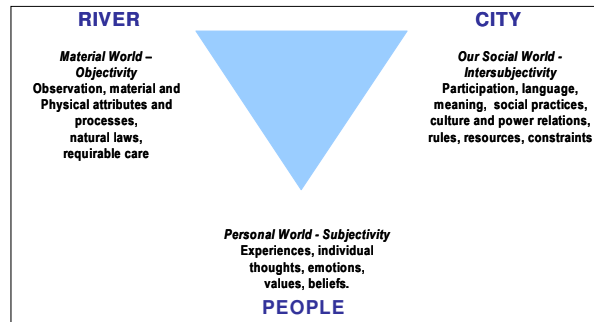


Fig.1– River-City-People framework

In this context the River can perform the material and “natural” world, the City can be viewed as the Social and “humanized” world and the People can perform the place of subjectivity, of individual emotions and perceptions (Fig.1). Within a first case study (Jardas stream within the city of Cacém in the Metropolitan Area of Lisbon) a refined set of viewpoints was established. In the following sections, the fundamental viewpoints used in each dimension are briefly described.

3.1. Natural features – the River

The main natural features of rivers that influence its aesthetics were aggregated into 4 viewpoints:

- ❑ River typology;
- ❑ River morphology;
- ❑ Biological components;
- ❑ Natural and technological hazards.

The spatial framework of eco-regions, as presented in the WFD (2000), has been used to frame the viewpoint “**River typology**”. Each river is strongly related with the territory that generates runoff and sediment transport, which is conducted by the water movement that reaches the fluvial system. The aesthetic appearance of an urban watercourse is also influenced by the basin size, the stream order where it is located, the river width and the morphology of the valley. In most situations river typology can not be changed by man.

The River is a natural dynamic system with a specific behaviour pattern, influenced by geology, geomorphology and climate. Thus “**River morphology**” reflects a balance of forces and processes that operate through it and upon it and

influences the aesthetic appearance - the balance between a “natural” morphology and a “man-made” one, like channelization, sinuosity, increasing view depth, mystery, focal points and other aesthetic attributes.

“**Biological components**” are associated with the biological features of the river system - the degree of naturalism, diversity/uniformity, variety of species, vegetation stages and contrast with land uses.

“**Natural hazards**” on the river corridor are mostly associated with floods and massif soil erosion processes, both in form of bank erosion or landslides. The associated risk depends on the natural characteristics, geological structure and hydrological regimen. Nevertheless the risk might be increased, or even induced, by human behaviours. The perception of risk and feelings of insecurity may influence aesthetical appreciation of rivers.

3.2. Urban environment – the City

Within the structuring process five fundamental viewpoints were identified as being the main issues that envelope a wide variety of elementary aspects that can describe and influence the aesthetic value of city-river landscape.

- ☐ Urban space quality
- ☐ Cultural heritage
- ☐ Activities on riverfront
- ☐ Accessibility
- ☐ Pollution

The “**Urban Space Quality**” can be related with *Visual Permeability* of built space, *Landmarks* or reference points physically perceptible on the landscape (Kevin Lynch: 1960), the *Quality of Built Space* in the river-corridor (quality of construction and maintenance, healthy conditions and the presence of basic infrastructures). The *Public Utility* given to both river watersides, expressed by the balance between public open areas in good condition and private open areas, can reveal the equity of access to the aesthetic values. It was also considered that low *Intensity of Construction* on the river margins would have better consequences in the aesthetical performance of the river.

“**Cultural Heritage**” (CH) of city-river landscape regards its public interest – the amount of collective memories, its social representation and level of attractiveness – which influences aesthetical performance.

It is also important to consider the “**Human Activities in the Riverfront**” – an intense human contact with the river increases the potential of interaction between people and the river. Diversity of uses and distinctiveness enriches the urban landscape and influences indirectly aesthetics.

Many towns and cities owe their existence to water, developing around a port or being located at a major crossing point. “**Accessibility**” is an indirect factor that

makes more or less possible the people enjoyment of aesthetic values of urban waterfront. In most urban watercourses, bridges are in fact the common way to cross the water, having two fundamental functions: Linking function and Contact zones (Manning, 1997). Also, the way in which people access the river has great importance. *Looking from the river to the city*, which highlights the traditional transportation function or *navigability* (the movement of people and goods by water transport has aesthetical significance) and *Looking from the city to the river* that highlights the use and abuse of private cars and the amount of parking surfaces. A well-balanced improvement of aesthetical value should promote more sustainable transport solutions - Public Transport Systems and Soft Modes. If the river is also considered an important focus and generator of events, we must mention the problem of valleys that have become a corridor for major urban roads or railways. Manning (1997:79) mentions this as the *disruption effect* that may be devastating. “**Pollution**” has also aesthetical consequences in water colour, odour, littering.

3.3. Human perception – the People

From the expert panel session a set on concepts emerged which are connected with the people-river relationship. These concepts were aggregated into three fundamental viewpoints:

- ☐ public perception of river landscape,
- ☐ place identity
- ☐ restorative capacity.

The viewpoint “**public perception**” is related to the process of extracting meaning from complex stimuli encountered in river landscapes, which depends from physical elements in the scene, their spatial arrangement, personal, cultural and training factors. On a public perception assessment there is a lack of objectivity, nevertheless it gives important information about people’s preferences and their behaviour in the landscape through the identification of cognitions, feelings and behaviours of its users. Literature on public perception of riverine areas in urban context identifies several dimensions: biophysical features; dimensions related with the urban surroundings of the river; dimensions that reveals people’s relationship with space as individual (e.g.: relax, attachment).

“**Place identity**” refers commonly to “*those dimensions of the self that define the individual’s personal identity in relation to the physical environment by means of a complex pattern of conscious and unconscious ideas, beliefs, preferences, feelings, values, goals, and behavioural tendencies and skills relevant to this environment*” (Proshansky, 1978:155) which plays an important role in the positive or negative perception of environmental problems and changes.

In relation to the “**restorative capacity**”, empirical research strongly suggests that viewing natural scenes may have a *restorative effect*, contributing, for instance, to reduce stress and promote positive moods and feelings (Ulrich and al., 1991). So, natural spaces in urban areas, and notably those with presence of water, can promote a positive view of the place stimulating the involuntary attention that requires little efforts. In the context of this research, it was used the Kaplan and Kaplan’ conceptualisation (1989, 1995) that considers four interrelated characteristics of restorative experiences: *being away*, *fascination*, *extent*, and *compatibility*. Understanding the restorative environment can be useful in environmental design, planning, and policy (Kaplan and Kaplan, 1989; Ulrich and al., 1991) and the measurement of restorative qualities of person-environment transactions can help in applying such understandings (Hartig and al. 1996).

The assessment of *People World* has been done using questionnaires, based on the concepts previously presented, and adjusted to local characteristics of the river, to the specific urban context, and to the social background present in the case studies. The integration of information on public perception in aesthetic evaluation is relevant in setting guidelines for river rehabilitation processes, because it informs about potential users expectations and desires towards the future of these landscapes. In this way the rehabilitation process may contribute to increase the users’ attachment and identity with the place and promote environmental conservation behaviour.

4. The profile of aesthetical performance

A multicriteria approach was used to model and making operational the evaluation process. The partial performances following each elementary viewpoint have been measured through a set of chosen indicators and descriptors. The resulting measurement scales have been standardized to a cardinal common scale of performance, using simple linear functions, varying from 0 (the worst plausible level) to 100 (the best plausible level). Fig. 2 shows the profile of aesthetic performance obtained for Jardas stream, the exploratory case study used within the project, showing the all set of criteria performance (Silva and al., 2003b).

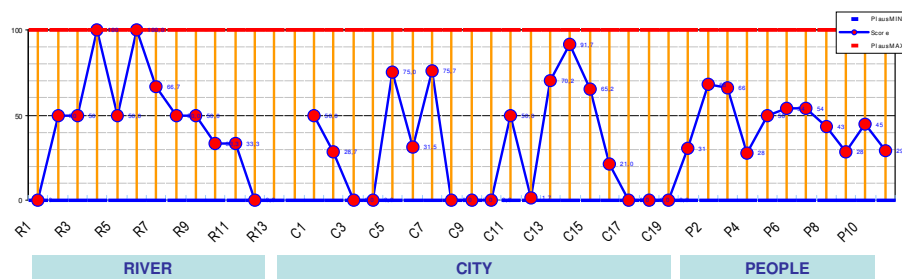


Fig. 2 - Profile of aesthetical performance for Jardas Stream

This profile can be a useful manner of showing more objectively the aesthetical performance of an urban watercourse, expressing the local plausible achievements and allowing comparability between criteria and between *worlds*. The profile is bounded which is useful to perceive the meaning of partial performances and supporting the selection of criteria where the best improvements on aesthetics can be made in a rehabilitation scheme. The profile does not express the preference system of decision makers (weights were not used). However, value functions and weights can be introduced to include value judgments from decision makers or other actors, in the decision making process.

5. Discussion

The methodology presented can be viewed as a *multimethodology*, using the arguments referred by Mingers (2001:289), because it deals effectively with the full richness of the real world, especially with aesthetical aspects, which are inevitably multidimensional. Combining different methods and approaches may well yield better results. This means reinforcing interdisciplinarity and using several approaches, from expert evaluation procedures to other involving public surveys and enquiries, that can include several “publics”, such as residents and users of city riverfronts, decision makers, planners, etc.

The approach described shows some advantages, as following:

- revealing the diversity of characteristics of each urban watercourse. Some could be more related with social and cultural context, other with a more “natural” landscape or even a specific geographic context;
- allowing perceiving and better understanding the different dimensions that can be improved in a river rehabilitation process and compare performances between rivers in different contexts.

We believe that this procedure can help to establish conclusions and comparisons about profiles of aesthetical characteristics of urban watercourses, helping also in defining priorities in urban rehabilitation processes and policies, taking into account landscape aesthetic values, which try to include not only expert procedures, but also some inputs from public surveys and human values assessment.

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Appendix 6



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Urban River Basin Enhancement Methods (URBEM)

Valerie Bain, Roger Bettess

HR Wallingford



Presentation outline

- The typical urban river environment
- URBEM project objectives
- URBEM decision-making framework
- Case study information
- Rehabilitation techniques
- Assessing aesthetics
- Assessing social capital
- Indicators of success
- Assessing rehabilitation potential
- Conclusions



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The typical urban river environment

River Tame, Birmingham, UK





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Urban river rehabilitation in practice

River Quaggy, London, UK

- Before



- After



Before: London Borough of Lewisham, Chinbrook Meadows, January 2003, Report on River Rehabilitation
After: Alfred Olfert, IOER Dresden, 2004



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Urban river rehabilitation in practice

Mill Race, Chrudim, Czech Rep.

- Before



- After



Before: Town of Chrudim

After: Alfred Olfert, IOER Dresden, 2004



URBEM project objectives

Framework to facilitate rehabilitation

- Decision making before, during and after rehabilitation project

Take into account regional variations

- Considering different modifications and different uses across Europe

Develop new tools

- New tools, techniques and procedures to enhance urban rivers

Provide decision support and training

- To planners, water managers, non-technical decision-makers, stakeholders, the public

Timescale

- Nov 2002 – Oct 2005

Partners





Approach

- A Framework for achieving
 - Efficiency
 - Effectiveness
 - Evolution
- Generic approach to assessing and managing river rehabilitation
- Support Guidance
 - Information that is available to inform the decisions taken in the generic approach
- Decision Guidance
 - Tools and assessment procedures that elicit a decision



Urban River Basin Enhancement Methods (URBEM) Activity Chart

SUPPORT GUIDANCE

How to navigate the framework

S1.1
Introduction to the Framework

WP9

S1.2
Glossary and Appendices

WP1

S1.3
Training and Dissemination

WP11

River Rehabilitation Information

S2.1
Existing Case Studies

WP2

S2.2
Study site monitoring

WP3

S2.3
New techniques

WP6

DECISION GUIDANCE

What techniques are available?

D1.1
Aesthetic Evaluation Methodology

WP4

D1.2
Social Appraisal Tool

WP7

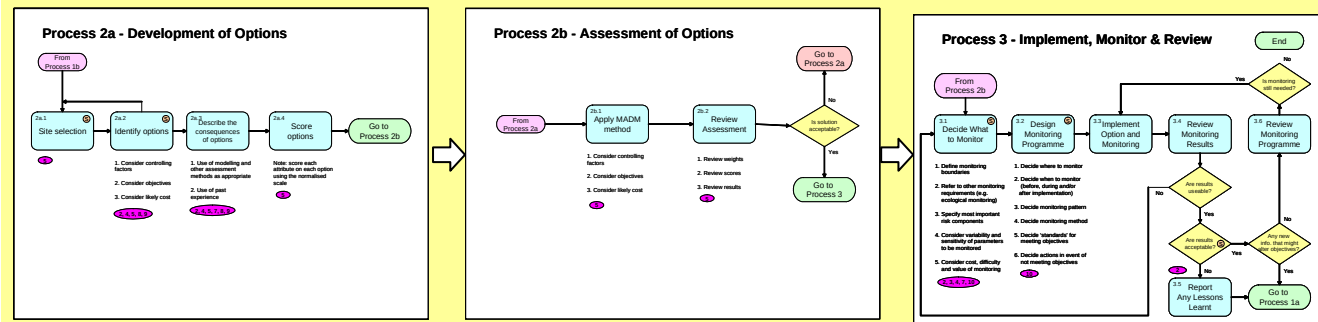
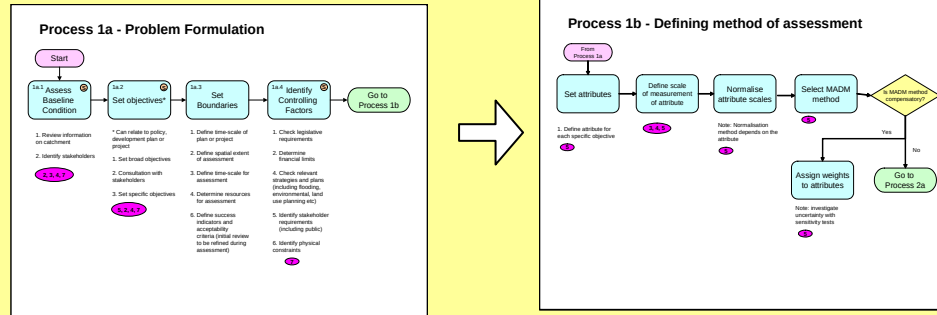
D1.3
Multi-Attribute Decision Making

WP5

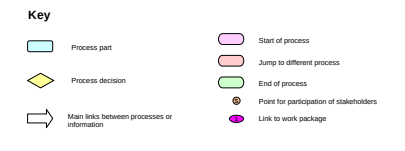
Which indicators can be used for decision-making?

D1.4
Indicators of Success

«Documents include success indicators for different objectives»
«Provides information on application»
«Guides existing data, models and measurements that (if available) can be used»



GENERIC APPROACH TO ASSESSING AND MANAGING RIVER REHABILITATION





How to navigate the framework

S1.1

Introduction
to the
Framework

WP9

S1.2

Glossary and
Appendices

WP1

S1.3

Training and
Dissemination

WP11





River Rehabilitation Information

S2.1

Existing Case
Studies

WP2

S2.2

Study site
monitoring

WP3

S2.3

New
techniques

WP8





Existing rehabilitation schemes in Europe and North America

- Approaches in managing and assessing rehabilitation
- Different techniques and scheme design
- Measuring the impact of the schemes in terms of ecology, hydromorphology and water quality



European Case Studies

European Union Member States

 [overview](#)

Austria

- > [Salzburg](#)
- > [Vienna](#)

Belgium

- > Brussels

France

- > Lyon
- > S  one

Germany

- > [Dresden](#)
- > [Hamburg](#)
- > Hannover
- > [Munich](#)
- > [Nuremberg](#)
- > [Ruhr](#)
- > [Wandsbeck](#)

Italy

- > [Florence](#)
- > [Rome](#)

Spain

- > Barcelona

The Netherlands

- > [Arnhem](#)

United Kingdom

- > Darlington
- > London
- > Newcastle

Other European Countries

 [overview](#)

Norway

- > Oslo

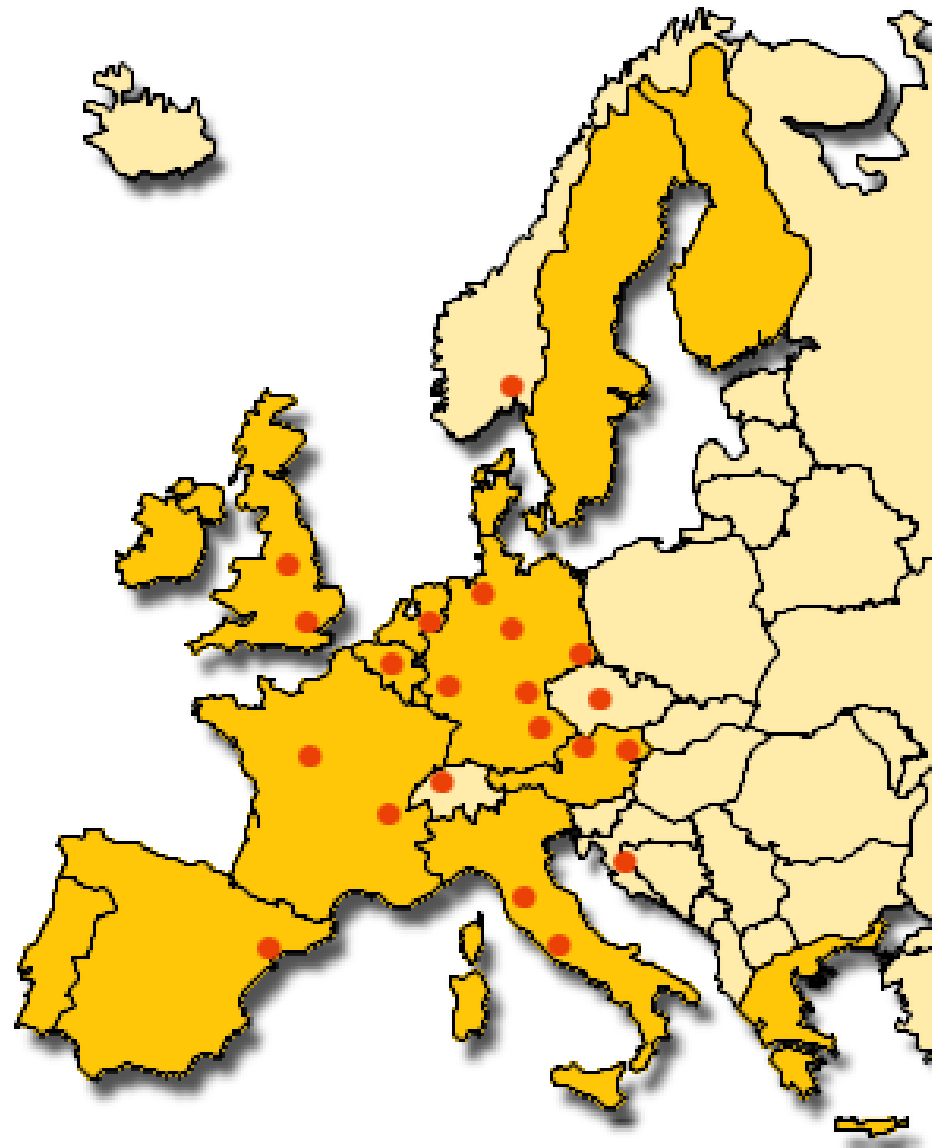
Switzerland

- > [Zurich](#)

New Member States

Czech Republic

- > Chrudim





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North American Case Studies



North American Countries

 [overview](#)

Canada

> [Toronto](#)

United States

> [Wilmington](#)

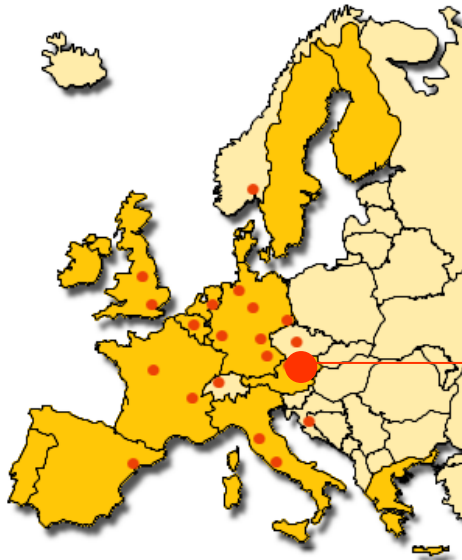
> [Washington](#)



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Austria

The Wienfluss, Vienna

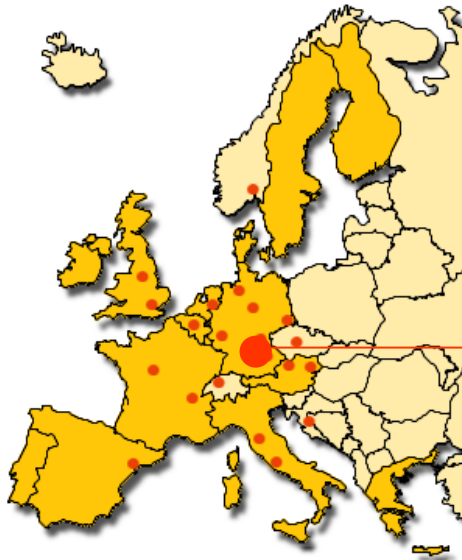




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Germany

The Isar, Munich

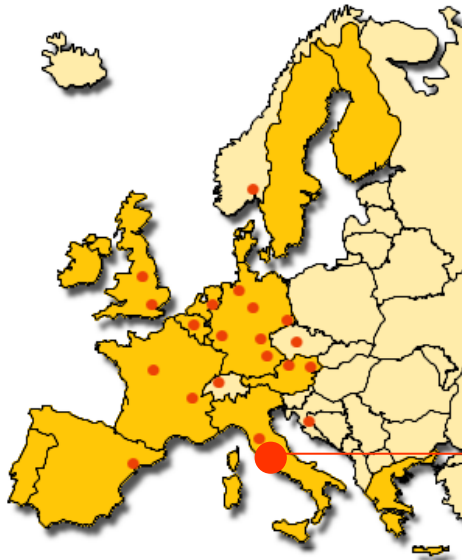




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Italy

Mugnone Brook, Florence

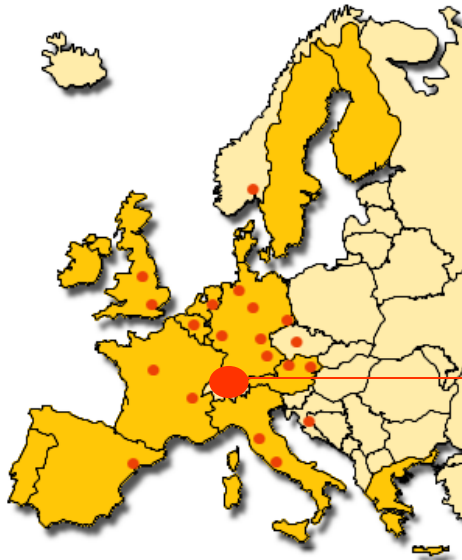




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Switzerland

Albisreader Dorfbach, Zurich

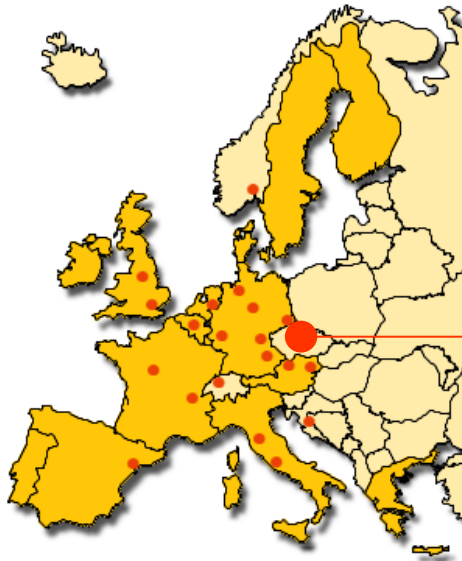




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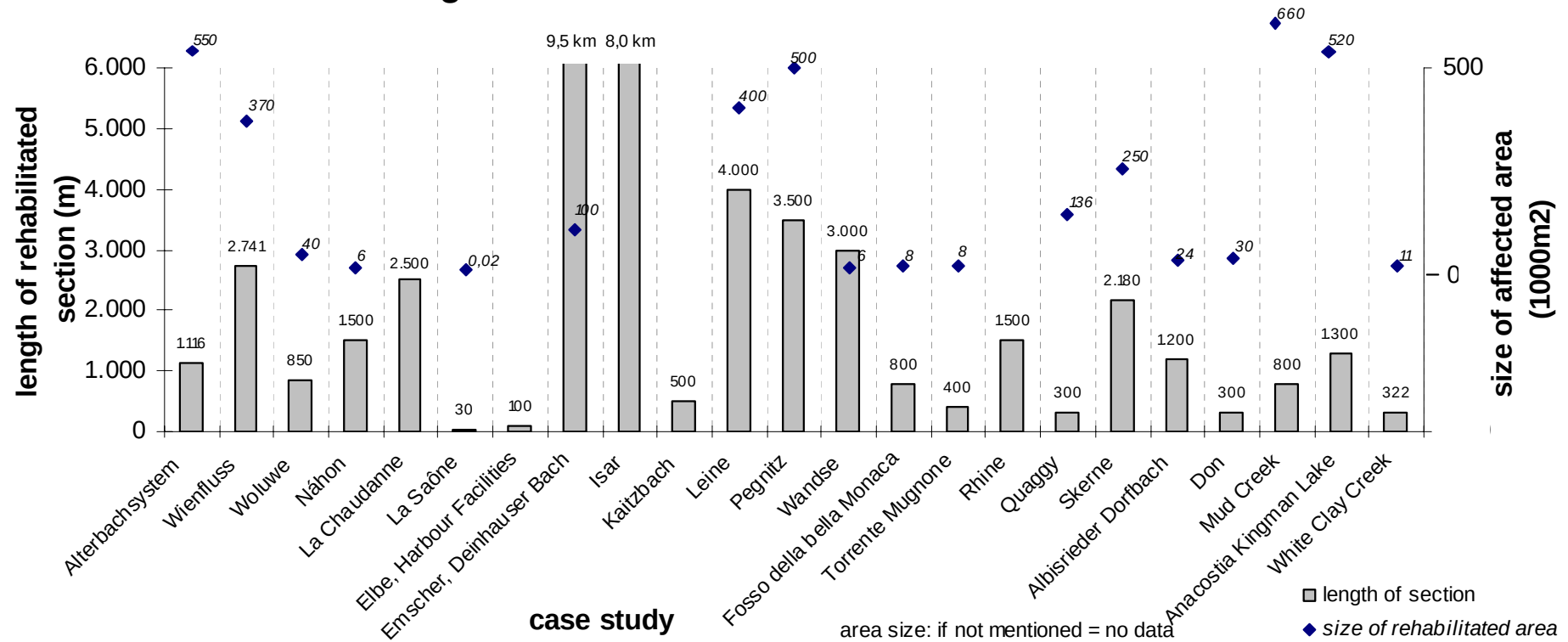
Czech Republic

The Nahon (Mill Race), Chrudim



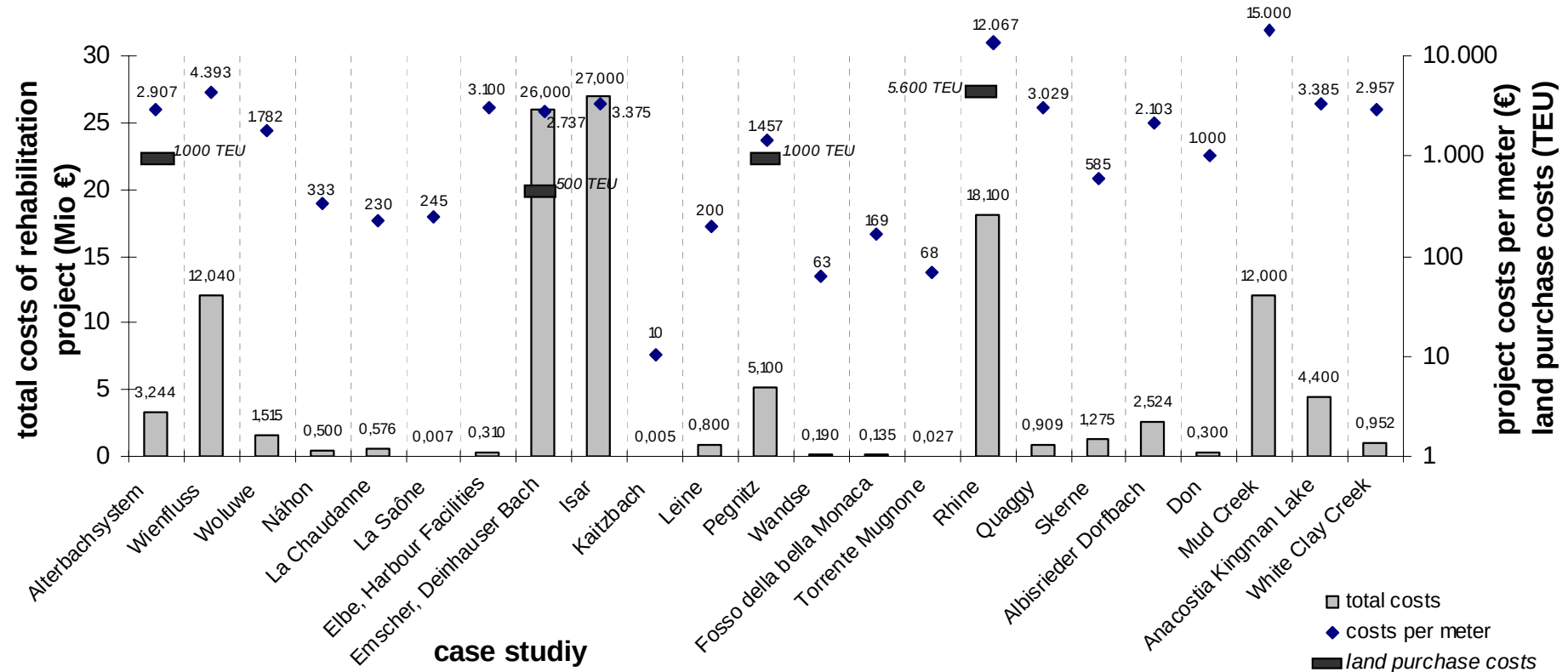
Scale of Rehabilitation

Length of rehabilitated section and size of area



Cost of Rehabilitation

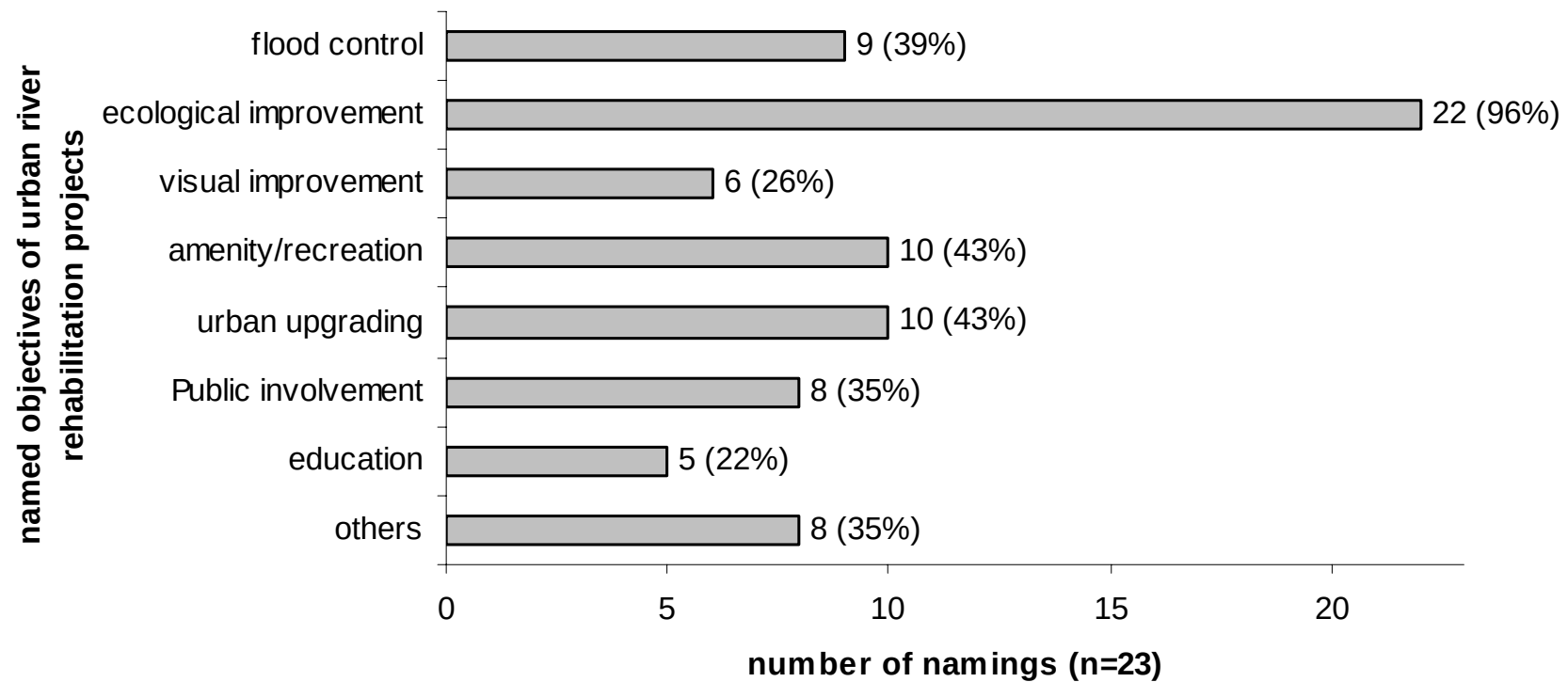
Total costs of rehabilitation projects and costs per meter





Objectives of Rehabilitation

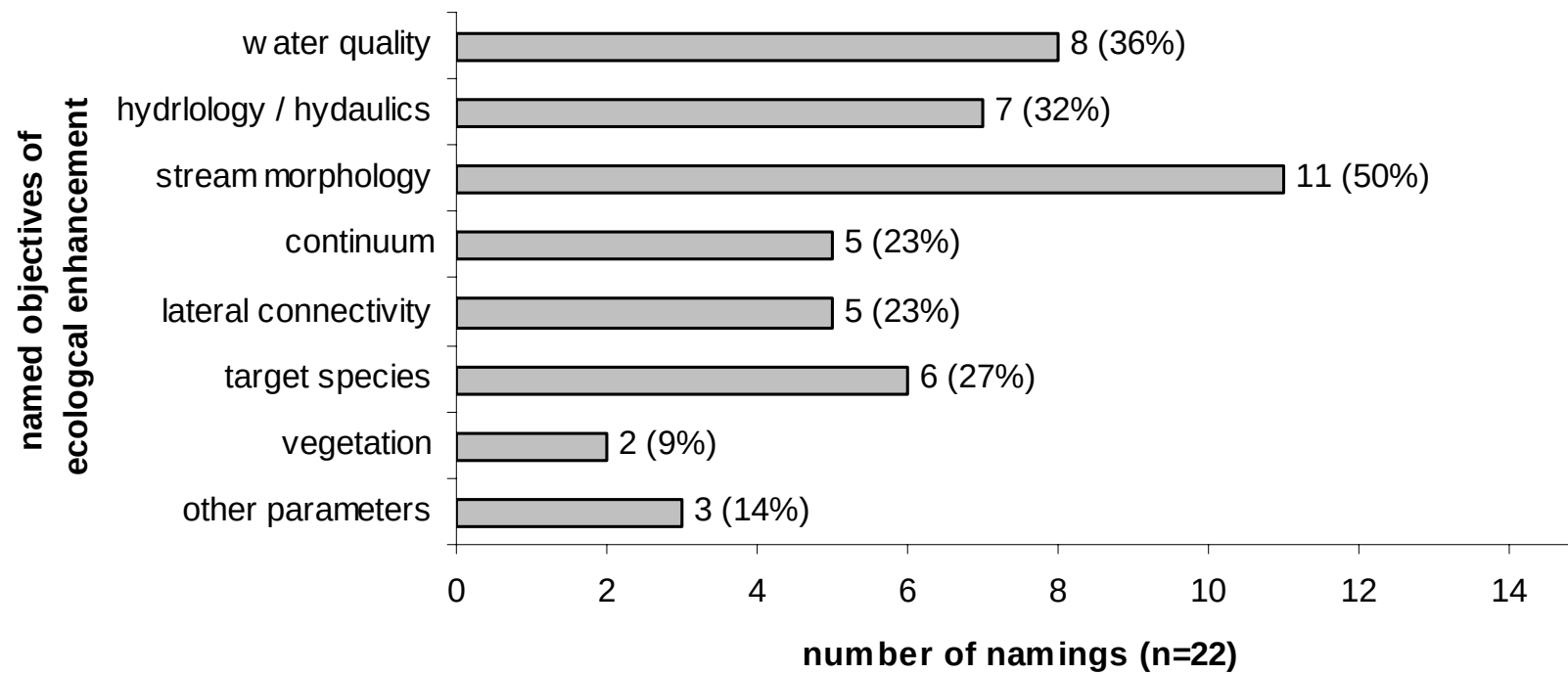
Objectives of urban river rehabilitation projects





Objectives of Ecological Improvement

Objectives of ecological improvement in urban rehabilitation projects



Improving Hydrology / Hydrodynamics

[illegible]



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La Chaudanne, Lyon

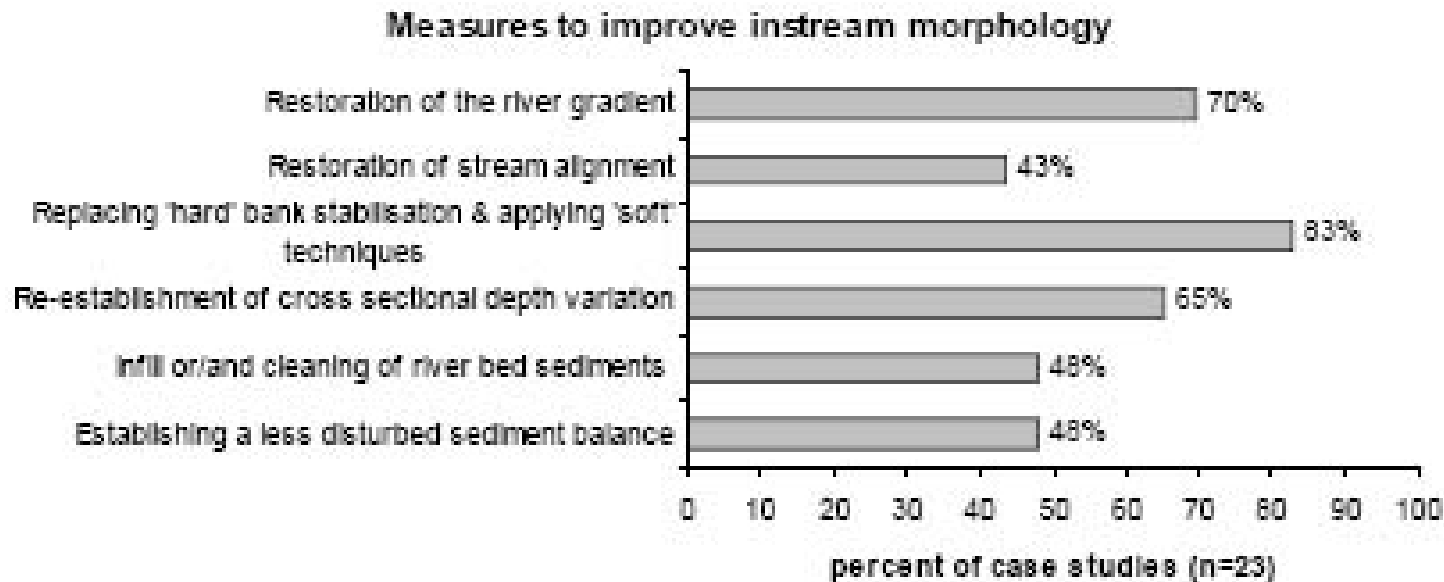
Infiltration Basins





Instream Morphology

- Working with hydromorphological processes
- Less disturbed sediment balance





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Working with water

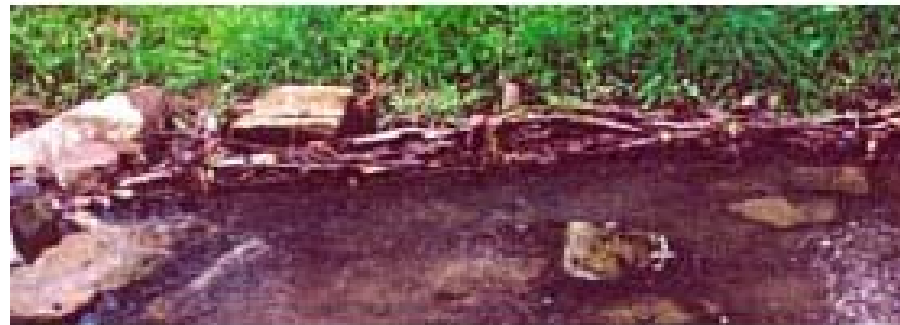
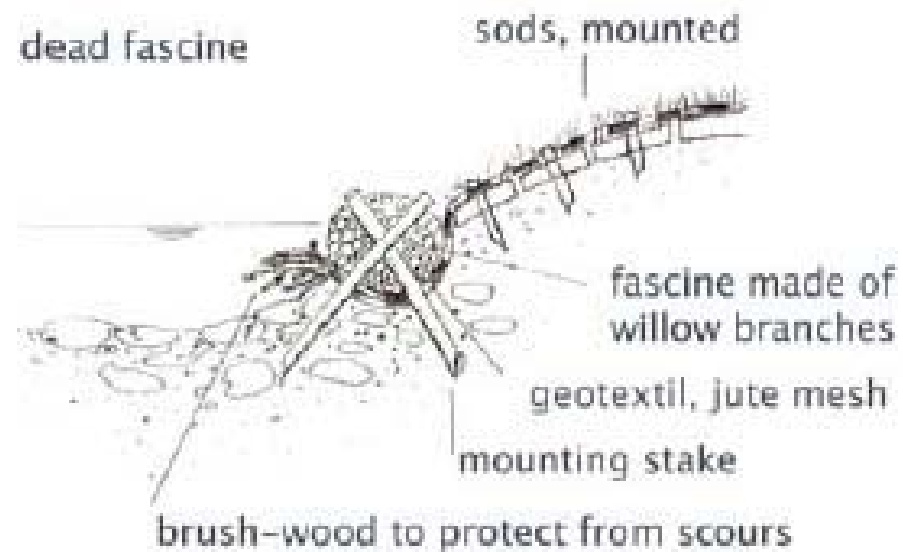
Nahon, Chrudim

Gravel banks





Scour protection

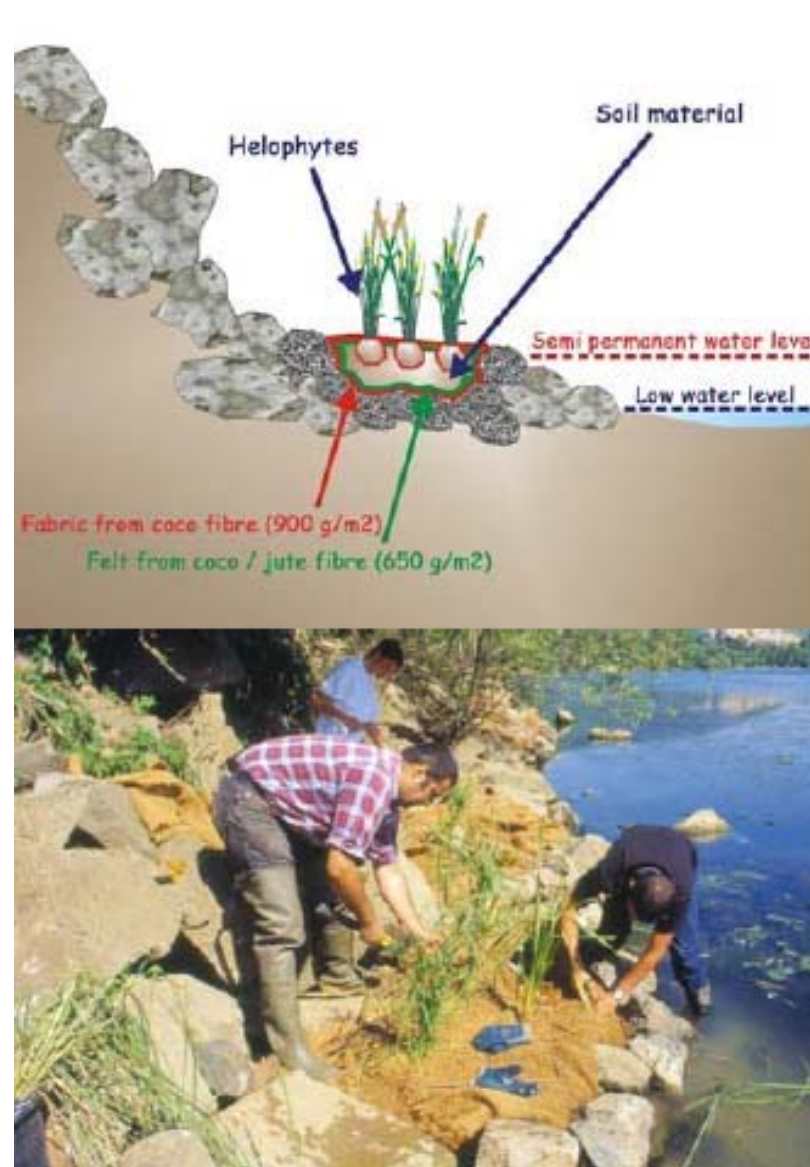




HR Wallingford
Working with water

La Saone, Lyon

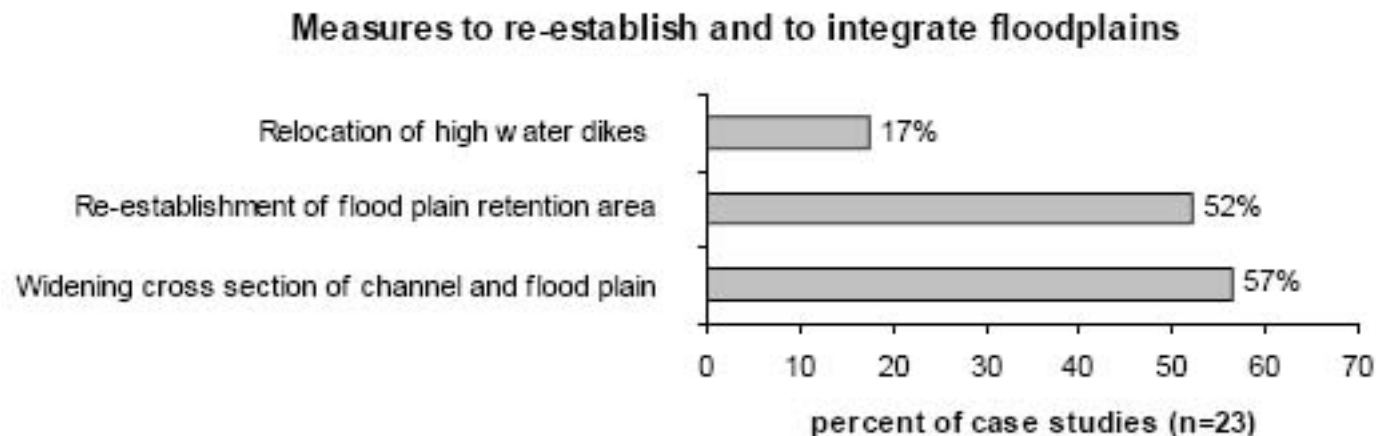
Vegetation on river banks





Integrating floodplains

- Promoting riparian flora and fauna
- Planting / natural succession
- Establish bank vegetation

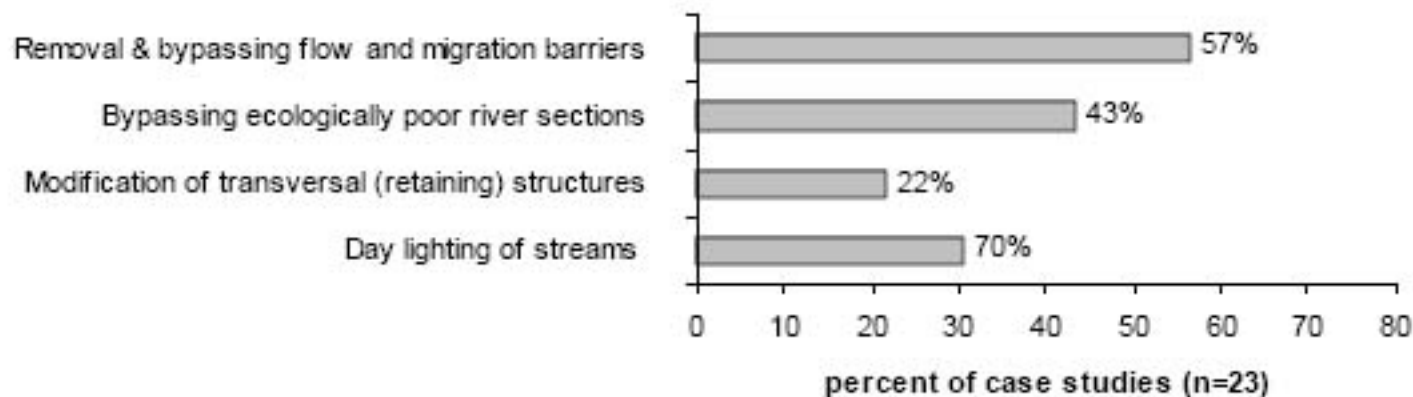




Improving stream continuity

- Remove transverse structures
- Fish Passes
- Daylighting
- Bypasses

Measures improving continuity



Improving water quality

[illegible]



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Torre della Bella Monaca, Rome

Detention ponds

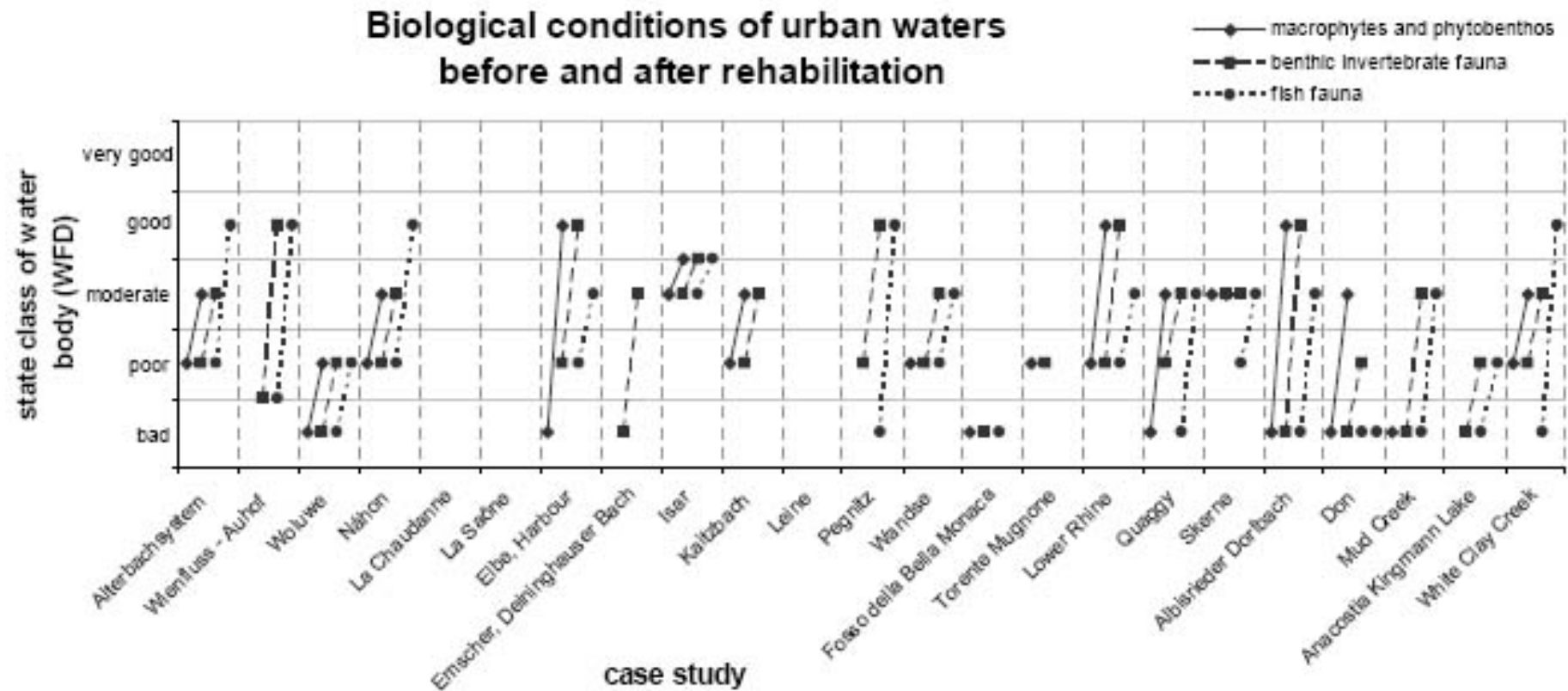


Improving Biodiversity

[illegible]

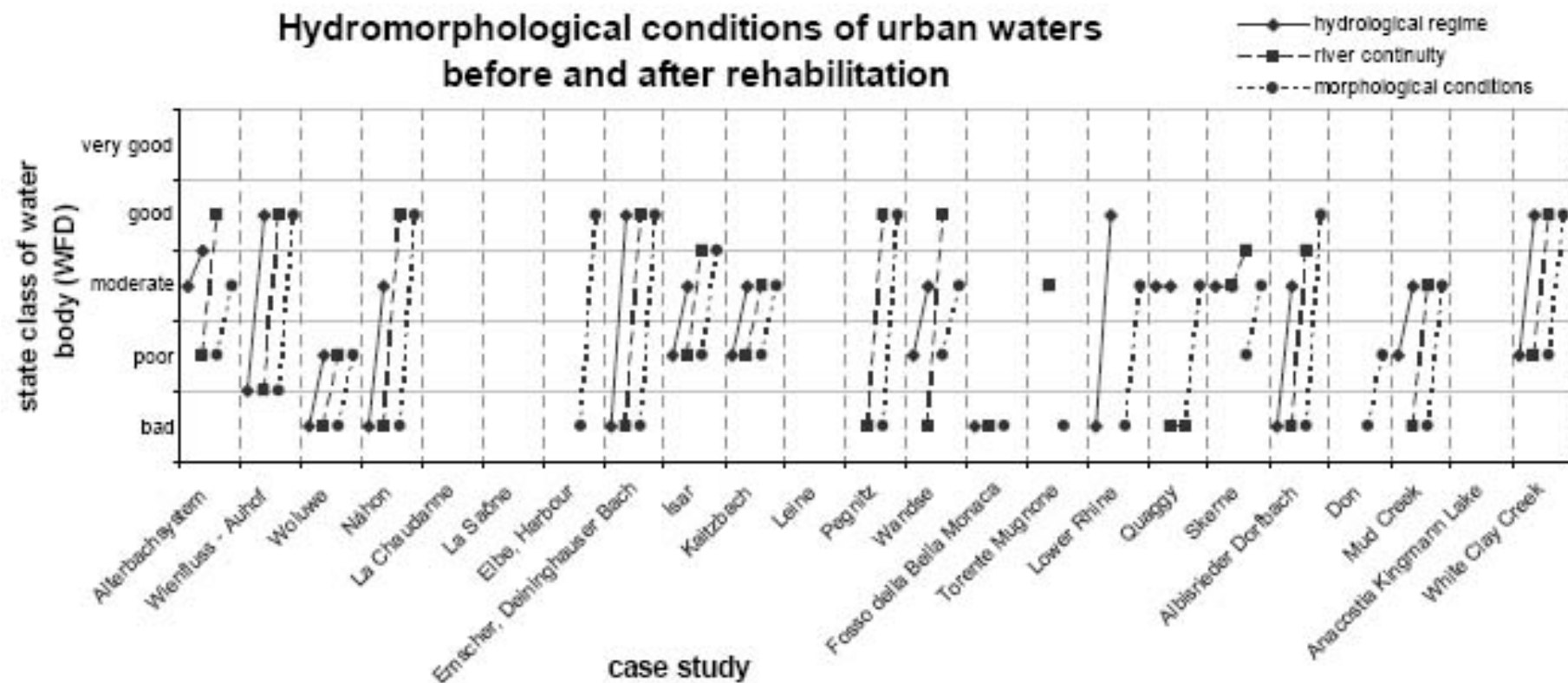


Ecological Impacts



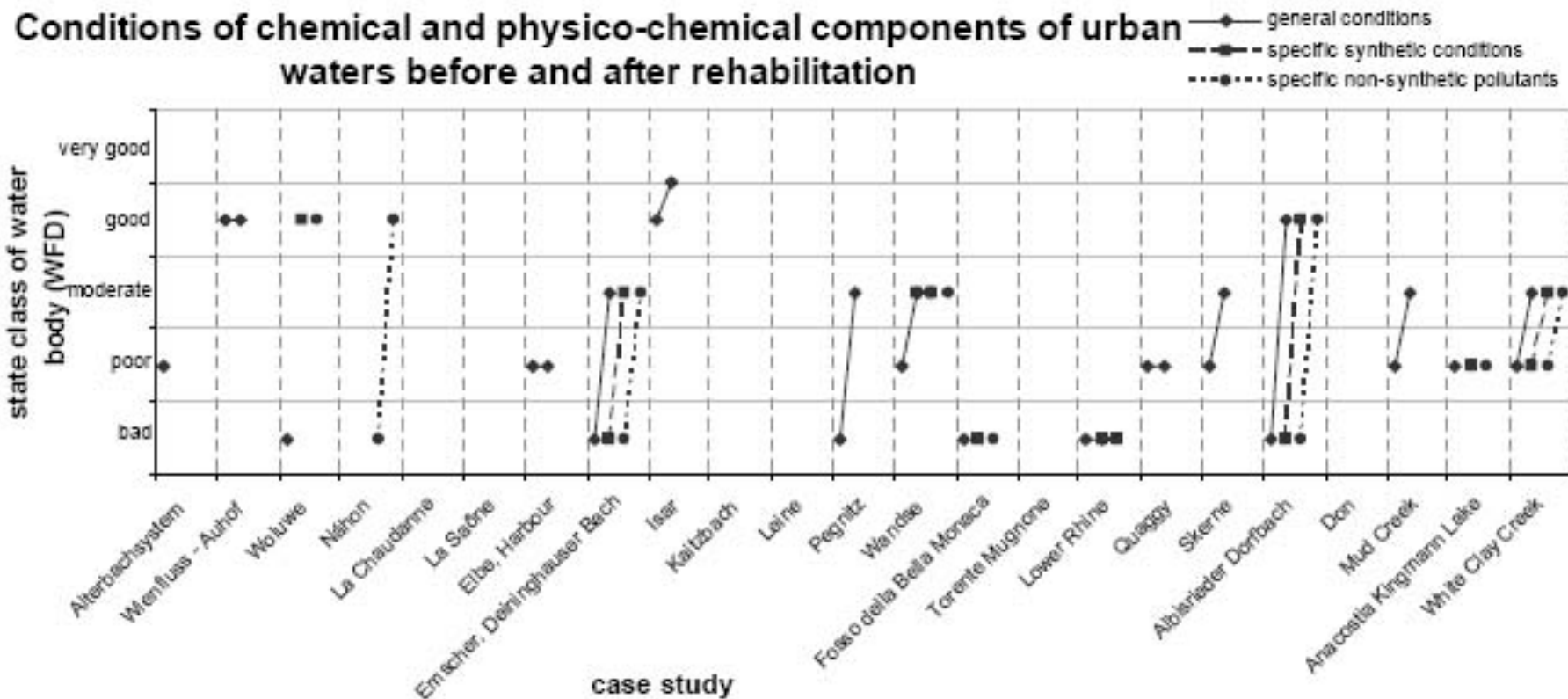


Hydromorphological Impacts





Water Quality Impacts





Case Studies

- Most projects on streams and small rivers
- Ecological improvement increasingly important
- Variety of soft techniques used

Enhancing urban river ecology

- Improvements demonstrated in all case studies

Way forward

- Schemes need systematic performance control





Data collection on selected sites

- La Chaudanne – Lyon, France
- Ljubljanska- Ljubljana, Slovenia
- Ouseburn – Newcastle-Upon-Tyne, UK
- Wien – Vienna, Austria
- Weidigtback – Dresden, Germany

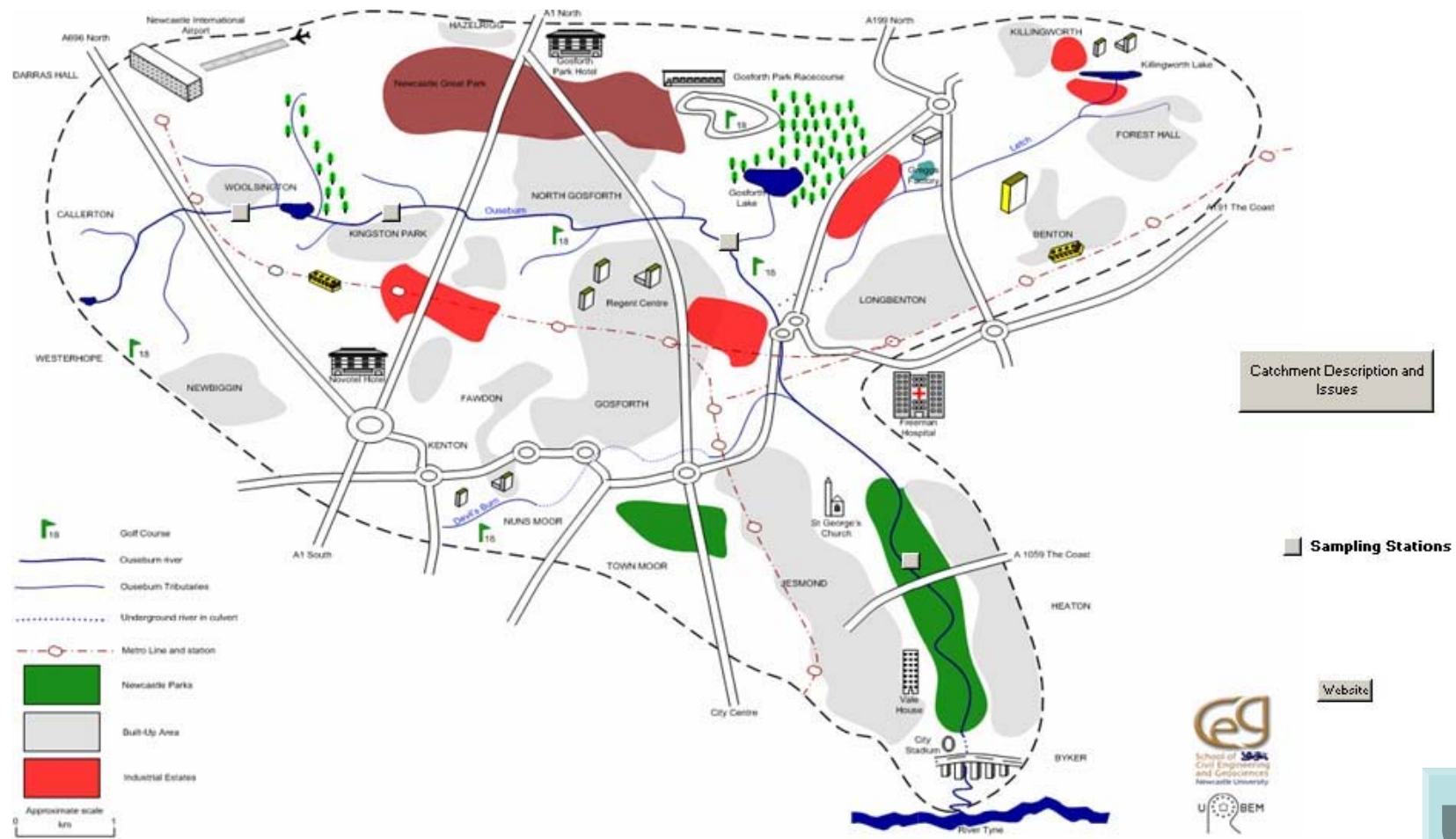


Types of data

- Hydraulic regime
 - Rainfall, flows, discharge
- Channel geomorphology
 - Cross sections, channel slope, bank material
- Water quality
 - pH, conductivity, BOD/COD, dissolved oxygen, suspended solids
- Biological data
 - Benthic invertebrates data
- Social and economic data
 - Crime rate, flood risk, housing costs, number of visitors



Perceptual catchment mapping





New Techniques for urban river rehabilitation

Methods to naturalise flow regime

New materials and techniques

Incorporation of wetlands, floodplains and sustainable urban drainage

Incorporation of safety features





What techniques are available?

D1.1

Aesthetic
Evaluation
Methodology

WP4

D1.2

Social
Appraisal
Tool

WP7

D1.3

Multi-Attribute
Decision
Making

WP5



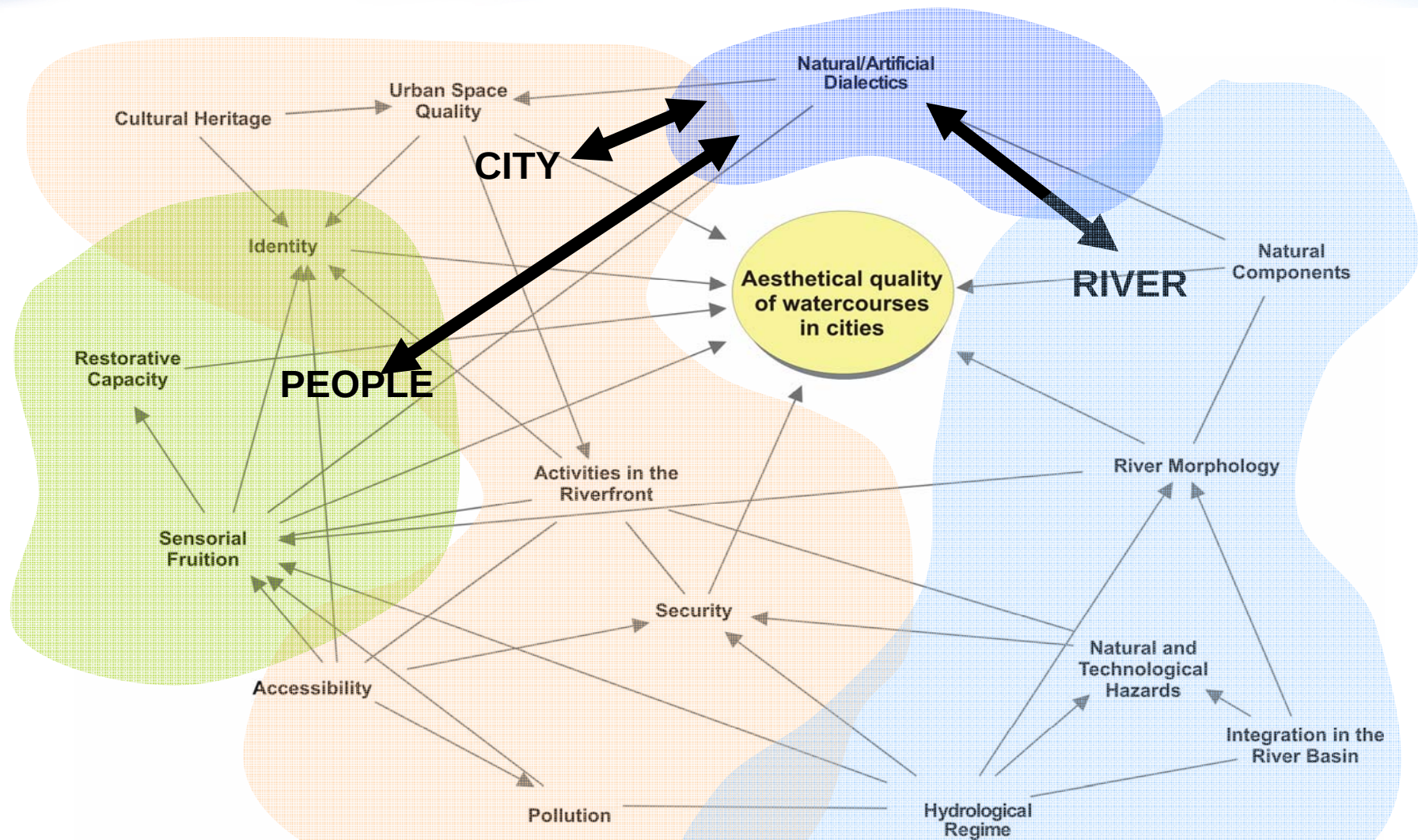


Benefits of Aesthetic evaluation

- Formalising the measurement of a high priority objective
- Aesthetic quality is a necessary component of sustainable development
- Relates to environmental awareness and planning
- Important to quality of life – contributes to well-being and satisfaction
- Important to visual identity – recognised worldwide



Aesthetic evaluation



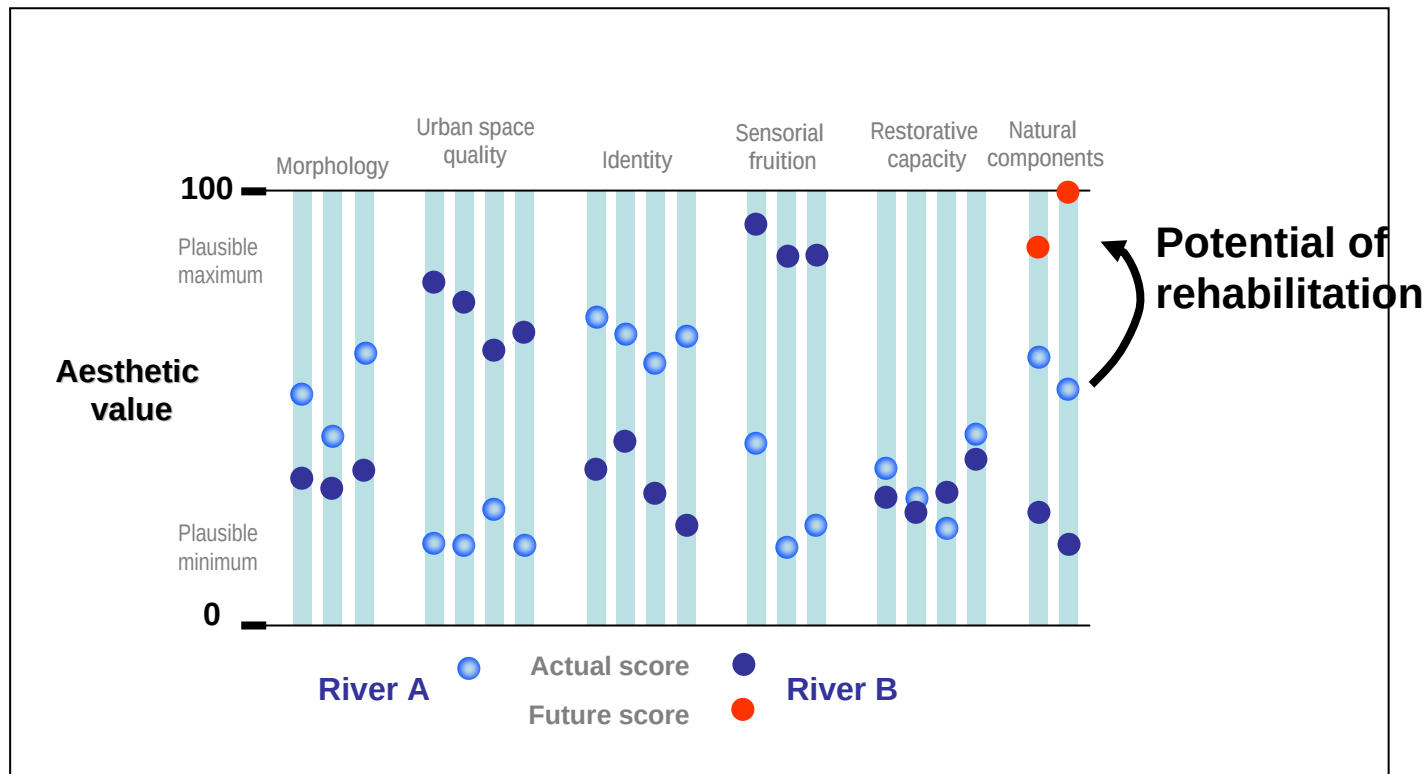
Minimal network of fundamental viewpoints that can influence
aesthetical quality of watercourses

("consensualness, intelligibility, isolability", Bana e Costa, 1992)



Measuring performance

- Aesthetic value profile





Benefits of social participation and appraisal

- Encourages ownership of the scheme
- Increases awareness and use of the urban river
- Increases social capital
- Measurement of social capital allows for improvement of social capital
- Understanding what methods are most effective in engaging public and stakeholders



ProveIt! Tool

- A method of public and stakeholder participation
- A method for assessing the social capital associated with the river environment
- Social capital is the social networks characterised by norms of trust and reciprocity
- Storyboard
- Pre and post questionnaire
- Evaluation poster



Prove It! Questionnaire

PROVE IT! Questionnaire for URBEM					
Sutcliffe Park and Quaggy River					
WHAT THEY ASK?	Read out the following statement, and ask respondents to choose one of the responses.				
USE AND VALUE	1. I think the river contributes to the economic wellbeing of this area.				
	<i>Strongly Agree</i>	<i>Agree</i>	<i>Not sure</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
	☐	☐	☐	☐	☐
USE AND VALUE	2. I think the river improves the quality of life of this area.				
	<i>Strongly Agree</i>	<i>Agree</i>	<i>Not sure</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
	☐	☐	☐	☐	☐
USE AND VALUE	3. I think the river provides a way to connect with this area's history.				
	<i>Strongly Agree</i>	<i>Agree</i>	<i>Not sure</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
	☐	☐	☐	☐	☐
USE AND VALUE	4. I think this community needs the river because of its wildlife.				
	<i>Strongly Agree</i>	<i>Agree</i>	<i>Not sure</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
	☐	☐	☐	☐	☐





Multi Attribute Decision Making

Basis of decision making

- Depends on how objectives are viewed – do you need to attain a minimum level? Is one objective far more important? Is a balance important?

Non-compensatory methods

- Trade-offs are not considered

Compensatory methods

- Trade-offs are considered





Which indicators can be used for decision-making?

D2.1

Indicators of Success

- Recommends suitable success indicators for different objectives
- Provides information on application
- Suggests existing data, models and assessments that (if available) can be used

Using success appraisal

- Demonstrates effective use of money by measuring achievement of goals
- Checks that the scheme is implemented as planned
- Used as an instrument of correction in planning and decision making – gives feedback and improves future action
- Provides valuable information for future scheme design

Indicator selection process

- Indicators are relevant to describing system quality elements
- Indicators have a target value (benchmark) – or if not, plausible targets can be established
- Data will be available to assess the indicator
- Assessment method must be traceable for ex-post assessment
- Re-evaluate and refine indicator list – remove if not critical
- Use suitable indicators for communicating results to different audiences



Indicators of success

Category Subcategory	Existing Conditions and Quality of River and River Site Settings Public Accessibility to River and River Site	SOCIAL
Quality Element	Access from City to River Site	
Name of indicator:	Soft Mode Access Barriers	NO: S 1
Operationalisation	Measured parameter: 1) Length of barriers cutting of access from residential areas to river site or river/ length of river section 2) Number of people in the catchment area having to barriers to reach the river site/Number of inhabitants in river corridor	Unit: %
	Benchmarks: individual Tendency: stable or decreasing	Potential classification: individual
	Temporal scope: with implementation Spatial scope: River site and adjacent neighbourhood	



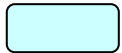
Indicators of Success

Rationale	Rationale: The more access barriers exist, the less people are able and willing to access the site. Potential barriers to be considered include major roads, industrial or non-residential areas, gates or styles which are difficult to traverse, pathways hardly to cross in bad weather. References: Silva et. al. (2003) URBEM - Classification of the aesthetic value of the selected urban rivers – Methodology – Deliverable 4.2., CESUR-IST/UTL, Portugal PAGE C (1997) Predicting the Social Impacts of Restoration in an Urban Park. In: Yale F&ES Bulletin, p. 100 et seqq. Found at: www.yale.edu/environment/publications/bulletin/100pdfs/100page.pdf Urge 2003
Data enquiry	Enquiry method: On site visit Desk study Potential sources of data: Aerial pictures, topographical maps
Application	Application and Applicability: The indicator will easy to be assessed, if GIS data of the site exists, but it is also easily to be assessed through an on site visit. It should be assessed if recreational use of the site is of importance. Relation to other Indicators: Reverse to Access Points for Soft Modes (S 4)

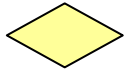




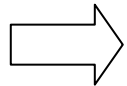
Key



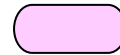
Process part



Process decision



Main links between processes or
information



Start of process



Jump to different process



End of process



Point for participation of stakeholders

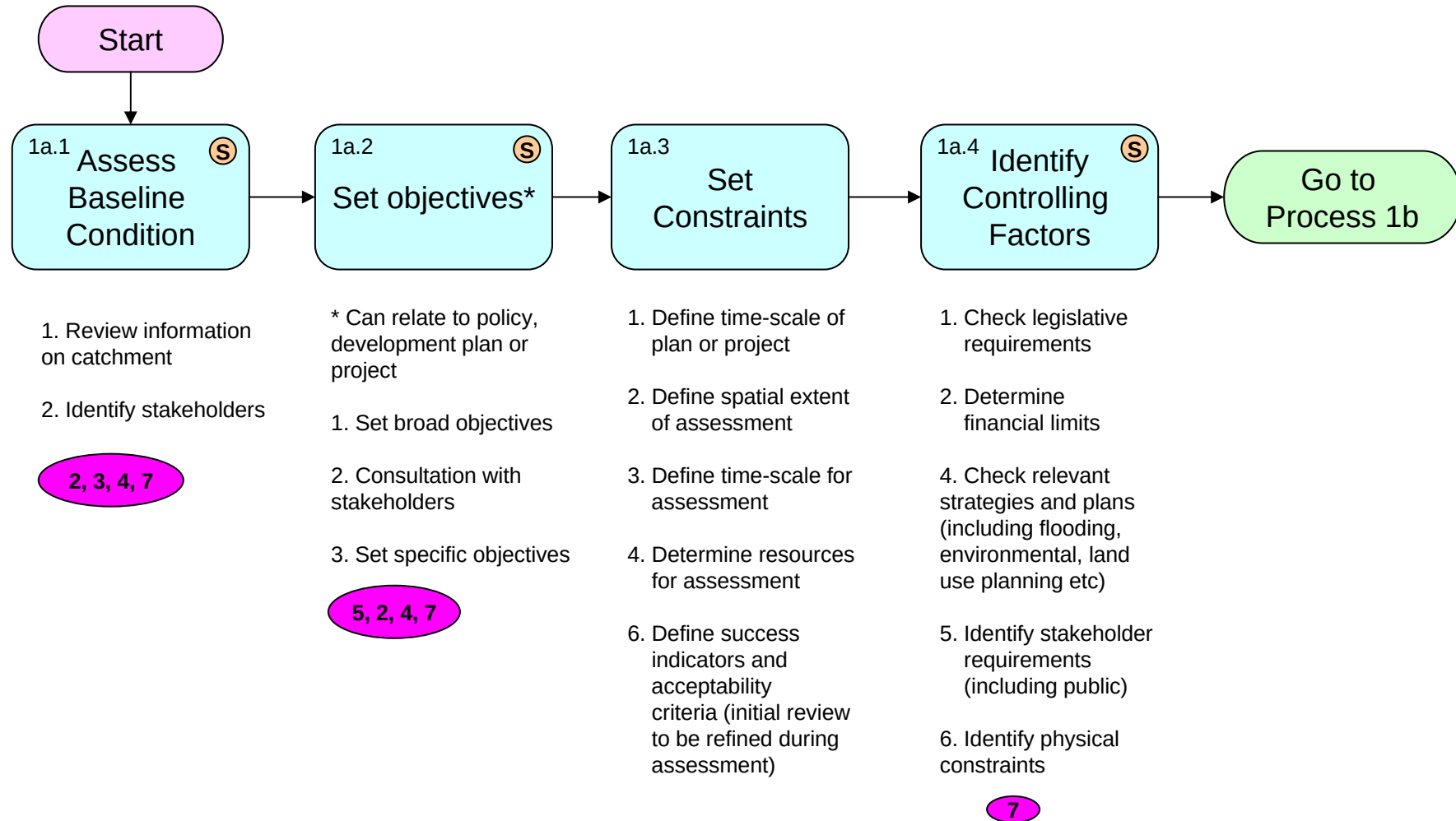


Link to work package



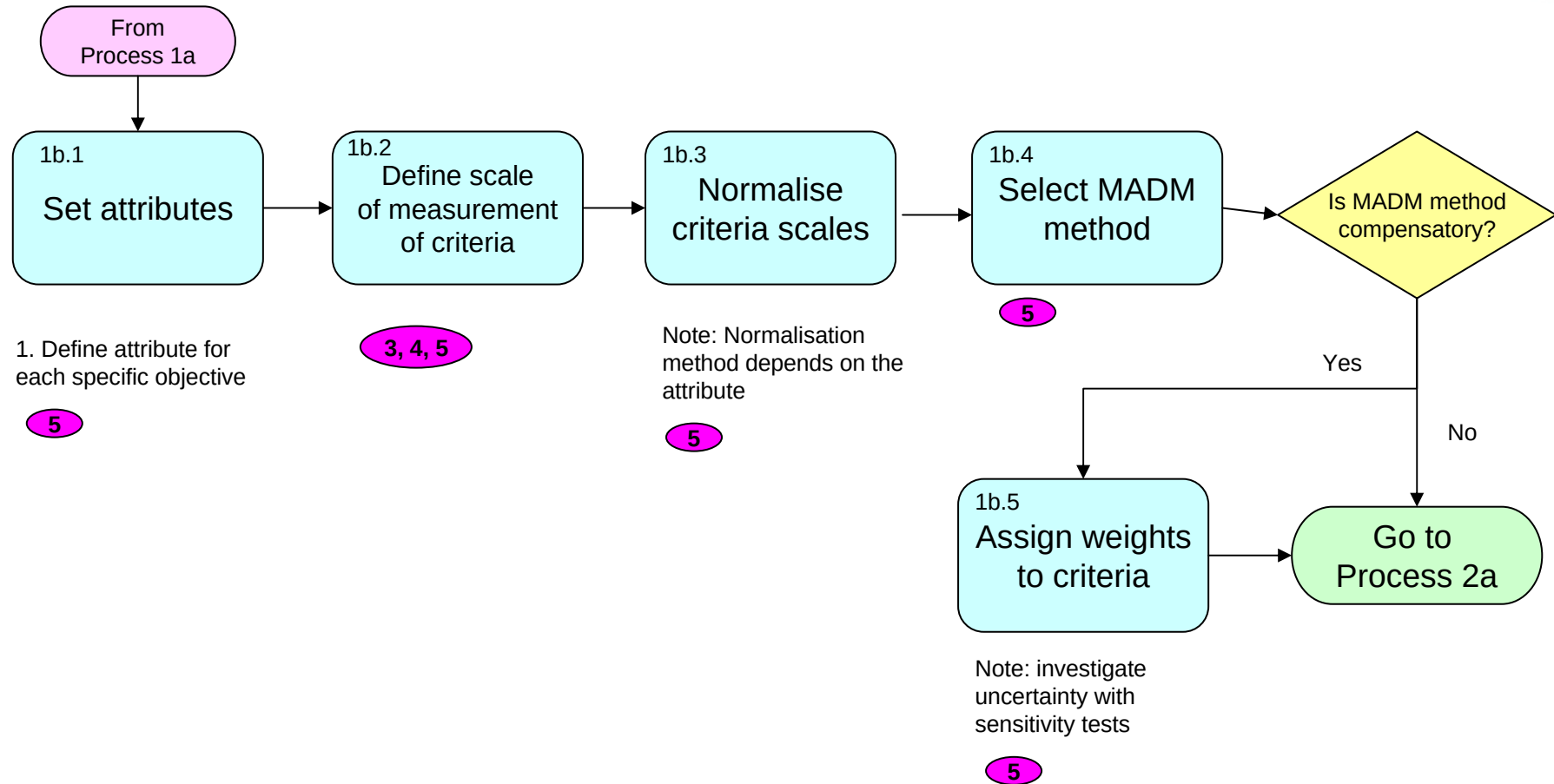


Process 1a – Formulating River Rehabilitation Goals



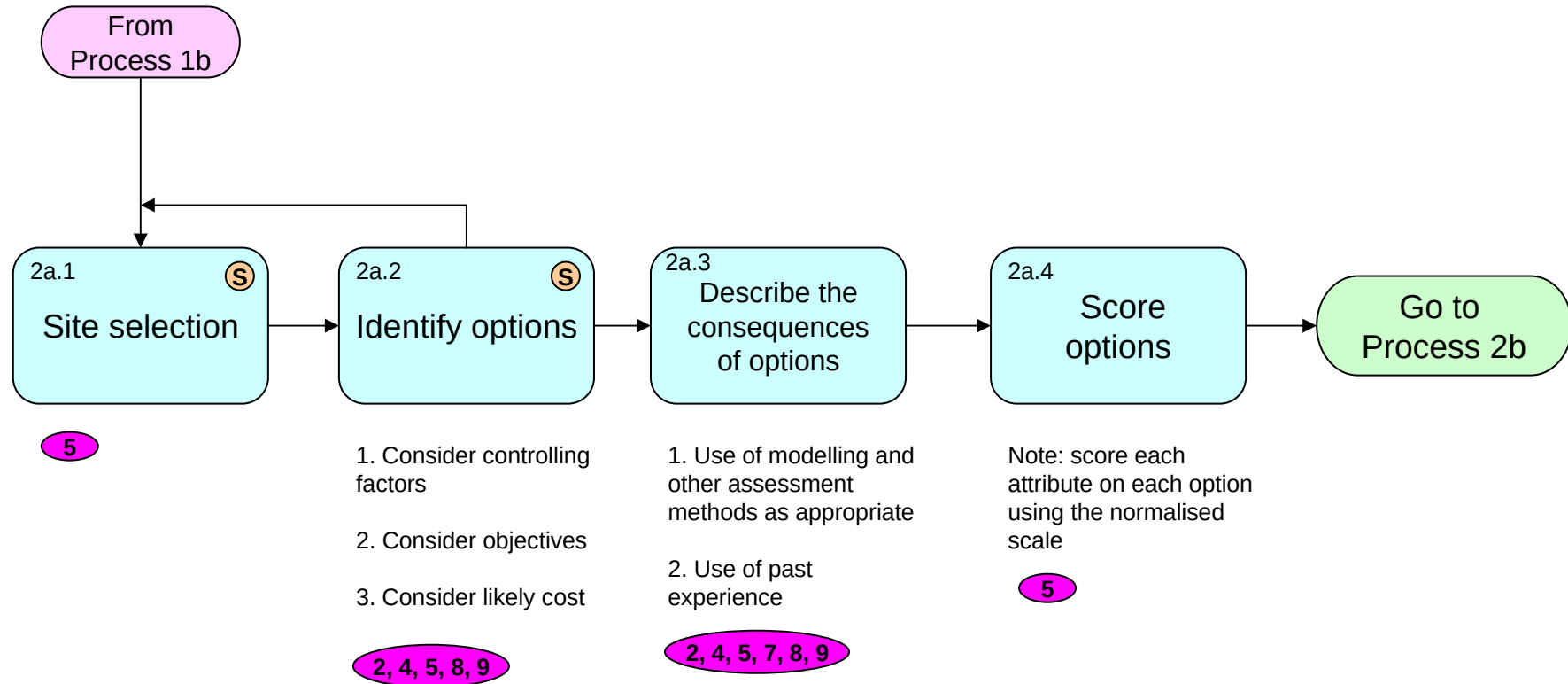


Process 1b - Defining method of assessment



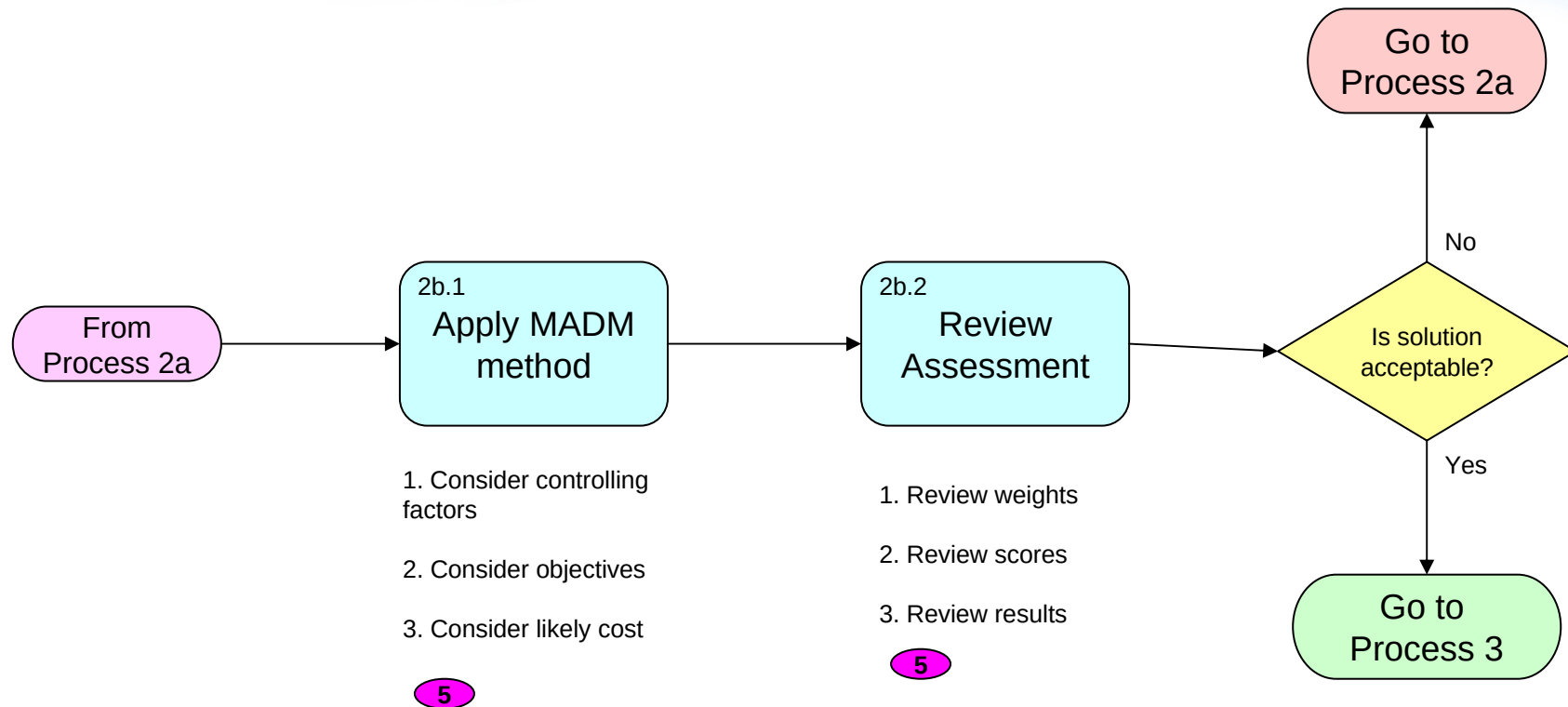


Process 2a - Development of Options



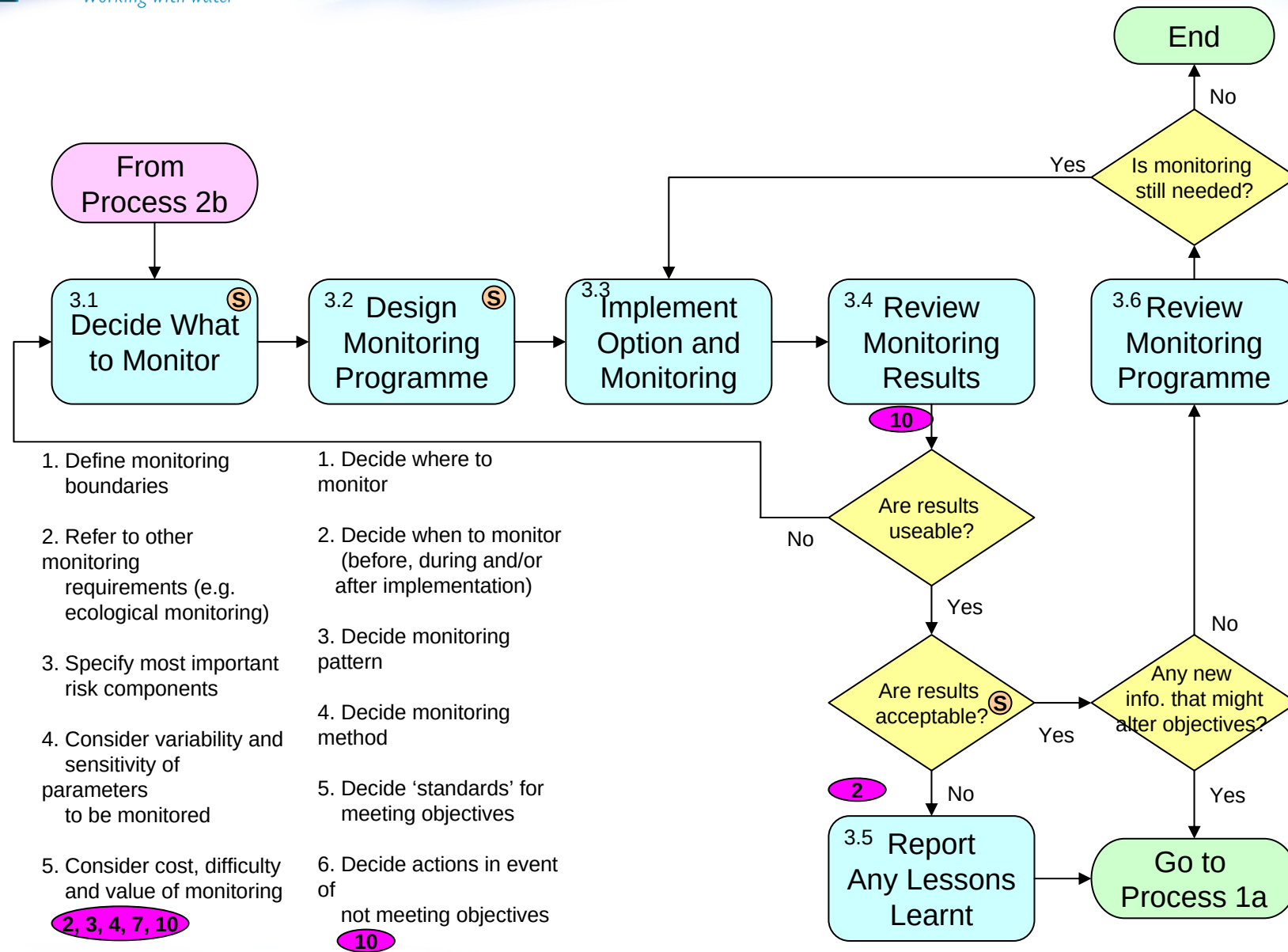


Process 2b - Assessment of Options





Process 3 - Implement, Monitor & Review





Three user groups

- Technical specialists
- Non-technical decision makers
- Public, stakeholders

Training package on each aspect of the framework

- Teach yourself
- Lectured courses



Public reports

- Describing the use of URBEM tools

Web site

- <http://www.urbem.net>

International Conference on Urban River Rehabilitation 2005

- Dresden, Germany

Training available

- On each work package



Updating of modular framework

- New methods, techniques
- Linking to existing references

Development of interactive web-based framework

- Easy to use

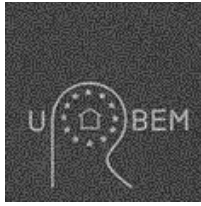
Development of web-based manual of techniques

- Design criteria, expert review

International data exchange

- Using data bases and conceptual mapping

Appendix 7



Urban River Basin Enhancement Methods

HOW TO TAKE ACTION FOR RIVER RESTORATION

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Dissemination Status

Public

Report Authors

Mitja Brilly

INTRODUCTION

Urbanisation and river regulations go back to ancient times, they gradually developed in the 19th century and intensified in the second half of the 20th century with irrigation, water power development and river regulations for urbanisation of inundated land. Regulation and deterioration of rivers has a long history. The process was lead by specific, economically defined interests and simple decision-making schemes. The main task in urban areas was how to take and develop, safely for diferent economical purposes, space of river corridor and even space of river stream by culverting.

To day the urban river corriodors are overloaded by different interests that is main obstacle of river restoration with enlargement of stream chanel and renaturation of river banks. That is also reason why river renaturation is costly and time consumptive work. It is very difficult to develop river restoration by short intensive integrated action and reestablish entire river watershed. Mostly river restorations are set of broad actions diverted in space and time that step by step redesign river and its watershed.

River restoration means taking broad actions, which differentiate in scale, size, timing etc. The implementation depends on different sources and several decision-makers driven by different interests, which should all be co-ordinated in a common task. Such a complex process with numerous actors has to include social analysis and tentative actions.

Guidelines and manuals have been developed for river restoration and environmental protection (UNEP,2004, US, 1998, EU 2002). Good sources of guides and ideas for implementation should correspond to the own specific natural situation and social conditions. Examples of good practice could provide encouragement but they cannot simply be transferred or copied elsewhere without a critical review of actions. Action-taking should be tailored to the local natural an social conditions.

Water management policy proceeds from development to management. The importance of environmental sustainability has been recognized overall. The decision making should integrate more interests, calls for a greater decentralization, more participation and greater financial viability. A new paradigm of Integrated Water Resources Management (IWRM) has been developed in the guidelines of WFD and worldwide. The IWRM is complex, requiring an almost idealistic approach (Brilly 2001). Today, there are no economically well-defined interests and simple decision making schemes involving few stakeholders. The results should provide an environmental benefit that is very difficult to evaluate financially.

Action should be organised and driven by a body recognised by all involved parties, UNEP 2004. Efforts and actions must involve a pro-active participation and contributions of both governmental and non-governmental stakeholders. An NGO or private sector can act as a partner in action. The form of organisation depends on the local practice, legislation and size of action. Action should take place at the lowest possible level and then demand-driven approaches could be applied. All stakeholders should be involved from the beginning in selecting the appropriate solution and management options. Attention must be given to local demands. Comprehensive analyses of present and future societal demands are required, and strong support and acceptance from local communities should be

secured. With such analyses realistic choices can be made from a wide range of technological, financial and management options. River rehabilitation needs maintenance and care, which is not possible without full co-operation of locals and stakeholders.

In management and decision-making processes transparency should be ensured, which would establish trust of the inhabitants. Early, continuous, targeted and transparent communication between all parties is required to establish firm partnerships. Management of problems is related to our interests, knowledge and experience. The idealistic technical approach lies in sophisticated modelling with all necessary data including assessment of possible risk. Lack of data and knowledge asks for a more simple analysis with best expert estimation, but such system fails if the experts have particular interest or they would like to promote particular solutions. Independent facilitators of the decision making process could be beneficial when problems are particularly difficult with opposing interests of stakeholders. A third party also helps to avoid that the competitive authorities dominate in the process.

Regardless of the approach chosen, each river restoration asks for a flexible, tailor-made set-up. Each necessary step can be taken at different points in time, depending on available resources and capabilities. It is thus advisable to apply a well-defined logical framework, consisting of a comprehensive set of logically related tasks:

1. Identification of the need for action (getting started)
2. Establishing steering committee
3. Setting boundaries
4. Development of preparation plan
 - Review of information
 - Goals and objectives (new techniques)
 - Identification of needs and opportunities (RBD plan)
 - Identification of financing sources
 - Formulation of management plan
 - Setting objectives
 - Formal adoption.

5. Implementation

Operational management: on-site versus off-site

Institutional arrangements, such as capacity building, awareness raising and public participation

6. Monitoring and evaluation

Monitoring

Evaluation

Each phase can be subdivided into several tasks, where relevant stakeholders should always be involved as early as possible in the process. To achieve the

objectives set, all the phases and tasks are best performed when they follow a certain logical order. In practice, Phase 1, although often the logical place to start is not always the first phase taking place. An evaluation of an existing system (a Phase 5 task) may show that there is a discrepancy between present and required performance. This then starts a new cycle, which may require that the originally set tasks be redefined, starting with new problem identification (Phase 1), planning (Phase 3) and implementation (Phase 4). Thus, tasks like identifying opportunities or evaluating the current situation or identification of financial sources may well come first. You can start at any phase of the cycle, as long as certain tasks are followed by specific other tasks, as laid down in the logical framework.

The incentive for action may come from several sources: state, town council, NGO, stakeholder or interested groups, and individuals. The administration may initiate the restoration effort as a result of a directive to implement the RBD plan. Citizen groups or groups with special cultural or economic interests in the river (e.g. landowners, sport fishermen) may also initiate a restoration effort. Others might undertake river restoration as part of a broad initiative that is funded from various sources and addresses a diversity of interests and objectives. The local representatives familiar with the situation should be involved from the start.

An important step in the process is the formation of a steering committee. The steering committee includes key stakeholders, interested citizens, public officials, and any other groups or individuals who are interested in or might be affected by the restoration initiative (US 1998). Local citizen groups comprise multiple interests that hopefully share a common concern for environmental conservation and interest of local community. Such broad-based participation helps ensure that self-interests of administration do not operate the process from the top down. The steering committee ensures high level of participation in the development and implementation of the revitalization action. Interested parties will participate actively in the planning process by discussing issues and contributing to their solution as a member of the steering committee. They will share the decision making and objectives. Shared decision-making implies that the interested parties not only participate actively in the planning process, but also become partly responsible for the outcome (EU ppguid).

The steering committee generally takes care of the following:

- Carrying out restoration planning activities.
- Co-ordination of development of a preparation and implementation plan.
- Identifying the public's interest in the restoration effort.
- Making diverse viewpoints and objectives known to decision-makers.
- Ensuring that local values are considered during the restoration process.

It is important to remember that the true role of the steering committee is to advise the decision-maker or sponsor (the agency, organisation, or individuals that support the restoration effort) on the development of the restoration plan and execution of restoration activities. The primary decision-making authority should be in the hands of the stakeholders. The steering committee will provide recommendations and inform the decision-makers of various restoration options and the opinions of the various participants. It is important to note that the decision-maker, as well as the steering committee, may be composed of a

collection of interests and organisations. Other relevant sectors should be included, such as urban development and implementation of the RBD plan. Although the steering committee will play an active planning and co-ordinating role, it will not always make the final decisions. It is thus important that all members of the steering committee understand the issues, develop practical recommendations, and achieve consensus (US 1998). The identification of the key participants is the most critical issue. The exact number of groups or individuals that will compose the steering committee is difficult to determine and is different from situation to situation. Membership in the steering committee should be free and open. In general, it is important that the group should have representatives of all involved stakeholders, landowners and citizens, who are in touch with the action.

The steering committee activities require a lot of precious voluntary work. The members are in place according to their interests. The steering committee could collect its own funds from donors or own participatory financing action or technical support. There might be cases where a landowner or stakeholder chooses to take on all the responsibilities of the steering committee group in addition to playing the leading or decision-making role. Regardless of the number of individuals involved, it is important for all project participants to note that the usual duration of a project is 2 to 3 years (US 1998). There are no guarantees that every project will be a success, and in some cases a project may fail simply due to lack of funds, lack of time or lack of the willingness to act. All participants must be reminded at an early stage to set realistic expectations for the project and for themselves.

The Preparation plan is an essential document for the task force action. It contains major information for possible solutions, including cost, legislative issues and control of possible funding. An interdisciplinary team should carry out the study with the suggested contents, Checklist 1. The size of the document differs from a short memorandum to a full-sized detailed project documentation, and is situation-specific.

Each stream corridor that is targeted for restoration is unique. Each stream targeted for restoration is unique. A project goal of restoring multiple ecological functions might include the channel systems, the active floodplain, and possibly adjacent buffer areas that have the potential to directly and indirectly influence the project. In the urban areas, land uses close to the stream bank are a major obstacle for environmental protection; however, the restoration of the surrounding land is an opportunity for restoration of the nearby river. The restoration stretch of the river should be as wide as possible. The steering committee should optimise the interests of the participants with the available funds.

A wide river corridor restoration is possible outside of urban areas, but inside, the development is limited by land use and town development plans. The objective of the past river regulation works was to take the minimum space for the river flow and demand for flood protection produced channelisation of the river with the minimum roughness coefficient. Any restoration work in such a channelized stream will increase the roughness and the water level during floods. The additional space for flood flow inside the river corridor is crucial for possible restoration measures. The problem is how much public land is available in the corridor and how high is the willingness of landowners to support such project.

Identification of funding sources is often the first and most important step toward an effective stream restoration. The funding may be minimal or substantial, and it may come from a variety of sources. Funding may come from EU, country or local sources that have recognised the need for restoration. Funding may come from any entity that has taxing authority. Charities, non-governmental organisations, landowners' associations or any developer invested in river corridor and voluntary contributions are other funding sources. Regardless of the source of funds, the sponsor will almost certainly influence restoration decisions or act as the leader and decision-maker in the restoration effort. The attributes in the tool for assessing the potential for rehabilitation are weighted taking in account financial sources for action.

References

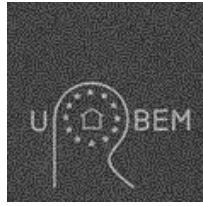
BRILLY, Mitja. The integrated approach to flash flood management. In: GRUNTFEST, Eve (ur.), HANDMER, John W. (ur.). *Coping with flash floods*, (NATO science series. 2, Environmental security, v. 77). Boston: Kluwer Academic Publishers, 2001, 2001, pp. 103-113,.

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Appendix 8



Urban River Basin Enhancement Methods

MONITORING THE IMPACTS OF URBAN ENVIRONMENT ON RIVER WATER BODIES AND IMPORTANCE OF VOLUME OF THE WATER BODY – CASE STUDY

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Dissemination Status

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Introduction

Urban areas present complex features, resulting from different land uses, different development densities, ages of development, and variable proportions of space occupation. As land urbanises, natural land surfaces are replaced by artificial surfaces such as paved roads, parking lots, and roofs that usually implied vegetation clearing and soil compaction (Riley, 1998; Gareth et al., 2003). The drainage system is also affected as gutters, drains and storm sewers are laid in the urban areas to convey runoff rapidly to stream channels. These stream channels may be extremely modified and relegated to underground culverts. Also, urban development may expand to river flood plains reducing storage and conveyance area for floodwater.

The impact of urbanisation on the hydrological cycle is complex and affects almost all the hydrological processes (Fig. 1). The overall belief is that urbanisation alters watershed response to rainfall, by increasing the volume and peak flow and flood risk downstream, decreasing low flows, increasing pollution and reducing stream corridor habitats.

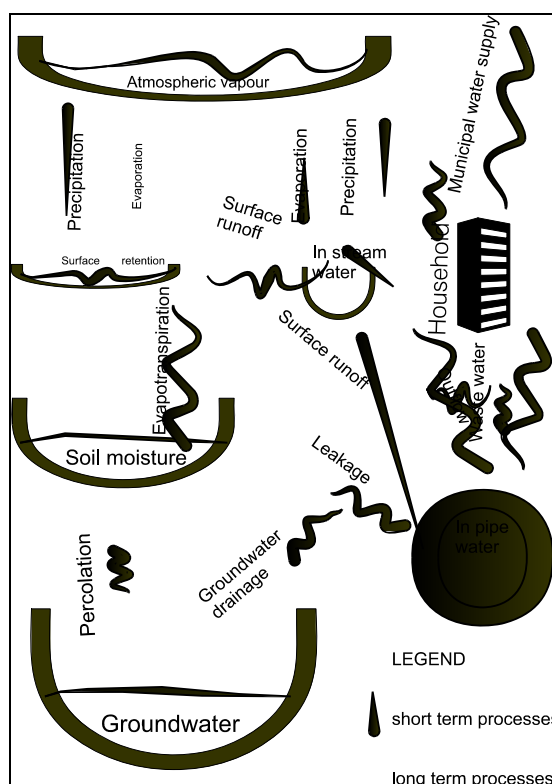


Figure 1: Hydrological cycle in the urban area.

The implications of urbanization on runoff processes depend on the scales of the watershed area and urban development (Quinn, 2004). Small river basins that have been densely urbanized are stronger affected by the urban runoff flows than large rivers flowing through large cities where local urban runoff peaks contribute only a very small proportion of the flow in the river (Maksimovic and Tucci, 2001). As streams are mainly a product of the upland watershed area, urbanization affects not only the local runoff but also produces effects downstream, where flood peaks increase. During the process, the discharge of small and frequent yearly floods increases and changes the curve of discharge duration, so that the flood discharge

water bodies has included the valuation of the biochemical state in the rivers of Mali Graben, Mestna Gradascica and Glinscica in combination with hydrological conditions on the urbanised part of the watershed.

Hydrological as well as physical changes in urban streams and rivers affect habitat characteristics and more or less determine the present biocenosis. The hydrological, fluviomorphological and substrate dependant changes as a consequence of heavy regulations of the Glinscica River caused changes in the abundance and especially diversity of macroinvertebrates and fish community. The impacts of relatively simple rehabilitation measures in terms of improvement of living conditions for water organisms in the urban section of the Gradascica River (also called the Mali Graben) were also assessed.

Measurements of water level during the flood event in the Gradascica and Glinscica water courses, (Fig. 3), have shown a strong impact on the water regime of the stream inside the Mestna Gradascica with several peaks caused by the quick response of the runoff collected from the streets by the drainage system. The response of the more natural larger upstream watershed areas on the Glinscica and the Gradascica rivers is smoother. The runoff collected by the urban drainage system reaches the main stream faster than the natural flow coming from the upstream part of the watershed. Only the last peak was produced by the natural water regime. The runoff from urbanised areas is significantly faster than the runoff from the upper natural part of the watershed and far before the flood peak reaches the urbanised area. In this particular event, the flood hazards of the urbanised area and downstream does not increase as an impact of urbanisation.

Water temperature also has significant dynamics depends the volume of water body (Fig. 4). While daily temperature fluctuation depends on air temperature during runoff, the water temperature differs according to the temperature of the runoff water. The temperature of the runoff water in the urban part of the watershed is significantly higher than the runoff formed in the more natural upper part of watershed.

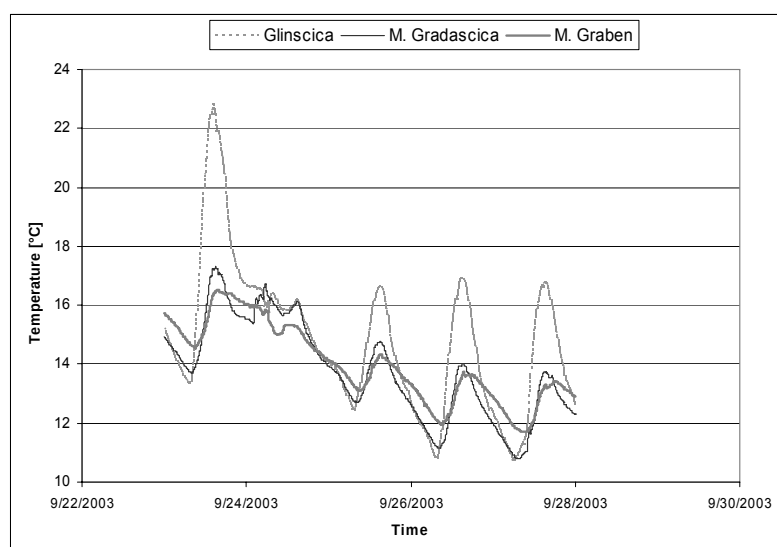


Figure 4: Temperature of water during flood wave in the Mali Graben, Mestna Gradaščica and Glinščica rivers.

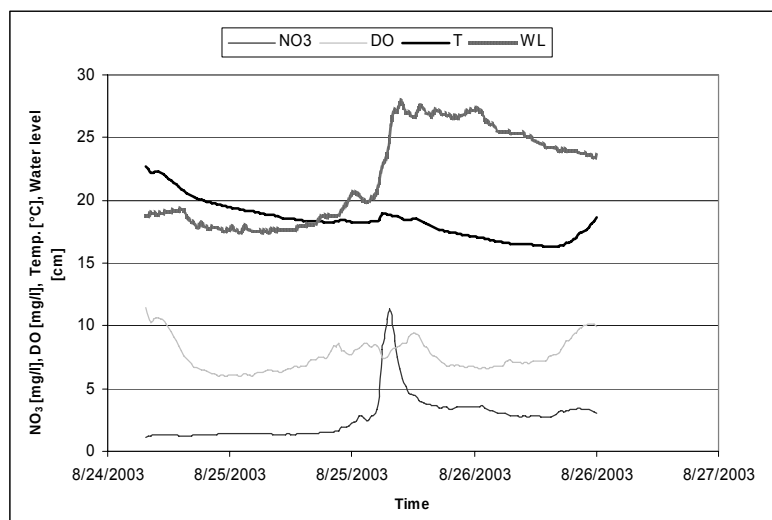


Figure 5: Temperature, dissolved oxygen and NO₃ dynamics during a flood event.

Nutrients content as all other non-point pollutants are highly dependent on the flow rate. Flood flows can highly increase the content of nutrients and non-point source pollutants (Fig. 5). The NO₃ content has increased by 6 times in this particular flood event. The sharp rise of the NO₃ concentration is a consequence of quick drainage of the polluted runoff from impermeable surfaces through the urban drainage system in the early stage of the water level rising. The high concentration of NO₃ is afterwards very sharply lowered due to dilution.

The water quality along the stream also shows significant seasonal dynamics (Fig. 6 and Fig. 7).

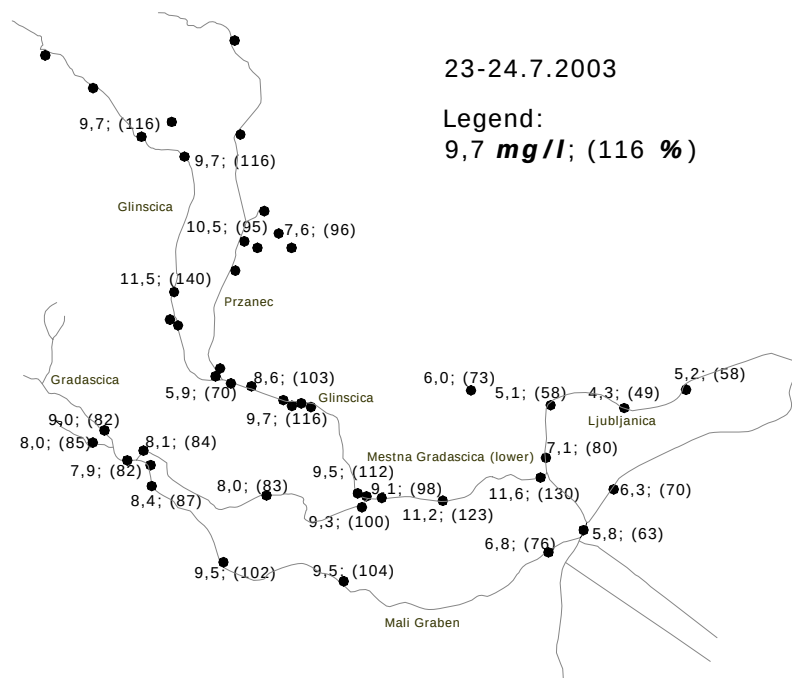


Figure 6: Dissolved oxygen content in the summer time.

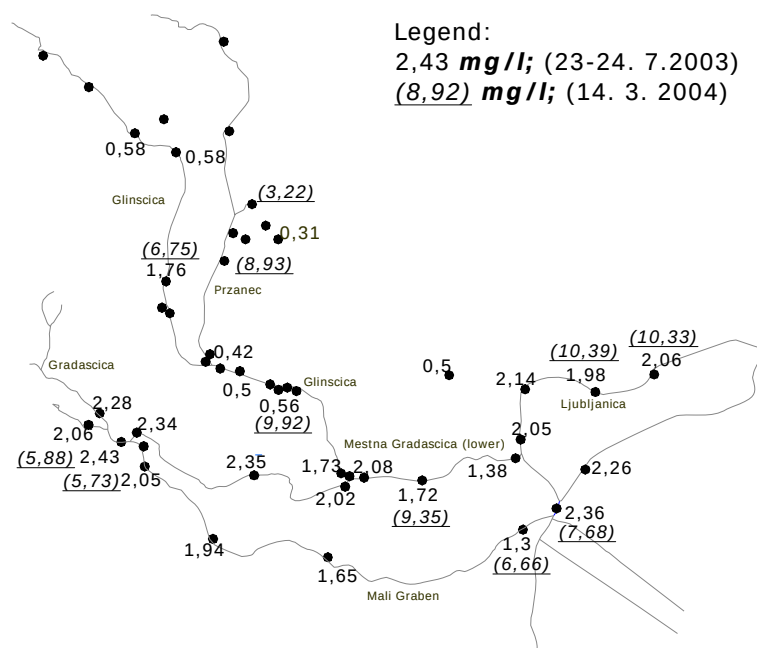


Figure 7: Nitrate concentration in summer 2003 and spring 2004.

The impact of urbanization is evident from Figure (7) in the increase of nutrients on the part of the stream during low flows in the summer time (Fig 7). The river restoration works in the Mali Graben channel, carried out in 1982, introduced stone weirs into the regulated channel, which significantly increased the dissolved oxygen content in river.

Volume of the water body

The main characteristic of a water body is its volume. Unfortunately, in hydrological data the emphasis is on water discharge or water level and not so much on the volume of water. Discharge and water level do not properly indicate the size of the water body that is crucial for the habitat. Volume of the in stream water provides space for river habitat, decrease daily temperature fluctuation, dilutes pollution and increases the available volume of water for different purposes.

The volume of water is indirectly included as an objective and incorporated into different attributes of the river restoration works. Sinuosity and pools increase the volume significantly. Weirs are often used for river restoration works to decrease the erodability of stream and form pools. They increase the volume of water and aeration. Small weirs up to eighty-centimetre high were built in the Mali Graben stream twenty years ago. The volume of water has increased by 2.5 times with the same discharge, and the number of fish species has increased by 50%, (Figs. 8 and 9).

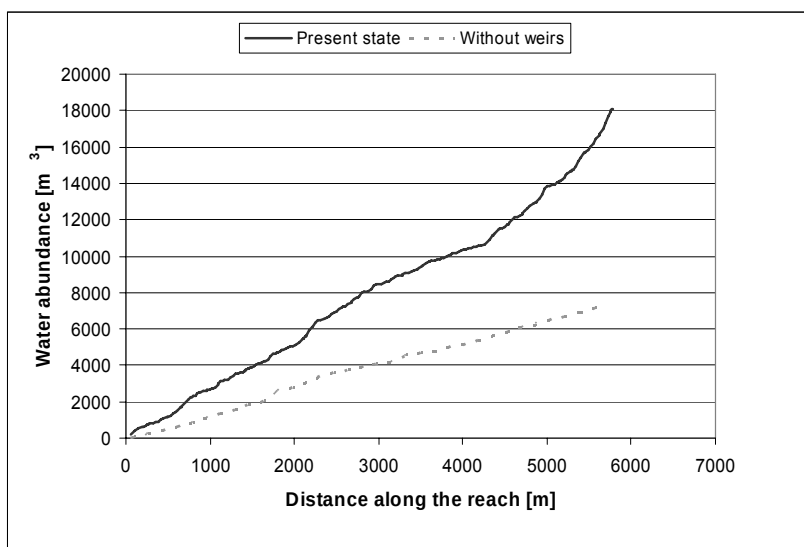


Figure 8: Increase of the water volume due to stone weirs in the Mali Graben channel.

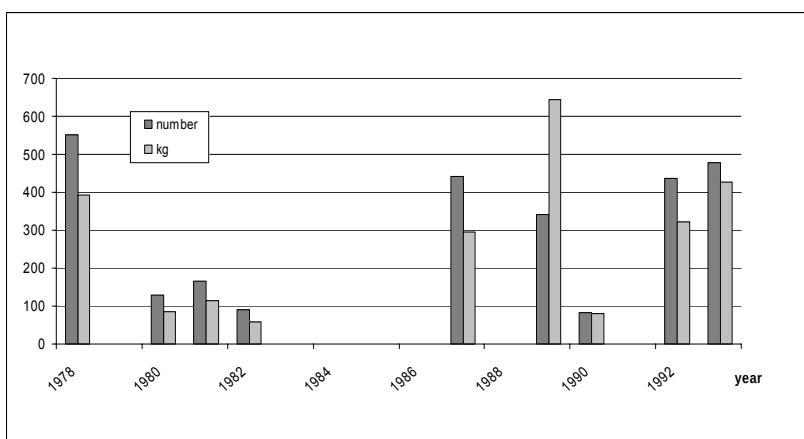


Figure 9: Catch of the nase (*Chondrostoma masus*) in the Mali Graben.

The volume of groundwater is also very important. The groundwater is often the main source of low flows in stream and also the most important source for water supply. Deepening of the stream by regulation works decreases the level and volume of groundwater. Regulation works and development of hydropower structures on the Sava River have decreased the groundwater level in the Ljubljansko polje aquifer by 10 metres, Figure 10. The volume of the groundwater body has decreased by $40 \cdot 10^6 \text{ m}^3$.

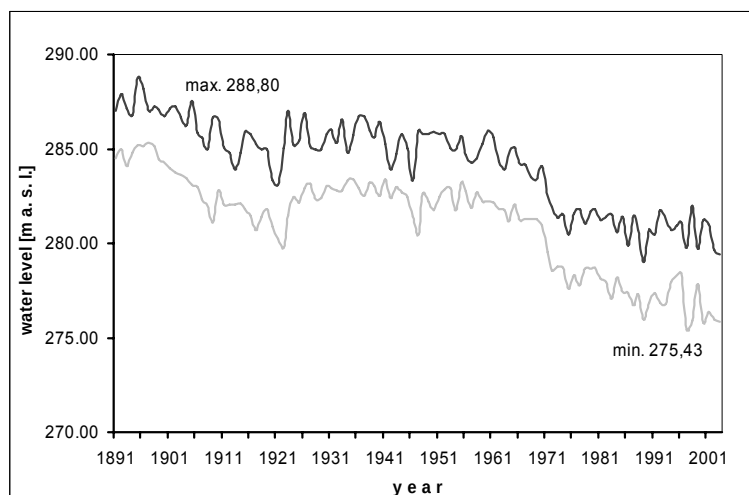


Figure 10: Minimum and maximum yearly ground water levels for time period 1891–2003.

The task of developing the volume of water body as an objective is to promote the increase of the water stored in the urban environment. The more water there is, the larger is the space for water habitats and the more social activities can be developed and associated to the water environment. We could easily measure or estimate:

- Volume of water body in stream.
- Volume of groundwater body.
- Volume of water in soil moisture.
- Volume of storage available to storage water during rainfall events.

More water in the water body increases the water storage for the dry season and may increase low flows. It is very important if restoration measures increase the volume of water in any sense, thus mitigating flood or drought hazard.

Restoration measures could be assessed by the percentage of increasing (+) or decreasing (-) of particular volume of water. For example: increased sinuosity, increased length of the river stretch, and the construction of weirs will increase the in-stream volume of water. Accordingly, recharge from the riverbed and permeable pavements will increase the volume of groundwater or soil moisture.

Conclusion

The impact of urbanisation is very complex and should be measured. In relation to the impact of urbanisation on water regime, there are certain rules, which are not always valid. Today measuring equipment (with loggers) enables us to measure the dynamics of processes and particular impacts.

The increase of water content in different water storages in the hydrologic cycle is important for river restoration. The increase of water body results in the increase of the water habitat and decrease of vulnerability to drought and flood hazard. More water means more possibilities for social and economic activities on water.

The volume of the water could be easily measured and recognised by all involved parties in the river restoration process. It is also indicative for different kind of

measures: for morphological development, in stream construction and watershed arrangements.

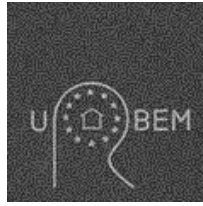
Acknowledgement

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Appendix 9



Urban River Basin Enhancement Methods

THE STUDY SITE MONITORING OF THE GRADASCICA CATCHMENT

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Dissemination Status

Public

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SUMMARY

The recent trend in water management is to improve the water environment in order to achieve a good water status. According to the EU directive (Directive 2000/60/EC), evaluation of the ecological state of a specific water body calls for determination of the chemical and biological state, taking into account the characteristic living structures in water ecosystems. River rehabilitation is an important part of the process of achieving a good ecological water status. The complex, urbanised part of the Gradascica River watershed in Slovenia of about 26 square kilometres in surface was equipped with several rainfall stations, three Doppler velocity meters and a water quality multiprobe. In a short period of time, more than ten thunderstorm events were recorded and analysed. The project of monitoring the impacts of urbanisation on ecological state of urban river water bodies includes the valuation of the water quality aspect and biological state of the Gradascica River and its tributaries in combination with hydrological conditions on the urbanized part of the watershed. The impacts of relatively simple rehabilitation measures in terms of improvement of living conditions for water organisms in the urban section of the Gradascica River (also called the Mali Graben), are also presented in the paper.

INTRODUCTION

The process of urbanisation has been accompanied by intensive changes of hydrological characteristics of watersheds. The concept of the watershed in urban areas has become more complex and difficult to define because the natural topography is disturbed in the process. Thus, the water may be drained through storm drains and in some cases it may be diverted by drains into other basins (Riley, 1998). Therefore the area contributing to runoff may be completely different in an urbanised watershed as in its natural condition. As the land urbanises, which usually means that natural land is replaced by artificial paving in combination with vegetation clearing and compaction of the soil, the dynamics of hydrological processes change due to accelerated surface runoff and conveyance through drainage systems into the river channels. To assure the designed conveyance for floodwaters, these channels are usually extremely modified, heavily regulated or even culverted. The ecological role of the channel is diminished to the minimum.

Commonly, the response of urbanised watershed to the rainfall is explained by increased volume, peak flow and flood risk downstream, decreased low flows, increased pollution and degraded stream corridor habitats (Hall, 1984; Packmann, 1979). That mainly applies, however this may be false due to the interacting nature of runoff processes involved. Another important aspect is the actual scale of the watershed area. Small-sized, densely urbanised river basins are more affected by the changed runoff pattern than large-sized rivers flowing through large urban areas, where the local urban runoff peaks contribute towards rather a small proportion of the entire river flow (Maksimovic et al., 2000). Stream channels are largely a product of the upland watershed area; the urbanisation affects not only the local runoff but also produces effects downstream, where flood peaks increase. Furthermore, higher nutrient levels are usually recorded in streams of altered watersheds (DeAngelis, 1992). The surface water chemistry of a river at any point reflects several major influences, including the lithology of the watershed, atmospheric inputs, climatic conditions and anthropogenic inputs (Bricker and Jones, 1995).

STUDY AREA DESCRIPTION

The Gradascica River basin spreads in the transitional area from the Dinaric into Alpine region in the central part of Slovenia. The headwater section flows through the varied mountain relief of the Dolomites, and is carved with numerous ravines and valleys (Fig. 1). The Gradascica River basin comprises an area of 154.4 km², which reaches far into the Polhov Gradec Mountains.

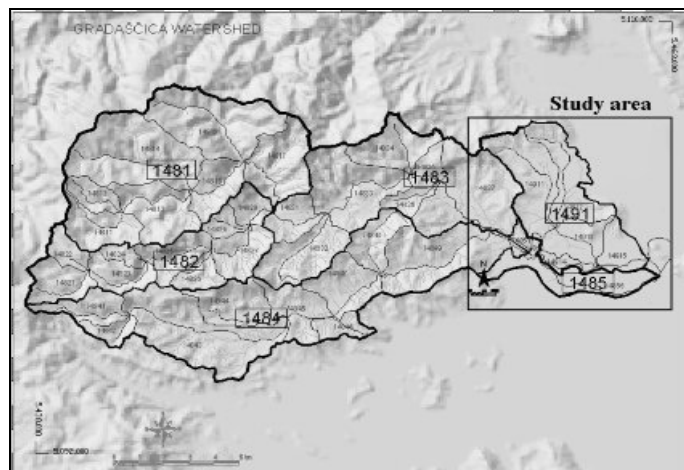


Fig. 1: The Gradascica River watershed.

Steep slopes, fairly high altitudes and abundance of precipitation (average yearly quantity from 1600 to 1700 mm) result in a quick rise in the water level of the Gradascica. The plain area of the Ljubljana basin widens on the eastern part of the watershed. At the Bokalce dam, the Gradascica splits into two water bodies, the Mestna Gradascica and the Mali Graben, which flow into the Ljubljanica River (Fig. 2). The peak discharge of the secular high water wave in the profile above the Bokalce dam is up to 243 m³/s. The Bokalce dam controls the discharge to Mestna Gradascica stream and only about 10 % of discharge of the Gradascica River diverts to the Mestna Gradascica stream. The Mali Graben carries in total about 90 % of discharge of the Gradascica River.

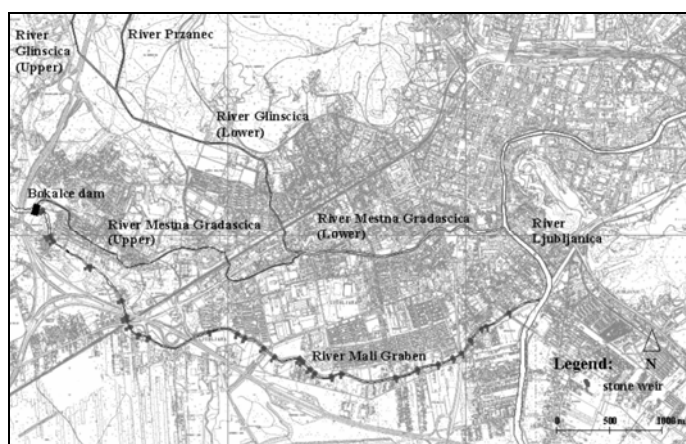


Fig. 2: The urbanized part of the Gradascica River watershed.

The study area is a sub-watershed of the water bodies of the Mali Graben, Mestna Gradascica and Glinscica, which is the tributary of the Mestna Gradascica stream. The Mestna Gradascica watershed is situated parallel to the Mali Graben watershed. The area is close to the city centre and is heavily urbanised. The stream was heavily modified and regulated by concrete blocks. The Mestna Gradascica also divides into the upper and lower part related to confluence with the Glinscica. The Glinscica water body divides into

the upper Glinscica, tributary Przanec and lower Glinscica (Fig. 2). Yearly precipitation in the study area is 1400 mm.

The former watershed area of the Glinscica stream comprised 16.7 km². The runoff within the urban area was determined by the removal of rainfall water by the sewerage system, and thus the orographic barrier failed to coincide with the actual Glinscica drainage area. The total drainage area of the Glinscica up to its outflow into the Mestna Gradascica stream is somewhat larger and comprises 19.3 km² of the watershed area, since the precipitation runoff from the area on the north-east part is diverted to the Glinscica watershed area via a storm water system. According to the CORINE database, there are estimated 21 % of urban areas and 26 % of urban green areas, that is 12.1 km² of the study area.

The land cover of the study area consist of continued and discontinued urban fabric, industrial units and roads; green urban areas, sport and leisure facilities; agricultural areas consist of non-irrigated arable land, pastures, complex cultivation patterns and land, principally occupied by agriculture, with large areas of natural vegetation; and forests include broad-leaved forest, coniferous forest and mixed forest.

METHODS

Data are collected from available databases and by monitoring. Maps and past water quality data are collected from the databases of the Agencies of the Ministry of the Environment, Spatial Planning and Energy of the Republic of Slovenia (ARSO), the land use data are taken from the CORINE database (Heymann et al., 1993).

The measuring equipment includes a one-dimensional ultrasonic Doppler instrument, 2D/3D handheld Doppler velocimeter and water quality multiprobe. One-dimensional Doppler instruments, which are placed at the bottom of streams, continuously record the water level, measure water velocity and temperature. The multi-purpose instrument, designed for in-situ and flow-through applications, measures parameters simultaneously. It can be used for remote or attended monitoring of fresh, salt, or polluted water; in both, surface and groundwater. The multiple parameters include: nitrate, temperature, conductivity, depth, dissolved oxygen, Oxidation Reduction Potential (ORP) and pH. Measurements by multi-purpose probe were carried out in different seasons in approximately 40 measuring cross sections along the streams Glinsica, Mestna Gradascica, Mali Graben and Przanec from July 2003 to July 2004 (Fig. 3). The continuous measurements of fluctuations of parameters in streams were also derived by the probe for 24 hours at 15-minute sampling rate in 3 cross sections equipped by the Doppler instruments. Six rain gauge stations were used for rainfall measurement.

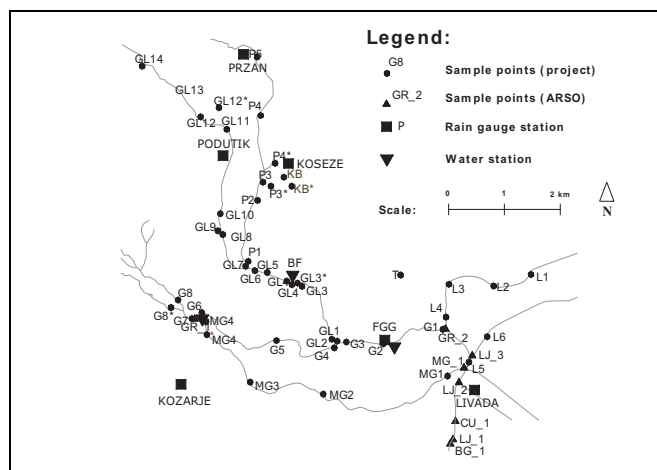


Fig. 3: Measuring cross sections, rain gauge stations and water stations.

In order to manage all the collected data, an information system has been established. It is based on a country-based watershed register (Šraj, 2001; Brilly, 2000). The system contains information thematic layers. Data for the information themes are organised as a file system managed with AutoCAD MAP 2004 GIS tool and prepared as vector or raster data, available for browsing on Internet.

RESULTS AND DISCUSSION

The measurements of parameters by the multi-purpose instrument were performed in four two-day campaigns in July, October 2003, and January, March 2004. The number of measuring points was reduced during each campaign because of the rather small scale of the studied area. Among the parameters measured, the measurements of dissolved oxygen and pH value are discussed in detail.

Dissolved oxygen

Dissolved oxygen is a basic requirement for healthy aquatic ecosystems (Wharton, 2000). Oxygen concentrations in the water column fluctuate under natural conditions, but oxygen can be severely depleted as a result of human activities. Urban runoff is often loaded with high concentrations of organic materials derived from variety of sources (Klein, 1979).

The water in the streams was saturated with dissolved oxygen for more than 70 % of the time. The water was over-saturated in the summer time (Fig. 4).

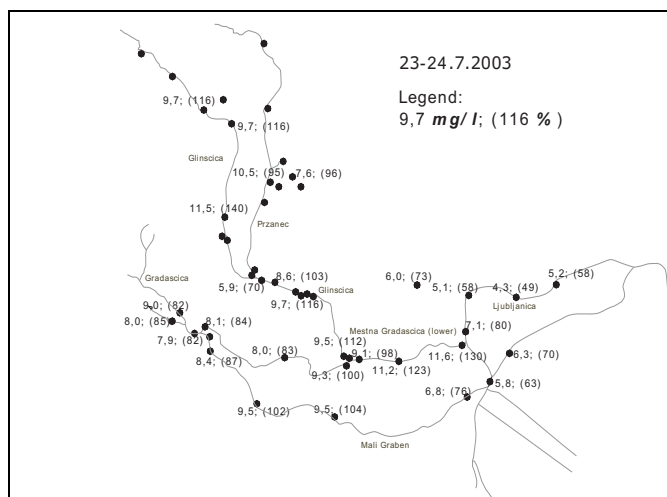


Fig. 4: Dissolved oxygen content in the summer time.

The over-saturation with dissolved oxygen was higher in heavily modified concrete channels of the Mestna Gradascica and Glinscica streams than in the rehabilitated channel of the Mali Graben River. The concrete bottom and banks of the Mestna Gradascica and Glinscica streams are intensively overgrown by algae. As the concrete channel is mainly unshaded, the photosynthetic activity is very intense. This is reflected on the high concentration of dissolved oxygen, which is oversaturated in summer time.

pH

The pH of the stream water reflects the chemical characteristics of precipitation and land surface. Additional characteristics of pH in some poorly buffered waters is high daily variability in pH values attributable to biological processes that affect the carbonate buffering system (Jarvie et al., 2001). Levels of dissolved carbon dioxide in stream water reflect the balance between uptake of carbon dioxide by aquatic organisms (for photosynthesis) and release of carbon dioxide (by respiration). On the other hand, the concentration of dissolved oxygen is increased by the photosynthetic activity during the daytime and the dissolved oxygen can be depleted during the night by the respiration of water organisms. The product of the reaction of carbon dioxide with water is bicarbonate ion and hydrogen ion; increased concentration of hydrogen ion means increased acidity and lowering of the pH (Chapra, 1997).

Continuous pH records reveal a wealth of detail on short-term variability and extremes in river water quality and have particular application for examining water quality signals which occur episodically and on shorter timescales.

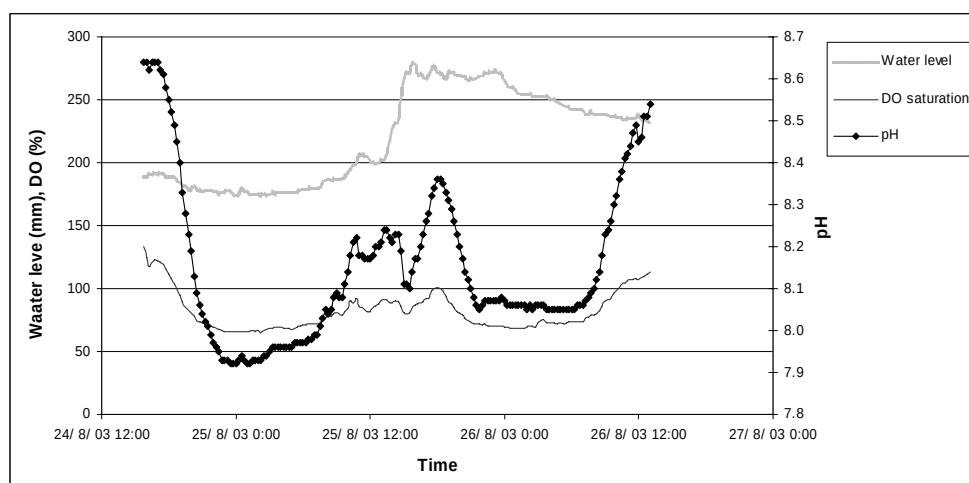


Fig. 5: Continuous measurements of water level, pH and dissolved oxygen saturation in the Mestna Gradascica River.

Continuous measurements of water level, pH and dissolved oxygen saturation in the Mestna Gradascica River are shown in Figure 5. The measurements were logged automatically at 15-minute intervals. The relation between the variations of pH and dissolved oxygen saturation is evident. Increased values of pH and dissolved oxygen saturation during the daytime are result of diurnal photosynthetic activity in the water body. The temporal fluctuations of pH and dissolved oxygen saturation are also related to the increased water discharge during a small flood wave produced by 11 mm rainfall.

Improvement of the aquatic habitat in the Mali Graben River

The revitalisation works in the Mali Graben River were carried out between 1984 and 1986, following the initiative of fishing and angling societies. There were several stone weirs built in the river channel (Fig. 2), however no concrete walls were built and the living conditions remained favourable.

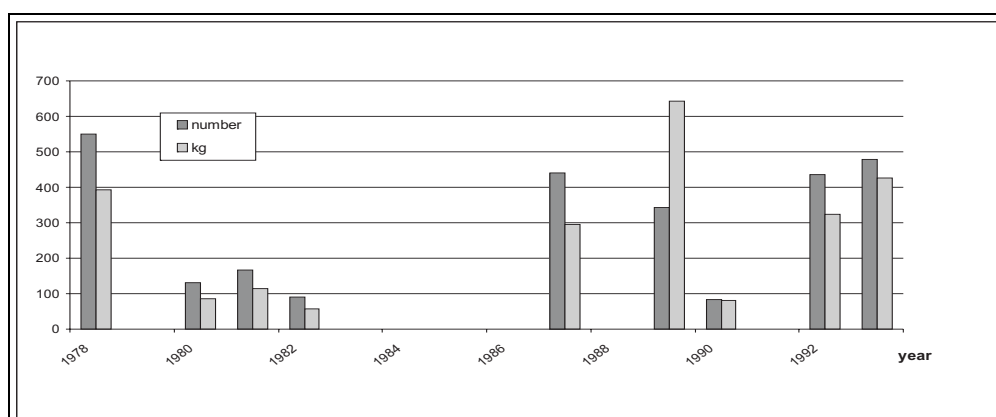


Fig. 6: Catch of the nase prior and after the restoration works in the Mali Graben River.

The weirs increased the water abundance in the channel during low flow conditions. The fish population has significantly increased after the introduction of stone weirs (Fig. 6). The measures present a good practice of urban river rehabilitation techniques.

CONCLUSION

The results of the monitoring demonstrate a wide range of information that can be gained from continuous measurements of basic water quality parameters in connection with analysis of hydrological regime of the urban environment. One of the major advantages of this type of monitoring is the possibility to quantify water quality extremes that cannot be detected by traditional spot measurements or sampling (Quinn, 2004). This leads to a better understanding of dynamic short term variability in stream water quality and a new insight concerning watershed and in-river processes. The understanding of the processes calls for many field measurements, modelling, data mining and analyses. The use of monitoring is the first step of research, which would help understand the system and identify the key factors for modelling.

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