REFORM

REstoring rivers FOR effective catchment Management

Hydromorphology of rivers and floodplains – What is at stake and how does REFORM contribute?

REFORM 4th national stakeholder workshop
"Elementi di novità a supporto dell'attuazione della DQA"

Rome, 10 September 2015

Tom Buijse
Deltares
Utrecht, the Netherlands
E: tom.buijse@deltares.nl

Hydromorphological pressures in European surface waters

- 127 000 surface water bodies
  - 82% rivers
  - 15% lakes
  - 3% coastal and transitional waters
- HYMO pressures affecting ..
  - 40% river and transitional waters
  - 30% lakes
- Causes
  - Hydropower
  - Navigation
  - Agriculture
  - Flood protection
  - Urban development

Source: EEA report 8/2012 European waters – assessment of status and pressures

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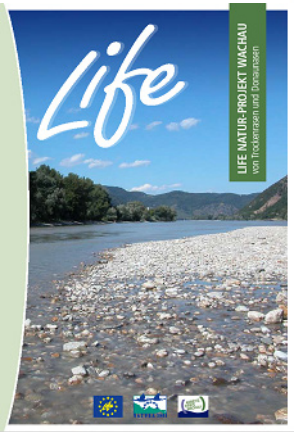
How do we share expertise on river restoration?

Examples of EU funded River River restoration projects

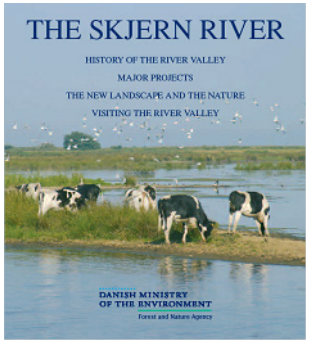
http://wwwlife-donau-ybbsat/

Count of ProjectName	Programme		
Global objective	INTERREG	LIFE	Grand Total
Flood management	20	1	21
Integrated River Basin Management	26	1	27
River & floodplain restoration	17	114	131
Water quality improvement	4	1	5
Species conservation and management	14	55	69
Grand Total	81	172	253

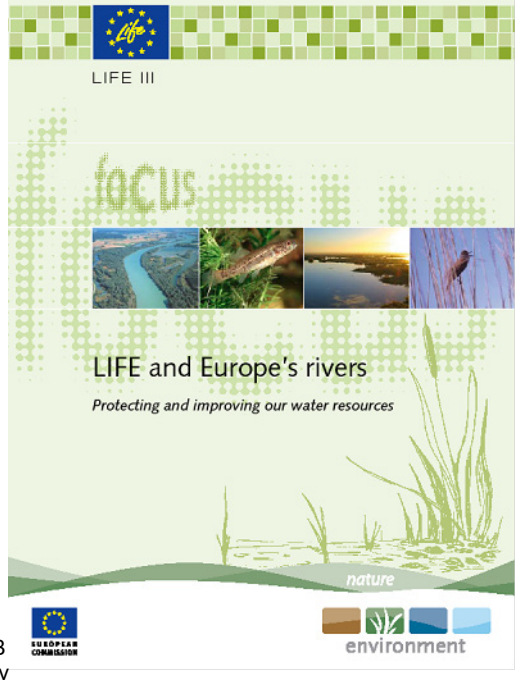


http://wwwlife-wachauat/

http://webarchivenationalarchivesgovuk/20110303155229/http://wwwstreamlifeorguk/



http://wwwnaturstyrelsendk/Naturoplevelser/Beskrivelser/Vestjylland/SkjernEnge/Skjern_River_Wetlandshtm



www.wwf.se/flodparlmussla

LIPPE aue
LIFE PROJEKT

http://wwwhammde/lifelippeauehtml

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November 2011 – October 2015

Tom Buijse NL
Roy Brouwer NL
Ian Cowx UK
Harm Duel NL
Nikolai Friberg DK/N
Angela Gurnell UK
Daniel Hering GE
Eleftheria Kampa GE
Erik Mosselman NL
Susanne Muhar AU
Matthew O'Hare UK
Tomasz Okruszko PL
Massimo Rinaldi IT
Jan Vermaat NL
Christian Wolter GE

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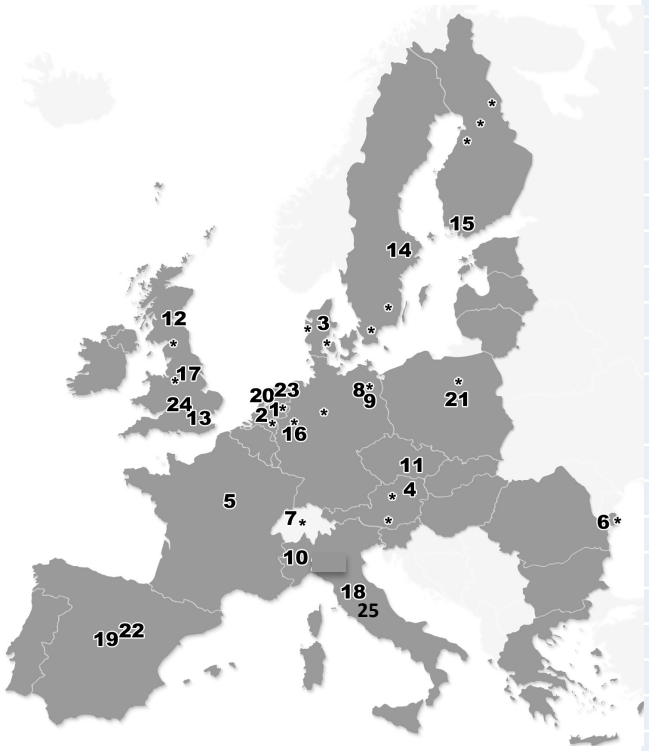
Partners



26 partners from 15 European countries

No	Name	Short name	Country
1	Stichting Deltares	Deltares	Netherlands
2	Stichting Dienst Landbouwkundig Onderzoek	Alterra	Netherlands
3	Aarhus University	AU-NERI	Denmark
4	Universitaet fuer Bodenkultur Wien	BOKU	Austria
5	Institut National de Recherche en Sciences et des Technologies pour l'Environnement et l'Agriculture	IRSTEA	France
6	Institutul National de Cercetare-Dezvoltare Delta Dunarii	DDNI	Romania
7	Swiss Federal Institute of Aquatic Science and Technology	EAWAG	Switzerland
8	Ecologic Institut Gemeinnützige Gmbh	Ecologic	Germany
9	Forschungsverbund Berlin E.V.	FVB.IGB	Germany
10	Joint Research Centre- European Commission	JRC	Belgium
11	Masaryk University	MU	Czech Republic
12	Natural Environment Research Council - Centre for Ecology and Hydrology	NERC	United Kingdom
13	Queen Mary University of London	QMUL	United Kingdom
14	Swedish University of Agricultural Sciences	SLU	Sweden
15	Finnish Environment Institute	SYKE	Finland
16	Universitaet Duisburg-Essen	UDE	Germany
17	University of Hull	UHULL	United Kingdom
18	Universita Degli Studi Di Firenze	UNIFI	Italy
19	Universidad Politecnica de Madrid	UPM	Spain
21	Warsaw University of Life Sciences	WULS	Poland
22	Centro de Estudios y Experimentacion de Obras Publicas	CEDEX	Spain
23	Dienst Landelijk Gebied	DLG	Netherlands
24	Environment Agency	EA	United Kingdom
25	Istituto Superiore per la Protezione e la Ricerca Ambientale	ISPRA	Italy
26	Norsk Institutt for Vannforskning	NIVA	Norway
27	Stichting VU-VUmc	VU-Vumc	Netherlands

Objectives of REFORM

APPLICATION

1. Select indicators for cost-effective monitoring
2. Improve tools and guidelines for restoration

RESEARCH

1. Review existing information on river degradation and restoration
2. Develop a process-based hydromorphological framework
3. Understand how multiple stress constrains restoration
4. Assess the importance of scaling on the effectiveness of restoration
5. Develop instruments for risk and benefit analysis to support successful restoration

DISSEMINATION

1. Enlarge appreciation for the benefits of restoration

Cooperation with …

WISER

Restoring Europe's Rivers

European Centre for River Restoration
ECRR

Lourdes Alvarellos, Gary Brierley, Johan Kling, Margaret Palmer, Hervé Piégay, Peter Pollard, Ursula Schmedtje, Bas van der Wal

MARS PROJECT
Managing Aquatic ecosystems and water Resources under multiple Stress

make use of earlier research projects (e.g. REBECCA, WISER, FORECASTER)

RESTORE (LIFE+ Information & Communication)

European Centre for River Restoration (ECRR)

WFD Implementation: common implementation strategy (CIS)

Advisory Board of REFORM

Connecting to new research projects (e.g. MARS)

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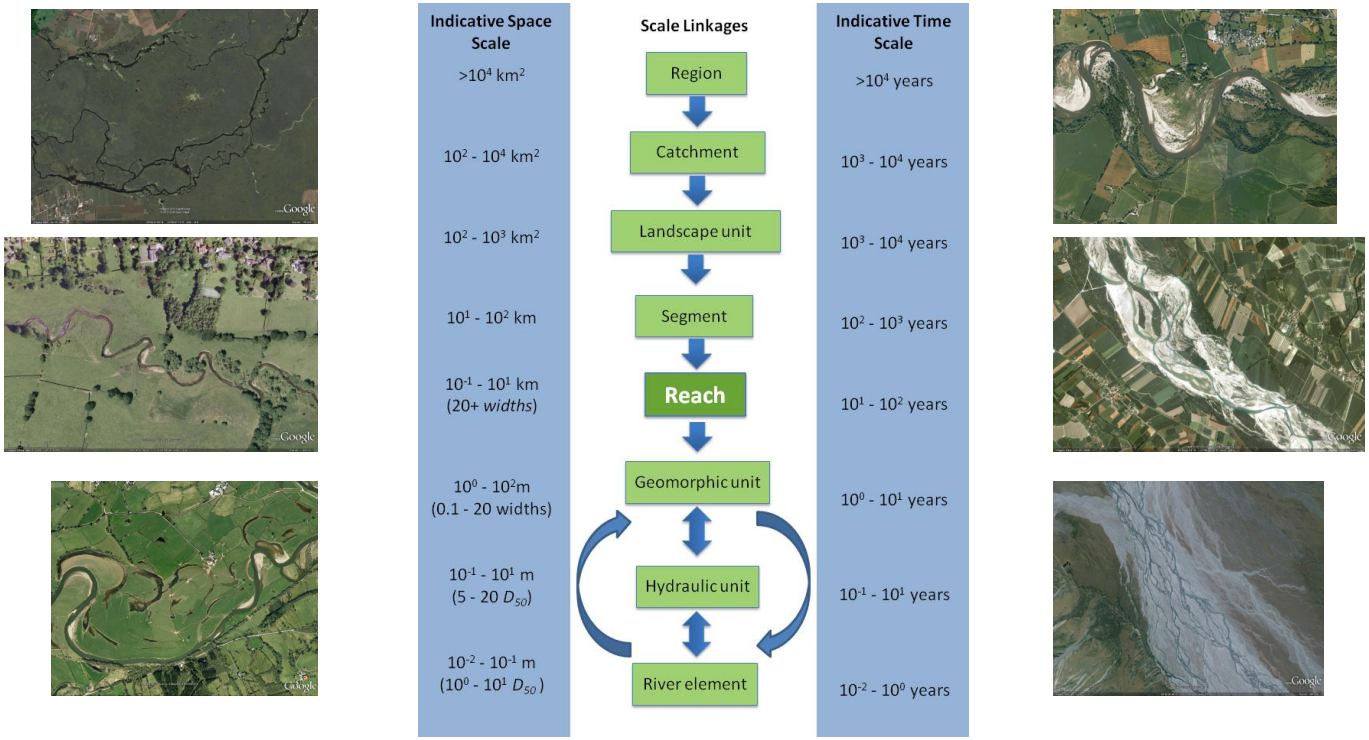
EVENTS

- European stakeholder workshop – Brussels February 2013
- National stakeholder workshops
  - Zutphen, the Netherlands November 2013
  - York, UK May 2014
  - Seville, Spain June 2014
  - Rome, Italy September 2015
- Thematic workshops
  - Role of groundwater for river ecosystems – Biebrza, Poland September 2014
  - Linking E-flows to sediment dynamics – Rome, Italy September 2015
  - ECOSTAT Hydromorphology – Oslo, Norway October 2015
- Summer school – Wageningen, Netherlands June 2015
- Scientific conference – Wageningen, Netherlands June 2015

Take the catchment perspective

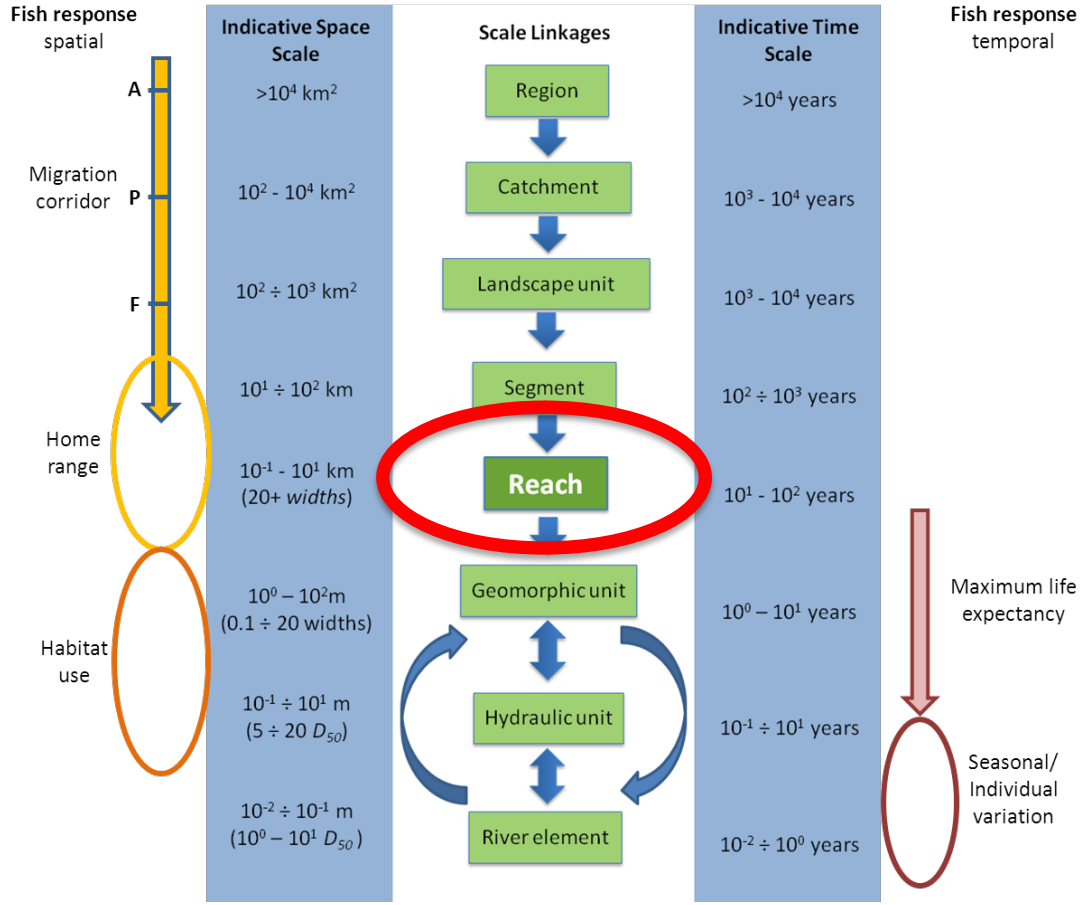
Awareness to relevant spatial and temporal aspects beyond river restoration project boundaries and project life span



Grabowski, R.C., N. Surian and A.M. Gurnell (2014) Characterizing geomorphological change to support sustainable river restoration and management. WIREs Water. doi/10.1002/wat2.1037

Gurnell, A. et al (2014)Multi-scale framework and indicators of hydromorphological processes and forms. REFORM deliverable 2.1

Connecting biota to multiple scales



Garcia de Jalon, D., Wolter, C. et al. (20140 Influence of natural hydromorphological dynamics on biota and ecosystem functioning. REFORM deliverable 2.2 part 2

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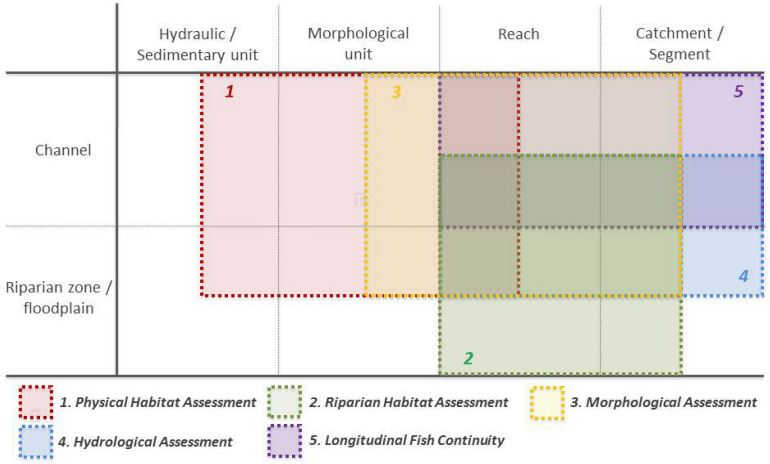
Consider physical processes

most applied hydromorphological methods do this insufficiently



Countries	Categories of methods					TOT
	1. Physical habitat	2. Riparian habitat	3. Morphological assessment	4. Hydrological assessment	5. Fish continuity	
Europe	**40**	**5**	**13**	**4**	**13**	**75**
Austria	6				1	**7**
Belgium	2				2	**4**
Czech Republic	1		1			**2**
Denmark	5					**5**
England & Wales	4		4		2	**10**
France	3		2		2	**7**
Germany	5				1	**6**
Ireland	1		1			**2**
Italy	2	1	1	1	1	**6**
Netherlands	2				1	**3**
Poland	3		1			**4**
Portugal	1					**1**
Scotland			2	1	1	**4**
Slovakia	1					**1**
Slovenia	1					**1**
Spain	2	4	3	2	2	**13**
Sweden	2					**2**
US	**24**	**5**	**8**	**4**	**5**	**46**
Australia	**4**	**2**	**1**			**7**
Switzerland	**1**					**1**
Others*	**4**	**2**	**2**	**2**	**2**	**12**

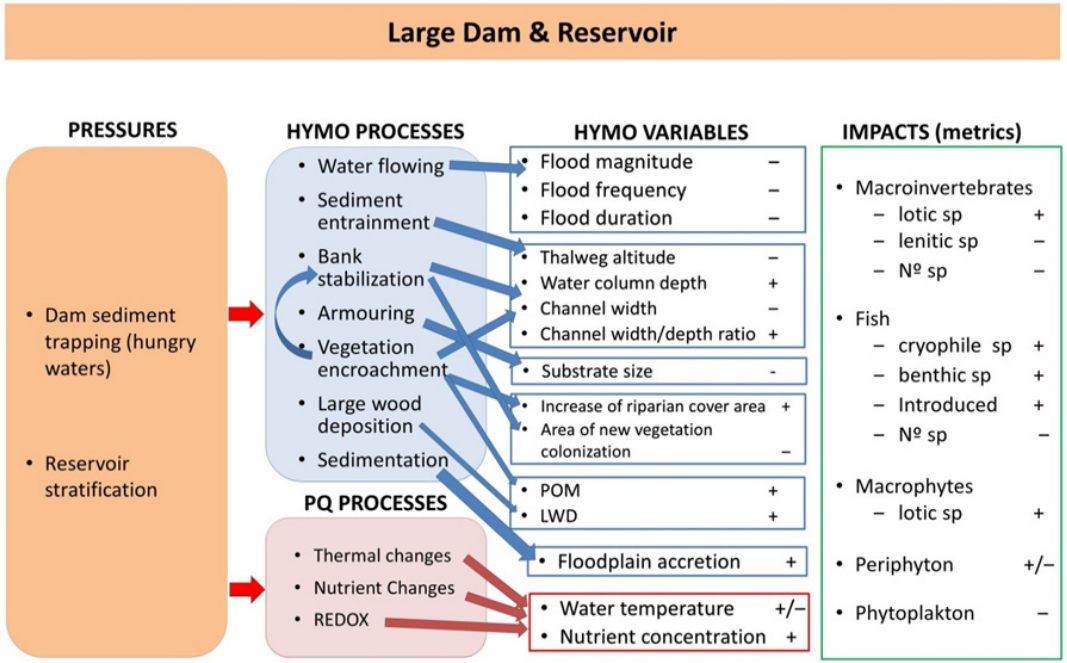
*South Africa, Canada/Quebec, China, New Zealand, Ukraine

Rinaldi, M., B. Belletti et al. (2013) Review on eco-hydromorphological methods. REFORM deliverable 1.1

Belletti, B., Rinaldi, M., Buijse, A.D., Gurnell, A.M., Mosselman, E (2015) A review of assessment methods for river hydromorphology. Environmental Earth Sciences 73:2079–2100

Beware of gardening, don't restore the past, rivers respond

Conceptual DIAGNOSIS
pressure – process – impact framework

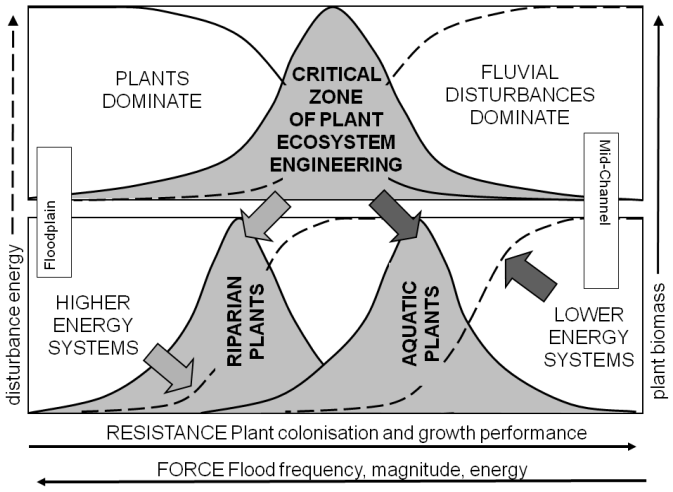


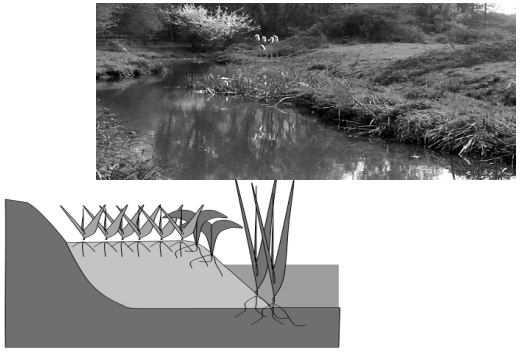
- 18 most significant HyMo pressures reviewed that impact aquatic biota
- Diagnosis helps to identify appropriate restoration measures

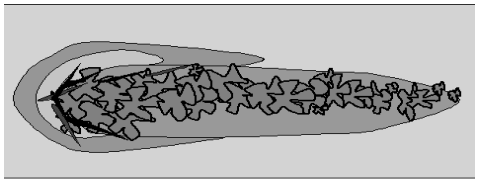
Garcia de Jalon, D. et al. (2013) Review on effects of pressures on hydromorphological variables and ecologically relevant processes. REFORM deliverable 1.2

Wolter, C. et al. (2013) Review on ecological responses to hydromorphological degradation and restoration. REFORM deliverable 1.3

Vegetation as ecosystem engineer for river restoration is too often insufficiently taken into account







Gurnell, A. et al. D2.2 (2014) Influence of natural hydromorphological dynamics on biota and ecosystem functioning. REFORM deliverable 2.2 part 1

Gurnell, A.M. (2014) Plants as river system engineers. Earth Surface Processes and Landforms 39: 4–25

REFORM enhanced insights in the relation between HYMO and biota

- Fish and macrophytes appear better suited to assess HyMo degradation than diatoms and benthic invertebrates
- Terrestrial and semi-aquatic species benefit most from restoration
- Restoration resulted in a higher number of individuals but few new species
- Restoration affected specific species or traits rather than increasing the mere total number of species

Friberg, N. (2014) Impacts and indicators of change in lotic ecosystems. WIREs Water 2014 doi/10.1002/wat2.1040

Friberg, N., M. O'Hare & A.M. Poulsen [eds.] (2013) Impacts of hydromorphological degradation and disturbed sediment dynamics on ecological status. REFORM deliverable 3.1

O'Hare, M. et al. (2015) Understanding biological responses to degraded hydromorphology sediment dynamics and multiple stress. REFORM deliverable 3.2

Verdonschot, P. et al. (2015) Evaluation of candidate indicators for case studies including uncertainty. REFORM deliverable 3.3

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Standardised sampling of restored reaches across mid-sized rivers in Western, Central and Northern Europe

Mid-sized lowlands rivers

Mid-sized mountain rivers

Where?	Who?	Where?	Who?
Em / Mörrum	SLU	Ruhr / Lahn	UDE
Skjern / Stora	NERI	Thur / Töss	EAWAG/UDE
Regge / Dommel / Dinkel	Alterra	Drau / Enns	BOKU
Spree / Lippe	IGB	Becva / Morava	MU
Narew / Warta	WULS	Kuivajoki/Vääräjoki	SYKE

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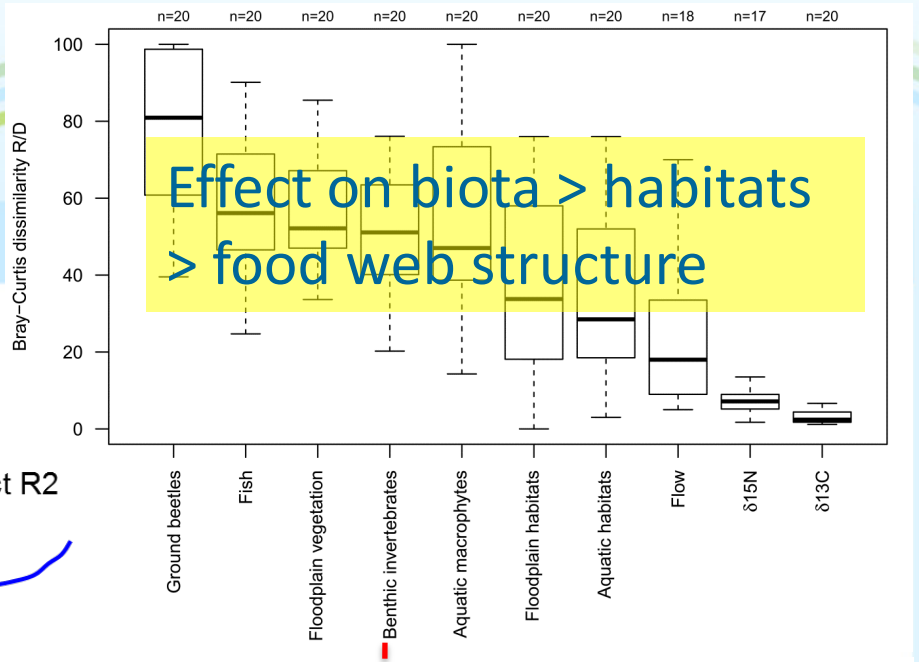
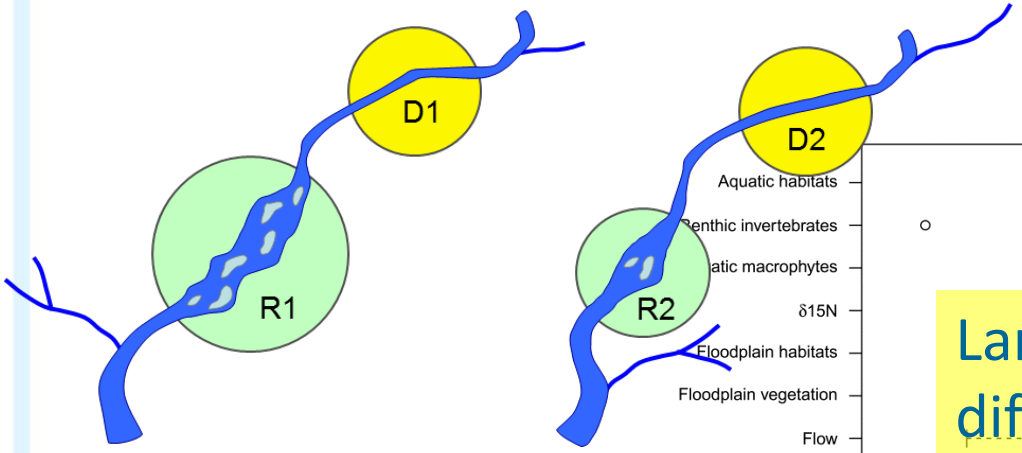
Restoration matters, but larger projects did not perform better then small ones

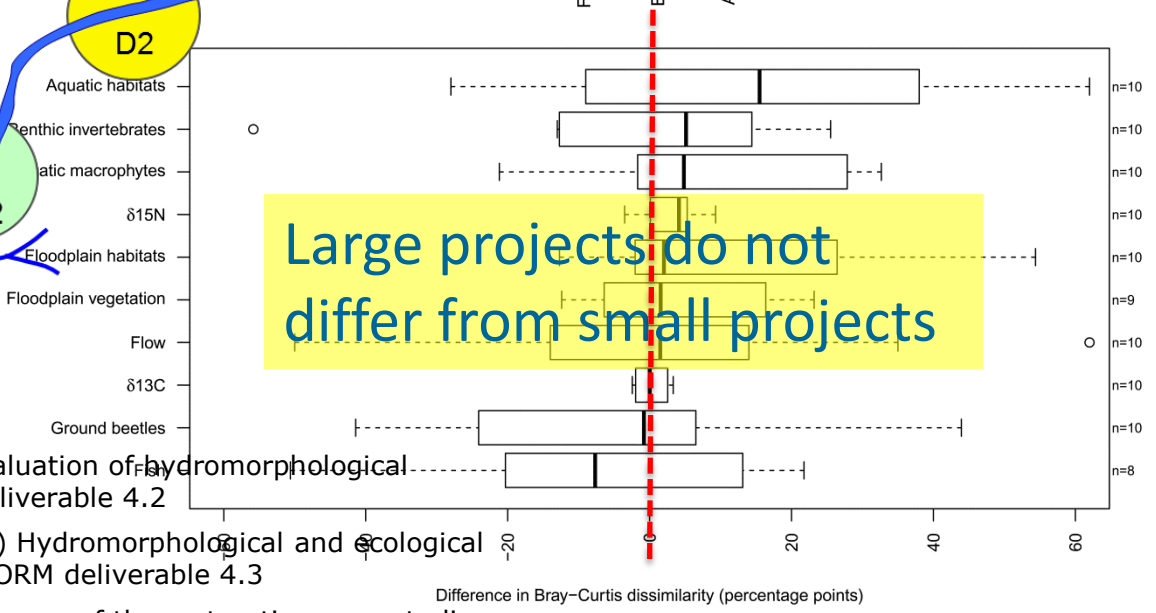


Effect on biota > habitats > food web structure

Large restoration project R1

Small restoration project R2





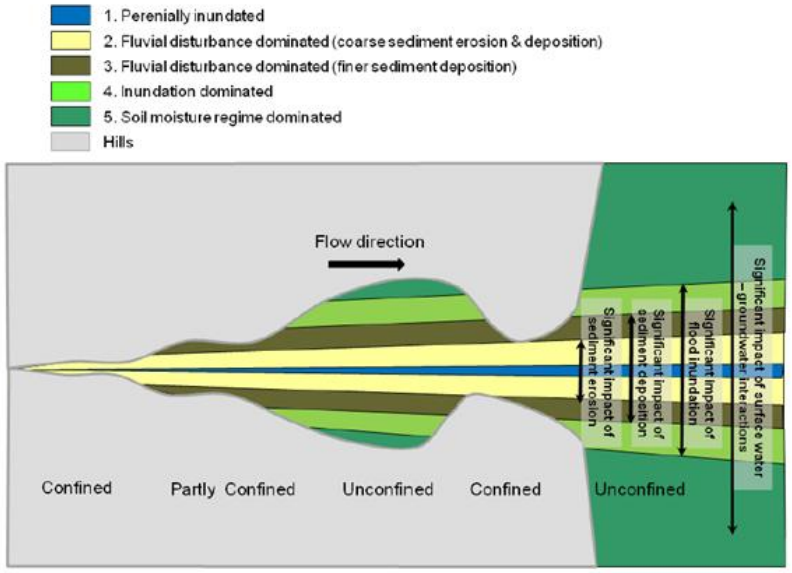
Large projects do not differ from small projects

Kail, J. & N. Angelopoulos et al. (2014) Evaluation of hydromorphological restoration from existing data. REFORM deliverable 4.2

Kail, J., A. Lorenz & D. Hering [eds.] (2014) Hydromorphological and ecological survey of the restoration case studies. REFORM deliverable 4.3

Vermaat, J. et al. (2015) Socio-economic survey of the restoration case studies. REFORM deliverable 4.4

Existing EU Directives provide a too limited legislative framework for riparian zones and floodplains

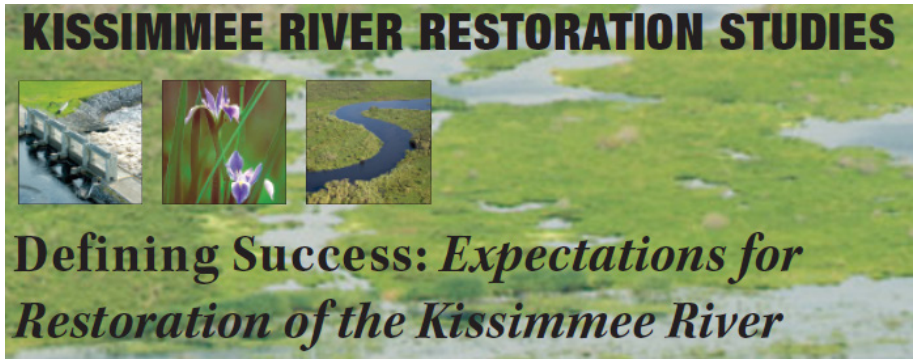


- Hydromorphological impacts can take years to fully manifest themselves
- Riparian and floodplain ecosystems are not subject to extensive monitoring
- Plant diversity alone cannot be considered a valid and exhaustive indicator to assess the health of a river system and its functioning
- A generic framework is recommended for assessing the impact on floodplain and riparian ecosystems

Baattrup-Pedersen, A., M. O'Hare et al. (2015) Guidance on how to identify impacts of hydromorphological degradation on riparian ecosystems. REFORM deliverable 3.4

Good planning and management

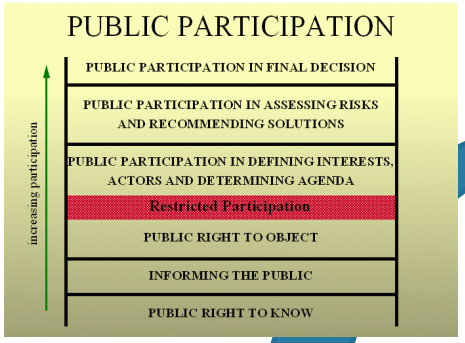
Restoration projects should have well-defined success criteria



- Nine expectations describe abiotic responses for hydrology, geomorphology, and water quality.
- Five expectations describe changes in plant communities in the river channel and floodplain
- Six expectations describe invertebrate and amphibian and reptile communities.
- Five expectations describe anticipated changes in fish and bird communities.

Good planning and management

Application of existing management tools can substantially enhance the efficiency and effectiveness of restoration



Plan

Diagnosis
Driver
Pressure
State
Impact
Response

Do

Restoration measures
Specific
Measurable
Achievable
Realistic
Time-bound

Check

Monitoring (BACI)
Before – **A**fter
Control - **I**mpact

Act

Participation ladder

Cost data are too scarce hampering cost-benefit analysis

Measure	Germany	Spain	UK	Netherlands
Flow Quantity (1)	1%	0%	0%	0%
Sediment Flow Quantity (2)	4%	**29%**	5%	**23%**
Flow Dynamics (3)	1%	0%	0%	0%
Longitudinal Connectivity (4)	**21%**	**32%**	7%	**55%**
Depth and Width Variation (5)	13%	0%	**53%**	9%
In-channel Structure and Substrate (6)	**27%**	7%	**19%**	9%
Riparian Zone (7)	4%	11%	7%	5%
Floodplains/Lateral Connectivity (8)	**29%**	**21%**	9%	0%
Total of Measures	453	228	45/55	30

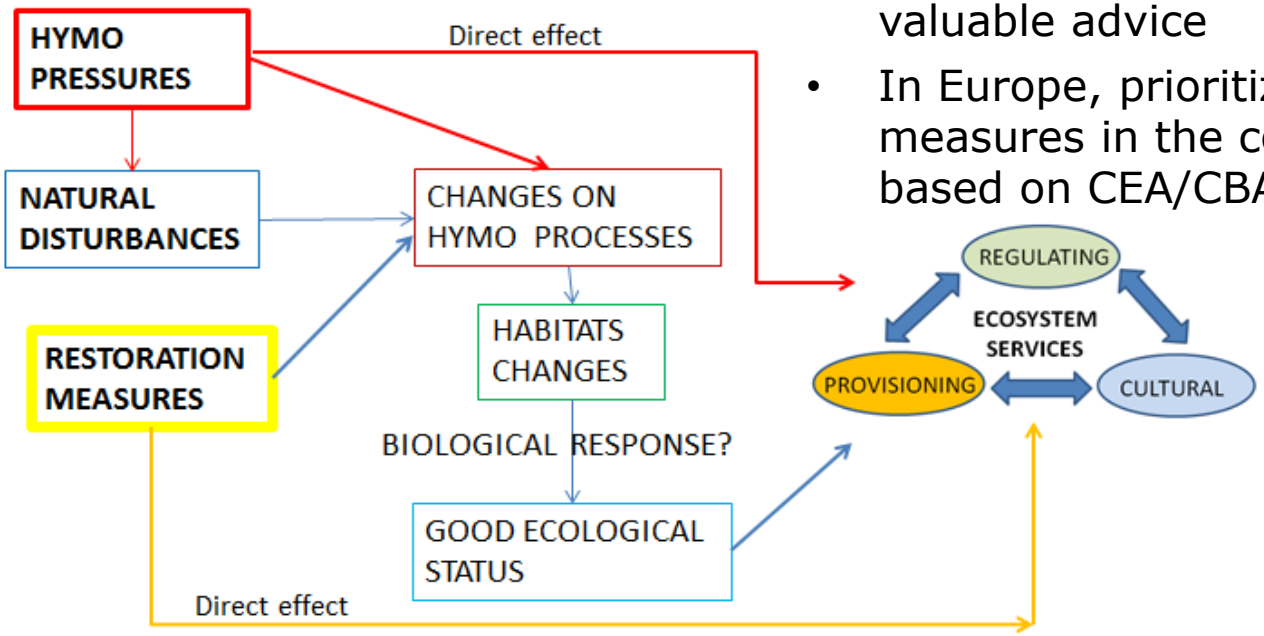
Conclusions & Recommendations

- Incorporating cost information into decision making is a prerequisite to increase river restoration efficiency -> more effort needed
- Difficult to determine ecosystem benefits and services from restoration projects both individually and as a whole

Ayres, A., H. Gerdes, M. Lago et al. (2014) Inventory of the cost of river degradation and the socio-economic aspects and costs and benefits. REFORM deliverable 1.4

Cost-Benefit Analysis aids in prioritizing restoration measures and plans

- Manuals and guidelines for the economic analysis of river restoration projects do not yet exist
- Important guidelines on the economics of water management in general offer valuable advice
- In Europe, prioritization of restoration measures in the context of the WFD based on CEA/CBA is still very limited



Brouwer, R., H. Gerdes, P. Reichert et al. (2015) Valuing the ecosystem services provided by European river corridors – an analytical framework. REFORM deliverable 5.2

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website: WWW.REFORMRIVERS.EU

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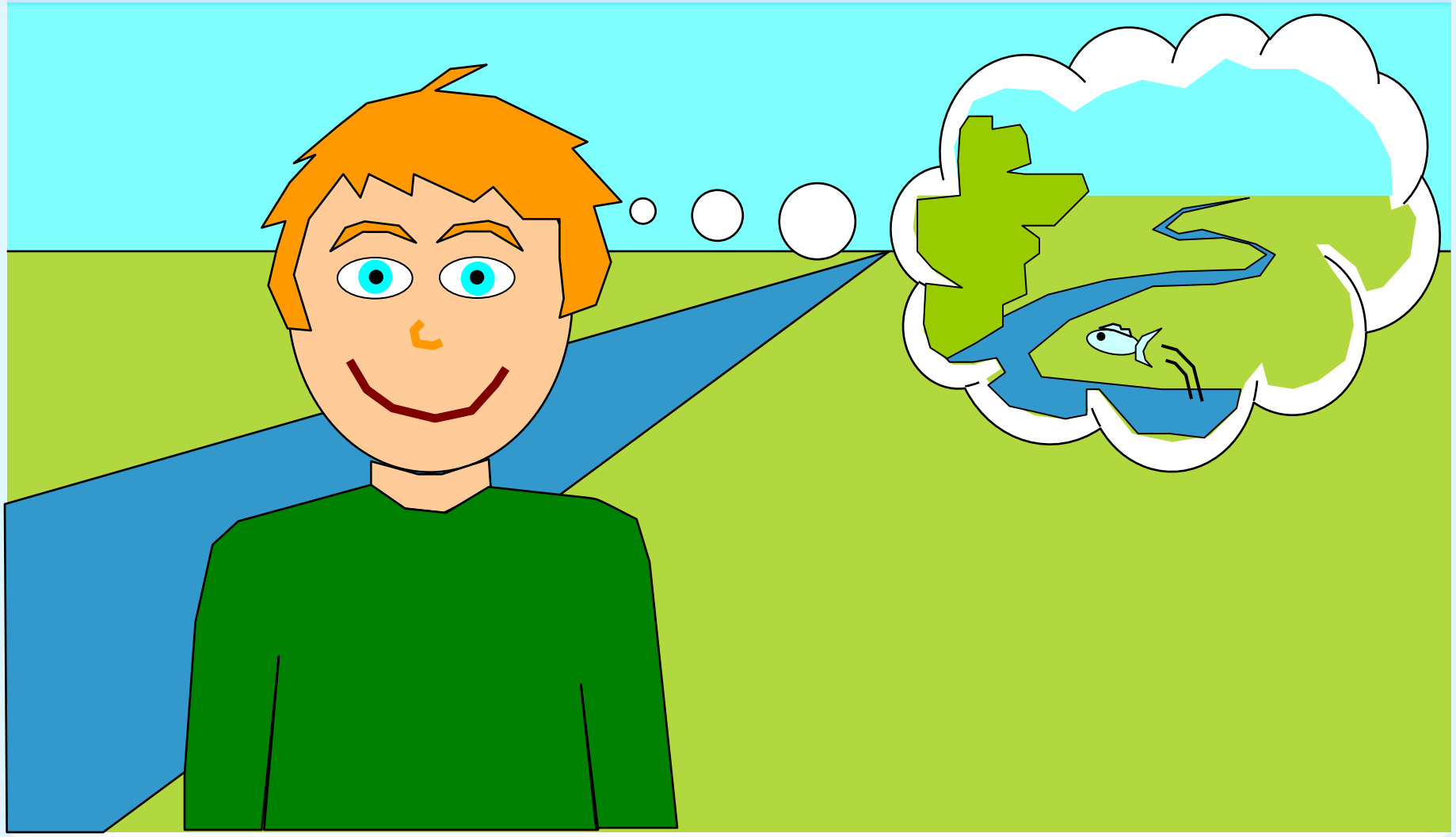

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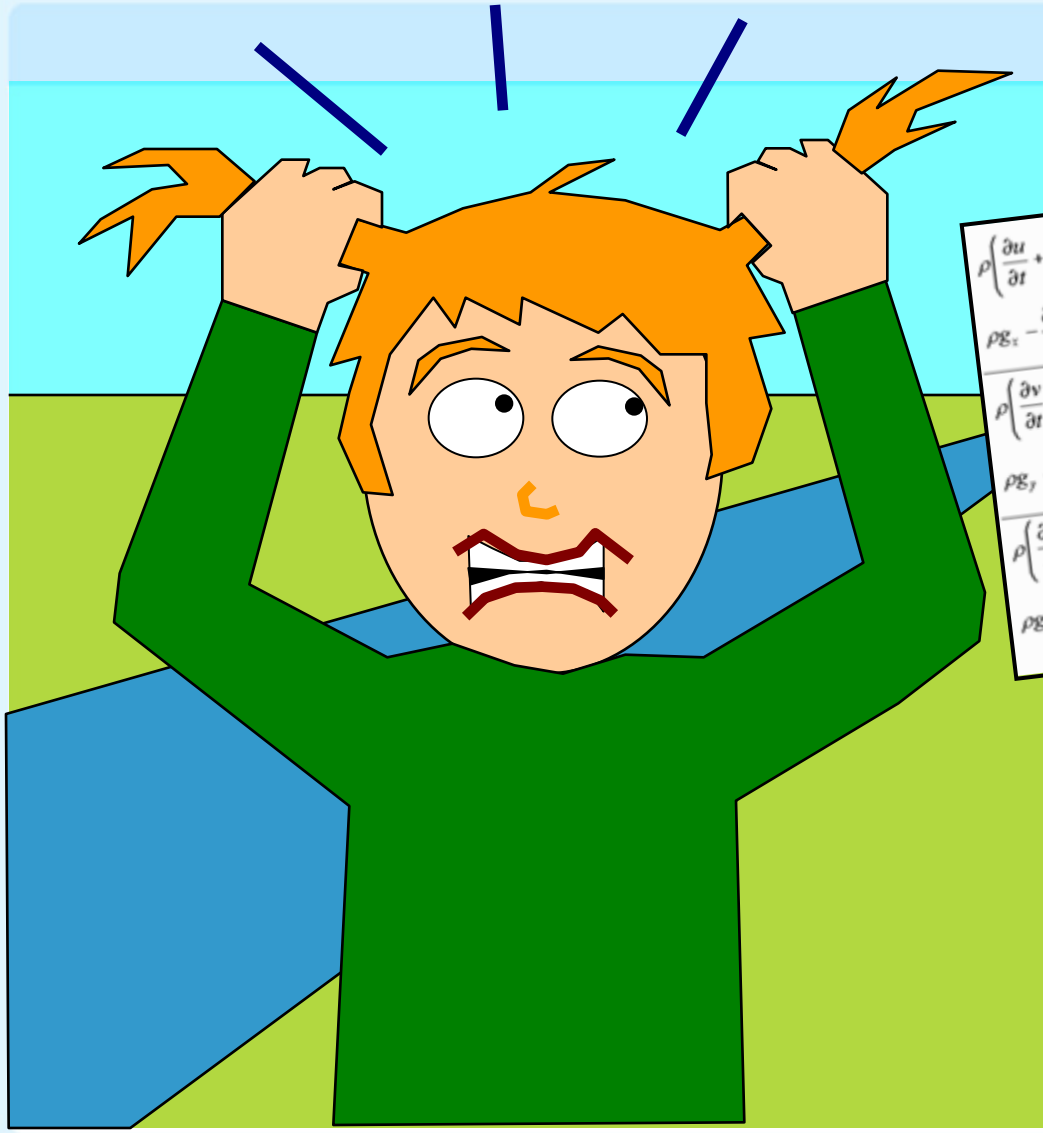

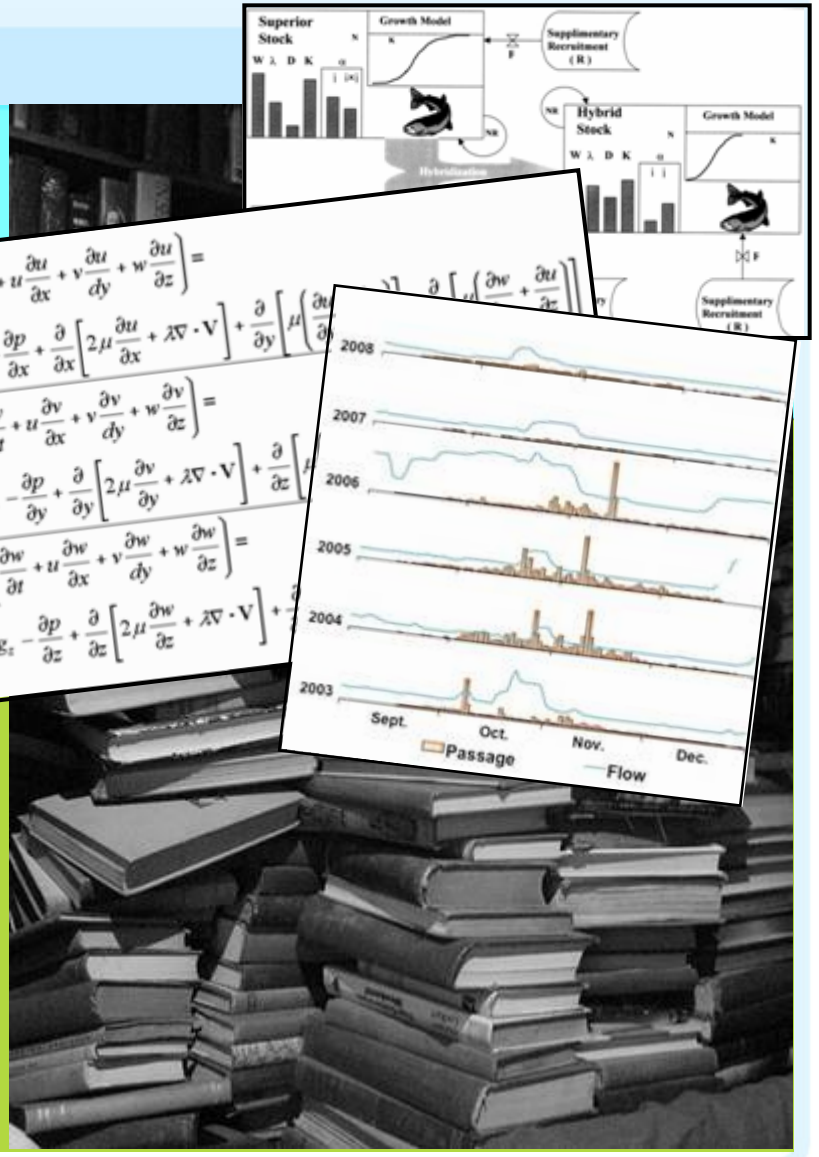

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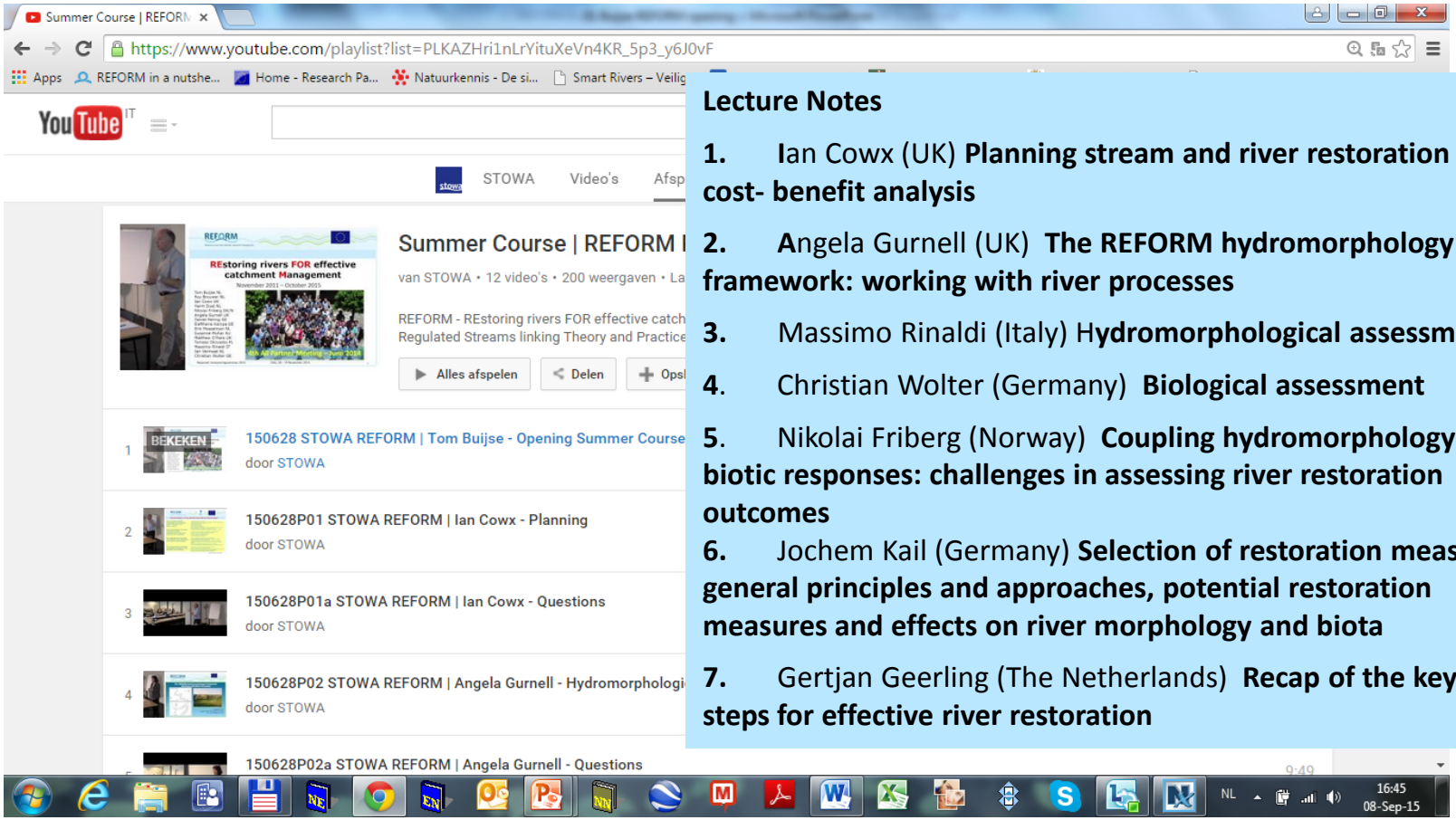
Summer school "Restoring Regulated Streams linking Theory and Practice"



Lecture Notes

1. Ian Cowx (UK) **Planning stream and river restoration and cost- benefit analysis**
2. Angela Gurnell (UK) **The REFORM hydromorphology framework: working with river processes**
3. Massimo Rinaldi (Italy) **Hydromorphological assessment**
4. Christian Wolter (Germany) **Biological assessment**
5. Nikolai Friberg (Norway) **Coupling hydromorphology to biotic responses: challenges in assessing river restoration outcomes**
6. Jochem Kail (Germany) **Selection of restoration measures: general principles and approaches, potential restoration measures and effects on river morphology and biota**
7. Gertjan Geerling (The Netherlands) **Recap of the key reform steps for effective river restoration**

http://www.reformrivers.eu/events/summer-school

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Guidance and tools – REFORM WIKI

How does my river work?
River characterisation

What's wrong?
River condition

Driver – Pressure – State - Impact

How can we improve?
Identifying potential measures

Response

Programme of measures
Implementation

Project cycle
Plan – Do – Check – Act

Page

How does river work?
- How does my river work?
- Introduction to characterisation
- Hydromorphology
- Role of vegetation
- Ecosystem services
- Models

What's wrong?
- What's wrong?
- Hydromorphological Quality
- Biological Quality
- Pressures
- Hydromorphological assessment tools

How can we improve?
- How can we improve?
- Restoration planning
- Measures
- Case studies
- Planning tools

Extra

Guidance
in Europe
ssessment and physical
is currently being overha
mprove contents and our landing

Hydromorphology an sturation

Flowing water, inundation, mentation ...
These are key processes for dplain ecosystems from the
the European Water
attention to hydrom
why the European
project for improvin
hydromorphologica
guides the practitio

Why this wiki?

Successful river res
the complex systems
ecology. Processes operate at different scales,

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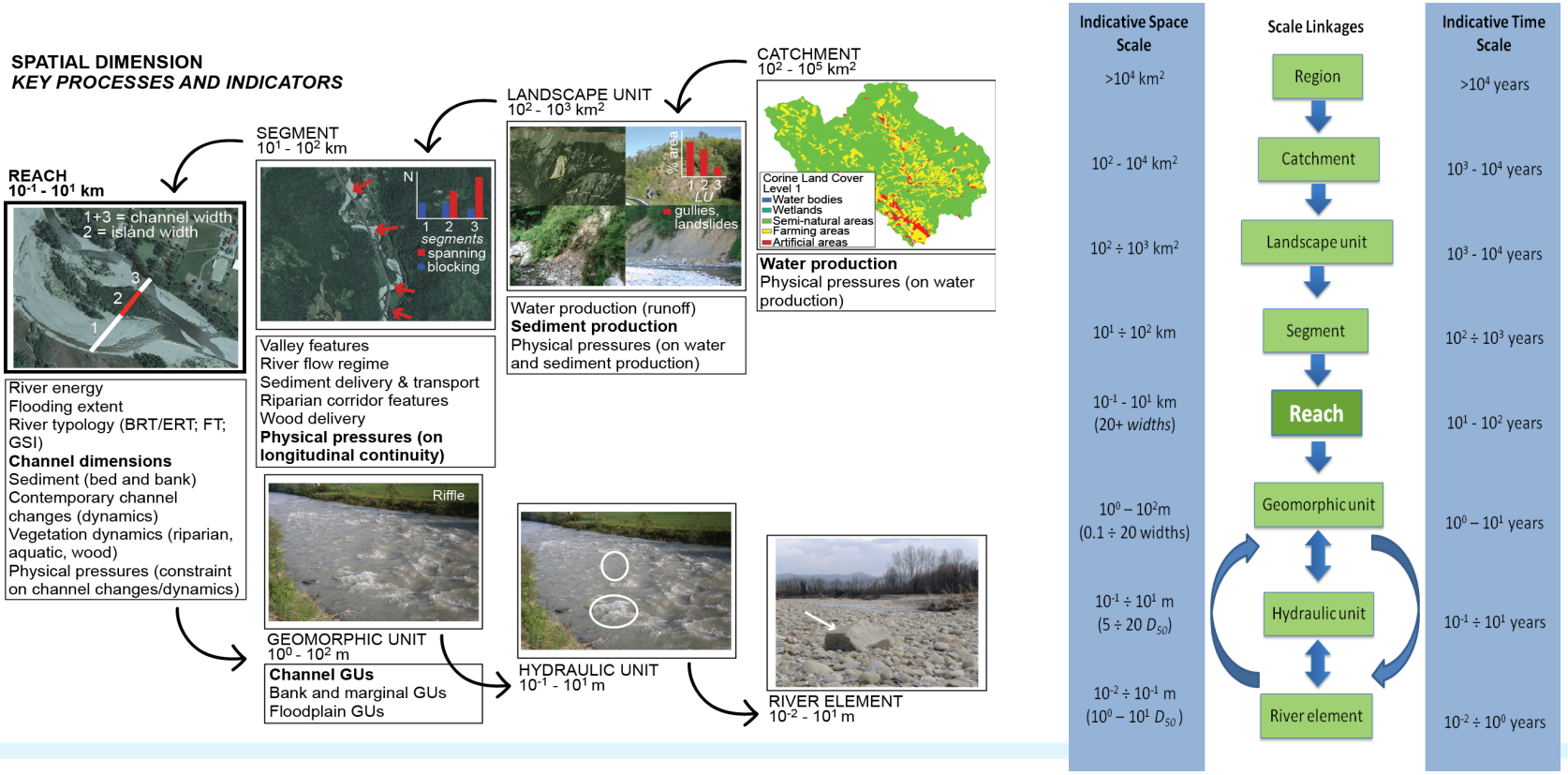
How does my river work?

Multiscale hierarchical framework for hydromorphological river characterization



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How does my river work?

Insights in interactions of water and sediment with vegetation

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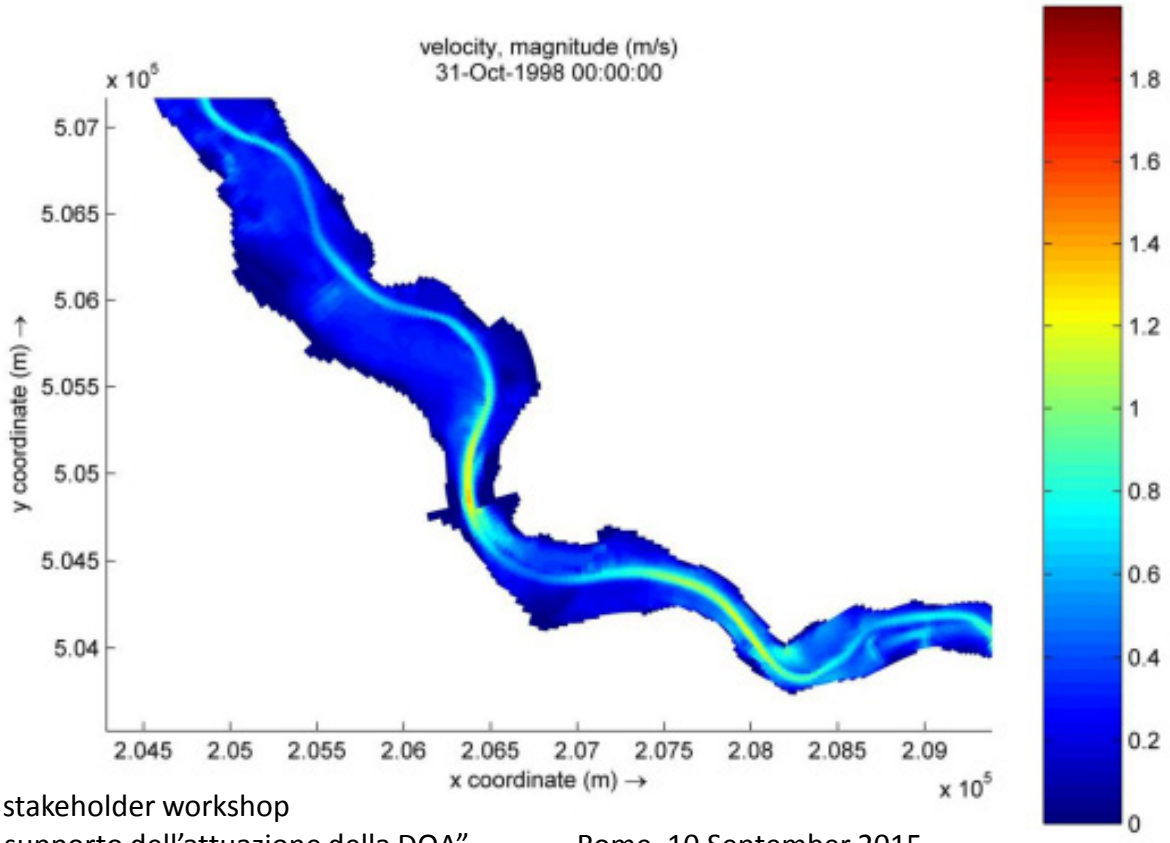
How does my river work?

Assessment of ecosystem services

How does my river work?

Numerical models: fact sheets



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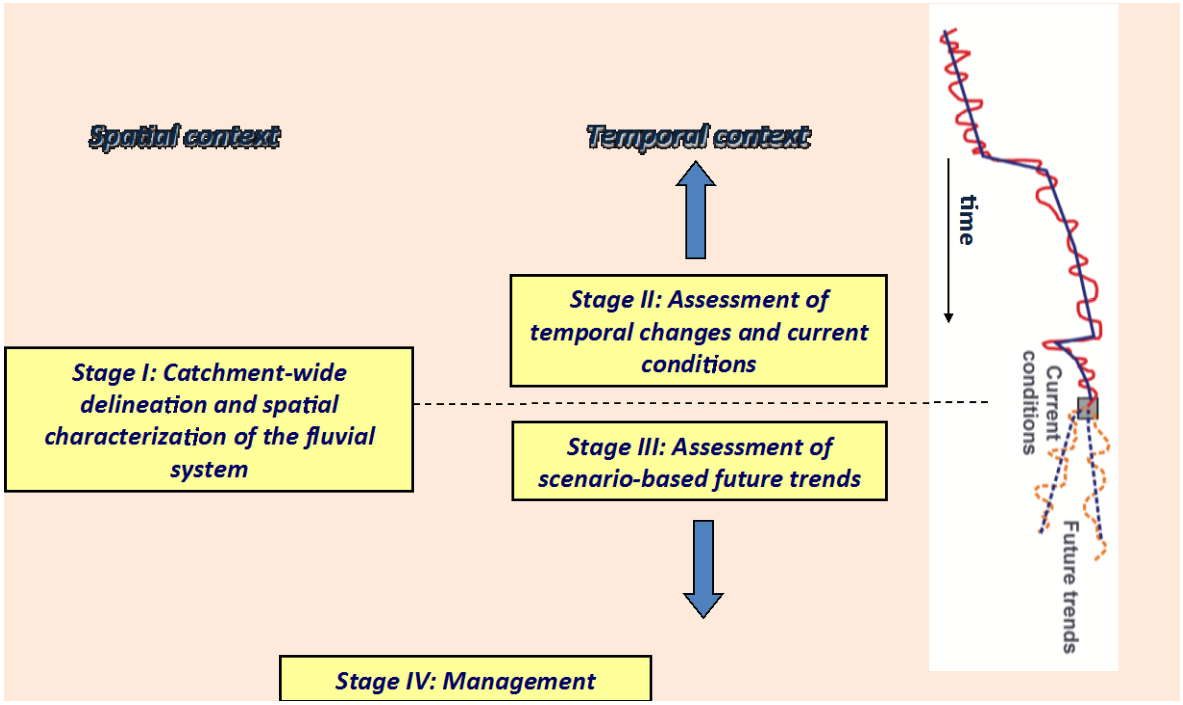
What's wrong?

Assessment and monitoring of hydromorphological conditions



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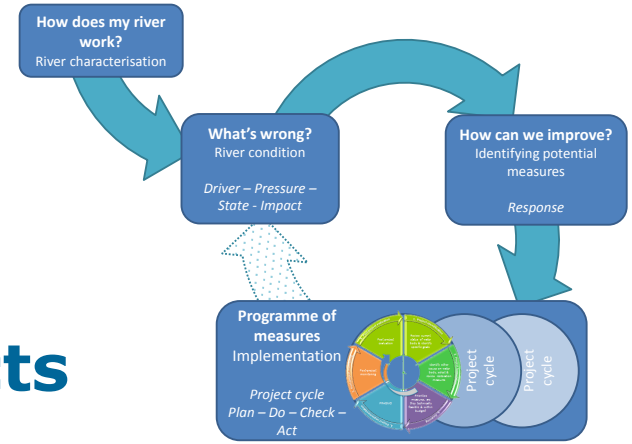
What's wrong?

Biological quality indicators to detect HyMo impacts

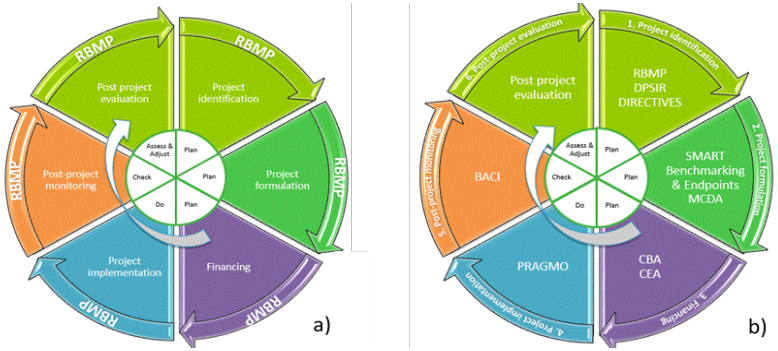
How can we improve?

Planning at catchment scale

1. River characterization
2. River condition
3. River restoration potential
4. Programme of measures
5. Project identification



Planning of individual projects



PDCA cycle

REFORM

REstoring rivers FOR effective catchment Management

How can we improve?

Category | Discussion | Read | View source | View history | Search

REFORM river restoration wiki
- Main page
- What's in this wiki?

How does my river work?
- How does my river work?
- Introduction to characterisation
- Hydromorphology
- Role of vegetation
- Ecosystem services
- Models

What's wrong?
- What's wrong?
- Hydromorphological Quality
- Biological Quality
- Pressures
- Hydromorphological assessment tools

How can we improve?
- How can we improve?
- Restoration planning
- Measures
- Case studies
- Planning tools

Extra
- Multi-lingual glossary
- Methods and tools
- EU Directives
- Database
- Related Sites
- The REFORM project

Category:Measures

Aims & Measures

[1]

River restoration and rehabilitation projects are implemented to achieve given objectives which are translated in the physical environment into **Aims** for improving hydromorphological and/or ecological conditions in the river system. The methods or activities used to achieve these **Aims** are usually called **Measures**.

For example:
- **Aim:** Longitudinal connectivity improvement
- **Measure:** Installation of a fish pass

In this web-based tool information from sixty restoration and rehabilitation measures have been compiled from the River Basin Management Plans of the countries represented in the FORECASTER consortium and information provided by the Environment Agency of England and Wales[2].

The measures have been organized according to their aims into the 9 measure groups indicated below as **Subcategories**. Click in the subcategory to see the measures contained in it. The complete list of measures is presented at the bottom of the page under **Pages in category "Measures"**

References:

1. ↑ Environmental Issues, Dams and Fish migration. Neste River, France
2. ↑ Royal Haskoning. 2007. Hydromorphology and the Water Framework Directive. Work package 6 of the Environment Agency WFD Hydromorphology Project

Subcategories

This category has only the following subcategory.

0
- 01. Water flow quantity improvement
- 02. Sediment flow quantity improvement
- 03. Flow dynamics improvement

0 cont.
- 04. Longitudinal connectivity improvement
- 05. River bed depth and width variation improvement
- 06. In-channel structure and substrate improvement

0 cont.
- 07. Riparian zone improvement
- 08. Floodplains/off-channel/lateral connectivity habitats improvement
- 09. Other aims to improve hydrological or morphological conditions

How can we improve?

1. PDCA cycle: Plan – Do – Check – Act
2. DPSIR framework: Driver – Pressures – State – Impact – Response
3. WISE conflict and resolution matrices
4. Decision matrix
5. Benchmarks and endpoints
6. Setting SMART project objectives
7. Problem tree analysis and tree of objectives
8. Logical framework approach
9. Risk and uncertainty analysis
10. Multiple-criteria decision analysis (MCDA)
11. Monitoring design
12. Cost-benefit analysis (CBA)
13. Cost-effectiveness analysis (CEA)

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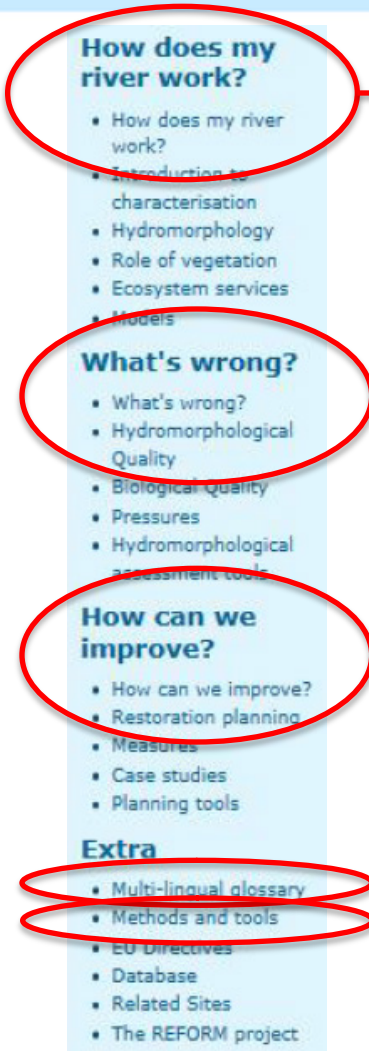

How does my river work?

What's wrong?

Evaluation of status

How can we improve?

Programme of measures

Multi-lingual glossary

Methods and tools

REFORM

REstoring rivers FOR effective catchment Management

Acknowledgements

REFORM receives funding from the European Union's Seventh Programme for research, technological development and demonstration under Grant Agreement No. 282656

Thank you for your attention

Our project website is our display window

www.reformrivers.eu

COLLABORATIVE PROJECT
LARGE SCALE INTEGRATING PROJECT

ENV.2011.2.1.2-1
HYDROMORPHOLOGY AND ECOLOGICAL OBJECTIVES OF WFD

GRANT NO. 282656