

REFORM
Restoring rivers FOR effective catchment Management

Hydromorphological assessment

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Basic definitions

Delineation: identification and delimitation of boundaries of spatial units within the catchment and river system

Characterization: description of spatial units and controlling factors to support understanding of the system

Assessment: evaluation of the condition and functioning of the fluvial system

Monitoring: periodic measurement or evaluation of variables, parameters, indicators to assess temporal trends

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D1.1 Review on eco-hydromorphological methods

Task 1.1 Existing ecological and geomorphological methods

D1.1 Review on eco-hydromorphological methods

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Categories of hydromorphological assessment methods

1. Physical habitat assessment
 - Methods to identify, survey and assess physical habitats
2. Riparian habitat assessment
 - Previous type but more specific for riparian habitats and vegetation
3. Morphological assessment
 - Methods performing a more general evaluation of 'morphological conditions' (pressure-response)
4. Hydrological regime alteration assessment
 - Methods specific for the assessment of the hydrological regime
5. Longitudinal fish continuity assessment
 - Methods specific for continuity of fish communities

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Summary of reviewed methods for each category

Country	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

Total: 139

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Physical and riparian habitat assessment

Strengths: provide accurate inventory useful to characterize the range of physical and riparian habitats

Limitations: (1) Detailed site-specific data collection: application to large number of water bodies impracticable (2) Limited consideration on processes

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Morphological assessment



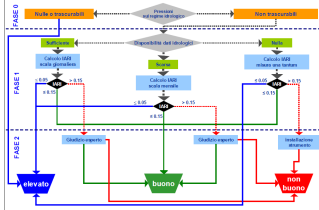
(MIMAS, MQI, SYRAH, etc.)

Strengths: (1) consideration of physical processes; (2) understanding of cause-effect relationships

Limitations: (1) physical processes difficult to assess; (2) more limited attention to geomorphic units

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Hydrological regime alteration assessment



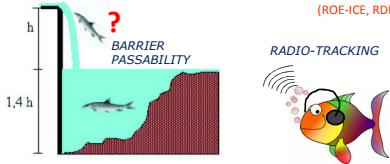
(IAHRIS, IARI, QM-HIDRI, etc.)

Strengths: Use of robust indicators based on quantitative, statistical or physically-based models

Limitations: (1) requires large data sets and long-time series; (2) hydropeaking and groundwater alterations not assessed

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Fish continuity assessment



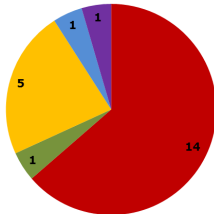
(ROE-ICE, RDB-DRN, etc.)

Strengths: (1) basic inventory of existing barriers relatively simple to obtain; (2) direct link with ecology (fishes)

Limitations: few cases of more detailed assessments and standardized protocols/structured methods

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Methods implemented for WFD




- 1 - Physical habitat assessment
- 2 - Riparian habitat assessment
- 3 - Morphological assessment
- 4 - Hydrological regime alteration*
- 5 - Longitudinal continuity for fish

– Consideration of physical processes remains the main gap

– Integrated use of different components of the assessment is limited but is recently increasing

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The importance of consideration of geomorphic processes



Uvas Creek, California Jan 1996, 2 mo post-construction

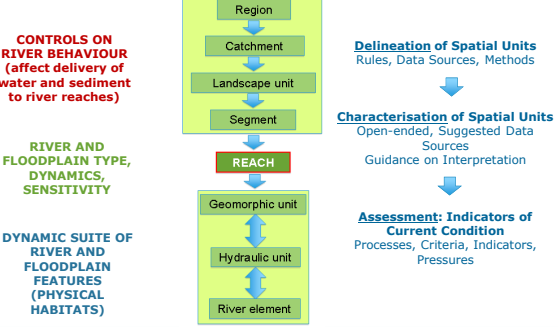
Channel failed Feb 1996, 3 months after construction (source: M.Kondolf)

– Designers did not look upstream at high erosion rates, did not account for evidence of **historical aggradation and braided morphology**

– Tried to impose a **channel form inconsistent** with the runoff regime and sediment supply

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Spatial hierarchical framework of REFORM



CONTROLS ON RIVER BEHAVIOUR (affect delivery of water and sediment to river reaches)

RIVER AND FLOODPLAIN TYPE, DYNAMICS, SENSITIVITY

DYNAMIC SUITE OF RIVER AND FLOODPLAIN FEATURES (PHYSICAL HABITATS)

Delineation of Spatial Units
Rules, Data Sources, Methods

Characterisation of Spatial Units
Open-ended, Suggested Data Sources
Guidance on Interpretation

Assessment: Indicators of Current Condition
Processes, Criteria, Indicators, Pressures

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Spatial hierarchical framework of REFORM

Catchment, Landscape Units, Segments Segments, Reaches

Open-ended approach to allow for optimum use of locally available data sets, particularly information already gathered to meet WFD requirements

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Temporal context: concept of trajectory

-Use of a 'static' channel typology (meandering, braided, etc.) as "reference" should be avoided
- Knowledge of past evolution fundamental to identify actions maximizing morphological benefits related to the trajectory

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Overall REFORM Assessment Framework

Spatial context **Temporal context**

1. Delineation of spatial units 2. Assessment of past temporal changes

3. Assessment of present hydromorphological conditions

4. Monitoring hydromorphological conditions

5. Prediction of possible future changes

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Overall REFORM Assessment Framework

Assessment
definition of a set of indicators to:

- (1) assess current river conditions and degree of alteration;
- (2) assess potential reach condition in the context of its segment and landscape unit setting

Application to:

- (1) identification of best condition reaches to be protected;
- (2) selection of most effective locations for restoration;
- (3) selection of appropriate actions of restoration

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Morphological Quality Index (MQI)*

Aim: to assess and classify (WFD) the morphological conditions of a given river reach

Main characteristics

1. Specific tool which is part of the much broader REFORM framework
2. **Spatial scale:** hierarchical nested approach (REFORM): "reach" basic spatial unit
3. Emphasis on processes
4. **Temporal component** explicitly accounted
5. Integration of GIS- remote sensing and field survey

* RINALDI M., SURIAN N., COMITI F., BUSSETTI M. (2013) – A method for the assessment and analysis of the hydromorphological condition of Italian streams: the Morphological Quality Index (MQI). Geomorphology, 180-181, 96-108.
http://www.isprambiente.gov.it/site/en_GB/Publications/Handbooks_and_Guidelines/Documents/manuale_66_2011.html

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Indicators of MQI

Extended European version: in progress within REFORM

Three sets of indicators:

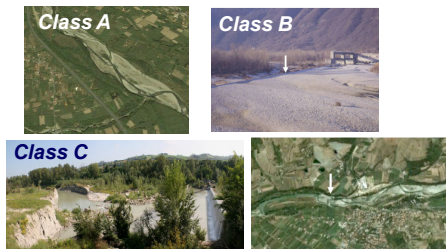
Functionality
(1) Longitudinal continuity; (2) Lateral continuity; (3) Channel pattern; (4) Cross-section; (5) Substrate; (6) Vegetation

Artificial elements and pressures
(1) Alteration of longitudinal continuity; (2) Alteration of lateral continuity; (3) Alteration of channel morphology and substrate; (4) Removal

Channel adjustments
(1) Adjustments in channel pattern; (2) Adjustments in channel width; (3) Bed-level adjustments

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Indicators of Functionality

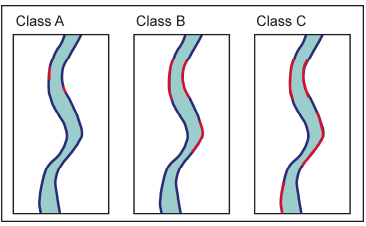


GEOMORPHOLOGICAL FUNCTIONALITY

Continuity	part	prog	conf
F1 Longitudinal continuity in sediment and wood flux			
A Absence of alteration in the continuity of sediment and wood	0		
B Slight alteration (obstacles to the flux but with no interception)	3		
C Strong alteration (discontinuity of channel forms and interception of sediment and wood)	6		

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Indicators of Artificial elements

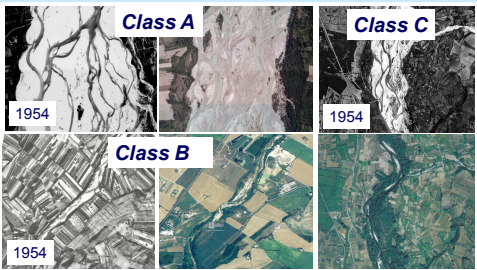


Alteration of lateral continuity

Artificial elements	part	prog	conf
A6 Bank protections			
A Absence or localized presence of bank protections (<5% total length of the banks)	0		
B Presence of protections for <33% total length of the banks (sum of both banks)	3		
C Presence of protections for >33% total length of the banks (sum of both banks)	6		

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Indicators of Channel Adjustments

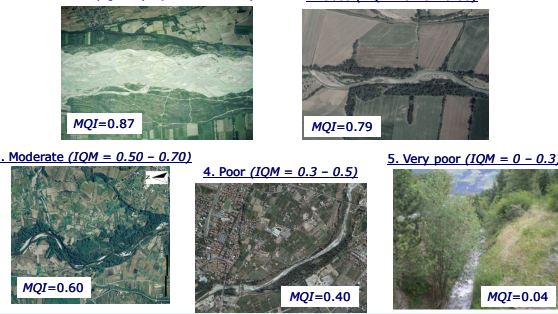


CA1 Adjustments in channel pattern (applied only to channels wider than 30 m)

A Absence of changes of channel pattern since 1950s	0
B Change to a similar channel pattern since 1950s	3
C Change to a different channel pattern since 1950s	6

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Classification of morphological quality



1. Very good (MQI = 0.85 - 1.0) MQI=0.87

2. Good (MQI = 0.70 - 0.85) MQI=0.79

3. Moderate (MQI = 0.50 - 0.70) MQI=0.60

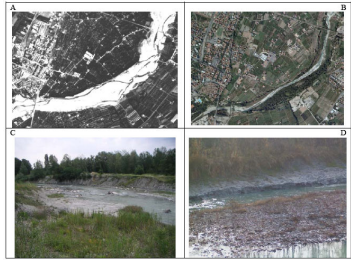
4. Poor (MQI = 0.3 - 0.5) MQI=0.40

5. Very poor (MQI = 0 - 0.3) MQI=0.04

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Example: Panaro River

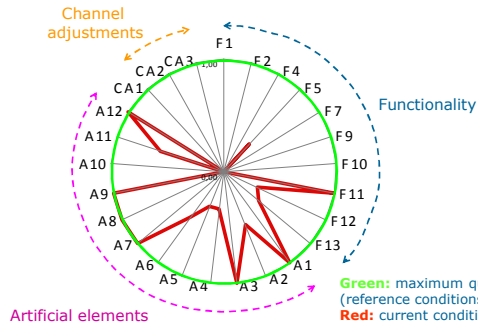
Limited artificial elements but heavy degradation of forms and processes related to channel adjustments



MQI=0.40 (Poor)

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Application of MQI to Panaro River

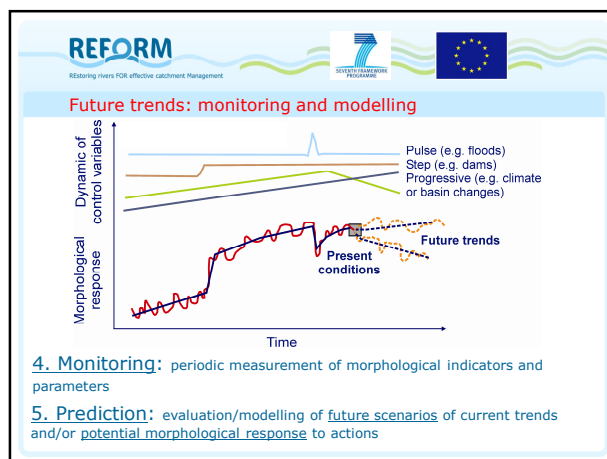
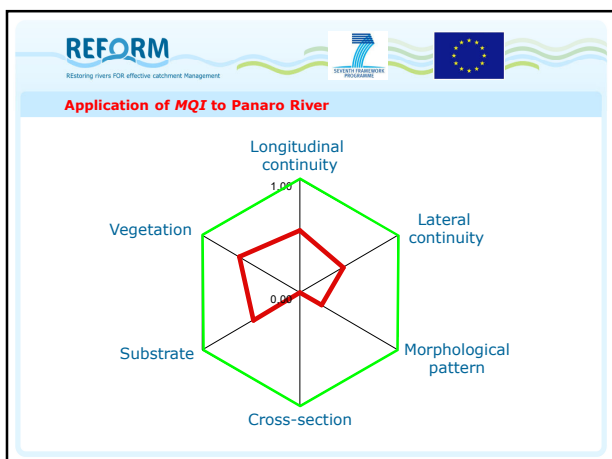


Channel adjustments

Functionality

Artificial elements

Green: maximum quality (reference conditions)
Red: current conditions



- 4. **Monitoring:** periodic measurement of morphological indicators and parameters
- 5. **Prediction:** evaluation/modelling of future scenarios of current trends and/or potential morphological response to actions

