European Commission

NWRM

Natural Water Retention Measures

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Individual NWRM

Stream bed re-naturalization

ACTeon environment research & consultancy

Office International de l'Eau

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BEF LATVIA

enveco Environmental Economics Consultancy

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institute IMdea water

REGIONAL ENVIRONMENTAL CENTER

REKK

SLU

SRUC

Environment

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I. NWRM Description

Streambed (or riverbed) represents the floor of the river, including each riverbank. In the past, riverbeds were artificially reconstructed with concrete or big stones, therefore modifying flows and decreasing fauna habitat and vegetation diversity. Those modifications were aiming at flood prevention or supporting changes of agricultural practices for example. This has led to uniformed flows in the rivers and often having effect of reducing travel time along the river. Streambed re-naturalization consists in removing some concrete or inert constructions in the riverbed and on riverbanks, then replacing them with vegetation structures, in order to avoid these damages and restore biodiversity.

The re-naturalization of river beds and banks could have a high impact on the erosion process. Stabilisation techniques are among the main measures to be implemented. The maximum impact is reached when the stabilisation technique restores the vegetation cover and the naturalness of the banks. Most of the time, techniques use plants for bank stabilization. According to their degree of complexity, these techniques can be grouped into two categories:

- bank re-naturalization
- plant engineering

Bank re-naturalization is a stabilisation technique used to correct mild erosion problems and that does not require a high degree of expertise to be implemented.

Plant engineering is defined as the techniques combining the principles of ecology and engineering to design and implement slope, bank and bank stabilisation works, using plants as raw materials for making vegetable frames.

II. Illustration

River before revitalisation

River after revitalisation

Source: http://chandrashekharasandprints.wordpress.com/2012/05/11/restoring-an-urban-river-bed-to-its-natural-eco-system-a-singapore-experiment/

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	Possible	Streambed re-naturalization can be applied on any type of land use. In artificial surfaces in particular, attention should be paid in remaining strong bank stabilization, in order to protect socio-economic issues.
Agricultural Areas	Yes	
Forests and Semi-Natural Areas	Yes	
Wetlands	Yes	

Region	Applicability	Evidence
Western Europe	Yes	This process can be implemented on any river where the bed has been de-naturalised.
Mediterranean	Yes	
Baltic Sea	Yes	
Eastern Europe and Danube	Yes	

IV. Scale

	0-0.1km2	0.1-1.0km2	1-10km2	10-100km2	100-1000km2	>1000km2
Upstream Drainage Area/Catchment Area	Yes	Yes	Yes	Yes	Yes	Yes
Evidence						

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	None	
	Slow Runoff	None	
	Store River Water	Medium	By diversifying the channel width and depth, this measure can increase the water storage capacity of the river.
	Slow River Water	High	By diversifying the river bed morphology and increasing its roughness, especially with vegetation, this measure helps slowing down the river flow.
Reducing Runoff	Increase Evapotranspiration	Low	Any replacement of concrete structure by vegetation structure will allow increasing evapotranspiration
	Increase Infiltration and/or groundwater recharge	High	The re-naturalization of the river bed restores the connectivity between the stream and the accompanying groundwater, therefore increasing stream-subsurface water exchanges.
	Increase soil water retention	Low	Any replacement of concrete structure by vegetation structure will allow increasing soil water retention
Reducing Pollution	Reduce pollutant sources	None	
	Intercept pollution pathways	Medium	By restoring the natural design of the riverbed and banks, the measure contributes to intercepting pollution pathways through the filtration and auto-purification capacities of the vegetation.

N5: Stream bed re-naturalization

Soil Conservation	Reduce erosion and/or sediment delivery	High	These techniques allow protecting the riverbed and the riverbanks against erosion, by improving their roughness, cohesiveness and biodiversity.
	Improve soils	Medium	These techniques allow the development and improvement of soil, due to the increasing presence and growth of vegetation.
Creating Habitat	Create aquatic habitat	High	The re-naturalization of the river bed and banks promote the heterogeneity of the habitats The impact of the measures is highest in low water period as it allows maintaining a base flow necessary for aquatic life which protects habitats from drying out. In addition to the natural modification in the riverine habitats resulting from the reinstated river dynamics, human intervention further could help in accelerating habitat restoration by the application of targeted gravel extraction to mimic natural habitat mosaics while avoiding excessive accumulation of sediment. This exploitation could clearly be motivated by a biodiversity restoration objective but could be designed so as to accommodate sustained, but re-oriented economic activities while abiding by safety rules and regulations (Oggier, 2003, 2007). Hydrogeomorphic processes within alluvial river systems create, maintain and degrade riparian habitat. The dynamic interactions between water, sediment, aquatic–terrestrial landforms and biotic elements control the functional processes and biodiversity.
	Create riparian habitat	High	
	Create terrestrial habitat	Low	Re-naturalizing river banks will allow better connecting aquatic and terrestrial lands, therefore creating or enhancing terrestrial habitat at the interface between both lands.
Climate Alteration	Enhance precipitation	None	
	Reduce peak temperature	Medium	Riparian vegetation (trees) could provide shadow for the river, reducing the peak temperature especially during the summer season while base flows occur.
	Absorb and/or retain CO2	Low	Any replacement of concrete structure by vegetation structure will allow absorbing and/or retaining CO_2

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	Low	This measure helps storing river water by restoring the river's natural channel capacity.
	Fish stocks and recruiting	Low	By restoring aquatic habitat and biodiversity as well as ensuring the base flow, stream bed re-naturalization favours fish stocks.
	Natural biomass production	Medium	Through the creation of riparian vegetation, this measure enhances local natural biomass production.
Regulatory and Maintenance	Biodiversity preservation	High	By diversifying flows, water depth and channel morphology, and by favouring vegetation development, this type of measure aims to improve the diversity of habitats offered by the river, and create new habitats. The creation of habitats and the storing of river water help to create and preserve biodiversity. Limiting erosion of the riverbed especially during floods also preserves habitats sustainably. Riverbed re-naturalization fosters the development of riparian habitats on the river banks and so preserve or restore the aquatic and riparian biodiversity.
	Climate change adaptation and mitigation	None	
	Groundwater / aquifer recharge	Low	Restoring the connectivity between the river bed and the accompanying aquifer helps the aquifer recharge.
	Flood risk reduction	Medium	The fact that this measure helps the storage of water and may increase infiltration makes it a good flood risk reduction measure. Retaining and evaporating a portion of rainfall waters, shoreline vegetation helps to reduce the flooding risk.
	Erosion / sediment control	High	Shoreline vegetation helps in stabilizing the bank, reduce siltation of spawning grounds and prevent soil loss.
	Filtration of pollutants	Medium	The shoreline vegetation retains a portion of fertilizers, pesticides and sediment in runoff, preventing the transfert of pollutants.
Cultural	Recreational opportunities	Medium	By diversifying the river landscape, improving the biodiversity, the river bed re-naturalization allows the river to recover its recreational and aesthetic value. Landscape Function: The natural character of the river shall guarantee the beauty of landscapes. Re-naturalization actions within the riparian zone contributes directly to their ecological integrity and societal value.
	Aesthetic / cultural value	Medium	

Abiotic	Navigation	None	
	Geological resources	None	
	Energy production	None	

VII. Policy Objectives

Policy Objective		Rating	Evidence
Water Framework Directive			
Achieve Good Surface Water Status	Improving status of biological quality elements	High	This measure helps to improve the status of biological quality elements through the creation and diversification of habitats. This aspect is closely linked to the physical quality of the rivers which has direct and important impacts on habitats. In other words, good hydromorphological conditions are essential to guarantee a good biological quality.
	Improving status of physico-chemical quality elements	Low	Since it intercepts pollution pathways, this measure helps to improve the physico-chemical water status.
	Improving status of hydromorphological quality elements	Medium	By removing artificial covers on the river bed (stream and banks) allowing the river returning to its natural flow velocity, re-naturalization allows the river recovering its natural hydromorphological processes.
	Improving chemical status and priority substances	Low	Since it intercepts pollution pathways, this measure helps to improve the chemical status.
Achieve Good GW Status	Improved quantitative status	Low	This measure has the potential to slightly improve the connectivity with the accompanying groundwater so it has an impact on the level of the aquifer and on the maintaining of base flows.
	Improved chemical status	Low	Since it intercepts pollution pathways, this measure may help to improve the chemical status of groundwater.
Prevent Deterioration	Prevent surface water status deterioration	Medium	By slowing down the flow of the river, intercepting pollutants and creating new habitats, this measure helps to prevent surface water deterioration.
	Prevent groundwater status deterioration	Medium	By increasing the infiltration and intercepting some pollutants, this measure prevents the deterioration of groundwater.

Floods Directive		
Take adequate and co-ordinated measures to reduce flood risks	Medium	This measure is a good flood risk mitigation measure since it stores and slows down river flow, and reduces erosion.
Habitats and Birds Directives		
Protection of Important Habitats	High	By diversifying the habitats through the variety of flow speed, channel width and water depth, this measure provides and protects important habitats.
2020 Biodiversity Strategy		
Better protection for ecosystems and more use of Green Infrastructure	High	This measure protects the habitats and the waters from deterioration.
More sustainable agriculture and forestry	None	
Better management of fish stocks	High	Through its interception of pollutant paths and the creation of new aquatic habitats, this measure helps a better management of fish stocks.
Prevention of biodiversity loss	High	The creation of new habitats and the interception of pollutants help preventing biodiversity losses.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	Various: It depends of the length and size of the river to be re-naturalized.
Space required	Various: It depends of the length and size of the river to be re-naturalized.
Location	Can be implemented everywhere along a stream bed where the bed has previously been de-naturalized.
Site and slope stability	There is no specific condition on site and slope stability.
Soils and groundwater	There is no specific condition on soils and groundwater.
Pre-treatment requirements	There is no specific pre-treatment requirement.
Synergies with Other Measures	Usually set-up along with the following NWRM: “Natural Bank Stabilization”, “Elimination of riverbank protection”, “Flood plain reconnection”, “re-meandering”.

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition		Assess general costs would have no sense because they fully depend of the local context. Type of costs to be anticipated are: - Land acquisition (agricultural or urbanised in most of the cases). - Investigation and studies cause this kind of measure will require a planning of the project and eco-engineering. - Capital costs: there is a large variety of materials and vegetation to be mobilized to implement river bed re-naturalization (riparian vegetation, infrastructures in the river bed…)
Investigations & Studies		
Capital Costs		
Maintenance Costs	n/a	
Additional Costs	n/a	

X. Governance and Implementation

Requirement	Evidence
Definition of the responsibilities	The effective planning, design, and operation of this type of measure requires the involvement of a wide range of stakeholders. This includes local planning authorities, environmental regulators, private landowners and land managers, farmers and other bodies with responsibilities water management (e.g. irrigation bodies, drainage boards, etc). "Involving stakeholders like farmers, fishermen and (local) citizens (during the design phase, through consultation meetings and sessions is) one the key factors of (this kind of) project".

XI. Incentives supporting the financing of the NWRM

Type	Evidence
National Water Agencies	Numerous national water agencies could provide incentives according to their programmes of measures. Their contribution is decided case by case on a concrete project proposition.

LIFE Nature and Biodiversity	Article 10 of the Habitats Directive promotes the natural rivers which are "essential for the migration, dispersal and genetic exchange of wild species"

XII. References

Reference
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