European Commission

NWRM

Natural Water Retention Measures

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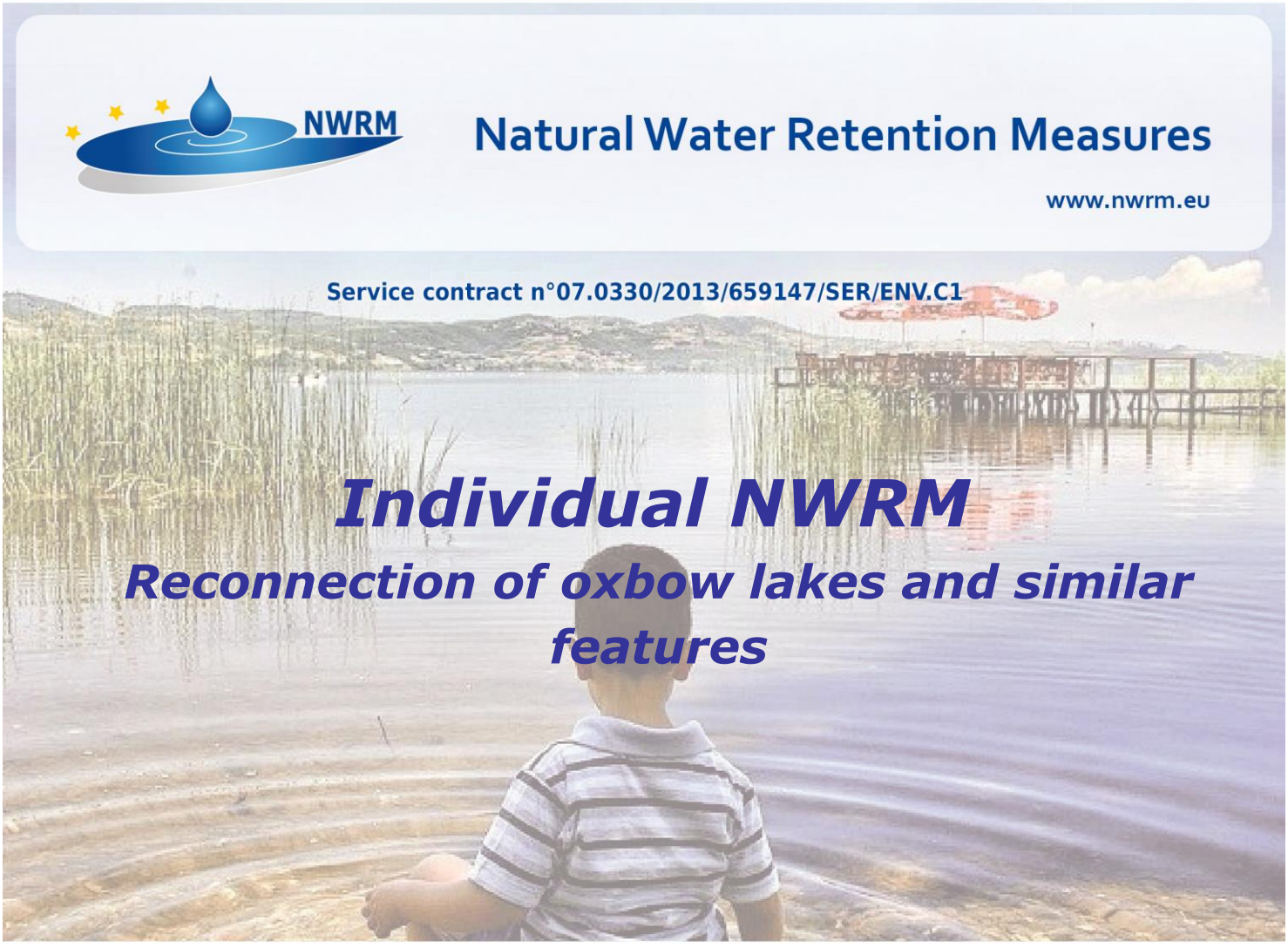

Individual NWRM

Reconnection of oxbow lakes and similar features

Environment

This report was prepared by the NWRM project, led by Office International de l'Eau (OIEau), in consortium with Actéon Environment (France), AMEC Foster Wheeler (United Kingdom), BEF (Baltic States), ENVECO (Sweden), IACO (Cyprus/Greece), IMDEA Water (Spain), REC (Hungary/Central & Eastern Europe), REKK inc. (Hungary), SLU (Sweden) and SRUC (UK) under contract 07.0330/2013/659147/SER/ENV.C1 for the Directorate-General for Environment of the European Commission.

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I. NWRM Description

An oxbow lake is an ancient meander that was cut off from the river, thus creating a small lake with a U form. Reconnecting it with the river consists in removing terrestrial lands between both water bodies, therefore favouring the overall functioning of the river by restoring lateral connectivity, diversifying flows and cleaning the river section of the present oxbow for a better water retention during floods.

II. Illustration

Example of re-used meander, (France)

Source: http://nature.on-rev.com/2011/composants-du-paysage/

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	No	
Agricultural Areas	Yes	
Forests and Semi-Natural Areas	Yes	In some cases old oxbow lakes are dried and transformed into forest plantations, pastures, meadows or other semi-natural areas. Reconnection could be challenged by the need for land use change.
Wetlands	Yes	Measure is applicable for many oxbow lakes currently isolated from the main channel by embankments. These oxbow lakes usually exist as wetlands with permanent or seasonal water.

Region	Applicability	Evidence
Western Europe	yes	Straightening river beds and artificial cutting off the meanders, oxbow lakes and other similar features have been common practice in many regions. It was particularly intensive in Western Europe in XX century. Currently
Mediterranean	yes	
Baltic Sea	yes	

Eastern Europe and Danube	yes	there are many oxbow lakes remaining as a result. The first applications of the measure are found in Western Europe. Oxbow lakes can also form naturally and, in that case, it might not be sensible to try to re-connect them as they form when the river naturally re-routes itself.

IV. Scale

	0-0.1km2	0.1-1.0km2	1-10km2	10-100km2	100-1000km2	>1000km2
Upstream Drainage Area/Catchment Area				✓	✓	✓
Evidence	Oxbow lakes and similar features are originally present in floodplains, located on sites with a drainage area above 10 km^2.					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	High	An ox-bow lake, even if disconnected, can accumulate surface runoff from adjacent lands. However, its reconnection to riverbed, therefore increasing the river length, can largely increase its capacity in this aspect.
	Slow Runoff	High	In some cases the runoff from adjacent lands is the main source of water inflow, e.g. in cases where the main river became deeper due to the bottom erosion. Moreover, oxbow lakes can play the role of buffer zones for permanent systems downstream by providing a river bed aiming at slowing runoff flows
	Store River Water	High	Reconnected oxbows and side arms may fill in and retain water from the main river. Depending on the outflow (with sluice facility), this storage capacity could be controlled. Indeed, as it increases the length of the river this measure helps increasing the storage of river waters
	Slow River Water	High	In cases of high waters and floods, the reconnected oxbows could play important role of retention volumes.
Reducing Runoff	Increase Evapotranspiration	Low	In case vegetation is largely present on the oxbow lake banks, increased surface of the water table and humidity in soils can result in increased evapotranspiration.
	Increase Infiltration and/or groundwater recharge	High	Reconnection increases the surface of interaction with ground waters.

	Increase soil water retention	Medium	Reconnection increases the surface of interaction with soil, therefore increasing soil water retention, especially in the area around re-connected lake/wetland.
Reducing Pollution	Reduce pollutant sources	Low	Indirect impact by increased self-purification capacity
	Intercept pollution pathways	Medium	Depending on the amount of vegetative cover and soil organic matter on the oxbox lakes banks, indirect impact by increased self-purification capacity for the polluted runoff can be effective.
Soil Conservation	Reduce erosion and/or sediment delivery	High	As it increases the length of the river, therefore slowing down the river flow, this measure allows reducing erosion on the river bed and banks, as well as favouring sediment deposition.
	Improve soils	Low	Where soil is protected against erosion, especially on riverbanks, soil conservation and improving can be effective. It is mainly due to improved water balance.
Creating Habitat	Create aquatic habitat	High	Oxbow lakes and re-connected side arms play important role, creating habitat diversity within the same river section. Often these habitats are used for spawning places by fish and other aquatic groups.
	Create riparian habitat	High	The bank vegetation usually expands after re-connection because of improved water regime.
	Create terrestrial habitat	Low	Usually the measure covers limited area and does not change significantly the pattern of terrestrial habitats. However in some cases the increased ground water table improves the quality of the forests and grassland habitats nearby.
Climate Alteration	Enhance precipitation	Low	In case vegetation is largely present on the oxbow lake banks, and depending on the size (area), increased evapotranspiration may result in increased precipitation.,.
	Reduce peak temperature	Low	In case vegetation is largely present on the oxbow lake banks, and depending on the size (area), peak temperature may be reduced.
	Absorb and/or retain CO2	Low	In case vegetation is largely present on the oxbow lake banks, CO_2 may be absorbed and retained. CO_2 balance could be different depending on the water regime and depth of the reconnected wetland. In most cases CO_2 is captured in biomass.

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	Medium	Measure does not directly create new storage volumes but connects these volumes with the river to restore the water balance of the system.
	Fish stocks and recruiting	Medium	The diversity and coverage of aquatic habitats created by the measure may result in increased fish stocks.
	Natural biomass production	Low	Potential for utilization of reed biomass in re-connected oxbows.
Regulatory and Maintenance	Biodiversity preservation	High	Improvement of both aquatic and riparian habitats can result in improved populations of water birds, amphibian, reptilian and mammal species.
	Climate change adaptation and mitigation	Medium	Increased retention volumes for peak flows and improved water storage in the river system in droughts can participate to climate change adaptation and mitigation.
	Groundwater / aquifer recharge	Medium	This measure can increased ground water level and surface for natural groundwater recharge.
	Flood risk reduction	Medium	Although the retention capacity of the single application is usually not large, the cumulative result could be high if systematically applied.
	Erosion / sediment control	High	By increasing the length of the river, therefore decreasing flow velocity, this measure can prevent and mitigate bank and bottom erosion, as well as favouring sediment deposition.
	Filtration of pollutants	Medium	This measure can increase path of the polluted water and contact filtrating surface. As far as it is present and developed, riparian vegetation plays a filtration role of pollutants.
Cultural	Recreational opportunities	Low	Creation of places for sport fishing
	Aesthetic / cultural value	Medium	Restoration of the natural riparian landscape.
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 biology quality elements	Medium	Potential increase in fish abundance and richness, benthic invertebrates and macrophyte indices.
	Improving status of physico-chemical quality elements	Low	This measure may improve the status of physico-chemical quality elements, depending on the water velocity and oxygen regime.
	Improving status of hydromorphological quality elements	High	Improved latitudinal connectivity, and status of riparian zones to a lesser extent
	Improving chemical status and priority substances	Medium	Possible deposition and degradation of pollutants. Potential decreased organic pollutants and nutrients due to the improved self-purification capacity of the river system.
Achieve Good GW Status	Improved quantitative status	Medium	Reconnecting oxbow lakes with the main river may increase ground water levels
	Improved chemical status	Medium	By playing a filtration role and infiltration role, reconnected oxbow lakes contribute to improve river water chemical status, with an indirect impact via self-purification of surface waters, affecting the quantity of ground waters.
Prevent Deterioration	Prevent surface water status deterioration	Medium	By slowing down the river water and creating new aquatic and riparian habitats, the reconnected oxbow lakes may help preventing surface water status deterioration, with a complex impact via biological, physico-chemical and chemical quality elements
	Prevent groundwater status deterioration	Low	By playing a role of filtration, restored and reconnected seasonal streams contribute to prevent groundwater quantitative status deterioration.
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		High	By storing water and slowing down the river flow, this measure provides flood risk mitigation.
Habitats and Birds Directives			
Protection of Important Habitats		High	This measure improves the conservation status of aquatic, riparian and terrestrial habitats, protected according to Habitat Directive and improved habitats of protected birds.

2020 Biodiversity Strategy		
Better protection for ecosystems and more use of Green Infrastructure	High	Restoration of natural green areas and connectivity. Reported increased biodiversity after the implementation of measure (example: Layman's report of BIOMURA Project).
More sustainable agriculture and forestry	Low	Potential to decrease the needs for artificial irrigation due to the improved soil humidity in lands close to the oxbow.
Better management of fish stocks	Medium	Re-connecting oxbows can create fish habitat diversity
Prevention of biodiversity loss	High	Re-connecting oxbows can result in increased count of fish and bird species, including species with high conservation value.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	The re-connection work could vary from completely open connections to construction of a system of inflow and outflow facilities – sluices located at the dyke/embankment. Dimensions are from 1 to 15 km. (based on data from the case studies) In some cases connection channels are necessary. In cases of significantly deepened river bed (due to bed erosion after straightening), re-connection is only possible with construction of a weir for raising the water level. Alternative solution is to fill the oxbow from side tributaries, if possible.
Space required	Usually a small place is required for construction of new facilities (inflow and outflow sluices) digging connection channels. Total required area for facilities is <1 ha. The area of the existing oxbow lake may vary significantly. It could be considered as a significant space requirement only if the land use inside the (former) lake is already transformed into agriculture, forestry etc.
Location	Reconnection facilities are usually located at inflow and outflow points of the old meander.
Site and slope stability	In cases where the river bed of the main channel has been significantly deepened (due to bed erosion after straightening), re-connection is only possible with construction of a weir for raising the water level or connection to tributaries.
Soils and groundwater	No specific requirements.

Pre-treatment requirements	If the measure involves cutting of dyke or embankment, it is important to ensure appropriate consideration of flood management requirements, including potential flood protection for surrounding areas. If the land use pattern or land property in the old meander are significantly changed, coordination with owners is mandatory.
Synergies with Other Measures	Stream bed re-naturalization; Wetland restoration and management; Re-meandering; Elimination of riverbank protection; Forest riparian buffers; Restoration and reconnection of seasonal streams.

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition	EUR 0 - 60'000	Based on figures from the relevant cases studies.
Investigations & Studies	EUR 0 – 100'000	Based on figures from the relevant cases studies.
Capital Costs	EUR 100'000 - 2'000'000	Based on figures from the relevant cases studies.
Maintenance Costs	EUR 10'000 – 1'000'000	Based on figures from the relevant cases studies.
Additional Costs	EUR	No information

X. Governance and Implementation

Requirement	Evidence
Measures in RBMPs to improve the ecological status of river sections affected by hydro-morphological alterations	

XI. Incentives supporting the financing of the NWRM

Type	Evidence
EU and national funds allocated for implementation of programmes of measures according to WFD 2000/60/EC and Habitat Directive 92/43/EC	Projects funded by LIFE+ Programme and national budgets.
Agricultural compensations done in the context of EU CAP Pillar 2	For maintenance, performed by the farmers

XII. References

Reference	Comment
http://nwrm.eu/content/conservationmurabanks	BIOMURA - Conservation of biodiversity of the Mura river (Slovenia)
http://nwrm.eu/content/revitalisationofriverbanksconnectionofhydraulicannexesalongsidescarperiver	Revitalisation of riverbanks and connection of hydraulic annexes alongside Scarpe river (France)
http://nwrm.eu/content/river-basin-management-ill	River basin management of the Ill (France)
http://nwrm.eu/content/babina-restoration-project	The Babina Restoration Project (Romania)
http://nwrm.eu/content/fortuna-restoration-project-danube-delta	The Fortuna Restoration Project-Danube Delta (Romania)