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Natural Water Retention Measures

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Individual NWRM

Wetland restoration and management

ACTeon environment research & consultancy

Office International de l'Eau

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Environment

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I. NWRM Description

According to the Convention on Wetlands (1971), a wetland is an area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. It provides water retention, biodiversity enhancement or water quality improvement.

Wetland restoration and management can involve: technical, spatially large-scale measures (including the installation of ditches for rewetting or the cutback of dykes to enable flooding); technical small-scale measures such as clearing trees; changes in land-use and agricultural measures, such as adapting cultivation practices in wetland areas. They can improve the hydrological regime of degraded wetlands and generally enhance habitat quality. Creating artificial or constructed wetlands in urban areas can also contribute to flood attenuation, water quality improvement and habitat and landscape enhancement.

II. Illustration

Source: **Living Murray Initiative**

http://www.nccma.vic.gov.au/What_We_Do/Current_Projects/The_Living_Murray/index.aspx

Source: **Seda bog area, Latvia. Author: Dace Strigune.**

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	possible	Wetlands are most frequently restored in former agricultural lands which used to be drained to increase land productivity. Wetlands are restored where forest land has been drained in the past. Wetland restoration can be implemented in all categories of forest land cover. The limiting factor might be hydrological regimes, topography etc. Wetlands are restored and maintained primarily due to high value of biological diversity. Wetland restoration measures are implemented in both land cover categories – inland and coastal wetlands. Inland wetland restoration may be implemented in the locations where peat as natural resource has been cut. Restoration of coastal meadows are driven by nature protection as well as protection measure against storm surges and sea level rise.
Agricultural Areas	yes	
Forests and Semi-Natural Areas	yes	
Wetlands	yes	

Region	Applicability	Evidence
Western Europe	yes	A wide range of applications on wetland restoration has been implemented in the Western Europe. The projects are listed in the EU programme LIFE project data base. Wetlands International as well as other organisations have been implementing wetland restoration projects also in South Europe. For example, WWF's work in Doñana, where the Guadalquivir River reaches the Atlantic Ocean,
Mediterranean	yes	
Baltic Sea	yes	
Eastern Europe and Danube	yes	

		focuses restoring agricultural land back to original wetland. MedWet also implements a number of projects in the countries around the Mediterranean. A number of wetland restoration projects have been implemented or are ongoing. The water storage measures have been implemented in Poland, Germany, while other countries have focused on water quality issues and biodiversity protection. A number of projects of wetland restoration have been implemented in Danube region. The focus has been on protection of the biodiversity, by funding of the LIFE programme.

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	possible	possible
Evidence	Wetlands naturally can be located throughout river basins. The scales for restoration and maintenance measures vary, as activities can vary from constructing small urban wetlands, to wetlands in agricultural areas, to restoring wetlands at a landscape scale. Some examples are 1 – Small wetlands constructed in the frame of the Polish national programme on small retention. 2 – 11.5 ha of coastal wetlands were restored in Estonia, Matsalu area or Kylmäojankorpi forested wetland, Vantaa, Finland. 3 - Vallei van de Grote Nete, the Scheldt river catchment in Belgium. 4 - Restoration of 4035 ha of former wetlands on two project sites – Belene Island (2 280 ha) within the Persina Nature Park and Kalimok/Brushlen (1 755 ha) within the Kalimok/Brushlen Protected Site, Bulgaria.					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	High	Wetlands function like natural tubs or sponges, storing water and slowly releasing it. This process supports runoff water storage capacity in the area. Although a small wetland might not store much water, a network of many small wetlands can store a large amount of water. Storage capacity depends on where (in what type of land use) and how (what elements wetland contains) a wetland is established. If the wetland is established in area with existing high water level, the additional storage capacity

			for runoff might be low. If a wetland is established in drained or dray area the storage capacity is higher.
	Slow Runoff	High	Natural swamp covered with clumps of sedges and shrubs are characterized by a large hydraulic resistance. Moreover, they are usually areas with small denivelations of the area. Therefore, the snow melt water, as well as flood waters very slowly leave the surface of the swamp. The water flow monitoring data from Finnish wet forest has shown that the wetland areas reduce peak flows. It was reduced by 38% in the study area.
	Store River Water	Medium	The wetlands in the floodplain areas support the storing of the river water. The example of the restoration of wetlands along the Vallei van de Grote Nete estimates that the NWRM will increase the storage capacity in the river valley from 6.6 million m^3 to 8.4 million m^3.
	Slow River Water	Medium	Water that spilled on the surface of the swamp slowly flows into the river, thus flattening the flood wave occurs on a section of the river below swamp area. This phenomenon is clearly visible in the wide (over 10 km) Biebrza valley, Poland bottom. Sometimes water is kept here on the surface for a few months. A drop of water flows freely, but very slowly. The study in Finnish wet forests indicated that stream discharge was reduced by 47%.
Reducing Runoff	Increase Evapotranspiration	None	
	Increase Infiltration and/or groundwater recharge	Medium	Some wetlands can resupply aquifers, others are fed by groundwater moving upwards.
	Increase soil water retention	Medium	Rainwater can be retained in soil pores between the ground surface and groundwater table. The higher the level of groundwater, the lower the retention capacity of soil as it is defined as the volume that can be filled with inflowing water (flooding, precipitation). In natural swamps where water table is situated on the surface, the volume of soil retention is virtually zero.
Reducing Pollution	Reduce pollutant sources	None	
	Intercept pollution pathways	Medium	Wetlands can reduce river pollution by trapping nutrients swept off agricultural land by rainfall. Most studies investigated water quality improvement, with the majority examining nutrient retention (nitrogen and phosphorus). However this depends on the wetland's size, location and the vegetation it contains.

			In Poland, it has been estimated that the average water flow should not be greater than 0.15 m^3/sek to ensure a decrease of N load in such areas is ca. 1 g/m^2 of the area per year. The study in Finnish wet forest wetlands shows that the concentration of nitrogen is reduced by 15%. Increased pollution holding capacity is possible when the bottom of the reservoir is covered by submerged and emergent aquatic vegetation and the shore zone and slope are covered by reed, wicker, etc.
Soil Conservation	Reduce erosion and/or sediment delivery	Low	Sediment can deposit in wetlands, therefore reducing sediment delivery on the river.
	Improve soils	Low	There are likely to be some improvement in soil quality due to the changes in land use. The percentage of organic matter will increase over time.
Creating Habitat	Create aquatic habitat	High	Coastal areas represent a number of valuable habitats. They also support important bird habitats.
	Create riparian habitat	High	Wetlands are associated with all habitats listed in the category 31 and 32 of the Habitats Directive, Annex 1.
	Create terrestrial habitat	Low	Wetlands can be important for forest and grass related habitats as well as raised bogs and mires and fens.
Climate Alteration	Enhance precipitation	None	
	Reduce peak temperature	None	
	Absorb and/or retain CO2	High	Peatlands are storehouses of large quantities of CO2, thus reducing atmospheric greenhouse gases. However, peatlands remain carbon 'sinks' only as long as they remain in good status. When damaged, drained or burnt, or when peat is extracted for fuel, peatlands turn from being net carbon sinks to net carbon 'sources'. Therefore, the maintenance of peatlands in good condition is an invaluable asset in climate change mitigation. Wetlands may account for as much as 40% of global reserve of terrestrial carbon and can make an important contribution in combating climate change (EC. 2007. LIFE and Europe's wetlands: Restoring a vital ecosystem). Example: Due to improved conditions for peat formation with the consequent CO2 accumulation in the Amalva mire (Lithunia) and significantly reduced emissions from the Amalvas polder, total greenhouse gas emissions from degrading peat are expected to fall substantially from the currently estimated 10000-15000 t of CO2 equivalent/year.

			Greenhouse gases (GHG) have been continuously monitored at the Gateway wetland by the eddy covariance method from air (measures fluxes) and directly from water (measures concentrations). Measurements of GHG concentration in water during winter 2012-2013 indicate that the site has been a source of CO2 and CH4 into the atmosphere. However, ice cover has prevented GHG emissions. The GHG concentrations in the water were sensitive to changes in flow rates.

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	Medium	The role of the wetlands in storing water is important, especially in areas where seasonal draughts occur. Therefore, Poland has been implementing the national wide programme on small water retention in rural agricultural and forest areas to improve water balance during the summer period.
	Fish stocks and recruiting	High	In Europe more than two thirds of the fish we consume are dependent on coastal and inland wetland areas. Six wetlands along the Bulgarian Danube stretch were studied in 2009 and 2010. Totally 30 fish species were founded, 10 of them are of conservation significance. The highest species richness was recorded in the Srebarna Lake and the lowest one – in the Garvan marshes. Recently the commercial fishing in the wetlands has lost its economic significance because of the dramatic decline of fish stocks and degradation of fish communities. The volume of the permanent water bodies, the flooding regime and the regular connection with the river are the factors determining either the state or succession of the fish communities(Pehlivanov L. Et al., 2011)
	Natural biomass production	Medium	Since it creates new habitats (aquatic, riparian and terrestrial), this measure increases the biomass production. In some regions, wetlands are also providing wild food products: e.g., cranberries, cloudberries; mushrooms, etc.
Regulatory and Maintenance	Biodiversity preservation	High	Wetland ecosystems hold an important part of Europe's biodiversity. They are especially important for birds, providing vital nesting and migratory flyway areas, as well as for other fauna species, such as dragonflies and amphibians. Countless specialist plants depend on wetlands. Projects granted by EU LIFE programme have been contributing to a large number of projects

			supporting the conservation of wetland ecosystems within the Natura 2000 network.
	Climate change adaptation and mitigation	Medium	Peatland areas store CO_2. For example, due to improved conditions for peat formation with the consequent CO2 accumulation in the Amalva mire (Lithuania) and significantly reduced emissions from the Amalvas polder, total greenhouse gas emissions from degrading peat are expected to fall substantially from the currently estimated 10000-15000 t of CO2 equivalent/year.
	Groundwater / aquifer recharge	Medium	Some wetlands can resupply aquifers. Others are fed by groundwater moving upwards.
	Flood risk reduction	Medium	Wetlands can participate in reducing or delaying floods. Surface water run-off is slowed and stored by wetland vegetation, which can reduce downstream flooding.
	Erosion / sediment control	Low	As sediment can deposit in wetlands, sediment delivery on the river can be reduced. The monitoring data in Finland shows the reduction of TSS compared to the inflow and outflow of the river stretch. Besides, wetland restoration in coastal areas supports protection against sea storms and surges. This has been one of the objectives to implement measures in Belgium for Scheldt river basin (Sigma plan).
	Filtration of pollutants	Medium	Pollutants can deposit in the wetland. The monitoring data in Finland shows the reduction of nitrogen and increase of dissolved oxygen compared the inflow and outflow of the river stretch.
Cultural	Recreational opportunities	Medium	Wetlands are important bird areas, thus bird watchers are attracted to them. When implementing wetland projects, authorities often provide accompanying recreational infrastructure such as trails, towers, and recreation sites.
	Aesthetic / cultural value	Medium	Wetlands are used for nature photographers and for landscape painters, as well as for general public. Urban wetlands or wetlands near to the vicinity of the cities can create an aesthetic value to area in particular when the areas has been industrialised and contaminated in the past.
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	Wetland restoration and management help reaching a good global water ecological status. The contribution to achieve WFD objectives depends weather wetlands which are directly or indirectly connected to the "water body". It also might take longer time to observe improvements. For example, while physico-chemical quality has been improving in Tullstorpsån river, the monitoring results on status of macrobenthic fauna do not reflect improvement yet.
	Improving status of physico-chemical quality elements	Medium	The study in Finnish wet forest wetlands shows that the concentration of nitrogen is reduced by 15%. Similar results (16% of nitrate; 6.5% of nitrate and 91% of Ammonia) were achieved in urban wetland constructed near the river Tolka, in Dublin, Ireland. The good results have been also achieved in Tullstorpsån river catchment, Sweden. Due to restoration of wetlands, the average concentrations of phosphorous have decreased by 30%.
	Improving status of hydromorphological quality elements	Low	For some water bodies, the structure and condition of wetlands in the riparian, shore or intertidal zones is important for supporting the achievement of the good status values for the hydromorphological quality elements.
	Improving chemical status and priority substances	None	
Achieve Good GW	Improved quantitative status	Medium	Wetland restoration and management can allow increasing infiltration and groundwater recharge
	Improved chemical status	None	
Prevent Deterioration	Prevent surface water status deterioration	Medium	As wetland restoration and management can play a role in improving biological and physical status of water surface, they can prevent surface water status deterioration
	Prevent groundwater status deterioration	Medium	As wetland restoration and management can have a role in pollutant deposition, they can prevent groundwater status deterioration.
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		Medium	The measure can support reduction of flood risks.

Habitats and Birds Directives		
Protection of Important Habitats	High	A large number of projects of wetland restoration and management are targeted to restore habitats and to provide adequate living conditions for species of the community importance. LIFE projects have been targeted to different species (birds, amphibians, insects, plants, etc) which are dependent of the habitat.
2020 Biodiversity Strategy		
Better protection for ecosystems and more use of Green Infrastructure	High	The measure is directly contributing to this policy objective. All LIFE programme projects report on improved conditions on different species in the restored areas by use of the wetlands as a type of green infrastructure.
More sustainable agriculture and forestry	Low	Although wetlands can be used for treatment of agricultural runoff, the increase of wet area increases costs of management as different technology needs to be implemented. It also limits access to area in wet periods.
Better management of fish stocks	High	Wetlands can be important spawning areas for fish species (related to estuary habitats, river or lake habitats).
Prevention of biodiversity loss	High	The measure is directly contributing to this policy objective. All LIFE programme projects report on improved conditions on different species in the restored and managed areas.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	The case studies on NWRM indicate that scale of measures varies from less than 10ha up to several thousand hectares. Smaller size wetlands are set up at agricultural areas, while larger ones are generally in areas of former peatlands, or lowland river valleys.
Space required	Space is related to topography and natural hydrological regime.
Location	Very varied locations – from urban or sub-urban up to remote forest areas which have been drained in the past or where peat has been cut.
Site and slope stability	Wetlands are either in flat areas with certain soil conditions or in topographic depressions.
Soils and groundwater	Natural wetlands are most likely to occur in natural depressions with low permeable soils, except when they are on floodplains or where there are springs. The case studies indicate that the measure on wetland restoration has been implemented on Peat/organic soils or gluey soils.

Pre-treatment requirements	No.
Synergies with Other Measures	When wetland is constructed to provide a 'SuDS' purpose (in urban or agricultural areas), then other measures identified under the 'urban' sector can be beneficial. River restoration measures (floodplains, connectivity, etc) also support creation of wetlands.

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition	From 1210 EU/per ha.	If land has been used for agricultural purposes then the acquisition to turn that into wetland is needed. In several cases when the projects have been focused on the restoration or maintenance of wetland habitats, the land has been owned by the state or municipality, thus no acquisition were needed. The costs are related to land value in particular region, e.g. in the Lithaunian LIFE+ project the 25 ha of the land was purchased for c.a. 31 000 EUR. In Spain, for implementation of the Arga and Aragón rivers' project c.a. 466 500 € were spent on land acquisition.
Investigations & Studies	16-600 th. EU per study	All investment works require investigations and technical/design projects. The projects implemented represent a combination of measures related to river restoration (reconnection, re-meandering and removing of embankments). For example in Spain, the preparatory actions in the LIFE + project on Arga and Aragón rivers cost about 600 000 EUR, while in Lithuania for restoration of hydrological regime in the Amalvas wetland areas direct costs related to technical studies were about 16000 EUR.
Capital Costs		As many projects are pilot and experimental, the costs include also side-costs related to project management and reporting to the donor.
Maintenance Costs		It depends from the site and which maintenance activities are requested. In some areas mowing and grazing is needed, in others maintenance of hydraulic structures, etc.
Additional Costs	From few thousands up to 500 000 EUR	Additional costs may relate to the awareness raising activities, involvement of stakeholders. Depending on the size of the project such costs can be up to 500 000 EUR as indicated by the example of Spain. The additional costs are often related to the whole project which are complex and include a set of NWRM.

X. Governance and Implementation

Requirement	Evidence
Environmental impact assessment	If wetland restoration includes investment and activities which might cause significant changes in the environment, then an environmental impact assessment is likely to be required. The intensity of the assessment depends on the scale of the measure.
Technical/design project	If the work involves building/construction activities, many countries require the development of a technical or design project.
Local land use plans	Wetland restoration might result in land-use change which needs to be reflected in the local land-use plans. Thus also some planning approval process might need to be implemented.
Stakeholder involvement	The stakeholder involvement in the implementation in the wetland restoration or construction activities has proven to be very important. Depending on the current land use (either it is agricultural, forest or urban built-up areas) the different stakeholders shall be involved from planning up to implementation actions. This is also related to the issue of the land ownership and willingness of the owners to accept the natural water retention measures such as wetlands.

XI. Incentives supporting the financing of the NWRM

Type	Evidence
LIFE+ programme, direct grants	Project data base indicates almost 240 projects under keyword "wetland" which have been implemented in the past. Although "wetlands" are not explicitly mentioned in the LIFE multiannual work programme for 2014-17, priorities have been identified, which includes also support to the actions in relation to wetlands: For example: "Planning and establishment in urban and rural areas of natural water retention measures that increase infiltration, storage of water and remove pollutants through natural, or 'natural-like' processes and thereby contribute to the achievement of the WFD and the Floods Directive (FD) objectives and to drought management in water scarce regions". Projects renaturalising river, lake, estuary and coastal morphology and/or recreating associated habitats including flood- and marsh-plains, to allow the achievement of WFD and FD objectives.
INTERREG or cross-border programme, direct grants	For example: Ecological restoration of Comana Wetland in Romania http://www.cgiurgiu.ro. The new programmes are launched at the end of 2014; beginning 2015. See more on http://ec.europa.eu/regional_policy/index_en.cfm

European Agricultural Fund for Rural Development (EAFRD) for 2007-2013 (2014-2020), direct grants	For example: Irelands' Rural Development Programme The support to restoration or construction of the wetlands in rural areas depends on each country either on national or regional level. The new EAFRD regulation No 1305/2013 defines the following priorities relevant for the wetlands: restoring, preserving and enhancing ecosystems related to agriculture and forestry.
Cohesion Funds 2007-2013 direct subsidies	Small-scale water retention in lowland areas, for example in forests in Poland. The new national programmes for 2014-2020 are still under development in many countries.
National Government direct grants	e.g. Flemish government; Polish Government, Swedish Government

XII. References

Reference	Comments
"Costs, benefits and climate proofing of natural water retention measures"	Stella Consulting, NWRM Final Report - May 2012
http://ec.europa.eu/environment/life/project/Projects/index.cfm	The data base on the LIFE+ projects
European Communities, 2007. LIFE and Europe's wetlands: Restoring a vital ecosystem.	The brochure presents a selection of these LIFE wetland projects. Most focus on the restoration and management of wetlands, while a number also target key wetland species.
http://www.sigmaplan.be/	The Sigma Plan consists of different project areas, distributed across a large part of Flanders, Belgium. These project areas are located along the tidal rivers: the Scheldt and its tributaries the Durme, the Rupel, the Nete, the Kleine Nete, the Grote Nete, the Dijle and the Senne.
Department of the Environment, Heritage and Local Government. Integrated Constructed wetlands. Guidance Document for Farmyard Soiled Water and Domestic Wastewater Applications. Ireland, 2010.	http://www.environ.ie/en/Publications/Environment/Water/FileDownLoad,24931,en.pdf
WETLIFE project in Lithuania	http://www.wetlife.gpf.lt/en/projekto-ataskaitos
A.Taylor. 2012. The regulation of stream water quality and flow by a forested wetland, Kylmäojankorpi, Vantaa.	The study shows: - Forested wetlands improve and regulate certain water quality and stream flow characteristics - Urban wetlands are valuable in sustainable urban planning, but natural wetlands should not be degraded.

Pehlivanov L.; Stefanov T., Mihov S., Biserkov V., Vassilev M., Apostolou A., Velkov B. 2011. Recent ichthyofauna in the wetlands along the Bulgarian section of the Danube. Scientific Annals of the Danube Delta Institute, Tulcea – Romania.	The study shows about the importance of wetlands in fish stock in the Danube basin.
Mioduszewski W. 2012. Small water reservoirs – their function and construction. Journal of Water and Land Development. No. 17 p. 45–52	The article reviews on studies and experiences in implementing small water retention measures in Poland.
European Communities, 2003. COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC). Guidance Document No 12 Horizontal Guidance on the Role of Wetlands in the Water Framework Directive.	About the role of wetlands in achieving WFD objectives