European Commission

NWRM

Natural Water Retention Measures

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Individual NWRM

Meadows and pastures

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. The information and views set out in this report represent NWRM project's views on the subject matter and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this report. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein.

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I. NWRM Description

Meadows are areas or fields whose main vegetation is grass, or other non-woody plants, used for mowing and haying. Pastures are grassed or wooded areas, moorland or heathland, generally used for grazing. Due to their rooted soils and their permanent cover, meadows and pastures provide good conditions for the uptake and storage of water during temporary floods. They also protect water quality by trapping sediments and assimilating nutrients.

The measure offers the potential for temporary flood storage, increased water retention in the landscape and runoff attenuation. Soil cover is maintained at all times with rooted vegetation, this reduces the surface flow of water and allows greater infiltration to the soil. Rates of soil erosion are considerably lower than arable land with potential benefits for water quality.

II. Illustration

Illustration: flooded meadow, Scotland (UK)

Source: Chris Spray's presentation, NWRM Workshop 1 (Scotland)

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	No	Not applicable
Agricultural Areas	Yes	Pastures, heterogeneous agricultural land
Forests and Semi-Natural Areas	No	Not applicable
Wetlands	No	Not applicable

Region	Applicability	Evidence
Western Europe	Yes	The measure can be applied in all areas where pasture is found, although the highest concentrations of this land use are found in North-western Europe (see **Erreur ! Source du renvoi introuvable.**).
Mediterranean	Yes	
Baltic Sea	Yes	
Eastern Europe and Danube	Yes	

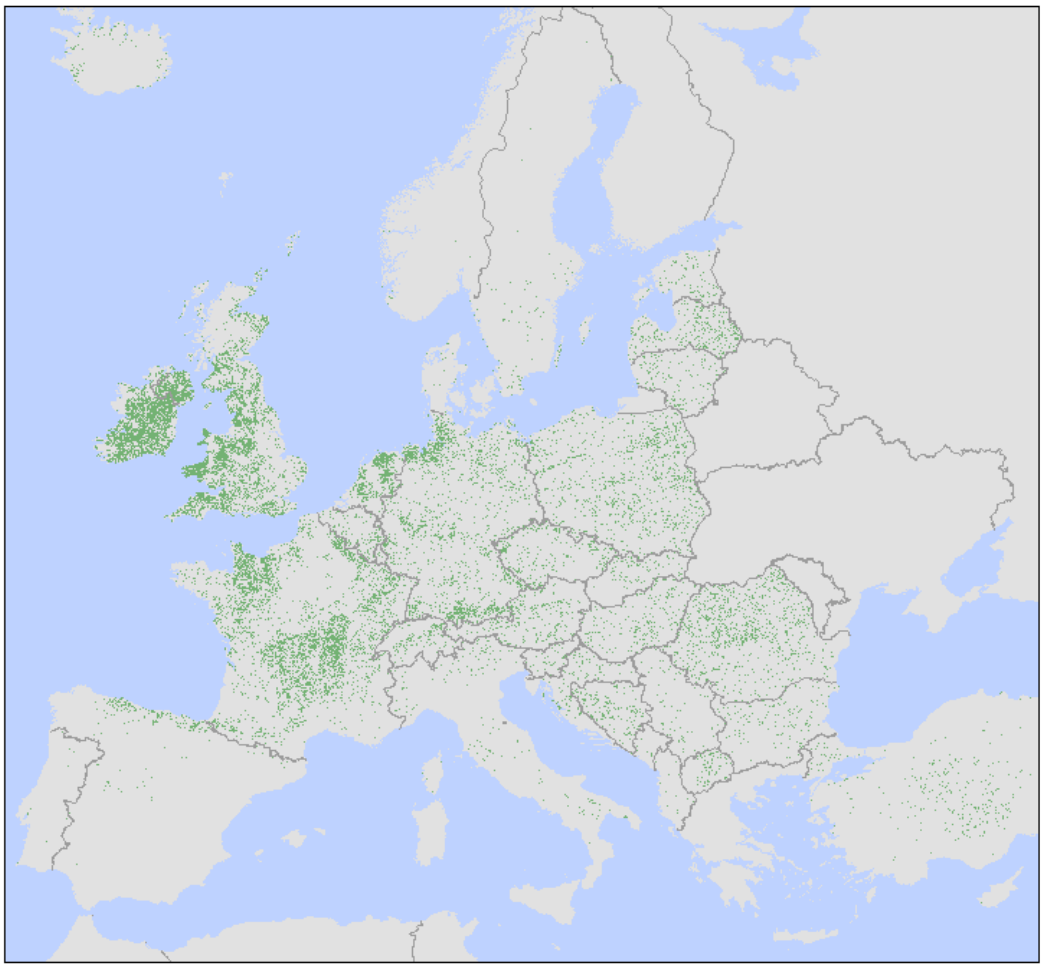

Illustration 1 : Corine 2006 Land Cover – Pasture (Source: European Environment Agency, http://www.eea.europa.eu/data-and-maps/data/clc-2006-vector-data-version-3)

IV. Scale

	0-0.1km^2	0.1-1.0km^2	1-10km^2	10-100km^2	100-1000km^2	>1000km^2
Upstream Drainage Area/Catchment Area	✓	✓				
Evidence	This measure operates and field/farm scale.					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	None	
	Slow Runoff	High	BIO Intelligence Service (2014) report that a study in Catalonia (Spain) found that run off was 1884 m^3/ha for arable land compared to between 643 to 962m^3/ha for grassland, i.e. reductions of between 49% and 66%. Kedziora (2010) reports on the impacts of different land management practices in the Wielkopolska region of Poland. Run-off was lower for meadows versus arable land: • Dry year (627mm precipitation): 0mm for meadows versus 108mm. • Normal year (749mm precipitation): 155mm for meadows versus 233mm, i.e. 33% lower. • Wet year (936mm precipitation): 271mm for meadows versus 351mm, i.e. 23% lower.
	Store River Water	None	
	Slow River Water	None	
Reducing Runoff	Increase Evapotranspiration	Medium	Kedziora (2010) reports on the impacts of different land management practices in the Wielkopolska region of Poland. Annual evapotranspiration was higher for meadows compared to arable land across a range of rainfall patterns: • Dry year (80% of average precipitation): 490mm for meadows versus 364mm, i.e. 35% higher. • Normal year: 510mm for meadows versus 422mm, i.e. 21% higher. • Wet year (120% of average precipitation): 549mm for meadows versus 507mm, i.e. 8% higher.

A1: Meadows and pastures

	Increase Infiltration and/or groundwater recharge	Low	Improved soil structure, for example through grass root systems, can increase infiltration rates. However, meadows and pastures are susceptible to compaction and poaching from machinery and livestock; although these management factors interact with soil type/texture and climactic conditions to influence compaction and poaching risk (Newell-Price et al., 2012)
	Increase soil water retention	Medium	Soil water retention can be improved by increased organic matter content and improved soil structure (Kedziora et al., 2011). The extent to which this can occur will depend on interactions between management, soil type and climate.
Reducing Pollution	Reduce pollutant sources	None	
	Intercept pollution pathways	None	
Soil Conservation	Reduce erosion and/or sediment delivery	High	Pasture and meadow management can reduce erosion and sediment delivery by ensuring greater vegetation coverage; this reduces surface flow and availability of sediments. Interactions with management, particularly stocking density where poaching is a risk may be important.
	Improve soils	Low	Well managed pasture should have improved soil quality, including good structure and high organic matter content.
Creating Habitat	Create aquatic habitat	None	
	Create riparian habitat	None	
	Create terrestrial habitat	None	
Climate Alteration	Enhance precipitation	None	
	Reduce peak temperature	None	
	Absorb and/or retain CO_2	Medium	Well managed pasture should have improved organic matter content

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Food provision	None	
	Water Storage	None	
	Fish stocks and recruiting	None	
	Natural biomass production	None	
Regulatory and Maintenance	Biodiversity preservation	None	
	Climate change adaptation and mitigation	Medium	Well managed grassland can contribute towards climate change mitigation through higher carbon storage.
	Groundwater / aquifer recharge	Medium	This may be achieved through the higher potential infiltration, but will also depend on management and soil types.
	Flood risk reduction	High	Flood risk can be reduced through reduced runoff and increased soil water storage.
	Erosion / sediment control	High	Pasture and meadow management can reduce erosion and sediment delivery by ensuring greater vegetation coverage; this reduces surface flow and availability of sediments. Interactions with management, particularly stocking density where poaching is a risk may be important.
	Filtration of pollutants	Medium	Higher vegetation coverage and reduced surface flow can result in greater filtration of pollutants.
Cultural	Recreational opportunities	None	
	Aesthetic / cultural value	None	
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	None	
	Improving status of physico-chemical quality elements	None	
	Improving status of hydromorphological quality elements	Medium	This can be achieved through reduced surface flow/runoff and reduction in erosion and sediment delivery.
	Improving chemical status and priority substances	None	
Achieve Good GW	Improved quantitative status	Low	Meadows and pastures can contribute to this objective through increased storage and water in soils.
	Improved chemical status	None	
Prevent Deterioration	Prevent surface water status deterioration	Medium	Meadows and pastures can contribute to this be reducing sediment and pollutant delivery to water bodies due to reduced runoff and filtration.
	Prevent groundwater status deterioration	Low	Meadows and pastures can improve filtration of pollutants, consequently contributing to groundwater quality status.
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		High	Well managed meadows and pastures contribute to this objective by reducing runoff, slowing surface flow and increasing infiltration. These would be need to be coordinated at catchment scale.
Habitats and Birds Directives			
Protection of Important Habitats		None	
2020 Biodiversity Strategy			
Better protection for ecosystems and more use of Green Infrastructure		High	Meadows and pastures contribute to this objective by reducing soil erosion and sediment delivery.
More sustainable agriculture and forestry		Medium	Well managed meadows and pastures can reduce the negative impacts of agricultural production whilst delivering a variety to positive benefits.

Policy Objective	Rating	Evidence
Better management of fish stocks	None	
Prevention of biodiversity loss	Medium	Meadows and pastures are key elements in Nigh Nature Value farming systems.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	
Space required	
Location	
Site and slope stability	
Soils and groundwater	
Pre-treatment requirements	
Synergies with Other Measures	This measure can be implemented together with *Controlled traffic farming* and *Reduced stocking density*, the latter may be particularly important to ensure the benefits of meadow and pasture restoration are realised.

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition	0	No change in land ownership
Investigations & Studies	0	Not required
Capital Costs	0	No capital investment required
Maintenance Costs	€159 - €420 (grazing) €189 - €358 (hay)	Grassland operational costs 2013 prices per ha per year (SAC Consulting, 2013)
Additional Costs	€154	Opportunity costs if converting land from arable to permanent grassland, though this is more likely on the most marginal arable land. Additional costs per ha per year 2006 prices, annualised conversion cost over 20 years at 4% discount rate (European Commission, 2006): • Conversion from arable: €200/ha or €14/ha/yr • Loss of revenue from arable: €140/ha/yr

Values in £ converted at £1 = €1.20

X. Governance and Implementation

Requirement	Evidence

XI. Incentives supporting the financing of the NWRM

Type	Evidence
New CAP (Pillar I) 'greening' measures with respect to limiting the loss of permanent pasture.	Effective payment rate will depend on MS implementation of Pillar I and choice of greening measures.
New Rural Development Programme (Pillar II) measures might include payments for converting arable to permanent pasture and reducing the intensity of inputs and stocking levels	Payment rates are based on income forgone/cost incurred and will vary across MS Mean EU 2007-13 RDP payment Rates (European Commission, 2011): Conversion from arable: €313 (range €101 to €733) Grassland management: €230 (range €7 to €1103)

XII. References

Reference
BIO Intelligence Service (2014), Soil and water in a changing environment, Final Report prepared for European Commission (DG ENV), with support from HydroLogic. http://ec.europa.eu/environment/soil/pdf/Soil%20and%20Water.pdf
European Commission (2011) Impact Assessment, Common Agricultural Policy towards 2020 Annex 2C, Commission Staff Working Paper. http://ec.europa.eu/agriculture/policy-perspectives/impact-assessment/cap-towards-2020/report/annex2c_en.pdf
Kedziora A (2010) Landscape management practices for maintenance and enhancement of ecosystem services in a countryside, Ecohydrology & Hydrobiology 10(2-4): 133-152.
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Newell-Price P, Chambers B and Whittingham M (2012) Characterisation of Soil Structural Degradation Under Grassland and Development of Measures to Ameliorate its Impact on Biodiversity and Other Soil Functions, Grassland Soil Compaction Assessment – Stages 1 and 2, Final report to Defra BD5001. http://randd.defra.gov.uk/Document.aspx?Document=10020_BD5001_WP1_FINAL_REPORT_May_2012.pdf
SAC Consulting (2013) The Farm Management Handbook 2013/14, SAC Consulting Ltd.