European Commission

NWRM

Natural Water Retention Measures

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Individual NWRM

Re-naturalization of polder areas

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

A polder is a low-lying tract of land enclosed by embankments (barriers) known as dikes that forms an artificial hydrological entity, meaning it has no connection with outside water other than through manually operated devices. Its re-naturalization consists in enhancing polders with sub-natural characteristics, allowing better water storage in watercourses inside the polder, as well as increased biodiversity.

II. Illustration

Example of polder: Juist (Germany)

Source: http://commons.wikimedia.org/wiki/File:2012-05-13_Nordsee-Luftbilder_DSCF8997.jpg

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	Yes	Eastern and Southern Flevoland, together known as the Flevopolder, the largest artificial island in the world.
Agricultural Areas	Yes	The traditional polders in The Netherlands have been formed from the 12th century onwards, when people started creating arable land by draining delta swamps into nearby rivers. In the process, the drained peat started oxidizing, thus soil levels lowered, up to river water levels and lower. Throughout the centuries farmers have been adapting their agricultural system to lowering soil levels and occasional floods and invented new ways to organise themselves and keep sea and river water out – resulting in the building of hundreds of drainage windmills and later pumping stations to pump water from polders into the rivers and the sea.

Forests and Semi-Natural Areas	Possible	
Wetlands	Possible	

Region	Applicability	Evidence
Western Europe	Yes	Poland: Stobrawa Polder Ukraine: South of the Odessa oblast, Kilia rayon
Mediterranean	Yes	Italy - Delta of the river Po such as Bonifica Valle del Mezzano
Baltic Sea	Possible	
Eastern Europe and Danube	Yes	Germany: Altenheim Peene Valley

IV. Scale

	0-0.1km2	0.1-1.0km2	1-10km2	10-100km2	100-1000km2	>1000km2
Upstream Drainage Area/Catchment Area					Yes	
Evidence	Polders tended to be developed in the lower reaches of large rivers with large upstream catchments were high flood storage capacity was desired. Therefore this is most likely to be relevant in the downstream reaches of major river catchments.					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	High	This measure, by enhancing the polder structure (number of dikes) and functioning, can increase its capacity for storing runoff
	Slow Runoff	Medium	This measure, by enhancing the lake structure (size) and functioning, can slow down the runoff
	Store River Water	High	The water is stored in watercourses inside the polder. This measure, by enhancing the polder structure (number of dikes) and functioning, can increase its capacity for storing river water
	Slow River Water	Medium	This measure, by enhancing the polder structure (number of dikes) and functioning, can slow down the river water

Reducing Runoff	Increase Evapotranspiration	Low	Since it can enhance vegetation development, especially of riparian and grass covers, this measure can increase evapotranspiration.
	Increase Infiltration and/or groundwater recharge	Medium	Re-naturalization of polder areas can allow increasing infiltration and groundwater recharge.
	Increase soil water retention	Low	Soil water retention might change according to the number of dikes and its boarding vegetation.
Reducing Pollution	Reduce pollutant sources	None	
	Intercept pollution pathways	Low	As the river runoff and water are slowed down, pollutants can deposit easier in the polder
Soil Conservation	Reduce erosion and/or sediment delivery	Low	As the river runoff and water are slowed down, sediment can deposit easier in the polders, therefore reducing sediment delivery on the river.
	Improve soils	Low	Sea water is admitted to a bunded polder on acid sulfate soil for soil improvement and weed control (example in Guinea Bissau). Soil quality might change according to the number of dikes and its boarding vegetation
Creating Habitat	Create aquatic habitat	High	In Altenheim aquatic macrophytes were documented by the assuming method of Kohler and Janauer. The water courses thus became habitat of different invertebrate and fish species
	Create riparian habitat	Medium	Re-naturalization of polder areas could have an impact on the riparian vegetation by rebuilding or creating natural environment for riparian species.
	Create terrestrial habitat	Low	In Altenheim the amount of terrestrial plants and the domination of single species in different vegetations layers was done by rough assuming.
Climate Alteration	Enhance precipitation	None	
	Reduce peak temperature	None	
	Absorb and/or retain CO2	None	

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	High	The water is stored in watercourses inside the polder
	Fish stocks and recruiting	Medium	Fish stocks could be increased by improving habitat, of different invertebrate and fish species.
	Natural biomass production	Medium	Since it creates new habitats (aquatic, riparian and terrestrial), this measure increases the biomass production.
Regulatory and Maintenance	Biodiversity preservation	High	Several groundbeetle and dragonfly species came back to the new established alluvial forest. The mosquito population / pests increases considerably, with negative consequences for the nearby municipalities.
	Climate change adaptation and mitigation	None	
	Groundwater / aquifer recharge	Medium	Ecological flooding leads to rising groundwater levels outside the polder that can affect property. Therefore a complex drainage system including channels, wells, lakes and pumping stations can be created.
	Flood risk reduction	Medium	Cost-Benefit-Analysis of several ecosystem services reveals polder flood retention areas to provide cost-effective protection against flood damage, with additional ecological benefits.
	Erosion / sediment control	Low	Sediment can deposit easier in the polders.
	Filtration of pollutants	Low	Pollutants can deposit easier in the polder.
Cultural	Recreational opportunities	Low	It is possible to adapt and modify the ecosystem inside a polder to water retention events by ecological flooding. Due to the measures the polder becomes a valuable recreational area for the citizens of the neighbouring community. Recreational value since the polder area is used for hiking, jogging, cycling and canoeing
	Aesthetic / cultural value	Medium	Several examples illustrate the large variety among cultural landscapes and heritage services in terms of scale and character. In the Netherlands, the historic slagen (long stretched land parcels) landscape Krimpenerwaard is a specific type of polder landscape situated in the "Green Heart" of the country. The Green Heart–polder is located between Amsterdam, Rotterdam, and the Hague and is a land reclamation system based on a systematic drainage process that

			determines the characteristic structural and functional landscape patterns of the area. Its characteristic features include long and narrow access roads; straight, parallel drainage ditches in regular sequences linking up with naturally meandering water courses in right-angle patterns; land segregations; blind alleys; and numerous parallel ditches.
Abiotic	Navigation	Low	For canoeing
	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	Medium	As aquatic and terrestrial fauna can install respectively in the polder water and in its boarding areas, this measure can improve the status of physico-chemical quality elements
	Improving status of physico-chemical quality elements	Low	Some measurements have shown that the overall water quality could deteriorate when the water passes the polder. However no danger for the drinking water supply existed.
	Improving status of hydromorphological quality elements	None	
	Improving chemical status and priority substances	Low	As pollutants can deposit easier in the polder, this measure can improve the chemical status
Achieve Good GW Status	Improved quantitative status	Medium	Re-naturalization of polder areas can allow increasing infiltration and groundwater recharge
	Improved chemical status	Low	As polders can enhance pollutant deposition, they can have a role in improving the chemical status of groundwater
Prevent Deteriorat	Prevent surface water status deterioration	Low	As re-naturalization of polder areas can play a role in improving biological, physical and chemical status of water surface, they can prevent surface water status deterioration

	Prevent groundwater status deterioration	Low	As polders can enhance pollutant deposition, they can prevent groundwater status deterioration
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		High	Renaturalisation of polders, i.e. water retention inside the polder leads to a avoiding of inundation of cities / livable areas. The concept of ecological flooding is applicable here.
Habitats and Birds Directives			
Protection of Important Habitats		High	Renaturalised polders lead to increased number of invertebrates and fish species, as well as birds and insects.
2020 Biodiversity Strategy			
Better protection for ecosystems and more use of Green Infrastructure		Low	As re-naturalization of polder areas can increase the water ecological status, it can allow better protection for ecosystems
More sustainable agriculture and forestry		None	
Better management of fish stocks		Medium	Renaturalised polders lead to increased number of invertebrates and fish species.
Prevention of biodiversity loss		Medium	Alluvial plant and animal communities could be established. The floods diversify the water courses, enhancing habitat of different invertebrate and fish species.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	n/a
Space required	n/a
Location	n/a
Site and slope stability	n/a
Soils and groundwater	n/a
Pre-treatment requirements	The regular flood events are source of mosquito pests that require a specific treatment.

Synergies with Other Measures	N12 Lake restoration

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition	n/a	
Investigations & Studies	n/a	
Capital Costs	n/a	
Maintenance Costs	n/a	
Additional Costs	n/a	

X. Governance and Implementation

Requirement	Evidence
n/a	

XI. Incentives supporting the financing of the NWRM

Type	Evidence
n/a	

XII. References

Reference	Comment
The remarkable history of polder systems in The Netherlands	http://www.fao.org/fileadmin/templates/giahs/PDF/Dutch-Polder-System_2010.pdf
Management of polder areas	http://postel.obs-mip.fr/IMG/pdf/POLDER-1_BRDF_usermanual-I2.20.pdf
EU Biodiversity Strategy to 2020	http://ec.europa.eu/environment/nature/info/pubs/docs/brochures/2020%20Biod%20brochure%20final%20lowres.pdf
Water Framework Directive	http://ec.europa.eu/environment/pubs/pdf/factsheets/water-framework-directive.pdf
Altenheim Polder	http://recette.nwrm.eu/case-study/polder-altenheim