European Commission

NWRM

Natural Water Retention Measures

www.nwrm.eu

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Individual NWRM

Restoration of natural infiltration to groundwater

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

Groundwater is the part of infiltrated water which composes the water resource for population and human activities. Previous modifications of the landscape have reduced the infiltration capacity of many European soils, thereby limiting the rate at which precipitation is able to infiltrate and recharge groundwater aquifers. Restoration of natural infiltration to groundwater enables a lowering of run-off from surrounding land, and enhances the condition of groundwater aquifers and water availability. The natural cleaning processes associated with infiltration can improve water quality. This measure can also be known as "Artificial Groundwater Recharge" in the engineering literature.

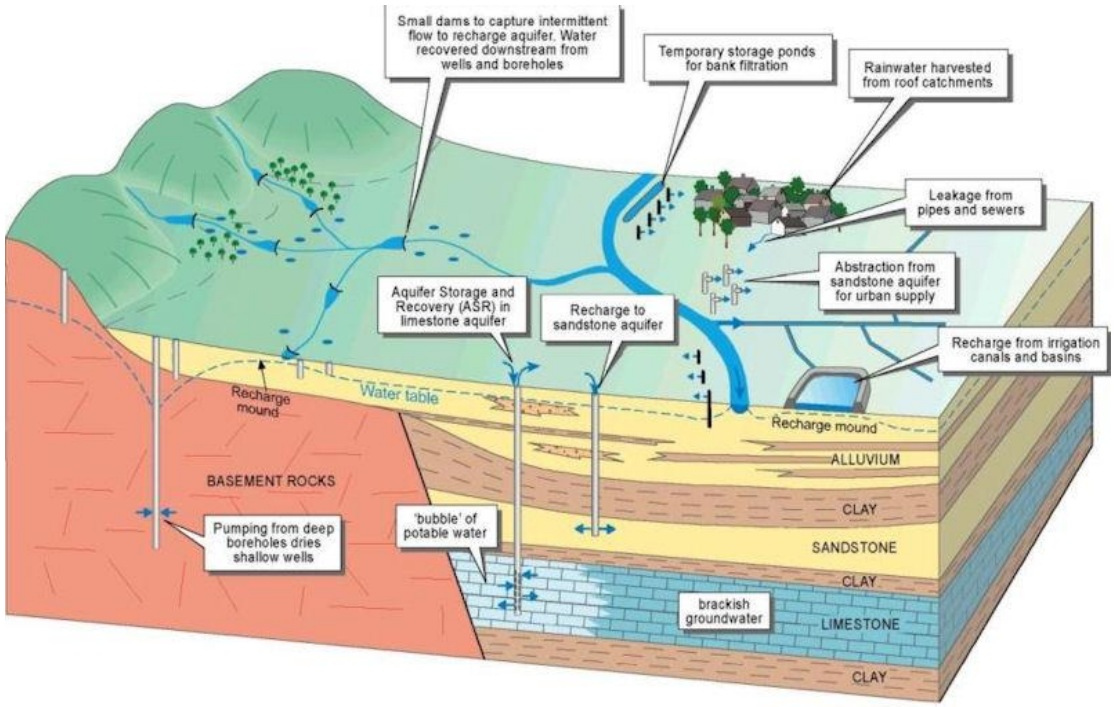
Mechanisms to restore or enhance natural infiltration capacity include:

(i) surface structures to facilitate/augment recharge (such as soakaways and infiltration basins);

(ii) subsurface indirect recharge – infiltration capacity is enhanced through wells drilled within the unsaturated zone; and

(iii) subsurface direct recharge – infiltration and recharge of the groundwater aquifer is accomplished through wells reaching the saturated zone.

II. Illustration



Explicative scheme of enhanced infiltration (UK)

Source: http://www.bgs.ac.uk/research/groundwater/agrar.html

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	No	Natural infiltration to groundwater can be effective in agricultural areas, forests and semi-natural areas, and wetlands. In particular, wetlands help maintaining the level of the water table and exert control on the hydraulic head. This provides force for groundwater recharge and discharge to other waters as well. The extent of groundwater recharge by a wetland is dependent upon soil, vegetation, site, perimeter to volume ratio, and water table gradient. Groundwater recharge occurs through mineral soils found primarily around the edges of wetlands. The soil under most wetlands is relatively impermeable. A high perimeter to volume ratio, such as in small wetlands, means that the surface area through which water can infiltrate into the groundwater is high. Groundwater recharge is typical in small wetlands such as prairie potholes, which can contribute significantly to recharge of regional groundwater resources. Researchers have discovered groundwater recharge of up to 20% of wetland volume per season.
Agricultural Areas	Yes	
Forests and Semi-Natural Areas	Yes	
Wetlands	Yes	

Region	Applicability	Evidence
Western Europe	Yes	
Mediterranean	Yes	Technical report on groundwater management in the Mediterranean and the Water Framework Directive
Baltic Sea	Yes	Direct Groundwater Inflow to the Baltic Sea by Kimmo Peltonen
Eastern Europe and Danube	Yes	Groundwater Legislation and Water Supply in the Danube River Basin

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	Actions for natural infiltration to groundwater can be carried out whatever the catchment area					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	Low	This measure, by enhancing infiltration into deep soil, especially with shallow wells, can increase its capacity for storing runoff
	Slow Runoff	Medium	Rain falling on the landscape may flow quickly over soil or rock surfaces as runoff to stream channels. Alternately, some water may flow more slowly downslope toward streams within the soil. Some may percolate downward through pores in soil and fractures in rock to reach the top of the saturated zone (often called the water table). Below the saturated zone, it flows much more slowly as groundwater. Therefore increasing recharge to groundwater reduces the amount of water available for rapid surface runoff and increases availability of groundwater for baseflow.
	Store River Water	None	
	Slow River Water	None	
Reducing Runoff	Increase Evapotranspiration	None	
	Increase Infiltration and/or groundwater recharge	High	Restoration of natural infiltration to groundwater enables groundwater recharge. The significance of the latter depends on the number of structures restored.
	Increase soil water retention	Low	Soil water retention might slightly change according to the infiltrated water
Reducing Pollution	Reduce pollutant sources	None	
	Intercept pollution pathways	Low	The measures can favour intercepting and infiltrating pollutants, but this represent a risk of introducing pollutants to groundwater, particularly when injecting directly in to an aquifer, by bypassing natural near-surface filtration, or by using contaminated water that would not normally infiltrate.
Soil Conservation	Reduce erosion and/or sediment delivery	Low	Depending on their surface areas, infiltration basins may intercept sediment.
	Improve soils	None	

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 CO2	None	

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	Medium	Part of surface water can be stored in the ground, therefore enhancing water storage.
	Fish stocks and recruiting	None	
	Natural biomass production	None	
Regulatory and Maintenance	Biodiversity preservation	None	
	Climate change adaptation and mitigation	Low	Groundwater resources and their long-term replenishment are controlled by long-term climate conditions. Climate change will therefore have a great impact on groundwater resources. Groundwater has to be used and managed in a sustainable way in order to maintain its buffer and contingency supply capabilities as well as adequate water quality for human consumption, also under predicted climate changes. Land use planning has to consider groundwater resources as a precious and finite resource, and take all possible measures to protect groundwater resources and their recharge mechanisms in the long run.
	Groundwater / aquifer recharge	Medium	Restoration of natural infiltration to groundwater enables groundwater recharge. The significance of the latter depends on the number of structures restored.

	Flood risk reduction	Low	Depending on the quantity of infiltrated water, flood risk may slightly be reduced
	Erosion / sediment control	Low	Depending on their surface areas, infiltration basins may intercept sediment
	Filtration of pollutants	None	
Cultural	Recreational opportunities	None	
	Aesthetic / cultural value	None	
Abiotic	Navigation	None	
	Geological resources	High	Water is an essential part for human existence and nearly all human needs depend on it in one way or another. Nearly 98% of fresh water resources exist as groundwater. Groundwater usage includes potable drinking supplies in addition to agricultural, recreational and industrial demands. During drought conditions, where surface water flows are minimal, groundwater resources become important. Groundwater can also be protection from bacterial contamination through natural filtration processes. In addition many plants and aquatic organisms depend on groundwater or groundwater discharge for survival.
	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	None	

	Improving chemical status and priority substances	None	
Achieve Good GW Status	Improved quantitative status	Medium	By improving groundwater recharge, the measures for restoration of natural infiltration have a positive impact on water quantity.
	Improved chemical status	None	
Prevent Deterioration	Prevent surface water status deterioration	None	
	Prevent groundwater status deterioration	Medium	By improving groundwater recharge, the measures for restoration of natural infiltration contribute to prevent groundwater status deterioration
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		Low	As they enhance water infiltration, the measures for restoration of natural infiltration participate to reduce flood risks.
Habitats and Birds Directives			
Protection of Important Habitats		None	
2020 Biodiversity Strategy			
Better protection for ecosystems and more use of Green Infrastructure		None	
More sustainable agriculture and forestry		None	
Better management of fish stocks		None	
Prevention of biodiversity loss		None	

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	Only relevant where the underlying solid geology is permeable, i.e. there is an aquifer.
Pre-treatment requirements	Depending on the approach to infiltration and the source of the water, pre-treatment may be necessary to prevent pollution reaching groundwater.
Synergies with Other Measures	This type of measure has overlaps with a range of the other measures included in the database that provide infiltration to groundwater by varying means.

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
Water Framework Directive	http://ec.europa.eu/environment/pubs/pdf/factsheets/water-framework-directive.pdf
European Commission	http://ec.europa.eu/environment/water/
New York State – Conservation Reserve Enhancement Program	http://www.nys-soilandwater.org/crep/forms/FactSheet7.pdf
QUANTIFYING DECREASES IN STORMWATER RUNOFF FROM DEEP TILLING, CHISEL PLOWING, AND COMPOST-AMENDMENT By Jeremy D. Balousek, P.E. Dane County Land Conservation Department, 2003	https://www.countyofdane.com/lwrd/landconservation/papers/quantifyingdecreasesinswrunoff.pdf
Dauphin County's Stormwater Publication for Municipalities Issue 5 • March 2007	http://www.envirothon.org/pdf/2012/01_fact_sheet_1.pdf
Technical report on groundwater management in the Mediterranean and the Water Framework Directive	https://circabc.europa.eu/sd/a/50c3b2a9-4816-4ab1-9a33-d41c327759e3/Mediterranean%20Groundwater%20Report_final_150207_clear.pdf
Direct Groundwater Inflow to the Baltic Sea by Kimmo Peltonen	(Available as a Google book)
Groundwater Legislation and Water Supply in the Danube River Basin	http://www.umweltbundesamt.at/fileadmin/site/umweltthemen/wasser/Grundwasser/conference/Abstracts_Presentations/4_2_Werderitsch.pdf