European Commission

NWRM

Natural Water Retention Measures

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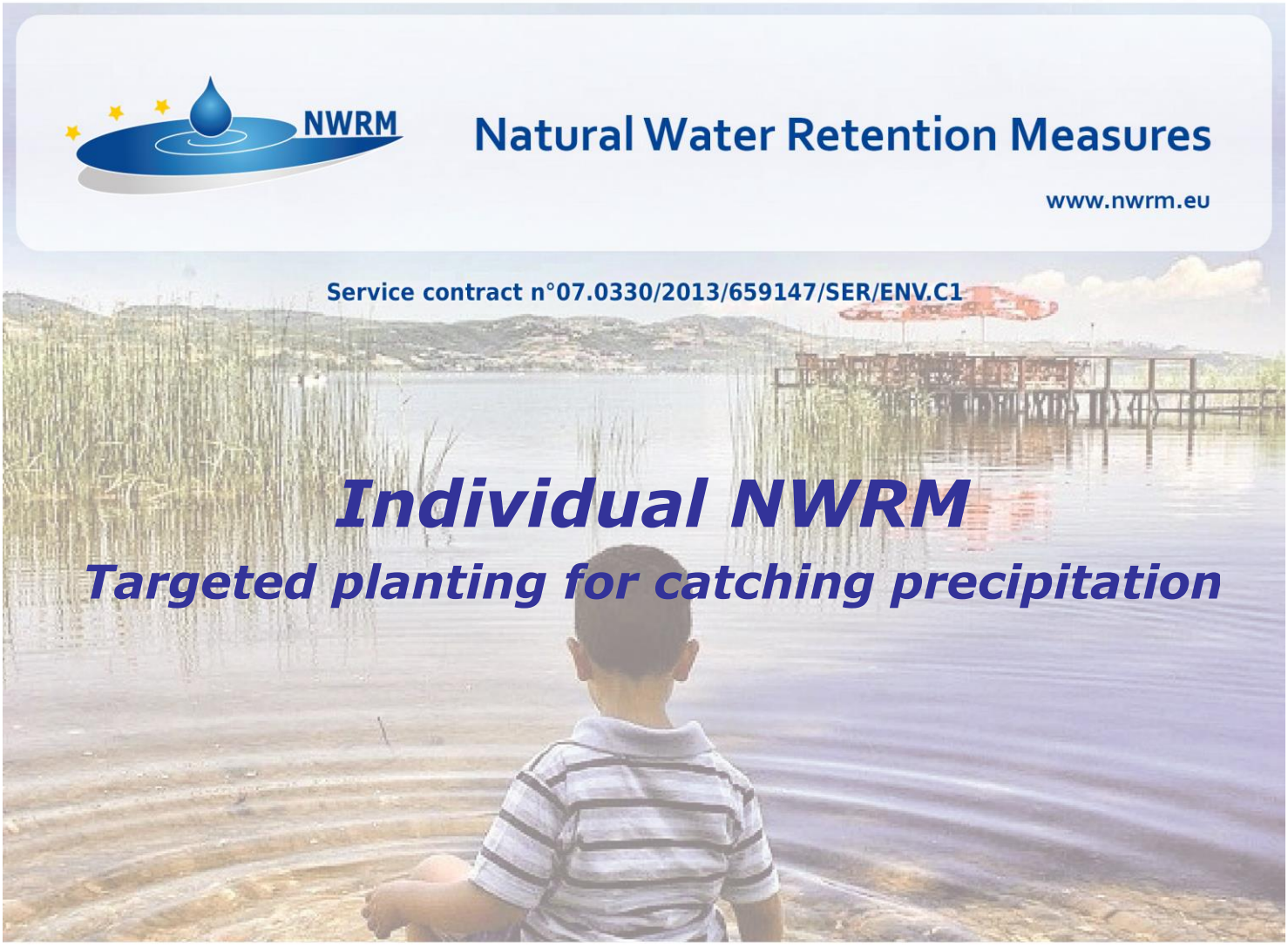
Service contract n°07.0330/2013/659147/SER/ENV.C1



Individual NWRM

Targeted planting for catching precipitation

ACTeon environment research & consultancy

Office International de l'Eau

amec foster wheeler

BEF LATVIA

enveco Environmental Economics Consultancy

I.A.CO Ltd Environmental & Water Consultants

institute IMDEA water

REGIONAL ENVIRONMENTAL CENTER

REKK

SLU

SRUC

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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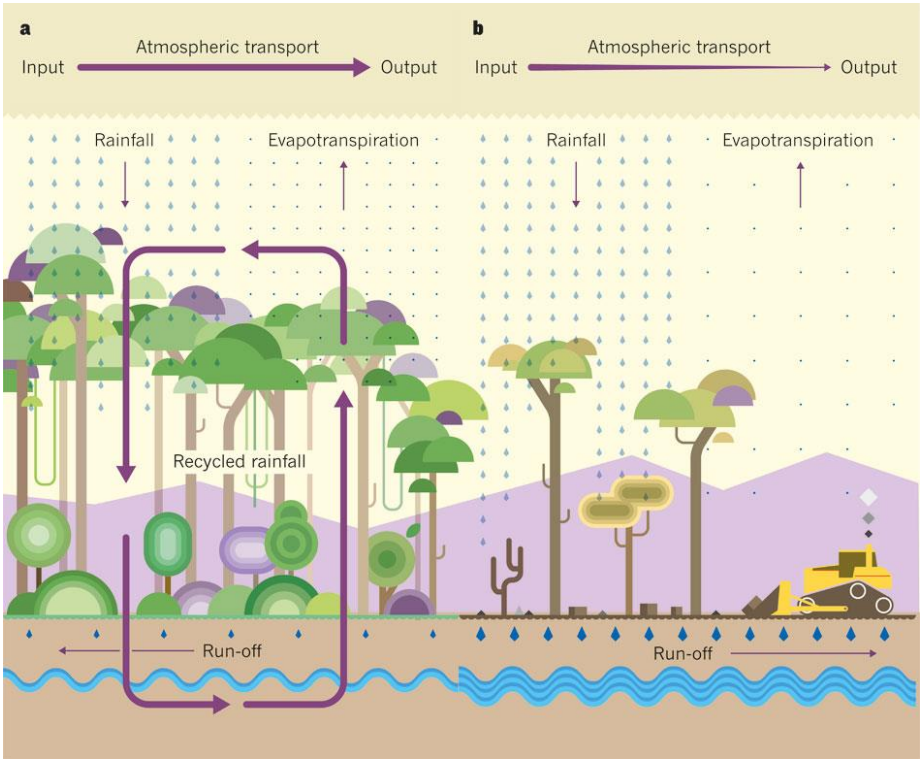
I. NWRM Description

There is some evidence to suggest that loss of tree cover on Mediterranean hill slopes has altered weather patterns, which in turn have altered precipitation amount and timing. Modelling results suggest that Mediterranean precipitation regimes are very sensitive to variations in air temperature and moisture. Land use change and associated deforestation may have led to changes from and open monsoon-type regime with frequent summer storms over inland mountains to a regime dominated by closed vertical atmospheric recirculation where feedback mechanisms suppress storms over the coastal mountains and lead to increased summer time sea surface warming. This warming leads to torrential rains in autumn and winter. These rains can occur across the Mediterranean basin. This can be exacerbated by greenhouse heating associated with air pollutants. Targeted afforestation in some parts of the Mediterranean may be one means of combating drought and desertification.

II. Illustration



Functioning of the water cycle in forests

Source:

http://www.nature.com/nature/journal/v489/n7415/full/nature11485.html?WT.ec_id=NATURE-20120913

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	Possible	Land use conversion (F5) through targeted afforestation of artificial surfaces may create forests for catching precipitation. Alternatively, parks created for recreation may have ancillary benefits of catching precipitation in some areas of Europe.
Agricultural Areas	Possible	Land use conversion (F5) through targeted afforestation of agricultural areas may create forests for catching precipitation.
Forests and Semi-Natural Areas	Yes	Forests in some parts of Europe may alter the transport patterns of atmospheric moisture and contribute to enhanced precipitation.
Wetlands	No	Wetlands are unable to serve this function.

Region	Applicability	Evidence
Western Europe	No	There is no evidence that targeted planting is effective in the Western Europe region.
Mediterranean	Yes	Targeted planting for precipitation capture is only likely to provide benefits in the Mediterranean region. Millán et al. (2005) suggest that deforestation may have altered the precipitation regime in parts of the Mediterranean region with a reduction in summer storms and an increase in autumn/winter precipitation.
Baltic Sea	No	There is no evidence that targeted planting is effective in the Baltic Sea drainage basin.
Eastern Europe and Danube	No	There is no evidence that targeted planting is effective in Eastern Europe and the Danube basin.

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	No	No	No	No	Yes	Yes
Evidence	The evidence from modelling studies suggests that targeted planting to affect precipitation patterns in the Mediterranean basin only works at a very large spatial scale. Millán and colleagues have assembled a considerable body of evidence about the long term effects of deforestation on regional weather patterns which suggest that changes in land use and land management have caused observed changes in regional weather and drought.					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	None	
	Slow Runoff	None	
	Store River Water	None	
	Slow River Water	None	
Reducing Runoff	Increase Evapotranspiration	Moderate	Trees are able to increase evapotranspiration (ET) rates above levels possible from bare ground.
	Increase Infiltration and/or groundwater recharge	Moderate	Tree cover can improve soil structure through increased accumulation of organic matter from leaf litter and improvements to soil permeability. Improved soil structure can lead to greater infiltration, higher rates of groundwater recharge and increased soil water retention. The main way in which targeted planting for catching precipitation is proposed to increase groundwater recharge is through enhanced precipitation where greater amounts of rainfall are available to infiltrate and to maintain groundwater and soilwater levels.
	Increase soil water retention	Moderate	
Reducing Pollution	Reduce pollutant sources	None	
	Intercept pollution pathways	None	
Soil Conservation	Reduce erosion and/or sediment delivery	Moderate	Afforestation has the potential to reduce erosion and sediment delivery. Root networks can contribute to erosion resistance of soils. Afforestation of riparian areas (F1) can contribute to reductions in sediment delivery. Furthermore, afforestation has the potential to reduce the energy of precipitation reaching the soil surface, thereby reducing the rate at which sediments are detached from parent materials and made available for transport.
	Improve soils	Moderate	Afforestation has the potential to improve soils, primarily through improvements to infiltration, better soil structure and increased organic matter content. This is an ancillary benefit of targeted planting for catching precipitation.
Creating Habitat	Create aquatic habitat	None	
	Create riparian habitat	None	

	Create terrestrial habitat	None	
Climate Alteration	Enhance precipitation	High	The overall goal of this measure is to enhance regional precipitation by altering regional weather patterns. While there is strong modelling and empirical evidence that deforestation and drainage of wetlands has contributed to drought and declines in precipitation, there is as yet incomplete evidence as to the changes in precipitation associated with afforestation.
	Reduce peak temperature	Moderate	Afforestation can decrease peak temperatures in the local environment. Modelling results (Millán et al. 2005) suggest that targeted planting can alter regional weather patterns and potentially reduce summer time maximum temperatures of the Mediterranean.
	Absorb and/or retain CO_2	Moderate	An ancillary benefit of this measure is that growing trees and an increase in soil organic matter content can contribute to carbon sequestration.

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	None	
	Fish stocks and recruiting	None	
	Natural biomass production	High	Targeted tree planting for catching precipitation has a high potential for natural biomass production. However, it seems counterintuitive to harvest the trees as excessive deforestation led to the initial problem. Instead, the natural biomass production should be used as part of a strategy for carbon sequestration.
Regulatory and Matinenance	Biodiversity preservation	Moderate	Afforestation of areas previously deforested using native or indigenous species has the potential to preserve or improve biodiversity by providing habitat types used by endemic species.
	Climate change adaptation and mitigation	High	The key purpose of targeted planting for catching precipitation is reversal of local or regional climate change induced by land use change. If successful, this measure will largely mitigate the negative effects of deforestation on Mediterranean summer precipitation regimes.
	Groundwater / aquifer recharge	High	The overarching goal of this measure is to restore antecedent precipitation regimes with an increase in summer rainfall events which would contribute to groundwater and aquifer recharge.
	Flood risk reduction	Moderate	
	Erosion / sediment control	High	Afforestation has a strong potential to reduce erosion and control sediment. Soils under forest cover can have greater structural integrity due to tree roots and better aggregate

			structure due to a higher organic matter content associated with litterfall.
	Filtration of pollutants	None	
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 biology quality elements	None	
	Improving status of physico-chemical quality elements	None	
	Improving status of hydromorphology quality elements	None	
	Improving chemical status and priority substances	None	
Achieve Good GW Status	Improved quantitative status	Possible	Improved groundwater recharge associated with more summer precipitation could in principle improve the quantitative status of groundwaters in the region.
	Improved chemical status	None	
Prevent Deterio	Prevent surface water status deterioration	Possible	A restoration of historical summer precipitation patterns could contribute to preventing surface water and groundwater status deterioration from reference

	Prevent groundwater status deterioration	Possible	conditions. Anecdotal observations from older residents in parts of Spain suggest that streams which used to run year round are now dry in the summer (Millán et al. 2005). If these changes are due to deforestation, targeted planting for precipitation catching could contribute to restoring groundwater levels, which in turn would help to maintain summer base flow in streams.
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		Not Applicable	
Habitats and Birds Directives			
Protection of Important Habitats		Not Applicable	
2020 Biodiversity Strategy			
Better protection for ecosystems and more use of Green Infrastructure		Not Applicable	
More sustainable agriculture and forestry		Not Applicable	
Better management of fish stocks		None	
Prevention of biodiversity loss		Possible	It is possible that this measure could contribute to prevention of biodiversity loss. Afforestation of areas previously deforested using native or indigenous species has the potential to preserve or improve biodiversity by providing habitat types used by endemic species. Furthermore, wetter summers may leave vegetation in the region less susceptible to fire, which will also contribute to prevention of biodiversity loss.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	The hypothesized changes in precipitation regime which would be addressed by this measure were caused by large scale deforestation and drainage in regions bordering the Mediterranean.
Space required	
Location	The available evidence to date suggests that this measure is only applicable in the Mediterranean basin.
Site and slope stability	

Soils and groundwater	
Pre-treatment requirements	
Synergies with Other Measures	

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition		Given the large area required for afforestation, land acquisition does not seem a reasonable option as it would almost certainly be too expensive. Better solutions would involve changes to subsidies or other support systems to encourage afforestation of the appropriate areas.
Investigations & Studies		While the idea of targeted planting for precipitation catching is based on rigorous scientific studies carried out over the past 25 years, there is no unequivocal evidence that this measure will actually work. However, targeted planting for precipitation capture shares this difficulty with almost all geoengineering projects, and unlike many geoengineering projects, there are no significant adverse risks associated with implementation of this measure.
Capital Costs		
Maintenance Costs		
Additional Costs		

X. Governance and Implementation

Requirement	Evidence
	Changes to agricultural policies and rural subsidies would be needed to make this measure attractive to land owners, land managers and other stakeholders.

XI. Incentives supporting the financing of the NWRM

Type	Evidence

XII. References

Reference	Comments
Millán, M. M., et al. "Climatic feedbacks and desertification: the Mediterranean model." *Journal of Climate* 18.5 (2005): 684-701.	Describes theory associated with forest modification of hydrological cycle in Mediterranean environments
Ellison, D., N Futter, M., & Bishop, K. (2012). On the forest cover–water yield debate: from demand-to supply-side thinking. Global Change Biology, 18(3), 806-820.	Conceptual paper describing the overall role of forests in the hydrological cycle and the differences between largr scale and small scale effects.
Neary, Daniel G., George G. Ice, and C. Rhett Jackson. "Linkages between forest soils and water quality and quantity." *Forest Ecology and Management*258.10 (2009): 2269-2281.	Good general reference on forest water issues