European Commission

A guide to support the selection, design and implementation of

Natural Water Retention Measures in Europe

Capturing the multiple benefits of nature-based solutions

NWRM Natural Water Retention Measures

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Environment

A guide to support the selection, design and implementation of Natural Water Retention Measures in Europe

Capturing the multiple benefits of nature-based solutions

EUROPEAN COMMISSION
Directorate-General for Environment
Directorate C — Quality of Life, Water & Air
Unit C1 — Water

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WHAT YOU NEED TO KNOW BEFORE READING THIS GUIDE

Water managers, spatial and urban land use planning bodies, nature protection organisations, agriculture professionals and forest managers, public authorities and stakeholders show an **increasing interest in Natural Water Retention Measures (NWRM)**. Their interest lies with the multiple benefits NWRM can potentially deliver, and their capacity to contribute simultaneously to the achievement of the objectives of different European Union (EU) policies, including *inter alia*: the Water Framework Directive (WFD)[1], the Floods Directive (FD)[2], the EU Biodiversity Strategy[3], the EU Action on Water Scarcity and Drought[4], the EU Climate Change Adaptation Strategy[5] or the Marine Strategy Framework Directive (MSFD)[6].

To support the implementation of NWRM, the European Commission (EC) has launched a number of **initiatives on NWRM** over the last few years, in the context of the Common Implementation Strategy (CIS) of the WFD. In particular, these have included: (1) a **scoping study** aimed at identifying NWRM along with their expected costs and benefits[7] (2) an ***ex-ante* evaluation** of the effectiveness of NWRM to support the achievement of EU water policy objectives[8] ; (3) an **NWRM Pilot Project** that combined the establishment of a web-based NWRM knowledge base with support for the emergence of an NWRM 'community of practice'[9]; (4) the development of an EU **NWRM policy document** that advocates

1 DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy. *http://ec.europa.eu/environment/water/water-framework/index_en.html*

2 DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks. *http://ec.europa.eu/environment/water/flood_risk/key_docs.htm*

3 COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. Our life insurance, our natural capital: an EU Biodiversity Strategy to 2020. COM(2011) 244 final. *http://ec.europa.eu/environment/nature/biodiversity/*

4 COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL. Addressing the challenge of water scarcity and droughts in the European Union. COM(2007) 414 final *http://ec.europa.eu/environment/water/quantity/eu_action.htm*

5 COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. An EU Strategy on adaptation to climate change. COM (2013) 216. *http://ec.europa.eu/clima/policies/adaptation/what/documentation_en.htm*

6 DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).
http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm

7 Stella Consulting (2012). Costs, benefits and climate proofing of natural water retention measures (NWRM). Final report.

8 Joint Research Center. 2012. Evaluation of the effectiveness of Natural Water Retention Measures. Support to the EU Blueprint to Safeguard Europe's Waters. JRC Scientific and Policy Reports. *http://ec.europa.eu/environment/water/blueprint/pdf/EUR25551EN_JRC_Blueprint_NWRM.pdf*

9 *http://www.nwrm.eu*

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for better use of NWRM[10]. In addition, many initiatives are taking place in EU Member States (MS) to support the design and implementation of (sub-sets of) NWRM.

For more information on the EU initiatives on NWRM, please contact: ***Env-water@ec.europa.eu***

This guide, entitled ***A guide to support the selection, design and implementation of Natural Water Retention Measures in Europe- capturing the multiple benefits of nature-based solutions,*** has been developed as part of the NWRM project. It places the emphasis on the multiple-benefits NWRM can deliver and on the required policy coordination and coherence that is required to make best use of NWRM.

- It aims to **support the selection, design and implementation of NWRM** in Europe.
- It targets **managers, decision makers, experts and stakeholders** involved in the selection, design and implementation of NWRM as part of plans and programmes addressing water, floods, biodiversity, climate change adaptation, forestry, agriculture or urban issues. In addition, the guide can be of value to organisations financing projects in these policy domains.
- It helps **navigate** through the internet-based NWRM knowledge base (*http://www.nwrm.eu*), proposing logical steps to access the different types of information and experiences that have been assembled there.

The guide complements:

- The **EU NWRM policy document** that sets the overall policy umbrella and the relevance of implementing NWRM for achieving water and related policy objectives.
- Existing **guidance** on **planning processes** that consider NWRM as practical options for achieving individual policy objectives (e.g. guidance on river basin management planning, urban planning, the development of sustainable forest management plans, etc.).
- Existing **guidance** on the **practical design and implementation** of **NWRM-like measures** proposed for individual sectors (see a non-exhaustive list of guidance document in the following page).

10 European Commission. 2014. EU policy document on Natural Water Retention Measures. By the drafting team of the WFD CIS Working Group Programme of Measures (WG PoM). *https://circabc.europa.eu/sd/a/2457165b-3f12-4935-819a-c40324d22ad3/Policy%20Document%20on%20Natural%20Water%20Retention%20Measures_Final.pdf - https://circabc.europa.eu/sd/a/2457165b-3f12-4935-819a-c40324d22ad3/Policy%20Document%20on%20Natural%20Water%20Retention%20Measures_Final.pdf*

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Interested in the implementation and detailed design of specific NWRM?
There may already be guidance out there!

Do look for existing practical guidance and knowledge base developed in your own country on specific NWRM. Such guidance does not focus on NWRM per se, but on members of the NWRM family such as SuDS, soil conservation measures, runoff attenuation features and river restoration. See for example:

- General reference: UNEP, UNEP-DHI, Partnership – IUCN, TNC and the WRI. 2014. Green Infrastructure Guide for Water Management: Ecosystem-based management approaches for water-related infrastructure projects
- Rural SuDs: Environment Agency. 2012. Rural Sustainable Drainage Systems (RSuDS)
- Agriculture: Natural England. January 2013 Entry Level Stewardship Environmental Stewardship Handbook. Fourth Edition.
- Focused on the forest sector: Aurélien Bansept and Julien Fiquepron. 2014. Protéger et valoriser l'eau forestière. Guide pratique national, réalisé dans le cadre du programme ' EAU + FOR ' - 2014
- Focused on hydromorphology: Stanford, J. A., Ward, J. V., Liss, W. J., Frissell, C. A., Williams, R. N., Lichatowich, J. A., and Coutant, C. C. 1996. A General Protocol for Restoration of Regulated Rivers. Regulated Rivers-Research and Management, 12, 391-413
- Focused on river restoration: Onema, 2010, actualisation en 2012. La restauration des cours d'eau : recueil d'expérience sur l'hydromorphologie *(http://www.onema.fr/Hydromorphologie,510*, in English and in French)
- Focused on urban measures: Woods-Ballard, B., Kellagher, R., Martin, P., Jefferies, C., Bray, R and Shaffer, P 2007 The SuDS Manual. CIRIA report c697. *www.susdrain.org*

Visit the NWRM website to find other basic references.

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The guide focuses on what needs to be accounted for in any given (catchment/rural/urban) planning process to ensure that NWRM are duly considered. This guide **does not:**

- ☑ **Repeat the basics of water, soil, land and spatial planning and development**, or other existing sectoral planning. These are well addressed in existing guidance documents developed at the EU and country levels for different sectors and (water) management issues. This guide focuses on addressing **specificities and differences that might arise from considering NWRM** in terms of: setting objectives, identifying management issues, assessing potential impacts/effectiveness or 'getting organised' for effective and successful implementation.

- ☑ **Set compulsory steps** you have to add to existing planning processes. It is **a source of inspiration** that can help you give NWRM their due role adapted to your own context and territory, even if the final answer of your assessments is: 'I cannot implement NWRM'. In many cases, your own experience will bring additional thoughts and will complement the elements presented in this guide.

- ☑ **Propose standards** for the design of NWRM. Still, some relevant information that will help with the design of NWRM under site-specific conditions is provided in the NWRM identity cards presented in the NWRM toolbox integrated in the guide.

- ☑ **Duplicate the technical content** of the synthesis documents addressing assessment and policy issues developed under the EU NWRM Pilot Project (see the list of synthesis documents presented below) . You will find these Synthesis Documents (SD) under *www.nwrm.eu/synthesis-documents/*.

The synthesis documents developed by the EU NWRM Pilot project

The EU NWRM Pilot Project has developed 12 synthesis documents (SD) addressing the following thematic areas:

SD n° 0: Introducing NWRM

SD n° 1: Biophysical impacts and effectiveness of NWRM

SD n° 2: How effective are NWRM in contributing to the achievement of policy objectives?

SD n° 3: Assessment methods for effectiveness of NWRM

SD n° 4: What are the benefits of NWRM?

SD n°5: What are the costs of NWRM?

SD n° 6: What is the cost-effectiveness of NWRM?

SD n° 7: Economic assessment methods for the costs and benefits of NWRM

SD n° 8: 'Windows of opportunities' for NWRM

SD n° 9: Barriers and success factors for NWRM

SD n° 10: Policy coordination linked to NWRM – How do they integrate with different European Directives?

SD n° 11: How can NWRM be financed?

FINDING YOUR WAY THROUGH THE GUIDE

HOW TO NAVIGATE THROUGH THE GUIDE

The guide combines general text and practical illustrations that originate from the wide range of experiences that have been analysed as part of the EU-funded NWRM Pilot Project. When you read the guide, three icons will help you understand the type of information provided in boxes.

represents an **illustration** describing an NWRM implemented, the results of assessments or a planning process put in place to support the implementation of NWRM.

suggests **further reading** for those wishing to investigate a specific policy issue, an illustration or an assessment method.

gives **warning** to avoid drawing too simplistic conclusions from the elements presented. Indeed, real life remains more complex than what is presented in the guide.

1 What makes a measure a Natural Water Retention Measure?

Natural Water Retention Measures or NWRM are measures with the primary function of enhancing and/or restoring the retention capacity of natural and man-made soil and aquatic ecosystems. As a result, they deliver a range of services and multiple benefits to people while contributing to the achievement of the objectives of different environmental strategies and policies.

As defined in the EU policy document on NWRM (see Box 1[11]), NWRM

- **Retain water** (runoff or river flows) beyond the existing capacity of systems, releasing it at a controlled rate, or infiltrating it to groundwater[12];
- Use the retention capacity of soils and of aquatic ecosystems to **provide other environmental and well-being improvements**, such as water quality, biodiversity, amenity value or resilience and adaptation to climate change impacts;
- Are usually applied at relatively **'small scale',** in comparison to the size of the water catchment or territory in which they are implemented;
- Emulate a **natural process**, although are not always 'natural' features themselves (as clearly illustrated by green roofs).

The definition of NWRM appeals both to a single purpose (safeguarding, enhancing or restoring the water storage potential) and also to a particular set of means (using natural processes). The actual distinctive character of NWRM has to do with the latter.

Box 1

The definition of NWRM as provided in the EU policy document

Natural Water Retention Measures are ***multi-functional measures*** that aim to protect water resources and address water-related challenges by ***restoring or maintaining ecosystems*** as well as ***natural features and characteristics*** of water bodies using ***natural means and processes***.

The main focus of applying NWRM is to ***enhance the retention capacity of aquifers, soil, and aquatic and water dependent ecosystems*** with a view to improve their status. The application of NWRM supports ***green infrastructure***, improves the ***quantitative status of water bodies*** as such, and reduces the ***vulnerability to floods and droughts***. It positively affects the ***chemical and ecological status of water bodies*** by restoring natural functioning of ecosystems and the services they provide. The restored ecosystems contribute both to ***climate change adaptation and mitigation***.

11 European Commission. 2014. EU policy document on Natural Water Retention Measures. By the drafting team of the WFD CIS Working Group Programme of Measures (WG PoM)

12 Note that not every measure that increases the water stored in water bodies is a NWRM. Alternatives such as water saving options, water efficiency measures, wastewater treatment, demand management and others that might result in an improvement of water bodies and of their water retention potential may not be considered as NWRM.

The members of **the NWRM family** are very diverse in their types and in the land use they can be applied to. You will find many examples of NWRM in the accompanying NWRM toolbox that can:

- **Modify ecosystems directly or indirectly** (via changes in soil and water management practices);
- Be **sector-specific** (agriculture, for example) or **applicable for different sectors and (rural and urban) environments**. Overall, NWRM are in theory relevant to any land use and sector, if applied appropriately.

NWRM are not new measures, as some have long been implemented in different countries and sectors. You have probably already heard of, or even used NWRM under other names and specialists' jargon – have a look at some examples in Box 2! What is new, however, is the recognition of their **multiple benefits** giving opportunities for their application in policy areas other than the one(s) under which they have been developed and are traditionally implemented.

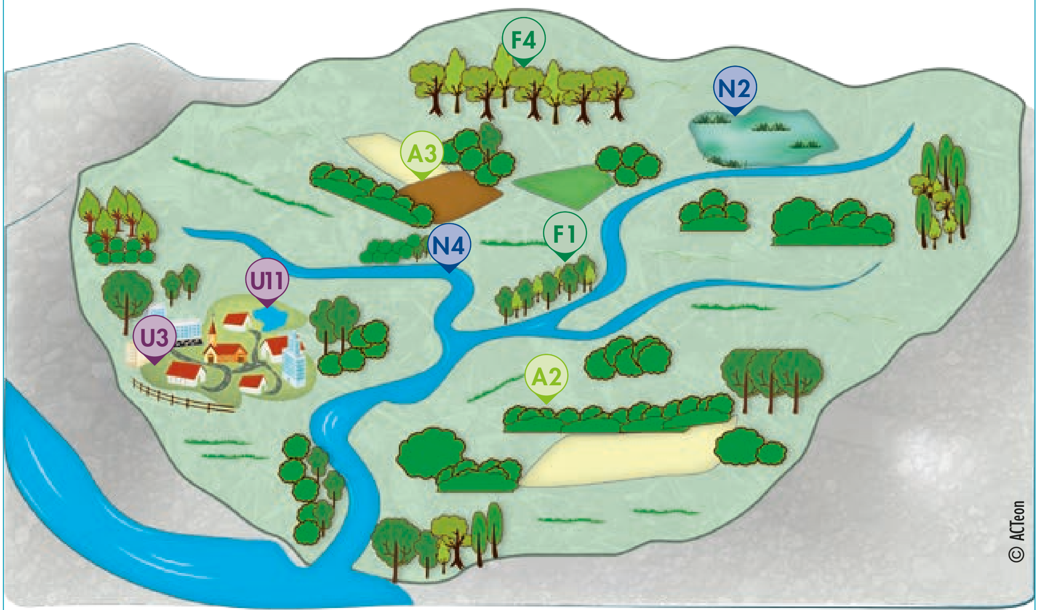
As you will realise when reading this guide and exploring different experiences of NWRM, individual NWRM are rarely implemented in isolation: they are primarily **implemented in combination with other NWRM and often with grey infrastructures.** The challenge is to find the right combination of measures that responds to the characteristics and management issues of your catchment or planning process.

Box 2

The many aliases of members of the NWRM family

Many NWRM measures are not new, and are already being implemented – including maybe by you. They might sometimes be new to water specialists as newcomers to a domain where inspiration came first from pioneers of urban and rural planning, nature conservation and climate change adaptation. You might have heard of terms such as: green infrastructures; ecosystem or nature- based approaches; soil-based practices; soil conservation practices; giving 'room to the river' or 'making space for water'; wetland restoration; Sustainable or Natural Flood Management; Sustainable Drainage Systems (SuDS); bioengineering practices; water harvesting; Runoff Attenuation Features (RAFs) ... and probably many more. These terms are not synonymous but they refer to some members and features of the wider NWRM family.

Schematic catchment with 8 NWRM covering a range of sectors and types of measures



A2	Buffer strips and hedges	**F1**	Forest riparian buffers
A3	Crop rotation	**F4**	Targeted planting for catching precipitation
U3	Permeable surfaces	**N2**	Wetland restoration and management
U11	Retention ponds	**N4**	Re-meandering

2

Reasons for selecting and implementing NWRM

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You will have your own reasons for choosing, designing and implementing NWRM, depending on your role and responsibilities and on the characteristics of your surrounding environment. Still, these are five reasons that are central to the selection and implementation of NWRM for addressing a diversity of management and policy challenges.

Giving more space to nature

Restoring or establishing natural functions, processes and ecosystems may be your **primary guiding principle** for policy development and implementation. This principle is the essential element defining NWRM, which are features that rely on nature to act in the long term and to enhance the resilience of our landscape. By allowing nature to perform its task, NWRM can also have a competitive advantage in the long run over grey infrastructure, which require a continuous flow of inputs over time to support their function. Better integration of measures in the landscape can also lead to better acceptance of measures by the local population

Delivering multiple benefits

NWRM can make different people and sectors better off at the same time, and thus lead to **shared benefits, improve people's welfare and their living environment, and open opportunities in different areas of the economy**. For example, NWRM can: reduce flood risks while improving water quality; sequester carbon while enhancing biodiversity; regulate water storage while improving water delivery; reduce the need for expensive infrastructure to manage rainwater while improving the landscape; and make cities greener while delivering amenities to its inhabitants.

Contributing to the simultaneous achievement of different policy objectives

As they deliver **multiple benefits**, NWRM can contribute to the achievement of **different EU policy objectives**. They can: enhance the status of aquatic ecosystems in line with the objectives and requirements of the EU Water Framework Directive; reduce flood risk of vulnerable territories and populations in coherence with the objectives of the Floods Directive; enhance biodiversity and contribute to the objectives of the EU Biodiversity Strategy; enhance the adaptive capacity of systems and contribute to climate change adaptation; address water scarcity and drought; contribute to sustainable urban planning; and improve the quality of the environment in which we live[13]. Under some conditions, the simultaneous contributions made by NWRM to different policy objectives can steer policy coordination, synergies and coherence. Several EU policies already make explicit references to NWRM (see Table 1) as a means of achieving their individual objectives.

13 Other policies that can benefit from the implentation include: the Urban Waste Water Treatment Directive; the Bathing Water Directive; the Groundwater Directive; sustainable forest management; land use as a resource.

Providing cost-effective solutions

NWRM can be **cost-effective solutions** when looking at their establishment, operation and maintenance costs as compared to traditional engineering solutions and grey infrastructure. In some cases, their financial costs and effectiveness towards achieving a single objective alone may already make them more cost-effective, in particular in a long-term perspective. In other cases, you might need to factor in their contributions to meeting several policy objectives in order to realise their cost-effectiveness. The ability to simultaneously deliver multiple benefits is one of the main reasons that NWRM are economically appealing overall. In the longer term, the higher resilience of NWRM to natural hazards such as flood or seismic risks (compared to grey infrastructure) is also an advantage to be considered.

There are many opportunities for financing NWRM

Because of their potential to deliver multiple benefits and to contribute to different policy objectives, you might find many beneficiaries potentially interested in supporting the NWRM you are considering. NWRM can be financially **supported by a wide range of public subsidies** (EU and national), **voluntary agreements or compensation funds**. These can act as facilitators to their implementation, in particular when some of the benefits are not only realised by those in charge of implementing and/or financing the measure. For example, financial incentives can support soil conservation practices that are beneficial for those affected by diffuse pollution, erosion and flood risk, even in cases where they are perceived as detrimental to agricultural yields and rural income.

More information on financing mechanisms for supporting the implementation of NWRM is presented under the section 'Find the right incentives'. Financing is also addressed in the synthesis document SD n°11: How can NWRM be financed? *(www.nwrm.eu/synthesis-documents/)*

However: Remain critical, when you decide to choose and implement NWRM, as they are not a cure-all!

As you will learn in the following chapters of this guide, delivering multiple benefits and contributing simultaneously to different policy objectives requires careful selection and design of NWRM. In some cases, the main role of NWRM will be to complement large-scale grey infrastructure. This will help minimise the size (and costs) of grey infrastructure, and can also minimise, or compensate for, potential negative impacts of grey infrastructure. In general, NWRM have to be tailored to your specific conditions as it should not be assumed that they will automatically deliver multiple benefits (as indicated in the NWRM identity cards presented in the NWRM toolbox).

Nevertheless, **do give NWRM their chance** to contribute to the cost-effective achievement of multiple policy objectives !

More information on the potential impacts of different NWRM is summarized in *www.nwrm.eu/benefit-tables* and is addressed in the synthesis documents ***SD n°1: (Biophysical impacts and effectiveness of NWRM)*** and ***SD n°2: (How effective are NWRM in contributing to the achievement of policy objectives?)*** *(www.nwrm.eu/synthesis-documents/)*

Box 3

Myth and reality with NWRM

There are myths about what NWRM can or cannot deliver. Advocates of NWRM will stress that they are more cost-effective solutions than grey infrastructure. However, cost-effectiveness is not a permanent feature of NWRM as it is context, measure and policy specific. And NWRM are not always cheaper than grey infrastructure. When land prices are high, NWRM can be, or at least appear to be, expensive options! Furthermore, NWRM cannot address all policy challenges: for example, they are likely to have only a marginal role in addressing extreme flood events in large densely populated catchments with lots of existing development on the floodplain.

However, myths exist also about what grey infrastructure and traditional approaches to water management can deliver! People favouring grey infrastructure will stress their effectiveness in contributing to set policy objectives. However, there is a risk that their negative direct and indirect environmental impacts are hidden , and that the opportunities lost due to the multiple benefits of NWRM not being delivered are not considered. In addition, grey infrastructure implementation costs can be significantly higher than costs estimated in ex-ante appraisals, with potentially significant impacts on public budgets and reduced cost-effectiveness when compared to the costs anticipated at the design stage.

Table 1 - Illustrating how selected EU policy initiatives recognise the potential role of NWRM in contributing to the achievement of their objectives

EU policy	Overall policy objective(s)	Explicit and implicit links to NWRM or similar	Source
Water Framework Directive	To achieve good status for all waters in Europe	Annex VI of the WFD provides a list of measures that can be considered in the programmes of measures. These include *inter alia* the recreation and restoration of wetland areas.	DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy
Floods Directive	To reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity	Article 7 of the Floods Directive specifies that Flood risk management plans may also include the promotion of sustainable land use practices, improvement of water retention as well as the controlled flooding of certain areas in the case of a flood event.	DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks
Climate Change Adaptation Strategy	To make Europe more climate-resilient and enhance the preparedness and capacity of all governance levels to respond to the impacts of climate change	The EU Adaptation Strategy calls for a strong emphasis on incorporating win-win, low-cost and no-regret adaptation options. These include sustainable water management and early warning systems. Ecosystem-based approaches are usually cost-effective under different scenarios. They are easily accessible and provide multiple benefits, such as reduced flood risk, less soil erosion, improved water and air quality and reduced heat island effect	COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS An EU Strategy on adaptation to climate change
Green infrastructure	To promote the development of Green Infrastructure (GI) by creating an enabling framework to encourage and facilitate GI projects within existing legal, policy and financial instruments to exploit their benefits for sustainable development.	Green infrastructure solutions that boost disaster resilience are also an integral part of EU policy on disaster risk management. […] The impacts of such events on human society and the environment can often be reduced using GI solutions such as functional flood plains, riparian woodland, protection forests in mountainous areas, barrier beaches and coastal wetlands that can be made in combination with infrastructure for disaster reduction, such as river protection works.	COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Green Infrastructure (GI) — Enhancing Europe's Natural Capital

EU policy	Overall policy objective(s)	Explicit and implicit links to NWRM or similar	Source
EU Water Blueprint	To ensure that a sufficient quantity of good quality water is available for people's needs, the economy and the environment throughout the EU.	The EU Water Blueprint promotes alternative land use practices for contributing to the achievement of WFD good ecological status, making specific references to NWRM. In particular, it states the following: *Among the measures that can greatly contribute to limiting the negative effects of floods and droughts is green infrastructure, particularly NWRM. These include restoring floodplains and wetlands, which can hold water in periods of abundant — or excessive — precipitation for use in periods of scarcity. Green infrastructure can help ensure the provision of ecosystem services in line with the EU Biodiversity Strategy. Reducing soil sealing is another measure that can diminish flood risks. These measures should be included in both RBMPs and FRMPs and, as mentioned, should become a priority for financing under the CAP, Cohesion and Structural Funds.*	COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. A Blueprint to Safeguard Europe's Water Resources
Common Agricultural Policy (CAP)	Enhancement of environmental performance through a mandatory 'greening' component of direct payments which will support agricultural practices beneficial for the climate and the environment.	CAP 'greening' measures including crop diversification, maintaining permanent grassland and ecological focus areas will account for 30% of single farm payments.	COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future
Rural Development Regulation (RDR)	Restoring, preserving and enhancing ecosystems related to agriculture and forestry,	Water retention is an implicit objective in the EU's priorities for rural development. Article 5 of Regulation 1305/2013 refers to restoring, preserving and enhancing ecosystems related to agriculture and forestry, with a focus on the following areas: a) restoring, preserving and enhancing biodiversity, including in Natura 2000 areas, and in areas facing natural or other specific constraints, and high nature value farming, as well as the state of European landscapes; b) improving water management, including fertiliser and pesticide management; c) preventing soil erosion and improving soil management.	REGULATION (EU) No 1305/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005

3

Enhancing policy coordination to make the most out of NWRM in your planning process

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Making the most of NWRM is not just about looking for and selecting a new type of measure. It is a change in the philosophy of management and planning that takes account of the following key principles:

Principle 1 - Giving **priority to nature-based solutions.**

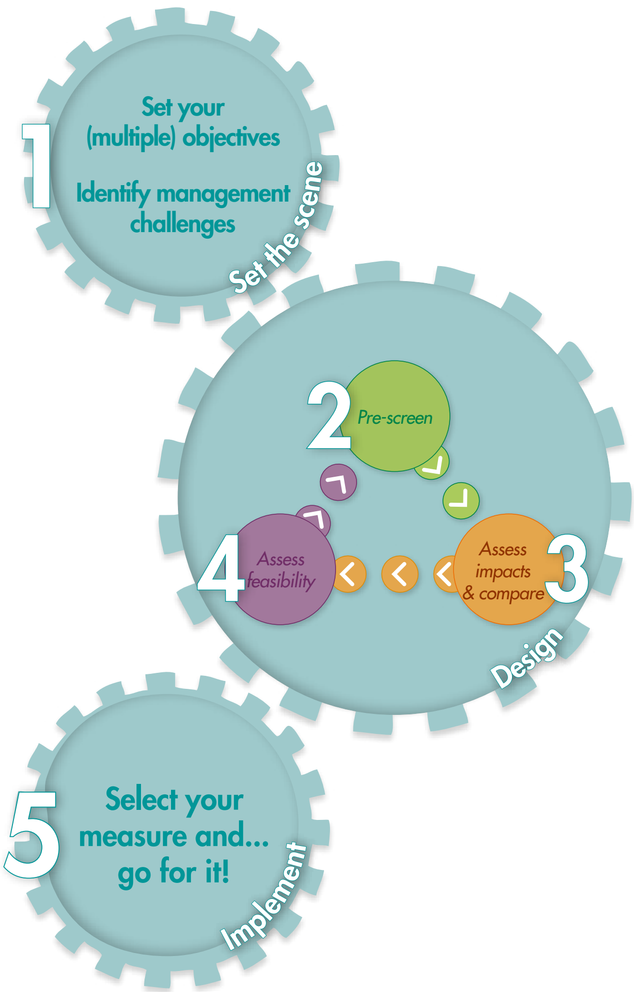
Principle 2 - Joint accounting for the potential **multiple benefits** of measures.

Principle 3 - Capturing all opportunities favouring **policy integration** and simultaneous contributions to the objectives of different policies.

Principle 4 - Thinking of a **bundle of measures** from the outset, which can include both NWRM and grey infrastructure measures.

It requires careful adaptation in the different steps of any planning process being carried out at a given geographical scale (see figure below) so that the opportunities offered by NWRM are adequately considered and taken advantage of while accounting for their limitations.

Keys steps in the planning process



Step 1 - Set the scene and identify key management challenges

If you are going to be serious about NWRM, setting the scene requires that:

- The **multiple 'policy objectives'** relevant to the territory considered in the planning process are clearly spelled out. While the objectives of many planning processes are often 'one-dimensional' (e.g. improving water status as required under the WFD or addressing flood risk as required under the FD), the challenge is to make all policy objectives explicit, including those beyond water policy. Relevant information includes: the operational objectives of each policy; the areas and/or sectors to which these apply; the time horizon of policy objectives; possible exemptions in policy objectives, and how these can apply/be justified. In some cases, priorities between objectives might exist and need to be spelled out.

- An **integrated diagnosis of the current and forthcoming pressures and challenges** for the relevant territory is developed. It requires that **key biophysical, social and economic features of the territory relevant to the different policies** are identified. It also requires that problems relevant to different policies, along with sectors that are the origin of those problems and the trends in sector developments, are clearly spelled out[14]. This helps to identify different interconnected challenges that will need to be addressed by future actions/measures. It also helps to identify the possible incoherence between actions implemented under different policy domains.

Illustration 1

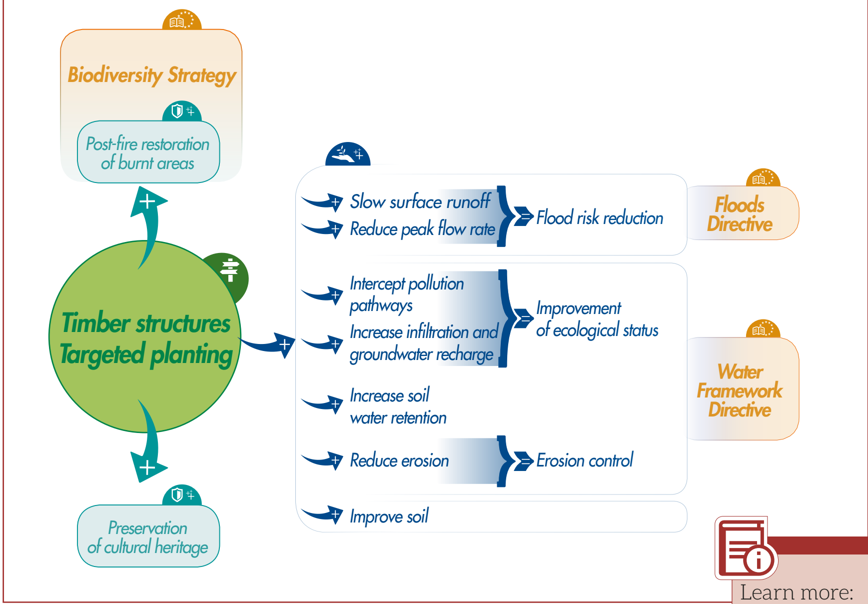
The multiple policy objectives of water retention management in the broader area of Ancient Olympia, Elia, Greece

The measures implemented in the water retention management project of the broader area of Ancient Olympia include the temporary installation of structures utilising locally available timber, together with targeted planting to reduce post-fire erosion, increase water retention and stabilise the hill slopes. The measures are based on changing the morphology of the area as well as the soil composition, for example by (shortening the length of the slopes, increasing surface roughness and soil infiltration, reducing peak flow, attenuating surface runoff and sediment. The primary targets when designing this application were soil erosion management, flood control and flood risk mitigation in the context of restoring a fire-affected area of extreme

14 It requires, for example, the following questions to be addressed: what is the current and future water status, flood risk, biodiversity state, vulnerability to climate change, landscape state, living conditions of inhabitants? Which are the main sectors exerting pressures that mean that the current and predicted future situations are different to what the different policies and strategies are aiming to achieve?

cultural interest (Ancient Olympia site). Multiple policy objectives have been considered:

- Preservation of ***cultural heritage*** (rehabilitation of the archaeological site of Ancient Olympia)
- Post-fire ***restoration of burnt areas*** (environmental objectives, improved vegetation quality, protection of forest ecosystems)
- ***Flood risk reduction*** (the timber structures function as a water retainer that slows down the water velocity and the surface runoff resulting in the decrease of floods frequency and intensity)
- ***Erosion control*** (sediment attenuation)
- ***Soil quality improvement*** (afforestation of the area succeeds in eliminating the hydrophobic layer that was created in the soil after the fires and thus increases soil storage capacity and quality)
- ***WFD objectives*** - ecological status of the water bodies (after the wildfires the water quality was poor. Vegetation helped to improve surface water quality and groundwater quantity and quality through increased infiltration)



Learn more: *http://www.nwrm.eu/*, case studies, Water retention management in the broader area of Ancient Olympia, Elia, Greece (case study 36)

Illustration 2

Dyke relocation on the river Elbe near Lenzen, Germany: a project addressing multiple benefits of NWRM

In Germany, a dyke along the River Elbe was relocated to reconnect 420 ha floodplain retention area with diverse habitats. The idea for the scheme initiated with a local farmer, who realized the potential to link local ecologically-friendly economic activities with regional development in the Elbe floodplain. Supported by the local biosphere reserve administration discussions with scientists, administrations and regional and national agencies were launched, and the idea was later implemented within the reconstruction of the flood protection dyke near Lenzen. Thus the dual aims of ecological improvements and flood protection were integrated in a federal and state funded nature conservation project. This meant that the scheme development had the dual aims of ecological improvements and flood protection at the forefront of planning. ***Considerable research*** was carried out prior to implementation, and the scheme was investigated from many different angles including recreation of near-natural ***habitats*** (particularly the reintroduction of alluvial forest), ***navigation*** (the Elbe is an important waterway), optimising the fluvial ***flood benefit***, reducing groundwater ***flood risk***. Consideration of the local as well as upstream and downstream impacts, across ecological and human needs, was key to the successful implementation of this project.

Learn more:
http://www.nwrm.eu/, case studies, Dyke relocation on the river Elbe near Lenzen (case study 22)

Illustration 3

Additional objectives addressed by Belford 'rural runoff attenuation' scheme, UK

The measures applied at Belford involved a network of small measures to capture and delay runoff from the rural catchment, such as detention ponds and overland flow features. The measures were implemented in order to reduce the risk of flooding in the village of Belford downstream by providing flood storage and attenuation. The target policy challenges considered were mainly linked to the ***Floods Directive***, to take adequate and coordinated measures to reduce flood risk. However, additional objectives were considered including improving the ***physical and chemical status of waters*** due to diffuse agricultural pollution and the ***protection of habitats for endangered and migratory bird species***.

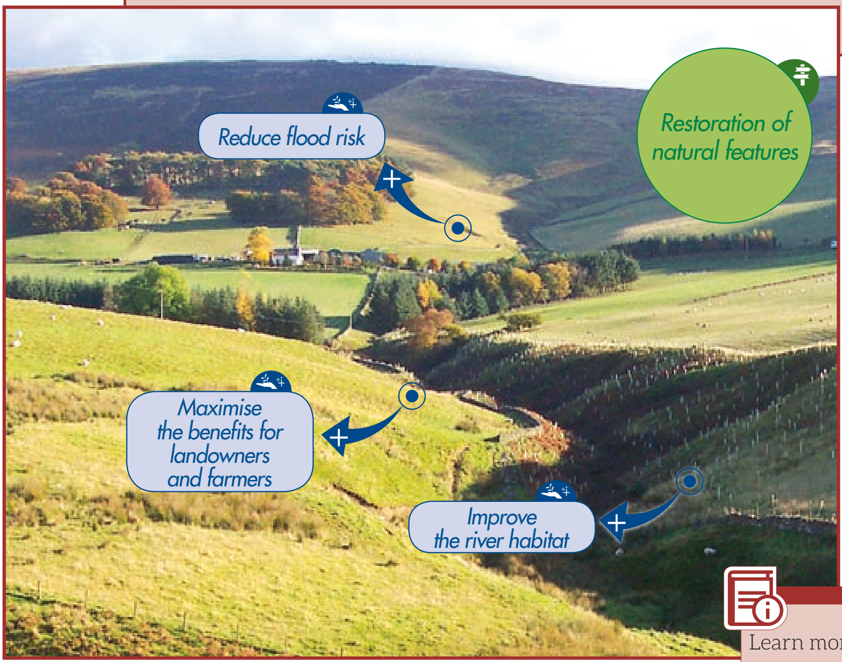
Learn more:
http://www.nwrm.eu/,
case studies, Rural runoff attenuation in the Belford catchment, UK(case study 41)

Illustration 4

A catchment context assessment to address several policy challenges: the case of the Eddleston Water, Scotland:

The Eddleston Water is a small tributary of the River Tweed, flowing 20 km before reaching the main river in the town of Peebles. Over time, the course of the river has been extensively altered and long sections were straightened in the early 19th century. Other changes in land management, both in the ***river valley and on the surrounding hill slopes***, have also altered how the land drains. Together, these changes have resulted in an ***increased risk of flooding*** to Eddleston and Peebles, as rainfall and flood waters travel ever more quickly and directly from the hill slopes and along the river channels towards these communities. At the same time, these changes have also damaged the ***river environment*** itself, leading to the loss of over a quarter of the river's original length, and ***habitat loss*** for plants and animals, including salmon and trout, as well as rare and protected species such as otters and lampreys. The project to restore the Eddleston Water addresses three main challenges for the catchment:

- Investigate the possibility of reducing the risk of flooding to the communities of Eddleston and Peebles by restoring some of the original natural features of the catchment;
- Improve the river habitat for wildlife and fisheries;
- Work with landowners and communities in the Eddleston valley to maximise the benefits they would gain from such work, while maintaining the profitability of local farms.



Learn more and source:
http://tweedforum.org/publications/Leaflet_2013.pdf

Step 2 – Pre-screen NWRM

There are many measures that can be included under the heading of NWRM… but not all of them will be relevant for your own catchment or useful for addressing the different challenges you have identified via your integrated diagnosis. There are at least two reasons for this:

- Some NWRM **are not relevant to your context** because of a wide range of issues: technical feasibility; limited (expected) benefits and effectiveness site-specific biophysical and socio-economic conditions, or absence of relevant pre-conditions for implementing the measures.

- While the delivery of multiple benefits is promoted as one of the key advantages of NWRM, not all **NWRM deliver the same range of benefits**. This is illustrated in the figure below, which presents the potential benefits of a sample of NWRM (see *www.nwrm.eu/benefit-tables*), and presented in the NWRM fact sheets (*www.nwrm.eu/measures-catalogue/*) and in the NWRM identity cards presented in the attached NWRM Toolbox. Based on the relative importance of the main problems and challenges you are facing, and on the different policy and strategic objectives you have set, you need to pre-select NWRM that have the potential to address your problems.

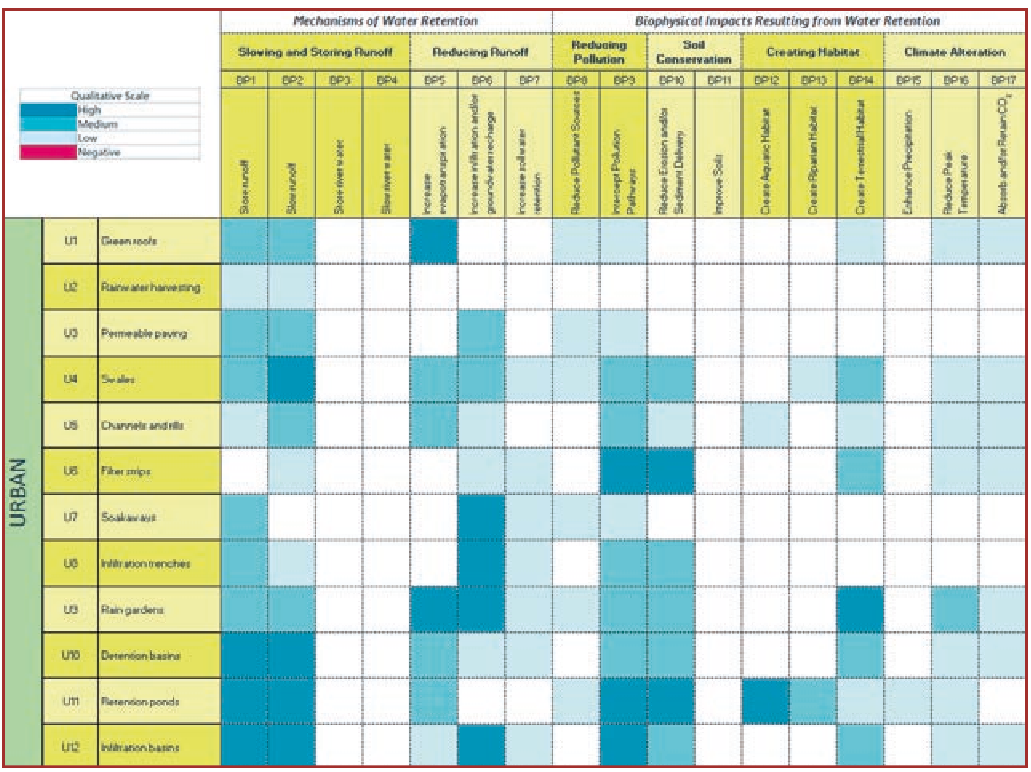


Illustration 5

Green roofs: a design dependent on specific parameters

Urban green roofs can provide benefits for biodiversity, water management as well as social services (recreation, gardening, etc.). They require specific technical conditions to be set up. Green roofs have been used across Europe in a range of climatic condition, but nevertheless those climatic conditions needs to be considered thoroughly to ensure that the design is appropriate. For example, in the Baltic Region, high snowfall may appear to be a restriction, as the green roof will be covered by snow for a significant proportion of the year. This may limit the effectiveness of vegetation in spring and early summer and requires specific consideration in design. In the Mediterranean Region, potential restrictions can appear related to high temperatures and dry weather may appear to be a restriction, providing challenges for vegetation maintenance. However these can potentially be overcome through irrigation (preferably using water stored from runoff from the green roof) and careful choice of vegetation.


© Wikipedia - Simon Garbutt

Learn more:
http://www.nwrm.eu/,
Catalogue of NWRM,
Urban, Green roofs (U1)

Step 3 – Assess potential impacts, effectiveness and... compare

Assessing effectiveness, cost-effectiveness and impacts requires that you investigate the expected contributions of proposed measures (whether they are NWRM and/or grey infrastructure) to solving your main problems.

Information about how potential measures might affect water retention in the first place is crucial, and how this in turn might affect the (ecosystem) services delivered and contribute to the achievement of policy objectives you have identified as being relevant for your territory. You need to assess all the costs, i.e. financial (investment, operation, maintenance and renewal) costs, and also indirect economic costs and whenever relevant environmental costs.

You will then need to assess the **potential effectiveness of proposed measures** at contributing to addressing the pressures and achieving the different policy objectives you identified under Step 1. Because of the characteristics of NWRM, their effectiveness cannot be taken for granted. They will be more effective in some situations than others, and may not be the 'best' solution everywhere. [15] [16]

The effectiveness of NWRM and their influence on ecosystem services depends on:

- **Local conditions and the relative location of the measures in the catchment.** The impact and effectiveness of measures such as buffer strips, riparian afforestation or groundwater recharge differ depending on location.

Illustration 6

Inverstigating the effectiveness of NWRM under different contexts

JRC (2013)[15] summarises the impact of agricultural measures and notes that 5m buffer strips can remove between 15 to 20% of phosphorus with this range rising to 42-96% in hilly areas. These results highlight both the difference between contexts and the potential for wide ranges in impacts with similar contexts. The design of the measure may also need to reflect location: Natural England (2011)[16] suggest that a 6m buffer strip may be sufficient to slow surface flow on slopes of less than 7° (medium soils) or 11° (sandy and light soils), whereas a 12m buffer strip might be required on steeper slopes .

- The spatial **area covered** by the measure (e.g. how many hectares, kilometers of river or number of green roofs).

15 JRC (2013) River Basin Network on Water Framework Directive and Agriculture: practical experiences and knowledge exchange in support of the WFD implementation, EUR 25978 – Joint Research Centre – Institute for Environment and Sustainability

16 Natural England (2011) Protecting water from agricultural run-off: buffer strips, Natural England Technical Information Note TIN100 *http://publications.naturalengland.org.uk/file/102003*

- The **combination of measures** considered, in particular the combination of small scale, decentralized and flexible NWRM, or of NWRM with grey infrastructure measures in addressing catchment level challenges. Modelling may be required to predict the effectiveness of a combination of measures. For example, the 'Slowing the Flow at Pickering' project in England[17] was able to use hydrological modelling of the catchment to identify the impacts of a combination of NWRM including floodplain storage, woody debris dams, riparian and floodplain woodland.

- The **scale of the system** considered for undertaking assessments of (direct and indirect) impacts and benefits.

Combining information about both costs and effectiveness will then help you to rank measures based on **cost-effectiveness** ratios. Traditional Cost-Effectiveness Analyses (CEA) deal with a single (financial) cost and a single effect (contributions to water status in line with the objectives of the EU WFD, for example). In contrast, NWRM have a complex cost structure (for example including financial costs, non-financial costs, foregone benefits, avoided costs, co-benefits, indirect benefits) and provide multiple benefits (energy savings, reductions in Greenhouse Gas Emissions, water quantity, water quality, biodiversity, etc.), contributing to the achievement of several effects and policy objectives at the same time.

There are several options for analysing effectiveness that take into account the possibility of providing multiple benefits.

Option 1 - If all policy objectives identified for your catchment or territory are accounted for simultaneously, you can compare different combinations of measures by carrying out a Cost-Benefit Assessment (CBA) that accounts for all (positive and negative) impacts and ecosystem services delivered. You can also perform a Multi-Criteria Analysis (MCA) that will consider how the proposed combinations of measures contribute to the achievement of the different policy objectives identified, as well as to wider societal objectives. Use of Cost-Effectiveness Analysis to identify the cheapest way to achieve multiple policy objectives simultaneously is an approach that can be applied if a single, composite, effectiveness score or index can be estimated. The choice of approach (CBA, MCA or CEA) may be driven by the availability of cost and benefit data..

More information on the costs, benefits and cost-effectiveness of NWRM is available in SD n°4 (What are the benefits of NWRM?), SD n°5 (What are the costs of NWRM?) and SD n°6 (What is the cost-effectiveness of NWRM?) Information on the economic assessment methods that can be applied for assessing the costs and the benefits of NWRM is also available in SD N°7 (Economic assessment methods for the costs and benefits of NWRM) (*www.nwrm.eu/synthesis-documents/*)

17 *http://www.forestry.gov.uk/fr/INFD-7YML5R*

If your planning process gives priority to a single policy objective (e.g. the achievement of good water status for all waters as specified by the EU WFD, or the reduction in flood risk in line with the objectives of the FD), you might choose between one of the following options:

Option 2 - If you intend to perform a cost-effectiveness analysis for selecting the 'best' measures or scenarios, you need to ensure that the costs accounted for in your cost-effectiveness analysis are economic costs, i.e.: financial (investment, operation and maintenance) costs of the measures plus indirect costs (e.g. linked to foregone farm incomes) minus costs avoided as a result of the contribution to other policy objectives (e.g. reduced electricity costs due to better temperature control of green roofs, or avoided fertilizers costs due to better soil management);

Option 3 - If you intend to compare different combinations of measures within a CBA framework, you will look at all (positive and negative) impacts and ecosystem services delivered by each scenario (similarly to Option 1, except focusing on a single policy objective rather than multiple). You can then also carry out a MCA, to account for the contributions of measures to other (non-priority) policy objectives and wider societal objectives.

Box 4

Investigating the multiple benefits of combinations of measures

The extent of 'multiple benefits' can be wide-ranging: try not to forget any! You will need to include benefits that are ancillary to 'water policy' (e.g. carbon sequestration or contribution to biodiversity) but can nevertheless be essential in selecting NWRM. You should consider both private (benefits arising to individual(s), including costs avoided as a result of implementation) and social benefits. The table below gives you an indication of some potential benefits (the list is not comprehensive, and you should always consider what else might be relevant to your situation).

When assessing benefits, do check their distribution, as they might be specific to a social group. And you may need to consider a scale wider than your own catchment or territory.

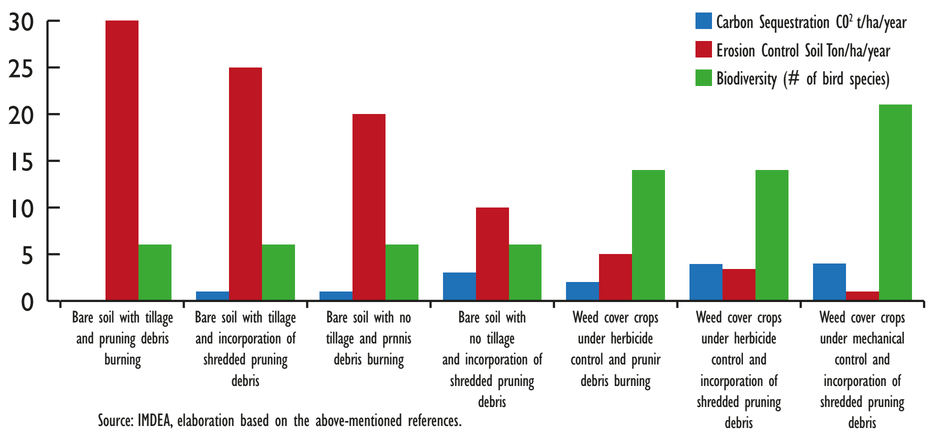
Assessing benefits helps to identify the best measures and improve their design based on trade-offs and synergies among the benefits pursued. It is also a good basis for identifying opportunities for cooperation (synergies between policy domains) and for the establishment of incentives to engage people into the implementation of NWRM.

Social (external) benefits from :	Private (financial/internal) benefits from:
Improvements to air quality	Increase lifespan of the roof covering
Improvements to water quality	Reduced energy costs
Greenhouse gas abatement	Fire protection
Biodiversity conservation	Enhanced noise muffling
Urban temperature control	Improved aesthetic quality
Stormwater retention	

Illustration 7

Effectiveness of soil conservation practices for achieving various policy goals

Soil conservation practices in southern Spain have been studied for their contributions to fixing carbon (Nieto et al., 2010; Smith et al., 2008; Sofo et al., 2005; IPCC, 2003), retaining sediments (Gómez et al., 2009 and Francia-Martínez et al., 2006) and effectiveness at increasing bird diversity (Duarte et al., 2010; De la Concha et al., 2007; Muñoz-Cobo et al., 2003). All this information has been compiled and compared by Rodríguez-Entrena et al., 2014; (see the figure below). However, the existing literature is uninformative about the effect of the measures over water balances.



Source: IMDEA, elaboration based on the above-mentioned references.

Illustration 8

Green Roofs in Vienna, Austria: a cost-effective measure

Since 2003, the City of Vienna has supported the installation of green roofs on flat rooftops in the city at a rate of 8-25 €/m² (2,200€ maximum). A study on the economic efficiency of green roofs has shown that the additional costs of installation compared to conventional roofs are offset by energy savings and the longer lifespan of the roof. For example, Porsche and Köhler (2003) and Hermy et al. (2005) assume that the life span of the roof covering doubles when a green roof is constructed. Mann (2002) and Saiz et al. (2006) estimate the life span of green roofs to be between 30 and 50 years.

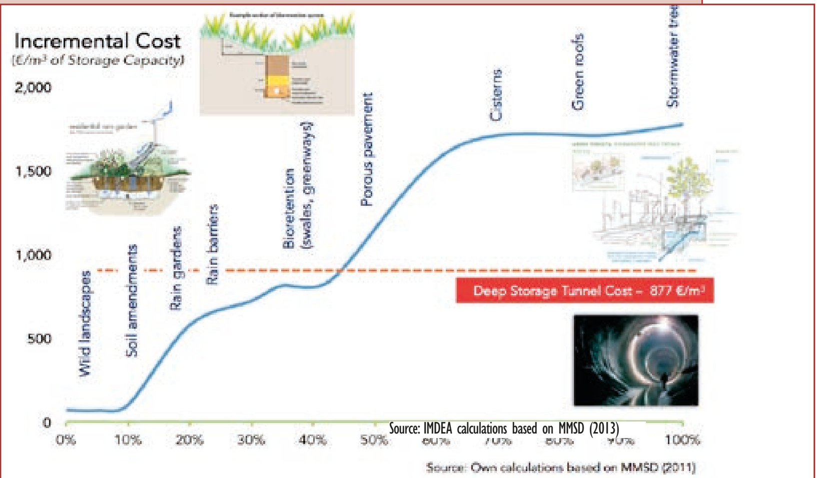
Learn more:
http://www.nwrm.eu/, case studies, Green Roofs in Vienna, Austria (case study 37)

Illustration 9

NWRM: even more attractive solutions than they appear at first sight

MMSD (2011) considered the financial cost-effectiveness of a deep-storage tunnel for urban storm water management, and compared it to other storage possibilities. The illustration below shows that some of the alternative approaches to urban storm water management are more (financially) cost-effective than deep-water storage. However the most cost-effective are not the kind of measures that could be extensively applied in the artificial soils that are prevalent in urban landscapes (e.g. native landscaping, soil amendments and rain gardens). On purely financial grounds, NWRM would then be concluded to play only a marginal role in cost-effective urban storm water management.

However, the comparison in the figure is incomplete and misleading because traditional cost-effectiveness analysis only considers one effect (captured stormwater run-off), one benefit (reduced infrastructure cost) and financial costs. Thus, the cost of the infrastructure is underestimated (as the externalities of the deep tunnel storage are not accounted for), the costs avoided by the green infrastructure options are ignored (savings in water treatment, reductions in energy consumption in households, etc.), as are the co-benefits (increase in property values, reduced pollutant loads, groundwater recharge, improved air quality, etc.). Within this comparison a completely different result would arise if the external costs of the deep tunnel storage were taken into account, with the horizontal line in the figure moving upwards. If the avoided externalities implied by the direct and ancillary benefits, or positive externalities other than storing water were considered, all the net costs of the NWRM would then be lowered.



X = % of increased storage capacity as compared to target capacity (Milwaukee's Regional Green Infrastructure Plan: MMSD, 2011).
Y = Incremental cost (€/m3 of storage capacity). [Note: An Exchange rate of 1 €= 1.35 US$ was applied]

Illustration 10

Incomplete benefit assessment in the Baltic Sea projects

The majority of NWRM implemented in the Baltic Sea region are focused on the restoration of biodiversity and habitats. Therefore, the problem analysis and the criteria used for selecting measures are commonly targeted at understanding how a change in hydrological conditions can support wet-loving species and habitats. Consequently, the indicators for evaluating the success of the measures are biodiversity indictors and not water management indicators. Broadening the types of impact included in the assessment would give a more complete assessment and may allow alternative and improved solutions to be identified.

Sources: case studies: Nummela 'Gateway' wetland park, Finland (case study 117); Wetland biodiversity protection in Kamanos Strict Nature Reserve, Lithuania (case study 124); Restoring the Kuresoo bog, Estonia (case study 63); Restoration of Amalvas and Žuvintas Wetlands, Lithuania. (case study 14)

Illustration 11

Combining measures for increasing effectiveness

In Belford catchment, a range of measures was implemented including ponds, ditch blocking, bunding of diffuse flow paths, and specific sediment-capture measures. Using a variety of measures was seen as more appropriate than a single-measure solution due to variations in topography and land-use (despite the small size of the catchment). Monitoring and modelling showed that the effectiveness of the combination of measures was higher when considering both water retention and water quality impacts.

Learn more: *http://www.nwrm.eu/*, case studies, Rural runoff attenuation in the Belford catchment, (case study 41)

Step 4 – Check the feasibility of proposed NWRM

Similarly to any other measure type, you will need to check a wide range of feasibility and implementation issues before deciding on your measures. These include (also see the next chapter, which focusses on pre-conditions for implementation and effectiveness of NWRM) *inter alia*:

- Checking the **technical feasibility** of proposed NWRM (e.g. ensuring that the drainage management benefits of infiltration SuDS do not act as a potential pollution vector to groundwater, and if so, considering whether adaptations to design may avoid the risk);
- Ensuring **financial resources** are available to support the implementation of NWRM;
- Assessing the adequacy of the current **governance** (and suggesting possible changes if necessary), and identifying responsibilities for implementation;
- Checking **investment cycles** and identifying when measures might best be implemented.

While these are issues that you will already have considered through Steps 1 to 3, it can sometimes be a bit more complex with NWRM, hence the need to revisit them at Step 4. This is especially so if the measures will be implemented, financed, or monitored by department services or organisations responsible for policy areas others than that of the lead organisation in charge of the planning process. An integrated planning process is thus essential for successful implementation.

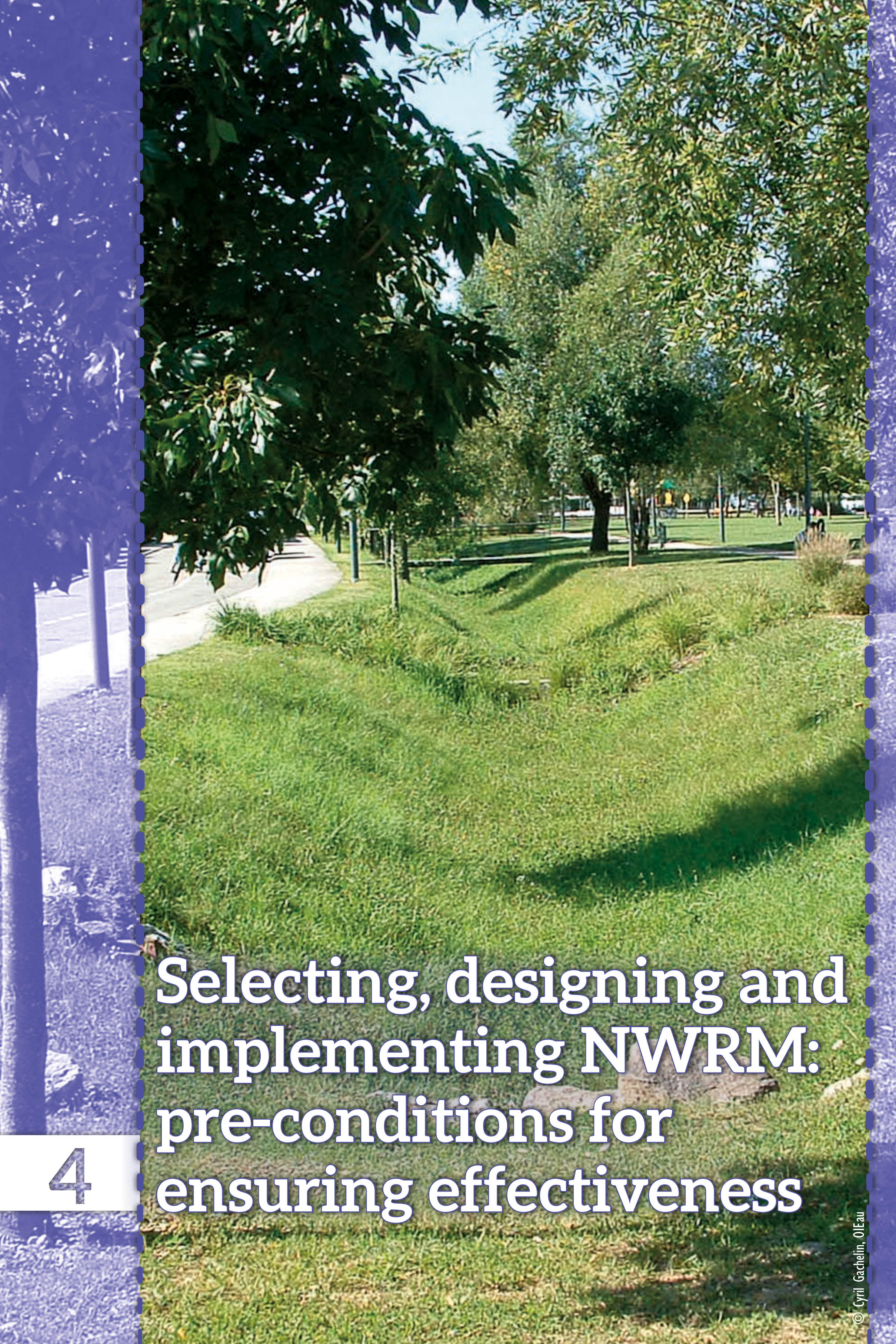
You will find information relevant to your feasibility checks in SD n°8: (Windows of opportunity for NWRM), SD n°9: (Barriers and success factors for NWRM) and SD n°11: (How can NWRM be financed)? (*www.nwrm.eu/synthesis-documents/*)

Step 5– Now select your measures - and go for it!

Based on the assessments carried out, and on the many discussions with relevant stakeholders and decision makers (see below), it is time for you to choose the right combination of measures including NWRM, and to implement them!

In doing so, ensure you allocate sufficient human and financial resources to:

- **Monitor and evaluate** the effectiveness and impacts of the bundle of measures you are implementing (as discussed further in the section on monitoring and evaluation).
- **Regularly interact** with organisations from other policy domains as well as potential beneficiaries of the services NWRM will deliver, so that actual effectiveness at achieving the interests of those parties can be identified and discussed, and adaptation in implementation can be proposed if felt necessary.
- Allow for **adjustments to the measures** based on the results of monitoring and evaluation, to ensure that your objectives are met cost-effectively.
- **Share** the information with others who have an interest or stake in the scheme or other similar schemes, as this will encourage co-learning as a basis for better policy coordination and effectiveness in future.
- **Communicate** the implementation challenges and relevant impacts to stakeholders and to the wider public.



4

Selecting, designing and implementing NWRM: pre-conditions for ensuring effectiveness

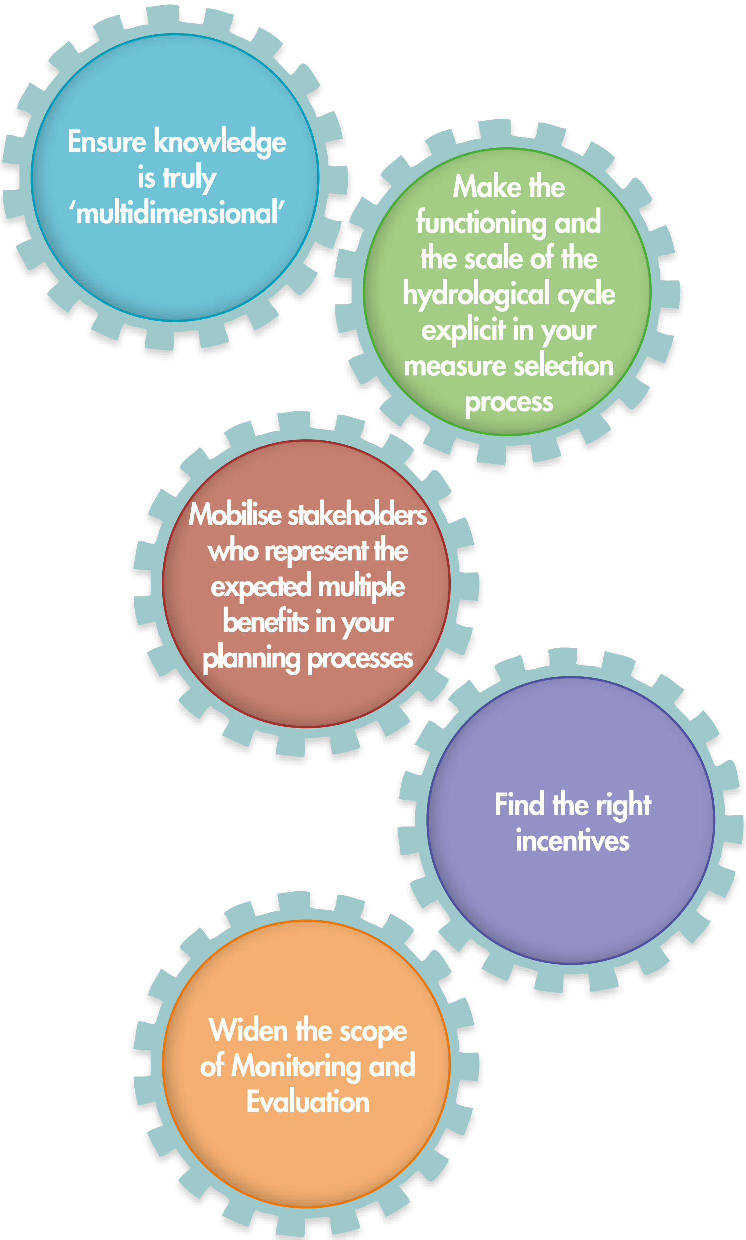
Many factors influence the implementation, effectiveness and success of NWRM, and these are likely to differ from one country, catchment, urban or rural area to the next. The main challenge is to provide the right incentives for different policies and strategies to be implemented in a coordinated manner. NWRM may play a facilitating and connecting role if they are not viewed solely from their water dimension. As policy coordination is already embedded into existing policies (see table below), you have a clear basis for promoting it at all decision making levels including cities, water catchments or rural areas.

Table 2 - Policy coordination, a pre-requisite to policy implementation embedded in EU policies

Policy	Basis for ensuring coordination and synergies with other EU policies and strategies
Water Framework Directive	The WFD requires *further integration of protection and sustainable management of water into other Community policy areas such as energy, transport, agriculture, fisheries, regional policy and tourism […]*. In addition, the WFD *should provide a basis for a continued dialogue and for the development of strategies towards a further integration of policy areas*. Specifically, each River Basin Management Plan (RBMP) should be the focus of a 'climate check' to ensure adaptation to climate change is fully accounted for in RBMPs.
Floods Directive	Because of their 'water focus' and common planning unit (river basins/catchments), it is essential to establish synergies between the achievement of good water status (WFD) and the management of flood risk (Floods Directive). Very specifically, Article 9 of the Floods Directive specifies that *Member States shall take appropriate steps to coordinate the application of this Directive and that of Directive 2000/60/EC focusing on opportunities for improving efficiency, information exchange and for achieving common synergies and benefits having regard to the environmental objectives laid down in Article 4 of Directive 2000/60/EC*.
Biodiversity Strategy	Policy coordination is essential to the achievement of the objectives of the EU Biodiversity Strategy. The Strategy specifies that *reaching the 2020 target will require the full implementation of existing EU environment legislation, as well as action at national, regional and local level. Several existing or planned policy initiatives will support biodiversity objectives. For instance, climate change, which is a significant and increasing pressure on biodiversity that will alter habitats and ecosystems, is addressed through a comprehensive EU policy package adopted in 2009*. […] The Strategy also stresses the importance of a future *framework directive to protect soil, which is needed to allow the EU to reach the biodiversity aims*. The need for *EU efforts to promote enhanced cooperation between the different Biodiversity conventions, Climate Change and Desertification Conventions* is stressed because of the mutual benefits it will deliver.
Common Agriculture Policy	Policy integration is made explicit in the objectives of the future CAP that include: (a) *to pursue climate change mitigation and adaptation actions thus enabling agriculture to respond to climate change* and (b) *to guarantee sustainable production practices and secure the enhanced provision of environmental public goods*, since many of the public benefits generated through agriculture are not remunerated through the normal functioning of markets. The direct payments of the future CAP now include the WFD within the scope of cross compliance. The future CAP highlights the need *to strengthen the coherence between rural development policy and other EU policies*, in particular via the establishment of *a common strategic framework for EU funds*. It also requires MS to designate ecological focus areas, their aim being to *underpin the implementation of Union policies on the environment, climate and biodiversity*.
Green Infrastructure	The EU Strategy for Green Infrastructure (GI) stresses *GI can make a significant contribution in the areas of regional development, climate change, disaster risk management, agriculture/forestry and the environment*. It further specifies that GI needs to become *a standard part of spatial planning and territorial development that is fully integrated into the implementation of these policies*.
EU Water Blue Print	Recognising the challenges in achieving good water status as required by the WFD, the EU Water Blue Print stresses the *need for better implementation and increased integration of water policy objectives into other policy areas, such as the Common Agriculture Policy (CAP), the Cohesion and Structural Funds and the policies on renewable energy, transport and integrated disaster management*. It further stresses the need for increased policy integration that will support the development of green infrastructure. It also emphasises the need to make *full use of RBMPs that require an integrated approach to managing water resources across policy areas such as agriculture, aquaculture, energy, transport and integrated disaster management*.

Beyond the basic process for selecting and identifying measures that has been presented and discussed in the previous section, there are pre-conditions that are considered to be key to the successful selection, design and implementation of NWRM, as illustrated in the following diagram.

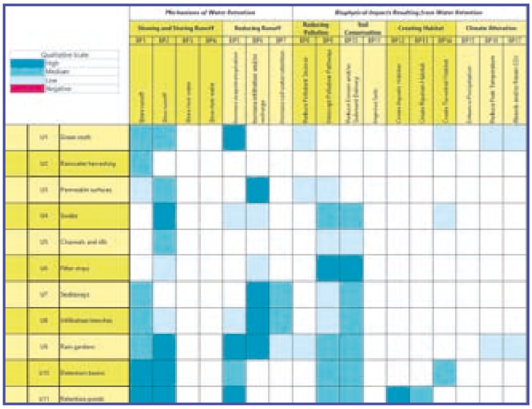
Pre-conditions to the successful selection, design and implementation of NWRM



Issue 1 - Ensure knowledge is truly 'multidimensional'

With their multifunctional and multiple benefit character, and the need to encompass multiple policy objectives, performing ex-ante assessments of NWRM for supporting measure selection requires an understanding of the main causes of failing achieving different policy objectives (understanding the relationships between drivers, pressures, the state of the environment and related impacts for each policy area). It also requires knowledge on the multi-dimensional impacts of NWRM, even if with some degree of uncertainty. In many cases, however, this is not yet common practice.

- Available knowledge often addresses only a single issue. In many cases, detailed knowledge of the potential impacts of any given measure fails to cover the whole potential range of biophysical and ecosystem service impacts that NWRM might be expected to achieve (see table and *www.nwrm.eu/benefit-tables/*);



- When NWRM are considered in a given planning process, the search for knowledge is commonly limited to knowledge relevant to the priority objective of that process. Generally, limited attention is given to other impacts and contributions to other policy objectives;

- Studies often address causal relationships for a very specific context (pilot urban sites or catchments). There is limited understanding about how to transfer site-specific information to other sites and contexts.

Therefore, you might want to consider specific activities that will help to access knowledge of the expected multidimensional impacts and effectiveness of NWRM.

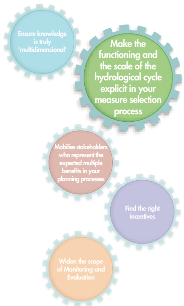
- **Mobilise key experts and stakeholders from other policy domains** to bring their views and practical knowledge in key steps of the measures selection process.

- Provide **additional funding to existing studies** that in their current form are only partially addressing the multiple benefits of NWRM. The additional funding should be used to widen the range of benefits assessed, ensuring good value for scarce available financial resources.

- **Implement 'integrated pilot projects'** to test the application of NWRM under real life conditions, and systematically monitor the diversity of expected biophysical and ecosystem service impacts. Engage key decision makers in other relevant public administrations to steer, monitor and/or evaluate the pilot, as a mechanism for raising awareness of NWRM and enhancing policy coordination. Integrated projects at the catchment scale are, for example, one of the priorities of the new LIFE Multi-Annual programme 2014-2020, offering a clear opportunity for demonstrating NWRM and assessing their impacts and effectiveness under real life conditions.

- When implementing your own measures, make sure you do not fall into the same traps, and **provide a suitably wide evidence base** to support and provide advice for future implementation of similar measures.

Issue 2 - Make the functioning and the scale of the hydrological cycle explicit in your measure selection process



NWRM impacts and effectiveness will commonly be best assessed at scales that help translate local changes in biophysical parameters to changes in river flows, river status, habitat status or other relevant ecosystem services. This can be the catchment scale (often considered as the management unit in water policy), or an alternative scale that helps capture the impacts of proposed NWRM on the hydrological cycle.

Your own area of work will also have an influence on the best spatial scale for assessing impacts. For example, as a…

- ☑ **Water planner**: you are likely to already work at the water catchment scale, looking in particular at water management issues that need to be solved for individual water bodies or for your entire catchment. However you will also need to account for benefits delivered by NWRM outside the water catchment, and for spatial scales relevant to other policies, e.g. for biodiversity, if migratory species are the focus of WFD measures.

- ☑ **Urban planner:** you should make the water cycle explicit in your territorial planning. This will require an understanding of the interactions between urban water hydrology and wider water resources processes and aquatic ecosystems.

Table 3 - Enhancing the water-relevance of sector-specific scales

Sector	Currently used management scales	Connecting to water
Agriculture	Field/farm, agricultural region	Positioning farms within the catchment, identifying links between farm management and the hydrological cycle making explicit the impacts of farm units on aquatic ecosystem status
Urban	Urban centre, agglomeration	Linking permeable/impermeable areas to the hydrological cycle, connecting water services (drinking, sewage) to aquatic ecosystems/water bodies
Forestry	Forest management unit, mountain range	Linking forest management units to the hydrological cycle (via infiltration, runoff), connecting forest to local nature protected sites and to wider biodiversity
Aquatic ecosystem restoration	River reach, wetland	Positioning the restoration site within the water catchment, linking the restoration site with wider biodiversity, linking restoration sites with nearby urban areas that might benefit from the amenities delivered

- **Nature conservation agency or organisation:** you should investigate and understand the links between the hydrological cycle and biodiversity. In some cases, your nature protection efforts can contribute to the achievement of water policy objectives and to restoring good water status further downstream in your catchment.

Focusing the assessment at the catchment scale, or making the water cycle explicit in your planning process, requires:

- A clear definition of **multiple policy and management objectives at the catchment/territorial scale** addressing the range of benefits and policies that NWRM might contribute to. For example, river basin management planning in some countries addresses mainly WFD objectives and leaves aside flood risk, habitat or climate change adaptation challenges. Unless the latter challenges can be brought in to the river basin scale, this reduces the opportunities for NWRM to be recognised as good candidates for contributing to the achievement of these multiple objectives.

- The establishment of **assessment mechanisms** or rules that help to combine and address the potential multiple impacts that measures (NWRM and others) might deliver at the scale of the catchment (or other relevant water-related geographic scale). This could be a Geographic Information System to help identify areas with the highest potential for NWRM, as well as providing qualitative evidence on the ecosystem services they might deliver, and the target population that might benefit from those services. It could take the form of a managed process for bringing together (and consolidating) expert and stakeholder knowledge of the geographical areas with the highest potential for NWRM and their potential impacts. It could also build on complex spatial simulation models that help to link potential measures with changes in catchment hydrology or ecology (see illustration 13).

- A clear understanding of **upstream-downstream linkages**, to ensure that opportunities are recognised for providing benefits in one part of a catchment by implementing actions elsewhere.

It is important to stress that the selection of measures can be performed at different scales, such as:

- The scale of water bodies as defined under the WFD;

- The scale of a nature-protected area that has specific protection measures for biodiversity;

- The scale of an urban area.

Whatever the main scale of focus, the scale of the water catchment remains relevant for translating the changes in retention parameters at specific locations into changes in policy-relevant indicators such as river water status, river flows, etc. In some cases, however, the ecosystem services that will be provided, and the populations benefiting from those services, might still be outside your water-relevant planning area. And these will still need to be accounted for when selecting measures.

Illustration 12

Large-scale mapping as a tool for decision making

The Federal Nature Conservation Agency in Germany has developed a national 'floodplain status ***inventory***' that assesses loss or degradation of floodplain on all major rivers across the country. This has involved a mapping approach similar to that of water body status under the WFD. This type of national mapping allows effective ***prioritisation*** of restoration schemes, thereby being an invaluable tool for cost-effective river basin management. After implementation, the approach allows an aggregated evaluation of success (covering morphodynamics, hydrodynamics, vegetation and land use).

Source: Presentation by Dr Stephanie Natho, second Western Region workshop - *http://www.nwrm.eu/regional-networks/western-regional-network/second-western-region-workshop*

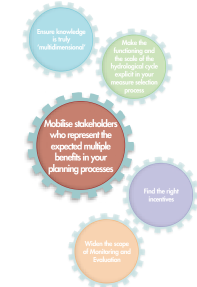
Illustration 13

Catchment scale modelling to assess flood risk reduction

The program of restoration measures in the Eddleston catchment (Scotland) aimed to slow flood flows by recreating specific ecosystem that are elements often missing from our modern landscapes. These elements included riparian vegetation, meandering channels, functioning floodplain, intact banks, large woody in-channel debris and wetlands. Each of these had a role to play in slowing down flood flows and increasing infiltration. The project worked with CBEC eco-engineering to undertake extensive hydrological modelling to ensure that the restoration measures would be sited at the most appropriate locations. In 2012, Tweed Forum designed a demonstration model which showed how features in the landscape could contribute to reducing floods. This model would be taken to local agricultural shows and community events.

Learn more: *http://www.tweedforum.org/projects/current-projects/eddleston_aim3*

ISSUE 3 - MOBILISE STAKEHOLDERS WHO REPRESENT THE EXPECTED MULTIPLE BENEFITS IN YOUR PLANNING PROCESSES



Mobilising stakeholders and citizens is key to successful river basin, catchment, urban or biodiversity plans and strategies. By contributing to awareness-raising and ensuring ownership, it increases the likelihood of success and effectiveness. In addition to the general consultation and participation principles promoted by the Arhus Convention, EU legislation already promotes the consultation and participation of stakeholders and the wider public, as illustrated in Table 4.

Table 4 - References to stakeholder mobilisation and participation in relevant key EU policy initiatives

	Legal references to stakeholders mobilisation and participation
Water Framework Directive	In its preamble, the WFD stresses that its success *relies on […] information, consultation and involvement of the public, including users*. Article 14 of the WFD is dedicated to Public information and consultation, specifying that *Member States shall encourage the active involvement of all interested parties in the implementation of this Directive, in particular in the production, review and updating of the river basin management plans.*
Floods Directive	Article 10 of the Floods Directive[18] specifies that *Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans.*
Biodiversity Strategy	In its section 4.1, the Biodiversity Strategy promotes Partnerships for Biodiversity. It specifies that *the active involvement of civil society will be encouraged at all levels of implementation. Citizen science initiatives, for instance, are a valuable means of gathering high-quality data while mobilising citizens to get involved in biodiversity conservation activities.*
Common Agriculture Policy	The new Common Agriculture Policy promotes different mechanisms for enhancing information sharing about possible actions in the field of agriculture and on their benefits, including at the European scale. In particular, it promotes the networking of national networks, organisations and administrations involved in the design, implementation and evaluation of rural development plans, as it has proven *it can play a very important role in improving the quality of rural development programmes by increasing the involvement of stakeholders in the governance of rural development as well as in informing the broader public of its benefits*. Its article 53[19] also promotes the establishment of an European Innovation Partnership (EIP) network to address *agricultural productivity and sustainability and that shall enable the networking of operational groups, advisory services and researchers*. This EIP network will: *(a) facilitate the exchange of expertise and good practices; (b) establish a dialogue between farmers and the research community and facilitate the inclusion of all stakeholders in the knowledge exchange process.*

With NWRM, **widening the circle of stakeholders** beyond current practice represents the main challenge. It is critical for ensuring that views and stakes from different policies and expected multiple-benefit issues are identified, discussed and considered when deciding on the measures to be financed and implemented.

You will find information on governance, stakeholder mobilisation and policy coordination in SD n°9 (Barriers and success factors for NWRM) and SD n°10 (Policy integration linked to NWRM: how do they integrate with different European Directives?) (*www.nwrm.eu/synthesis-documents/*)

18 Chapter V, Coordination with Directive 2000/60/EC, public information and consultation

19 REGULATION (EU) No 1305/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005

If you are a…

- **WFD river basin planner**, attempt to interact with decision makers and stakeholders with an interest in flood risk management, biodiversity, climate change or urban planning. Make sure that they are invited, consulted with, and potentially involved in the measure selection process as often as feasible.

- **Urban planner**, connect your analysis and measure selection to the wider functioning of the hydrological cycle and aquatic ecosystems. Inviting in catchment management planners, climate change experts and biodiversity specialists for discussion will help you to capture the wider pros and cons of your actions, and help identify those that are win-win for both your own and other sectors.

- **Forest manager**, discuss with nearby urban decision makers to identify amenities that forests can deliver to citizens. Interact with water decision makers so that the role of forests in contributing to the sustainability of the hydrological cycle is recognised and enhanced.

- **Agriculture professional,** discuss with water planners and nature protection agencies the identification of locations where changes in farm practices will deliver the highest water and biodiversity benefits.

This leads to several challenges, firstly as mechanisms for mobilising stakeholders from other policy domains do not always exist, and secondly because of the risk of 'consultation fatigue' if everybody is involved everywhere . This stresses the need for 'connecting' and integrating all the different processes more closely, so that joint thinking about policies can take place.

Specific mechanisms that might enhance collective discussion at different decision making scales and potentially have an impact on decisions that take into account different policy goals include:

- Building a **common knowledge base** that encompasses the multiple benefits of potential measures, so that decision makers and stakeholders of each policy area recognise their own interests and the issues they have responsibility over.

Illustration 14

Developing multi-policy measure databases

In Germany, a 'Recommendation on a Coordinated Application of the EU Flood Risk Management Directive and the EU Water Framework Directive' has been developed to identify inter alia potential synergies in the programs of measures. In this context an assessment matrix for analysing interactions between measures under the FRMD and the WFD has been set up. Within this approach the relevance and mutual effects of WFD and FD measures with regard to WFD management objectives and flood risk management objectives is systematically evaluated. It is planned to extend this approach with regard to the potential contribution of MSFD measures.

Learn more:
The Recommendation incl. the matrix (Annex I) is available on the following site:
http://www.wasserblick.net/servlet/is/146574/

- Establishing **specific discussion/steering arenas** (working groups, consultative committees, workshops) for representatives of the different policies and stakeholders of water and land management. This can help to establish or reinforce integration between different planning processes and policies, including discussions of the pros and cons of possible actions (including NWRM) that might deliver a wide range of benefits.

- **Streamlining information, communication and awareness** raising activities so they promote an integrated view of the different facets of land and water management at the catchment scale, and thus contribute to the understanding of when and how to choose NWRM because of their potential multiple benefits.

Illustration 15

Restoring the River Quaggy in London, UK: an example of a qualitative stakeholder and expert process

As urban development has increased in the Quaggy river valley and natural flood plain, near Lewisham in central London, fluvial flooding experienced by local residents and businesses has also increased. In 1968 the centre of Lewisham flooded to a depth in excess of 1m, and more recent flood events have occurred. A flood alleviation scheme was required to prevent further loss to the remaining floodplain within the catchment. It involved various stakeholders: the Environment Agency, Quaggy Waterways Action Group, local residents, London Borough of Greenwich, London Borough of Sutton. Communication and a positive attitude, early and on-going ***consultation*** happened to be key elements for this type of project to achieve. The process included active residents/stakeholders engagement and involvement during the design and construction stages, including partnerships, schools and groups etc. Following implementation not only ensured understanding of the work but also a feeling of ***'ownership' and responsibility*** that has been continuing for the length of the NWRM lifespan. A full-time public liaison officer was employed during the planning and implementation phases. A ***multidisciplinary*** team of engineers, landscape architects and ecologists worked on the design to ensure that opportunities for major visual, social and ecological enhancements were optimised at the same time as managing the flood risk.

Learn more:
http://www.nwrm.eu/, case studies, Restoring the River Quaggy in London, UK (case study 12)

Illustration 16

Slowing the Flow at Pickering and Exmoor Mires projects: two different approaches

The Slowing the Flow at Pickering project involved the use of NWRM for natural flood management in a situation where traditional hard engineered flood defences had been rejected as they did not succeed in passing the cost-benefit criteria. Given the degree of public concern and the need to work with multiple stakeholders throughout the project a Community Engagement Plan[20] was developed. This comprised of the following steps:

Step 0 – What are the project team's roles and background?	• Project team lines of communication • Project key roles and responsibilities • Background
Step 1 – What do we want to do together?	• Engagement level • Contextual issues • Business objectives • Key messages • Success criteria
Step 2 – Why work with the community and others?	• Engagement objective
Step 3 – Who do we need to engage?	• Stakeholder analysis and contact details
Step 4 – How will we engage different parties?	• Engagement programme
Step 5 – What will we use and how?	• What do we need in order to start? • How will we record any evaluation and learning?

In contrast, the Exmoor Mires project[21], which seeks to manage water runoff through upland peatland restoration, has adopted a more 'educational' approach to engagement. This draws on links to existing outreach activities and materials[22] and public events[23].

The degree of public concern or controversy with respect to proposed NWRM schemes will be important for determining the optimal extent and nature of stakeholder engagement.

20 http://www.forestry.gov.uk/pdf/stfap_final_report_appendix12_7_Apr2011.pdf/$FILE/stfap_final_report_appendix12_7_Apr2011.pdf

21 http://upstreamthinking.org/index.cfm?articleid=8699

22 http://upstreamthinking.org/index.cfm?articleid=9633

23 http://upstreamthinking.org/index.cfm?articleid=11396

Illustration 17

Information and awareness raising activities in wetland restoration projects in the Baltic Region

In the case studies on wetland restoration and management activities in the Baltic States, the information and communication with stakeholders have been focused on raising awareness about the importance of wetlands, in particular the values of species and habitats. During the restoration of the raised bogs Aklais in Latvia, the project team created a ***documentary*** 'Mires uncovered' and ***mobile exhibition*** 'Secrets of Mires'. When Amalvas and Zuvintas wetlands, Lithuania, were restored, the project also developed a documentary on 'Revival of wetlands', and modernised exhibition about raised bogs in the Visitor Centre of the Zuvintas biosphere reserve. As many wetland restoration projects are implemented with financial support from LIFE programme, ***information boards*** are set up at the project sites. They include information about the area, implemented activities, and importance of the site for nature conservation.

Aklais bog areas in Latvia. Source: Mr. Gunars Balodis, Latvia

Learn more: *http://www.nwrm.eu/*, case studies, Restoration of Amalvas and Zuvintas wetlands, Lithuania (case study 14), and Restoration of the raised bogs Aklais in Latvia (case study 123)

ISSUE 4 - FIND THE RIGHT INCENTIVES

Achieving comprehensive consideration of different policy objectives and sectors within a single decision making process, and accounting for multiple benefits, is clearly challenging. However it is worth persevering with to widen the scope of opportunities that can make a difference (even if small), as long as the right incentives are provided to make the change happen.

Incentives for economic operators, local authorities and stakeholders involved in the implementation of NWRM can take the form of:

- **Information and communication** about the benefits of NWRM and on available funding opportunities.
- **Training** in the assessment of multiple benefits.
- The establishment of specific **governance mechanisms** that enhance policy coordination and shared decisions -making.
- Supporting the NWRM **community of practice** in sharing experiences among very diverse sectors and regions.
- The establishment of **voluntary agreements** between those implementing NWRM and those benefiting from their implementation.

> You will find further information on financing and sources of funding in SD n°11: How can NWRM be financed? (*www.nwrm.eu/synthesis-documents/*)

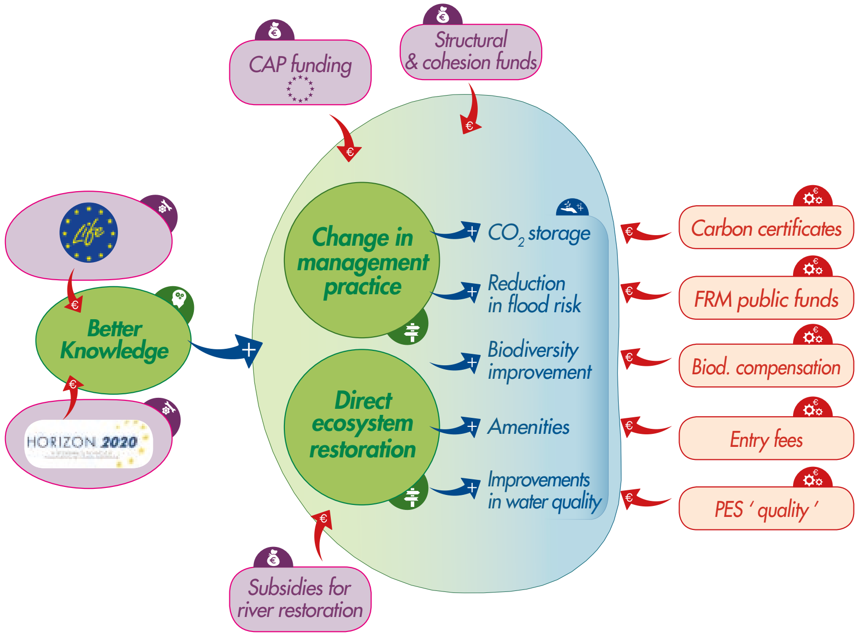
Incentives can also take the form of financial support. As NWRM can deliver multiple benefits, thereby contributing to different policy objectives, there could be many different financing instruments available for funding them, be it compensation payments for the delivery of specific services, or funding from private and public sources that support a change in practice.

Financing engineering becomes a central management task that can make the difference in the successful implementation of NWRM. Its objective is to establish an integrated combination or bundle of local, national and European funding sources targeting different sectors, different benefits of NWRM and their potential contribution to different policy objectives. If successful in establishing the relationship between those benefiting from the services delivered, compensation payments will indirectly reduce pressure on public (e.g. national, local authorities, municipalities) budgets.

> Bundling financing sources for the delivery of different benefits will facilitate the implementation of NWRM. But this might not be 'free money': it is likely that you will need to monitor the services and benefits (see next section) to ensure they are effectively delivered, as this evidence may provide the basis of financial payments.

Funding might sometimes come from **unexpected sources.** Even if your main interest is in addressing water challenges, make sure you look at funding opportunities supporting the other benefits that can also be delivered by NWRM: for example, their capacity to store CO_2 and contribute to climate change mitigation policies, or the amenities they deliver that may have high value for inhabitants in urban areas.

Matching potential funding sources to potential benefits



Box 5

Look for NWRM opportunities in EU funding mechanisms!

Today, funding opportunities for NWRM exist in most of the EU funding mechanisms, in particular: the European Agricultural Fund for Rural Development (EAFRD) (which is Pillar 2 of the Common Agriculture Policy), the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund (CF). In particular, the Rural Development Programs (RDP) represent a key source of financing for supporting NWRM, which can be included under agri-environment climate measures, non-productive investment measures, Natura 2000 and WFD-related payments or forest/afforestation measures. Competitive funding to support NWRM accounting for their multiple benefits is also available through the new LIFE programme 2014-2020 that gives priority to integrated water catchment projects[24] while still supporting smaller scale projects that offer opportunities for the demonstration of NWRM. The EU research programme Horizon 2020 also offers funding opportunities for enhancing the existing knowledge base on NWRM under the Challenge Climate Action, Environment, Resource Efficiency and Raw Materials. It also promotes demonstration activities and pilot pre-market projects that can focus on NWRM implementation.

Illustration 18

Combining national and EU funds for supporting the Small Forest Water Retention Program in Poland

The Small Forest Water Retention Program of Poland is a national scale project implemented from 2007 to 2013 to increase water storage in forests. Its objectives are, on the one hand, to increase water retention and flood prevention, and on the other hand, to restore habitats such as wetlands and moors. The Programme was co-financed by the ***EU Cohesion Fund***. However, its implementation relied on previous experience on implementing small water retention measures in forest areas: from the mid-90s, the Polish forest management authority undertook a variety of small-scale water retention works, financed from a combination of its ***own and external funds:*** the Polish Ecofund, and the Polish National Fund for Environmental Protection and Water Management.

Learn more:
http://www.nwrm.eu, case studies, Small Water Retention Program in Forests (lowlands) of Poland (case study 120)

Supporting WFD and habitats benefits with Flood Risk Management funds: example of the Sigmaplan

Sigmaplan in Belgium is a nationally funded programme to manage ***flood risks*** in the Scheldt basin. It originated following the extensive tidal flooding of 1976, with the aim of improving protection through improved flood defences and use of flood control areas. The scale of the programme is such that the work has continued since the programme inception to the present day, with the first phase now having been completed. In 2005, an updated Sigmaplan was developed, which evolved significantly in its aims and set out a second phase of schemes. Today there is greater recognition of the risks of ***climate change,*** optimal approaches to ***water management,*** and the desire to conserve and enhance ***nature***. The revitalised Sigmaplan places emphasis on allowing rivers space to flow and flood, and explicitly incorporates nature conservation objectives, thereby achieving wider benefits from the extensive national funding.

Learn more:
www.sigmaplan.be

24 Integrated projects (sub-programme for Environment, not for Climate Action) are projects implemented on a large territorial scale (regional, multi-regional, national or trans-national scale) environmental or climate plans or strategies required by specific Union environmental or climate legislation primarily in the areas of nature (including Natura 2000 network management), water, waste, air and climate change mitigation and adaptation, while ensuring involvement of stakeholders and promoting the coordination with and mobilisation of at least one other relevant Union, national or private funding source.

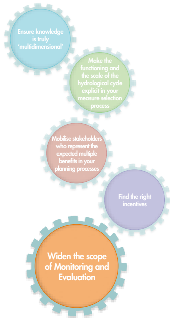
Illustration 19

Various benefits addressed by EU LIFE funds

Case studies show that EU LIFE funds can finance various benefits: in the case of fluvial and ecosystem restoration of the Arga-Aragon Rivers systems (Spain), LIFE funds aimed to improve ***specific habitats*** but also appeared to be effective in ***reducing flood risk***. Other LIFE funded projects address requirements related to various policies, including: ***Birds and Habitats Directives*** (Wetland restoration in the Senne and Medzibodrozie SPAs, Slovakia); ***Water Framework Directive*** (Floodplain restoration in Lonjsko polje Nature Park in Croatia, Revitalization of the upper Drau River in Austria); ***Floods Directive*** (Alzette river restoration in Dumonshaff, Luxembourg).

Learn more:
http://www.nwrm.eu, case studies, Revitalisation of the upper Drau River in Austria (case study 4), Fluvial and ecosystem restoration of the Arga-Aragon Rivers systems in Spain (case study 33), Wetland restoration in the Senne and Medzibodrozie SPAs in Slovakia (case study 28), Floodplain restoration in Lonjsko polje Nature Park in Croatia (case study 23), Alzette river restoration in Dumonshaff, Luxembourg (Case study 21).

Issue 5 - Widen the scope of monitoring and evaluation



Why do we need to discuss monitoring and *(ex-post)* evaluation? It is already compulsory, for example, as a result of existing regulation (e.g. for monitoring water quality, water status or the status of habitats), or requirements defined by access to public subsidies (to check best use of funds and delivery of expected benefits). And it is a clear added value when you want to assess or demonstrate the impacts of your decisions. But it needs further attention by:

- **Addressing the different management challenges** identified at the **integrated diagnosis phase** (which was described in Step 1);

- **Shifting the focus of monitoring** from monitoring measures to **monitoring impacts and effectiveness**, including when the delivery of specific services is the basis for (financially supported) agreements;

- **Starting** monitoring activities **prior to the implementation of NWRM**, in particular for the lesser-known services and benefits that are expected to be provided. This ensures that baseline reference conditions, against which impacts and effectiveness can be assessed, are better known. Interviews with inhabitants and key stakeholders for understanding reference conditions prior to implementation can also help raise awareness, refine the design of NWRM and strengthen local community involvement.

The specific aspects of NWRM have direct implications for their monitoring and evaluation because:

- It is **not just about water**! For example NWRM might deliver: amenities to urban inhabitants; improved landscape; carbon storage; enhanced biodiversity; the capacity to respond to extreme events or to adapt to climate change. These expected impacts might need to be monitored too.

- Monitoring cannot be limited to assessing the contribution of NWRM to a single policy objective. Their **potential simultaneous contribution** to different policy objectives needs to be assessed.

More systematic monitoring and ex-post evaluation of the multiple benefits effectively delivered by NWRM will progressively enhanced the existing NWRM knowledge base, supporting the future uptake of NWRM.

Monitoring every single relevant biophysical impact and ecosystem service might be cumbersome, not to mention expensive. But expense should not be an excuse for not monitoring. Costs for an appropriately detailed monitoring programme should be incorporated into project costs from the outset. Where funding is limited, monitoring may be prioritised by focusing on the main effects expected for different NWRM (as identified in the NWRM identity cards). It should always be recognised that the potential impacts of NWRM, in particular when delivering amenities, are not just about biophysical impacts: enhanced citizens' well-being and enjoyment of green spaces are important components that need to be captured. Thus, it is essential that the monitoring base is enlarged as far as possible to capture these types of impacts.

- Adding key water related indicators and related services complementary to water status (as defined under the WFD) might be possible in the context of **existing water monitoring programmes.** However it needs proper justification, in particular when proposed under tight budgetary conditions;

- Mobilising **different sources of funding** that target different benefits can clearly facilitate 'multi-impact' monitoring (both in terms of its justification and the financial resources available). It is best to integrate monitoring costs into the overall NWRM costs that benefit from financial support, to ensure that monitoring is treated as an integral part of the project, not a 'nice to have';

- Combining **different methods** to ensure pragmatic monitoring of NWRM impacts and effectiveness. Along with traditional monitoring of key soil and water biophysical and ecological parameters, monitoring of benefits can build on: interviews with citizens, as direct users of the amenities that new urban landscapes deliver; visual observations and photos for capturing landscape and amenity changes; or the collation of biodiversity information observed by members of environmental NGOs active on the ground.

Illustration 20

Assessing the success of NWRM and feeding inputs for future similar projects through monitoring: the example of the restoration and enhancement of riparian forest of Nestos River, Greece

The measures implemented in the riparian area of the Nestos River in Greece are based on the principles of restoring the natural vegetation. The measures have been applied across an area of 280 hectares, with a total of 79,343 plants having been planted. The water is retained through improvement of the soil and changes in the riparian vegetation. Thus, soil erosion and nutrient leaching are controlled, and the stream velocity during flood events is reduced. A monitoring programme of the vegetation restoration works of the riparian forest of Nestos has been set-up with the main purpose of ***evaluating the success of the restoration*** of the vegetation structure. The programme monitors both ***biotic and abiotic parameters*** (vegetation, meteorological, hydrological and soil parameters, landscape evolution, etc.). The monitoring programme also aims to assess the ***soil preparation techniques***, production and management of ***planting material*** and plant care ***practices*** after planting. These elements will be used when designing the restoration of ***other areas*** of the riparian forest in the future.

Source:
Kakouros, P. and S. Dafis. 2010. Monitoring program of the vegetation restoration works of the Riparian Forest of Nestos (2nd edition). Greek Biotope-Wetland Centre. Thermi.

Illustration 21

Monitoring the multiple impacts of NWRM to get people 'on board': example of Nummela 'Gateway' Wetland Park, Finland

The project of Nummela 'Gateway' Wetland Park, Finland, demonstrates the importance of monitoring and evaluation activities to ***verify the benefits*** from the wetland construction, thus enabling stakeholders comprehension and ***engagement***. Monitoring was and still is performed to monitor impacts with regard to water quality and quantity, carbon content in soils, greenhouse gases, and vegetation as well as to evaluate ecosystem services. The monitoring data are published on line at *http://www.helsinki.fi/urbanoases/*.

Learn more:
http://www.nwrm.eu, case studies, Nummela 'Gateway' Wetland Park, Finland (case study 117)

5 Visiting experiences of ‘NWRM in practice’!

© Directorate of Persina Nature Park

NWRM are not new, and are already being applied in practice by water managers, nature protection organisations, farmers, urban planners and many others. Implementation may be as part of catchment management, rural and urban planning processes, or sector-oriented strategies (e.g. for the agriculture or the forestry sectors).

If you travel throughout Europe, you will discover practical experiences of NWRM applications under many different climate, ecological, socio-economic and institutional contexts. Maybe some of these experiences are just around the corner! (See the map for the experiences documented as part of the EC-funded NWRM pilot study under *www.nwrm.eu*). Existing experiences can be **sources of inspiration** for your own organization, planning process and geographic area.

Box 6

Visiting examples of practical application of NWRM in Europe

Around 100 case studies of existing NWRM have been documented in the context of the NWRM Pilot project. These case studies have been documented with regards to: their context (biophysical/ecological/socio-economic); the measures implemented (alone or in combination with other measures); the governance put in place to support their design, selection and implementation; evidence of observed impacts on retention and connected ecosystem services; contribution to the achievement of EU policy goals; key implementation challenges. The level of detail varies, with around 40 having a more in-depth assessment available. The case studies are all available at *www.nwrm.eu/list-of-all-case-studies* . To select the case studies that are most relevant to your own queries and context, you can:

- Select the case studies that are in your (or other) regions of Europe via an interactive map;
- Use the search tool of *www.nwrm.eu* and select case studies based on: the types of NWRM implemented; the country of implementation; the relevant sectors targeted by the measure (agriculture, forestry or urban, and those that cut across sectors to improve the hydromorphology of water bodies directly).

Five well-documented applications that will help you understand the challenges, pre-conditions and the likely pros- and cons- of 'NWRM in practice' have been summarized here, covering a wide range of issues and contexts (see table below).

Table 5 - The NWRM case studies in a nutshell

Case study name	Country	Main characteristics of the territory	NWRM implemented	Institutions involved and governance	For more information, to contact…
Órbigo river ecological status improvement	Spain	The floodplain is covered by broad-leaved forest, mainly irrigated poplar plantation, a narrow natural riparian vegetation band, irrigated cereal crops, moors and heathlands and urban areas	Floodplain restoration and management (N3), Stream bed re-naturalisation (N5), Removal of dam/longitudinal barriers (N9), Natural bank stabilisation (N10), Elimination of riverbank protection (N11), Forest riparian buffer (F1)	Ministry of the Environment and Rural and Marine Affairs of Spain, along with the River Basin Authority. Involvement of municipalities and NGOs	Ignacio Rodríguez Muñoz, Duero River Basin Authority (Confederación Hidrográfica del Duero, CHD), irm@chduero.es
Flood-breaking hedgerows in Southern France	France	The catchment is primarily agricultural land (83% of the area). Riparian vegetation and trees are dense, but within 28 years, 300km of hedgerows have disappeared.	Buffer strips and hedges (A2)	SMIVAL (association of 24 municipalities), Chambers of agriculture, considered as part of the process for developing an Action Programme for Preventing Floods in the Lèze basin	Thomas BREINIG, Director of the SMIVAL, smival@wanadoo.fr
Rural runoff attenuation in the Belford catchment	UK	The catchment (5,7km^2) is upstream of Belford village and covered by pasture and cultivated grasslands.	Basins and ponds (N1), Coarse woody debris (F10), Overland flow areas (F14), Peak flow control structures (F13)	Environment Agency and Northumbrian Regional Flood Defence Committee, Newcastle University and Northumberland River Trust, farmers' involvement	*http://research.ncl.ac.uk/proactive/belford*
Nummela 'gateway' wetland park	Finland	Half of the 500ha watershed is urbanised, but agricultural lands remain. The wetland has been implemented at an abandoned crop field site.	Retention ponds (U11)	University of Helsinki, Municipality of Vihti, Uusimaa Centre for Economic Development, Transport and the Environment, involvement of a wide range of local and regional stakeholders	Outi Wahlroos, University of Helsinki, Department of Forest Sciences, outims@mappi.helsinki.fi
Wetland restoration in Persina	Bulgaria	The two sites are former wetlands along the Danube River, of 1 755 ha and 2 280 ha within the Persina Nature Park	Wetland restoration and management (N2)	Ministry of the Environment and Water of Bulgaria, Participatory process mobilizing inhabitants	Directorate of Persina Nature Park, *www.persina.bg*, persina@abv.bg

Enjoy visiting these five experiences! To gain a more thorough understanding of these five case studies, and learn about other existing initiatives across Europe, please visit the *www.nwrm.eu* knowledge base or contact directly the organisations that are involved in these projects.

Órbigo river ecological status improvement

Recovered flood prone areas after creating 'room for the river' (flood event in April, 2014)

NWRM IMPLEMENTED

- **N3** Floodplain restoration and management
- **N5** Stream bed re-naturalization
- **N9** Removal of dam/longitudinal barriers
- **N10** Natural bank stabilisation
- **N11** Elimination of riverbank protection
- **F1** Forest riparian buffer

Context

The Órbigo River is located in the Duero river basin, in northwestern Spain. The Órbigo River sub-catchment has an area of 1 605 km^2. The measure has been implemented on a **23.5km long reach** (reach 1). Almost half of the 45ha of floodplain of reach 1 is covered by broad-leaved forest, mainly irrigated poplar plantation (42% of the area). River banks are occupied by a **narrow natural riparian** vegetation band (6% of the floodplain area). One third of the area is cultivated (irrigated cereal crops) and the rest is occupied by moors and heathlands (9%) and urban areas (8%). A quarter of the river reach length contains longitudinal barriers. The river has a very low gradient, ranging between 0 and 1.82%. For the Órbigo River basin as a whole, the average slope is 27%. Mean annual rainfall is 535 mm/yr, with only half as much rainfall in summer compared to winter. The river in this reach has a permanent flow regime, with water quality that is classified as good-very good.

Management issues

The Municipalities of Cimanes del Tejar, Llamas de la Ribera, Carrizo de la Ribera, Turcia and Santa Marina del Rey located by the Órbigo River (León province, Castilla y León Region) were suffering from the effects of historic changes to hydromorphology (e.g. weirs, channels) and land use patterns in this water body. These have included: loss of lateral and transversal **connectivity** (with the former in particular contributing to flooding), alteration of river **dynamics** (resulting in problems with erosion and sedimentation), flow alteration and **loss and fragmentation** of riparian forest. Several issues need to be addressed, including: the hydromorphological impacts of flooding, which have long-term consequences on the ecological and chemical status of surface water bodies, and potentially on chemical status of groundwater bodies; impacts on infrastructure (utilities, power generation, transport, storage and communication); soil loss; impacts of floods on biodiversity, flora and fauna; altered habitats due to morphological and hydrological changes.

Effects of a flood event in a municipality located by the Órbigo River prior to the implementation of the restoration project.

Objectives

The project has two main objectives: first, flood control and mitigation, and secondly, mass stabilisation and control of erosion rates. However, it also addresses biodiversity and gene-pool conservation in riparian areas, and aims to improve the ecological status of the river. Achieving mitigation of flood risk requires recovery of the natural morphology and hydraulic capacity of the former stream bed of the river and its connectivity with the flood plain, and improvements to longitudinal continuity. That is to say, there is a need to give **more space to the river**. Improving the **ecological status** of the river requires improvement of river continuity and morphological conditions. Through targeting these issues, the project aims to mitigate both Floods Directive pressures (natural exceedence and blockage/restriction) and Water Framework Directive pressures (physical alteration of channel/bed/riparian area/shore of water body and dams, barriers and locks for flood protection). It also responds to the requirements of the Spanish National Strategy for River Restoration, sub-programme 3 and 4: Improvement of the longitudinal and lateral continuity of the rivers within the Duero basin.

The measures implemented

The measures have been implemented on a 23.5km long reach and treat about 45ha. In the near future, similar projects will be carried out in downstream reaches (27.5 and 57.8km). Works to improve lateral connectivity and dynamics include removal of 4.72km rock armour and 8.71km earth embankments, set-back of earth embankments away from the channel for 5.22km, removal of 7 deflectors and 480ha of flood-prone area recovery (i.e. the area that has been re-connected to the river and is now able to flood as a result of the project). Works to improve longitudinal continuity include modification of **in-river obstacles** to allow the passage of fauna (fish) and sediment transport past two insurmountable weirs; reconnection of 26 secondary arms (equivalent to 10.06km); **revegetation** of 7.2ha with riparian vegetation (Salix alba, Populous nigra, Alnus glutinosa, Fraxinus angustifolia) ; treatments to improve riparian vegetation health on 25km. The project also includes works to improve riverbank stabilisation, using local willows, live stakes and fascines.
Construction works started at the end of 2011 and lasted one year (though the project was drafted in 2008 and submitted for public consultation prior to its approval in 2010).

Works to improve the river lateral connectivity and dynamics: earth embankments removal

Public participation process: local population active involvement during one of the meetings taking place during the project implementation

Órbigo river ecological status improvement

Governance

The project was initiated by the Ministry of the Environment and Rural and Marine Affairs of Spain, along with the River Basin Authority. It was financed by the Ministry within the framework of the National Strategy on River Restoration. The **Duero River Basin Authority** was responsible for determining the design details of the measures (selecting a candidate project to be developed within the framework of the National Strategy on River Restoration) and for implementing them; this included the preparatory phase, diagnosis, public hearing process, works, environmental education and volunteering program. The authority is also responsible for monitoring the effects of the measures. Municipalities, local entities, neighbouring associations and NGOs have been involved during implementation process: they participated in the preparatory phase, diagnosis and public hearing process, and NGOs also volunteered in the river restoration activities.

Mobilising financial resources

The total projected budget of the measures is M€3. As of 2014, the executed budget is a little over M€2. The project has been financed entirely by the Ministry of the Environment and Rural and Marine Affairs of Spain within the framework of the **National Strategy on River Restoration**. 52% of the projected budget is to cover lateral connectivity and dynamics improvement works, 15.7% longitudinal continuity improvement works, 7.52% riverbank stabilisation works, 11.14% site access improvements and 2.57% supplementary works. Monitoring of works has an allowance of 3.89% of the budget, environmental monitoring 3.89%, risk prevention 2.23% and waste management 1.06%. No land acquisition was necessary since the project has been carried out on land that is already in the public domain. No operational costs are predicted. Maintenance costs are very variable depending on the elements considered: re-vegetation generally implies maintenance costs up to 20% of the investment cost, while for riverbank stabilisation maintenance costs are anticipated to be 15% of the investment cost. **Maintenance costs** are assumed by the River Basin Authority within the framework of its Public domain conservation program.

Main impacts & benefits

The implementation of the measure has had positive effects in terms of **connectivity** between the river and floodplain: 85.8% of the rock armour and 98.7% of earth embankments has been removed, and 90.4% of earth embankments have been moved away from the channel. Regarding longitudinal continuity, 0.6% of riparian vegetation has been recovered. Modification of in-river obstacles has contributed to allowing the passage of fauna (fish) and sediment transport at two insurmountable weirs. The results of the first stage of evaluation show that the ecological status of the river has been improved since implementation of the measures. The measures also provide a benefit of flood risk reduction through recovering **480ha of flood prone areas**, which have a high capacity to attenuate floods naturally. According to the Planning Office (River Basin Authority, on-going evaluation), the project has performed as planned against floods that took during winter 2013 (160m^3/s flood, which were similar to those that occurred in 1995 and 2000, in the former cases causing serious damage) and during spring 2014 (300m^3/s in April). These were successfully abated in terms of favourably smoothing the floods and the lack of material damage (e.g. avoided damage to buildings and houses at Carrizo de la Ribera) and, subsequently, the absence of complaints from the local population. In addition, increased infiltration rate and rate of recharge of the natural alluvial floodplains are expected.

Naturally reconnected floodplain after the restoration works. During the flood event in April 2014 the area benefited from recharge of the alluvial floodplain and soil fertilization

Implementation challenges

One of the most significant barriers to implementation of the project was the initial **attitude of the stakeholders**: at first, the local population was reluctant since it did not understand the 'theory'. Indeed, the concept of 'giving more space to the river' sounded very different from what had previously been carried out on the river and was hard to understand in real-life terms. However, active public participation during the whole life cycle of the project tackled this obstacle and contributed greatly to making the project a success. Decisions makers, staff and consultants adopted an **innovative approach** (taking into account a long river reach within a catchment and 'historical' scale), involved stakeholders strongly and promoted participation, which also facilitated the implementation.

Lessons learnt from other case studies

Other cases studies show that the effective planning, design, construction and operation of measures such as floodplains or natural bank stabilisation require the involvement of a **wide range of stakeholders**. This includes local planning authorities, environmental regulators, private landowners and land managers, farmers and other bodies with responsibilities relating to water management (e.g. irrigation bodies, drainage boards, etc). Involving stakeholders like farmers, fishermen and local citizens (during the design phase, through consultation meetings and sessions) is one of the key success factors for this kind of project. Restoration of floodplains can be a **no-regret measure,** but only insofar as it can be implemented without heavy investment and taking into account local conditions. Overall, floodplain restoration may be expensive and relatively inflexible, since it generally causes major land-use changes and requires a medium to long-term planning horizon. Very often, floodplain restoration requires land acquisition and potentially results in loss of revenue from agricultural land, which is afforested or used for flooding as part of the measure. However restoration of floodplains provides a wide range of benefits by restoring the natural function of the floodplain: reducing runoff and flood risk, creating habitats and preserving biodiversity, filtering pollutants and controlling erosion…

Other measures such as river bank stabilization require analysis of the local needs in order to select the best solution. Some of the measures need maintenance to keep being efficient and prevent deterioration, to maintain the vegetation and bank stabilisation systems.

For additional information

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Ignacio Rodríguez Muñoz, Duero River Basin Authority (CHD), *irm@chduero.es*

Full case study factsheet:

http://www.nwrm.eu/list-of-all-case-studies, Órbigo River ecological status improvement, Spain (case study 6)

Floodbreaking hedgerows in southern France

NWRM IMPLEMENTED

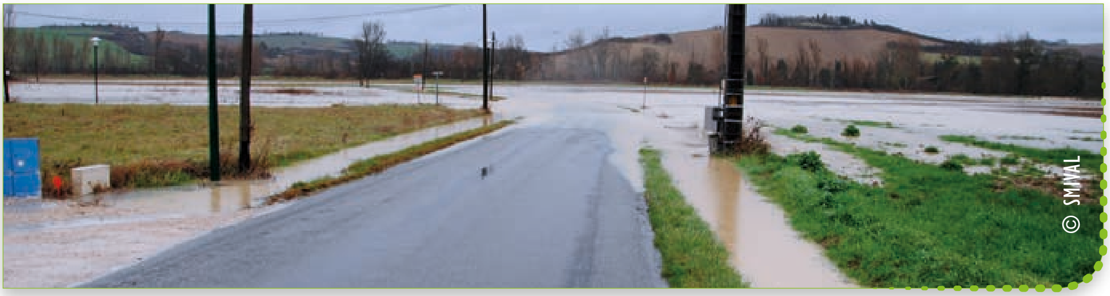
- **A02** Buffer strips and hedges

Context

The Lèze river basin is a narrow valley of 350km² and 52km length, located in the Midi-Pyrénées region (Southern France). It is located in the Pyrenees mountain range, extending from the hills down to the plains, with altitudes ranging between 160 and 700m. 83% of the catchment is covered by **agricultural land**, mostly irrigated cereals covering the plains and part of the hills. Riparian vegetation and trees are dense, but within the last 28 years, 300km of hedgerows have disappeared, mostly due to land consolidation. Upstream, the steep slopes make agriculture harder, and copses occupy most of the landscape. Mean annual rainfall in the catchment reaches 795mm

Management issues

In 2000, the catchment experienced its **largest and most destructive flood** since 1875, which damaged hundreds of houses and impacted economic activities. A long duration rainfall event localized above the catchment and of a huge spatial extent, combined with soils already saturated with water, played a role in creating the flood. However, the main factor is considered to have been the state of the landscape and water courses. Indeed, the loss of **hedgerows** has had several direct consequences on the water cycle: decreased infiltration rate and increased runoff rate, concentration of the runoff and acceleration of overland flow, an increased risk of soil erosion and more frequent risk of mudslides, and ultimately higher and faster **peak flow** during flood events. The floods that occurred in 2000 and again in 2007 showed that water management needs to be planned at the whole-catchment scale.



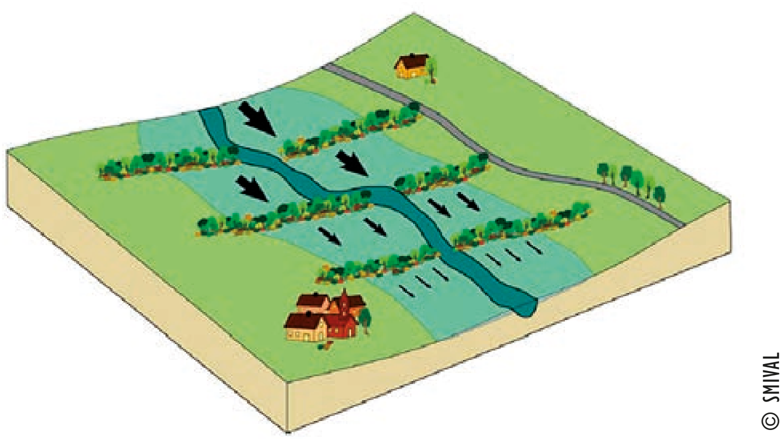
Floods in the Lèze valley

Objectives

Planting flood-breaking hedgerows addresses several policy objectives. The primary target that justified their implementation in the Lèze basin is **flood risk mitigation.** Indeed, the aim of flood-breaking hedgerows is to delay and spread out the peak-flow of the river during flood events; by partially obstructing the flow, hedges can slow down running water. If the length of the hedgerows network is sufficient, the measure can have a cumulative effect at the scale of the whole valley, leading to decreased flows and reducing flood risks. Flood-breaking hedges also aim to reduce the energy of the river and its potential for erosion, and help to filter nutrients; these contribute to improving the status of physico-chemical and hydromorphology quality elements (under the Water Framework Directive), thus helping to prevent surface water status deterioration. Planting hedges also contributes to maintaining and increasing **biodiversity**, through species diversity and by providing habitat and connectivity.They also contribute to the provision of cultural benefits by recreating a traditional heterogenic landscape.

The measures implemented

Flood-breaking hedgerows are composed of three to five rows of **native trees, shrubs or bushes** adapted to the local soil, climatic and disease conditions. Hedgerows are planted on the floodplain **perpendicular** to the riverbed and are regularly spaced (every 300 to 500 m). The trial site and plantation program were launched in 2009-2010 by planting two pilot hedgerows. In total between 2009 and 2014, about 6km of hedgerows have been planted across the Lèze floodplain, with a further 5km waiting for administrative approval. The objective is to reach **35km** by 2016.



Floodbreaking hedges obstructing the flow and slowing down running water

Flood - breaking hedgerows in southern France

Governance

Planting flood-breaking hedges is one of the measures of the **Action Programme for Preventing Floods** in the Lèze catchment, a French policy tool that aims to prevent and mitigate flood risk. Its implementation is supervised by a Technical Committee, presided over by the president of the SMIVAL - an association of 24 communes located in the Lèze's valley. As the responsible party for leading, defining and implementing actions for qualitative and quantitative use of the Lèze and for preventing floods, the SMIVAL is the initiator and the responsible party for the implementation of flood-breaking hedges. As the project concerns cultivated areas, the SIMVAL involved the Chambers of agriculture (representing farmers) in all the steps linked to agricultural issues (e.g. consultation phase, definition of a land policy) and proposed different types of **agreements to farmers.**

Mobilising financial resources

Up to now, about €75 000 has been spent on planting flood-breaking hedgerows, including compensation for farmers and technical studies (about €9 000). Several financial resources have been mobilised for implementing the measure. 20% came from the SMIVAL itself, which is partly financed by all the municipalities that compose it, and 80% from other partners: mainly the **Water Agency** and the **French State**, then the Region and the Department and finally Europe (ERDF). One linear meter of hedgerow is assessed in the Action Programme for Preventing Floods as costing €11, but costs reached €45 to 60 on the pilot sites.

Workshops organized with local stakeholders

Main impacts & benefits

Although no in-depth hydrological analysis has been carried out in order to assess the impact of flood-breaking hedges on the dynamic of flood events, hydrological models show that covering the Lèze floodplain by regularly spaced flood-breaking hedgerows can **reduce the peak flow** during flood events by 25%, in comparison to the same floodplain with field crops only. In reality, hedges already existed in the catchment (about 900km in total) and the project will not be able to create as dense a network of hedges as assumed in the hydrological modelling. Thus, the impact on peak flow might be lower than 25% Regarding biodiversity and habitat restoration, no monitoring has been carried out. A **botanical path** has been installed by the pupils of a local school, which includes interpretation boards presenting the local species constituting the hedges, and allows people to become familiarised with the ecosystem they are living in. Through this, they are providing a cultural amenity benefit..

Implementation challenges

Implementation of flood-breaking hedgerows requires the involvement of farmers and land owners, since hedges are planted on private land. Thus, it faces several challenges: addressing land property and attachment to land, dealing with farming constraints such as locations of irrigation and drainage equipment, mitigating the impacts of the measure on the organisation of the farm, providing a sufficient level of compensation to raise the interest of concerned farmers and owners. Regarding technical issues, the location and design of hedgerows requires hydrological studies.

Lessons learnt from other case studies

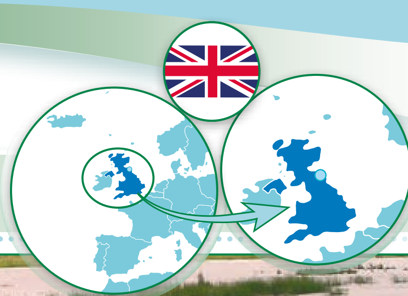
Other case studies involving buffer strips and hedges are often primarily implemented to target **diffuse pollution**, particularly on agricultural land. The most common types of buffer strips are grass strips along the sides of the fields, which appear to have a positive impact on nutrients concentration reduction. In this case however, the primary target is flood risk. In fact, buffer strips are good examples of multi-benefits measure since they generally have an impact on both water quality and runoff. Habitat restoration and biodiversity preservation are also usually addressed by such measures.
Other examples of implementation also show that the involvement of **farmers and land owners** in the process is a key success factor for implementation of buffer strips and shelter belts. In Heilbronn (Germany), farmers have been involved from the design stage, which has helped them to make the project their own. Establishing a trusting relationship between farmers and local authorities is essential. In all cases, **compensation** arrangements for farmers are needed to raise their interest and make the project economically acceptable for them. Sustainability of compensation is a main issue, since financing often relies on multi-annual programs. Another success factor demonstrated by Orség National Park case study, in Hungary, is the ability of the measures to address several pressures and of the local authorities to make their impacts visible; raising people's awareness about their environment and the provision of aesthetic or recreational amenities contributes greatly to making the measures acceptable.

Plantation of hedges

For additional information

Contact:
Thomas BREINIG, Director of the SMIVAL, *smival@wanadoo.fr*
Full case study factsheet:
http://www.nwrm.eu/list-of-all-case-studies, Flood-breaking hedgerows in Southern France (case study 13)

Rural runoff attenuation in the Belford catchment



Offline storage pond constructed of a leaky timber barrier, to release flow slowly to the river

NWRM IMPLEMENTED

- **N1:** Basins and ponds
- **F10:** Coarse woody debris
- **F13:** Peak flow control structures in managed forests
- **F14:** Overland flow areas in peatland forests

Context

Belford Burn catchment is located close to the eastern coast of the United Kingdom, in Northumberland. The catchment area upstream of Belford village is 5.7km². It is a generally **rural area,** at an altitude of between 50-200m AOD, with predominantly **pasture and cultivated grasslands**, and some mixed forest. In the catchment, average annual rainfall is around 700mm, with an average annual standard percentage runoff of 40% (but often much higher during storm events).

Management issues

Belford village has a long history of **flooding**, with historic damage to properties and infrastructure (roads and rail), and approx. 35 homes being identified as at risk from flooding. An Environment Agency flood defence pre-feasibility study concluded that **traditional flood defences were not suitable** for Belford because of the high cost, lack of space for flood walls and banks, and the small number of properties at risk, resulting in an unfavourable cost-benefit assessment. There was a desire to deliver an alternative catchment-based and more cost-effective solution to the problem.

In addition to the flood risk concerns, the river waterbody Water Framework Directive (WFD) **ecological status** for Belford Burn in 2009 (i.e. early in implementation) was classed as **poor**, and predicted to remain as such by 2015. Average annual reactive P concentrations exceeded levels prescribed under the WFD. Other water quality determinands (Ammonia, DO and nitrates) were below recommended thresholds. Main sources of water pollution identified were agricultural diffuse pollution and domestic septic tanks. Potential water quality risks could also affect Lindisfarne National Nature Reserve and Special Protection Area (300 species of birds) which is located at the downstream end of the catchment.

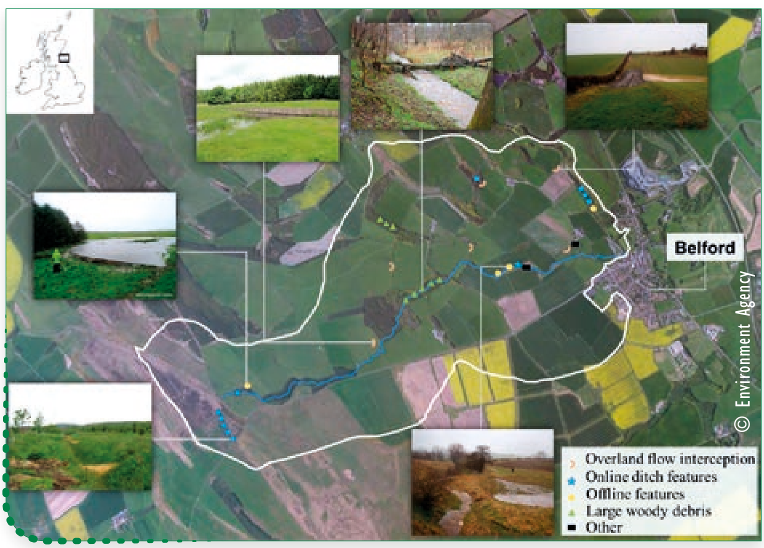
Management issues therefore include **three types of pressures:** flood pressures (a combination of natural exceedance and alterations to land use and drainage upstream), WFD pressures (changes in water quality status due to agricultural diffuse pollution within the catchment) and Birds Directive pressures (also relating to poor water quality being transferred downstream).

Objectives

The main objective of the project was therefore to provide a **catchment-based** solution to flood risk mitigation, by **attenuating runoff** upstream of the areas most at risk from flooding. The catchment-based approach would also provide opportunities to address water quality concerns linked to agriculture, which had been identified under the WFD. It therefore aims to address European requirements related to the Floods Directive (mitigating flooding to homes and infrastructure in a sustainable way through catchment-based approaches), but also to the **WFD** (achieving good ecological status and objectives for protected areas), and to **Birds Directive** (protection of habitats for endangered as well as migratory species). National requirements related to flood risk management are also targeted.

The measures implemented

The Belford Burn catchment project was implemented between 2008 and 2013. The project involved the installation of a suite of **35 small NWRM**, which are operating in combination upstream of the village of Belford. The measures include interception of diffuse overland flow paths, on-line ditch blocking (including the use of large woody debris) and off-line ponds. In total they treat slightly less than 570ha. The total storage capacity from the main phase of work (i.e.35 NWRM) was between 9 000 and 10 000m^3. The maximum capacity of individual features was up to: 1 000m^3 for overland flow interception, 150m^3 for online ditch features, 3000m^3 for offline ponds, 150m^3 for large woody debris. A few further features were also added at a later stage, as opportunity and funding became available, in particular some measures designed more specifically for sediment trapping. These have increased the total storage towards **15 000m^3**.
The upstream characteristics of the watercourse (small channels) are ideal for implementation of these types of NWRM features as the scale of flows to be retained is not large and the size of the feature can be kept small, resulting in little loss of agricultural land. The catchment offers low grade ditches that can be engineered without damaging existing conservation and ecological factors.



Belford catchment, with examples of measures located throughout the catchment

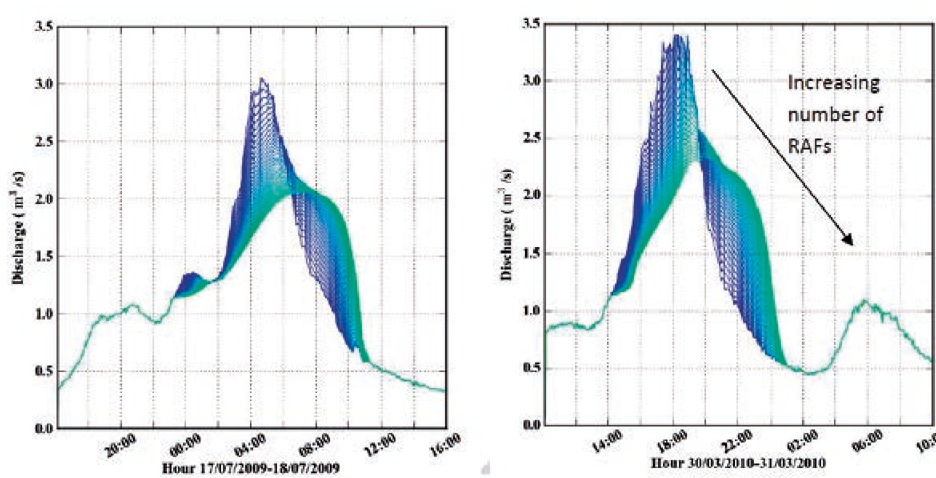
Rural runoff attenuation in the Belford catchment

Governance

The Belford application was initiated by the **Environment Agency and Northumbrian Regional Flood Defence Committee**, and involved the formation of a project team that included the Environment Agency, Newcastle University and Northumberland River Trust. The Environment Agency was in charge of the implementation and both of coordination and financing of the project. Design and delivery was carried out by Newcastle University for Phase 1 and the Environment Agency to Phase 2.
The willingness of the regulator (Environment Agency) to consider **alternative approaches** was crucial for enabling exploration of non-traditional solutions to flood management. Some delays occurred in early measure implementation due to the need to **consult widely** on the approach. Dealing with a new concept meant that time was required in the early stages to work with farmers and the community. The **involvement of farmers** in the programme was central to achieving the greatest level of effectiveness, with farmers being engaged in decision-making and able to suggest locations for measures and modify designs to gain greater agricultural and environmental benefits. Good existing relationships between farmers and the wider community helped throughout the scheme.

Mobilising financial resources

The project was funded by the **North East Local Levy,** which was raised by the Northumbria Regional Flood Defence Committee though Local Authorities (public funding). The total project cost to date has been €300 000. Individual features cost approximately: barriers (€900-2 000/m dependant on material), woody debris (€120- 1 200 per feature), offline ponds (€6 000 per feature and less if there are multiple ponds in close proximity). The land on which the measures are located is still owned by the farmers, with the measures having been implemented with **minimal loss of farm land.** A one-off payment of €1 200 per feature was made by the Environment Agency to farmers for land access during implementation.



Modelled influence of an increasing number of retention features on a flood peak

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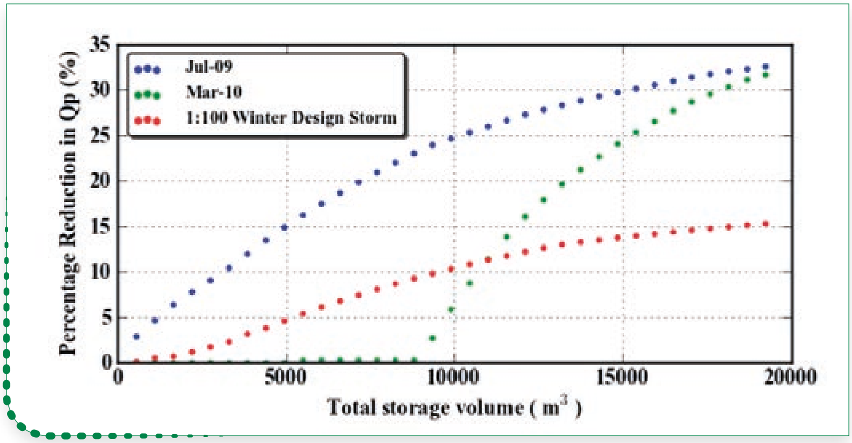


Model results showing the influence of increasing storage volume on reducing peak flows

Source: P. Quinn, G. O'Donnell, A.Nicholson, M. Wilkinson, G. Owen, J. Jonczyk, N. Barber, M. Hardwick and G. Davies (2013). Potential Use of Runoff Attenuation Features in Small Rural Catchments for Flood Mitigation. Newcastle University and Royal HaskoningDHV in partnership with the Environment Agency

Main impacts & benefits

Monitoring of benefits regarding flood risk reduction is ongoing. Photographic and video evidence from farmers showed that the NRWM were clearly holding water upstream of the village. **Modelling** results from the project have demonstrated a network of runoff attenuation features, similar to those implemented in Belford catchment, to have a positive impact on flood hazard in small catchments. Modelling and direct comparison work (using monitoring data) indicates that the individual impact of a single feature on peak flows is relatively small because individual features provide only a small amount of storage each. The benefit to peak flow rate reduction is achieved through implementing a larger number of measures, distributed throughout the catchment, which provides a **cumulative positive effect.** Further assessment has been undertaken on the combined impacts of a hypothetical pond network providing 19 250m^3 of storage, which modelling showed to provide 15 to 30% peak flow reduction. Investigations to assess effectiveness of features for reducing losses of sediment and nutrients began in 2009. Monitoring showed that after a large runoff event a single retention bund captured an estimated **1 tonne of sediment**. The overall, cumulative impact of all the NWRM has been found to be difficult to prove, and to require extensive monitoring. However, it was identified that different features operate to retain pollutants under contrasting flow conditions. Online features appeared to be functioning to reduce chronic losses of suspended solids, but were less effective in storm events (being ineffective at retaining pollutants during the rising limb and peak of flood events). In contrast, a multi stage NWRM (constructed following findings of initial NWRM) that included a sediment trap and willow barriers worked effectively to reduce sediment and nutrient losses from the catchment during storms: it showed average reduction in pollutant concentrations of 40% SS, 26% TP, 25% soluble RP and 15% NO3 over a 24hour storm event. While clear quantitative evidence is not yet available at the catchment-scale, improvements in the water quality within the catchment should improve ecological status and biodiversity. Habitat benefits are also likely to be associated with the creation of pond features within the catchment.

Implementation challenges

Some of the NWRM features implemented at Belford (e.g. ditch blocking) themselves do not directly result in a loss of the land available for farming, due to being sited within the river channel. Others, such as ponds, do involve a possible loss of productivity due to land loss, but individual features are very small and total coverage of all measures in the catchment was a very small proportion of the total area. **Loss of land** was able to be minimized at Belford, particularly by working closely with farmers. For example, measures can be located in the corner of fields, integrated in to buffer strips, or can make use of low-lying areas that may have had lower productivity historically anyway due to becoming waterlogged.

Fish passage requirements can pose a constraint to the type of NWRM applied, since passage can be restricted by online structures (e.g. in stream dams). As a result, they are more suited to small watercourses and ditches where fish passage is not important or the watercourse runs dry during the summer months. On all watercourses, in-stream channel structures (e.g. online flow storage) that interrupt normal flow required a consent from the Environment Agency for works in a watercourse. All measures are under **continuous review** and a number of them are undergoing varying degrees of modification and optimization (for example to increase their storage capacity). The project has allowed preferred construction approaches to be identified, that can be applied in future projects (for example, a general preference for use of treated timber rather than earth bunds, particularly where livestock are present). Ultimately the measures are designed to be maintenance free, with the exception of the online ponds, for which an agreement is in place with the farmer. This type of maintenance in itself may provide an opportunity to re-use nutrient-rich sediments. Some ongoing inspection and management is, however, preferable, for example after large events.

An offline storage pond under construction in the corner of a field

Lessons learnt from other case studies

Other case studies involve basins and ponds and coarse woody debris implementation, such as **Pickering (UK) case study.** A major lesson learnt from this example is that local communities appear ready to embrace the concept of a **whole-catchment approach** to flood risk management. The concept 'makes sense' and fits the green agenda. However, there is a need to be clear in communicating flood risk. Partners also need to adopt a 'can do' attitude and not be risk averse and good communication is vital to ensure that plans are understood by all and incorporate local knowledge. Financial and legal context can in some cases be a major barrier to basin and ponds implementation: in **Poland**, low financial inputs but also complex formal procedures due to legal restrictions, associated mainly with environmental protection, led to only 9% achievement of the total capacity of thousands of reservoirs and ponds, reconstructed, modernized and constructed in order to manage flood risks. In Belford, a number of new features will be built differently based on experience gained through the project to date.

For additional information

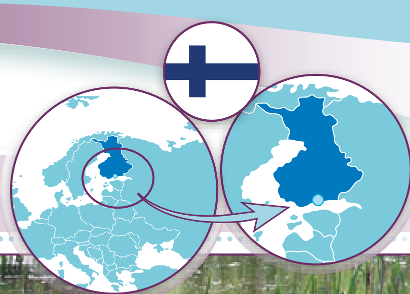
Contact:

In the first instance please refer to https://research.ncl.ac.uk/proactive/belford/

Full case study factsheet:

http://www.nwrm.eu/list-of-all-case-studies, Rural runoff attenuation in the Belford catchment, UK (case study 41)

Nummela 'gateway' wetland park



The Nummela Gateway Wetland Park is an oasis for urban dwellers

NWRM IMPLEMENTED

- **U11:** Retention ponds

Context

The **Nummela Gateway Wetland Park** was constructed in 2010 to celebrate the United Nations Year of Biodiversity. It is located in the municipality of Vihti, in the Uusimaa region of Southern Finland. The park is at the main freeway entrance from the Metropolitan Helsinki Area to Nummela. Vihti is located in the Kymijoki-Gulf of Finland River Basin District. Nummela Gateway Wetland Park was implemented as part of a wider project at the **catchment level,** following a holistic assessment of watershed processes and dynamics. New wetlands were created along the heavily degraded stream corridor to compensate for land-use changes within the watershed and to establish critically endangered clay stream corridor habitats, and a large wetland park named the Nummela Gateway Wetland Park was established at the mouth of the **Kilsoi stream**, just upstream of Lake Enäjärvi. Over a half of the 550ha watershed is urbanized, but agricultural lands remain: the wetland has been implemented at an abandoned crop field site. Climate in the area is cool temperate moist with 4.6°C mean temperature and 650mm/year of rainfall.

Urbanisation was degrading the Kilsoi Stream and sealing it into culverts until a management change was made in early 21st century.

Management issues

Two main management issues are targeted by the project. First, due to land-use changes and inadequate urban waste water management until the 1970s, the Lake Enäjärvi had been experiencing **poor water quality** and related adverse impacts such as increased algal blooms and fish mortality. Secondly, problems such as heavy erosion during rain and snowmelt events, degradation and loss of habitats, and low water quality were common in the area, preventing local people from accessing and enjoying their **surrounding natural environment**. The Kilsoi stream was disappearing into pipes and culverts and its name had been erased from maps. A mere straightened drainage ditch that had been cleared of vegetation was all that remained, and was not recognised as an asset in city planning.

Objectives

The design and implementation of Nummela Gateway Wetland Park aimed to achieve multiple purposes, both biophysical and social. It was constructed both as a landscape to provide mitigation to the water environment and as an urban park. The wetland was expected to have a moderate function in treating inflowing water quality before entering the receiving lake, thus **removing pollutants** (the wetland mean inundated area is only 0.1% of its watershed area, whereas it is commonly suggested that water pollution control requires 1-5 % wetland area of the contributing watershed area, hence the expectation of only moderate removal rates). The wetland also mitigates peak flows, reducing erosion typically associated with urbanisation. Furthermore, the Gateway Wetland Park targets biodiversity improvement through providing an **oasis for local fauna**: the park is a gateway for the lake fauna to the stream Kilsoi. Clay-dominated stream habitat is critically endangered in Southern Finland, so establishment of wide areas of this habitat type within the revived urban and clay-dominated Kilsoi Stream corridor was attempted. In addition to these biophysical aims, the desire was for the park to provide an oasis for local people and opportunities for environmental education.

The measures implemented

Nummela Gateway Wetland Park was constructed in 2010, on an abandoned crop field where the stream existed as a straightened and cleared ditch. In winter 2010, land formation works were carried out as winter-time dry excavation, to provide the basic structure of the site that defined long-term vegetation and habitat establishment. Vegetation was then allowed to self-establish on the area. **Three habitat islands** were constructed, the banks of which were secured with bundles of local willow branches. Native trees were planted during a volunteer event for local residents in order to provide shaded areas. Typical of an urbanised area, inflow to the wetland fluctuates greatly - from circa 10l/s during dry periods to circa 1 000l/s during heavy rain and snowmelt events. In addition to vegetation, widening of the stream and installation of stilling ponds and rock structures were used to dissipate erosive flow energies. All old drainage ditches within the site were blocked to create amphibian habitats that are safe from predatory fish that enter the wetland main pool (many fish spawn in the spring, from the lake). A bird observation tower was built at the wetland, which offers observation of birds both at the wetland and in Lake Enäjärvi.

A volunteer event for residents was carried out to plant native shade trees and install willow bundles to stabilise island banks.

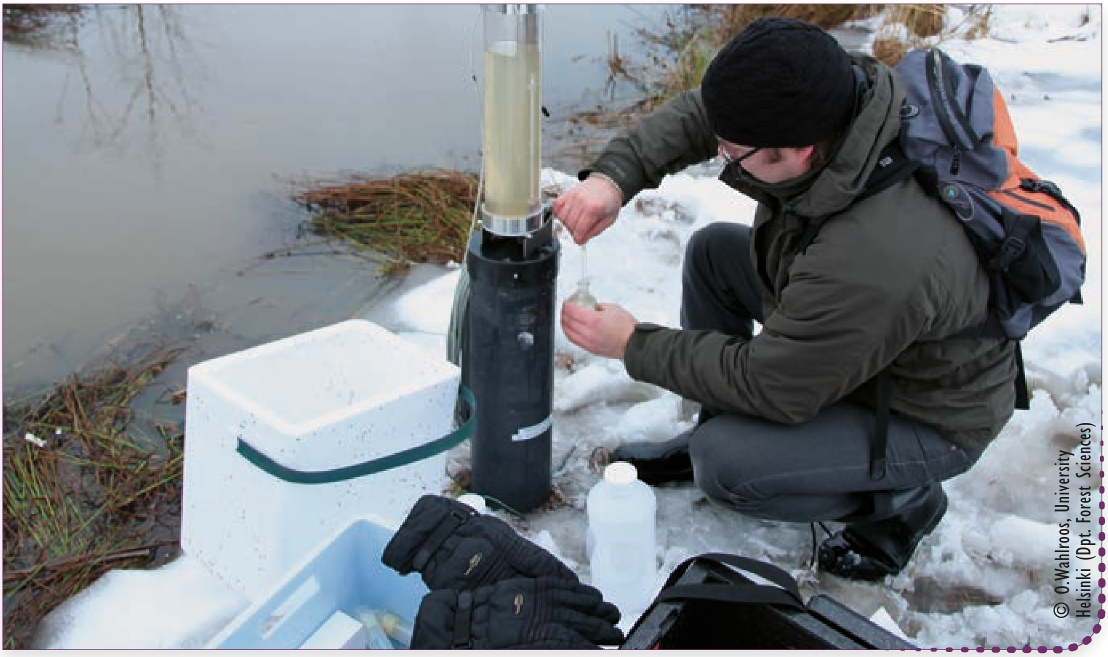
Nummela 'gateway' wetland park

Governance

As part of the UN year of biodiversity celebrations, the construction of the wetland was carried out as a collaboration between the University of Helsinki, the municipality of Vihti, and the Uusimaa Centre for Economic Development, Transport and the Environment (UUDELY), with support from a range of local and regional stakeholders. **Participatory approaches** and engagement of stakeholders in the design and implementation of the process were found to be beneficial to long-term success. **Collaboration** between environmental, planning and technical authorities was crucial. In addition, the local association for the Lake Enäjärvi water protection (VESY ry) was an active partner in the project supporting several voluntary actions. UUDELY participated in project management and monitoring from the beginning, providing **guidance and support** at the regional level. Appropriate **technical expertise** (e.g. sustainable landscape design and monitoring) was secured by involving experts from the University of Helsinki, Luode Consulting Oy, UUDELY, and Water Protection Association of the River Vantaa and Helsinki Region. The Finnish Association for Nature Conservation (SLL) has supported communication and **environmental education** activities.

Mobilising financial resources

The total initial cost of the Gateway Wetland Park project (which included creation of the clay-stream habitat and related wetlands, as well establishing vegetation and constructing a nature path) was €52 000. The project was funded by Vihti municipality (58%) and the regional authority of the Uusimaa Centre for Economic Development, Transport and the Environment (42% or €25 000). Subsequently, a **LIFE+ project** was then developed and implemented for 2012-2017 as follow up and expansion with similar activities in the area.



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Monitoring of the wetlands is carried out year round to elucidate the impact and to define ecosystem services provided

Main impacts & benefits

Several parameters have been **monitored** in water at the wetland inflow and outflow since implementation: continuous flow and water level, nutrients, conductivity, temperature, pH, oxygen, hydrocarbons, metals, bacteria. In addition to assessing impacts on water quality and quantity, the impact of the wetland on carbon cycling and greenhouse gases has been monitored. Vegetation and fauna have been observed in order to assess the establishment of critical habitats in urban settings. Evaluation of ecosystem services has included interviewing local residents about their perception of the created parks.

Based on continuous (sampling at 10 minute interval) water monitoring, water quality improvements have been observed, including a 10% reduction in phosphorus (P) concentration on an annual basis, which is contributing to **decreasing the risk of eutrophication** in Lake Enäjärvi. The wetland retains P comparatively most efficiently during the growing season in July, although P retention was highest in terms of absolute quantity during the rainy season in October and November. The highest-event based reduction of total phosphorus observed was 71%, during a late growing season rain event in 2013. **Peak flow rate** has decreased by 40% compared to the previous state (before the implementation of the measure).

The measure has also had positive impacts on **biodiversity**. The wetlands were constructed by excavation in abandoned crop fields, and vegetation was allowed to self-establish. Seven vegetation zones have been identified at the Gateway wetland: natural flood meadow by the lake; constructed islands; constructed wetland area; two drier wet meadow areas; area of Salix shrubs, and adjacent forest edge. Annual monitoring for species and foliar coverage in summers of 2010-2014 (94 plots of 0.5 m^2 each) revealed that self-establishment of vegetation in the Gateway wetland has been rapid, rich in taxa, and dominated by **native wetland species**. Only two alien species were identified: Elodea canadensis in deep water areas and Epilobium adenocaulon in drier meadow areas. The number of herbaceous species reached 102 in the fifth growing season in 2014.

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 concentrations in water during winter 2012-2013 indicate that the site has been a source of CO_2 and CH_4 into the atmosphere. However, ice cover has prevented GHG emissions in winter. The GHG concentrations in water were sensitive to changes in flow rates.

Frog heaven

Extra vegetation establishment was observed with 0,5 m^2 plots

Implementation challenges

Implementation of catchment scale based sustainable stormwater management measures such as the Nummela Wetland Parks requires **available space** at suitable locations in the landscape. In the increasingly urbanised Nummela, the majority of the Kilsoi stream was already confined in underground culverts before the management shift was made. The shift required collaboration within the municipality towards a common goal by environmental, planning, civil engineering and landscaping leadership. Outside assistance was provided on theory and practice of new solutions by academic and regional level environmental stakeholders. Public acceptance was assisted by the local water protection association. Voluntarily working towards a management shift was necessary by all these project participants. The sites included in the scheme are all within the same municipality, which allowed for the necessary changes to be made to zoning. If the stream or watershed had crossed municipality borders, or a landowner had not been willing to sell their land for park purposes, the extent of land available for implementation would have been less.

Nummela project shows that much more **education is needed, with more pilot sites**, in order for sustainable stormwater management to reach a status of ´common practice'.

Local people stated that being able to observe the species-rich and continuously changing natural environment was the best ecosystem service provided by the wetland.

Lessons learnt from other case studies

Other case studies provide key lessons regarding urban NWRM. The **River Quaggy** case study (UK) includes several (urban) NWRM and shows how effective these types of measure can be, implemented within an already constrained environment, at addressing **multiple benefits** to the environment and local residents. Three key lessons can be taken from the Quaggy case study for projects implemented at the catchment scale. First, communication and a positive attitude are necessary: early and continued **consultation** is important. This includes active residents/ stakeholder engagement and involvement during design and construction including partnerships, schools and groups, as it not only ensures that the work is comprehensive in covering people's needs, but ensures a feeling of **'ownership' and responsibility** following implementation that continues for the length of the NWRM lifespan. In the case of Nummela Gateway Wetland Park, the partnership and engagement of relevant stakeholders, and the collaboration between environmental, planning and technical authorities has been crucial to ensure the success of the project. Secondly, involving **multi disciplinary teams** of engineers, architects etc, that all contribute their specialties, ensures that visual, social and ecological enhancements are optimised at the same time as managing stormwater quality and floods. Monitoring to verify the benefits from the wetland construction is important. Finally, **taking a catchment-scale** approach allows greater overall improvement and enables some measures that cannot be implemented in isolation.

For additional information

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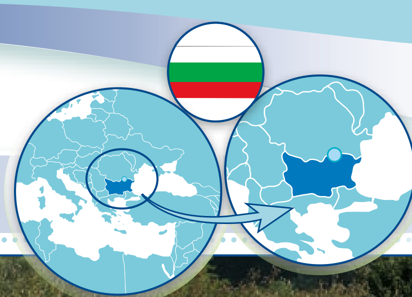
Full case study factsheet:

http://www.nwrm.eu/list-of-all-case-studies, Nummela 'Gateway' Wetland Park, Finland (case study 117)

Wetland Restoration in Persina



NWRM IMPLEMENTED

- **N2** Wetland restoration and management

Context

Bulgaria is a **riparian state** of the Danube, and the natural wetlands in the country are important for biodiversity and traditional livelihoods. Considering its size, the country has a great variety of topographical, climatic and biogeographical features. The major areas of former and existing wetlands are located along the Danube River and Black Sea coast.
More than 90% of Bulgarian **wetlands** along the Danube River have been lost through **drainage** over the last century. Drainage has been performed mainly for agricultural purposes, and also to reduce mosquito populations as a measure to combat malaria. Today the importance of the wetlands for biodiversity conservation and ecosystem benefits has been reconsidered and the Government of Bulgaria has implemented several restoration projects, which are supported by NGOs.
The project is located in Northern Bulgaria, alongside the **Danube River**, and covers two former wetland sites. Kalimok/Brushlen (1 755ha) is situated between the towns of Rousse and Tutrakan within Kalimok/Brushlen Protected Site, and Belene Island (2 280ha) is located within Persina Nature Park. The latter is the largest Bulgarian island on the Danube (15-16.5km long) and divides the river into two arms, northern and southern, where a number of smaller islands are located. The northern arm is a navigation route with great significance to international transport. The southern arm is barred by a pontoon bridge with an underwater barrier, so is accessible only to small boats. The dominant land use on these areas is thus rivers and wetlands, with lowland heath (natural, semi-natural) and arable lands also found on the banks. Soil types in the area include Fluvisols, Gleysols and Vertisols, with a very gentle slope. The climate is cool temperate dry and the mean annual river flow in the main river Danube at Belene is approximately 6000m^3/s.

Management issues

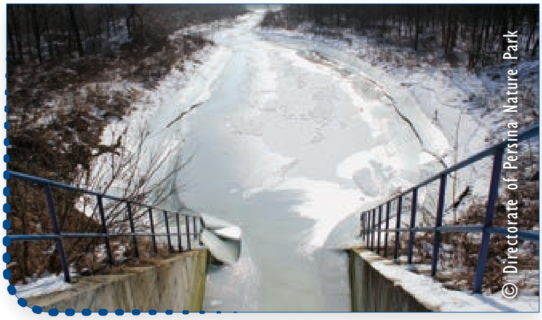
Along the Bulgarian bank of the Danube, about 1,280km^2 is floodplain. As a result of drainage, the wetland area is now only about **10% of its original size** at the turn of the century, reducing the capacity of its ecological functions. One of the key functions is considered to be water purification. Therefore, due to the loss of that natural function, **nutrient pollution** (from urban waste and agriculture) needs to be mitigated for. Bulgarian wetlands along the Danube provide essential spawning grounds for numerous species of fish and provide critical winter and feeding habitats for water birds migrating through the northwest shelf en route from Eurasia to Africa. This function is also threatened by wetland drainage: morphological changes have altered their **habitats**. Today, the Danube River is classified at **moderate ecological status** according to the monitoring data of Water Framework Directive (WFD) compliance quality elements. The biological monitoring (macro invertebrate fauna) vary between 2 and 2-3 (of 5 quality classes).

Objectives

Wetlands are of vital importance to biodiversity and provide essential environmental services such as retention/reduction of nutrients and reduced pollution of water and sediments, as well as groundwater recharge. Wetland restoration has two main targets: improving **natural assimilation** (purification) of effluents through dilution, dispersion, and physico-chemical processes, and conserving **biodiversity and the gene-pool** in riparian areas. More specifically, this project aims to 'create a model for reducing trans-boundary nutrient loads in the Danube and Black Sea basins and to preserve biodiversity in the protected sites through: restoration of wetlands, management plans for protected sites and support to the local people in adopting **environmentally friendly economic activities**'. Therefore, it addresses **WFD** requirements: mitigation of nutrient pollution and morphological alterations to achieve good ecological status, restoring a Heavily Modified Water Body (Lower Danube) and achieving objectives for protected areas (Natura 2000). It also addresses the **Birds and Habitats** Directives. Regarding national policies, the project responds to the River Basin Management Plan (RBMP) of the Danube River District, the National Wetlands Conservation Plan of Bulgaria and the National Biodiversity Strategy. Persina Nature Park and Kalimok/Brushlen Protected Site were selected as project sites due to the high value of their biodiversity, the wetland capacity to extract biogenic pollutants and their role for flood prevention.

The measures implemented

The project was carried out in the period 2002-2008, with wetland restoration works commencing in 2007. It consisted of constructing **engineering facilities**, including sluices, channels and dykes to protect the adjacent land, as well as access roads. The purpose of the new facilities was to enable water to flow into former wetlands, and provide options for controlled flooding, optimised trapping of nutrient elements, and restoration of biodiversity and fish populations. Today, the retention capacity of the two sites corresponds to **40 to 60 days of flooding annually**. The technical design of the project in the Persina site includes three inflow sluices (2 and 1.5m) corresponding to a maximum runoff capacity of 17.3m^3/s, and one outlet facility (double sluice with dimensions of 2 per 2/1.5m) with a maximum capacity of 34.6m^3/s. The technical design for Kalimok-Brushlen includes one inflow sluice (2 per 1.5/1m) with a maximum capacity of 18.6m^3/s, one inflow sluice (2/1.5m) with a capacity of 20.5m^3/s, and one outlet facility (2 per 2/1.5m) with a capacity of 37.3m^3/s.
The **design** of the infrastructure facilities was developed dependent mainly on the topography of the island (for Persina) and of the riparian bank and floodplain zone (for Kalimok-Brushlen). Other key factors were the shape and depth profiles of the former wetlands, design of the old dykes, hydraulic parameters of Danube River (flow, water level and seasonal fluctuations) and the desired water regime for the wetland biodiversity. The project design followed the objectives related to biodiversity conservation and the principle of conformity with the management objectives of the protected sites. It also relied on National standards and protocols, Environmental Assessment and EU WFD guidelines.



Inflow sluice and channel connecting the wetlands with Danube River

Inflow sluice on the protection dyke of Persin Island

Wetland Restoration in Persina

Governance

The project was initiated by the Ministry of the Environment and Water of Bulgaria, which was a success factor for the implementation. The Ministry took charge of the **overall project management and implementation,** including subcontracting of studies, technical design and construction works. NGOs also supported the project. Delays to the project occurred as a result of administrative difficulties related to land ownership/statute. **Participatory approaches** to wetland restoration design were critical for the project success, which hinged on changing people's **perceptions** of wetlands, and gaining the full support for restoration among authorities and stakeholders. Local Consultative Councils and public awareness campaigns effectively supported stakeholder involvement. Today, Persina Nature Park Directorate is involved in long-term maintenance and monitoring of impacts, which ensures continued future operation of the NWRM. The Danube River Basin Directorate is responsible for monitoring WFD compliant quality elements, and integration into the RBMP.

Mobilising financial resources

No economic and financial analysis was carried out prior the project start because of the emphasis on wetland restoration and biodiversity conservation, as opposed to revenue generation. However, the Project Appraisal included an incremental cost analysis and an analysis of **cost-effectiveness** for the removal of nutrients. It indicated that the project would be cost-effective at reducing nutrient loads in the Danube River. Total cost-effectiveness ratios were estimated at €1.15 to €4.40 per kilogram of nitrogen and €25.50 to €40.75 per kilogram of phosphorous removed annually.

The total cost of the wetland restoration project was M€9.7, including M€5.48 million for design and construction, M€0.6 for management and monitoring and M€3.6 for administrative costs (establishment of proper site management - including elaboration of a Management Plan -, capacity building, technical assistance and monitoring). It was mainly financed by **GEF / World Bank** (M€5.35), **State budget** (M€2) and **EU PHARE** Pre-accession instrument (M€1.5). **Municipalities** contributed M€0.07 and the Austrian government M€0.17. The long-term maintenance and operation will be ensured by State budget and/ or future grant contributions. No income loss is estimated for the wetland restoration: wetland restoration design physically excluded flooding and adverse impacts on private lands, and there are no remaining unresolved issues related to the land and property ownership or access to resources; thus no financial compensation was required.

Manual operation of the facilities by the staff of Persina Natura Park

Main impacts and benefits

The high river flow of the lower Danube makes it difficult to assess the relative impact of the NWRM due to the scale. It is however proven that the project has played a significant role in **re-connecting** former wetlands, with 80% of the water regime having been restored. The measure also impacts the overall water quality through **nutrient reduction and capture** (Nitrate, Phosphorous) and by capturing organic pollutants. Improved self-purification and nutrient capture capacity of the river system contributes to mitigating the impacts of untreated urban waste waters (responding to UWWT Directive requirements) and has a direct contribution to the implementation of the Bird and Habitat Directives. Regarding ecological status, the project showed positive impacts on **morphological parameters** (connectivity) as well as an expected positive impact on Biological Quality Elements – fish fauna. It contributes to the conservation objectives of water-dependent protected areas. It is expected to take 10 to 15 years for the restored wetlands to reach the desired ecosystem value. The river runoff reduced by 1 to 10%, which contributes to controlling runoff, but no published data or estimation exists on peak flow rate reduction: taking into account the total runoff of the Danube River in peak flow, the overall impact on flood reduction for the Danube is limited, although nevertheless contributes an incremental improvement.

Other benefits also resulted from application of the measure. **Biodiversity** has improved, with the number of birds of 22 species increasing and fish species increasing from 2 to 10 within two months of the first test flooding of Belene Island. Moreover, the wetland sites offer a chance for future **tourism** development in the region, new employment opportunities and economic benefits due to **fishery and biomass** production. As an example, the project supported initiatives such as manufacturing charcoal briquettes from reeds harvested from the restored wetlands. Improved farming techniques and the development of organic certified crops created potential for increased value of agricultural products and revenue for farmers. Finally, the Danube wetland restoration introduced a new idea that wetlands are not a necessary 'evil', also making the **landscape** attractive in additional to being functional. The first follow-up project, 'Kaikusha', has been approved under the EU LIFE+ program and will help develop feasibility studies to restore the Kaikusha Marshes in the Danube River basin.

Marsh harrier

Wetland Restoration in Persina

Implementation challenges

One barrier encountered during the project was the lack of **solid knowledge** on the baseline and of defining **specific objectives** during the design phase. The targeted ecosystem status had not been clearly defined at the project start. Moreover, insufficient national **expertise** in wetland restoration led to difficulties with the technical design of the project. There were some delays in the completion of detailed design for Belene and Kalimok marshes wetland restoration and management planning, causing a delay in the construction works and so in the development of the nutrient reduction strategy guidelines. Changes to national legislation during the period of the project implementation also affected the approval procedure and imposed constraints in terms of budget and time. Another difficulty during implementation was gaining public attention on wetland restoration as a nutrient reduction tool. A lack of sustainable business cases for sustainable reed biomass utilisation challenged the project feasibility.

Lessons learnt from other case studies

Another wetland restoration and management project (Kylmäojankorpi forested wetland, Finland) shows that wetlands are efficient measures to improve and regulate **water quality** and **stream flow** characteristics. In Odense River, Denmark, water detention through temporary flooding of wetlands plays a significant role in reducing peak flows, and thereby decreasing water levels and **flood risk** in downstream towns and villages during extreme precipitation events. **Economic and social** (recreational) benefits can often be generated by the projects and can be a supporting factor for implementation. In all cases, involvement of farmers is a key success factor for projects implemented in agricultural areas. Similarly to the Bulgarian project, the wetland restoration project in Western Lowland Area of the Dümmer Lake, Germany, led to a LIFE+ project (Project Meadows Birds).

For additional information

Contact:
Directorate of Persina Nature Park, *www.persina.bg, persina@abv.bg*

Full case study factsheet:
http://nwrm.eu/list-of-all-case-studies, Wetland restoration in Persina, Bulgaria (case study 29)

YOUR NWRM GLOSSARY

You will find below the definitions of key terms used in the guide. If you are looking for additional definitions related to NWRM or similar measures, you might find them in the glossary of the NWRM knowledge base at *www.nwrm.eu/glossary/*.

Term	Definition
Avoided costs (or costs avoided)	Equivalent to an indirect benefit: financial outlays, negative impacts or welfare losses on anyone which are avoided by choosing one specific course of action among different alternatives. Some natural water retention measures (NWRM) may protect rivers and freshwater sources thus reducing other protection costs, increasing rivers' natural assimilation capacity and making other quality measures redundant. For example, mulching and other NRWM may reduce erosion and extend the lifespan of reservoirs while reducing their maintenance costs etc. These benefits are context-based (and potentially site-specific) and therefore often difficult to identify and quantify. Valuation alternatives range from the estimation of production losses to the cost of defensive and replacement measures (i.e. averting behaviour).
Common Agriculture Policy (CAP)	The Common Agriculture Policy is the set of legislation and practices adopted by the European Union to provide a common, unified policy on agriculture. (*http://ec.europa.eu/agriculture/glossary/index_en.htm*)
Common Implementation Strategy (CIS)	The Common Implementation Strategy (CIS) is the strategy developed by the European Commission and EU Member States (MS) to support the implementation of the EU WFD. It builds on the work of different expert working groups under the steering of the Water Directors of EU MS. Today, it also addresses wider EU water policy challenges, including the implementation of the Floods Directive; (see *http://ec.europa.eu/environment/water/water-framework/objectives/pdf/strategy.pdf*).
(water) catchment	A water catchment (sometimes referred to as a watershed or drainage basin) is an area of land where surface water from rain, melting snow, or ice converges to a single point at a lower elevation, usually the exit of the basin, where the waters join another waterbody, such as a river, lake, reservoir, estuary, wetland, sea, or ocean. (*http://en.wikipedia.org/wiki/Drainage_basin*)
Cost-benefit Analysis (CBA)	A framework of analysis based on economic rationality (within a number of constraints one will always try to make the decision that increases one's individual welfare) and founded on welfare economics. CBA compares costs and benefits of different alternatives and provides rational criteria for decision-making. CBA is a critical input for some decisions but does not replace decisions themselves (i.e. its result is not a binding one). CBA quantifies in monetary terms and compares the pros and cons of any initiative, including items for which the market does not provide a satisfactory measure of economic value. CBA yields profitability indicators (financial, economic or social) on the basis of information throughout the lifespan of the project. It is to be used when the objectives of different NWRM or Programmes of Measures are not the same, that is to say, when what is at stake is not just a set of alternative measures themselves but also different collective aims.

Term	Definition
Cost-Effectiveness Analysis (CEA)	Analytical tool or appraisal technique that assesses the costs of alternative ways of producing the same or similar output. It ranks alternative measures on the basis of their costs and effectiveness, where the most cost-effective measure gets the highest ranking. Since CEA is suggested for comparative analyses, costs to be collected should include those that are not site-specific.
Ecosystem services	Ecosystem services are the benefits people obtain from ecosystems. These include: provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling (Source: *http://www.unep.org/maweb/documents/document.356.aspx.pdf*)
Grey infrastructure	From the perspective of Natural Water Retention Measures (NWRM), grey infrastructure usually refers to the traditional methods of managing water, using man-made, constructed assets, most often water tight and designed to avoid any type of ecosystem growing on it. Grey infrastructure includes measures such as channels, pipes, sewers and sewage treatment works, ditches, dikes and dams. Grey infrastructure is so-called because it is often constructed of concrete. Unlike green infrastructure, grey infrastructure typically does not deliver multiple benefits. Grey infrastructure such as sewers and sewage treatment works are needed in urban areas but their effectiveness can be enhanced by green engineering measures which help to restore the natural water retention capacity of the landscape. However, some modern grey infrastructure such as permeable pavements and some roof water retention systems mimic the natural water retention capacity of the landscape and help to restore more natural patterns of run-off and infiltration.
Horizon 2020	Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. (*http://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020*)
Hydrological modelling	Hydrologic models are simplified, conceptual representations of a part of the hydrologic cycle. They are primarily used for hydrologic prediction and for understanding hydrologic processes. *(http://en.wikipedia.org/wiki/Hydrological_modelling)*
LIFE	LIFE is the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU. See *http://ec.europa.eu/environment/life/*
Multi-Criteria Analysis (MCA)	Multi-Criteria Analysis (MCA) or multiple-criteria decision analysis (MCDA) is a method that explicitly considers multiple criteria for supporting decision-making. It make explicit the different (potential) impacts that policy options or measures might have, combining them into a single indicator using different weights allocated to each criteria or impact.

Term	Definition
Natural Water Retention Measure (NWRM)	Natural Water Retention Measures (NWRM) are multi-functional measures that aim to protect and manage water resources using natural means and processes, therefore building up Green Infrastructure, for example, by restoring ecosystems and changing land use. NWRM have the potential to provide multiple benefits, including flood risk reduction, water quality improvement, groundwater recharge and habitat improvement. As such, they can help achieve the goals of key EU policies such as the Water Framework Directive (WFD), the Floods Directive (FD) and Habitats and Birds Directive
NWRM identity card	The EU NWRM Pilot Project has developed fact sheets for individual NWRM (available at *www.nwrm.eu/measures-catalogue*) that present the available knowledge on NWRM. Drawing from that knowledge, shorter NWRM 'identity cards' have been developed and combined into an NWRM 'tool box' to facilitate its access to readers of this guide. You will find all NWRM identity cards in the second part of the guide.
Nature-based solution	Nature-based solutions are understood as living solutions inspired by, continuously supported by and using nature, which are designed to address various societal challenges in a resource efficient and adaptable manner and to provide simultaneously economic, social and environmental benefits. (*http://ec.europa.eu/research/environment/index_en.cfm?pg=nature-based-solutions*)
Retention	Retention is the capacity of (part of) the ecosystem to store water, nutrients or sediments, either temporarily or permanently.
Runoff	Surface runoff (also known as overland flow) is the flow of water that occurs when excess stormwater, meltwater, or other sources flows over the earth's surface. This might occur because soil is saturated to full capacity, because rain arrives more quickly than soil can absorb it, or because impervious areas (roofs and pavement) send their runoff to surrounding soil that cannot absorb all of it. Surface runoff is a major component of the water cycle. It is the primary agent in soil erosion by water. (*http://en.wikipedia.org/wiki/Surface_runoff*)
Runoff Attenuation Features (RAFs)	Runoff attenuation features (RAFs) are low-cost, soft-engineered catchment modifications designed to intercept polluted hydrological flow pathways. They can be used to slow, store and filter runoff from agricultural (or other) land in order to reduce flood risk and improve water quality.
Sustainable Drainage Systems (or SuDS)	Approaches to managing surface water that take account of water quantity (flooding), water quality (pollution) and amenity issues are collectively referred to as Sustainable Drainage Systems (SuDS). SuDS aim to mimic natural runoff and typically manage rainfall close to where it falls. SuDS can be designed to slow water down (attenuate) before it enters streams, rivers and other watercourses. They provide areas to store water in natural contours and can be used to allow water to soak (infiltrate) into the ground, evaporate from surface water, or be transpired from vegetation (known as evapotranspiration). (Source: Susdrain)
Water status	The water status represents the main characteristics of water bodies as defined under the EU WFD. The Directive aims to achieve 'good status' for all ground and surface waters (rivers, lakes, transitional waters and coastal waters) in the EU. The ecological and chemical status of surface waters covers the following elements: biological quality (fish, benthic invertebrates, aquatic flora); hydromorphological quality such as river bank structure, river continuity or substrate of the river bed; physical-chemical quality such as temperature, oxygenation and nutrient conditions; and chemical quality that refers to environmental quality standards for river basin specific pollutants. For groundwater, the WFD considers both its quantitative status and its chemical status.

LIST OF ACRONYMS

CAP	Common Agricultural Policy
CBA	Cost-Benefit Assessment
CEA	Cost-Effectiveness Analyses
CF	Cohesion Fund
CIS	Common Implementation Strategy
EARDF	European Agricultural Fund for Rural Development
EC	European Commission
ERDF	European Regional Development Fund
ESF	European Social Fund
EU	European Union
FD	Floods Directive
GI	Green Infrastructure
MCA	Multi-Criteria Analysis
MS	Member States
MSFD	Marine Strategy Framework Directive
NGO	Non Governmental Organization
NWRM	Natural Water Retention Measures
PES	Payments for Ecosystem Services
RBMP	River Basin Management Plan
RDP	Rural Development Programs
RDR	Rural Development Regulation
SD	Synthesis Document
SuDS	Sustainable Drainage Systems
UK	United Kingdom
WFD	Water Framework Directive

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NWRM CANDIDATES ARE NUMEROUS!

Please visit the **NWRM toolbox** that has been developed by the NWRM Pilot Project.

NWRM cover a diversity of measures that are implemented by different sectors or considered in different planning processes dealing with water, flood risk management, biodiversity protection, climate change adaptation or urban planning. Some of these measures aim to directly modify the ecosystem, while others focus on changes of practice of economic operators.

Depending on the main challenges you face in your catchment or geographic area, the services you would like to deliver or the main policy objectives driving your planning process, only some NWRM will be relevant to your situation. Once you have identified the most relevant NWRM for your own territory, you can find out the basics about them in the following **NWRM identity cards**. The cards provide:

- [x] A **short description** of the NWRM;
- [x] Its relevance to different **types of landscape**, along with selected **design parameters** in terms of retention/hydrological parameters and (mainly financial) costs;
- [x] Evidence on their contribution to the **delivery of different ecosystem services** and to the **achievement of different policy objectives**.

You can also visit the NWRM knowledge base (***www.nwrm.eu/measures/***) directly for additional evidence on their design, impacts and pre-conditions for successful implementation.

The NWRM presented in the NWRM tool box are not the only measures that can fit under the heading NWRM. It is likely that the NWRM tool box will progressively expand as new knowledge develops.

Feel free to propose your own additional NWRM and develop their identity cards, ensuring that they still have the key features that characterise NWRM, as presented at the start of the guide. Some identity cards have been left empty for you, for that very purpose.


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