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Meetings

Natural water retention measures NWRM

Measures offering multiple benefits to meet water-related challenges

The technical seminar held on 13 February 2020 in Paris - La Défense was organised as part of the «Water Meetings» by the French Biodiversity Agency (OFB), the International Office for Water (IOWater) and the Ecology Ministry. The meeting highlighted the opportunities to implement NWRMs in the agricultural, urban and forestry sectors, and the many advantages of the measures.

Natural water retention measures (NWRM) comprise an array of initiatives to restore the natural properties of ecosystems in view of slowing the runoff of surface waters and increasing the infiltration capacity of soil. Examples from projects in France stress the multiple benefits of the measures, notably the solutions provided for numerous problems, such as flooding, water shortages, water pollution and biodiversity loss.

What are NWRM ?

A total of 53 types of measures are grouped under the NWRM heading and range from hydromorphological restoration to creating hedgerows, installing buffer zones and intercrops in agricultural environments, management of wooded areas in the head waters of river basins, and restoring the permeability of soil in urban environments. These measures can be implemented on one or more sites and can target improvements in the functioning of degraded ecosystems, for example work to restore the hydromorphology of a river[1], or encourage adaptation of agricultural and forestry practices. A large number of NWRMs are nature-based solutions (NbS), however there are differences between the two (see the box on the next page). NWRMs increase water retention in river basins because several can be implemented in parallel, targeting both the hydrographic network and land use.

They are applicable to all types of environments, agricultural, urban, forests, etc. The selection of river basins as the suitable scale for projects is not new, but should be expanded even further in order to take the hydrological cycle as a whole into account and to connect the natural and human water cycles.

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Examples of natural water retention measures.

1. See the document Onema Meetings no. 33, titled River restoration and natural water retention measures..

Multiple benefits to meet climate challenges

A single measure can provide several benefits by ensuring ecological functions, supply of the resource and, in some cases, contributing to the local cultural heritage. For this reason, NWRMs are said to be multi-functional. For example, the restoration of a bocage (network of hedgerows) landscape contributes to mitigating climate change by absorbing greenhouse gasses. In terms of adaptation to climate change, a bocage landscape has a number of other advantages, e.g. the hedgerows serve as wind-breaks and provide shade that limit evapotranspiration of meadows and enhance the resilience of crops confronted with increased risks of water shortages. Given that a bocage landscape slows the runoff of water and pollutants, and reduces soil erosion, the risks of flooding and pollution are also limited. Finally, hedgerows diversify the landscape, serve as biodiversity hotspots and maintenance work on hedgerows produces firewood.

NWRMs and NbSs - common features and differences

These two umbrella terms cover a range of similar activities (creation of buffer zones or planted channels, restoration of hedgerows, remeandering of rivers, etc.). They are themselves part of a larger set of concepts, including ecological engineering, landscape ecology, etc., where the objective is to restore the functioning of ecosystems and to enhance their resilience. An NbS addresses an ecosystem as a whole and has the double objective of meeting human needs and improving biodiversity. An MNRE targets the restoration of ecosystem functions, in part or in whole. Both include non-natural techniques (e.g. farming practices or maintenance work in forests) designed to retain water, on the basis of the idea that the multiplicity of measures over an entire river basin will ensure their overall effectiveness. It follows that many NWRMs are also NbSs, however many differ from NbSs, e.g. the use of permeable surfaces for parking lots.

EU definition of NWRMs (2014) :

NWRMs are multi-functional measures that aim to protect and manage 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.

IUCN[2] definition of NbSs (2016) :

NbSs are actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.
https://www.iucn.org/sites/dev/files/content/documents/nature-based_solutions_to_address_global_societal_challenges.pdf

[2] International union for the conservation of nature.

FINDING YOUR WAY THROUGH THE IDENTITY CARDS

AGRICULTURE
- A1 - Meadows and pastures
- A2 - Buffer strips and hedges
- A3 - Crop rotation
- A4 - Strip cropping along contours
- A5 - Intercropping
- A6 - No-till agriculture
- A7 - Low-till agriculture
- A8 - Green cover
- A9 - Early sowing
- A10 - Traditional terracing
- A11 - Controlled traffic farming
- A12 - Reduced stocking density
- A13 - Mulching

FORESTRY
- F1 - Forest riparian buffers
- F2 - Maintenance of forest cover in headwater areas
- F3 - Afforestation of reservoir catchments
- F4 - Targeted planting for 'catching' precipitation
- F5 - Land use conversion
- F6 - Continuous cover forestry
- F7 - 'Water sensitive' driving
- F8 - Appropriate design of roads and stream crossings
- F9 - Sediment capture ponds
- F10 - Coarse woody debris
- F11 - Urban forest parks
- F12 - Trees in urban areas
- F13 - Peak flow control structures in managed forests
- F14 - Overland flow areas in peatland forests

HYDROMORPHOLOGY
- N1 - Basins and ponds
- N2 - Wetland restoration and management
- N3 - Floodplain restoration and management
- N4 - Re-meandering
- N5 - Stream bed re-naturalisation
- N6 - Restoration and reconnection of seasonal streams
- N7 - Reconnection of oxbow lakes and similar features
- N8 - Stream bed re-naturalization
- N9 - Removal of dams and other longitudinal barriers
- N10 - Natural bank stabilisation
- N11 - Elimination of riverbank protection
- N12 - Lake restoration
- N13 - Restoration of natural infiltration to groundwater
- N14 - Renaturalisation of polder areas

URBAN
- U1 - Green roofs
- U2 - Rainwater harvesting
- U3 - Permeable surfaces
- U4 - Swales
- U5 - Channels and rills
- U6 - Filter strips
- U7 - Soakaways
- U8 - Infiltration trenches
- U9 - Rain gardens
- U10 - Detention basins
- U11 - Retention ponds
- U12 - Infiltration Basins

Catalogue of 53 natural water retention measures for urban, forest and agricultural environments (source www.nwrm.eu).

NWRMs also improve links between the land and the sea by regulating the sediment and liquids transported by water, reducing pollutants arriving in estuaries. Thanks to the combined effects over entire river basins, these natural measures are useful supplements and, in some cases, can even replace grey infrastructure, i.e. the man-made technical solutions that are generally limited to a single function (drainage, storage, etc.). This is why the European Commission first identified in 2012 and then developed the umbrella concept of NWRMs, given that they facilitate the joint and integrated implementation of European policies such as the Water framework directive (WFD) and the European flood directive.

A return to the natural water cycle

A project to restore water retention in an agricultural environment underwent piezometric monitoring at three sites in the experimental network for the restoration of wetlands in Brittany. The results, following the removal of drainage systems, showed an effective increase in the level of groundwater, including during low-flow periods, and a reduction of variations in the water level. Positive effects were also observed in the local biodiversity and in the purification function of the wetlands. One consequence of the project was a reduction in the load-bearing capacity of the soil. The farmer solved this problem by using Breton Pie Noire cows, suited to the new conditions, to graze the land. The same effects were observed in the Chaux state forest (Jura department) following measures to reverse the negative effects of drainage work undertaken in the 1950s. In the head waters of the river basin, many rectified streams had since dried up and suffered bed erosion, a situation that led to significant transport of sediment during heavy rains. The work done over a total length of 45 kilometres consisted of recreating meanders in streams, obstructing drainage systems and ditches to reactivate the former beds, adding woody debris and reloading sediment to raise certain channels. Subsequent monitoring revealed that hydrological functioning in the sector had improved notably. During both the spring and fall, water remains present for up to 15 days longer in the small watercourses and a full month longer in the water table. In the periurban sector, modifications were made in the management of the flood retention basins in the Bièvre valley, located between Saint-Quentin-en-Yvelines and Massy (Paris region). Since their creation almost 40 years ago, the basins had been partially filled in for aesthetic and recreational reasons. They are now being progressively reconnected to the river by eliminating certain weirs. Starting in 2016, the strong winter floods could be fully absorbed thanks to the recovered storage capacities.

Reconstitution of hedgerows in the Léguer River basin in Brittany.

Assessment of results, important, but not an impediment

The water volumes set for retention in flood-control systems cannot be fully covered by NWRM or NbS measures, even the most effective. However, their implementation is still useful because they are less costly and the multiple effects are synergistic. They can contribute to meeting certain objectives of flood-control systems, e.g. flood prevention of urban zones, and in certain cases avoid the construction of flood retention basins. They also provide benefits for ecosystems and ecosystem services that grey infrastructure is incapable of offering.

Assessment of NWRM results, particularly the quantities of water effectively retained and the reduction in surface runoff, is very important in view of generalising the measures. The difficulties are both technical and financial in that the funds allocated to assess the results of projects are often very limited (see the box). However, the scarcity of quantitative data on results is not an impediment in that most stakeholders have already launched projects comprising NWRMs because they are convinced of their effectiveness in certain fields and of their multiple benefits.

High acceptance of measures by local stakeholders

In the agricultural sector, elected officials in the Lèze valley south of Toulouse became aware that hedgerows were disappearing and that there was a probable link with an acceleration in flooding and mud slides. Over the past ten years, the network of hedgerows has been restored in the framework of a project grouping 40 towns in the river basin. Thanks to management by a single river board, the declaration of public interest (work authorisation) is now multi-annual, which means that works can be undertaken quickly if mud slides cause damage. Following the creation of grass buffer strips and hedgerows, mud slides are now immediately absorbed during light rainfalls. The farming sector quickly accepted this solution given the clear results and is eager to inform the general public that it takes the issue seriously. The

Benoît Fribourg-Blanc, project officer for the European NWRM platform, at IOWater

Assessment of NWRM effectiveness has raised theoretical questions since the start of the work on the topic by the European Commission. The diversity of the measures and the importance of generalising the measures to the entire river basin to achieve cumulative effects are a source of two types of problems. Benefits cannot necessarily be quantified rapidly and the measurements must be carried out in a diverse range of fields because each situation requires a combination of the suitable NWRMs. Calculation of the cumulative effects is also made difficult because project initiators often target a particular benefit, i.e. they do not monitor attentively the full range of effects. However, a number of stakeholders have identified benefits from NWRMs that were not initially planned. On the basis of almost 150 reports on projects in Europe, the www.nwrm.eu site now offers tables cross-indexing the many advantages of the different measures.

only negative aspect is that among the potential land-use solutions, the farmers chose the most flexible, i.e. a contract for a period of ten years that is not transferred to the new owner if the land is sold.

A number of stakeholders have confirmed that hedgerows, fascines (bundled wood) and grass buffer strips, clearly visible in the landscape, have changed the perception of local residents. They are now aware of the importance of slowing the flows of water and mud. The population can then accept that the measures are not as effective as grey infrastructure. The overall changes also modify the reference data, such as the calculated discharges for 100-year floods that are generally used to size retention installations. Given the uncertainties, the capacity for adaptation by healthy ecosystems will become a major argument.

Even in areas where the risk of flooding is high, several examples of alternative, nature-based hydraulic measures have provided rapid results that reassure the population and elected officials. The example of the Eau-Morte valley, upstream of Annecy Lake (Haute-Savoie department) is significant. The local governments maintained the brave decision to implement a set of synergistic NWRMs over the years required to plan and prepare the project. The works, done between 2015 and 2018, produced immediate results. The floods in 2018 spread out over the planned areas and human activities were not affected. The local population was reassured and has relearned to deal with the water and the river. In the urban sector, a project to turn reverted land into a residential quarter in Fourqueux (Yvelines department in the Paris region) included works to improve water infiltration by creating a "water path" through a park. This feature reintroduced the population to the rhythm of the water cycle over the year, with its excesses and dry periods, and reminded everyone that urban areas must play a part in the integrated management of rain water. Living conditions have been significantly improved with cool oases and naturalised areas.

A set of solutions spread over the entire river basin

In the agricultural sector, examples such as the Bas-Rhin department highlight the wide range of measures that can be implemented in a river basin. The Chamber of Agriculture took action to manage mud slides following storms that affected both the farmers and the downstream villages. The Chamber put together a full array of proposals such as planned rotations of spring and winter crops, and a halt to tilling of parts of fields to conserve soil and crop residues on the surface, in view of slowing runoff speeds. The results are better than those achieved by hedgerows or fascines (bundled wood) because the water is retained in each field. The local governments also planted trees and undertook curative measures such as raising tracks. The discussions, modelling results and management reports from pilot sites convinced the local governments that water retention measures are in fact highly synergistic. In the forestry sector, management of wooded areas in the upper sections of river basins can take into account hydraulic issues, for example, by ensuring that the forestry machines do the least possible damage to small watercourses. In the urban sector, use of NWRMs is a means to combine synergistic measures (see the box).

Debates on using NWRMs and NbSs in urban environments

These concepts can occasionally evoke contradictory opinions. If an attempt is made simply to create or increase biodiversity in a few natural areas that already exist, the results in terms of water retention will be limited. However, more water in soil is required so that a wider range of plants can effectively evapotranspire during the summer and return humidity to the urban environment, thus creating the cool oases of such importance today. The main problem currently for urban elected officials is precisely to deal with periods of extreme heat. That is why some stakeholders ask that efforts not be limited to NbSs alone. They highlight the fact that NWRMs cover a wider range of solutions, for example permeable parking lots and soil-restoration work designed to take in and retain more water, thus reducing hydric stress and enabling greater evapotranspiration. The restoration of the permeability of a parking lot is not considered an NbS because it does not contribute directly to the local biodiversity. To be considered an NWRM, there must be an increase in retained water, i.e. the creation of a parking lot on previously permeable land is not an NWRM.

A permeable parking lot, an example of an NWRM in an urban environment.

An example of an NWRM is the preservation or restoration of a flood plain.

Public policies in favour of NWRMs

One of the intuitions underlying the NWRM concept concerns the joint implementation of several policies by taking advantage of their common features. This positive trend has gained speed in France with the development of synergies between topical policies. Examples of policies conducive to NWRM implementation are listed below:

- WFD programmes of measures;
- Management of aquatic environments and flood prevention (GEMAPI);
- Territorial projects for water management (PTGE);
- Contracts for ecological transition (CTE);
- the wide range of sectoral practices in the forestry, agricultural and urban fields.

NWRMs can therefore benefit from multiple sources of funding. For example, an array of funding sources are available for public entities for cooperation between townships (EPCI) in charge of GEMAPI policy, including the general budget of the EPCI, the GEMAPI tax, Barnier funds for flood risks, Water Agency subsidies, European funds, State-Region planning contracts, regional and departmental funds, and specific types of bank loans. The CTE, a new means of structuring territorial projects can facilitate NWRM implementation thanks to the single access point set up between the French State and its partners. The official recognition of the CTE facilitates institutional acceptance of projects and access to the various funding possibilities.

The Water Meetings (Assises de l'Eau) set a roadmap for NWRM development

The Water Meetings set ambitious national objectives for water management, notably the restoration of functional ecosystems capable of adapting to future change. The first step in those objectives is an unprecedented mobilisation in favour of aquatic environments. To that end, similar to the objectives concerning water savings, better resource management and the protection of groundwater abstraction sites, projects benefiting from or restoring natural functions were strongly encouraged, whatever the vocable used (NWRM, NbS, ecological engineering). The urban sector was not neglected with a roadmap planned for rain water and general management plans by 2026. The issue of water infiltration in soil will be included in the avoid / mitigate / compensate (AMC) system and reinforced in the Ecoquarter label.

PTGEs combine knowledge and action

The number of PTGEs is increasing for territories with insufficient water resources for their needs (50 by 2022 and 100 over the mid term). The entities in charge of water management contribute to identifying the territories using the available data, and to defining the relevant management perimeter. A territory confronted

Élise Jacob, policy officer for quantitative management of water resources, Ecology Ministry, and **Claire Magand**, policy officer for water resources and climate change, French Biodiversity Agency

"Among the very positive aspects of NWRMs, we should not forget the dialogue that takes place during their implementation. It is always an element in the success of the overall project and its acceptance. By listening to each other, planning together how to share the resource, the partners in a project make progress toward long-term solutions that enable them to better anticipate and overcome times of crisis. The tools currently being developed in the framework of territorial projects for water management (PTGE) will be of use to all stakeholders in the water sector. They include monitoring tools and management guides. For example, INRAE[3] recently published a guide on how to carry out economic and financial studies for a PTGE. Research results on the effectiveness of NWRMs may come from such studies because there are plans to quantify the benefits of creating a network of measures over entire river basins, in view of restoring a quantitative water balance. In the years to come, it will be necessary to make stakeholders aware of the documents available on NWRMs, NbSs and PTGEs, given that all these concepts target an improvement in the structural management of water resources."

[3] IRSTEA and INRA merged to form INRAE, the National institute for agricultural, food and environmental research.

with limited water resources can, on its own behalf, request that the basin prefect include the territory in a PTGE in order to benefit from public funding. A PTGE must be consistent with the river-basin management plan and the sub-basin management plan, and must strive to achieve synergies with the other territorial water policies. NWRMs can play a significant role in aiding territories in reducing quantitative deficits. Stakeholders taking part in PTGEs must be made aware of project feedback highlighting the beneficial aspects of NWRMs (see the box on the previous page).

Infiltration and retention basin in the Water Garden in the town of Fourqueux (Yvelines department).

GEMAPI, an integrated form of water management on the territorial level

The structure of EPCIs now makes it possible to exercise water responsibilities over coherent territories, combining the issues of natural environments, flood risks and, importantly, encouraging integrated forms of water management. That structure is also consistent with the tools implementing NWRMs, such as local development plans (PLU), sub-basin management plans (SBMP) and action programmes for flood prevention (PAPI). GEMAPI includes approximately 15 types of NWRM, e.g. restoration work on rivers and alluvial wetlands.

Conclusion

The necessity of encouraging the natural retention of water in a river basin has progressively become obvious for all water stakeholders. However, a number of points must be kept in mind in the future. It is important to monitor and assess NWRM results. At this point in time, it is difficult to measure the quantity of water retained in soil or by restored ecological functions, and to measure improvements in water quality. The multiplication of NWRMs should take place over entire river basins territory, i.e. not only on the hydrographic network, in order to ensure optimum effectiveness. It is also necessary to ensure that each measure remains in place over time. To that end, several policies should be implemented, between which synergies can progressively develop and be reinforced in the future.

For more information

- https://www.oieau.fr/actualites/oieau/retrouvez-les-presentations-faites-lors-de-la-journee-technique-mesures-naturelles
- on river restoration in France (English) http://www.river-restoration.onema.fr/
- http://nwrm.eu

River Resource Centre

The French national center for river restoration is intended for stakeholders in charge of implementing policies for water and aquatic environments. The multi-partner and collaborative system is based on three interconnected types of action:

- organising stakeholder networks and disseminating information (assessment of needs, organising contacts, coordination, etc.);
- technical assistance (training, technical meetings, etc.);
- designing, editing and disseminating resources (scientific and technical methods and tools, case studies, project feedback, web sites, etc.).

The work and documents produced by the resource centre may be found at:
www.coursdeau.fr
@Cours_deau
Contact: josee.peress@ofb.gouv.fr

Meetings

Editor: Christophe Aubel
Coordination: Josée Peress
Authors: Sylvie Vieillard, Josée Peress, Maxime Fouillet, Stéphane Grivel
Proofs readers: François Omnès, Aurélien Daloz
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