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# NATURE BASED SOLUTIONS E TERRITORIO: PRENDERSI CURA DELLA NATURA CON LA NATURA

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# NATURAL CLIMATE BUFFERS: PROMISING EXAMPLES OF NATURE BASED SOLUTIONS

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***Abstract:*** *Natural Climate Buffers (NCBs) are designated areas in which space is given to natural processes to contribute to the climate change adaptation and mitigation NBCs are also aimed at enhancing the specific biodiversity of each site. The idea for the designation and implementation of NBCs was developed in the Netherlands but has the potential to be applied throughout Europe. Eurosite, the organization that brings together European natural site managers, has adopted and promoted the concept across Europe. This article explains six different types of NBCs: ecosystems engineering, carbon sinks, living coasts, green air conditioning, room for nature and water management, natural sponges. The paper will also explain how the NCB concept relates to the concepts of Natural Water Retention Measures as promoted by the European Union and Nature-Based Solutions introduced by the IUCN.*

***Key words:*** *Climate change adaptation, climate change mitigation, Nature Based Solutions, biodiversity.*

***I Natural Climate Buffers: esempi promettenti di Soluzioni Basate sulla Natura***

*I Natural Climate Buffers (NCBs) sono aree in cui viene dato spazio ai processi naturali al fine contribuire all'adattamento o alla mitigazione degli effetti dei cambiamenti climatici. Oltre a questi obiettivi, i NCBs hanno lo scopo di favorire la biodiversità specifica di ogni sito in cui sono realizzati. Il concetto di NCBs è stato sviluppato ed implementato in Olanda ma ha le potenzialità per essere applicato all'intero territorio europeo. Eurosite, l'organizzazione che riunisce i gestori di siti naturali europei, ha adottato il concetto di NCBs e lo ha promosso in tutta Europa. Il presente articolo descrive i sei diversi tipi di NCBs così denominati: ingegneria degli ecosistemi, carbon sinks, coste vive, aria condizionata verde, spazio per la gestione delle acque e delle aree naturali, spugne naturali. L'articolo, inoltre, illustra come il concetto di NCB si relaziona con i concetti di Misure di ritenzione naturale delle acque, promosso dall'Unione Europea, e di Nature Based Solutions introdotto dall'IUCN.*

***Parole chiave:*** *Adattamento ai cambiamenti climatici, mitigazione dei cambiamenti climatici, Nature Based Solutions, biodiversità.*

## INTRODUCTION

In the last decades new approaches have arisen to integrate land use planning, water management and climate change adaptation and mitigation with nature protection. Some complement each other, some overlap to a certain degree, but they can all be summarized under the term "Ecosystem Based Approaches". According to the Convention on Biological Diversity (CBD) the ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way and which aspires to maintain the natural structure and functioning of ecosystems.

Within the concept of Ecosystem Based Approaches, Nature Based Solutions (NBSs) focus specifically on solutions for societal challenges inspired by natural processes providing benefits for nature and biodiversity as well as providing benefits to society.

The European Commission defines NBSs as "*solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions*".

The International Union for Conservation of Nature (IUCN) defines NBSs as: "*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*".

Parallel to the development of the concept of Nature Based Solutions, the Natural Climate Buffers (NCBs) approach has been developed in the Netherlands. In the following sections we will clarify the concept, how it relates to other concepts and show some examples of its application.

## NATURAL CLIMATE BUFFERS APPROACH

The Natural Climate Buffers approach was first defined in 2007, in a study commissioned by a number of Dutch environmental NGO's (Andriesse et al., 2007).

The study was the basis for the establishment of the Coalition for Natural Climate Buffers, a joint effort of seven (since 2016 eight) Dutch organisations working in the field of nature and environmental protection, aiming to make the Netherlands climate proof while restoring or improving landscape and biodiversity.

The definition and typology of Natural Climate Buffers developed in the 2007 study formed a starting point for today's definition: "*Natural climate buffers are areas where natural processes are given space. As a result, they "evolve" with climate change, adapt to it and can play a vital role in retaining and collecting water (thus preventing the floods or water shortages), tempering heat and reducing carbon dioxide in the atmosphere. Natural climate buffers can improve the quality of human life, while restoring and/or preserving the biodiversity at the same time, as well as providing a wide range of other ecosystem services"* (from the Eurosite document Defining NCBs).

Under the umbrella of the Coalition for Natural Climate Buffers a variety of projects are

planned, in progress or have been carried out; currently 33 projects have been implemented and at least 32 are in progress in the Netherlands. The Eurosite Wetlands and Climate Change Working Group is actively promoting the Natural Climate Buffers concept across Europe. The website of Eurosite presents a number of factsheets about climate buffer projects from the Netherlands but also examples from France, the United Kingdom and Ireland.

**The principles**

The guiding principle of the Natural Climate Buffers approach is the landscape approach or systems approach as it aims to integrate biodiversity with economic, social and environmental aspects towards a climate proof society. To achieve this, it looks beyond the borders of protected areas and instead promotes the benefits of working with nature for the society as a whole. NCBs can "buffer" the impact of climate change by:

- retaining water;
- temporarily storing flood waves and lowering water levels by creating "space for water";
- reducing $CO_2$ in the atmosphere;
- regulating air temperature;
- adapting to sea level rise and absorbing wave energy.

NCBs are using ecological processes of a given area to adapt to or mitigate climate change impacts. By doing so, not only the impacts of climate change will be buffered, but biodiversity will be increased as well. NCBs can be located in rural as well as urban environments. Besides buffering climate change impacts and strengthening biodiversity, NCBs offer other ecosystem services like recreation and water purification. Most NCBs focus on making water systems more resilient and robust by retaining water, recharging ground water and thus preventing floods and limiting drought. But they can also serve to reduce heat in cities, alleviate the capacity of sewage systems, sequester $CO_2$ and strengthen coastal zones through stimulating the growth of mudflats and restoring mangroves and other coastal vegetation.

Prioritization and designation of large scale Natural Climate Buffers, for instance along the main rivers and along the coast, should preferably be an integral part of the national spatial and climate adaption and mitigation planning process. Small and medium scale NCBs can be integrated in planning of infrastructure or city planning.

In a nutshell, Natural Climate Buffers:

- use natural processes as spatial solutions to create climate resilient urban and rural landscapes;
- prioritise climate adaptation as the main ecosystem function while safeguarding other existing ecosystem functions;
- increase biodiversity and ecosystem connectivity.

A recent evaluation of the application of the NCB concept in the Netherlands carried out by Wageningen Environmental Research (WENR) supports the potential of NCBs to adapt and mitigate climate change impacts. The nature-based climate buffers that have been realised are great examples for the steps to be taken towards a climate-proof

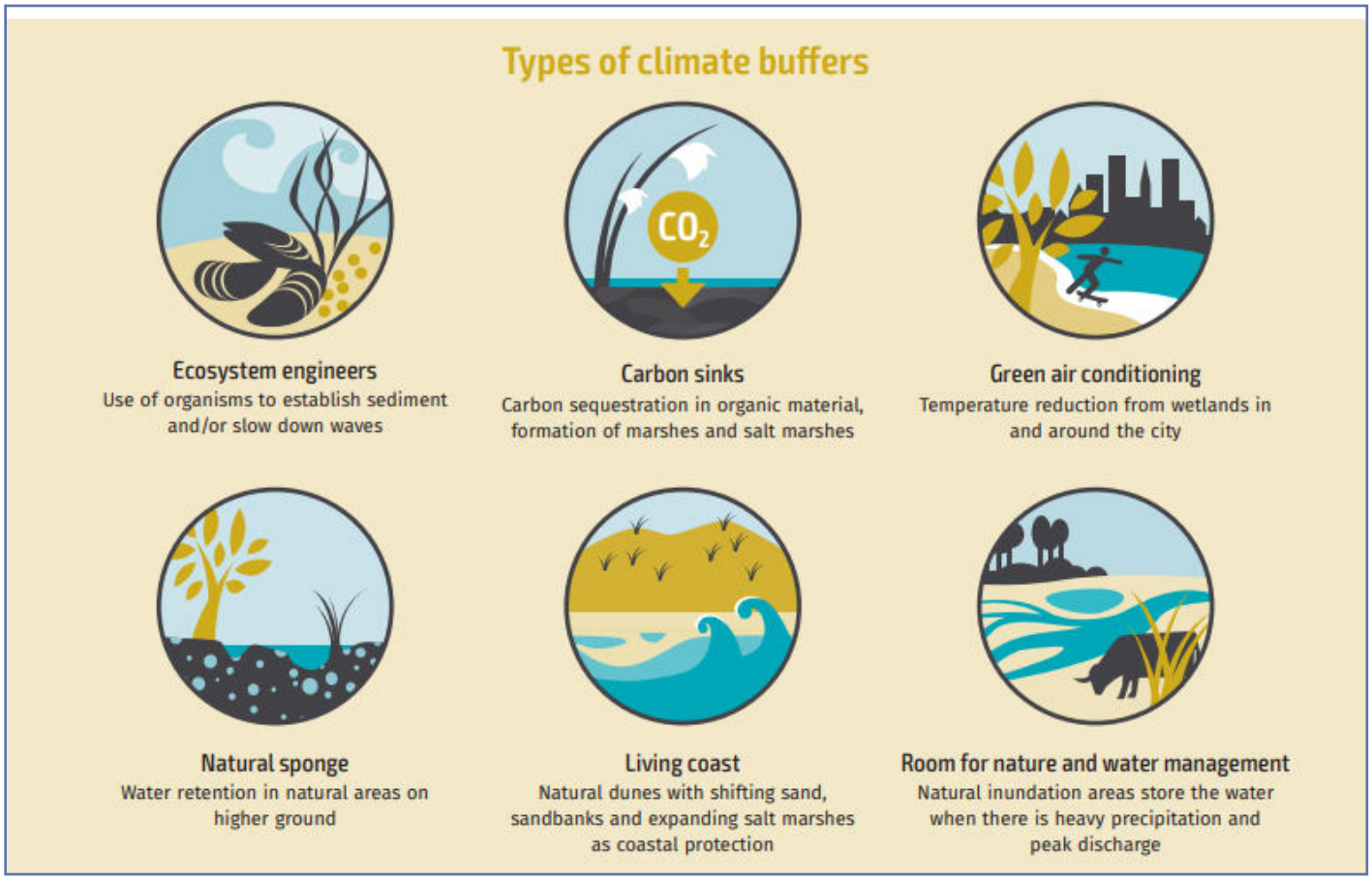


*Figure 1. Types of Natural Climate Buffers (source: The Dutch Coalition for Natural Climate Buffers).*

Netherlands. According to this evaluation, nature-based solutions like the NCBs contribute to climate resilience and support biodiversity. The main challenge for the coming years is to make the next step from successful local and regional initiatives towards an integrated plan at national level (Veraart et al., 2019a).

## EXAMPLES OF NATURAL CLIMATE BUFFERS

The Dutch Coalition for Natural Climate Buffers distinguishes six types of NCBs as shown in Fig.1.

Many NCB projects involve two or more types of climate buffering. For instance, by creating natural inundation areas to store water during periods of heavy precipitation, these areas can also function as green air conditioning when located near or in cities.

An overview of ongoing and finished NCBs projects can be found at the website of the Dutch Coalition for Natural Climate Buffers (most of this website is only in Dutch, but some crucial information is summarized in English factsheets).

In the following paragraphs four NCB projects will be described to clarify the different types.

### The "Peazemerlannen" project

NCBs types: living coast, carbon sinks.

The living coast concept contributes to the protection of coastal areas against the rising sea level. This type of climate buffer

strengthens the primary flood defence through a natural design of the coast, such as dune formation with free-flowing sand and natural salt marshes and mud flats that slow down wave energy and silt up with the rising sea level. This approach is also referred to as bio-engineering. In some cases, this type of natural climate buffer also contributes to sequestering $CO_2$. An example of strengthening the primary flood defence is a project in progress in the Province of Friesland, in the north of the Netherlands. The Peazemerlannen project consists of summer polders (flooded only during spring tides and heavy winter storms), salt marshes, dikes and mudflats. In the current situation, the summer polder only receives sea water and new sediment through the inlet of valve divers in the summer dike. As a result, sedimentation is slow and lags behind the sea level rise. The project includes connecting the summer polders to the tidal influence of the sea again by creating wider gaps in the summer dike resulting in the restoration of the salt marsh. Direct access to the sea allows the summer polder to silt up again with 10 mm/yr and grow with the rising sea level, strengthening the natural flood defence function of the salt marsh. In addition to the siltation, $CO_2$ is being sequestered by the salt marsh vegetation. Measurements showed that with 7 tons $CO_2$-eq/ha/yr the $CO_2$ sequestration is comparable with the carbon sequestering capacity of fast growing North-western European forests. This project aims to collect specific knowledge about negative (erosion) and positive (siltation) items in the carbon balance in the area and the associated costs. The development of the vegetation is also monitored and research is being carried out to assess how and how much vegetated foreshores can contribute to flood risk reduction.

The project contributes to the biodiversity by increasing the surface of the rare habitat of salt tidal marshlands. This habitat type was once widespread in the Netherlands but disappeared through embankments and its use for agriculture. Ecologically, salt marshes are important for specific plant species like marsh samphire (*Salicornia spp.*), sea aster (*Aster tripolium*) and insects depending on these plant species like the sea aster bee (*Colletes halophilus*). Salt marshes offer lots of food, space and hiding places for breeding birds like gulls, terns (*Sterna* spp.), redshanks an avocets and migratory birds like barnacle geese and different plover and sandpiper species (from It Fryske Gea).

**The “Onlanden“ project**

NCBs types: natural sponge, room for nature and water, carbon sink.

The Onlanden is located in the north of the Netherlands, just south of the city of Groningen. A number of small rivers confluence just south of Groningen and transport their discharge through the city. Increasingly, Groningen suffered from flooding issues, which can be attributed to climate change and land and water engineering activities upstream in the river systems. To address this problem, large wetland areas have been created south of the city, in the valleys and downstream floodplains of these small rivers. This area is part of the Dutch National Ecological Network, which means that policies are aimed at increasing the

nature value.

The dominant soil type in the valleys is peat and, because the valleys were drained for agriculture, vast amounts of $CO_2$ were emitted. Rewetting and the creation of water retention, with space for 6 to 10 million $m^3$ of water, implied that modern agricultural use was impossible and the land had to be acquired by the regional authorities, who designated a total area of approximately 2.500 hectares as natural water retention area.

Already in 2012, the year of the project's completion, during a severe period of heavy rainfall, the water level in the city was 20-40 cm lower compared to the situation without the retention area downstream and saved the city from serious flooding problems.

Apart from reduced flooding problems in Groningen, additional benefits of the project are improved water quality downstream of the retention area and the creation of recreational facilities in the form of hiking and biking routes.

The impact on the release of greenhouse gasses is a matter of further research especially to what extent the reduction of $CO_2$ emissions from the drained peat soils is offset by possible increased methane and $NO_2$ emissions but first cautious calculations from greenhouse gas flux measurements by Wageningen Environmental Research show a net positive climate impact compared with the former agricultural use of the area. (Veraart et al., 2019)

Since its redesignation, the area has developed into a beautiful nature reserve of about 2.500 hectares including lakes, fens, reed lands, meadows and alder forests, resulting in the comeback of many protected plants and animals, especially marsh birds like egrets, bitterns, black-necked grebes, reed warblers, etc.

Some lessons learned from this project:

- Due to more extreme climate forecasts, the storage capacity must be increased by 5 million $m^3$ in order to further reduce the flood risks in Groningen. Water authorities prefer to increase the storage capacity of the existing climate buffer but nature protection organizations argue for creating extra storage capacity more upstream, which will increase the natural area and reduce $CO_2$-emissions.
- Influx of nutrients from the agricultural lands outside of the valley are posing a threat to the development of the nature values. It is uncertain what impact this will have on the pace of succession.

**The “Anserveld – Leisloot” project**

NCB type: natural sponge.

The Anserveld/Leisloot area (approximately 150 ha) is part of the National Park Dwingelderveld (approx. 4.000 ha) and the dominant habitats are wet and dry heathlands with a large amount of shallow fen lakes. The soil sub-layer consists of boulder clay and sand. Locally peat soil is present and after rewetting peat bog development is considered to be possible, provided that the groundwater table remains within 0.05 and 0.20 m –below surface.

The wet heathlands and fen lakes have suffered from the falling ground water tables for a long time, resulting in their poor condition. To turn the trend from ever falling water tables and desertification, around

2014 plans have been developed to retain the precipitation so that fen lakes are holding water and groundwater can be recharged.

Downstream of the Dwingelderveld the city of Meppel is located and water from the Dwingelderveld is flowing to Meppel via a network of small streams. These streams have all been canalised and straightened during large scale land consolidation projects in the 20th century. As a result, water discharge patterns have changed with increased peaks during periods of heavy rainfall and with no areas left where water can be (temporarily) stored.

The Anderveld – Leisloot project was developed to rewet the heathlands and fens while at the same time reducing flood risks in Meppel. The hydrological restoration works, now analised, include the building of weirs and damming of ditches that drain the heathland. These measures have led to rewetting of the heathland and to the recovery of wet soil layers and to increased water levels in the fen lakes. Excess water is discharged in a lower pace contributing to flood safety in Meppel (Veraart et al., 2019).

The project had a positive impact on biodiversity through the increased surface of the habitat of wet heathland and increased and more stable water levels in the fen lakes.

**The "Hunze" project**

NCBs types: natural sponge, room for nature and water, carbon sink.

This climate buffer project (approx. 785 ha) concerns a brook valley and consists of three sub-projects which were carried out from 2010 to 2019. They are part of a long term programme to restore the approx. 40 km long formerly meandering regional river, which had been channeled and straightened during the 1950's as an important final part of the centuries-long reclamation of one of Europe's largest bog areas, the Bourtanger Moor. Since 1996 the Hunze's restoration was initiated and realized in small sections, like beads on a bead string. The three Hunze sub-projects belong to the last links of this chain. Besides nature development, peak water retention and water conservation are important goals. Before implementation of the proposed measures, the groundwater tables varied between 0.6 m and 1,2 m below surface during winter and 1,20 m below surface in the summer. The average water levels in both seasons are expected to increase by 0,55 m with the measures taken (Veraart et al., 2019).

The project positive impacts include a significant reduction of $CO_2$ emissions from the earlier drained peatlands through the rewetting of these soils. Biodiversity has increased through an increase of the grassland biodiversity, including the return of some rare butterflies, the resettlement of the quail, in the Netherlands a rare gallinaceous bird species of extensively managed grasslands. The implementation of the more downstream part of the Hunze climate buffer has resulted in the return of water insects like dragonflies, the use of the swampy floodplains by rare waterfowl and waders like avocets and great egrets, as well as new populations of the reintroduced beaver and otter (Van der Bilt et al., 2017).

*Table 1. Overview of the impacts of three described NCB's and their contribution to national climate policies (Veraart et al., 2019a).*

| *Criterium* | *Onlanden (2500ha)* | *Hunze (785 ha)* | *Anserveld/Leisloot (150 ha)* |
|---|---|---|---|
| **Climate policy** | | | |
| Water storage ($m^3$) | + 5.600.000 | + 2.350.000 | + 250.000 |
| Impact water quality | + | + | + |
| Δ reduction GHG (hypothis) | 15 - 60 kt $jr^{-1}$ | 1.8 – 7.5 kt $jr^{-1}$ | Marginal |
| **Nature protection** | | | |
| New nature<br>Restored habitat | 1100 ha<br>Fen marsh | 250 ha<br>River valley | 200ha<br>Wet heathland, living peatbog, acid fen lake |
| **Economical features** | | | |
| *Costs* | | | |
| Investment water storage (M€) | 20 | 1.3 | 1.0 |
| Additional investment (M€) | 23 | 3.2 | 0.9 |
| Total (M€) | 43 | 4.5 | 1.9 |
| Investment per hectare (€ $ha^1$) | 17000 | 5700 | 12900 |
| *Cost effectiveness* | | | |
| Water storage (€ $m^{-3}$) | ≈ 3.60 € $m^{-3}$ | ≈ 1.90 € $m^{-3}$ | ≈ 4.00 € $m^{-3}$ |
| *Benefits* | | | |
| $CO_2$-eq storage<br>*($CO_2$-price 2019)* | 30-120 €$ha^{-1}$ $jr^{-1}$ | <30-120 €$ha^{-1}$ $jr^{-1}$ | marginal |
| Reduction water quantity problems | + | + | + |
| Water quality | + | + | 0 |
| Recreation | + | + | + |
| Drinking water | 0 | + | 0 |

## IMPACT OF THREE ANALYSED NATURAL CLIMATE BUFFER PROJECTS

First of all, it is worthwhile to notice that the created NCBs are the result of intensive cross sectoral cooperation between water boards, nature protection organisations, provinces and municipalities.

Table 1, derived from Veraart et al. (2019a), presents a preliminary overview of the contribution of three analysed NCB's to the national climate and biodiversity policies.

A substantial area of "new" nature has been added to the National Nature Network. Biodiversity has benefitted from the examples presented by recreating the basic conditions for the restoration of brook valley biodiversity (in the case of the Hunze project) wetland biodiversity (in the case of the Onlanden) and wet heathland

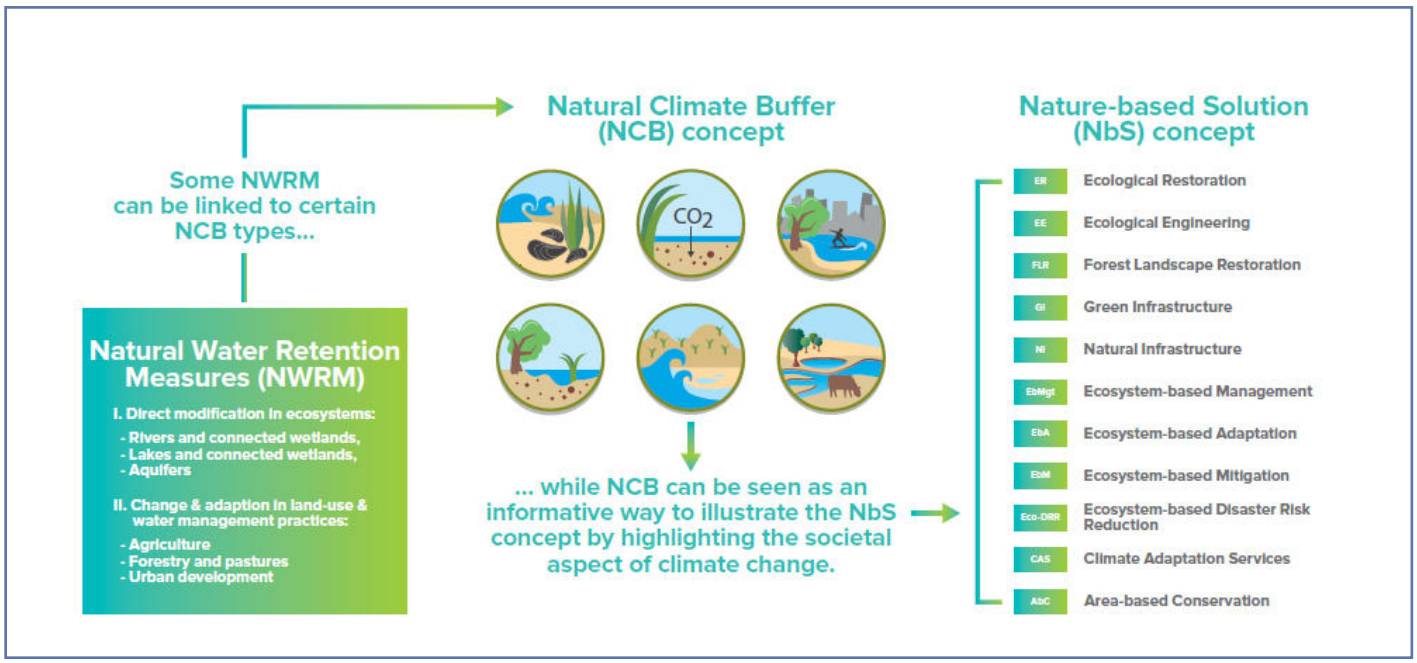


*Figure 2. Relation between NCBs, NWRM and NBSs (source: Eurosite).*

and fen lake biodiversity (in the case of the Anserveld). It is too early to be able to draw conclusions about the impact on the related plant communities. However, the creation of the water retention in the projects had an immediate positive impact on bird populations.

The Onlanden and Anserveld projects have significantly reduced the flood threats for the cities of Groningen and Meppel respectively.

In the case of the Dwingelderveld the realised water retention concerned a substantial portion (>20%) of the total water storage needs of the water board involved.

In particular for the Onlanden, on the edges of the city of Groningen, new recreation facilities have been realised that offer residents direct access to the newly created wetlands via walking and cycling routes.

To assess the impact of the projects on groundwater levels, additional research needs to be carried out.

## THE RELATION BETWEEN NATURAL CLIMATE BUFFERS, NATURAL WATER RETENTION MEASURES AND NATURE BASED SOLUTIONS

Natural Climate Buffers have a strong link with Natural Water Retention Measures (NWRMs) as promoted by European Commission; some types of NCBs are in fact also NWRMs and vice versa. This counts especially for the NCB types “natural sponge“ and “room for nature and water“.

According to the EU, NWRMs 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. NWRMs 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 the Birds and Habitats Directives (European Commission, 2014).

NCBs are also linked with the Nature-based Solutions (NBSs) promoted by IUCN. Where NBSs focus on the protection, sustainable management and restoration of natural or modified ecosystems, NCBs look beyond ecosystems and aim to become included into the wider concept of land use and land use planning. However, both concepts take the landscape scale as their starting point and the guiding principles overlap to a great extent. NCBs encompass various types of NBSs, including Ecosystem Based Adaptation, Ecosystem Based Mitigation, Ecological Engineering and Ecosystem Based Disaster Risk Reduction.

## FUTURE PROSPECTS

Since its introduction, the concept of Natural Climate Buffers has gained increasing support from policy makers and practitioners in the field of water management and nature protection. Still, the concept is not an integral part of the national strategic planning for water and climate change adaptation, which results in a lack of coordination and financial support. Initial analyses and evaluation are however very promising as the concept integrates a number of issues in climate change and water management policies (Veraart et al., 2019b).

Eurosite – the European Land Conservation Network is actively promoting the NCB concept in other countries through its Wetlands and Climate Change working group. For this reason, Eurosite organized three study tours in 2018 (the Netherlands), 2019 (Scotland) and 2021 (Ireland) in close cooperation with her local partners. The aim of these study tours is to introduce the principles of NCBs to practitioners and policy makers from across Europe and to exchange knowledge. Reports can be found on Eurosite website, section Wetlands and Climate Change Working Group.

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