



Ponderful
PONDS FOR CLIMATE

DENMARK 

PONDSCAPE : LYSTRUP



Pond Ecosystems for Resilient Future Landscapes in a Changing Climate

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WHAT IS A PONDSCAPE ?

DEFINITION

A pondscape is a network of ponds with spatial proximity (“connectedness”) and the surrounding landscape matrix.

The boundaries of a pondscape may be determined by physical or ecological settings (a valley, a catchment, a set of ponds in a nature reserve) or even determined by societal or political criteria (urban ponds, provincial or national boundaries).

PRESSURE/THREATS ON PONDS AND PONDSCAPES

50-90% of pond have been lost from European countries over the past century. Furthermore, ponds are largely neglected in water- and nature-related national and EU policies and strategies, including the EU-WFD.

WHY IS IT IMPORTANT TO PROMOTE THEM ?



BIODIVERSITY ENHANCEMENT

Largely neglected and generally undervalued, ponds are remarkably important for biodiversity conservation. Pondscapes represent biodiversity hotspots.



DISASTER RISK REDUCTION

Ponds and pondscapes play a fundamental role in mitigating flooding and also constitute a water reserve to fight fires.



HUMAN HEALTH

Ponds and pondscapes provide a wide range of co-benefits for human societies such as support for human health and quality of life, spaces for physical activities, or social interaction, but also aesthetic experiences and educational and recreational activities.



CLIMATE CHANGE MITIGATION AND ADAPTATION

Given their abundance and their high productivity, ponds influence markedly the carbon cycle by acting as both carbon sinks and sources.



WATER MANAGEMENT

Pondscapes provide a water reserve that is particularly important in the context of water scarcity. It is particularly useful for watering animals and for irrigation.

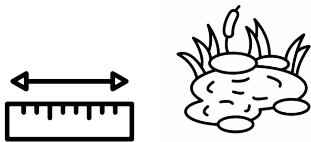
CONTEXT

The Lystrup Pondscape covers a sub-urban area located on the hillside at Egådalen, north of Aarhus, the second biggest city in Denmark. The neighborhood is a home for approximately 10,300 inhabitants living in single-family houses. The area is quite green with numerous gardens, few parks, and a network of 18 ponds. Nearly all ponds were altered or created after 2004, as part of the housing development. After a severe storm in 2012, four ponds were re-shaped and two constructed to mitigate the negative consequences of such events in the future. All together 11 different climate adaptation NBS were constructed from 2014 to 2016, aiming at reducing flood risks and runoff to the neighboring artificial lake (Egå Engsø/Egå Meadow Lake). The biggest NBS was created as a large-scale demonstration project of how biodiversity can go hand in hand with climate adaptation in a public park.



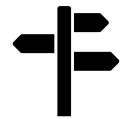
Name of the pondscape : Lystrup
Name of neighboring large town (in a 30 km radius):
 Aarhus (~290'500 inhabitants)
Bioclimatic zone : Continental

Dominant land use :
 pondscape - Urban (55%)
 surrounding environment - Grassland (40%)



Pondscape area : 5 km²
Ponds : number: 18 (14 included into Ponderful project survey)
density: 3.6 / km²
surface areas : 300 to 8'000 m²
depths : 0.4 to 2 m
ages : 5 to over 200 years

Land owner : Private homeowners' associations, Aarhus Kommune (municipality)
Land Manager : Aarhus Kommune, Aarhus Vand (water utility company), Lystrup Kogræsser- og Naturplejeforening (NGO)
Public access : almost 100 % of the area is accessible
Public amenities : extensive footpaths and some hides

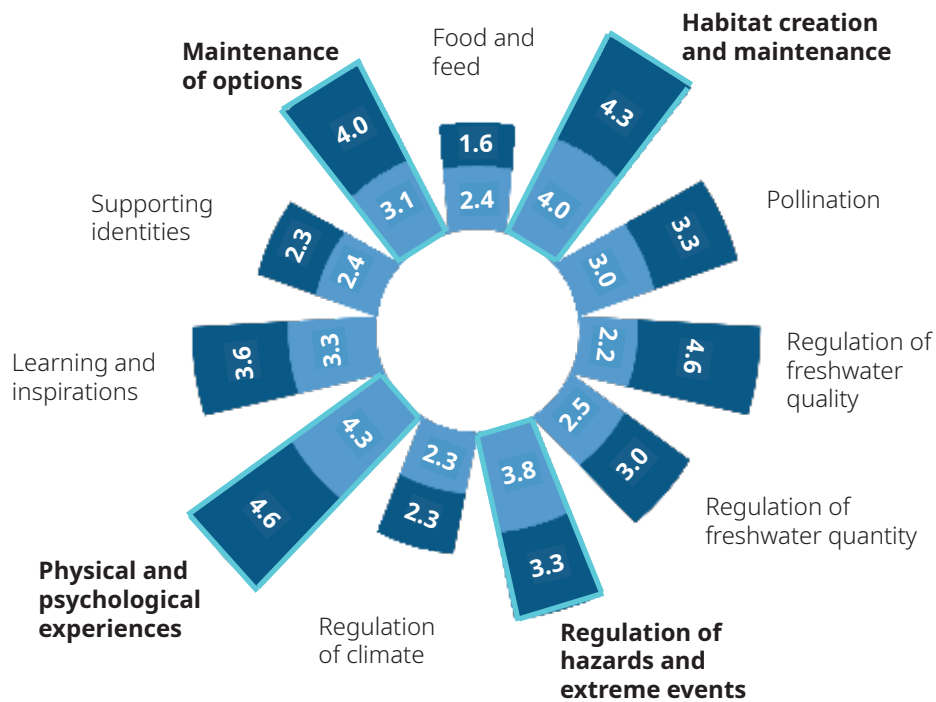


LOCAL COMMUNITY EXPECTATIONS

The 11 Nature-contribution to people (NCPs)

Scale : scores from 1 to 5

Public (n= 17)
Stakeholders (n= 3)



The expectations rely mainly on (i) the direct use of the natural areas by people (physical and psychological experiences), (ii) the habitat creation and maintenance, (iii) the regulation of hazards and extreme events as well as the maintenance of options.

LOCAL POLICIES

Most of the ponds in Lystrup were altered or created during the construction of housing. Despite this, the majority of ponds are protected against changes without permission by the Law of Nature Conservation (Naturbeskyttelsesloven). Some of the ponds were modified or created as part of a climate adaptation scheme to control and slow down stormwater flows according to the Aarhus municipality's climate adaptation plan.

The ponds in the area support a population of great crested newt *Triturus cristatus*. This is an Annex IV species of Habitats Directive, and so changes in their habitats are regulated by Law of Environmental Targets (Miljømålsloven). This means not allowing damage or destruction of their breeding and resting areas, intentional disturbance during breeding, migration or hibernating, as well as intentional capture or killing of individual newts.

Nearly 100% of ponds in the pondscape are protected, as so called '3 habitats' by the Danish Law of Nature Conservation (see image).

60% of ponds is used by *Triturus cristatus*, Annex II/IV species of Habitats Directive, for breeding and resting: *Triturus cristatus* was found in 11 ponds in Lystrup. It successfully breeds in 5 of them.

6 ha big urban park in the middle of Lystrup is managed by local inhabitants with cattle grazing.

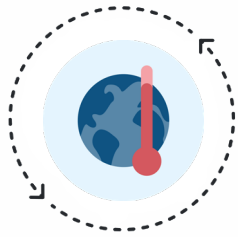
100%

60%

6ha

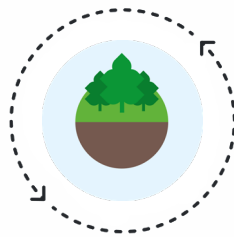


MAIN CHALLENGES AND OBJECTIVES



CLIMATE CHANGE ADAPTATION

Flood water storage was the primary aim of pond construction – it has been a success.



BIODIVERSITY ENHANCEMENT

Especially meadow vegetation around the ponds, and other measures aimed at enhancing populations of amphibians, birds, and aquatic plants.



HUMAN HEALTH

A refreshing place to walk and relax in, and to educate people about nature.



NATURE BASED SOLUTIONS (NBS)

New pond creation and their management are here the Nature-based Solutions (NbS) put in practice to address the three identified societal challenges.

NEW POND CREATION

1800s-1995

There were three ponds constructed

2004-2010

Creation of seven more medium-sized ponds primarily for storm water retention

2016-2017

Creation of three ponds and management of some existing ponds for storm water retention to deal with extreme rainfall events

PONDS AND PONDSCAPE MANAGEMENT



- At least six ponds are part of the NBS system built to collect water as well as reduce and delay runoff after storms.
- Dredging of terrestrialised ponds is needed every 15-25 years.



- Changes in lawn management from summer mowing to livestock grazing to manage pond edges in the urban park.
- Removal of nutrient rich topsoil and transfer of vegetation and seeds from a disused sand quarry around the biggest pond in the NBS system for storm water retention.



- Creation and maintenance of trails and nature observation points.

NATURE CONTRIBUTIONS TO PEOPLE AND MEASURED INDICATORS



AQUATIC BIODIVERSITY

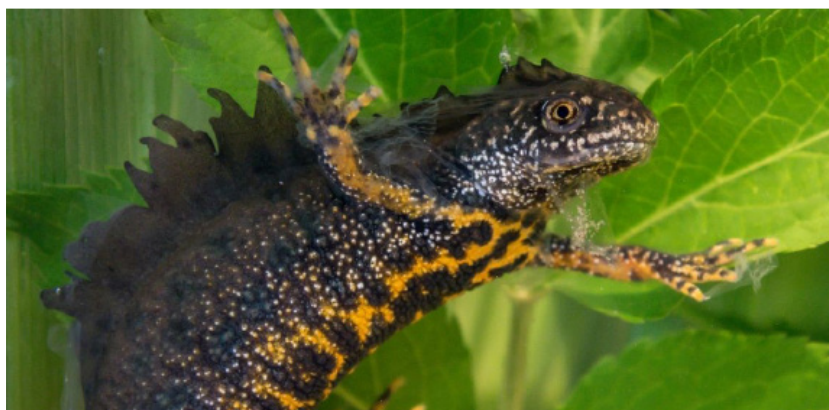
SPECIES RICHNESS

Aquatic plants : **22**
Water birds : **20**
Amphibians : **4**
Dragonflies : **11**
Families of invertebrates : **25**

AMOUNT OF

Conservation priority species : **8**
Species on Habitat Directive Annexes (N) : **1*** *Triturus Cristatus* (amphibian)
Invasive alien species : **1**

FLAGSHIP SPECIE :



*Triturus cristatus**



REGULATION OF CLIMATE

10.1t

Capacity of annual carbon storage in the ponds (by primary production, by organic matter accumulation) (tons CO₂eq /pondscape/year).

NATURE CONTRIBUTIONS TO PEOPLE AND MEASURED INDICATORS



PHYSICAL AND PSYCHOLOGICAL EXPERIENCE

Number of people visiting the pondscape (leisure, tourism, fishing, nature watching etc.) (nb/year)

10'000

100%

Area inside the pondscape accessible to the public

Self-reported satisfaction well-being (scale 1 to 5)

3.8

Most popular activities :

wildlife observation (25%), relaxing (23%) and hiking (16%)



WATER QUANTITY



9'300m³

Estimated volume of water stocked during a severe flood event (m³). The NBS constructed after flooding in 2012 reduced both flood risk and runoff to the neighboring artificial lake (Egå Engsø/Egå Meadow Lake).

Total water volume (m³) **18'600m³**



WATER QUALITY

Nutrients : **MIXED**

A wide range of pollution levels between ponds, some have good water quality (low nutrient values Total Phosphorus 0.07 mg l⁻¹ and Total Nitrogen 0.4 mg l⁻¹) whereas others are more impacted as it is typical for an urban areas.



COSTS AND BENEFITS ANALYSIS

The NBS construction works implemented during 2016-2017 to adapt the area to future extreme rainfall events costed approximately 4 millions euro. Half was financed directly by the Aarhus Vand (a water utility company), the other half was financed via loan taken out by Aarhus Municipality and repaid with money from ongoing water diversion tax payments to the Aarhus Vand by citizens. Members of the local community paid their water diversion charges as usual without additional expenses.

In addition to the construction costs, there are operating (maintenance) costs, including for example dredging the retention ponds every 15 - 25 years. Operating expenses for the NBSs are paid by the project owners, Aarhus Vand and Aarhus Municipality.

Ordinary maintenance costs of the green spaces are covered as before by the Aarhus Municipality, the owner. A stakeholder-led NGO was established during the project to manage the urban park in the area by livestock grazing.

The project also includes an agreement between Aarhus Vand and a farmer to direct excess rainwater onto his field. If water damages the harvest, the farmer gets compensation for loss of income.

REMAINING THREATS

1. The impact of people on biodiversity, including damage to pond banks from walkers and disturbance of wildlife.
2. The primary use of storm water retention and the urban setting of the ponds puts pressure on the ponds from a biodiversity perspective. With the increasing intensity of rainstorms and the urban setting of the pondscape, pollution from road surfaces is inevitable and likely to impact water quality and so biodiversity. This may be exacerbated by changes in hydrology linked to climate change, including the timing and quantity of rainfall. Smaller ponds are likely to disappear due to drying, which will also impact biodiversity.

SUCCESS STORY AND TRANSFERABILITY

STORM WATER PROTECTION AND BIODIVERSITY ENHANCEMENTS - PROVIDING MULTIPLE BENEFITS IN A PUBLIC PARK



In August 2012, Lystrup was hit by a heavy storm and received 49 mm of rain in three hours, overloading existing the typical 'grey' rainwater system designed to cope with 29mm in 4 hours. This extreme weather event caused substantial damage to both infrastructure and housing. Rather than investing in more grey infrastructure, like expanding the sewage network, Aarhus Municipality decided that Lystrup should become a pilot project for nature-based solutions (NBS). A total of 11 NBS measures including the creation of rainwater retention basins, dikes and swales were constructed as part of the municipality's climate adaptation plan. The construction (2014-2016) aimed at reducing both flood risk and runoff to the neighboring artificial lake (Egå Engsø/Egå Meadow Lake). It was one of the largest contiguous climate adaptation projects in Denmark at that time.

Aarhus University researchers approached Aarhus Municipality to develop this initiative as a demonstration project where residents would be involved in both the design and the implementation phase, and climate adaptation would be combined with the creation of habitat for biodiversity. The aim was also to increase recreational use and the stakeholders' involvement in the maintenance of the area post-construction.

The demonstration project, covering about 6 hectares in a large urban park, Hovmarksparken in the middle of Lystrup, was a partnership including the local community, a school, the public administration (the Aarhus City Council), a water utility company (Aarhus Vand), and scientists (Aarhus University).

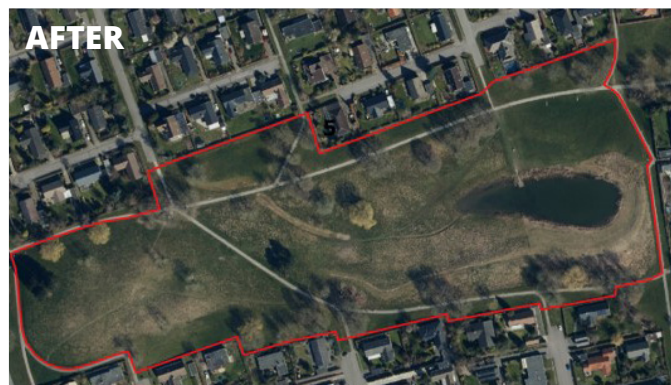


N°	NbS	Measures enhancing biodiversity
1	Detention basin	Sowing of seeds collected from plant species characteristic of natural grasslands (<i>Galium verum</i> , <i>Lotus corniculatus</i>)
2	Detention basins	-
3	Retention basin	A nutrient-rich topsoil removal, establishment of soil mounds ("hilock")
4	Swales, relocation of the road	-
5	Dike	-
6	Retention basin, dikes and ditches	Removal of vegetation and topsoil, transplantation of vegetation from a gravel pit, sowing of seeds collected from plant species characteristic of natural grasslands (<i>Galium verum</i> , <i>Knautia arvensis</i> , <i>Lotus corniculatus</i> , <i>Origanum vulgare</i> , <i>Vicia cracca</i>), establishment of soil mounds and fences for cattle grazing
7	Ditches, dikes and retention basin	Transplantation of vegetation from a gravel pit, sowing of seeds collected from plant species characteristic to natural grasslands (<i>Anthyllis vulneraria</i> , <i>Campanula persicifolia</i> , <i>Campanula rotundifolia</i> , <i>Knautia arvensis</i> , <i>Lotus corniculatus</i> , <i>Pilosella officinarum</i>)
8	Deepening of an existing basin	-
9	Dikes	Nutrient-rich topsoil removal
10	Retention basin and a ditch	Nutrient-rich topsoil removal
11	Deepening of an existing basin	Nutrient-rich topsoil removal

A large retention pond, swales and dike were constructed in what was previously a species-poor grass lawn. The nutrient-rich topsoil was removed, and vegetation and seeds from a disused sand quarry were translocated. Also, single perennials plants including *Pilosella officinalis*, *Anthyllis vulneraria*, *Campanula persiflora* and *Campanula rotundifolia* were also introduced. A mixture of native annual flower meadow seeds like *Lotus corniculatus*, *Leucanthemum vulgare* were sown to ensure the areas was aesthetically pleasing rapidly, giving a chance for the perennials to become established. To reduce the nutrient content, no humus-rich topsoil was placed at the bottom of the retention pond or on its margins and banks.

The objective was to increase the biodiversity of the area and to demonstrate a different ecological design principle for urban green parks as an alternative to the common homogeneous landscape of short-mown lawns.

The local community was involved in public meetings and workshops, and a cattle-grazing NGO was established to manage the area, give guided bio-tours, and develop site-specific play activities in parallel to the construction work.



Members of the cattle-grazing NGO (Lystrup Kogræsser- og Naturplejeforening) paid for some of the calves and received a share of the meat produced. They also maintain fencing in the area. The release of grazing animals into the park was an important local event, attracting 50 to 100 people and media attention.

The transformation of the park also required change in its management. Before the project implementation, the Aarhus municipality often mowed a few areas to allow for recreational activities such as picnic and football, and the whole area once in midsummer, leaving the grass clippings on site. The timing of mowing did not take into consideration the needs of insects and birds. The integration of biodiversity objectives into the overall park management required re-scheduling the mowing regime from a summer cut to once in spring and once in autumn, with the removal of grass cuttings and the introduction of cattle grazing. This way, for the first time in Denmark in a public urban park, a pasture was created for cattle managed by the local community.

The retention pond contributes to the natural value of the area. Two of the most common species of amphibians, *Lissotriton vulgaris* and *Rana temporaria* are breeding there. The new retention pond is also part of the network of ponds used by the protected species *Triturus cristatus*. A measurement of GHG emissions in the pond carried out during the Ponderful project has shown that the pond has buried more carbon than it emitted.

The effectiveness of the NBS has been shown during a storm in October 2023, when the area received about 60 mm of rain during 10-12 hours. This is equal to the amount of rain usually measured during a whole month. There was no damage reported in Lystrup with the exception of one settlement very close to the highway.



PHOTOS CREDITS

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