Deep Dive Cases

Aarhus Living Lab: Welfare Economic Assessment of Large-Scale Nature Restoration

About this brief

This brief presents the results of a social cost-benefit analysis of a large-scale nature restoration plan in the Municipality of Aarhus in Denmark.

A total of 11 Water- & Nature Parks are planned that would more than double nature areas. In this brief, one of the 11 parks, the Aarhus River Valley Water & Nature park is assessed economically in terms of:

- Surface water quality improvement
- Groundwater protection
- Improved recreation opportunities
- Enhanced amenity values
- Carbon sequestration
- Implementation and operational costs
- Results: for every euro invested, society gains €4.15

Context

Aarhus Municipality, the second largest in Denmark, has an ambitious plan to amplify the amount and quality of nature by 8,000 ha through the establishment of Water and Nature Parks. This will effectively increase the proportion of natural area in the municipality from 13% to 32%.

By taking agricultural land out of production and restoring nature at large scale, Aarhus Municipality intends to address several challenges in one go: ground water pollution from pesticides, biodiversity decline, greenhouse gas emissions, flooding, poor surface water quality, and the lack of recreational opportunities for a growing population.

However, the benefits of addressing these challenges are not typically assigned an economic value, while the costs are readily available, making decision-making in favour of nature investments difficult. To address this gap, Invest4Nature assessed the welfare economic impacts of implementing one of the 11 Water- & Nature Parks, the Aarhus River Valley Water- & Nature Park, to compare costs and benefits.

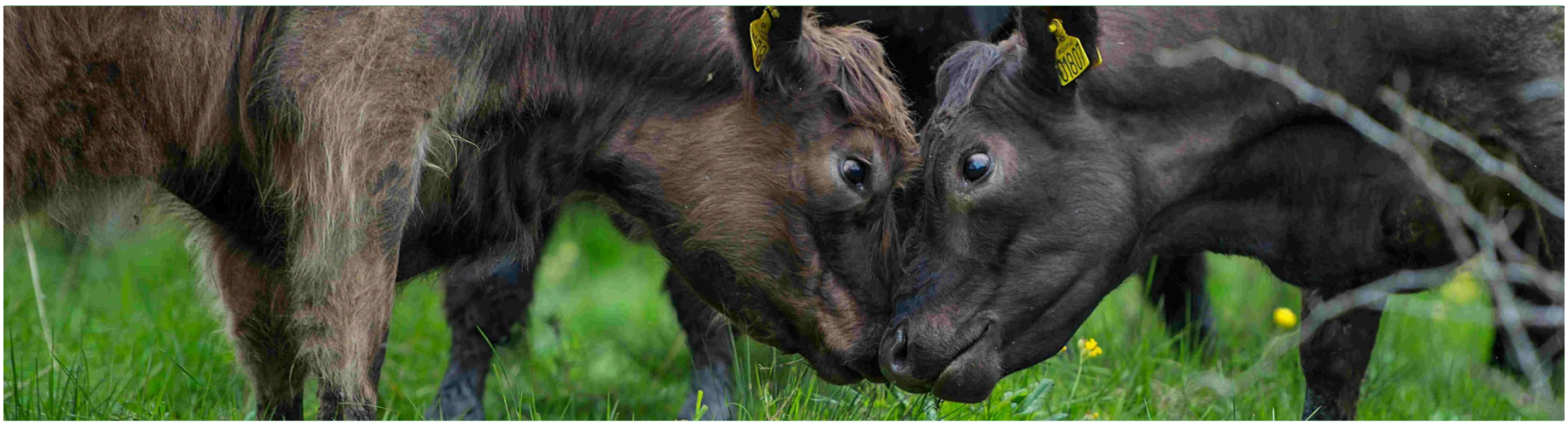
Methods to assess economic benefits comprise of different types of value transfers based on non-market economic valuation techniques and local data. Costs are based on actual planning & implementation data.

Digital version: Zandersen et al. (2025) https://doi.org/10.5281/zenodo.17508980

Funded by the European Union

Report Brief

Cost-Benefit Analysis of Nature Restoration



Water buffalos for rewilding © Aarhus Municipality

Nature Restoration Case

Aarhus River Valley Water- & Nature Park

is one of the largest suggested Water & Nature Parks with a projected total area of 2,368 ha connecting existing nature (forests, other terrestrial nature, lakes, streams) and agricultural land, which will be taken out of production and restored (total of 1,076 ha).

Aarhus River Valley Nature- & Water Park
© Aarhus Municipality

Nature-based Solutions (NbS)

The implementation of the Aarhus River Valley Water- & Nature Park will involve large-scale renaturation, restoration and protection of nature.

Specific NbS actions include afforestation on one third of acquired agricultural land, restoration of natural hydrology, restoration of open terrestrial nature with extensive grazing and the protection and restoration of blue infrastructure.

Additional material

- Zandersen, M., Telling, L.N., Panduro, T. E., Levin, G., & Nainggolan, D. (2025). Welfare-economic assessment of nature restoration of agricultural land in Aarhus, Denmark. Invest4Nature case study documentation. Horizon Europe Grant No. 101061083. https://doi.org/10.5281/zenodo.17158509

Funded by the European Union

Report Brief

Capital and Operational Costs

Capital costs involve the acquisition of agricultural land, fencing for livestock, creation of ponds, cutting drainage system on arable land, establish gravel pathways and parking area for recreational use, and adjustments in open nature (e.g., adjusting water flows and leveling of the parking area). Capital costs occur during the first 10 years with a planned acquisition and nature restoration rate of about 100 ha/ year.

Operational costs are costs that occur throughout the duration of the project. They comprise of the opportunity cost of land, maintenance of afforested areas including three years of weeding until the plants are tall enough, regular maintenance, fundraising, planning and design, general project management and citizens involvement.

Over a period of 50 years, present value of capital costs amount to €37.43 million and operational costs to €31.6 million (2024 values).

Costs are based on actual costs incurred in similar implemented nature restoration projects, scaled to the present case. We applied a 3.5% discount rate for the first 35 years and 2.5% discount rate for the rest of the project period. The factor prices of costs to consumer prices were also adjusted to make costs and benefits directly comparable using the Danish net charge factor, in accordance with guidance from the Danish Ministry of Finance.

Welfare Economic Benefits

Benefits are counted from year 11, when the project is fully established, for a project period of 50 years and a discount rate of 3.5% during the first 35 years and 2.5% during the rest of the project period. Results are listed in Euro in 2024 values.

Amenity Values

Private homes close to nature areas are generally more expensive than similar homes further away from green areas. Some 2,319 homes are estimated to experience a one-off increase in property value due to the enhanced proximity to nature when the park is fully established.

Based on a Danish hedonic pricing value transfer model, the amenity value is estimated at €3.4 million at year 11.

The present value of increased amenity values over the project period is €2.34 million.

Afforestation with citizens. © Aarhus Municipality

Recreation

The establishment of the 11 Water & Nature Parks in Aarhus Municipality will increase recreational opportunities, providing a higher number of recreational destination choices, larger consecutive areas and improved nature experiences.

In the estimation of the annual value of recreation, we take into account the increase in alternative recreation sites when all Water & Nature Parks are implemented, the features of the specific Aarhus River Valley Water & Nature Park, their perceived attractiveness and the population density in vicinity to the park. We apply an existing value transfer model that is based on a national and spatially explicit travel cost recreation model.

The annual recreation values amount to €2,382,809 which are counted from year 11 when the full area is established.

Over a 50-year period, present values of recreation amount to €57.34 million.

Funded by the European Union

Report Brief

Carbon Sequestration

Of the 1,076 ha agricultural land planned converted into nature, 287 ha will be fully afforested using native species, predominantly oak and other broadleaf (94% and remaining 6% Scotts Pine).

Using the model of the Danish Climate-Forest Foundation and applying a 15% buffer to account for risks and uncertainties, the afforestation is estimated to sequester a total of 100,097 tCO_2eq over 100 years. We use the annual carbon sequestration and the 2024 average price of the EU Emission Trading System to estimate the economic value of carbon sequestration.

The present value of carbon sequestration over the 50-year project period amounts to €2.6 million

Drinking Water

Ca. 40% of the groundwater resource used for drinking water purposes in Aarhus Municipality will be protected against pollution from pesticides when all 11 water and nature parks are in place. Especially areas with fast percolation time of below 20 years are in focus.

The Aarhus River Valley Water- & Nature Park will protect around 3 million m^3 drinking water per year. This represents about 3.8% of drinking water produced in the municipality, equating the annual consumption of 7,000 households.

A national Danish valuation study on protection of drinking water estimated the annual willingness-to-pay at €345 per household. Transferring this single point value to Aarhus suggests a total annual value of €2.4 million.

The present value of protecting groundwater for drinking water purposes amount to € 65.9 million.

Surface Water Quality Improvements

Water quality in the Brabrand lake in the Water & Nature Park is in poor condition due to excessive emissions of phosphorous and nitrogen. Also, it is not safe to swim in the lake due to occurrence of e-coli bacteria and algae.

The removal of 1,076 ha of agricultural land is expected to reduce phosphorus emissions by 161 kg per year. This corresponds to approximately 43% of the total reduction needed to lower phosphorus emissions into the lake. We assume that the lower phosphorus emissions from the water and nature park will improve the water quality in Brabrand Lake from “bad” to “poor” - that is, one step up on the EU’s five-step water quality ladder, where “poor” ranks above “bad.”

To assess the economic value of this improvement, we apply results from a meta-analysis of similar studies from the Nordic countries and combine them with local data on land use, the type and context of the water body, and population characteristics. In this way, we determine how much each household is willing to pay on average per year to improve water quality by one step from “bad” to “poor” ecological status: €40.8 for so-called “non-use values” and €32.3 for so-called “use values.”

Non-use values are intangible benefits that people derive from environmental quality improvements as opposed to use-values that come from direct experience like recreation. We exclude use-values from the valuation of surface water quality improvements to avoid double-counting with recreation benefits.

We apply the average non-use value benefit per household to the 137,107 households in the catchment.

The present value of surface water quality improvements over the project period is estimated at €158.2 million.

Funded by the European Union

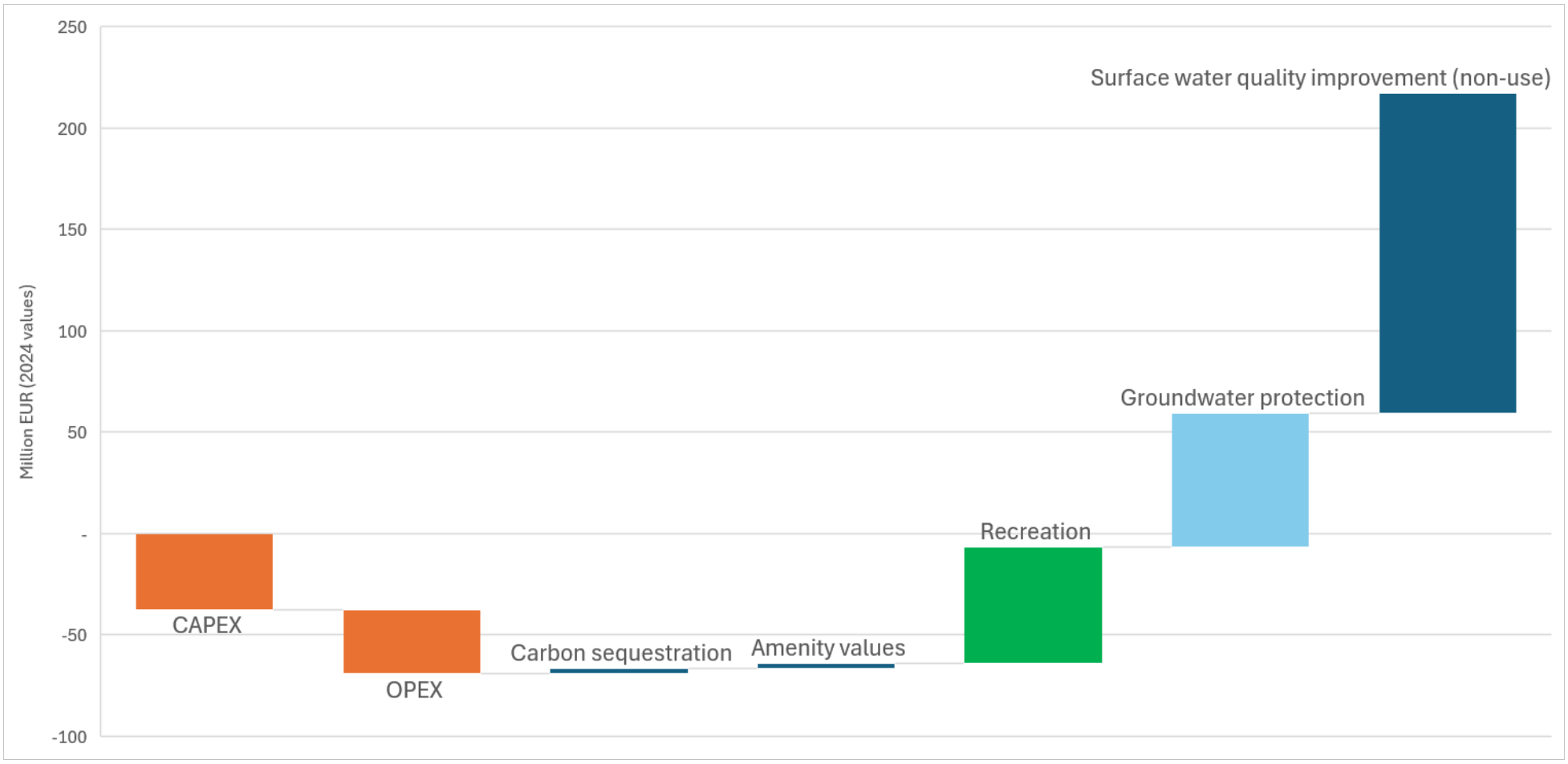
Report Brief

Cost-Benefit Analysis Results

Comparing the costs with benefits of establishing the 2,386 ha large Aarhus River Valley Water- & Nature Park over a 50-year period shows a **net benefit to society of €217.3 million.**

For every euro invested, society gains €4.15.

Cascading effects illustration of present value costs and benefits in million euro over a 50-year period:



Funded by the European Union

invest4 nature

The economics of nature-based solutions

Invest4Nature

Invest4Nature aims to attract investments in one of the key measures of climate change adaptation and risk reduction: Nature-based Solutions

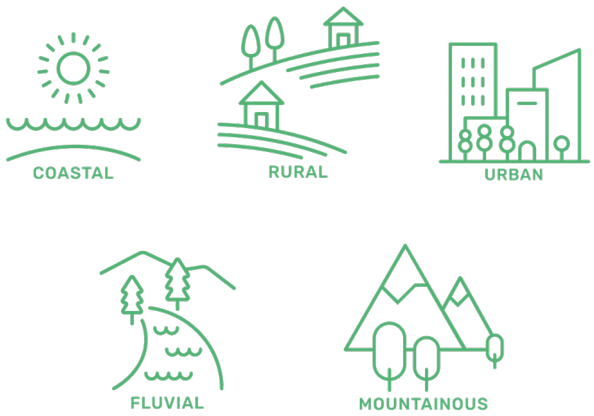
Invest4Nature **aims** to create flourishing markets for Nature-based Solutions (NbS) by:

- ↗ Creating thorough understanding **of the economic costs and benefits** of NbS to enable the creation of business models and suitable market conditions for NbS
- ↗ Developing a **decision support** tool to enable private & public stakeholders make **informed decisions** on NbS investments
- ↗ Creating a multi-stakeholder **online marketplace**
- ↗ Establishing a European NbS **investment community**

5 Living Labs

Austria, Denmark, Norway, Poland and Portugal

with **NbS cases** covering five **landscapes**:



Partners

Coordinator

JOANNEUM RESEARCH · oppla · Horizon Nua · AARHUS UNIVERSITY · Steinbeis Europa Zentrum

NBS Living Labs

TECHNIC AND ENVIRONMENT City of Aarhus Denmark · CASCAIS AMBIENTE Gestão do Ambiente Terrestre e Marítimo

usentric · MELOMYS ADVISORY · cmcc · Climate Alliance · eng · POZnań · KLIMA BÜNDNIS TIROL · NIVA Norwegian Institute for Water Research

Funded by the European Union

Learn more:

Invest4Nature

zenodo /communities/Invest4Nature

Explore more Invest4Nature briefs