Nature positive transitions: 6-years of societal impact

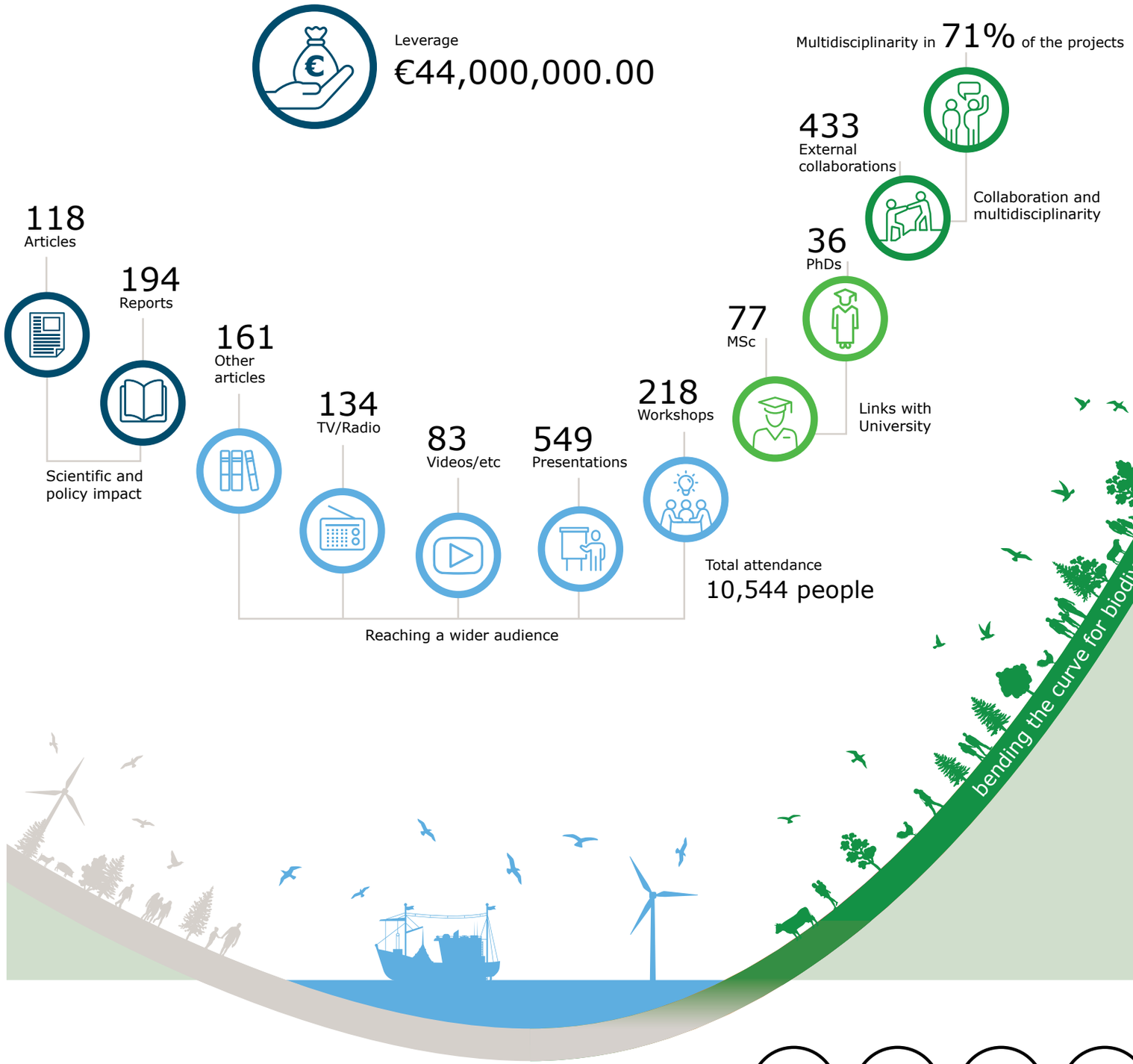
6-year impact assessment of the Knowledge-Based Programme: Biodiversity in a Nature Inclusive Society

The knowledge-based programme Biodiversity in a Nature Inclusive Society was established at the end of 2018 to run for six years between 2019-2024. The general goal of all the knowledge-based programmes is to: Deliver innovative applied research that has the potential for value creation.

To explore more of the programme or projects go to www.wur.eu/nature-inclusive-transitions

WAGENINGEN
UNIVERSITY & RESEARCH

Wageningen Research Impact



Project highlights
Looking to the future
Colophon

Biodiversity in a Nature Inclusive Society

The specific goal of this six-year programme has been to transform existing social and economic systems to better include biodiversity, make full and effective use of nature-based solutions that are socially inclusive, economically sustainable, and appropriately scaled, and to deliver sustainable ecosystem services. This short report presents an assessment of the programme's impact during its six years in operation. It is based on a questionnaire completed by project leaders of the 62 projects that ran during that period (not all of them for the full six years).
The figures presented here are remarkable in many ways and demonstrate what can be achieved through focused effort within the boundaries of a specific research programme.

Wageningen Research Impact visual

Here the figures shown in the graphic above are briefly explained:

- **Scientific and Policy Impact:** These figures represent published peer-reviewed articles and reports, as well as those in preparation or in press. These will be made available via the Kennisonline website to contribute to the ongoing dissemination of scientific knowledge.
- **Reaching a Wider Audience:** The programme reached more than 10,000 attendees at workshops and presentations, a remarkable outcome. It should be noted that one project on strip farming alone accounted for 6,000 of these attendees, holding regular workshops over the four-year period (it ended in 2023) and often attracting over 100 people per event. In addition, outreach efforts such as popular articles, TV and radio appearances, and other media presentations have significantly contributed to bringing science and research results to a wider community of interest.
- **External Collaboration and Interdisciplinarity:** The programme has shown strong external collaboration, which was essential for engaging other research institutes, universities, key stakeholders, business, and industry in advancing the projects. Many projects involved collaborations across multiple disciplines, enhancing the multi-transdisciplinary nature of the research.
- **Internal Multi-Interdisciplinarity:** The programme has been successful in achieving its aim of a multidisciplinary approach, with around 70% of projects involving researchers from two or more of the University institutes.
- **Links Between the Research Institutes and the University:** The programme funded by the University institutes has been successful in fostering collaboration with the University chair groups. Masters and doctoral students have been actively engaged in the research, contributing to data collection and analysis, much of which has formed the basis of MSc or PhD theses. Over 800 MSc students from international universities participated in a challenge run by one of the projects.
- **Leverage:** The total budget for the six-year programme amounted to €16.6 million. The leverage achieved from this initial investment, through additional related project funding, has been just under €44 million; the NL2120 approach developed in the project "Climate as a driver for a more natural future for the Netherlands" leveraged €110 million from the Dutch Nationaal Groeifonds, which has been shared between project partners, with Wageningen Research securing around €20 million over 10 years. This figure does not capture the intangible benefits, such as the ability to bring innovative ideas and knowledge into discussions with influential partners, thereby enhancing further collaboration, policy discussions, and the development of new innovations.

Conclusion:

As the programme concludes this year, it has demonstrated its significant impact in transforming biodiversity-related systems, advancing nature-based solutions, and contributing to the delivery of sustainable ecosystem services. Through its scientific outputs, extensive outreach efforts, and strategic collaborations, the programme has delivered valuable knowledge and resources to stakeholders across multiple sectors. The leverage achieved, both in financial terms and in terms of policy influence and partnerships, underscores the lasting value and effectiveness of the programme's efforts over the past six years. These results highlight the critical role of biodiversity in social and economic systems and pave the way for continued progress in nature-inclusive transitions.

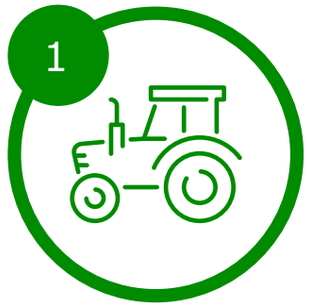
The 'KB' Knowledge Base - Kennisbasis - funding programme is provided to the Wageningen Research Institutes by the Dutch Ministry of Agriculture, Fisheries, Food Security and Nature to carry out independent research into pressing and topical issues with high societal impact. During the six years the KB36 programme 'Biodiversity in a Nature Inclusive Society' has contained more than 60 projects.

Individual project highlights

The overall objective of the KB programmes has been to: Deliver innovative applied research that has the potential for value creation. The objective and primary task of this KB36 programme is to transform existing social and economic systems to include more biodiversity, make full and effective use of nature-based solutions that are socially inclusive, economically sustainable and at the appropriate scale, and by delivering sustainable ecosystem services.

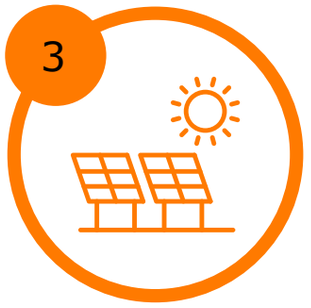
In order to achieve the objective so the projects were commissioned and organised in 9 topic clusters:

Main topic clusters:



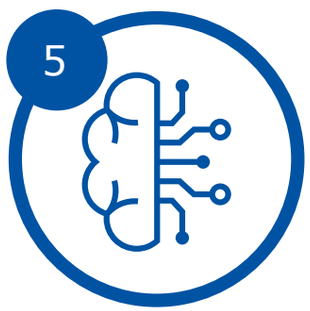
Biodiversity in Farming, Forestry and Circular Agriculture

Biodiversity climate nexus

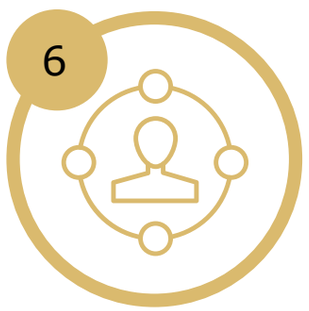


Energy Transitions

Marine and Coastal Solutions, Maritime Energy Transitions



Data Driven Biodiversity



Nature Inclusive Society and the Diverse Values of Nature

Spatial Management of Biodiversity in a Crowded Continent

As well as the clusters a number of minor clusters have also been identified:

Research to support environmental policy processes

The Dutch Caribbean

Per topic cluster highlights from individual project are set out.

Biomass production harvest and use in synergy with biodiversity goals

KB-36-003-001 | **Year** 2019-2022 | **Project lead** Wolter Elbersen

The project had marine and terrestrial components. The high level of integration of biodiversity work in Wageningen Marine Research was a highlight and this demonstrator project also accelerated the proof-of-concepts for the mussel sector, resulting in uptake in other KB programs, and two Public Private Partnership project ideas. On land, forest management change is a slow process - the effects are slow to show up - not harvesting of wood from forests is not necessarily better for biodiversity, indeed many forms of biodiversity benefit from harvesting.

An optimized system of harvest and biodiversity management probably achieves the best results.

Nature based solutions in strip cropping systems

KB-36-003-003 | **Year** 2019-2022 | **Project lead** Dirk van Apeldoorn

We show that bending the curve of biodiversity loss in agriculture is possible! Introducing flowering species has a positive effect on arthropod abundance and species richness. Strip cropping reduces herbivores abundance in cabbages and shows a higher species richness of natural enemies. After conversion to strip cropping we have seen a gradual increase of arthropods and birds over the years. However, biodiversity restoration is highly landscape dependent and varies between years. Crop diversity and semi-natural habitats seem to reinforce each other. We show bending the curve in specific cases is possible, but large scale application would require further understanding of mechanisms and longer data collection to see if this trend is maintained.

Nature-inclusive agriculture: from revenue models in niches to upscaling

KB-36-003-006 | **Year** 2019-2022 | **Project lead** Marie-Jose Smits

The highlights were the genuine collaboration and interdisciplinary work between four WUR institutes: WEcR, WEnR, WPR and WLR; an interactive iPdf made to reach out to stakeholders who have to make it happen, and with impact on (green) education and agricultural advisors; an article in Vakblad Natuur, Bos en Landschap (2022) for broad dissemination of our insights.

Biodiversity in Farming, Forestry and Circular Agriculture

Biodiversity outside natural areas

KB-36-003-007 | **Year** 2019-2022 | **Project lead** Anne Schmidt

To encourage farmers to enhance biodiversity on their farms it is necessary to reward them for their efforts. In the Netherlands a simple set of Key Performance Indicators (KPI's) is used for this aim. In order to be effective in 'bending the curve of biodiversity loss', it is important to complement KPI's with monitoring that can unambiguously determine whether biodiversity has in fact improved. The effects of permanent grassland (one of the KPI's) on insect diversity could not be proven by 3 years of monitoring in several agricultural fields of different farmers in the town of Staphorst. Patterns in species abundance and diversity cannot be linked to the age of the grasslands although there were shifts in community composition. In addition measurements by two different methods (led-buckets for moths and pyramid traps) showed different patterns. Management practices such as the use of fertilizers and pesticides (which is permitted for permanent grassland) might be of bigger influence than the age of the grassland. This questions the use of permanent grassland as a KPI for improving biodiversity.

Biodiversity in Farming, Forestry and Circular Agriculture

Biodiversity innovative agro ecological farming

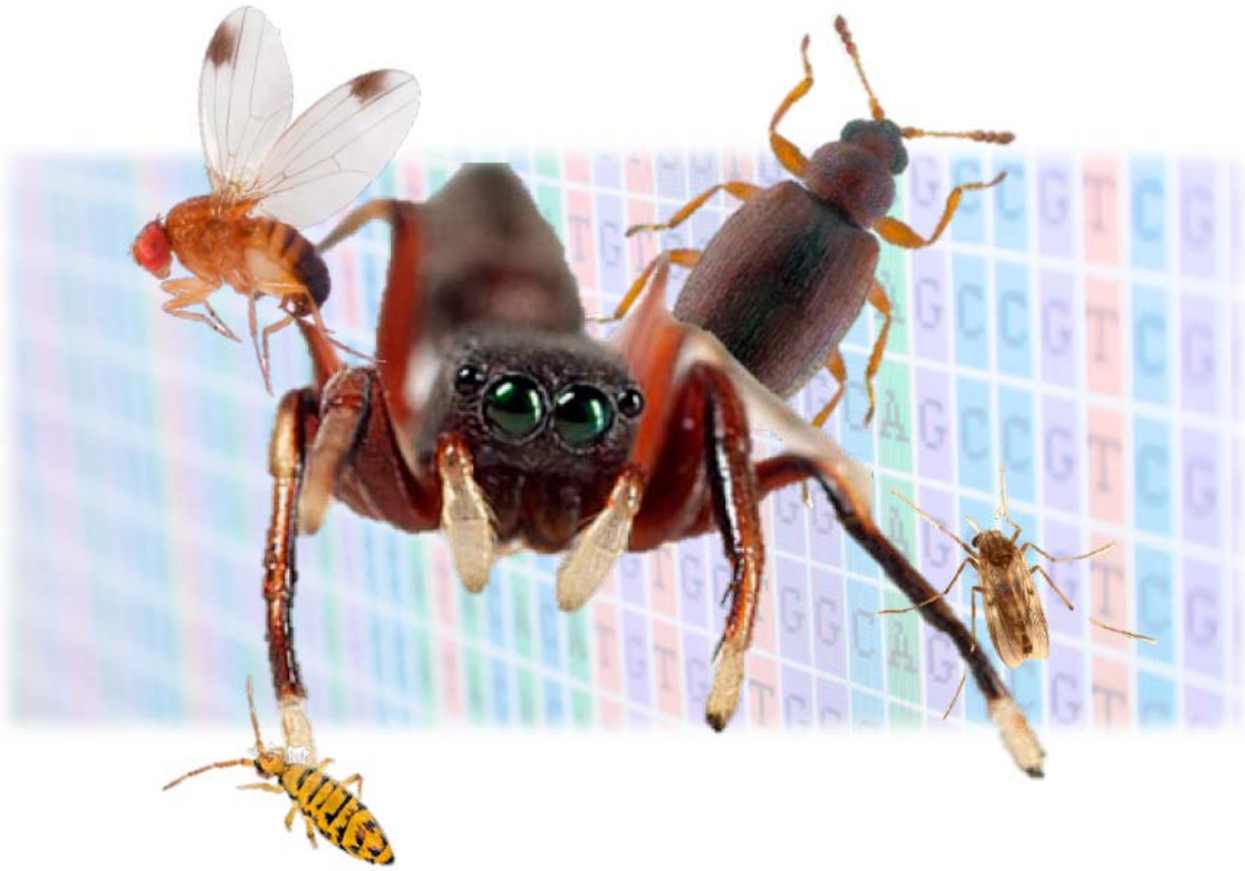
KB-36-003-024 | **Year** 2019-2022 | **Project lead** Jan Hassink

We have several highlights: the development of a simple monitoring system for biodiversity; the active involvement of Wageningen Research (WR) in networks of agro-ecological (AE) farmers, active participation of WR in the knowledge group of the national AE network, participation in the Voedsel Anders Congress, establishment of a good collaboration and joint monitoring with the Soil Biology Group, Leiden and Radboud University; increased visibility of the AE movement in Wageningen and in the Ministry of Agriculture, Fisheries, Food Security and Nature and establishment of a network of researchers connected to the Federation of AE farmers. Better insight in socio, economic and ecological functioning of AE farms and objectives, ideas, motivations of AE farmers and challenges they are facing. And finally we realised an extensive monitoring of soil biology and soil functioning of 80 sites with different management practices ranging from AE practices to conventional practices; dairy, arable and horticultural farms and a collaboration with several WUR networks of different types of farmers.

More efficient monitoring of the effects on biodiversity in making agriculture more sustainable

KB-36-004-006 | **Year** 2019-2022 | **Project lead** Karin Winkler

More than 550 taxa identified! There is a need for standardized monitoring protocols in order to follow up on attempts to restore biodiversity. Monitoring arthropods on a regular basis is challenging as surveys typically yield numerous species and their identification requires a high degree of specialization for the different taxa. In our study, arthropod biodiversity in an apple orchard was examined using DNA metabarcoding on samples from pitfall traps, sweep netting, limb jarring and Berlese funnels. Using DNA metabarcoding we were able to identify 554 taxa of which the majority (83%) at the species level, 10% at genus level and 7% at family level or higher. DNA identifications showed great overlap with identification by taxonomic specialists, but in many cases offered higher taxonomic resolution for a lower price. With the methodology further finetuned and optimized, DNA metabarcoding provides a promising tool for arthropod biomonitoring.



Species-rich grassland - the green machine

KB-36-005-007 | **Year** 2019-2022 | **Project lead** Judith Westerink

In this project many aspects of species rich grassland were studied. Taking an interdisciplinary approach was enriching and important. New aspects and data were formerly taken into account in grassland research. This will help innovate research and practice. The collaboration and interaction with the farmers was very good. In times of strong polarisation, as species-rich grassland is still a topic that unites farming and ecology. An important conclusion is that there is potential for more species rich grassland in Alblasserwaard-Vijfheerenlanden: this is based on a spatial-ecological analysis, on interviews with farmers, and on an economic analysis. We organised follow-up with the collective, provinces, the ministry and the chain to discuss what needs to be done to achieve 25% species-rich grassland in the area. This would mean a tremendous boost for biodiversity.

Nutrient Balance in Forests

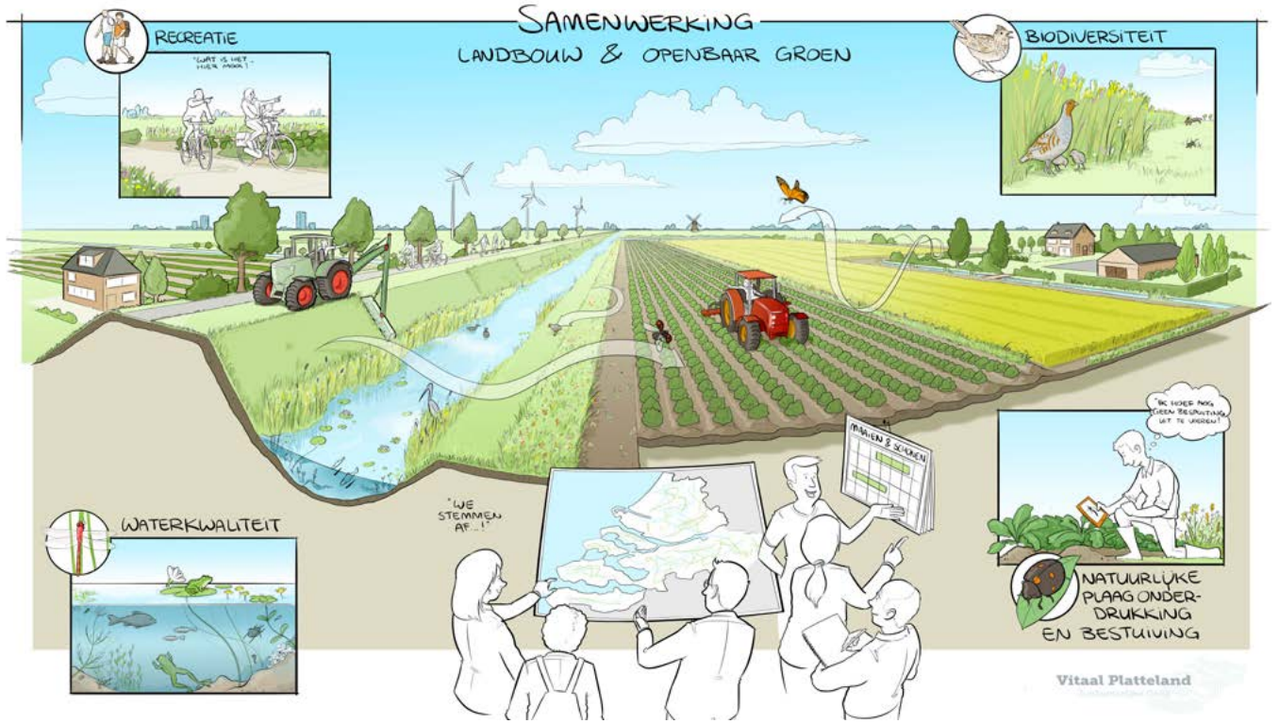
KB-36-003-019 | **Year** 2019-2022 | **Project lead** Joop Spijker

This project has generated new knowledge over the nutrients balance in forest system. Nutrients in the wood which is harvested and also a better understanding of the leaching of nutrients. The results have been discussed with the forest sector in the project Sounding Board Group, Association of forest and nature area owners - Vereniging van bos- en natuurterreineigenaren (VBNE), State Forstry (and nature) Service - Staatsbosbeheer, Dutch Society for Nature - Natuurmonumenten, Union of Forest Groups - Unie van Bosgroepen, Dutch Provinces, Dutch Ministry of Agriculture, Fisheries, Food Security and Nature, National real estate service - Rijksvastgoeddienst and forestry contractors. The result has been an improvement of the advisory system, published by VBNE. Another important result has been the comparison of the nutrient situation in the soil with the situation in the early ’90s of the last century (dataset Wim de Vries).

Field edge mixtures

KB-36-004-013 | **Year** 2021-2022 | **Project lead** Irene Bouwma

A picture can say more than thousand words. As part of the project an infographic was developed that shows the benefits of green-blue veining in a landscape dominated by agriculture. It highlights in particular the need for managers of public spaces such as provinces, waterboards, municipalities and farmers to work together to improve the quality of the landscape in area of the South-West Delta in the Netherlands. The picture was developed with the different partners in the project and distributed to all participants in a workshop attended by approximately 65 people.



Biodiversity and multifunctionality in the Ossekampen long term grassland fertilization experiment

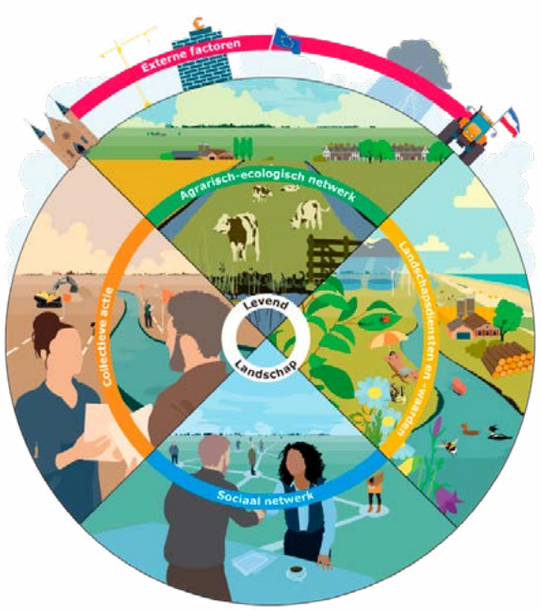
KB-36-004-014 | **Year** 2022 | **Project lead** René Schils

The Ossekampen Grassland Experiment was established in 1958 on a species-rich old pasture on heavy clay soil near Wageningen, the Netherlands, to track productivity and plant species shifts under long-term application of inorganic fertilizers and lime at extensive haying or grazing management. The project comprised an intensive multi-disciplinary one-off measurement campaign, during the 2022 growing season, on soil and plant indicators of biodiversity and ecosystem service delivery. A highlight of the campaign has been that it was a joint initiative of WUR research groups and chairs, Amsterdam University, Utrecht University, NIOO and LBI. The main objective is to quantify the long term effects of nutrient input on above and belowground biodiversity and provision of ecosystem services. The results will be published in Ecosystem Services or comparable journal.

Agroecological landscapes

KB-36-006-001 | **Year** 2023-2024 | **Project lead** Isabella Selin Noran

Agricultural landscapes are crucial for preserving and restoring biodiversity. While individual efforts are valuable for a sustainable future, addressing sustainability on a larger landscape scale is more effective in the long run. However, this scale introduces complexity, as it involves diverse stakeholders with varying and sometimes conflicting interests.
Our project aims to assess how landscapes perform for both people and the planet. We developed a framework for landscape stakeholders to encourage dialogue about different landscape functions. This framework helps stakeholders identify their roles and how their actions can enhance the landscape.
The framework was tested in three 'Living Labs,' receiving positive feedback from landscape managers, including policymakers. They appreciated its iterative design, comprehensive setup, and flexibility, which allows for adaptation to various situations. Our framework is open to all and suitable for any agrarian landscape. We've already engaged with local groups eager to utilize it. If you are involved in landscape management as a farmer, policymaker, or part of a nature organization, we invite you to use our framework to enhance landscape values and biodiversity.



Climate as a driver for a more natural future for the Netherlands

KB-36-003-004 | **Year** 2019-2022 | **Project lead** Tim van Hattum

NL2120 has reached a large audience and created significant impact. Policy makers, government officials, business leaders, NGOs and research organisations were inspired and developed further thinking on the importance of an integrated spatial vision with a healthy natural system as the starting point. There is a huge need for system change and visualising a desired and nature-based future. With NL2120 WUR has shown itself to be a thought leader in this field.

Mark Harbers, the minister of Infrastructure and Water Management received the NL2120 report from Tim van Hattum.

Biodiversity climate nexus

BwN Waddenzeehavens: Marconi - Maritime Concepts In view

KB-36-003-009 | **Year** 2019 | **Project lead** Martin Baptist

Constructed salt marshes as a Nature-Based Solution for coastal defense offer additional benefits over conventional engineering, but project realization is often hampered by practical and governmental obstacles. We assessed the execution of a local-scale salt marsh construction project as a Nature-Based Solution (NBS). The chosen NBS consists of a city beach and two salt marshes, a salt marsh park that is open to the public and a pioneer salt marsh that is only accessible for research. The pioneer salt marsh was constructed by raising the seabed to around mean high tide with sand obtained from a capital dredging project. It was used as a large-scale natural experiment in salt marsh construction. We found that when constructing a salt marsh by raising sand and mixing mud, a mud content of 25% is practically feasible and results in high vegetation cover and species richness.

Biodiversity climate nexus

BwN Waddenzeehavens Koehoal

KB-36-003-010 | **Year** 2019-2020 | **Project lead** Martin Baptist

We tested an innovative approach to beneficially re-use dredged sediment in the form of a semi-continuous source of mud in a shallow tidal channel allowing natural processes to disperse the sediment to nearby mudflats and salt marshes. In carrying out the pilot we learned that the feasibility of such a Mud Motor depends on an assessment of additional travel time for the dredger, the effectiveness on salt marsh growth, reduced dredging volumes in a port, and many other practical issues. Our improved understanding on the transport processes in the channel and on the mudflats and salt marsh yields design lessons and guiding principles for future applications of sediment management in salt marsh development that include a Mud Motor approach.

Biodiversity climate nexus

Mangrove restoration Indonesia

KB-36-003-012 | **Year** (2016 -) 2019[1] | **Project lead** Dolfi Debrot

This project contributed to the realization of four peer-reviewed papers, all dealing with different aspects of a multidisciplinary Ecoshape mangrove restoration project conducted off Semarang on the north coast of Java, Indonesia. One study looked at how mangrove restoration can be enhanced and accelerated using a combination of soft coastal interventions and planting, showing that most mangrove recovery can take place without planting in areas where propagules are abundant but that supplementary planting can be of value to speed up mangrove restoration in areas where propagule abundance is less. A second study examined artisanal fisheries in the restoration area and found that the recovery of natural fish stocks was quite rapid following mangrove reestablishment. By the end of the study fishing had improved to the point at which it became more profitable than laborious extensive pond aquaculture which was the main remaining local source of income to the poor coastal communities. A third study discussed the need to develop mangrove-friendly livelihood alternatives in order to make mangrove restoration socio-economically sustainable. Finally, a fourth study was devoted to developing mussel culture as a promising alternative source of livelihood. Based on the results Wageningen, together with other consortium partners applied for and obtained funding from NWO for further research (MUMACO project) on the use of mussels for sustainable livelihoods.

1 The project began in 2016 and concluded in the first year of this KB programme.

Biodiversity climate nexus

LUMBRICUS: Fascinating Brook Valleys

KB-36-003-013 | **Year** 2019-2021 | **Project lead** Gilbert Maas

Nature-based restoration of streams and river landscapes in the Netherlands has potential for cost-effective sustainable water management and landscape restoration. However, current practice and research reveal a patchwork of experiments and interventions; fragmented across spatial, temporal and administrative scales. This severely limits the effectiveness of the measures due to a lack of integrity, as well as the adaptability needed to respond to climate change and to deliver ecological and social values sustainably. Therefore, there is a need for a holistic method to analyse and plan nature-based interventions in view of dynamic system behaviour of river landscape. We propose to use 'adaptation pathways', originally proposed as a planning approach for climate change adaptation. Building on our experience of applying the adaptation path approach for two Dutch river basins, we conclude that the use of adaptation path approach as a planning tool is of limited use. The value of the adaptation pathway approach lies not so much in the technical planning process itself, but rather in learning about social and ecomorphological aspects of system behaviour and related uncertainties.

Biodiversity climate nexus

Baalhoek/Knuitershoek

KB36-003-014 | **Year** 2019-2022 | **Project lead** Chiu Cheng

Our study integrates the findings from two different WMR projects, encompassing three locations within the Western Scheldt. Among these is Perkpolder (in the 2nd phase), where an innovative “dike-realignment” project was implemented in 2015 to once again expose the long-enclosed polder to tidal inundation. From multi-year monitoring, measurements are available to track the ecological, morphological, sedimentary and hydrodynamic developments. We mainly focus on the ecological development in the benthic community and identify the most relevant parameters driving the changes in species composition, abundance and biomass over time. Furthermore, we try to link the two projects to determine the commonalities in these relationships, given the different interventions implemented (groins vs. dike realignment). We observe an ongoing change in the benthic community at all locations and a general increase in biomass over time, particularly at the areas near the structures. Moreover, the benthic community assemblages are best distinguished along the immersion gradients and the sediment silt content.

Biodiversity climate nexus

Marker Wadden

KB-36-003-015 | **Year** 2019-2021 | **Project lead** Joep de Leeuw

Marker Wadden is profiled as a bird paradise. An important precondition for a true bird paradise is the availability of sufficient food within the range of the Natura 2000 target bird species. The islands increase the habitat and breeding ground for birds. An important question is how fish, macrofauna, aquatic plants and the like develop as a food source for the birds of the Markermeer. By cleverly organizing Marker Wadden, especially the riparian zones, it is expected to increase local food availability for fish, benthos and herbivorous birds.

Biodiversity climate nexus

Sustainable use of dredged sediment in the Ems Estuary

KB-36-003-017 | **Year** 2019-2022 | **Project lead** Marinka van Puijenbroek

Seeds were sown in the Delfzijldepot in November 2019 and these germinated very well. Results show that plant roots did enhance the aeration of the soil top layers. Furthermore the including plants reduced the minimum and maximum temperature of the soil, thereby creating a better microhabitat. So far, no clear difference is observed between the biological treatments compared to the mechanical treatments implying that using biological agents such as plants is promising for future upscaling in the business case.

Biodiversity climate nexus

Water pointer nature

KB-36-003-020 | **Year** 2019 | **Project lead** Hans Kros

In collaboration with the KWR Watercycle Research Institute, the so called Water Wijzer Natuur (WWN) was being developed. With the WWN, users can easily estimate the chances for vegetation and nature potential under climate-changing conditions. In this project the process models within the WWN were improved, especially those on nutrient richness and acidity. The improved model, esp. the response of nutrient richness and acidity, was validated on observations from two test areas. The improvement of the WWN with nutrient richness and acidity largely improved the applicability of the model in view of integrated policy analysis.

Biodiversity climate nexus

ACT on NbS

KB-36-005-005 | **Year** 2019-2022 | **Project lead** Monserrat Budding

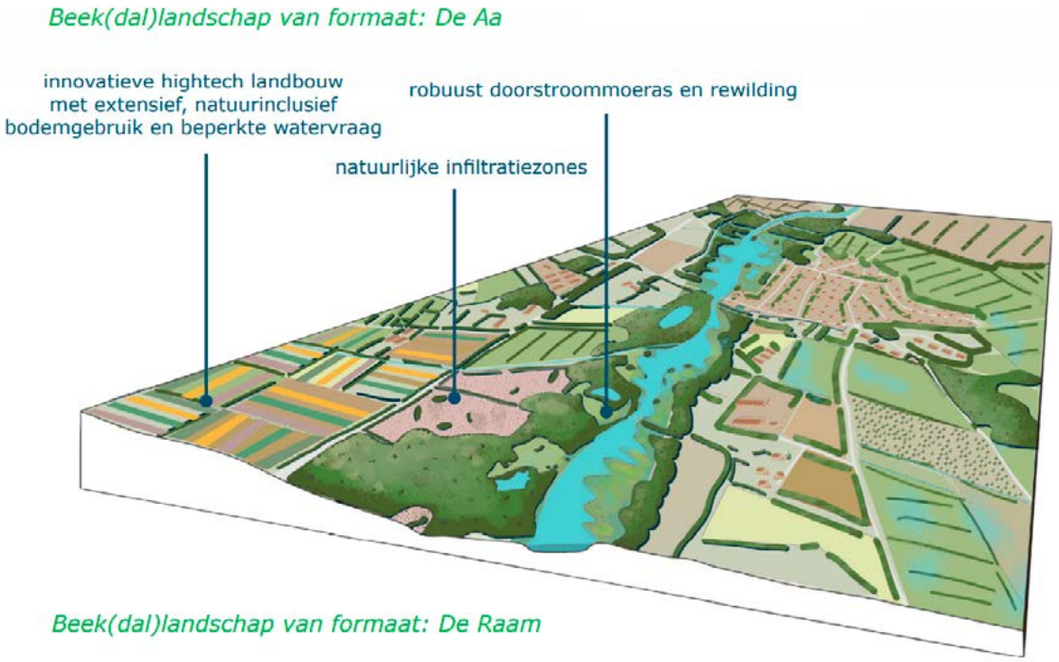
Cities are looking for systemic solutions to cope with climate change. Weather events can spell disaster for cities and the inhabitants in them. The Adaptive Cities Through integrated Nature-Based Solutions (ACT on NbS) project was designed to increase Nature Based Solutions (NbS) uptake. Despite the recognized potential of NbS to support climate adaptation, there are still barriers for a wider uptake of such NbS in urban areas. ACT on NbS developed a comprehensive research aimed to provide an overview of tools to facilitate the uptake of NbS for urban climate. Our research revealed four key challenges that municipal officers, urban experts and decision-makers experienced on the planning and implementation of NbS: 1) resources availability; 2) level of expertise, know-how or competence; 3) the institutional setting, and 4) collaborative governance and planning. We have developed a NbS tools catalogue, academic papers, and contributed to a NbS handbook and a Theory of Change report, which aim to help European municipalities, as well as urban professionals and other end-users to become aware on the existence of several NbS tools to accelerate its uptake.

Biodiversity climate nexus

The Circular Landscape

KB-36-005-006 | **Year** 2019-2022 | **Project lead** Sabine van Rooij

Highlights are the future visions that we created for Noord-Oost Brabant and the region of Arnhem. We demonstrated the it is possible to downscale the national future vision, not by detailing it, but downscaling the method and working in co-creation with the client. Also these visions proofed to be discussion provoking and helpful working towards a greener and climate proof future. Road to CAS event: we were able to present ourselves on this high level, global event. Klimaattop: we noticed a large need of information, ideas and inspiration for climate proofing their area, especially government officials. Our approaches were seen as a very good way of achieving that. Video's that are still in the making, that will communicate why green adaptation is required and that it can be appealing to contribute.



Restore-Connect - Restoring connectivity and landscape coherence

KB-36-007-001 | **Year** 2023-2024 | **Project lead** Theo van der Sluis

The European Nature Restoration Law has been accepted, and by June 2026, all Member States must submit a National Plan. Our Restore-Connect project focuses on what Member States and stakeholders need to do to implement this law. Time is very short, even to get started. Our country must have measures in place by 2030 to restore at least 30% of protected habitats or 20% of degraded systems. By the end of 2024, we need to formulate results and recommendations so that the government and public authorities can prepare better.
In our project, we looked at forests and agricultural areas in two regions towards the borders with Belgium and Germany. We assessed how habitat types and species from the Habitats Directive are under pressure due to climate change and other environmental factors, and what restoration measures are possible.
We found that while we know a lot about ecosystems and habitat restoration, there are still knowledge and time gaps. We also found that proper planning processes take time to involve relevant stakeholders and agree on the most feasible restoration options.

Impactlab 2012

KB-36-007-002 | **year** 2023-2024 | **Project lead** Sabine van Rooij & Onno Roosenschoon

The NL2120 community has achieved significant recognition, including the prestigious Rotterdam Grote Maaskantprijs 2024 for excellence in landscape architecture. Key contributions include a keynote at the Deltacongres on the role of the financial sector in realizing nature-based solutions, addressing 500 national stakeholders, and a presentation of EU2120 at the Eurosite conference to 150 international experts. The project also won the SAS hackathon’s 'Public Sector' category with the 'Team Only Planet 2120' submission, and organized a global student challenge with 300 participants. National and international influence is evident through participation in high-level discussions, including at the Dutch Senate and European Commission. An updated NL2120 vision looks towards a nature-based, climate-adapted Netherlands by 2050, while also exploring applications in low- and middle-income countries. Additionally, Charles Darwin University’s commitment to a vision for Australia’s Northern Territories positions WENR as a recognized partner in the region. These milestones demonstrate the project's growing impact and global relevance.

Biodiversity climate nexus

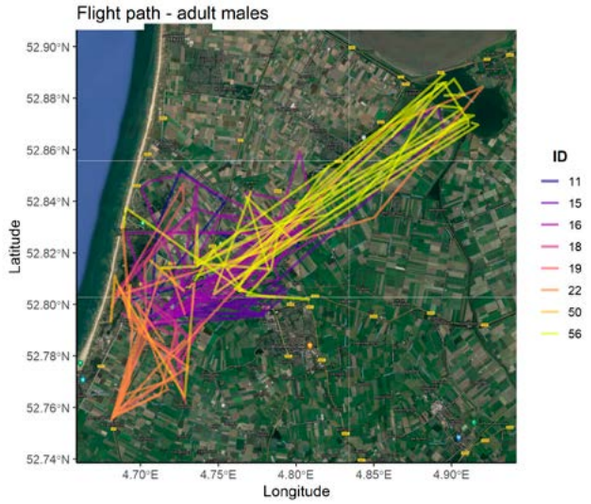
Development of instruments for a nature-inclusive energy transition

KB-36-003-002 | **Year** 2019-2022 | **Project lead** Ralph Buij & Sander Lagerveld

The energy transition does not only revolutionize the organisation of our energy supply, but the decentralization of facilities also offers great chances for the improvement of biodiversity and achieving of nature goals. But where do the main knowledge gaps lie, and how can those be addressed? How can existing and new knowledge contribute to the nature-inclusive design of wind and solar systems, that promote biodiversity as much as possible? Which tools or instruments can be developed to support this process?

The results of the analysis of flight movement of White-tailed Eagles for the project has generated interest by Windpark Zeewolde in Flevoland, who wishes to reduce casualties among raptors and especially the eagles. They have asked us to help support the instalment of an automated flight detection system at the wind park, by analyzing GPS tracking data for the eagles at their wind park.

GPS-tagging of Common Noctules in North Holland revealed that some individuals forage over the North Sea, potentially within reach of offshore wind farms. In a subsequent more extensive project, commissioned by Rijkswaterstaat, the overall habitat use of coastal Common Noctules was investigated. This project identified high-risk areas for wind-energy developments on the mainland, whereas offshore wind developments were found to be a minor risk for this species.



Solar parks for conserving our indigenous flora

KB-36-003-025 | **Year** 2019-2020 | **Project lead** Nils van Rooijen

The ecological pressure on nature, landscape and biodiversity is growing rapidly, as is our need for renewable energy. Within the Wageningen Solar Research Program (WSRP) we are investigating new ways to how to implement biodiversity in solar park developments and how solar parks may even add to biodiversity in its environment. The key is consistent ecological management and therefore solar park developers need to be given the proper tools to develop and maintain biodiverse vegetation in and around solar parks. In this KB-project we initiated the collaboration between solar park developers and experts on nature management and ecological plant breeders. A link was also made with The Living Archive, an initiative that aims to secure the Dutch indigenous flora and improve its integration in the landscape. The study considered how red-listed species may also find refuge in solar parks, which may form biodiversity islands in high intensive agricultural landscapes, particularly when they are properly managed and well-integrated in the environmental context. In the field labs created by WSRP (e.g., Haarweg Solar park), an ecological management plan was created.

Breeders of indigenous plant species are currently involved in its development and maintenance towards achieving a nature-inclusive solar park within a few years. In the future it even might offer opportunities for conservation of rare and endangered species.

Energy Transitions

North sea ecosystem services to protect biodiversity

KB-36-003-022 | **Year** 2019-2022 | **Project lead** GerJan Piet

Human exploitation of the marine environment is increasing, resulting in the degradation of habitats and loss of biodiversity. At the same time, society is becoming more dependent on the sustainable supply of marine ecosystem services, such as supplying food from the sea, as well as climate regulation,nutrient cycling and waste removal. This project is working on an investigation of how the concepts and valuation of ecosystem services can help in decision making towards a sustainable exploitation of the marine environment and the conservation of marine biodiversity.


Oscar Bos

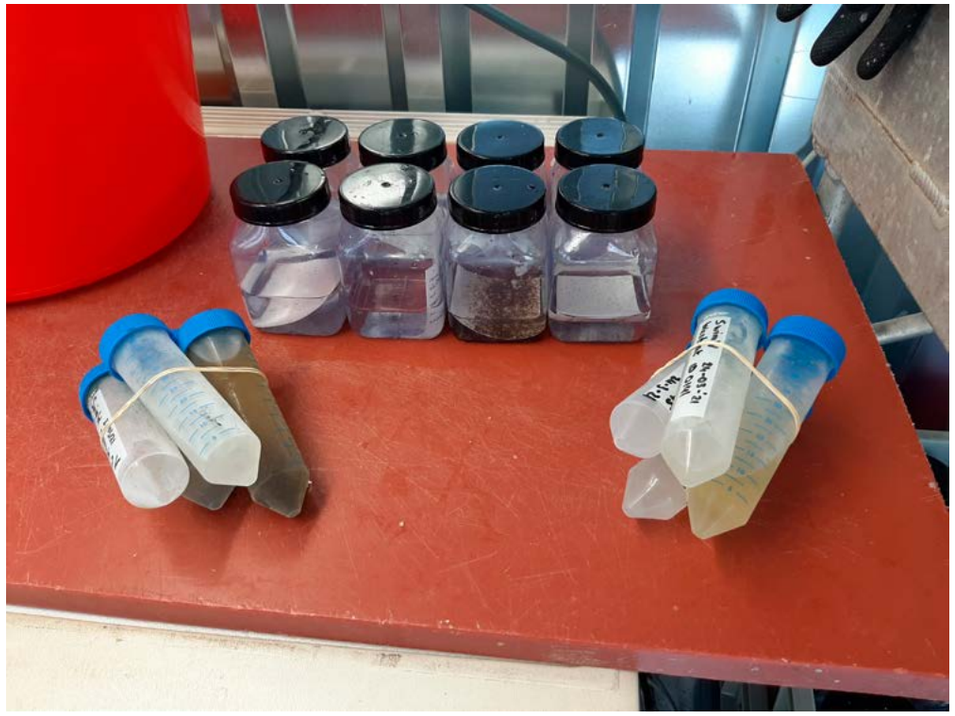
Marine and Coastal Solutions, Maritime Energy Transitions

eDNA zooplankton

KB-36-004-002 | **Year** 2019-2022 | **Project lead** Robbert Jak

This project aimed to develop cost-effective monitoring tools for zooplankton, a group rarely monitored in the Netherlands, and to bring this to the attention of policymakers. Both goals were largely achieved. DNA barcoding methodology, developed during the project, reveals zooplankton biodiversity, while the image analysis technique (zooscan) quantifies abundance and biomass, offering a powerful combination for future applications. Authorities responsible for monitoring (RWS) funded additional projects during the KB project to explore how zooplankton monitoring could address key questions about biodiversity and production trends in the Wadden Sea and North Sea.

The project also facilitated workshops and collaborations, culminating in the establishment of zooplankton monitoring in the North Sea, supported by RWS, and laying the groundwork for future research initiatives. These methodologies are now ready for deployment, enabling cost-effective and comprehensive zooplankton monitoring in upcoming projects.



Roadmap to an effective application of innovative eDNA

KB-36-004-004 | **Project lead** Martine van den Heuvel-Greve

The project focused on how to best apply the diversity of (environmental) DNA techniques in aquatic monitoring and research, and to improve the network of eDNA researchers within WUR. Several case studies were run: 1) does genetic background influence mussel performance?, 2) how to best assess the presence of fish in salt marshes?, 3) can diet of shellfish larvae be assessed using DNA techniques?, 4) what are the dominant species and potential invasive species of the Spitsbergen coast using eDNA analysis? A decision tree was developed that can be used to prepare effective (e)DNA studies and several workshops were held to exchange knowledge and information of genetics tools and applications. Multiple (scientific) publications are expected as a result of this project.

BENSO

KB-36-004-008 | **Year** 2020-2022 | **Project lead** Afra Asjes

The BENSO consortium consisting of WUR, Bureau Waardenburg (leader) and Waterproof, worked the collation of international datasets on benthos in offshore wind farms and other structures. This now includes data from structures in Denmark, Germany, Netherlands and Belgium and will soon be published open access with support from the ICES working group on marine benthal and renewable energy developments. The dataset was already used by teams of international scientists to assess benthic impact of wind farms on an international scale. In 2021 the BENSO team successfully placed an offshore experiment in the North Sea, to study the impact of different rock sizes on benthic communities. In 2022 the site was visited again and sampled. The team also analysed benthic communities on different types of hard substrates, placed in the Borssele offshore wind farm, resulting in new insights in effects of different materials in scour protection layers around wind turbine foundations.

Marine and Coastal Solutions, Maritime Energy Transitions

Fish in salt marshes

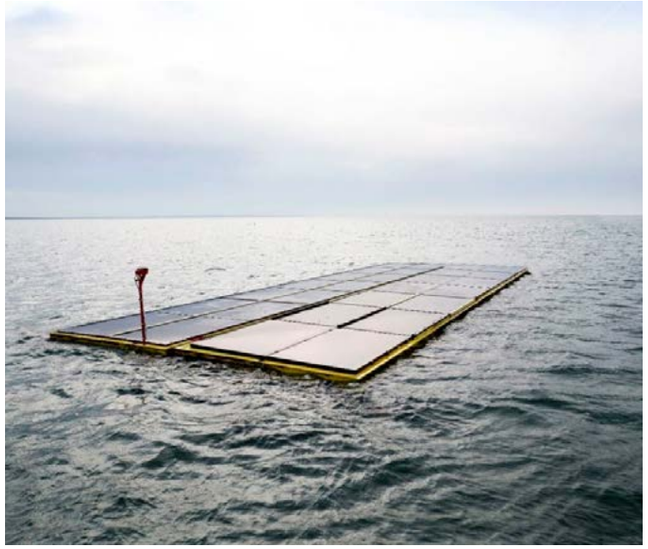
KB-36-003-033 | **Year** 2020-2022 | **Project lead** Alicia Hamer

The Rammegors is a former sludge depot that was created in 1971 as a result of the construction of the Scheldt-Rhine Canal. The area includes salt marshes , mud flats, sandbars and creeks. The ecological function of a man-made salt marsh differs from a natural salt marsh, but how exactly is still unclear, especially with regard to its function as a breeding and foraging area for young (commercial) fish. Since 2017, Rammegors has been connected to the Oosterschelde with the purpose of restoring the salt marsh area in the region. Its unique character allows fish to move freely back and forth and provides lots of hiding places for young fish in the shallow creeks. In this study fish sampling was carried out between 2020 and 2022 to understand how and when fish utilise this area and to monitor their development. Subsequently, the focus of the project shifted to researching the further development of the artificial salt marsh in Rammegors. The area has since developed into a thriving saltwater ecosystem, attracting various fish species; the catches indicated that both juvenile and adult fish, including various species of flatfish, sand smelts, herrings, mullets, and eels, utilize the area. A strong seasonal pattern was observed, which confirmed that the area serves multiple functions by being used by different species in different seasons.

Solar at sea

KB-36-003-034 | **Year** 2021-2024 | **Project lead** Ninon Mavraki

Floating offshore solar energy is an emerging market with great potential to meet future energy needs. While no large-scale floating solar structures currently exist in the North Sea, Oceans of Energy (OOE) has installed a significant offshore structure (ca. 10,000 km²) about 12 km from the coast, comprising multiple solar panels. Collaborating with Wageningen Marine Research, OOE monitored the ecological impacts of these panels by regularly sampling fouling organisms on their undersides. Initial findings revealed a dominance of coastal, shallow-subtidal species, such as mussels and hydroid polyps, along with numerous invertebrates like shrimp. Highlights include presentations at the 2022 United Nations Ocean Conference.
With the solar panels now removed, the project shifted focus in 2024 to studying nutrient fluxes of fouling organisms on artificial structures, aiming to understand their environmental influence. The project will conclude in July 2025 with the publication of an end report, adding to one completed paper and another in preparation.



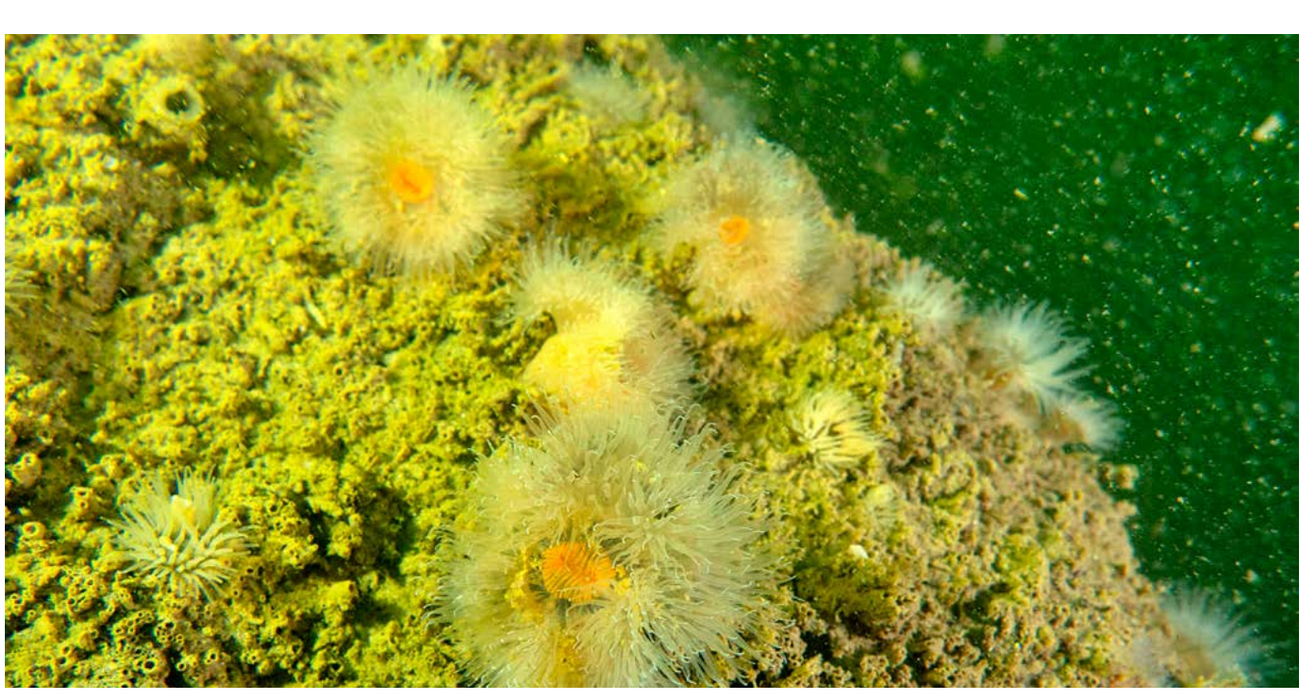
Marine and Coastal Solutions, Maritime Energy Transitions

Rewilding Sabellaria reefs in the Wadden Sea

KB-36-009-001 | **Year** 2023-2024 | **Project lead** Martin Baptist

Sabellaria tubeworms are fascinating creatures that build their homes into a sandstone reef. These natural reefs are crucial for marine biodiversity. They provide food and shelter for fish and sea slugs, and offer a place for sponges, sea squirts, and anemones to attach. The worms also filter seawater, and the reef structures help to stabilize sandbanks and gullies.

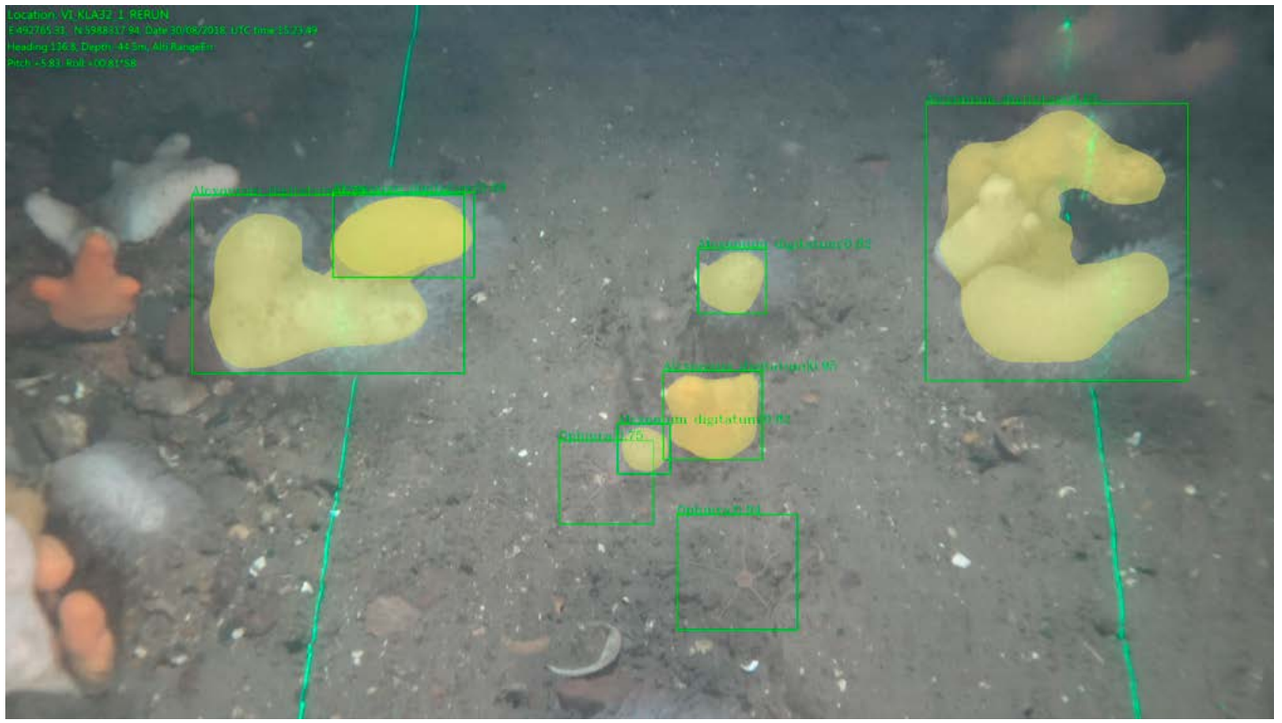
In the 20th century, Sabellaria reefs disappeared from the international Wadden Sea. In our project we investigate if Sabellaria reefs can be reintroduced in the Dutch Wadden Sea. By creating a complete inventory of historical reef locations in the international Wadden Sea, we identified the best environmental conditions for reef development. Using these most optimal conditions, near Texel, we even found a Sabellaria worm, marking it the third known sighting in the Dutch Wadden Sea this century. For the future, reintroduction of Sabellaria reefs will increase natural hard substrates and boost biodiversity in the Wadden Sea, thereby highlighting the natural values of this important UNESCO World Heritage site.



Ecological area assessment with remote sensing and machine learning

KB-36-004-001 | **Year** 2019-2022 | **Project lead** Freek Daniels

When research is being carried out to establish the effectiveness of interventions for the conservation and management of biodiversity, comparative before and after measurements need to be taken. This project looked at the potential for the latest developments in image processing to perform accurate, objective and complete species counts and distribution measurements. Using artificial intelligence and machine learning models a method for automatic species counting is being developed and validated based on the epifauna community of the Dutch North Sea seabed and the bird population on the IJsselmeer. Our project has been very successful in bringing Computer Vision expertise into the marine domain, initially with projects within WMR but also later at WU and NIOZ.



Data Driven Biodiversity

Fire and drones: drone imagery as a tool to fingerprint satellite information

KB-36-004-005 | **Year** 2019-2021 | **Project lead** Saskia Keesstra

In this project we developed applications for drone-based imagery, related to the prevention of wildfires and the assessment of the damage and recovery rate of the vegetation after a fire. Images from drone-based sensors were used to interpret satellite imagery with higher accuracy and precision. This efficiency step can be a leap in the prevention of wildfires by determining the available fuel in a nature reserve. The vegetation recognition technique developed in this project can also be used for estimating the flammability of vegetation. After a wildfire, the damage can be assessed and possibly the high-resolution images can be used to deduce the location and cause of the fire's ignition. Finally, we focussed on the restoration of vegetation. Satellite images do not provide enough detail to assess biodiversity dynamics as vegetation recovers from a wildfire, but the drone images may allow us to generate more insights to estimate the change in vegetation types, number of new seedlings and regeneration of vegetation cover. Two case study areas have been identified: one in Spain, in collaboration with the University of Albacete and a knowledge partner in Israel (University of Haifa); the other on the Veluwe in the Netherlands in collaboration with the Institute for Physical Safety.

Data Driven Biodiversity

Biodiversity in air samples

KB-36-004-011 | **Year** 2021-2022 | **Project lead** Marcel Polling

What biological particles are present in the air and what drives their diversity and dispersal? And how can air monitoring help create a healthy living environment for animals and plants? These are questions we try to answer in our study on the aerobiome (= community of airborne micro-organisms) on the Dutch island Ameland. We collected airborne particles at a daily basis at two locations located 500m from each other for the duration of one week. We analyzed DNA from these samples on the presence of fungi, eukaryotes, bacteria and pollen. In just one week of sampling we discovered more than 70 different plant species, more than 130 fungi and 180 types of bacteria. Innovatively, we found that the main driver for pollen diversity was the local environment, while diversity of bacteria and eukaryotes was mainly determined by meteorological conditions. This opens the door to further studies on specific drivers of airborne biodiversity.

Data Driven Biodiversity

Flower Rich Green Veins

KB-36-004-012 | **Year** 2021-2022 | **Project lead** Sabine van Rooij

Today, many governments, companies and civil society organizations work together on biodiversity in social-ecological networks. To prioritize measures and create maximum impact, the availability of up-to-date and reliable maps that show the quality of the biodiversity of nature areas and of the 'green veining' that provide ecological connectivity is crucial. In addition, such maps also provide the possibility for monitoring changes. In this project we investigated if it is possible, using high-resolution satellite images and smart AI-techniques to map the floral wealth of green veins in the landscape. We have shown that it is possible with a high level of confidence to detect flower richness on dikes by means of satellite images and artificial intelligence.

This is a promising first step in the detection of herbal diversity in green veins in the landscape. When this method is further developed, it will have high potential for application in the work of a range of statutory bodies, policy-makers and businesses that need to implement and monitor nature positive landscapes.

Data Driven Biodiversity

Integrated biomonitoring to assist sustainable land use transitions

KB-36-010-001 | **Year** 2023-2024 | **Project lead** Arjen de Groot

Biodiversity is crucial for agricultural systems, providing essential functions like pollination and pest control. However, a comprehensive assessment of species in innovative nature-positive agroecosystems, such as food forests, is currently lacking. To address this, we need innovations in biodiversity monitoring that are time-efficient, budget-friendly, and less reliant on taxonomical expertise.
In our project, Integrated Biomonitoring to Assist Sustainable Land Use Transitions, we explored innovative methods like environmental DNA, drone-based remote sensing, and automated image recognition. We compared their pros and cons in terms of spatial coverage and detection success against conventional methods. Our findings revealed that air-sampled DNA efficiently monitors birds and small mammals. Additionally, DNA analysis of pollen grains from pollinators showed that native insects could effectively pollinate non-native crop species in these forests. Based on these results, we are integrating various traditional and modern methods into efficient monitoring frameworks and establishing user-friendly platforms to visualize our data. This enhances our ability to assess the impact of measures and accelerates the transition to a nature-positive society."

Data Driven Biodiversity

MOLAS

KB-36-010-002 | **Year** 2023-2024 | **Project lead** Jenny Lazebnik & GerJan Piet

Biodiversity is in decline, primarily due to human activities. Our research project aims to understand and map the multiple threats to biodiversity in the Netherlands. Various methods exist for conducting cumulative impact assessments, and our findings indicate that the choice of methods significantly influences outcomes when dealing with complex data from multiple stressors.
In the MOLAS project, we studied three areas in the Netherlands: the Veluwe, the North Sea, and the Wadden Sea. On the Veluwe, we focused on the Black Woodpecker and Northern Lapwing, examining how different stressors affect these species in distinct habitats. In the North Sea, we assessed how sector-based stressors impact species groups through a broader activity-based approach. In the Wadden Sea, we analyzed various policy frameworks, including the Water Framework Directive and the Marine Strategy Framework Directive.
By employing different approaches across ecosystems, we can enhance our understanding of biodiversity threats. The results assist policymakers in reporting biodiversity progress, highlighting specific threats, and identifying high-risk areas, ultimately guiding effective conservation strategies for a more sustainable future.

Data Driven Biodiversity

MINLAND

KB-36-003-018 | **Year** 2019 | **Project lead** Anouk Cormont

Our work formed one of the pillars in policy guidelines on the practice of land use planning processes and the integration with mineral policies. Our work described the challenges related to the transparency in land use planning processes in relation to minerals, highlighting three important aspects: 1) Transparency by providing clarity on how the planning process takes place; 2) Transparency in relation to the consultation of and communication with stakeholders in mining operations, including stakeholders' role and power; and 3) Transparency with regard to the ways and ethics of decision making.

Lumbricus – Participatory Monitoring

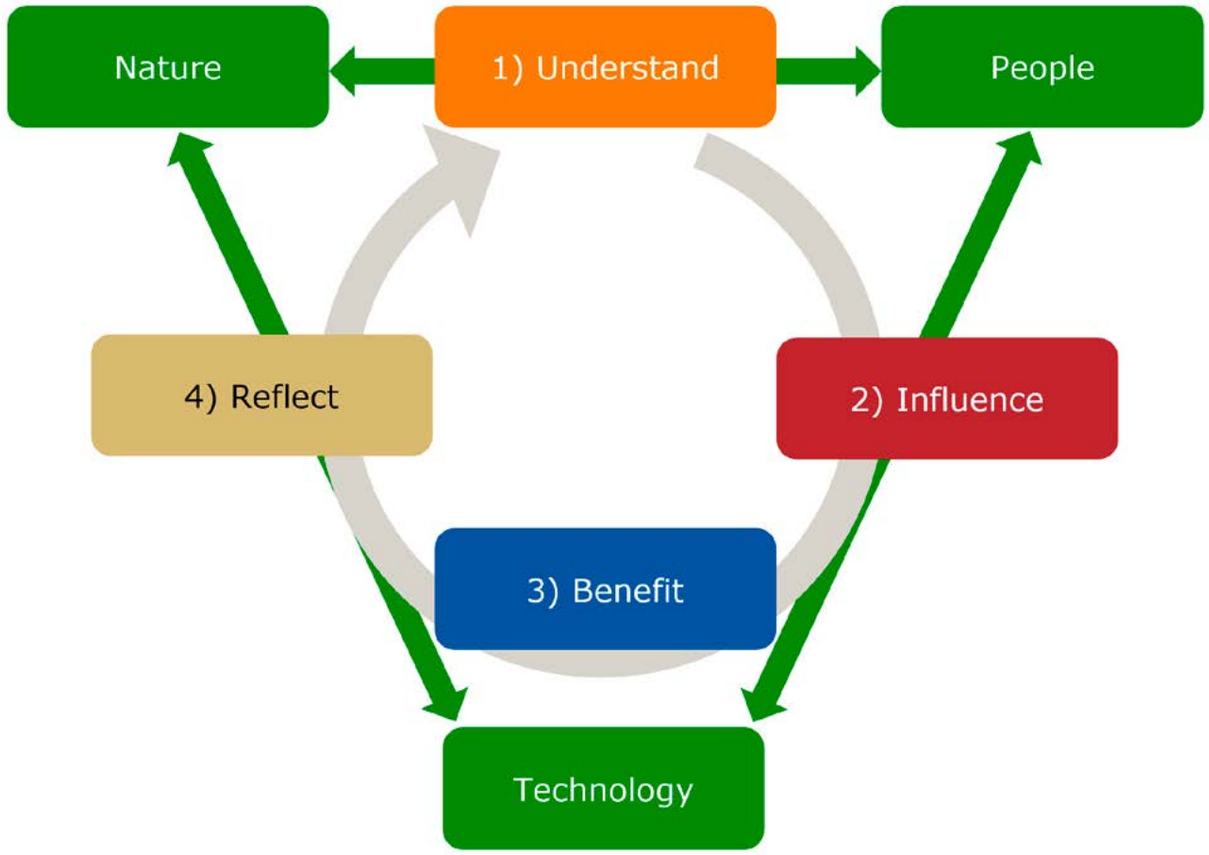
KB-36-003-016 | **Year** 2019-2020 | **Project lead** Bas Breman

The Lumbricus project paved the way for extra focus on the typical challenges of the Dutch higher sandy soils, climate adaptive thinking and an approach that is based on the Water and Soil system as a point of departure for (nature-based solutions). All of which are currently at the heart of policy thinking on the future of the transition of rural areas (NPLG). The project focused on participatory monitoring as a means to raise awareness and for collective learning amongst stakeholders. Thus also strengthening insights on the socio-cultural dimension of transition to a nature-inclusive society.

Digital Conservation

KB-36-003-026 | **Year** 2019-2020 | **Project lead** Bas Breman

The past two decades have shown an incredible development in the domain of (digital) technologies and communication. Although technology is increasingly being recognized as an important driver for how humans interact with their environment, there are still many blind spots in relation to how exactly digital technology is influencing the experience, management and conservation of nature. The goal of this Knowledge Innovation Project was therefore to explore and identify, through a literature review, key-topical questions considering the role of digital technology in human-nature interactions. Looking more closely at the body of literature included in our review it became clear that technology is already an important mediator in socio-ecological systems and will undoubtedly continue to grow over the coming years and decades. Following some of the authors, we suggest that technology in the socio-ecological domain can be conceptualized as a force with can have both positive and negative impact. As such a better understanding of this force is needed in order to be able to consciously explore manners to guide and steer this force for the desired purposes. WUR has a strategic role to play in this field and we suggest several focal points for future research.



Cost-effective monitoring and pricing of biodiversity

KB-36-004-003 | **Year** 2019-2022 | **Project lead** Rolf Michels

Highlights have included: 1) Collaboration and interdisciplinary work between 4 WUR institutes: WEcR, WEnR, WMR and WFBR; 2) Relationship between the cost-benefits concept, accounting, life cycle assessment, and biodiversity concept is quite new. Going into detail in the empirical background has been an important step forward. The most used biodiversity indicators, MSA and PDF, only partly cover the biodiversity concept, and cannot be consistently valuated from an economic perspective. Different aspects of biodiversity have to be monetarized separately, for example ecosystem services, Red-List-species, ecosystem quality, intrinsic value; 3) State of the art integrated marine biodiversity assessment methods, representative biodiversity indicator sets and recommendations for improvement are identified in a targeted literature search. A so-called ecosystem based approach can be recommended to assess biodiversity status, trends and human activity induced changes; 4) Article in ESB for broader dissemination of our insights (and more articles to follow).

Nature Inclusive Society and the Diverse Values of Nature

Citizens for biodiversity

KB-36-005-001 | **Year** 2019-2022 | **Project lead** Arjen Buijs

The project Citizens for Biodiversity developed, tested and implemented a practical e-tool for grassroots to increase their impact and contribute to sustainable transformations. Based on theoretical and empirical analysis of the motivations, activities, outcomes and transition pathways of active citizen groups, we developed a tool which enables grassroots to develop and critically assess their Theory of Change towards sustainable societies. This tool helps to develop a strategy to move from aims and activities to actual impacts, based on an exploration of the assumptions, opportunities, barriers and resources of grassroot organisations. It has been used and evaluated by local grassroots as well as small scale- NGOs, such as Stichting De Noordzee and the Tiny Forest movement initiated by IVN Natuureducatie and can also be used in grant applications. The Tool is launched at the opening symposium of Collectieve Kracht, a National network organisation linking and supporting social and environmental grassroots.

Perspectives for action in a nature-inclusive society

KB-36-005-003 | **Year** 2019-2022 | **Project lead** Maria Naranjo Barrantes

The transition to nature-inclusive agriculture and fisheries requires an underpinning in which entrepreneurial behaviour in the short and long term plays an important role. This project is about entrepreneurs who are able to realize a revenue model around nature-inclusive agriculture. The approach is driven by a model which we named CoESM (Collective Ecosystem Services Model). We implemented changes to the model after an expert workshop in 2021. We have integrated a behavioural module, which includes human aspects of decision-making that can simultaneously be reflected in the ecological module and with outcomes that can be reflected in the landscape. We have presented the model in international conferences and modelling workshops. We plan for a peer-reviewed publication to be submitted by the end of the year, where we test the importance of the different modules in the model. There are also synergies with another model and publication developed for KB35. An ODD protocol will be developed (essential for modelling documentation) and a Policy Brief on the valorisation and applicability of the model. We want to link the latter publication to a workshop targeting policymakers and potential users.

Modelling Bird Biodiversity in Domestic Gardens

KB-36-005-010 | **Year** 2019 | **Project lead** Sjerp de Vries

The amount of vegetation in residential areas has been beneficially associated with human health and well-being. The importance of the biodiversity of such nearby natural elements in this regard is unknown. To address this gap, a large geo-referenced and accurate dataset is needed. In this project, such a dataset was developed for city bird species richness and abundance, based on the Dutch "Meetnet Urbane Soorten". After combining the spring observations from several years, robust data were available for over 5000 locations. Although these data do not pertain to the city bird species richness and abundance at specific domestic gardens, they are thought to be indicative of this for the immediate surroundings of all dwellings near a location where observations took place. Upon completion of the project, the new dataset has been used in a project that looks closer into the relationship of garden greenery and biodiversity with human health.

Telecoupled Landscapes for Nature Inclusive Transitions

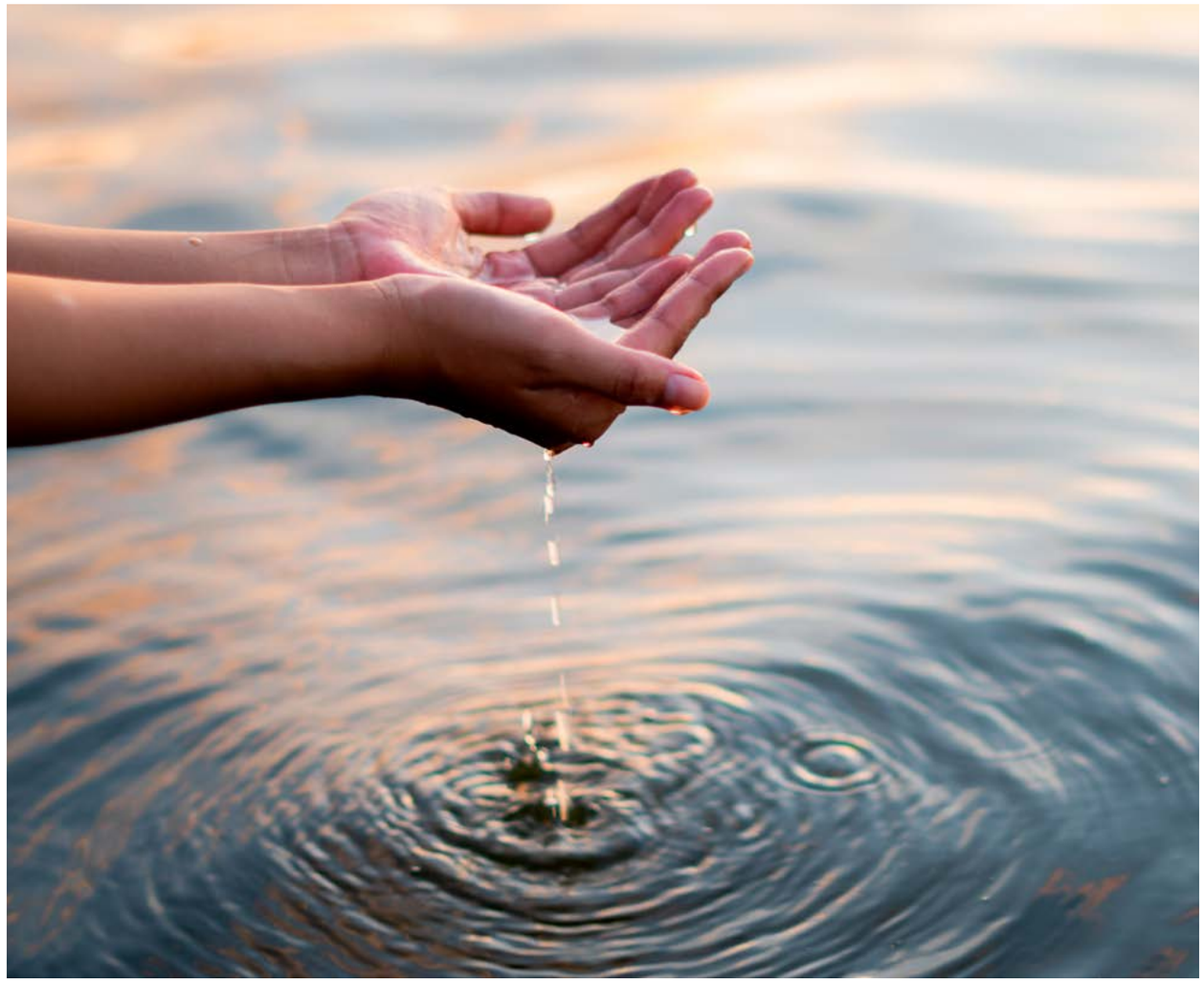
KB-36-005-020 | **Year** 2021-2022 | **Project lead** Cora van Oosten

This conceptual framings and methods research has paid attention to the impact that nature-inclusive transitions in the Netherlands may have on telecoupled countries or landscapes in the Global South. It is based on the concept of 'telecoupling', which refers to the idea that most landscapes are directly or indirectly shaped by development trends in distant landscapes, influences the flows of ecosystem goods and services across the globe. There is a small but growing body of literature on telecoupling, emphasising that the costs and benefits of ecosystem goods and services are often spatially distant, in which nature-inclusive transitions in one place may be a driver of agricultural intensification and environmental deterioration elsewhere. In this research we studied the different scholarly views on telecoupling, and conclude that its multiple approaches range from structural to actor based and governance. They all seem to confirm our hypothesis that nature-inclusive transitions may lead to new interdependencies and equalities, which connects to scholarship on power, equity, transformative change and environmental justice. This will help us to discover how new interactions between distant stakeholders under telecoupling can lead to a process of trans-local social learning on nature-inclusive transitions in practice.

Towards a stewardship economy for biodiversity

KB-36-011-001 | **Year** 2023-2024 | **Project lead** Vincent Linderhof

Despite numerous efforts through international agreements, legislation, and market-based instruments, biodiversity loss continues.
A stewardship economy for biodiversity presents a transformative path toward a sustainable and just future, emphasizing collective care and responsibility for nature at all societal decision-making levels. Instruments such as environmental taxes, biodiversity accounting, and true pricing can help formalize this responsibility.
Our project examined four global cases of small-scale stewardship economies for biodiversity: Lake Dembele in Ethiopia, the impact of mass tourism and population growth on Bonaire, the Netherlands' forest strategy linked to EU policies, and the use of indigenous knowledge to preserve nature in Lombok, Indonesia. These cases reveal both commonalities and differences in context and approach, providing valuable insights for other regions.
The vision of a stewardship economy advocates for a societal shift toward greater care for nature. It positions biodiversity as a crucial element in decision-making, promotes collective ownership of resources, and underscores the importance of education regarding nature and biodiversity for humanity's present and future.



Biotraces

KB-36-011-002 | **Year** 2023-(2026)[1] | **Project lead** Rosalie van Dam

The BIOTraCes project is developing knowledge and strategies for transformative changes towards a just and nature inclusive society. This is crucial for the future of our planet. To address biodiversity loss effectively and fairly, profound changes are needed in how we feel, govern, and act. This requires collaboration from citizens, businesses, policymakers, and scientists.

The project focuses on understanding the complex causes of biodiversity decline and creating innovative solutions for recovery. It thereby embraces the principles of Pluralism, Empowerment, Politicising, and Embedding (PEPE). BIOTraCes will develop Theories of Transformative Change for Biodiversity that relate plurality of cultural, religious, social, and economic values and power (lock-ins and leverage) to behaviour in relation to the underlying drivers of biodiversity decline. The project is looking at transformative biodiversity innovations in agriculture and food, forestry, water and urbanization through nine case studies in Europe.

1 The project began in 2023 and will conclude after the KB programme has finished.

TransPath

KB-36-011-003 | **Year** 2023-2024 | **Project lead** Maria Naranjo Barrantes

The project has advanced science and society across four impact pathways by achieving key outputs. A conceptual framework initiated the Transformative Navigation Toolkit, integrating climate and biodiversity actions within socio-cultural contexts and long-term uncertainty. This framework supports creating a ‘safe and just operating space’ for biodiversity, climate, and human rights, refined through stakeholder needs. A roadmap was developed to guide inclusive co-production for designing transformative pathways. Sectoral interventions in finance and trade were explored to address climate and biodiversity challenges, contributing to a Toolbox on Transformative Interventions. Communication efforts included a branding portfolio, a website, collaboration with Horizon projects, and a European Commission policy workshop. Together, these outputs enhance knowledge, tools, and processes for navigating societal transformations toward sustainable futures.

BioAgora

KB-36-011-004 | **year** 2023-(2026)[1] | **Project lead** Joke de Jong & Judith Westerik

The BioAgora project, funded by the European Commission, aims to create a transformative "Science Service for Biodiversity" that bridges the gap between policymakers, scientists, and society. The project focuses on developing a framework to assess the transformative potential of networks engaged in the science-policy interface. Wageningen University has co-developed this framework, which encourages networks to reflect on their role in driving societal change. Key insights reveal the importance of networks addressing root causes of biodiversity loss, being diverse, and embedded in a broader network. The framework promotes agile networks that collaborate, challenge, and disrupt to foster transformative change. It supports policy makers in creating the conditions for such networks to thrive, contributing to nature-inclusive transitions.

1 The project began in 2023 and will conclude after the KB programme has finished.

Nature-inclusive climate adaptation of cities

KB36-003-008 | **Year** 2019-2022 | **Project lead** Robbert Snep

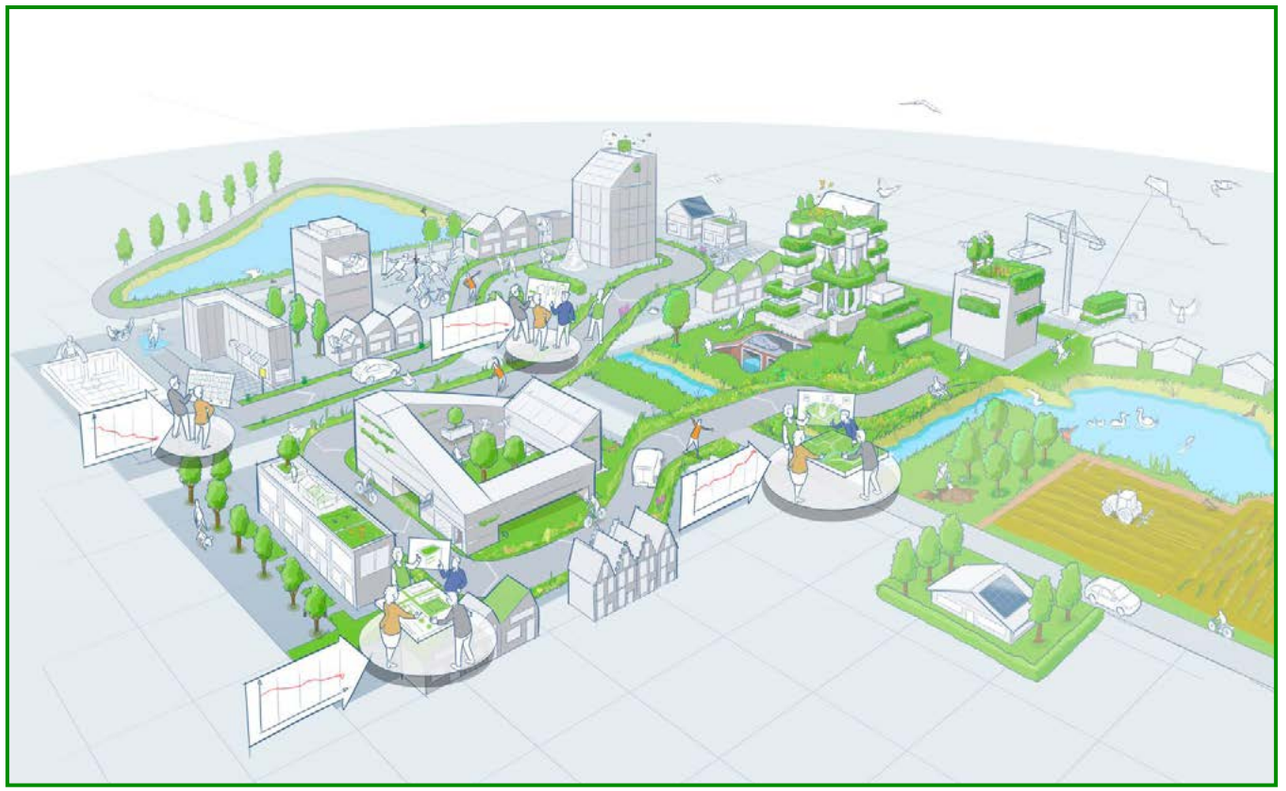
This project collaborated with key actors in policy and practice to explore solutions to overcome the barriers in developing nature-inclusive, climate-adaptable cities. The project yields a series of scientific and popular publications & workshops, and media events, on innovative ways to deal with funding of NBS in urban development, and enhancing technological and biodiversity aspects of NBS. Our 2020 no/low/high-tech NBS paper in Frontiers was appreciated by a worldwide 10k audience. On the funding of NBS we worked with national and local governments, and researchers and consultants, to provide more insight in the potential of evidence-based NBS design as a new element in funding schemes for residential district development. On the aspect of nature-inclusive NBS and urban development we addressed sharpened goals and adjoining critical conditions. By doing so we reached 500+ professionals in urban design and developing, both in the Netherlands and beyond.

Spatial Management of Biodiversity in a Crowded Continent

Nature-inclusive entrepreneurship in urban areas

KB-36-005-004 | **Year** 2019-2022 | **Project lead** Marijke Dijkshoorn-Dekker

Of the many highlights from the projects, the following stand out: cooperation with the target group and the use of different ways of communicating have led to an extended dissemination of our insights; our interactive communication tool shows the importance of nature-inclusive building and what is needed to realise a green(er) and biodiverse city; we identify key recommendations for promoting Nature inclusive construction (NiC): (1) facilitate knowledge development and promote the exchange of NiC-knowledge; (2) incorporate and reward NiC in environmental certification schemes and tender criteria; (3) translate a strategic vision on NiC into concrete regulations to bridge the policy implementation gap; (4) stimulate the uptake of NiC in corporate visions; we were able to connect nature inclusiveness to intended behaviour. The findings showed that attitude, social norms and perceived behavioural control are all significant explanatory variables.



Spatial Management of Biodiversity in a Crowded Continent

UrbanBioPath

KB-36-008-001 | **Year** 2023-2024 | **Project lead** Marijke Dijkshoorn-Dekker

Cities offer unique opportunities for fostering a nature-inclusive society, particularly in residential developments and business sites Our project examined how local governments, businesses, and other key actors can enhance biodiversity in their practices. Through a systemic approach, we identified critical conditions needed to scale up biodiversity actions among project developers, local governments and businesses. For project developers, integrating biodiversity into key performance indicators and raising employee awareness about the importance and benefits of including nature and biodiversity are crucial. To ensure that business sites are economically and ecologically viable, collaboration among companies, park managers and local governments is essential. Long-term success requires creating a level playing field and scaling up best practices to mainstream adoption, which necessitates national regulations. Regional and national policymakers should prioritize urban settings where local conditions best support impactful biodiversity actions. Based on our findings, this project provides guidelines for policymakers to facilitate effective decision-making toward a nature-inclusive future.

Spatial Management of Biodiversity in a Crowded Continent

Nature-inclusive climate adaptation of cities

Nature-inclusive entrepreneurship in urban areas

UrbanBioPath

European Topic Centre Biodiversity ETC-BD

KB-36-003-021 | **Year** 2019-2022 | **Project lead** Theo van der Sluis

Membership of the consortium that makes up the Topic Centre for Biodiversity has given Wageningen Research several highlights. The process has involved the authoring or co-authoring of a number of important and influential reports into issues such as the European ecological network, the classification of European habitats, 'wall-to-wall' maps of European habitat and vegetation types, the development of biodiversity indicators and the resilience and restoration of habitats. Apart from allowing us to engage with an extensive network of European research and policy institutions, it has provided us with the opportunity to contribute knowledge generated from our research to the leadership and management of processes that have involved representatives from across the EU Member States.

Research to support environmental policy processes

European Topic Centre Biodiversity ETC-BD

European Topic Centre – Urban Land and Soil Systems ETC-ULS

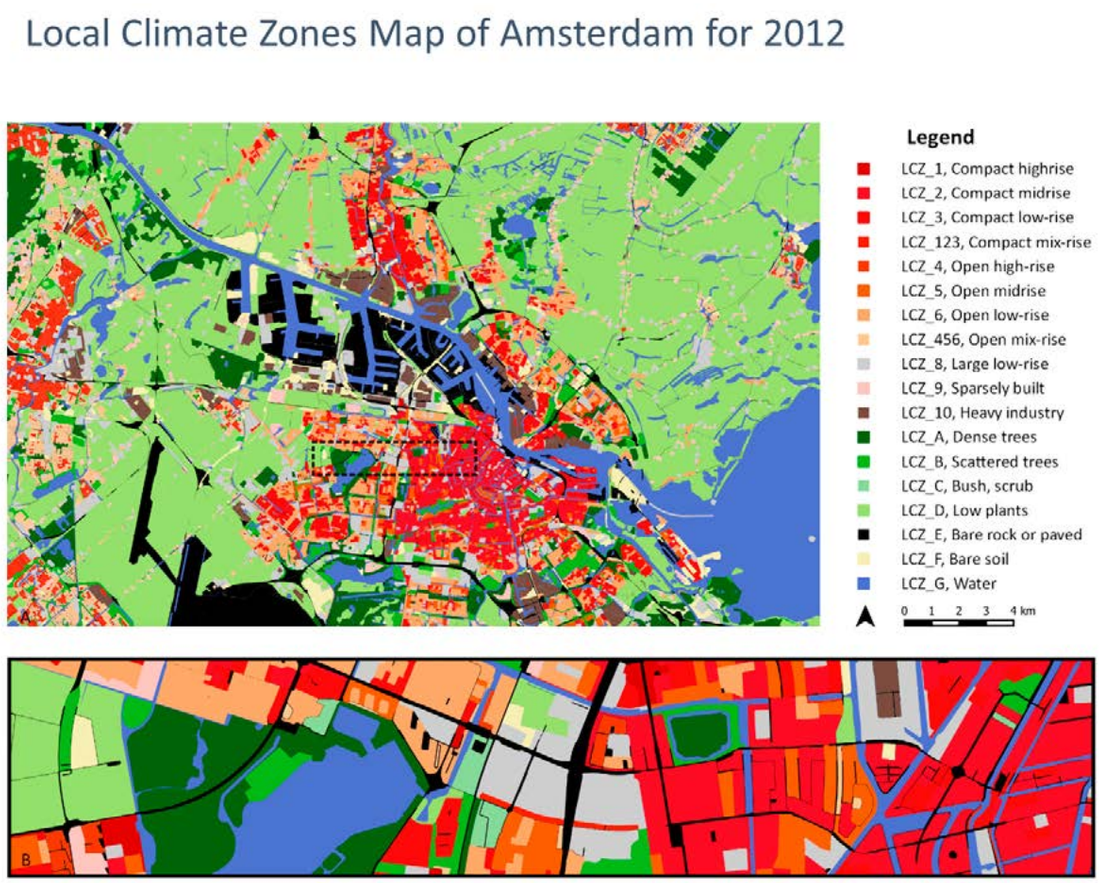
NISEL

Zoology Zoogether

European Topic Centre – Urban Land and Soil Systems ETC-ULS

KB-36-003-023 | **Year** 2019-2022 | **Project lead** Gerard Hazeu

In the consortium, Wageningen Environmental Research contributed, among other things, to the development of agro-environmental indicators and assessments, supports the analysis of the CAP and offers support to the National Reference Centre (NRC) for agriculture and the environment. WENR is one of the partners of ETC/ULS (since 2022 called ETC/DI). We are contributing amongst others to the development of agro-environmental indicators and assessments, supporting the analysis of the CAP, offering support to the National Reference Centre (NRC) for agriculture and the environment, exploiting machine learning to map EUNIS habitat types and developing a methodology to map Local Climate Zones for the larger urban areas of Europe. The concept of Local Climate Zones (LCZ) helps with the standardization and generalization of urban and rural categories having similar thermal characteristics. It provides a framework for Urban Heat Island studies of Functional Urban Areas (FUAs), which implicates two of the most important environmental issues: population growth and climate change.



Research to support environmental policy processes

European Topic Centre Biodiversity ETC-BD

European Topic Centre – Urban Land and Soil Systems ETC-ULS

NISEL

Zoology Zoogether

NISEL

KB-36-005-012 | **Year** 2020-2022 | **Project lead** Fred Kistenkas

Nature Inclusive Sustainability and Environmental Law (NISEL) conducted a critical legal analysis of the newly proposed Dutch Omgevingswet and its implications for nature conservation law. The findings, published in several columns in Vakblad Natuur Bos Landschap and a chapter in the VMR Jubilee Book (Milieurecht in transitie, BoomJuridisch Den Haag, 2022, p. 191–198), warned that after decades of building an EU-driven biodiversity law system, the Omgevingswet might severely undermine nature protection. This concern aligns with an official New Zealand evaluation of their integrated environmental act, which revealed similar challenges. Wageningen's warnings were taken up by members of the Dutch parliament (kamervragen), but the drafting of the Omgevingswet continues.

Although NISEL concluded in 2022, the project's legacy continues. In 2024, F.H. Kistenkas published Recht voor natuur. Beleid en recht als contrapunt (Uitgeverij Noordboek), accompanied by a TV appearance and podcast, emphasizing the interplay between environmental law and policy—marking 40 years of progress in nature conservation law.

Research to support environmental policy processes

European Topic Centre Biodiversity ETC-BD

European Topic Centre – Urban Land and Soil Systems ETC-ULS

NISEL

Zoology Zoogether

Zoology Zoogether

KB-36-003-027 | **Year** 2019-2022 | **Project lead** Edgar van der Grift

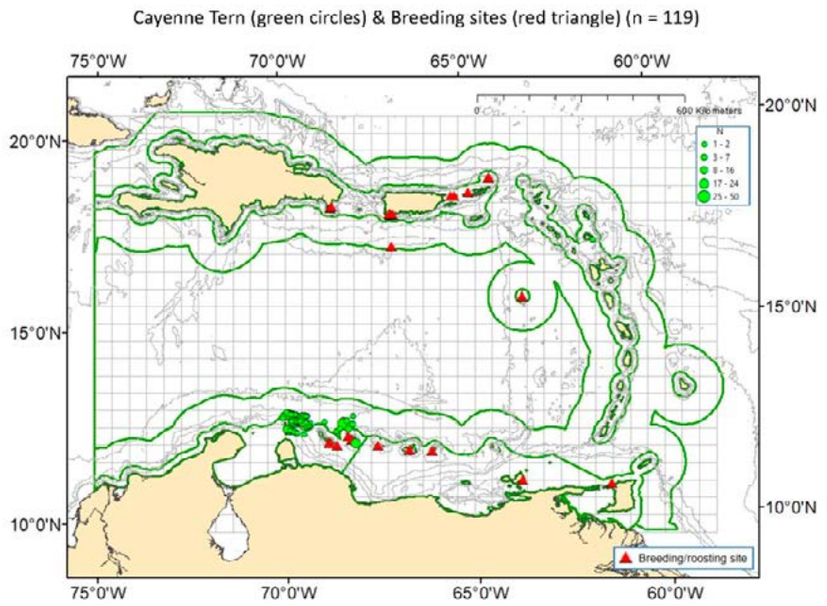
We tested the effectiveness of a wildlife fence intended to prevent pine and beech martens from crossing dangerous roads. We were able to show that the fence can be (easily) bridged by both species. We tested modifications to the design of the fence, until we were able to prove that it inhibited the martens from climbing over. Due to the success of the first phase of the experiment additional funding was secured for a second phase from the KB programme and co-funding was received from stakeholders. Awareness was established among stakeholders through testing innovations in a controlled setting (zoo) before implementing them on a large scale. Excellent working relationships were established with the zoos which will be the basis for future research and experiments.

Research to support environmental policy processes

Seabirds in the Caribbean

KB-36-003-012 | **Year** 2019 | **Project lead** Dolfi Debrot

This project documented the importance of Dutch Caribbean pelagic habitat for use by rare endangered Caribbean endemic seabirds.
A database was developed and a sightings map of 150,000 seabird records for 65 species for the eastern Caribbean. The Dutch Caribbean EEZ amounts to about 92,000 km2 of the Caribbean Sea and very little is known about if and how seabirds use this area. We are especially proud to have incorporated major (but previously unavailable) sources of data for the Dutch Caribbean and key Spanish-language sources for the southern Caribbean. Based on this work we are now in a position to report the first of several major new insights into seabird use of the Caribbean pelagic waters, to be published in a paper that will be ready for submission in January 2023.



The Dutch Caribbean

Nature-inclusive design Caribbean

KB-36-005-002 | **Year** 2019-2022 | **Project lead** Peter Verweij

What would Bonaire look like in 2050? A future in which a sustainable economy and a nature inclusive society go hand in hand to maintain what is precious, and to restore what is damaged. Experts from the island and Wageningen University & Research addressed that question by working together with stakeholders on the island. The very diverse landscapes of Bonaire range from dry cacti forests, traditional kunukus, biodiverse reefs, to extensive salt flats. For each of Bonaire's landscapes a vision with potential nature inclusive measures was mapped during design sessions, interviews and workshops with local experts, decision makers and researchers in the field of nature, culture, recreation, agriculture and governance. The resulting drawings of each of the landscapes show measures such as rooftop water harvesting, reforestation, greening gardens, growing local food, creating cactus fences, installing solar panels, and coral restoration to meet the challenges ahead. These challenges include managing (mass-) tourism, preventing high erosion rates that are due to free-roaming cattle, and adaptation to sea level rise. The measures and challenges are symptomatic for many small tropical islands.

Vegetation Map for Aruba

KB-36-005-016 | **Year** 2021-2022 | **Project lead** Rene Henkens

The last vegetation study was done in Aruba in late 1990s, by John de Freitas of Carmabi. Aruba's vegetation report was never completed or published. As a result of collaboration in this project between Fundacion Parke Nacional Aruba (FPNA), an independent foundation responsible for the conservation and management of designated terrestrial and marine protected areas in Aruba, together with Wageningen University & Research (WUR) and Carmabi announce they have discovered more than 20 plant species new for Aruba. About half of these species are native to the Caribbean region, and can be considered part of the natural flora of Aruba.

The Dutch Caribbean

TRUPIAL

KB-36-008-002 | **Year** 2023-2024 | **Project lead** Peter Verweij

'Nature is the foundation of all life, providing food, clean air, and water. On small tropical islands like those in the Caribbean, nature is vital for culture and income, attracting tourists for diving, beaches, and natural landscapes. Tourism is the primary source of income, making nature conservation essential. Despite various initiatives, nature continues to deteriorate, indicating that mere protection is insufficient.
In the TRUPIAL project, we aim to strengthen nature by integrating it into sectoral perspectives, drawing from residents' views and local initiatives gathered through surveys, workshops, and interviews. Collaborating with governments, NGOs, and businesses, we identified challenges and developed a vision for the future, addressing these challenges with landscape interventions. Examples include capturing rainwater for food and garden irrigation or replacing non-native plants in hotel gardens with native species to attract butterflies and hummingbirds, enhancing tourist appeal.
This whole-of-society approach has been applied to Bonaire, Aruba, and St. Eustatius, each with its unique environmental and societal contexts. We are currently exploring pathways to achieve our desired future, where top-down and grassroots initiatives work in harmony.'

The Dutch Caribbean

Looking to the future (Beyond 2024)

As we reflect on the successful delivery of the Wageningen University Knowledge-Based programme, "Biodiversity in a Nature Inclusive Society," we celebrate the impact of over 60 completed projects. These initiatives have produced remarkable results, generating valuable insights and practical solutions that enhance our understanding of biodiversity and its critical role in fostering a sustainable future.

Looking ahead, we are optimistic that the innovations, knowledge, and findings from these projects will play a pivotal role in shaping future research and addressing pressing societal challenges. The need for nature-inclusive transitions is more urgent than ever, as we face critical issues related to biodiversity restoration, protection, and management, alongside the necessity for climate change adaptation. Our aim is to integrate a nature-positive approach into key sectors, enabling us to navigate the complexities of our changing world.

Building on the achievements of the past six years, we are excited to announce the launch of five new programmes in 2024, running until 2029. These programmes will take forward much of the cutting-edge technology and insights developed during the first six years, while also pushing new boundaries in research. Our focus will be on expanding our understanding of biodiversity's role in both societal systems and natural ecosystems, testing new strategies for ecosystem restoration and resilience, and developing innovative solutions to emerging challenges. These new programmes will also aim to deepen collaborations with stakeholders across the public, private, and academic sectors, ensuring that we continue to build on the momentum of previous initiatives.

The lessons learned from our past projects will inform ongoing and future research initiatives, fostering a collaborative environment among researchers, policymakers, businesses, and communities. By leveraging the insights gained, we can better understand how to implement effective strategies for biodiversity conservation and ecosystem management.
We envision a future where biodiversity is at the forefront of decision-making across various sectors, driving policies and practices that not only protect but also enhance our natural environments and increase their resilience. This shift will require innovative approaches, collaboration, and a commitment to sustainability, ensuring that all stakeholders understand the intrinsic value of biodiversity and its vital role in supporting human well-being.

As we move beyond 2024, our focus will be on scaling up successful strategies and fostering partnerships that drive meaningful change. We will continue to engage with diverse stakeholders to ensure that our efforts resonate within local, national, and global contexts. By doing so, we can collectively address the multifaceted challenges of our time, ensuring a resilient, nature-inclusive society for future generations.

In summary, the achievements of the "Biodiversity in a Nature Inclusive Society" programme serve as a strong foundation for the future. We are committed to building on this momentum, encouraging the integration of biodiversity considerations into all aspects of societal planning and action. Together, we can create a sustainable and biodiverse future that meets the needs of both people and the planet.

Colophon

About the programme
The ‘KB’ Knowledge Base – Kennisbasis – funding programme is provided to the Wageningen Research Institutes by the Dutch Ministry of Agriculture, Fisheries, Food Security and Nature to carry out independent research into pressing and topical issues with high societal impact.

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