9 Environmental Sciences Research Program 2023-2027

GREAT

Governance Research and Environmental Sciences for Action and Transitions

Department of Environmental Science, Open Universiteit

9.1 Overview of the department

The Department of Environmental Sciences is part of the Faculty of Science at the Open Universiteit (OU). The Department embodies the commitment of the OU to excellence in the environmental sciences, science for impact, and lifelong learning in the sustainability domain. The Department brings together people working on integrated environmental modelling, human health and the environment, learning for sustainability, and environmental governance and has about 20 team members. The Department has long recognised that solutions to environmental problems require interdisciplinarity between various natural sciences, and with the social sciences. Reflecting this, the Department holds chairs in Integrated Environmental Modelling, Natural Sciences, Technology-enhanced Learning for Sustainable Development, Data-driven decision making in healthcare, and it holds the longest standing Chair in Environmental Governance in the Netherlands. The Department of Environmental Sciences has a strong track record in research, as witnessed by its publication record in outstanding academic outlets and its acquisition of prestigious grants.

9.1.1 Research focus of the department

The research of the Department aims to contribute to the understanding of social-ecological systems, the development of solutions for environmental and conservation issues, and to the wider body of knowledge that helps societies to reach their sustainability goals. There is a close link between the research and the education programs of the Department – our students are actively encouraged to get involved in our research program, and in turn, our research helps us maintain the level and currency of our education programs to the benefit of these same students. Collaboration within a growing network of universities and societal partners, both nationally and internationally, ensures state of the art research and the continuous alignment of research efforts with societal needs.

The department has a very strong interdisciplinary focus that brings together four distinct research lines:

1. Integrated Environmental modelling,
2. Human Health & Environment,
3. Learning for Sustainability, and
4. Environmental Governance.

These research lines indicate the academic domains to which we seek to contribute with our research. The research concerns many different environmental issues, with a particular emphasis on three main themes:

1. pollution,

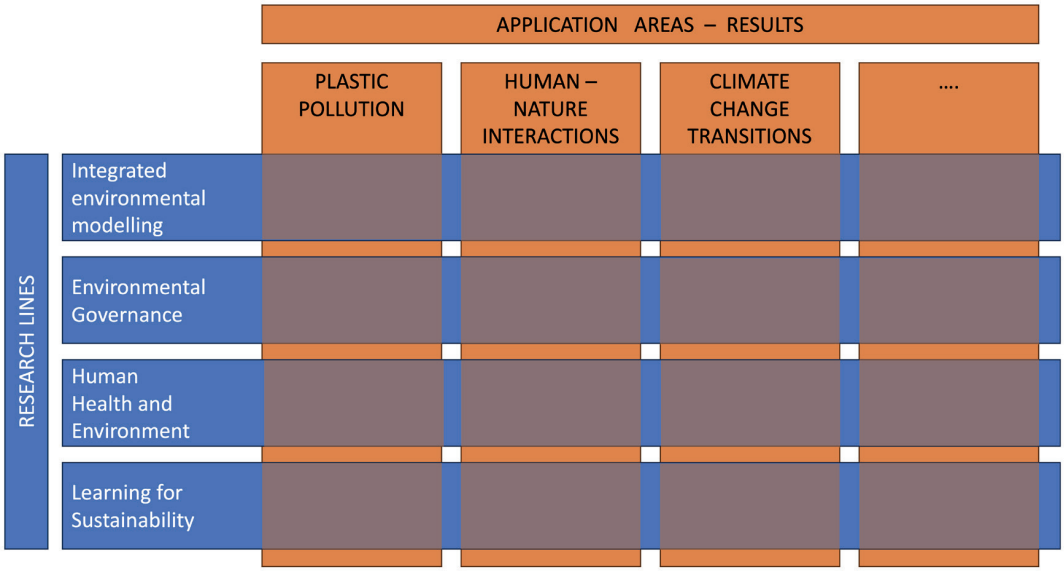

Figure 1: The ES expertise matrix

2. human-nature interactions, and
3. climate change transitions.

The relation between the research lines and the themes is shown in Figure 1. This figure also includes an open theme, as not all research fits neatly in the figure, as the themes will evolve over time, and as new themes might be included in the future.

9.1.2 Size

In the beginning of 2024, the department included 4 full professors, 1 special professor, 3 Associate professors, 10 assistant professors, 1 teacher, and 2 junior researchers with a total of 15.9 FTE. Staff at the department typically has 30% of their time available for research. In addition, there were 6 internal PhD students (PhD students with a contract at the OU) and 11 external PhD students (PhD students without a contract and often employed elsewhere).

9.2 Research Lines

9.2.1 Integrated Environmental Modelling

Environmental sciences focus on the functioning of social-ecological systems, with a specific focus on the complex interactions between natural systems and humans which has

become increasingly important in the Anthropocene. Particularly while undergoing increasingly rapid changes, it is key to understand the resilience and self-regulations in these systems but also the tipping points and the potential cascading effects. A better understanding allows for an ex ante assessment of e.g. environmental changes and environmental policies. But at the same time the environmental sciences help us to design and evaluate alternative interventions like nature-based solutions. The Department of Environmental Sciences at the OU aims to achieve this understanding through Integrated Environmental Modelling. These models can function as digital twins of a social-ecological system to support e.g. stakeholder discussions and informed decision making. Within our research we do not make a priori decisions on the type of models, but rather let the case determine the type of model. As such we develop and make use of a wide range of modelling approaches that can range from rather simple back-of-the-envelope calculations, and flow mapping (often based on structured literature reviews), to more complex mechanistic models, neural networks, agent-based modelling and artificial intelligence. Within the research line on Integrated Environmental Modelling, we are specifically searching for tools to develop parsimonious models with the right level of complexity to deal with the social-ecological system and to answer the specific question at hand. In addition, we study the role that these models can play in facilitating stakeholder discussions.

References and more

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9.2.2 Human Health and Environment

Nature provides the basis for human health and well-being. Essential elements such as clean air, safe food and pure drinking water are vital to sustaining life. Additionally, natural environments offer opportunities for recreation, relaxation and social interaction, while raw materials support the comforts of modern life. Yet, environmental pollution persists, contributing significantly to the burden of disease and mortality. Fortunately, this burden can be significantly reduced through concerted efforts to improve environmental quality. Unfortunately, the burden of environmental diseases is not evenly distributed. The most vulnerable people in our society are most affected by environmental stress. Socially disadvantaged communities are exposed to higher levels of air pollution, noise and heat stress. In addition, children, pregnant women, the elderly and people with chronic diseases are more affected by environmental health risks than others. As a result, higher levels of exposure to environmental stressors and the greater burden of health impacts exacerbate existing health inequalities.

The human health and environment research line aims to contribute to a better understanding of the health impacts of environmental factors such as pollution, climate change and urban environments, while assessing the health benefits associated, for example, with the use of green spaces and climate mitigation measures. We focus on various exposures, including pollution, temperature and green space, and their potential impact on outcomes such as premature mortality, cardiovascular and respiratory health, and cognitive function. The research line is therefore closely aligned with the research themes of pollution and human-nature interactions, with a particular focus on vulnerable communities, and contributes to several Sustainable Development Goals, including SDG 3 (Good Health and Well-being), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action).

Moving forward, this novel research line will continue to evolve, refining multiple research paths and enhancing our comprehension of the dynamic interplay between the environment and human health. Our ambition is to deepen our understanding of environment-related health implications, with a focus on water quality, air pollution, food safety, temperature, and green spaces. By expanding the body of scientific knowledge in these areas, our research will provide valuable information that can serve as a basis for future studies, policies, and interventions aimed at mitigating environmental related health risks and promoting human well-being.

References and more

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9.2.3 Learning for Sustainability

The research in the field of Learning for Sustainability aims at a better understanding of the role of learning processes in systemic sustainability transitions in our society. The research focuses on the study (of integration) of different types of knowledge (such as experiential knowledge, exact scientific knowledge, actionable knowledge), stakeholder perspectives (including values, norms and interests), and integrative knowledge concepts in science and sustainability. Current research themes include competences for sustainability professionals, social learning as a catalyst for building resilience among smallholder farmers, technology-enhanced action-oriented learning in higher education and (professional) practice (including MOOCs), action capacity development, learning of stakeholders in multilateral environmental treaty-making (specifically on plastic pollution), and transformative learning in neighbourhoods, cities, and regions including in the Global South. Specific attention is also paid to the theoretical understanding of the role and functioning of learning processes in governance.

The Department has over 30 years of expertise in (online) learning design, curriculum development and networked learning in higher education environmental sciences pro-

grammes. In the last years the focus has been broadened to social learning, learning regions, and transformative learning for sustainability in society.

The research is innovative and performed at the national and international forefront, often in consortia consisting of both scientific institutions and societal partners, such as the Dutch Climate Research Initiative (KIN), UNESCO and UNEP. Much of the work can be classified as transdisciplinary, since it is carried out collectively with stakeholders (co-creation with professionals, informal leaders, citizens, etc.). In addition, our students bring in experiential knowledge from their professional employment. Applied research methodologies include newly developed action research for sustainability transitions and action learning, combined with quantitative surveys, focus groups and interviews.

We envision that our research will inform and empower students and teachers, citizens, professionals and (informal) leaders in their understanding of sustainability and in achieving and accelerating sustainability transitions.

References and more

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9.2.4 Environmental Governance

The research line Environmental Governance is dedicated to accelerating sustainability transitions. The aim of this research line is to develop and improve theoretical approaches for analysing and evaluating processes of stability and change in governance and contributing to the societal debates about current governance systems and the possibilities to transform and improve these systems through research, education, and capacity development.

Contemporary societies face a range of environmental problems and sustainability challenges. It has become clear that current ways of production, consumption and governing need to be changed to stay within planetary boundaries, while ensuring the minimal social standards necessary for human well-being, such as food, water or education. These ambitions and their interrelations are also reflected in the Sustainable Development Goals. Innovation, transition and transformative change are increasingly called for to realise these ambitions. At the same time, it has become clear that bringing about necessary changes is difficult and more research is needed to better understand the processes of stability and change in governance and the various factors that play a role in these processes. The research under this line therefore aims to enhance the understanding of the functioning and evolution of governance systems and their impact on the environment and sustainable development. It focuses on unravelling the pathways of stability and change, analysing the main drivers and mechanisms of transitions, and providing practical recommendations and solutions to improve environmental governance outcomes. It calls for holistic and integrative approaches that are increasingly developed and applied in cooperation with societal partners.

Societal engagement and stakeholder involvement are central themes in this research line. While there is some general agreement on the different environmental challenges and sustainable development goals, the perspectives on environmental issues and on the why, how and what of successful and just transformations can largely diverge. Informing the societal discussions about sustainability transformations therefor also calls for insights in these different perspectives and their impact on governance, as well as in the various ways to integrate stakeholders' perspectives and needs in the pathways of change.

The research line environmental governance builds on a long tradition of research in related domains like public policy and administration, environmental politics, nature resource management, international relations, sociology, philosophy, anthropology, etcetera. The scientific literature on environmental governance has gradually evolved into a set of inclusive and integrated approaches that recognise the complexity and interconnectedness of environmental challenges. It emphasises the need for participatory approaches, adaptive management, and global cooperation to address these challenges effectively. With this in mind, the group wants to be at the forefront of theoretical advancement as well as work on societal impact, by translating scientific insights for practical use and by actively contributing to societal debates. More specifically, three interrelated topics and their integration gain specific attention in the research of the group. These will be

described next.

9.2.4.1 Multi-actor governance

First of all, the literature shows a clear shift from public policy and administration towards more diverse forms of environmental governance that include a wide range of public and private actors and both formal and informal institutions. This shift emphasizes the involvement of multiple stakeholders in environmental governance, including governments at different levels, businesses, civil society organizations, and local communities. It brought attention to models of stakeholder involvement, capacity development, changing patterns of inclusion and exclusion, and the various ways in which different perspectives, forms of knowledge and ways of valuing can be brought together. Moreover, there has been a growing recognition of the importance of global environmental governance, as environmental issues have become increasingly transboundary in nature. The literature explores topics such as international environmental agreements, global environmental institutions, and is increasingly paying attention to the role of non-state actors in shaping global environmental governance beyond international environmental agreements and contributing to implementation. Multi-level and multi-actor governance have therefore become key concepts that address the interrelations between different levels of governance and the multiple actors that are involved in each level.

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9.2.4.2 Understanding the processes of change (and stability)

Secondly, one can witness a growing attention for the **process of change and stability** in environmental governance. Governance systems are always changing, but increasingly attention is given to the ways in which the processes of change can be understood, planned and steered. This brought attention to concepts like transitions, transforma-

tions and transformative governance. Within the literature attention is given to several of the main drivers of change that include social learning, politics, fairness concerns and changing societal views and paradigms, as well as for the obstacles for change, path-dependencies and lock-ins. Furthermore, some stability in governance is needed to stabilize expectations, enhance coordination over time, and to ensure that new policies persist over sufficient timeframes to bring about desired effects. More broadly, democratic political systems need to provide sufficient stability to uphold legitimate, fair, and accountable sets of rules, while also being flexible in adapting to economic, social, and environmental change over time. Within this context of change, scientific research can help to refine our understanding of the functioning of policy and planning and different forms of steering, and to better identify the possibilities for and limits to strategy to accelerate sustainability transitions.

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9.2.4.3 Just transitions (quality of the process)

Thirdly, environmental problems and its governance create winners and losers, and if more leading to conflicts as well. Benefits and harms vary among stakeholders, different parties are involved in diverse ways, and diverse groups frame environmental controversies differently – all give rise to pleas for justice, equity, and inclusion. That makes there is inevitably a **normative dimension in environmental issues**. This goes against the idea that justice is a separate sphere or domain that can, for instance, be dealt with only through social policy or tax reforms. There is now a growing literature on just transition (climate change), environmental justice and inclusive conservation (nature conservation). Research tackles different dimensions: the mapping of inequalities (how are different groups affected or involved); explaining the mechanisms and processes behind such differentiation; distinguishing and applying different dimensions of justice, such as distributive (who gets what), procedural (who decides) and recognitive justice (how groups and value systems are treated); and examining assumptions, such as in narratives, policy tools and research approaches. Examining justice aspects in not inde-

pendent of legitimacy and public support. If processes, outcomes, and policy instruments are perceived as more just, fair, or inclusive, people often see these as more legitimate and tend to support these more. Understanding justice and pluralism claims requires involvement of local actors and citizens, since justice is context dependent. Increasing societal pleas for just transitions therefore demand for a better understanding of all these normative dimensions.

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9.2.4.4 Integrative approach to governance

The research line environmental governance integrates these three topics and their interrelations from a holistic perspective on governance. The focus of the research is on environmental governance in general, with more specific attention for environmental degradation, biodiversity loss, climate change mitigation and adaptation, and (plastic) pollution. The research therewith enriches empirical understandings of environmental governance, it contributes to the development and improvement of theories and methodologies for analysing environmental governance, while the transdisciplinary focus and outreach activities help to enhance societal impact and contribute to capacity development among relevant actors.

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9.3 Research themes

9.3.1 Pollution

The research on environmental pollution covers a wide spectrum, from the study of adverse effects on individual cellular components to broader considerations of human physical and even mental health, and from the development of innovative analytical methods to the implementation of comprehensive risk assessments. Projects in this thematic area range from overcoming technical challenges in detecting environmental pollutants in blood (including micro- and nanoplastics, regardless of whether they are free-floating in the plasma phase or associated with immune cells) to investigating their pathophysiological effects (e.g. uptake, translocation and effects of these micro- and nanoplastics in an intestinal system) and assessing their impact on different disease processes in humans (e.g. disruption of immunological to chronic inflammatory processes, cardiovascular abnormalities, or diabetes). In another project, the presence of microplastics in seafood from markets in Semarang, a coastal city in Java, Indonesia, will be linked to human exposure through a nutritional study, which will lead to a comprehensive risk assessment. Within the wider theme of pollution, the focus over the last decade has been on marine litter and plastic pollution. Research on this theme is carried out within all research lines.

9.3.1.1 Theme link with Integrated Environmental Modelling

Within the research line Integrated environmental modelling several studies are carried out dealing with tire particles, sea-based sources of plastics and solid waste management. The main aim of a large study on car tires is to contribute to our understanding of the accumulation of tire particles in the environment by examining the contribution of tire particle emissions from road wear, the presence of tire particles along the Dutch road network and the contribution of tire particle emissions from artificial turf. In addition, to place these findings in statutory context, the research project delves into the political process of enacting legislation to reduce tyre emissions.

Another study on car tires uses a transdisciplinary approach to mitigating tire microplastics in which we develop an effective tire microplastic mitigation strategy using environmental modelling. Mitigation strategies are developed and assessed involving various European stakeholders, e.g., from universities, industry and policy.

The contribution of sea-based sources such as shipping and fisheries has in specific geographical sea areas been identified as the dominating source. However, the sources and pathways of microplastic pollution from ships have not been systematically documented and quantitative data is lacking.

We use system dynamics to diagnose causes of failing waste collection in developing countries. Often 60% of the population in low-income countries is not serviced with

waste collecting and we investigate the main factors influencing this failing performance.

References and more

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9.3.1.2 Theme link with Human Health and Environment

The research on environmental pollution covers a wide spectrum, from the study of adverse effects on individual cellular components to broader considerations of human physical and even mental health, and from the development of innovative analytical methods to the implementation of comprehensive risk assessments. Projects in this thematic area range from overcoming technical challenges in detecting environmental pollutants in blood (including micro- and nanoplastics, regardless of whether they are free-floating in the plasma phase or associated with immune cells) to investigating their pathophysiological effects (e.g. uptake, translocation and effects of these micro- and nanoplastics in an intestinal system) and assessing their impact on different disease processes in humans (e.g. disruption of immunological to chronic inflammatory processes, cardiovascular abnormalities, or diabetes). In another project, the presence of microplastics in seafood from markets in Semarang, a coastal city in Java, Indonesia, will be linked to human exposure through a nutritional study, which will lead to a comprehensive risk assessment. The aim of this research is to determine the risks of exposure to microplastics through food and the environment. The presence of microplastics in various types of seafood from local markets in Semarang, Java, Indonesia, is studied and estimate residents' levels of exposure based on their diet. In line with this, as part of the MOMENTUM consortium, we are investigating the uptake, translocation and effects of microplastics in small intestinal cells in order to link the presence of microplastics to the molecular processes that cause the harmful effects. These results contribute to the development of an integrated risk assessment of microplastics for food safety.

References and more

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9.3.1.3 Theme link with Learning for Sustainability

The research aims to understand how technology can help to scale up and speed up learning for sustainability, by reaching and empowering a very large and diverse audience of motivated change-agents, and how the outcomes and impacts of this learning can be made deeper and longer lasting. The current research focus is on the learning ecosystem around the MOOC on Marine Litter and Plastic Pollution. Key questions concern its effectiveness and options to further enhance this, including options to help learners increase their impact, to identify and target specific key actors and their capacity development needs, and to make the MOOC-ecosystem more accessible to a larger and more diverse group of learners.

References and more

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9.3.1.4 Theme link with Environmental governance

The effectiveness of multilateral environmental agreements, as in legal effectiveness, has been debated in recent years. However, effectiveness beyond legal bindingness has not yet been the subject of extensive research. This theme therefore considers multilateral environmental agreements and their ancillary functions (beyond legal bindingness) to identify how effective these are, and how they could potentially be further improved for more sustainable outcomes. More specifically a part of the research in the theme pollution focuses on the complex problem of nitrogen deposition and its adverse effects on biodiversity. This research integrates insights from environmental sciences, legal studies, public administration, and sociology to reflect on the evolution of governance

systems and their impact on biodiversity goals.

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9.3.2 Human-nature interactions

This theme focuses on a better understanding of the multiple dimensions through which human systems and natural systems interact. While humans are intrinsically interwoven into social-ecological systems and while human agency is now a potent force shaping landscapes and resource fluxes at a global scale in the Anthropocene, the term 'human-nature interactions' facilitates a pragmatic analytical approach. Human-driven modifications of nature trigger impacts on ecosystems, which have a direct impact on other living beings and a direct or indirect impact on human health and wellbeing. Mapping and understanding people's attitudes and behaviour towards nature is also key to foster sustainable social-ecological systems in which human and non-human entities can thrive sustainably. Our research aims to contribute to the growing evidence base of the diversity of human-nature interactions at different spatial and temporal scales and it wants to contribute to make these interactions more sustainable. In this research theme we propose a roadmap which zooms in on a range of specific topics and approaches which highlight the human dimension of nature conservation and environmental management.

9.3.2.1 Theme link with Integrated Environmental Modelling

Human-nature interactions are notoriously difficult to model due to the multiplicity of decision-makers involved. These include human decision-makers of course, but also animals which are decision-makers themselves. Agent-based modeling applied to human and animal decision-making is one of the themes in which we develop and apply new knowledge. This knowledge can be used directly to address human-wildlife conflict in Europe (e.g. human-carnivore conflict) and in Africa (e.g. human-elephant conflict). The environmental modeling of human-modified landscapes is another key element of

a better understanding of human-nature interactions. Modeling the carbon and water fluxes of landscapes and integrating stakeholders' views into this modeling approach yields applicable knowledge to improve the climate resilience of our landscapes and to learn with and from neighbouring European countries. Species distribution modeling allows us to understand and predict how human activities impact other species' living environments and distributional shifts. Co-creating actionable environmental knowledge is key to harnessing all the available types of knowledge and to strengthen the societal support base for necessary, socially robust societal transition. Hence our modeling research explicitly fosters social learning for better environmental outcomes.

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9.3.2.2 Theme link with Human Health and Environment

As human forces increasingly impact the environment, negative health effects of a degraded environment impact human health and wellbeing. We study these health impacts at various scales, and propose solutions to address these challenges, from the potential effect of micro-plastics on human health to the negative impact of climate change on human livelihoods (such as slum inhabitants in Indonesia). However, humans and nature also interact in positive ways, as exposure to nature and green spaces positively impacts human health and wellbeing. Our research on this issue feeds into recommendations regarding land use and urban planning. Similarly, understanding the positive contributions of nature to people are an intrinsic part of ecosystem services assessment and form the basis of the One Health approach which stresses the interconnection between human, animal and ecosystem health, and which we contribute to make more tangible through our research.

Research associated with this theme focuses on the interaction of environment and health in vulnerable communities, focusing on literacy, education, income, access to health care, etc. Examples relating to this research line include investigations into the positive effects of green environments on human well-being, particularly in vulnerable neighbourhoods (e.g. part of the Heerlen Noord project). The aim of this project is to reveal citizens' preferences, needs, and desires in relation to their living environment, with a focus on green spaces, so that the living environment can be designed to provide the highest health benefits. This project bridges the gap between environmental sciences, health, and psychology. Another example is the connection between, for example, the patient's origin (e.g. living environment, socioeconomic status, type of work, etc.) and, for example, the occurrence of chronic (musculoskeletal) pain. This project thus directly addresses the adverse effects of the combination of increased exposure to environmental stressors and increased vulnerability.

References and more

- Saenen, N. D., Nawrot, T. S., Hautekiet, P., Wang, C., Roels, H. A., Dadvand, P., Plusquin, M., & Bijnens, E. M. (2023). Residential green space improves cognitive performances in primary schoolchildren independent of traffic-related air pollution exposure. Environmental Health, 22(1), 33. https://doi.org/10.1186/s12940-023-00982-z

9.3.2.3 Theme link with Learning for Sustainability

Improving the process and outcomes of dynamic human-nature interactions requires a learning mindset from all involved actors. Gaining and applying new knowledge is key especially at the collective level, which is why social learning is a leading concept in our research strategy. From social learning among smallholder farmers who are key actors in sustainable food production and climate resilience strategies to learning by using ecosystem services assessment tools and serious games related to human-wildlife co-existence, resource use and/or land use and forest management, our research strategy aims to feed into, and apply the 'green competences' any actor in a social-ecological system should ideally have. Learning is intrinsically linked to new ways of relating to nature, which is reflected in the concept of plural valuation of nature on which we focus in our research strategy. Attaching a range of values to nature, ranging from instrumental to intrinsic to relational values, is a first step into recognizing, assessing and realizing the diversity of human perspectives on nature. Ultimately this plural valuation of nature, which can be facilitated by citizen science initiatives, contributes to more sustainable human-nature interactions which benefit humans and nature alike. In our research, we map people's perceptions and valuation of nature, which contributes to fostering more inclusive land use planning (e.g. in port areas in the Low Countries or in Protected Areas in Africa).

References and more

- Vogel, S. M., Songhurst, A. C., McCulloch, G., & Stronza, A. (2022). Understanding farmers' reasons behind mitigation decisions is key in supporting their coexistence with wildlife. People and Nature, 4(5), 1305-1318.

9.3.2.4 Theme link with Environmental governance

Understanding and (re-)organizing the governance of human-nature interactions is key in order to keep human activities within the limits of Earth's planetary boundaries. This requires dealing with novel challenges at various scales: this includes plastic pollution and its (inter)national governance, among others through Multilateral Environmental Agreements; the governance of human-wildlife conflicts in Europe and beyond; the study of the effectiveness of protected areas (PAs) and how to improve their governance; the con-

ceptualization and implementation of environmental justice; and the application and effectiveness of (environmental/sustainability/social/biodiversity) impact assessment processes. Recognizing environmental governance as a multi-actor endeavour is key, which requires insight into people's knowledge, perceptions, attitudes and behaviour, to which our team contributes through our extensive experience in environmental social science methods.

References and more

- Batkai, Hugé, Huitema, Semeijn, Lambrechts, Stoorvogel. 2023 Social learning as a catalyst for building resilience among smallholder farmers: Exploring its role in promoting transformations. NJAS: Impact in Agricultural & Life Sciences 95 (1)
- Beunen, R., & Lata, I. B. (2021). What makes long-term perspectives endure? Lessons from Dutch nature conservation. Futures, 126, 102679.
- Bogatinoska, Lansu, Hugé, Dekker. 2022 Participatory Design of Nature-Based Solutions: Usability of Tools for Water Professionals Sustainability 14 (9), 5562.
- Broussard, A., Dahdouh-Guebas, F. & Hugé, J. 2023 Diversity of perspectives in biodiversity conservation: a case study of port land use in Antwerp & Rotterdam. Journal of Environmental Management 341: 117937
- Hugé, J. et al. 2020 Ecosystem services assessment tools for African Biosphere Reserves: a review and user-informed classification. Ecosystem Services 42: 101079
- Vogel, S. et al. 2023 Identifying sustainable co-existence potential by integrating willingness to co-exist with habitat suitability assessments. Biological Conservation 279 (109935).

9.3.3 Climate change transitions

This theme focuses on better understanding socio-ecological transition processes towards climate resilience. Terrestrial socio-ecological systems, such as river catchments, face challenges due to among others climate change. What are the key mechanisms in these socio-ecological systems for climate resilience? How does scale matter in these processes, both geographically and in terms of socio-economic and institutional proximity of actors? How do green climate adaptation interventions as nature-based solutions (NbS) interact with climate mitigation interventions in the landscape? And vice versa keeping in mind the multifunctionality of the landscape with its various ecosystem services? How can climate transitions be accelerated in urban regions, at neighbourhood level? There is a growing awareness that nature-based solutions (NbS) offer cost-effective solutions. Therefore, it is essential to identify key principles that promote societal support, economic viability of NbS and their impact on socio-economic resilience.

9.3.3.1 Theme link with Integrated Environmental Modelling

To reach a Net Zero ambition in Europe it is a challenge to link large scale data that points to good environmental decisions with local and regional practitioners who make the decisions and implement the policies that determine land use and land use dynamics (in IPCC LULUCF). The information may be available, for example free access earth observation data – but at the local level it may not be of use, applicable or understandable. Smart decision-making combining spatiotemporal modelling with GeoAI, AutoML and other novel tools could become more actionable, especially when the modelling is scaffolded by smart designing of the learning of these practitioners. The aim of this theme is to bring the data to those that can connect it to land and water management policies and interventions. This way of Integrated Environmental Modelling in co-creation with practitioners allows for scientifically backed decision-making and consistent monitoring of the outcomes.

References and more

- Bogatinoska, Lansu, Hugé, Ali, Dekker, Stoorvogel. 2024 Analysing Landscape Multi-Functionality by Integrated Modelling. `http://dx.doi.org/10.2139/ssrn.4705609`
- Bogatinoska, Lansu, Huge, Dekker, Stoorvogel. 2023 Water, Carbon, and Climate: An Integrated Modelling Approach to Nature-Based Solutions Wageningen Soil Conference, 112-113

9.3.3.2 Theme link with Human Health and Environment

While the health effects of climate change are increasingly being recognised and the Right to Health is embedded within the Paris Agreement, climate health impacts have received little attention to date. How practitioners at the local level can increase the pace of urban greening to make an urban environment more resilient to ecological climate risks such as the urban heat island effect, drought and flooding is one question that this theme addresses. The aim of this theme is to find out where there are opportunities to make greening policy more effective and socially just in order to ensure the desired acceleration. Increased awareness around the impacts of climate change and climate adaptive actions has an impact on participation and the success of greening. To this end, the relationship of greening actions with ecosystem services, social equality and participation is examined.

References and more

- Saenen, N. D., Nawrot, T. S., Hautekiet, P., Wang, C., Roels, H. A., Dadvand, P., Plusquin, M., & Bijnens, E. M., 2023 Residential green space improves cognitive performances in primary schoolchildren independent of traffic-related air pollution exposure. Environmental Health, 22(1), 33. https://doi.org/10.1186/s12940-023-00982-z
- MacAfee EA, Löhr AJ. 2023 Multi-scalar interactions between mismanaged plastic waste and urban flooding in an era of climate change and rapid urbanization. WIREs Water. 2023; e1708 https://doi.org/10.1002/wat2.1708

9.3.3.3 Theme link with Learning for Sustainability

The climate transition requires versatile sustainability practitioners with diverse types of knowledge and skills and attitudes (i.e. competences). They are confronted with major challenges in their daily work situations that come with the complexity of the climate transition. Weighing and bringing together various "justice claims" (interests and ideals) of different stakeholders and also involving colleagues within the organization are challenging processes. To manage this, there is a need for transformative formal and informal leaders with a broad and new set of leadership competences. In the transdisciplinary action research, the set of competences towards fair climate transitions is explored together with stakeholders and current and future sustainability professionals and informal leaders in urban regions. One of the aims of this research theme is to develop, test and improve the set of competences needed for just climate transitions, to be used by sustainability practitioners and informal climate leaders and for impacting academic programmes on networked learning hubs.

References and more

- 2022 Participatory Design of Nature-Based Solutions: Usability of Tools for Water Professionals. Bogatinoska, Lansu, Hugé, Dekker. Sustainability 14 (9), 5562.
- 2022 Competencies of Sustainability Professionals: An Empirical Study on Key Competencies for Sustainability. Venn, R., Perez Salgado, F., & Vandenbussche, V. Sustainability, 14(9), 1-22. https://doi.org/10.3390/su14094916
- 2018 Dimensions of professional competences for interventions towards sustainability. Perez Salgado, F., Abbott, D. & Wilson, G. Sustainability Science, 13(1), 163-177. https://doi.org/10.1007/s11625-017-0439-z
- 2017 International E-learning Programmes for Sustainable Development in Higher Education in Europe and Africa. Perez Salgado, F., & Rikers, J. H. A. N. In G. Michelsen, & P. J. Wells (Eds.), A Decade of Progress on Education for Sustainable Development: Reflections from the UNESCO Chairs Programme (pp. 48-58). Paris: UNESCO.
- 2013 Changing professional demands in sustainable regional development: a curriculum design process to meet transboundary competence. Lansu, Boon, Sloep, van Dam-Mieras. Journal of cleaner production 49, 123-133.

9.3.3.4 Theme link with Environmental governance

Preparing for and coping with the accelerating impacts of climate change requires adaptation in a wide range of policy areas. Yet, despite increasing calls for action, policy change to allow this is often slow. A range of counteracting forces and barriers can make it difficult to embed adaptation objectives into important policies and move them away from 'business-as-usual'. However, deeper dynamics are also at play, where self-reinforcing mechanisms, feedbacks and path dependencies interact across different spatio-temporal scales and coalesce to establish policy lock-ins. One of the aims of this research theme is to uncover these lock-in dynamics and examine the extent to which they account for varying levels of climate change adaptation in among others the Netherlands. More specifically the barriers and enablers for sustainability transitions are explored to identify effective and just strategies for changing governance systems.

References and more

- Batkai, Hugé, Huitema, Semeijn, Lambrechts, Stoorvogel 2023 Social learning as a catalyst for building resilience among smallholder farmers: Exploring its role in promoting transformations. NJAS: Impact in Agricultural & Life Sciences 95 (1).
- Groen, Alexander, King, Jager, Huitema 2023 Re-examining policy stability in climate adaptation through a lock-in perspective Journal of European Public Policy 30 (3), 488-512.
- Oberthür, Groen 2018 Explaining goal achievement in international negotiations: the EU and the Paris Agreement on climate change Journal of European Public Policy 25 (5), 708-727.

9.4 Impact

The impact of the department is made through collaboration in research projects, a diversity of research outputs, as well as via a range of dedicated dissemination activities, including the development of (online) teaching materials and training for professionals. For this section we distinguish between scientific, educational and societal impact, although many activities and output focus on all three in a more or less integrated manner.

9.4.1 Scientific impact

The department of Environmental Sciences aims to make a significant contribution to the advancement of theoretical and methodological perspectives in various domains of environmental sciences. For that purpose, we publish books and high-impact articles in scientific journals and regularly participate in academic conferences. We also seek collaboration with academic research partners in a wide range of disciplines.

9.4.2 Educational impact

Educational impact is first and foremost realized via the BSc and MSc programs on Environmental Sciences, in which teaching materials increasingly include theories, methodologies, illustrations and examples from our own research projects. Furthermore, we offer students in different ways the opportunity to participate in our research projects. The department furthermore develops and teaches online courses for other audiences. Examples include MOOCs on marine litter, climate adaptation and a Masterclass on Unnecessary, Avoidable and Problematic (UAP). We particularly support lifelong learning with the development and teaching of dedicated training for professionals in the domains of environment, sustainability and governance. Some key examples of educational impact include:

- Together with UN Environment Programme we have created a Massive Open Online Course (MOOC) on Marine Litter as a key activity of the Global Partnership on Marine Litter. It is also part of the Clean Seas Campaign. The course is free for all students and available in 10 different languages.
- Together with partners from the international network of excellence dedicated to understanding policy and governance innovation for climate change (INOGOV) we have developed the MOOC Polycentric Climate Change Governance[1]
- Together with partners from the Dutch network Kennis voor Klimaat we have developed a MOOC and related online teaching materials about climate adaptation.
- OUNL has a strong infrastructure in learning design to support the networked learning of the project partners and water/land practitioners in transformative spatial processes, with a series of online webinars and Open Access Learning Hubs, like Co-adapt[2] and MOOC Polycentric Climate Change Governance[3].
- OUNL has created an online active training in the use of Climate Impact tools, to develop Carbon LULUCF strategies at local level, The training is incorporated into academic degree programmes and in practitioners' learning hub[4]

9.4.3 Social impact

The department is highly committed to making societal impact. We deploy a range of strategies to achieve impact, including partnerships with societal partners, online education and training (see also education impact), professional and publications, presentations at conferences, webinars, and regular media coverage. Many of the research projects specifically focus on solving socio-environmental problems such as climate change, biodiversity loss, or pollutions and apply a transdisciplinary approaches whereby mutual learning and co-creation of solutions, tools, and transition pathways are key aspects. Training and education of professionals and wider audiences are also means to achieve and strengthen societal impact (see educational impact). A more particular strategy for societal impact follows from the involvement of students and the professional organizations many of them are working for in research and education. Therewith students help in making productive interactions with societal parties and to share research findings. Some key examples of societal impact include:

- Virtual Consultant Company (VMAB): In their BSc thesis project students engage actively with clients and stakeholders and therewith link our research with societal issues. This is a two-directional route, whereby the questions of client act as a means to voice societal needs and questions that we can address in our research agenda, while the projects also contribute to the dissemination of relevant research

[1] https://youlearn.ou.nl/web/espub-climate-change/course-preview/-/pagestructurenavigator/60454259

[2] https://youlearn.ou.nl/web/co-adapt/dashboard

[3] https://youlearn.ou.nl/web/espub-climate-change/course-preview/-/pagestructurenavigator/60454259

[4] https://youlearn.ou.nl/web/co-adapt/climate-adaptation

findings.

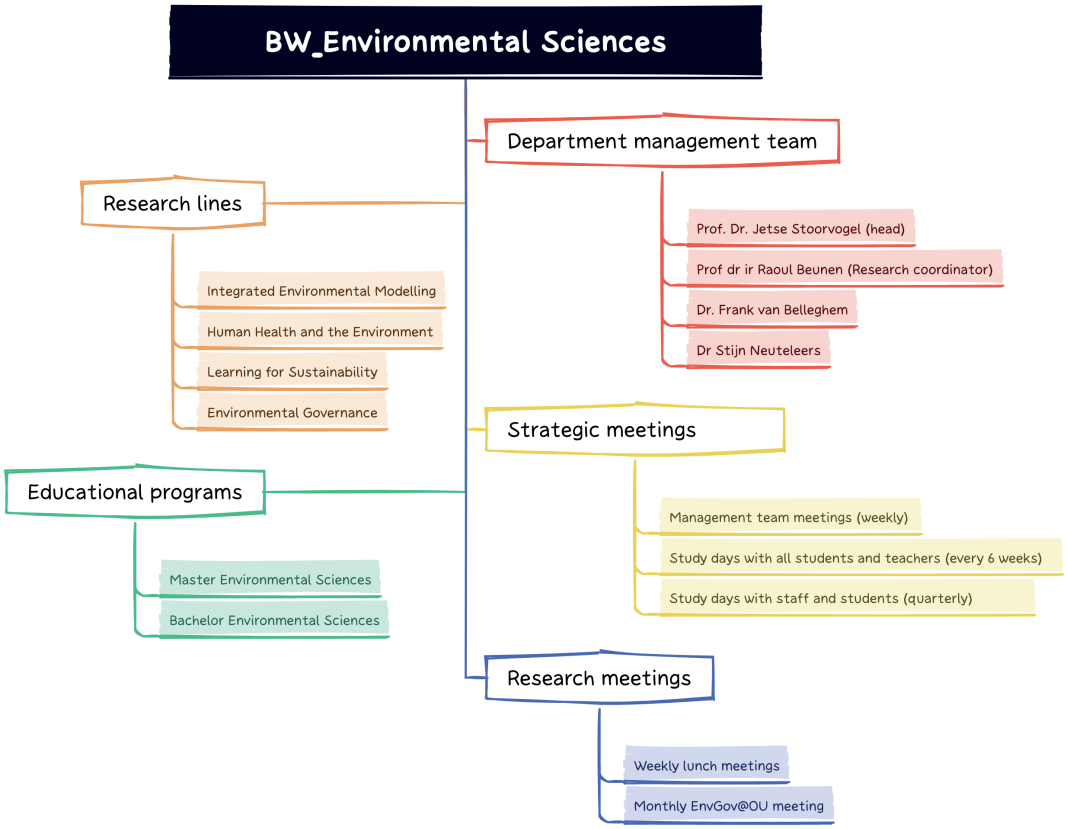
- Availability of spatial plans and GIS data(.shp) files of the territory - OUNL Hydrological, Soil, Land Use data coverage on coupled hydrological and carbon modelling in Brabant catchment Aa of Weerijs, cross border Netherlands and Belgium[5].
- Worldwide Capacity Development on Plastic pollution and Marine litter together with United Nations Environment Programme (UNEP) and the Global Partnership on Plastic pollution and Marine Litter (GPML) since 2014.
- Knowledge to Knowledge partner in Partners for International Business "Waste and Circular Economy Business Indonesia – Netherlands (since 2019) Waste and Circular Economy Business Indonesia - Netherlands — RVO.nl — Rijksdienst
- In the Resilient Indonesian Slums Envisioned (RISE) project (NWO - RISTEK-BRIN), led by Radboud University and Universitas Indonesia, our department leads the Knowledge Sharing and Capacity Building work package together with Yayasan Humanis dan Inovasi Sosial (HIVOS) Research: Resilient Indonesian Slums Envisioned (RISE) — Radboud University (ru.nl)
- ACT: Accelerating Just Climate Transitions in Urban Regions (2024-27), NWO-KNAW Dutch Climate Research Initiative (KIN). This work program aims to support the acceleration of just climate transitions in neighbourhoods in the Netherlands. We do so by developing local action pathways and agendas through collaboration between previously disconnected stakeholders: including residents, housing corporations, civil servants and sustainability professionals.
- Together with the Province of Zuid-Holland and the Ministry of Infrastructure and Water Management several workshops and multi-media[6,7] are developed to communicate and discuss the lessons learned on participation and trust in government to a wider audience of municipalities, provinces and waterboards.

[5] http://ssrn.com/abstract=4705609

[6] https://kennis.zuid-holland.nl/podcast/komt-te-voet-en-gaat-te-paard/

[7] https://www.ou.nl/en/-/webinar-terugkijken-over-relatie-participatie-en-vertrouwen-in-openbaar-bestuur

9.5 Organisation of the department and meetings



9.6 Scientific and societal partners and collaborations

The department collaborates with a wide range of societal and scientific partners. These partnerships are reflected in the research projects and participation in various regional, national and international networks of collaboration.

9.6.1 Research projects

- **ACT: Accelerating Just Climate Transitions in Urban Regions (NWO, 2024-2027)** – Klimaattransitie in stedelijk gebied door de lens van klimaatrechtvaardigheid, NWO-KNAW Dutch Climate Research Initiative (KIN). This work program aims to support the acceleration of just climate transitions in neighbourhoods in the Netherlands. We do so by developing local action pathways and agendas through collaboration between previously disconnected stakeholders: including

residents, housing corporations, civil servants and sustainability professionals.

- **EIFFEL4Climate[8] (Horizon Europe, 2021-present)** – Earth Observation applications for climate change adaptation & mitigation – Pilot 1 Water and Land Use Management, Brabant NL. Development of a framework, models and DSS for embedding co-design into spatial water and land management strategies to enhance climate resilience, focusing on water shortage, droughts and soil carbon sequestration. Regional stakeholders use climate impact atlases for testing adaptation measures.
- **Blue Green Governance[9] (BGG) (Horizon Europa, 2024-2028)** – BGG pursues an innovative approach to the governance of the seas and coastal areas that links marine policies with the management of the land and water. More precisely, BlueGreen Governance will develop evidence-based pathways for the design and implementation of innovative governance schemes around the land-sea connection that incorporates both the scientific predictions of future developments (about the biodiversity-water-climate nexus) and societal views on the most viable policy responses.
- **2seas Co-Adapt (Interreg 2019-2024)** – Co-Adapt: Climate Adaptation through Co-creation – We developed in co-creation a Guide and framework with tools for co-creation, adaptive pathways to Nature-based solutions, incl. e-Learning resources to support uptake of the Co-Adapt approach by professionals and organisations responsible for water and spatial management. Incl Crossborder strategy incorporating 2Seas vision, and regional transition roadmaps to replicate the Co-Adapt approach.
- **2023 PhD project on AutoML[10] in LUC (submitted)** – AutoML in land use change and effect on carbon sequestration. Nature-based solutions in brook catchments – Modeling land-use and its impact on terrestrial carbon pools. (with AutoML land use change tools): PhD-candidate Timmer, L., Supervisors: van Wijnen (OUNL), Lansu (OUNL), Fledderus (Windesheim), Stoorvogel (OUNL) elaboration on MSc thesis.
- **Resilient Indonesian Slums Envisioned[11] (NWO - RISTEK-BRIN) 2021-2025** – The project aims to develop an inclusive governance roadmap to transform Indonesian cities towards social-ecological resilience in the face of water-related disasters. The focus is on studying social-ecological interactions in slum areas in three different locations in Indonesia: Pontianak, Manado and Bima. Together, these represent most of the key social and water challenges that Indonesian cities face.
- **UNEP – Capacity development Marine Litter and plastic pollution**

[8] http://Eiffel4climate.eu

[9] https://www.cmcc.it/projects/bluegreen-governance

[10] https://research.ou.nl/en/studentTheses/nature-based-solutions-in-brook-catchments-modeling-land-use-and-

[11] https://www.ru.nl/en/research/research-projects/resilient-indonesian-slums-envisioned-rise

(since 2014) – Since 2014 the Department works in close cooperation with the United Nations Environment Programme (UNEP) and the Global Partnership on Plastic pollution and Marine Litter (GPML) on capacity development activities such as the Massive Open Online Course on Plastic pollution and Marine litter and the Community of Practice on Capacity Development.

- The Open University participates in the **European Horizon2020 project Labplas**, focusing on the sources, transport, distribution and impacts of plastic pollution in all environmental compartments. The Labplas project involves fieldwork in two contrasting case studies, collecting data that can serve as input for environmental modelling, identifying or predicting sources, transport among compartments and potential transfer of chemicals to biota. With this knowledge the project provides tools for environmental management and planning of effective mitigation measures. An action-oriented course will be developed to disseminate the results of the project to stakeholders.
- **ADAPT LOCK-IN[12] (DFG/ESRC/NOW)** –Understanding the impact of policy lock-ins on climate change adaptation. The aim of this interdisciplinary project is to uncover these lock-in dynamics and examine the extent to which they account for varying levels of climate change adaptation in Germany, the Netherlands and the U.K. (England).
- **E-SLP[13] European Short Learning Programmes (SLPs) for continuous professional development and lifelong learning. SLP 'Climate Change: from global to local Action' (Erasmus+ 2018-2020)** – In a cooperation between three distance learning universities, Universidade Aberta – UAb (Portugal), Open Universiteit in the Nederlands - OUNL and Universidad Nacional de Educación a Distancia – UNED (Spain), the project will develop an international Short Learning Program (SLP) 'Climate Change: from global to local Action', for professionals, managers and technicians from all type of organisations, from private and public sector. Output: learning materials, online courses, student guide, and video.
- The OU is a partner of the **MOMENTUM**[14] consortium that studies the effects of micro- and nanoplastics on human health on all levels. The MOMENTUM project aims to advance understanding of the internal exposure and kinetics of Micro- and Nanoplastics (MNPs) within the human body, focusing on lung, intestine, brain, and placental barriers. Additionally, it seeks to uncover the immunological hazards associated with exposure to plastic particles and MNP-linked pathogens. Building upon existing breakthrough projects, MOMENTUM will enhance knowledge on MNP formation and characterization, and develop a roadmap for comprehensive risk assessment.

[12] https://adaptlockin.eu/

[13] https://e-slp.eadtu.eu/

[14] https://momentummicroplastics.nl/

9.6.2 Partnerships

EcoBiose[15] is a regional partnership in the region of South Limburg focusing on biodiversity and a sustainable living environment. It connects governments, businesses and research and teaching institutions.

[15] https://www.linkedin.com/company/ecobiose1/