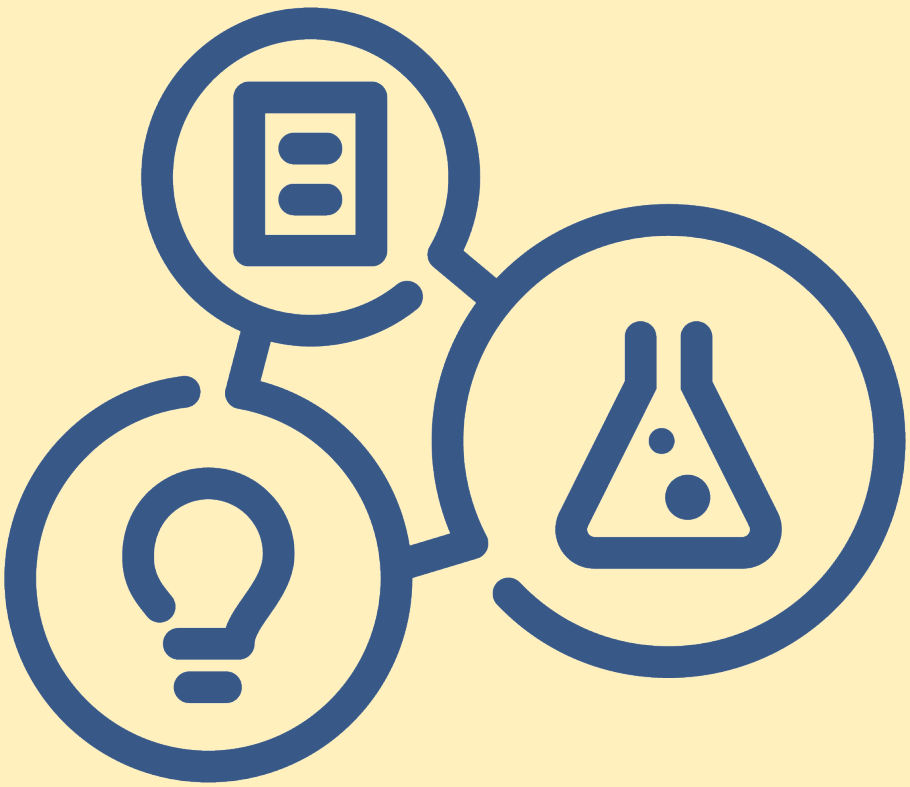
NordForsk

Interdisciplinary research

Key Results and Impact of the Research Initiative 2018–2026



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Introduction

Interdisciplinarity is generally acknowledged as essential for the generation of new and ground-breaking research results. Moreover, a wide range of important and relevant questions for research are complex and require scientific approaches that dare to think across traditional boundaries between fields and disciplines, thereby creating fertile ground for new approaches and insights. The integration of methods, data, perspectives, concepts, and theories from different scientific fields is crucial in the efforts towards expanding the scope of collective human knowledge.

In 2019, NordForsk launched an initiative on Nordic interdisciplinary research in collaboration with the Research Council of Norway, the Swedish Research Council, Forte, Formas, Independent Research Fund Denmark, the Research Council of Finland and Rannís. The main aim of the call was to fund bottom-up and scientifically excellent interdisciplinary research, with no constraints regarding the research themes or questions. Next to scientific excellence, the initiative was expected to generate Nordic added value by strengthening the ability of Nordic research environments to meet the increasing international demand for truly interdisciplinary research.

The call attracted huge attention among research groups in the Nordic region. The sheer volume demonstrated a widespread interest in interdisciplinary research in the Nordic region, and that there is a need for this kind of funding.

Eventually, twelve research projects were funded under this call, spanning a range of different topics, including social robots, migration law, pandemics, avalanches, forest policies and MRSA infections. I believe it is safe to say that the initiative has been a success, and that this is demonstrated by the results and outcomes that are documented in this report. On the one hand, the projects have generated new knowledge and new insights on many different areas of research, that might not have happened without this funding initiative. On the other hand, the initiative brought together researchers across disciplines and across national borders, establishing fruitful collaborations that perhaps would not have been realised without the NordForsk grants.

During the funding period, NordForsk organised two conferences where the projects met to discuss challenges and opportunities, and to present their results. Among the advises we received from the researchers, one message was oftentimes repeated: NordForsk and the national research funding agencies in the Nordic region must continue to support open, bottom-up programmes and funding instruments for interdisciplinary research.

At the end of the funding period, we can say that the results and achievements presented by the twelve projects make a strong argument for this message.

Arne Flåøyen,
Director of NordForsk

Nordic network on smart light-conversion textiles beyond electric circuits (Beyond e-Textiles)

Project leader: Jaana Vapaavuori, Aalto University
Project duration: 2021-2024
Participating countries: Finland, Sweden, Denmark and Iceland
Funding from NordForsk: 14,318,346 NOK
Project website: Beyond e-Textiles project

The research project Nordic network on smart light-conversion textiles beyond electric circuits (Beyond e-Textiles) has been investigating how the textile industry can become more sustainable by developing new experimental textiles as alternatives to, for example, cotton and the synthetic fibre elastane.

Impact story

The researchers from Beyond e-Textiles have developed innovative prototypes for sustainable textiles using materials like lupin yarn, potato starch and biobased PLA (polylactic acid).

These results were showcased in a series of exhibitions across the Nordic region and a major conference in London. The exhibitions not only demonstrated the potential of these eco-friendly materials to the public and industry stakeholders but also influenced educational practices, as showcased by the inclusion of these materials in needlework curriculums in Finnish schools.

This project contributes to reducing the environmental impact of the global textile industry, aligning with the European Commission's new sustainability criteria, while paving the way for a more sustainable textile production paradigm.

Key Findings

This project was first and foremost crafted to foster interdisciplinary collaboration throughout Nordic countries around a defined subject area - the development of novel yarns and textiles.

- This joint research of the partners, Aalto University, University of Borås, University of Turku, Iceland University of the Arts and VIA University College, on this vast domain, lead to new openings for paths that would warrant a research project of their own. These include healthcare, exemplified by textiles in the form of mineral-enhanced UV-detecting coating that could be directly printed on a t-shirt. This type of clothing may be essential in sensitizing users of the risk of UV illumination.

- On the other hand, new aesthetic norms, visible for example in stretchable woven fabrics were developed without the use of elastane, demonstrating how functionalities important to consumers can be produced with methods that allow easier end-of-life recycling.

- Finally, in a more speculative futuristic context, textile actuators being able to convert ambient energy (heat) or infrared light were developed in a number of prototypes. These demonstrators showcased how a motion of a single yarn could be transferred into a motion of large textiles thanks to textile design. These products may turn out to be useful for instance in climate-adaptive curtains in zero-energy buildings.

Key outputs

BEYOND ENTANGLED: A collection of research stories from the Beyond e-Textiles project 2021-2025 (2025) Vapaavuori J., Bang A.L., Dumitrescu D., Bjarnadóttir R., Miettunen K. (eds.) Publisher: The Iceland University of the Arts. ISBN 978-9935-9378-9-6. https://doi.org/10.22501/rc.3942493; https://static.lhi.is/BeyondTextile.pdf

SCALES in Textiles conference (2025) Aalto University, Espoo, Finland. Duration: 8 April 2025 → 10 April 2025. https://www.aalto.fi/en/events/scales-in-textiles-april-8-10-2025

'Entangled in the design of a relational materiality: Beyond smart textiles' (6 Aug 2025 – 8 Aug 2025) Nordes Design Research Society Conference "Relational Design", OsloMet - Oslo Metropolitan University, Oslo, Norway peer-reviewed: https://research.aalto.fi/en/publications/nordes-2025-exhibition

'Entangled – Reimagining textile functionalities' (6 Sep 2024 - 3 Oct 2024) Designs for a Cooler Planet festival, Aalto University, Espoo, Finland peer-reviewed: https://research.aalto.fi/en/publications/entangled-reimagining-textile-functionalities-designs-for-a-coole

The Network Dynamics of Ethnic Integration

Project leader: Carl Nordlund, Linköping University
Project duration: 2021-2026
Participating countries: Sweden, Finland and Denmark
Funding from NordForsk: 13,933,625 NOK
Project website: NordInt.net

This project has built capacity and expertise in network-scientific register-based research on ethnic relations and integration. Three core topics in ethnic relations research have been approached from a network-scientific perspective. This is inter-ethnic family formation ties, labour market integration and discrimination, and various sociodemographic aspects linked to residential segregation. Often utilizing available full-population micro-level register data in Denmark, Finland, and Sweden.

Impact story

The project has advanced understanding of how social, spatial, and structural forces shape ethnic integration across Nordic societies. By linking large-scale register data with advanced computational and network-analytic approaches, it reveals how geography and opportunity structures influence who forms partnerships with whom, how ethnic boundaries persist or blur, and how spatially anchored social networks have an impact on integration in different social domains.

In Sweden, the research demonstrates that residential segregation and demographic change — rather than cultural preference alone — sustain social divisions, while also identifying the emergence of broader pan-ethnic connections. In Denmark, the work has clarified how neighborhood contexts and internal migration flows structure both integration and marginalization, offering a dynamic view of how neighborhoods function. In Finland, analyses of fertility and migration patterns across ancestry groups have challenged conventional assumptions about cultural explanations, highlighting institutional and generational drivers instead.

Together, these studies establish new methodological tools and comparative insights for understanding the network dynamics of ethnic integration and their implications for social cohesion in increasingly diverse societies.

Key Findings

- The study examines how geography, ethnicity, and structural factors shape patterns of partnership, integration, and fertility across Nordic societies. Despite the digital era's potential to expand partner markets, geography remains crucial: people are far more likely to form unions with nearby partners. Ethnic endogamy persists most strongly among non-Western immigrants, particularly those of African, Middle Eastern, and Asian origin, though much of this is explained by residential proximity and segregation rather than direct preferences.

- Analyses of Sweden reveal that inter-ethnic family formation follows overlapping pan-ethnic boundaries rather than distinct national lines, reflecting both cultural ties and social distance. Over three decades, ethnic boundaries in Sweden show no signs of hardening; instead, shifts in partnership patterns largely stem from demographic and spatial changes.

- In Denmark, neighborhood composition has limited influence on immigrants' employment outcomes, highlighting the dominance of structural over social factors. Neighborhoods function as dynamic, shifting contexts shaped by migration flows rather than fixed determinants.

- In Finland, fertility patterns reveal generational divides across ancestry groups and emphasize institutional rather than cultural explanations. Finally, homophilic unions prove more stable than inter-ethnic ones, underlining how structural inequalities and gender-income dynamics shape intimacy and social cohesion.

Key outputs

Multiple journal publications, preprints, working paper, and two PhD theses in the making on the substantial topic of inter-ethnic relations and integration in the originally outlined fields of family formation, labor market integration, and residential segregation – see https://nordint.net/?page=output

Novel advances in network-analytical methods of general applicability, as well as novel application of network-analytical methods and novel usage of various datasets to develop the fields of network science and computational social science at large.

Development of a novel software client for network-analytical blockmodeling – socnet.se – that, in an interdisciplinary fashion, combines advanced computer-scientific search heuristics with the classical sociological ideas on social roles and social structure. Available as a compiled client for all major operating systems and architectures, as well as fully open source.

Two doctoral students (and forthcoming PhD holders) with specializations in the substantive fields of inter-ethnic relations and integration, Nordic register data, and the application of advanced network-scientific methods to address such questions.

Narwhal tusks: a tale with a twist

Project leader: Henrik Birkedal, Aarhus University
Project duration: 2021-2026
Participating countries: Denmark, Greenland and Sweden
Funding from NordForsk: 14,359,011 NOK
Project website: Narwhal tusks: a tale with a twist

What can we learn of the changing Arctic environment through narwhal tusks? The researchers have studied the mysterious helical structure of narwhal tusks and each individual layer of growth in the tusks of narwhals in Greenland, to find answers to what the tusks can tell us about living and climate conditions in the Arctic.

Impact story

The narwhal's spiral tusk has annual rings, and they can reveal past changes in the climate. Researchers from the project have discovered how the tusk is built and what is the origin of the spiral tusk structure and that there also appear to be rings within the annual rings, which can provide even more details about living conditions in the Arctic.

"We have realised that the tusk structure is more complicated than we had imagined. We have uncovered how the arrangement of the molecular-scale building blocks of the tusk result in its evocative spiral morphology. Additionally, we have developed a model of the annual growth bands that we hope will enable revealing variations in living conditions in the Arctic over the life of narwhals," says project leader Henrik Birkedal.

Key Findings

- Narwhal tusk has a puzzling spiral morphology – always forming a helix with the same handedness. The researchers have been able to determine how the molecular building blocks arrange in a hierarchical structure that results in the overall cm-scale helix of the tusk. This involved a tour-de-force set of advanced experiments using synchrotron X-ray facilities across Europe, including the MAX-IV synchrotron in Lund, Sweden.

- The tusk contains annual growth bands that mark how fast the tusk has grown per year – like rings in a tree. The researchers have studied these using many different methods and found that the elemental composition of tusk and tooth is related to where whales live around Greenland, that the position of the growth bands can be mapped to determine the narwhals age and that the growth bands impact some but intriguingly not all of the narwhal tusk structural features.

- Furthermore, they have refined methods for analyzing tooth material for hormones, including the stress hormone cortisol, providing insights into how individual narwhals respond over time to environmental change and ocean warming. The results provide deep insights into the structural design of this enigmatic tusk and provide the basis for relating tusk annual growth band structure to whale growth conditions and thereby to the living and climate conditions in the Arctic.

Key outputs

Interdisciplinary training of young talents in the project resulted in prestigious Marie Curie individual postdoc fellowships to two employees in the project.

New knowledge on the relationships between or variations of chemical composition, hormones, structural features of narwhal tusks and teeth – as well as statistical models of these – that will form the basis for mapping living conditions in the changing Arctic.

Improved methods for analysis of complex structural and compositional data from tissues like bone and teeth have been established – these will be openly available for other researchers.

Publications from the project: https://inano.au.dk/about/research-centers-and-projects/narwhal.

Grappling with Uncertainty in Environments Signaling Spurious Experiential Decisions (GUESSED)

Project leader: Audun Hetland (UiT, The Arctic University of Norway)
Project duration: 2021-2024
Participating countries: Norway, Sweden, Finland, Germany and USA
Funding from NordForsk: 15 MIO NOK
Project website: GUESSED

Making sound decisions under uncertainty in a rapidly changing world is more important than ever. The GUESSED project used avalanche terrain as a test-bed for developing theories and tools – which will have an impact far beyond the snow-covered mountains in the Nordic Countries. The GUESSED project aimed to reduce the loss of life from decision errors by improving the theory and practice of decision making in uncertain hazardous environments of non-representative feedback.

Impact story

The GUESSED project demonstrated that non-experts cannot be expected to make expert-level decisions in avalanche terrain. Even seasoned avalanche professionals cannot make reliable judgments on "day one" of a new snowpack—they need time to gather observations, exchange information, and interpret emerging patterns. Recognizing this, the project shifted focus from improving individual decision tools toward building collective structures that make expert knowledge more accessible and operational for both professionals and the wider public.

Through close collaboration between researchers, the national avalanche warning service (NVE), local guide companies, municipalities, and the tourism sector, the project developed and tested an integrated system for transforming expert assessments into concrete, actionable travel advice.

Key Findings

- The GUESSED project has fundamentally advanced our understanding of how people make risk decisions in high-uncertainty environments. Initially, the project set out to evaluate heuristic decision tools—specifically Fast-and-Frugal Trees (FFTs)—as potential aids for avalanche decision making. However, extensive collaboration and fieldwork with international avalanche experts revealed that such decisions cannot be reduced to simplified, rule-based heuristics. Expert assessments depend on context-sensitive interpretation, iterative information gathering, and experience-based pattern recognition that evolve dynamically over time.

- This insight led to a major conceptual shift: avalanche risk decisions are not best understood as a series of discrete choices, but as continuous sensemaking processes. By reframing decision making in this way, the project bridged behavioural science, cognitive psychology, and geoscience, contributing to broader decision theory on how expertise operates in "wicked" learning environments—contexts marked by uncertainty, feedback delays, and incomplete information.

- The project also identified striking differences between experts and non-experts. Non-experts typically received little feedback on their decisions, limiting learning and skill development. A multi-season field study showed that non-experts rarely updated their plans, often maintained static intentions, and were sometimes unaware of the prevailing avalanche hazard. In contrast, in-depth interviews with survivors of serious avalanche accidents—who had received direct, real-life feedback on flawed decisions—showed that many subsequently adopted more reflective, expert-like decision strategies.

Key outputs

The SkiGuide App serves as the public interface of this system. It presents more than 500 mapped ski tours across Norway, each with a terrain exposure score indicating inherent risk. However, terrain ratings alone do not capture the current avalanche conditions. To address this, the app is designed to integrate with insights from the daily Guide Meetings in the Lyngen region.

Online guide meetings gather inbound and local guides and the national avalanche warning service (NVE), observers to share field observations and jointly interpret the current avalanche situation.

Drawing on insights from longitudinal studies of expert decision making, the project worked with national education providers to propose updated learning goals for avalanche training in Norway. These emphasize adaptive expertise, reflective practice, and learning from feedback - aligning education with how real-world decision making actually develops.

The project initiated an International network on teaching human factors in avalanche education. Following the world's largest conference on snow and avalanche decision making (ISSW Tromsø 2024), GUESSED convened two workshops bringing together 117 leading international educators and researchers and decision makers in avalanche education from all over the world.

Technology-enhanced foreign and second-language learning of Nordic languages (TEFLON)

Project leader: Mikko Kurimo, Aalto University
Project duration: 2021-2026
Participating countries: Finland, Sweden and Norway
Funding from NordForsk: 14,850,007 NOK
Project website: Teflon Project

The Nordic countries accept many immigrants – not least because of the war in Ukraine. This means that there is considerable demand for learning one of the Nordic languages as a second language. Learning the language, and especially oral language skills, is crucial for the immigrants to become part of the Nordic societies. The TEFLON-project focused on how to create digital games to teach immigrant children to speak Finnish, Norwegian and Swedish.

Impact story

TEFLON has developed games because they increase children's motivation to learn languages. Children enjoy playing, and digital language-learning games can be particularly attractive to immigrant children. The games can supplement classroom-based language teaching, because they can be used individually, and they can be used regardless of where you're located or the time zone you are in.

They have developed a speech technology component that can be added into various fun games instead of building completely new games for language learning. Also, native children who have various speech sound disorders can use the games and learn to speak fluently and correctly.

They created new fruitful collaboration between experts in speech recognition, AI, neuroscience, speech therapy, and education from Finland, Sweden and Norway.

To build impact and trust to the stakeholders, they engaged directly with:

- Cities and school directors
- Teachers, who generously adjusted their schedules and trusted them with their classrooms. Bridged the TEFLON researchers with parents.
- Parents, who signed forms, asked thoughtful questions, and shared concerns about screen time and learning. Spent their time and efforts to let children play.
- Children, who laughed, played, struggled, and learnt. Whose openness made all the difference.

Key Findings

- We collected and annotated new children's speech data and used them to develop five versions of TEFLON mobile game applications called Pop2Talk_Nordic that were implemented, tested and used for learning experiments: SwedishSSD, Finnish-R, SwedishL2, NorwegianL2 and EnglishL2.

- Several articles were published about the data collection, mobile game application and our new methods for automatic pronunciation rating.

- Human learning experiments were also performed on the effectiveness of the game on immigrant children's language learning, comparing children's reading scores in their native language before and after gaming intervention and evaluation of the speech training game for children with speech sound disorders.

Key outputs

Yaroslav Getman, Nhan Phan, Ragheb Al-Ghezi, Ekaterina Voskoboinik, Mittul Singh, Tamás Grósz, Mikko Kurimo, Giampiero Salvi, Torbjørn Svendsen, Sofia Strömbergsson, Anna Smolander and Sari Ylinen. Developing an AI-assisted Low-resource Spoken Language Learning App for Children. IEEE Access, vol. 11, pp. 86025-86037, 2023.

Strömbergsson, S., Fröjdh, M., Pettersson, M., Grósz, T., Getman, Y., & Kurimo, M. Listening like a speech-training app: Expert and non-expert listeners' goodness ratings of children's speech. Clinical Linguistics & Phonetics, 39(2), 144-165, 2025.

Anne Marte Olstad, Anna Smolander, Sofia Strömbergsson, Sari Ylinen, Minna Lehtonen, Mikko Kurimo, Yaroslav Getman, Tamás Grósz, Xinwei Cao, Torbjörn Svendsen and Giampiero Salvi. Collecting Linguistic Resources for Assessing Children's Pronunciation of Nordic Languages. Proc. Language resources and evaluation conference (LREC-COLING) 2024, May 2024.

Yaroslav Getman, Tamás Grósz, Mikko Kurimo. NON-NATIVE CHILDREN'S AUTOMATIC SPEECH ASSESSMENT CHALLENGE (NOCASA). Proc. IEEE Workshop on Machine learning for signal processing (MLSP) 2025, September 2025.

Graphene-based drug delivery systems for treating MRSA infections (GraMI)

Project leader: Ivan Mijakovic, Chalmers University of Technology
Project duration: 2021-2023
Participating countries: Sweden, Denmark, Norway
Funding from NordForsk: 14,920,000 NOK
Project website: GraMI

Antimicrobial resistance (AMR) is one of the most serious health threats of our time. It means that within a few decades we might no longer be able to treat bacterial infections with antibiotics. It is therefore crucial that new drugs are developed that can provide an alternative to current antibiotics. This has been the main goal of the Nordic research group Graphene-based drug delivery systems for treating MRSA infections.

Impact story

The GraMI project has come up with a possible strategy to fight multidrug resistant Staphylococcus aureus, also known as MRSA. Each partner in the project has developed a component that together form what could become a new treatment against antibiotic resistance.

"So, we have the first hydrophobic antibiotic, the metallic nanoparticles, silver or gold, which are also toxic to bacteria, and these graphene knives, which do mechanical damage to bacteria. With this three-pronged approach, we are trying to attack bacteria from different sides at the same time," says Ivan Mijakovic.

The new antibacterial "weapon" has not yet been approved for use. The project's researchers hope to have clinical trials in the future, so that it may eventually be approved and used for treatment.

Key Findings

- Working with the key components of our three-pronged approach, insoluble antibiotic candidates, metallic nanoparticles and graphene coatings, the GraMI researchers have increased the understanding of how these components work together.

- Key findings include an elucidation of the molecular mechanism of action of the potent antibiotic candidate MBL-AB01 developed by SINTEF, optimization of "green" synthesis of antibacterial metallic nanoparticles developed by the DTU, and the development of methods for vertical/axial coating of objects with graphene spikes. The researchers have established that antibacterial effectiveness of these components used together is larger than the sum of individual contributions.

- They also understood the reason for this synergistic killing effect. The antibiotic, nanoparticles and graphene simultaneously attack different targets within the bacterial cell. Graphene act as a "molecular knife", cutting the bacterial membrane. Nanoparticles attack the cellular proteins/enzymes by causing oxidative damage. And the MBL-AB01 antibiotic blocks DNA replication. Because all these attacks happen simultaneously, bacterial cells have difficulties coping with them and find it difficult to develop resistance.

- Thus, in this project they have defined key principles of devising successful future strategies to fight bacterial infections. They have also discovered that new materials, such as the metal organic frameworks (Nobel Prize 2025), can also act as "molecular knives" and delivery platform for antibiotics.

Key outputs

"Biosensors Using Graphene for Infection Diagnostics", a new EU MSCA Doctoral network project with 4.54 M€ budget, coordinated by Prof. Ivan Mijakovic. The project builds on findings related to bacterial infections and nanomaterials, and involves two partners, DTU and CTH. It will educate 15 PhD students, working at several European universities, private companies and hospitals.

Based on our success in developing methods for curbing and monitoring bacterial infections, project partners were contacted by Mölnlycke Health Care (MHC), a world leading producer and distributor of wound care products. MHC distributes its products to 68 nations, with 378 million individual MHC wound-care products sold every year. A new collaboration was established between MHC and CTH in 2024, leading to several joint project applications and projects co-funded by MHC. The ongoing and future work with MHC is centred around developing "smart dressings" that will improve the standard of care for chronic wounds.

One of the main outcomes of the project is the training of future leaders in science and innovation, capable of working in interdisciplinary settings. Within the project, four postdoctoral fellows and three junior researchers have been trained. Among them, several have moved to leading positions in academia and industry post-project, illustrating the empowering effect of interdisciplinary training they have received.

Unconventional methods to inform sustainable design: Mediating the needs of people and nature in Nordic after-dark environments

Project leader: Ute Besenecker, Kungliga Tekniska högskolan
Project duration: 2021-2025
Participating countries: Sweden, Norway and Finland
Funding from NordForsk: 14,506,410 NOK
Project website: NorDark

How much light is needed for pedestrians to use paths in urban forests after dark, and how can we minimize the negative impact of that light on skyglow and wildlife?
These are the questions that the interdisciplinary research project NorDark set out to study. The project strived to develop new knowledge crucial to design for sustainability in the urban after-dark environments. Research teams from six different disciplines participated in this study. Each discipline made a distinct contribution to the overall project results.

Impact story

The research team has tested lighting scenarios in two selected locations in two Nordic cities – Ålesund in Norway and Uppsala in Sweden. Both locations are urban residential areas located adjacent to a protected green zone. The paths in these locations are used by residents for recreation, commuting, and getting to and from local schools and childcare facilities.

According to project leader Ute Besenecker, "Based on preliminary observations, we've established that by designing lighting qualities carefully, less light can be used without compromising pedestrian usability of these green areas."

Key Findings

- Preliminary results from field work in Sweden and Norway suggest that lighting guidance and conditions in the areas studied could be adjusted to reduce lighting and its impact on wildlife without compromising human usability, thus also enabling reduced energy consumption.
- Snow cover can also affect light exposure, alertness and melatonin suppression in residents.
- The evaluation of the digital twin showed that the visual simulation of dark conditions with snow cover was more positively evaluated than the condition without snow.
- Urban forests hold potential for psychological restoration even with fixed and portable electric lighting after dark; lighting designed to reduce negative impacts on wildlife still supported pedestrians' walking needs and, to some extent, provided positive experiences.
- In addition, despite the presence of the lit path, a significant number of active species were observed and characterized during the dark season, creating a new database of wildlife presence linked with associated environmental conditions.
- The findings were informed by various methods, procedures and tools developed by the collaborating research groups.
- Several papers and dissemination activities have and will be produced that describe these processes.

Key outputs

Dissemination to date:

- 10+ Articles, 1 Book, 5 Reports/Manuals, 14+ Conference Presentations and Proceedings, 10 Workshop activities (municipality and/or other stakeholders), several co-teaching activities between consortium members to each other's students, 4+ published Master Theses, 1 doctoral dissertation finished, 2 doctoral dissertations in progress.
- Lighting prototypes and lighting strategies.
- Feedback between local stakeholders and team members, fostering new ideas for future research and application.
- Digital Twin prototypes for use and further research, education, and development by all stakeholders.
- Art installation in development, raising awareness and enabling exploration of multispecies negotiations related to outdoor lighting.

Facilitation Robotics for Teams Foundational Research on Group Processes in Human-Robot Ensembles with Social Robots (S-FACTOR)

Project leader: Johanna Seibt, Aarhus University
Project duration: 2021-2024
Participating countries: Sweden, Denmark and Finland
Funding from NordForsk: 14,987,413 NOK
Project website: S-FACTOR

The project S-FACTOR investigated how human groups perform certain tasks when they are guided by a "social robot", addressing cutting edge issues in the multidisciplinary area of Human-Robot Interaction studies (official abbreviated 'HRI'). A team of 15 researchers from 7 disciplines conducted a series of experiments to explore whether social robots can facilitate positive group processes. The researchers investigated people's behavior in interaction with social robots, but also how humans, as groups and individuals, experience these interactions.

Impact story

Results from the project show that inviting a robot into your group can put the group into a positive mood which in turn can boost creativity in cognitive tasks. Like human facilitators, robots can repair participation imbalance in a group and repair trust after having made a mistake. While some HRI experiments have shown that humans follow the authority of a robot in practical emergency situation, the project's most complex experiment showed that in normal (work-like) situations human retained 'critical distance' and followed their dispositions for strategic collaboration.

The project's overall approach to the development of social robotics applications had special impact on the international research community and received local and national public attention since the project team organized two events.

Key findings

The project's key findings belong into three categories: 1. empirical results, 2. methodological results, and 3. results of conceptual (ethical) research.

1. The way a robot speaks (e.g., charismatic voice) can enhance group creativity but do not seem to enhance trust-in-action for practical tasks. Robots are 'emotionally contagious': The (simulated) emotional state (good mood, bad mood) of a facilitation robot puts human group members in a 'bad mood'/'good mood'. Robot gaze can mediate participation imbalance in groups with different skill levels. Robots can effectively apply human strategies for trust repair (justification, denial, promise to improve). Whether human dispositions for strategic rational collaboration are influenced by advice of an artificial social agent (robot, avatar) is context dependent.

2. The researchers advanced the key methodology (sociality analysis) for ISR (i.e., Integrative social robotics; the first R&D paradigm for developing applications of social robotics in human-centered manner): The project introduced and validated a new theoretical construct: "sociomorphing", to replace the theoretical construct of "anthropomorphizing," which showed to be inconsistently used in HRI. When humans are sociomorphing a robot, they attribute coordination capacities to the robot, forming partner models and self-models; with these tools one can trace with precision key ethical issues in human-robot interaction (e.g.deception, sentimentalism, debasement).

3. Central EU documents for responsible technology development rely on the capacity of institutions taking responsibility. The researchers developed models for distributed responsibility and introduced a generic condition that institutions need to fulfill if they can be held responsible. They clarified the conditions under which robots may be assigned «moral standing.»

Key outputs

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J. Seibt, R. Hakli, M. Nørskov (eds.), Robophilosophy—Philosophy of, for, and by Social Robotics, MIT Press, 2026.

The timing and ecology of the human occupation of Central Asia (THOCA)

Project leader: Jan-Pieter Buylaert, Technical University of Denmark (DTU)
Project duration: 2021-2024
Participating countries: Norway, Denmark, Sweden and Tajikistan
Funding from NordForsk: 14,955,177 NOK
Project website: THOCA

When did humans arrive in Central Asia and what was the environment and climate like at the time? Were there waves of migration of different species and did they only move when the climate was favourable, for example in the warm periods between glaciations? These questions are important because if we truly want to understand who we are today we need to understand our evolutionary past.

Impact story

The researchers from the project have carried out field work at different sites around the Khovaling Loess Plateau in southern Tajikistan. They have among other things collected sediment samples for chronology and climate proxies, and samples for biomarkers and ancient DNA.

"With this project we wanted to give Nordic scientists access to new research areas, establish new links with Tajik research, and provide a broad cross-disciplinary education to young scientists. Bringing together researchers from different Nordic countries and from different research disciplines creates Nordic added value," says Jan-Pieter Buylaert.

Key findings

- Chronology:
  The chronology teams have produced detailed independent chronologies for the sites studied in the Khovaling Loess Plateau in Tajikistan. The new chronologies represent the most comprehensive chronological records in Central Asia and beyond, as well as the first absolute chronology of the Early Palaeolithic in Central Asia. This has been done using the latest technologies in numerical dating, and by developing novel tools that now are being applied to other sites around the world. The new chronologies are crucial for accurate interpretation of the archaeological, environmental, and climatological records preserved at these sites.

- Archaeology:
  Expansion of our knowledge of the migration history of Central Asia to include occupations along the riparian corridor during cold (glacial) periods as well as warm (interglacial) periods. Our team further established that the use of fire by hominins occurred as far back as 600,000 years ago in this region, and that our ancestors were likely critical architects of vegetation in the landscapes they inhabited.

- Climate:
  The project has generated some of the most detailed climate records produced in Central Asia for the last 1.2 million years, including quantitative estimates of precipitation and temperature, as well as wind direction, based on a range of novel and established proxies. The findings demonstrate constancy in dust-transporting winds but shifting precipitation regimes over periods of human occupation. The team has established new analytical approaches in mineral magnetic and carbonate nodule analyses that are widely applicable in past climate science.

- Overall:
  Thousands of lithic artifacts were discovered in the Khovaling Loess Plateau. These discoveries have expanded our understanding of the early humans that occupied Central Asia through time, such as the Early Palaeolithic Karatau Culture that thrived between ~600 and ~400 thousand years ago. By combining these archaeological discoveries with new independent chronologies and reconstructions of environmental changes, we have obtained a much better understanding of the factors that drove human migrations in Central Asia and the surrounding regions during the Middle to Late Pleistocene (last ~800,000 years).

Key outputs

The project has established a firm Nordic network among researchers from Aarhus University, the Technical University of Denmark (DTU), Oslo University, Uppsala University and Copenhagen University. Furthermore, this network has expanded to include researchers from Central Asian countries (Tajikistan and Uzbekistan), Hungary, Germany and China. This expanded network has led to a mosaic of new collaborative efforts that highlight the interdisciplinary nature of the THOCA project and ensures its long-lasting legacy.

The THOCA project has rejuvenated archaeological and palaeoclimatological research in Central Asia, an understudied region with respect to our understanding of human dispersal across the globe and past climate change.

The project has also boosted local interest in the cultural heritage of Tajikistan. Investigations in the Khovaling Loess Plateau area have led to the establishment of a local (Tajik) working group which has the task to promote the Khovaling loess palaeolithic sites and eventually get them listed on the UNESCO World Heritage list.

The project will have produced 4 Nordic PhD theses (DTU, Aarhus, Oslo and Uppsala) and a long list of peer-reviewed publications.

Pathogens, Pandemics and the Development of Nordic Societies (NORDEMICS)

Project leader: Lone Simonsen, Roskilde University
Project duration: 2021-2025
Participating countries: Finland, Sweden, Denmark and Norway
Funding from NordForsk: 14,992,800 NOK
Project website: Pathogens, Pandemics and the Development of Nordic Societies

The project has examined pandemics within a historical context and investigated how factors such as urbanization, increased trade and travel, large-scale migration, vaccines and other public health interventions, climate change and ecological degradation influence the dynamics of epidemic and pandemic infections in human populations.

Impact story

The Nordemics project was fundamentally designed to unite the region's exceptional historical records, research traditions, and collaborative ethos to produce insights that no single nation could have achieved alone. By integrating and comparing these rich historical datasets across national borders, Nordemics has revealed how epidemics evolved within and between the Nordic countries, offering new understanding of the social, demographic, and institutional factors that shaped public health outcomes.

The funding has enabled Nordemics to establish a research network spanning Norway, Denmark, Finland, and Sweden. The pace has accelerated now that more researchers are working together. The project has led Nordic modelers to collaborate closely with health boards, strengthening Nordic pandemic cooperation and preparedness.

"For the first time, we have built meaningful collaborations with modelers, evolutionary biologists, and historical economists across four Nordic countries. We all share a tradition of collecting and preserving data going back hundreds of years - and we can find data once thought impossible to locate," says Nordemics project leader Lone Simonsen.

Key findings

- By combining rich Nordic historical data with interdisciplinary methods, Nordemics generated new insights to better understand key drivers and patterns of major past pandemics and epidemics in Nordic countries, with publications in top journals.

- Examples include an examination of malaria in Nordic climates in the 19th century. This involved identifying unique morbidity and mortality data, time series analysis to show that this was a widespread and mild illness that peaked in late spring, and due to a now extinct plasmodium that could survive cold winters inside the human host. They then demonstrated that its disappearance in the late 1800s was due to drainage in the context of development of agriculture.

- The researchers also studied the smallpox vaccine program in Finland around 1800, investigating the effect of laws in place, and the socioeconomic disparities effects on vaccinate uptake. Also, a joint modelling effort between teams in Denmark and Norway studied society-specific evolutionarily stable strategies on the spread of an unfolding emerging disease. Furthermore, collaborating with the Danish National Archives they analysed 100 years of deaths and identified all major childhood and adult epidemics.

Key outputs

Eilersen, A., Bjornstad, O. N., Li, R., Schreiber, S. J., Pei, Z., & Stenseth, N. C. (2025). Epidemic evolutionarily stable strategies within an age-structured host population. Proceedings of the National Academy of Sciences - PNAS, 122(12), Article 2418170122. https://doi.org/10.1073/pnas.2418170122

Pedersen, R. K., Ingholt, M. M., Van Wijhe, M., Andreasen, V., & Simonsen, L. (2024). Identifying signature features of epidemic diseases from 19th century all-cause mortality data. American Journal of Epidemiology, 194(2), 460–468. https://doi.org/10.1093/aje/kwae187

Ukonaho, S., Lummaa, V., & Briga, M. (2025). Socioeconomic Differences in Vaccination Coverage After a Mandatory Vaccination Law, 1855-1900. JAMA Network Open, 8(2), Article 2460558. https://doi.org/10.1001/jamanetworkopen.2024.60558

Ingholt, M. M., van Wijhe, M., Simonsen, L., & Weinberger, D. (2025). The disappearance of malaria from Denmark, 1862–1900. The Economic History Review. https://doi.org/10.1111/ehr.70025

Green forests policies: a comparative assessment of outcomes and trade-offs across Fenno-Scandinavia (Greenpole)

Project leader: Nils Droste, Lund University
Project duration: 2020-2026
Participating countries: Finland, Sweden and Denmark
Funding from NordForsk: 14,997,538 NOK
Project website: Greenpole

Half of the Nordic region's total area is covered by forest. Forests are home to a rich variety of flora and fauna and are important for ensuring biodiversity. Forestry also is an important industry and is an important national resource. Additionally, forests are the largest terrestrial carbon sink and can help to protect the climate. But not all these things can necessarily be at the same time and to the same extent. How shall we manage forests for all these benefits? This has been the focus of the Greenpole project.

Impact story

The researchers conclude that the dominant forest management practices are heavily optimised to produce biomass and forest products. Is the solution to stop cutting down trees altogether? Not if you ask Droste:

"If we left the forest untouched, it would have severe consequences for timber production and thus the economic income associated with forestry. We need to find a solution that balances out multiple benefits and cares for both forest owners and the climate but also biodiversity."

In the near future, we may be seeing a shift from clear-cutting to continuous cover forestry. This is an approach where selected trees are felled and not entire forest areas. This keeps the soil more intact, emits fewer greenhouse gases, and preserves the living conditions for animal and plant species.

Key findings

- Comparing forest policies in the Nordic countries Greenpole learned that they share a common principle: freedom with responsibility. This highlights the freedom of choice for forest owners but also stresses their responsibility for common goods such as climate and biodiversity.

- In theory it gives a substantial freedom to the owners, but somewhat ignores that the current market structure, international demand but also value chains and downstream buyers of course influence the choice of the owner. It would therefore in line with the principle of freedom with responsibility for the government to intervene in the market in order to increase the freedom of choice.

- In practice, however, the acceptability of these options differ among countries. While METSO, a payment for forest biodiversity in Finland is well accepted, the Naturvårdsavtal in Sweden is sometimes more seen as expropriation, despite above market compensation rates.

- The researchers learned that the knowledge base on the outcomes of forest policies such as certification and payment schemes is relatively thin in international, peer reviewed publications: they know more about certification schemes than payments but there is considerable uncertainty regarding outcomes. The need for evidence-based decision support regarding the trade-offs of forest policies is substantial.

- In the final phase of the GreenPole project they will thus model the Finnish METSO scheme, as lighthouse of a well-functioning Nordic forest policy and assess economic, ecological, social, and climate outcomes simultaneously.

Key outputs

Droste, N., Brownell, H., D'amato, D., Ekström, H., Fridén, A., Harrinkari, T., ... & Thomsen, M. (2025). Evaluating transformative policies in complex land-use systems. Ecological Economics, 238, 108734.

Ekström, H., Droste, N., & Brady, M. (2024). Modelling forests as social-ecological systems: A systematic comparison of agent-based approaches. Environmental Modelling & Software, 175, 105998.

Fridén, A., D'Amato, D., Ekström, H., Iliev, B., Nebasifu, A., May, W., ... & Droste, N. (2024). Mapping two centuries of forest governance in Nordic countries: An open access database. Forest Policy and Economics, 160, 103142.

Nebasifu, A. A., Pietarinen, N., Fridén, A., Ekström, H., Harrinkari, T., D'amato, D., & Droste, N. (2024). Forest policy in Nordic countries: Expert opinions on future needs, uncertainties, and recommendations. Trees, Forests and People, 16, 100582.

Nordic Refugee Determination: Advancing Data Science in Migration Law (NoRDASiL)

Project leader: Thomas Gammeltoft-Hansen, University of Copenhagen
Project duration: 2021-2026
Participating countries: Denmark, Norway and Sweden
Funding from NordForsk: 14,999,677
Project website: Nordic Asylum Law & Data Lab

Despite decades of legal harmonisation, the chance of receiving asylum for people from the same country or groups still varies significantly across Nordic and European countries. This has led to repeated accusations of legal decision-making as a "refugee roulette" or "asylum lottery". Based on a unique dataset and an interdisciplinary team of scholars from law, computer science and social medicine in Denmark, Norway and Sweden the NordASIL project set out to explore what determines asylum outcomes, and why decision-making patterns are so different from country to country.

Impact story

Asylum adjudication is characterised by a lack of hard evidence and decisions often hinge exclusively on the applicant's own testimony and assessment of her credibility. This places a great emphasis on asylum applicants to convince authorities about the veracity of their claim but also on the decision-makers not to succumb to flawed assumptions, bias, stereotyping, and discrimination.

"For decades legal decision-making in asylum has operated as a kind of 'human black box', which was very difficult for scholars to probe from the outside. Our dataset has opened up entirely new possibilities for empirically investigating these dynamics and point to specific areas of concern. It's been an arduous and years-long process to obtain access to this highly sensitive data, but it's paid off not only in terms of creating important new insights in the asylum field, but also opening up for much broader transfers of legal data and multiple major follow-up grants for members of our team. It's been one of the hardest projects I have ever been involved in, but potentially also the one with the most significant long-term impact," says Thomas Gammeltoft-Hansen.

Key findings

- The researchers built the first ever large-scale Nordic dataset of asylum decisions involving more than 850.000 individual case files from Denmark, Norway and Sweden. The dataset is unique in providing not only legal summaries but also information on case handling, transcripts of interviews and supplementary information such as medical reports. As such it provides the most in-depth resource for understanding and exploring legal decision-making in this area anywhere in the world, and an ideal platform for conducting comparative computational analysis of high value not only for the present but also several follow-up research projects.

- There is a rich but fragmented literature on asylum decision-making across disciplines. The dataset allowed the researchers to test many different hypotheses to validate, nuance or debunk previous findings. For example, decision-maker identity, political climate and gender dynamics have been shown to impact outcomes in other countries, but appear to play a less significant role in the Nordic context. Comparisons with data from other countries also showed that Nordic countries tend to have more coherent decision-making internally, suggesting that Nordic models with e.g. specialised panels and multiple decision-makers for the same case help even out variations.

- The project allowed the researchers to develop new, generally applicable methods for analysing large datasets of legal case files. Using deep neural networks and natural language processing we developed the best performing prediction model of asylum outcomes to date. Adapting methods from image classification similarly enabled the researchers to create word-level heatmaps in the legal decisions, thus providing an important stepping stone for implementing Explainable AI (XAI) in legal text domains.

Key outputs

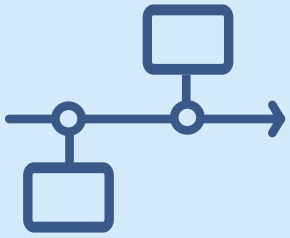
- An interdisciplinary Nordic lab and training ground for early career scholars working on AI and law, several of which have gone on to obtain competitive grants and follow-up positions.

- A testing ground for producing new knowledge and engaging interdisciplinary dialogue across law, social science, medicine, psychology and computer science from an evidence-based perspective.

- New and cutting-edge methods for computational analysis of legal decision-making that has already been applied in other legal domains and countries beyond the Nordics.

- Publications from the project: https://asylumdata.ku.dk/publications

Key Figures



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Nordic Added Value

NordForsk funded projects create Nordic added value in a number of ways. We have devised our own definition of Nordic added value to be used when developing initiatives, designing calls for proposals, assessing grant applications and reporting impact. In all, we have 11 categories of how research create Nordic added value. Read more about Nordic added value at nordforsk.org.

Reported Nordic added value from projects in the Interdisciplinary research initiative

Featured news articles

- **New textiles can make the clothing industry more sustainable**
  Many of the textiles produced today have a huge impact on the environment. Consequently, Beyond e-Textiles has now developed prototypes of what could become the sustainable textiles of tomorrow.

- **Opposites attract - or do they?**
  The Network Dynamics of Ethnic Integration has studied how Nordic citizens with a foreign background interact with each other, also when it comes to choosing a life partner. The results show that most people choose someone with the same national background.

- **Narwhal tusks are a tale with a twist**
  The narwhal's spiral tusk has annual rings, and they can reveal changes in the climate. Researchers from Narwhal tusks: A tale with a twist have just discovered that there also appear to be rings within the annual rings, which can provide even more details about living conditions in the Arctic.

- **With experience comes confidence, not necessarily safety**
  How can you make the best decision when assessing risk in hazardous environments? The research project GUESSED shows that experience isn't necessarily an advantage and can have disastrous consequences.

- **Games could teach children to speak the Nordic Languages**
  Over the past few years, many immigrant children have come to the Nordic Region. New digital games could help these children learn the Nordic languages because it's crucial that they become part of the Nordic societies, explains the project leader from Technology-enhanced foreign and second-language learning of Nordic languages (TEFLON).

- **What do pencils, Egyptian mummies and water have in common**
  New study from the research project Graphene-based drug delivery systems for treating MRSA infections (GraMI) shows that all three components contain something that together could be a future defence against antibiotic resistance.

- **Want to boost creativity? Invite a robot to join your Group**
  Social robots can be a great help to us. Especially if they are polite and have enthusiastic voices. This is according to the research project Facilitation Robotics for Teams Foundational Research on Group Processes in Human-Robot Ensembles with Social Robots (S-FACTOR), which also points to several dilemmas.

- **Central Asia was a migration corridor for the human species**
  For hundreds of thousands of years, human species have migrated across the globe. The project The timing and ecology of the human occupation of Central Asia (THOCA) has found stone tools used by early humans in Tajikistan and is looking into how our ancestors lived to understand our evolutionary past.

- **Nordic health data offers unique insight into pandemics**
  What can we learn about COVID-19 by studying the 18th-century smallpox epidemics and other past pandemics? The Nordic research project NORDEMICS have made use of Nordic health data to study pandemics from a historical perspective.

- **Nordic data can explain why the Nordic countries' asylum practices differ**
  Is it simply a lottery when the Nordic countries grant asylum? Why are the differences between the countries so significant? These are just two of the questions that Nordic Refugee Determination: Advancing Data Science in Migration Law (NoRDASiL)has tried to answer.

- **How much path lighting do we really need in urban green areas?**
  To orientate ourselves and navigate for commuting and recreation we need startlingly less path lighting than we think. NorDark has inspired wildlife-conscious outdoor lighting.

- **Policies can help minimise conflicts of interests in forestry**
  Forests are home to a rich variety of flora and fauna, and are important for climate change mitigation and a large timber industry. How do you design a forest policy that takes all these considerations into account? Finland is a pioneer
  .
- **Interdisciplinary research necessary for solving Nordic Challenges**
  Interdisciplinary research projects on everything from narwhal tusks to asylum policy and pandemic history are delivering game-changing results for the Nordics. This is the conclusion from committee head Jan Philip Solovej.

NordForsk

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