

Nordic Cooperation and Research in the Bioeconomy: A Journey Towards Sustainability

Introduction

The Nordic region, known for its pristine landscapes and environmental consciousness, had embarked on a collaborative journey to explore the vital role of water in the bioeconomy. This endeavor, led by the Nordic research funding organization Nordforsk, aimed to foster cooperation among the Nordic countries and advance the understanding of how water intersects with the bioeconomy. In this summary, we will delve into the Nordic Center of Excellence (NCoE) program initiated in 2015, the objectives, challenges, and achievements of three prominent NCoEs - BIOWATER, SUREAQUA, and NordAqua.

Nordic Center of Excellence Program

The Nordic Bioeconomy Programme was set in motion in 2015 by Nordforsk with the intention of creating a collaborative platform for Nordic countries to investigate the multifaceted role of water in the bioeconomy. The NCoE program recognized that transitioning towards a bio-based economy is a complex undertaking that requires a substantial volume of research. By pooling their expertise and resources through Nordic cooperation, researchers could share their knowledge and ideas more effectively and have a stronger voice in the EU's research and innovation program.

While the concept of the bioeconomy resonated across the Nordic nations, selecting a specific topic that would unite all participants proved to be a challenging task. Eventually, all Nordic countries except Denmark agreed to participate in the NCoE program. Funding was secured from Nordforsk, the Research Council of Norway, the Icelandic Center for Research RANNIS, FORMAS the Swedish Research Council for Environment, Agricultural Sciences, and Spatial Planning, and the Research Council of Finland, with a total budget of 90 million Norwegian Krone (€9.7 million).

The primary objective of the NCoE program was to generate fresh insights into the role of water in the bioeconomy. The common environmental characteristics of the Nordic countries, including their shared cold climate, allowed for research to be replicated and practically applied. Furthermore, the cultural similarities and compatible administrative systems facilitated flexible and effective cooperation.

Three Nordic Centers of Excellence

Out of the 30 applications received in the first phase of the NCoE program, 10 were selected to move forward to the second phase. Following rigorous evaluation by an international panel and the Bioeconomy steering group, three Nordic Centers of Excellence were chosen for funding: BIOWATER, SUREAQUA, and NordAqua. These projects, financed for a five-year period from 2017 to 2022, have

made substantial contributions to the field of the bioeconomy, with a particular emphasis on water-related aspects.

BIOWATER: Understanding the Impact of Land Use on Water

The primary focus of the NCoE BIOWATER was to investigate how the bioeconomy affects land use, water quality, and quantity. This multidisciplinary team explored the effects of the bioeconomy on material flows and water bodies, utilising extensive hydrological and water quality data and research catchment areas. The NCoE considered five potential transition paths for the bioeconomy, modelling how land use and climate change would impact Nordic waters.

The research conducted within BIOWATER led to the recommendation of the green transition path, which implies a shift towards a carbon-neutral bioeconomy society. Their findings indicated that land use has a more significant impact on water quality than climate change, and that local measures can effectively mitigate these effects while maintaining economic feasibility. Additionally, a valuation study was conducted to assess the economic significance of watershed impacts. The NCoE BIOWATER prioritizes the education of researchers through joint workshops and courses on modeling and hydrology.

The NCoE BIOWATER, comprising Nordic universities, research institutions, and both Nordic and non-Nordic non-academic partners, produced results which play a pivotal role in improving water quality and land use management in the region.

SUREAQUA: Advancing Sustainable Aquatic Production

SUREAQUA, a Nordic Center of Excellence for Sustainable and Resilient Aquatic Production, was a multi-faceted center dedicated to developing a sustainable aquatic bioeconomy in Northern Europe. The center's objectives included enhancing food security, optimizing the use of raw materials, and boosting employment in the blue bioeconomy sector while prioritising ecological, social, and economic sustainability.

With the participation of thirteen universities, research institutes, and various companies, SUREAQUA focused on various aspects of aquaculture. Noteworthy achievements included researching the utilization of brewery waste as fish feed, developing online fish health measurement technology, and exploring the potential of macroalgae cultivation. The center has also examined consumer attitudes towards algae-based food and the co-cultivation of fish, mussels, and algae as a strategy to reduce nutrient emissions from fish farming into water bodies.

SUREAQUA's remarkable results have been documented in approximately 30 scientific articles. The center's collaboration with industries and companies, including the utilisation of insects and brewery waste as fish feed, has had a substantial impact. SUREAQUA's active engagement in the training and networking of young researchers has resulted in the completion of four doctoral degrees. The center's work continues through various EU-funded projects.

NordAqua: Pioneering Nordic Algae Research

NordAqua, a Nordic Center of Excellence, constituted a network of ten Nordic universities, research institutes, industrial partners, and collaborators. It is at the forefront of research into the utilization of aquatic photosynthetic organisms for the production of chemicals, pharmaceutical products, biofuels, and more. The center primarily focused on algae-based products and the development of synthetic biology methods to create photosynthetic cell factories. The ultimate goal was to harness solar energy for various chemical and biofuel applications.

One of NordAqua's standout achievements was the establishment of the Nordic Algae Stock Collection, which strengthens the capacity and research in the field of algae in the Nordic region. The center has also developed infrastructure to facilitate year-round algae cultivation, utilizing wastewater phosphorus and nitrogen from greenhouses. Moreover, the center has explored algae cultivation in marine environments and created suitable infrastructure for this purpose.

NordAqua has actively engaged in business cooperation, particularly in areas closer to practical applications. Additionally, it has been instrumental in training and networking young researchers, resulting in the completion of sixteen doctoral degrees during the center's operation. Various courses, meetings, and workshops have been organized to foster the growth of young researchers. NordAqua's research efforts continue through multiple EU-funded projects.

Conclusions

The Nordic Centers of Excellence, including BIOWATER, SUREAQUA, and NordAqua, have made significant strides in understanding the role of water in the bioeconomy. These centers have achieved the objectives set by the program and their own research plans, with their publications demonstrating a high scientific standard. The interdisciplinary research environment established by the Nordic Bioeconomy Program has yielded substantial results despite its demanding nature. The centers have contributed a substantial amount of new knowledge, tools, and, most importantly, a cadre of young researchers who are equipped to contribute to the Nordic bioeconomies. The industrial collaborations within the NCoEs have significantly strengthened academy-industry networks in Nordic countries and beyond, with some cooperation schemes securing future funding from national and EU programs. NordForsk's new call, Green Transition, offers further funding possibilities for continued cooperation.

The success of these Nordic Centers of Excellence underscores the importance of Nordic cooperation in addressing the challenges of sustainability in the bioeconomy. As the Nordic countries continue to lead the way in this field, their research and innovation are poised to influence the broader global transition towards a sustainable bio-based economy. The collaborative efforts within these centers have not only expanded research capacity but have also led to groundbreaking findings and practical applications in various aspects of the bioeconomy, particularly in land use, aquaculture, and algae-

based products. The lessons learned from their journey towards sustainability offer valuable insights for addressing environmental and economic challenges on a broader scale, guiding the way towards a more sustainable future.