Academy Programme 2017 - 2020

Project Descriptions

ACADEMY OF FINLAND

BioFuture2025 Academy Programme promotes renewal of bioeconomy research

The Academy of Finland's BioFuture2025 Academy Programme is aimed at supporting the creation of a new knowledge base in bioeconomy research and at promoting major scientific breakthroughs through new ways of doing science. The programme seeks out the best ideas, identifies new opportunities and supports research that explores new avenues for advances in the bioeconomy field. The programme increases our understanding of the societal and environmental challenges flowing from the transition to a bioeconomy and creates a new knowledge base for the emergence of an economy founded on sustainable biobased solutions. The aim is to bring Finnish bioeconomy research to the international forefront and strengthen Finland's position as a world leader in sustainable bioeconomy.

The BioFuture2025 Academy Programme consists of ten Finnish research consortia that include a total of 29 subprojects. Projects working under the BioFuture2025 umbrella also collaborate with projects funded under NordForsk's Nordic Bioeconomy Programme.

The BioFuture2025 projects represent a wide range of research fields within the Academy Programme's two themes: *Smart biomass and high-value-added products, production technologies and services as part of the circular economy* and *Impact of societal changes, values, ethics and behaviour on the use of biobased natural resources.*

More information

www.aka.fi/biofuture2025

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NordForsk, Nordic Centre of Excellence (NCoE)
Nordic Bioeconomy Programme

Business Models of Born Globals in Forest-based Bioeconomy. *Mika Gabrielsson, University of Eastern Finland, Jouni Pykäläinen, University of Eastern Finland*

In Finland bioeconomy is very much connected to the forest sector and forest-based resources. This research challenges the traditional sector-oriented linear thinking and takes the perspective of innovative firms offering new bio-based products and solutions by utilizing novel channels to the networked global markets.

We approach the emerging bioeconomy from two perspectives: On one hand, we investigate the born-global companies that come outside of the traditional forest-sector and seek for indications of cross-sectoral business models and networks in the bioeconomy-related fields. On the other hand, we analyze established forest sector companies and their value networks which are being built around biorefineries developing new ways of utilizing opportunities from a bioeconomy. Through a comparative analysis of these two types of business actors, we aim at identifying new models of value creation and capture, which in turn may contribute to the redefinition of "forest-based resources" in the future: Instead of the accustomed measurements of cubic meters and tons in the forest-based sector, the new metrics may be molecules and substances, gigabytes of data, particles in the biosphere or changes in human blood pressure. The new ways of integrating both tangible and intangible resources, and the new ways of defining value for the customer, as well as for the society at large, are also a means to lay the foundation for next-generation bioeconomy solutions, practices, and technologies. Our aim is to identify the characteristics of successful business models of born-globals for a sustainable bioeconomy.

The research project (2017-2020) is interdisciplinary: It combines the born-globals research from the business disciplines and the natural resources based research from the forest sciences. New ways to value creation and capture are investigated with the assistance of analytic frameworks for business models. Methods include literature reviews, document analysis, in-depth case studies, including international comparisons, and a born-globals survey study in Finland. The research will produce new information on business models in an emerging bioeconomy, and it contributes to the resource based theories of the firm by extending the analytic framework towards a novel thinking about how valuable resources and capabilities can be defined in a sustainable bioeconomy.

The international research consortium consists of International Business Studies and Forest Sciences from the University of Eastern Finland, and partners from New Zealand, Sweden, and Uruguay.

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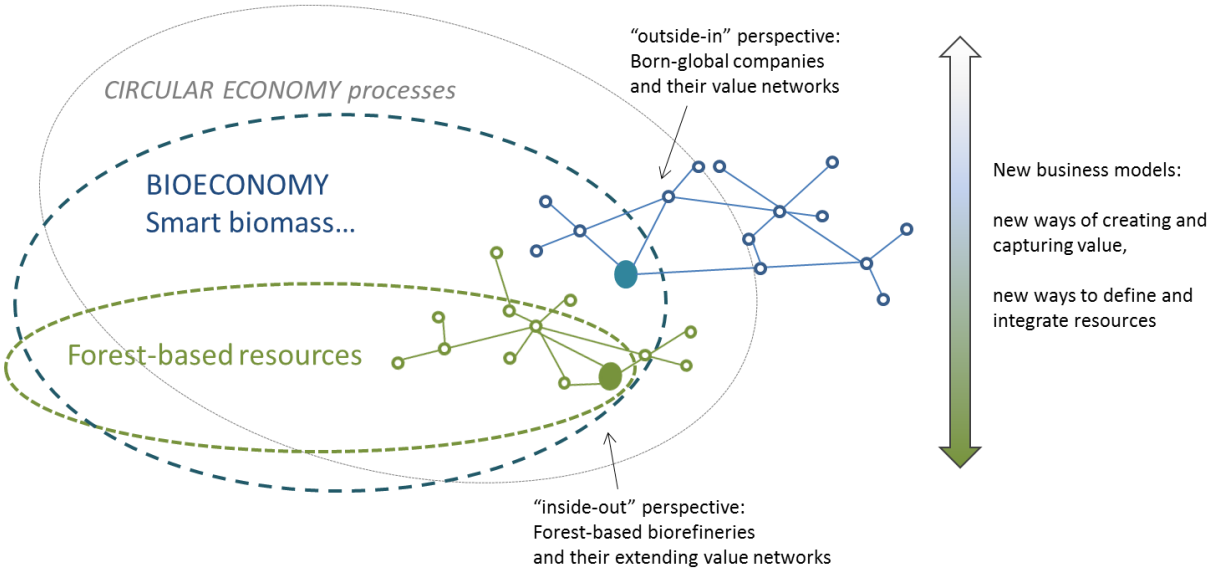

Figure: the research idea in brief

Overcoming Technology Barriers with Tailored Catalysts: Design of Molecularly Functionalized Heterogeneous Catalysts for Selective Reductions of Biomass-derived Materials. *Karoliina Honkala, University of Jyväskylä, Petri Pihko, University of Jyväskylä*

Future success in biomass-based economy requires rapid solutions for converting compounds available from biomass to value-added building blocks for materials and for the chemical industry. These rapid solutions can only be obtained by new catalytic methods. These methods need catalysts that do not yet exist.

This multidisciplinary project develops new catalysts for the processing of biomass-based raw materials. Specifically, it aims at the development of selective reduction catalysts since most of the biobased raw materials are highly oxidized, and reduction will render them more useful as building blocks.

The project focuses on the development and design of ligand-modified heterogeneous metal catalysts. The ligands are molecules that adsorb into the metal surface, modifying and amplifying the catalytic efficiency of the solid metal catalyst. In other words, the ligand molecules act as active co-catalysts. Theoretical and experimental studies are focused on co-operation of ligands and the metal, and on the effect of this cooperation on the efficiency and selectivity of reduction reactions.

The teams will bring to the project complementary expertise: The team led by Professor Honkala will focus on density functional theory calculations and the development of structure-reactivity models for the new catalysts. The group of Profrddot Pihko focuses on synthetic chemistry, including synthesis of ligands for characterization of catalysts and reactivity studies. Based on atomic-level understanding on the properties of the ligands and how they impact the activity and selectivity in studied reactions, the project seeks to obtain key descriptors to facilitate fast optimization and tailoring of catalysts for a variety of reduction reactions relevant to biomass-based raw-materials.

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Bioeconomy and Justice. *Matti Häyry, Aalto University, Markku Wilenius, University of Turku*

Background

The idea behind this research endeavour is that bioeconomy, or biobased economy, is a core future alternative to the current fossil fuel economy. In a fossil fuel economy, substances like gasoline and fuel oil are converted, by traditional methods, into energy, materials, and chemical and other products. This is seen as problematic for many sustainability- and environment-related reasons. Biobased economy, in its turn, promises to convert synthetic gas, sugars, oil, fibres, and other materials into energy, biomaterials, and chemical and other products in a more sustainable manner, by the use of emerging biotechnologies, with little or no damage to our shared social and natural environments.

Decision makers, private and public, business and political, are in a key role when the future direction of global economies is set. By making certain choices, agents promote the rise of the new age of bioeconomy; by making others, they make a renewed and possibly detrimental commitment to the prevailing economic order.

Objectives

The aim of the BioEcoJust consortium is to find out how probable a bioeconomic future is, what decisions need to be made for reaching it, who the principal decision makers are, and how their responsibility in making the crucial choices can best be described and evaluated, especially in terms of here-and-now and intergenerational justice. An integral part of the consortium's work is to make private and public decision makers aware of the consequences and responsibilities related to bioeconomic choices.

Work plan

The objectives will be met by pursuing two intertwined research strands.

Professor Markku Wilenius and his team at the University of Turku Finland Futures Centre will estimate the stage of bioeconomic development in Finland, in Europe, and globally by 2025, 2075, and 2125 in different scenarios. They will gather data by thematic expert interviews and a two-round Delphi survey. The resulting expert views will form the basis of scenarios for assessment and elaboration in Futures Cliniques workshops. Expert scenarios will then be turned into action scenarios and visions for the future of bioeconomy and its alternatives.

Professor Matti Häyry and his team at the Aalto University School of Business will, based on the work of the futures studies team, identify the decisions and agents who are judged to be causally responsible for choices on bioeconomy. By using the core philosophical methods of explication and interpretation, they will list the conditions on which causal responsibility can be seen to imply moral responsibility, and present the implications that this has on the justice of the choices made. A comparison to pre-set (e.g. Finnish governmental) views will yield normative recommendations.

To disseminate the results, the consortium will organise academic meetings; general lectures; panels with the Parliamentary Committee for the Future, with members of the parliament; and a seminar with the Standing Committee for Foresight in the Prime Minister's Office.

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Taking the Leap across the Rationale Gap: the Role of Emotions in Making the Transition to More Sustainable Materials. *Teemu Kautonen, Aalto University, Henri Hakala, University of Vaasa, Katariina Salmela-Aro, University of Jyväskylä*

The objective of Finland's national bioeconomy strategy is to facilitate economic growth and to create new jobs in bioeconomy-based business. Next to technological knowhow and willingness to innovate, firms aspiring to transition to more sustainable materials and technologies need the ability to identify new business opportunities. Courage and commitment to persevere in seizing these uncertain opportunities, and tolerating the uncertainty and the possibility of failure in pursuing them, are equally important. Therefore, the decision to transition to the bioeconomy involves both rational and emotional elements.

Economic cost and profitability considerations are often perceived as key motivators behind strategic business decisions. Business decision makers aspire to make – at least in their own opinion – rational decisions to secure the success and continuity of the company. Prior research also talks about 'rationalisation' of uncertainty by using different decision-making tools.

Furthermore, research tells us that also emotions affect decision making, implying that human decisions cannot be understood only by viewing them through a rational lens. Although both rational and emotional aspects of decision making have been examined in many studies, few research efforts have been dedicated to examining their interplay in the business context.

The objective of this project is to generate an understanding of the rational and emotional aspects of decision making in relation to transitions towards more sustainable, bio-based materials. In particular, the project focuses on investigating how emotions support, hinder, and perhaps override rational considerations in decision-making situations involving considerable degrees of uncertainty, such as in transitions to new materials and technologies.

The project is conducted in close collaboration between three universities. The project leaders are Teemu Kautonen (Aalto University, Entrepreneurship), Henri Hakala (University of Vaasa, Management), and Katariina Salmela-Aro (University of Jyväskylä, Psychology). The project also involves international partners from Singapore, Switzerland, and USA.

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The New Road to Silk: Bio-based Production of Silk-like Materials. *Markus Linder, Aalto University, Kirsi Niinimäki, Aalto University, Heikki Tenhu, University of Helsinki*

Biological materials are a fascinating study area for two main reasons: (1) biological materials provide a route towards a sustainable use of raw materials and overall reduced environmental burden, (2) in addition to being environmental friendly, biological materials often show very impressive functional properties. The ultimate goal is to combine these two concepts, leading to sustainable materials with impressive functional properties.

One such type of natural material that could find widespread use is the silk-like material produced by spiders. It has impressive properties because it is an extremely tough and elastic but also light material. Furthermore, different types of silk have different properties depending on their molecular level compositions. Unfortunately, we cannot expect to be able to use spiders for a large-scale production of this type of material. One of the most attractive promises of biotechnology is that this obstacle could be overcome by producing spider silk by microbes at a very large scale in reactors in factories. Because silk is a protein based material this approach is feasible, but it requires that the genetic information coding silk proteins are transferred to microbes, and that these are optimized for efficient production. Currently, a significant challenge is to turn the silk proteins that have been produced by microbes into the right form so that they can be used as a material. In order to achieve these goals, the NEWSILK project combines the knowledge of production of silk proteins with skills in polymer processing. Also, it involves a designers' creative perspective to explore new uses of such materials and to efficiently communicate the research results and process. It can be expected, that in the future we will be able to make new types of materials as inspired by how spiders make their silk, enabling sustainable use and consumption and with properties that surpass what we currently are able to achieve.

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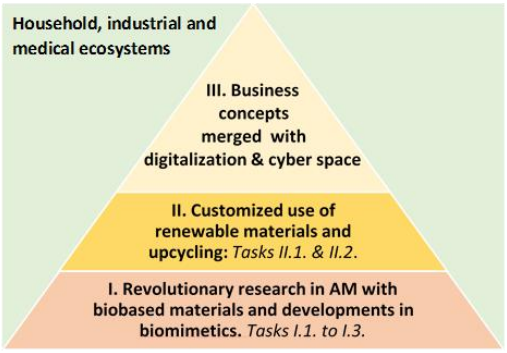
3D-manufacturing of Novel Biomaterials. *Jukka Seppälä, Aalto University, Jouni Partanen, Aalto University, Orlando Rojas, Aalto University*

Industrial biorefineries are in great role in implementing national bioeconomy strategy and promoting the development towards renewable resource utilization. The grand challenge in biorefining is the full utilization of biomass into high value-added products. In our *3D-Biomat* project, we will provide valorization pathways to overcome this gap. Our project combines the bioeconomy with the megatrend of digitalization via research and development of novel biomaterials with digital design and advanced 3D-additive manufacturing techniques including production value chains and business models. This production route will offer revolutionary pathways for biorefining and enable novel distributed, local and small to medium scale production opportunities. The *3D-Biomat* route will also promote the circular bioeconomy.

The *3D-Biomat* research is divided to three thrust areas covering (I) fundamental research of polymeric biomaterials, (II) use of the materials developed and, (III) creation of business and cyber/digitalization concepts, each having their respective main objectives and specific hypotheses. We will achieve dramatically new material concepts and production value chains by combining novel biomaterials with the fast-developing 3D-additive manufacturing technologies. Materials and technology research meet in this integrated approach and in consideration of the relevant ecosystem, from household to industrial environments.



Our project merges together three renowned research lines in a complementary way: Prof. Seppälä group's excellent background in polymer synthesis especially in biopolymer synthesis and functionalization; Prof. Rojas group's internationally recognized lignocellulose chemistry and engineering towards plant derived hierarchical materials; and Prof. Partanen group's world-leading research in additive manufacturing (AM), especially in high resolution stereolithographic. The 3D-Biomat consortium covers research of the whole value chain: from digital product design, to novel material and production technologies as well as demonstration of the products. Our focus is on converting digital information to design and individualized high performance products.

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Genomic Selection: Towards more Efficient, Financially Viable and Resilient Wood Production. *Teemu Teeri, University of Helsinki, Fred Asiegbu, University of Helsinki, Katri Kärkkäinen, Natural Resources Institute Finland, Outi Savolainen, University of Oulu*

Bioeconomy aims at a society that strongly relies on renewable biological sources, while achieving economic growth efficiently and sustainably. In Finland, forest industry has a key role in bioeconomy. Demand for wood will be increasing, as well as demand for tailor-made trees with specific chemical and physical wood characteristics. In the near future, climate change and associated natural disturbances (pests, pathogens, changing length of growing season and associated frost damage) may negatively affect the productivity of forests. Increased wood production must further be combined with ecological and societal demands for biodiversity and multiple uses of forests. These demands put pressure to radically enhance and speed up forest tree breeding.

Our goal in the project is to utilize novel genomic and phenotyping methods and examine the feasibility of conducting genomic selection in Nordic conifer species. The proposed research makes use of unique resources for Scots pine that have been developed in Finland during decades of research in forest tree genetics, breeding and biotechnology. Our project brings together research groups with complementary skills in molecular biology, population genetics and breeding, forest pathology, and economics.

Tree populations have large variation in many adaptive and economically important characteristics, enabling tree breeding based on natural genetic variation. Changes in the environment and in the use of wood put pressure to include new traits in breeding programs. On one hand, resilience of trees against changing climate and resistance against pests and pathogens must be included in the programs. On the other hand, forest industry demands more uniform and specific chemical and physical characteristics of wood that can be tailored by tree breeding.

Profitability of commercial forestry is strongly influenced by the rate of volume production, which, in turn, can effectively be increased by breeding. Traditional tree breeding is highly profitable (improved material shows up to 24% increase in growth) but is time and resource demanding. As the breeding cycle may take 40 years in Scots pine, methods accelerating breeding are clearly needed. Many new traits are being investigated that could be added to breeding programs and new ones will be investigated as bioeconomy proceeds. In addition to financial gains, the societal impact of breeding is becoming increasingly important.

Genomic tools are increasingly being used for breeding both animals and plants. Genomic selection uses genomewide markers to predict phenotypes. It is an especially useful method for breeding traits with complex, polygenic inheritance. In this project, we will utilize novel genomic and phenotyping methods and examine the feasibility of conducting genomic selection in Scots pine. More specifically, we will study phenotypic and genetic variation of the most relevant traits (growth, growth rhythm, disease and decay resistance, and wood quality), try to discover genes affecting the traits, generate large genotyping resources, conduct association analyses between traits and candidate genes and, finally, examine conducting genomic selection in southern Finnish breeding population.

We will further analyze the economic (financial gains) and societal outcome (carbon balance) of present and future breeding for volume production (growth) and quality (decay resistant timber as an example).

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Orchestrating Sustainable User-driven Bioeconomy: Policy, Transformation and Benefits. *Anne Toppinen, University of Helsinki, Lassi Linnanen, Lappeenranta University of Technology, Markku Ollikainen, University of Helsinki*

Competitive bioeconomy needs to encompass both tangible component associated with bio-resources, but also intangible component in terms of ability to produce and process knowledge to ensure adaptation in the changing global economic context and sustainability challenges. From this view, there is a need to identify sustainable business strategies and practices of bioeconomy networks in Finland and globally, and throughout this, enhance renewal of the smart, sustainable business to create sustainability leadership and to secure competitiveness and consumer acceptance in the international markets.

The overall purpose of this project is to orchestrate research on end-user driven systemic development and promote growth of sustainable and diversified forest-based bioeconomy with the research agenda organized under four work packages (WP)s, which focus on: 1) Grand societal challenges and related policy drivers, 2) Changing consumer behavior and consumer-driven business models, 3) Bioeconomy industry transition and business networks, 4) Orchestrating user-driven sustainable forest-based bioeconomy. With the share of forest sector as high as 50% in national bioeconomy output in Finland, our core focus is placed on the forest-based bioeconomy. However, with sectoral boundaries blurring in the bioeconomy via policy drivers and substitution effects in the markets, new forms of competition and co-operation emerge between established and new business actors from, e.g, forest, chemical, food, biotechnical and construction sectors. Thus, our research is highly relevant on the interlinkages across a range of renewable and non-renewable resource-based activities within society, contributing to making Finland's position a world leader in the sustainable bioeconomy. The result is a game-changing bioeconomy strategy, which outlines how the traditional bulk-producing forest sector will expand increasingly to consumer markets with high value-added biomaterial-based products.

To meet empirical targets of four WPs, the analysis is narrowed down to groups of relevant case-products with very different characteristics and positioned at different levels of forest bioeconomy value-pyramid: a) lignocellulose-based materials/chemicals driven from tall oil (highest value-added level); b) biomaterials for packaging use based on pulp or recycled fiber, c) new uses of wood in the multi-story construction (bottom level). ORBIT project team is highly multidisciplinary and via its international collaboration brings together leading experts from forest sciences, environmental economics, consumer science, sustainability management, strategy research and futures studies. The common denominator is the combination of both quantitative economic and statistical econometric modelling and a range of qualitative methods to the topical problems of industry and consumer behavior and by addressing the means of policy measures. We also use various and largely participatory futures research methodology tools as a cross-cutting approach. As a result of this, an evolutionary and systemic view on possible future developmental pathways is built together with providing information on the related bottlenecks that may influence to this development.

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Natural Secreted Nano Vesicles as a Source of Novel Biomass Products for Circular Economy. *Seppo Vainio, University of Oulu, Henrikki Liimatainen, University of Oulu, Tuukka Petäjä, University of Helsinki, Raija Tahvonen, Natural Resources Institute Finland*

This Bio Future 2025 project targets the nano- and micro vesicles that are called collectively here as the exosomes. The exosomes represent a new humoral, systemic layer that controls homeostasis. Since the exosomes are around the size of viruses and that they are also present in saliva, the exosomes may function as a novel bio aerosol class. The exosomes transmit various types of relevant cellular biomolecules such as proteins, RNA/DNA and the metabolites. Due to these reasons the exosomes may offer openings to target (biological) drugs, image tissues and organs in *vivo* and ways to develop even non-invasive surgery therapies at the end. The exosomes can be expected to offer fundamental opportunities for disease diagnostics. Individual exosomes may themselves serve as biological drugs when produced in mass quantities for medical practise. In summary the exosomes offer important opportunities to develop significant bio economically valuable products.

In the project we will enrich exosomes from the air, milk and certain other biological fluids. We will define the composition of the exosomes, their nucleic acids and proteins. We will develop better ways to purify the exosomes and to methods to define their molecular signatures. With the identified molecular tools we aim to enrich specific types of exosomes. We will then use the enriched exosomes in assays to learn more about their cellular functions and mechanisms of action. We will use nano level filters to analyse air and to study if the exosomes may serve as a novel way to characterize quality of air. We will develop technologies to enrich and characterize exosomes from milk. We will go on to target the roles of the milk-derived exosomes in wealth in defined model assay systems. The aim is to reveal the mode of their cellular entry and roles in metabolic control. Moreover we will study how nutrition may reflect to the composition of the exosomes and quality of milk and if the milk offers ways to obtain large amounts of exosomes and to generate custom made exosomes for the different sectors of bio economy. Form the obtained data sets we will generate a data bank.

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Transforming Waste into New Antibiotics. *Jari Yli-Kauhaluoma, University of Helsinki, Merja Hannele Kontro, University of Helsinki, Jouko Peltonen, Åbo Akademi University*

Background

Antimicrobial resistance constitutes a major global threat for public health and the associated costs are both economical and societal. Infections caused by resistant and antibiotic-tolerant bacteria, such as those mediated by the opportunistic biofilm forming *Pseudomonas aeruginosa*, are alarmingly rising and increasingly dependent on the use of last-resort drugs, such as colistin. Moreover, the multidrug-resistant, biofilm-forming *Staphylococcus aureus*, the causative species of hospital-associated infections, is of especially serious concern. Despite the recognized and urgent need for new antimicrobial compounds for clinical use, only two new classes of antibiotics have been brought to market in the last 30 years.

Following the same logic as in our previous work on natural compounds, we believe that potent antimicrobial compounds have evolved in bacteria of waste/wastewater treatment processes, similar to antibiotics that are the most effective against single-cell bacteria and enzymes decomposing biofilm structure. Despite their marked microbial diversity, these sources have not been explored for their antimicrobial potency before. Many important bacteria in these processes produce antibiotics and matrix-degrading compounds. However, access to these microbes has been limited by the fact that 99% of environmental bacteria are not cultivable under laboratory conditions.

The “uncultivable” microbial majority is regarded as our planet’s largest unexplored pool of biological and chemical novelty. The recent breakthrough discovery of teixobactin, a very potent antibiotic isolated from previously unculturable soil bacteria, has inspired new research on the relevance of resurrecting the exploration of environmental sources for the discovery of new antibiotics. The key issue in facilitating the culture of soil bacteria was the fact that the culturing was made *in situ* with help of a microwell array. We propose to take similar approach by developing clever microsystems, namely biofilm sensors that can be used for monitoring the antimicrobial activity *in situ* and microfluidic arrays for isolation of bacterial cells.

Objectives

We investigate low-value waste/wastewater treatment processes as unprecedented sources of antibiotics against biofilm-forming *Staphylococcus aureus* and *Pseudomonas aeruginosa* as well as their drug-resistant strains, by using advanced anti-biofilm and microsystems technologies.

Research methods

- Molecular methods are used to find suitable sites for biofilm sensors, to identify the enzyme-producing and biofilm-degrading bacteria as well as to evaluate risk associated with antibiotic resistance in the waste/wastewater treatment processes.
- Chemical synthesis is used to create a library of new anti-biofilm compounds mimicking those produced by the identified bacteria but with improved potency.

- Selected lead compounds are critically assessed via functional characterization for their anti-biofilm and matrix-degrading effects.
- Flexible cellulose-based printed platforms as substrates for biofilm sensors to facilitate screening of biofilm or matrix-degrading compounds at active waste process sites.
- New microsystems are designed for “domestication” of the previously unculturable antibiotics-producing bacteria from waste process sites.

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NordForsk, Nordic Centre of Excellence (NCoE)
Nordic Bioeconomy Programme

An Integrating Nexus of Land and Water Management for a Sustainable Nordic Bioeconomy (BIOWATER). *Project manager: Per Stålnacke, Norwegian Institute for Bioeconomy Research (Norway). Finnish project leaders: Seppo Hellsten, Finnish Environment Institute, Bjørn Kløve, University of Oulu, Artti Juutinen, Natural Resources Institute Finland*

BIOWATER will serve as the first Nordic science center and platform that provides solutions for land, environmental and water resources management in the face of potential and competing demands for biomass, land and water resources related to the green shift and concurrent bioeconomic development. BIOWATER consists of 8 Nordic partners and 5 non-Nordic external collaborating research institutions, and includes 19 stakeholder representatives across countries and relevant sectors. From the onset, we bring together scientists and stakeholders for optimal interaction and exchange where e.g., contrasting scenarios for bioeconomic development will be jointly developed. Potential impacts of land use change and climate change on water, elemental cycles and ecosystem services will be assessed from data-rich, experimental sites and intensively monitored catchments and up-scaled to larger river basins and Nordic regions. Assessment of the opportunities and limitations for a green bioeconomy in the Nordic countries (stakeholder integration, policy instruments and governance models considerations) will be based on the scenario outcomes from elemental budgets and ecosystem service accounting exercises. The center will interact with policy makers and stakeholders on the opportunities and limitations of the green, bioeconomic shift for the rural North.

BIOWATER gathers a critical mass of prominent Nordic scientists jointly covering a wide range of scientific disciplines, especially around freshwater catchment processes, ecosystem functions and ecosystem services. BIOWATER will provide an integrated understanding of how land use and climate changes will influence water resources including water quality and ecosystem services dependent on water flows. By evaluating the impact of various land use scenarios and options on hydrology, biogeochemistry, inland water quality, ecology, ecosystem services, as well as socio-economic costs and benefits, BIOWATER will strengthen the available knowledge base to identify the window of opportunities for sustainable bioeconomic development in the Nordic countries. BIOWATER has a clear goal and workplan to provide the input needed for future policies and actions related to these subjects. BIOWATER will have a long-lasting effect on Nordic water research in the bioeconomy context by linking key research institutes and scientists and by developing a program of doctoral education cooperation, in addition to the end-user involvement from the onset of the Centre. This will provide opportunities for collaboration between experienced researchers as well as form a platform for post-doctoral and other young researchers.

Finnish partners in BIOWATER are University of Oulu, Finnish Environment Institute (SYKE) and Natural Resources Institute Finland (Luke). In Finland, the planned two PhD thesis works at University of Oulu, in research units of Water Resources and Environmental Engineering (professor Klöve) and Ecology & Genetics (professor Muotka), will be related to studies on water related impacts of peatland use on future bioeconomy.

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Nordic Centre for Sustainable and Resilient Aquatic Production (SUREAQUA). *Project manager: Fiona Provan, International Research Institute of Stavanger (Norja). Finnish project leader: Mikko Kolehmainen, University of Eastern Finland*

Nordic Centre for Sustainable and Resilient Aquatic Production (SUREAQUA) is multidisciplinary center which will provide competence, innovation and technology to ensure sustainability and resilience in aquatic and associated land-based value chains, to ultimately advance the bioeconomy transition in the Nordic region. SUREAQUA aims to make significant contributions to food and nutrient security, employment and efficient use of resources, in the context of forecasted global changes.

The center is led by Fiona Provan International Research Institute of Stavanger. The consortium composes of several research institutions, namely IRIS (NO), NMBU (NO), NOFIMA (NO), SNF-NHH (NO), UiS (NO), DTU Aqua (DK), DTU Nanotech (DK), UGOT (S), UEF (FI), Fiskaaling (FO), RORUM ehf (IS), UoI (IS) and ECEHH (UK). The center is also an important opening for the strategic emerging research area *Aquatic Research in Changing World* in the University of Eastern Finland (UEF), creating a novel multidisciplinary network and platform for larger European level research co-operation and funding. The direct UEF-contribution to the center is by three research groups at the Department of Environmental and Biological Sciences, led by Mikko Kolehmainen, Raine Kortet and Amit Bhatnagar.

More detailed information can be found at:
https://www.nordforsk.org/en/programmes-and-projects/projects/nordic-centre-for-sustainable-and-resilient-aquatic-production-sureaqua

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Towards versatility of aquatic production platforms: unlocking the value of Nordic bioresources. *Project manager: Eva-Mari Aro, University of Turku (Finland). Finnish project leaders: Kaarina Sivonen, University of Helsinki, Merja Penttilä, VTT Technical Research Centre of Finland, Pirjo Mattila, Natural Resources Institute Finland*

The new Nordic Centre of Excellence "Towards versatility of aquatic production platforms: unlocking the value of Nordic bioresources" (NordAqua), led by Academy Professor Eva-Mari Aro, focuses on blue bioeconomy, i.e. on bioeconomy that is directly linked to water. The NordAqua project combines internationally highly ranked basic research into applied research and aims at developing commercial applications from micro- and macroalgae.

Beside the traditional green bioeconomy, which focuses on forests and agriculture, the blue bioeconomy is also getting more and more highlighted at both the national and global levels. Blue bioeconomy focuses on versatile and sustainable utilization of aquatic resources. Nordic countries, which are particularly rich in aquatic resources, have special expertise and interest to develop blue bioeconomy. The NordAqua project focuses on algae which have been acclimated to Nordic conditions, for example to low growth temperatures. The project will address the optimization of algae growth for biomass, as well as for the production of high-value products (pharmaceuticals, cosmetics, chemicals for industry etc). In the long-term, the NordAqua project aims at development of cyanobacterial-based "living factories" for the production of specific chemicals and fuels.

The Molecular Plant Biology Unit of the University of Turku is responsible for the NordAqua project leadership. Also entrepreneurship researchers from the Turku School of Economics are involved in the project. Other Finnish partners are the University of Helsinki, VTT (Technical Research Centre of Finland Ltd) and Natural Resources Institute Finland (LUKE). Swedish partners of NordAqua include the Umeå University and the Uppsala University. The Norwegian partners of NordAqua come from the University of Bergen, Norwegian Institute of Bioeconomy Research (NIBIO), Norwegian Institute for Water Research (NIVA) and the SINTEF Fisheries and Aquaculture. Furthermore, NordAqua has several industrial and societal partners within the field of bioeconomy.

The NordAqua partners from each participating country have established vast local algae culture collections. These, together with related datasets, will be merged into one comprehensive open database, which will be available also for commercial use. The NordAqua project will perform pilot scale experiments on algae growth in wastewater and in glass houses. The project will also focus on identification, and extraction of algal bioactive compounds and on enhancement of their concentration by various environmental treatments as well as by utilization of synthetic biology tools.

NordAqua project will encourage researchers from academia and industry R&Ds for innovative and broad-minded thinking concerning algae and their commercial utilization. The planned NordAqua courses and other education thus emphasize entrepreneurship. Networking of researchers within the field of blue bioeconomy will be fostered, and one specific aim is to encourage particularly early-career stage PIs for common projects and funding applications. As to the societal aims, NordAqua project will provoke discussion with all stakeholders and improve general awareness about blue bioeconomy, providing education for example to biology teachers.

Further information: NordAqua project leader, Academy Professor Eva-Mari Aro (evaaro@utu.fi)

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