Final report for Centre of Advanced Research (CAR)

The report should not exceed 4500 words (including words in the template).

1. Project title:	Centre of Advanced Research on Environmental Services from Nordic Forest Ecosystems (CAR-ES)
2. Reporting year:	2016-2021 (one-year extension for the funding period was granted due to COVID-19)

3. Project coordinator:	Raija Laiho
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Activity report

4. Provide a project summary, including:

a) The purpose of the project/main problems /hypothesis addressed

The operational aims for the networking within CAR-ES were to:
Provide a platform for interdisciplinary communication in Nordic and Baltic countries;
Integrate and share knowledge on ES;
Coordinate research, i.e. reduce overlap, improve the comparability of complementary national research, and contribute to national research agendas;
Share scientific tools, methodologies and data;
Identify hot issues requiring urgent scientific response, and initiate new research projects at the Nordic-Baltic scale and at the European scale with a strong Nordic-Baltic component.

CAR-ES work focused on four environmental ecosystem services or "environmental services" (ES) (Fig. 1): Carbon (C) sequestration, functional diversity, water quality, and soil quality. The activities were further divided into four focus areas that are important for the future provisioning of ES in the Nordic-Baltic region: A) the impacts of forest management, mainly silvicultural operations; B) the impacts of intensified harvesting caused by increased use of bioenergy; C) the impacts of land-use changes, such as afforestation and deforestation, and D) the impacts of and to climate.

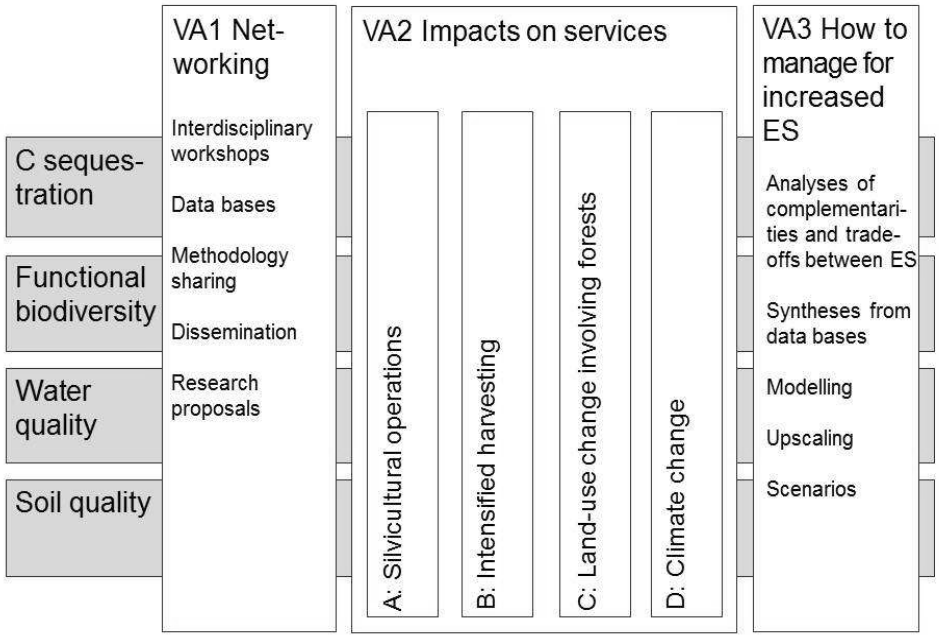

Fig. 1. Thematic structure of the CAR-ES III.

b) A short description of the main activities of the project

CAR-ES activities were based on active national, joint, and wider collaborative international research, network meetings, and e-mail communication. CAR-ES partners were active in initiating international proposals and resulting spin-off projects including SNS, H2020, Life and INTERREG projects. Also, important national projects were presented to the network, and national work was linked as much as possible. The progress of all research was reported in the network meetings, where joint interests were identified and coordinated efforts initiated. Network meetings were thus integral for CAR-ES, even though much of the communication in general took place via e-mail and in short online meetings. All network meetings included an open seminar or conference as well as sessions for network management issues. Activities included project-based dissemination at different levels, e.g., production of training materials (Other outputs) and training of forestry professionals. Review and synthesis papers were compiled on several key issues and methodological comparisons were done (*5. Published outputs*, marked with *). According to the original research plan, SNS funds were mainly used to networking, i.e., travel and meeting costs, and when possible, to initiate or finalize relevant research, including publication. The actual research was done within the partners' portfolio of experiments and externally-funded research projects.

c) Achieved targets and to what extent the research plan was fulfilled

CAR-ES successfully provided a platform for communicating, coordinating, and synthesizing forest ecological research aiming to support sustainability development within forestry. The open scientific events were of interest also for a wider global research community, as shown in *9. Number of participants*. CAR-ES was integral for forming consortia with a strong Nordic-Baltic perspective, providing research benefits for the whole region. Also, national research projects received strong support from methodological discussions and sharing data, experiences, and ideas. Several regional data or metadata bases were compiled and utilized.

Concerning C sequestration, we collated as planned all relevant data from drained organic forest soils in the region and beyond in a data base and prepared a synthesis (still unpublished; we will inform SNS when ready) as well as recommendations for future work (Jauhiainen et al. 2019; *5. Published outputs*). The work on organic soils, that are the soil-C hotspots of the region, continues in the Life OrgBalt project (*6. Other practical inputs*). SUSI Peatland Simulator was published, and further developed to project the different C fluxes taking place in forests on organic soils. Moreover, we worked in national and bilateral projects on the impacts of afforestation, e.g., YASSO15 simulation of SOC stocks following cropland afforestation, supporting focus area C., and C fluxes in forests on mineral soils, supporting focus area A.

Concerning functional diversity, we collated information on the status of research in the Nordic-Baltic region for an overall view on the different groups working on relevant topics in forest ecosystems, methodologies used, and soil communities targeted. The field is evolving rapidly along with methodological advances, but we found that there are still relatively few published data that could be used for preparing a synthesis on the effects on forest soil functions. Specific studies supported focus area D (e.g., Holmstrup et al. 2018).

Concerning water quality, work on buffer zones that was started in CAR-ES II was finished as planned (Ring et al. 2017). Extensive effort was channeled via Interreg project WAMBAF and national projects to providing tools for authorities and planners, forest owners, forest enterprises, and other interested parties to better manage drainage systems, riparian forests, and beaver activity in forests, and in doing so to keep clean waters flowing from forests to the Baltic Sea. This involved preparing guidance reports and educational films in different languages (English versions available at https://www.skogsstyrelsen.se/en/wambaf/) as well as training events and field excursions to demonstration areas.

Concerning soil quality, application of varying and often incompatible soil analysis methods generally hinders synthesis work. Accordingly, CAR-ES work included evaluation of different methodological options and resulting recommendations (e.g., Callesen et al. 2019). Further, soil quality was targeted within focus area B. (below).

Within focus area A., much effort has been put into evaluating the impacts of different silvicultural operations on C fluxes and soil C balance in forests on drained organic soils. We found that data so far published do not provide much information on operation impacts (Jauhiainen et al. 2019). First results are emerging from national studies and Life OrgBalt project, but longer-term monitoring is needed for a reliable synthesis. Work on ash recycling that was started within CAR-ES was continued by the SNS/EFINORD network NORDASH.

Within focus area B., an extensive meta-analysis on the impacts of intensified harvesting on forest soils was prepared (Clarke et al. 2021). This showed that intensified harvesting leads to greater reductions in nutrient concentrations, soil organic C and total N in forest soil, compared with stem-only harvesting in northern temperate and boreal forest ecosystems. The responses further generally depended on growing-season temperature and precipitation. The effects generally disappeared with time but were likely to last for several decades. Additionally, conferences and workshops with comprehensive participation, also by stakeholders, were arranged within this area, and a special issue was published in Energy, Sustainability, and Society (*6. Other practical outputs*).

Within focus area C., work on afforestation impacts was most intensive in Denmark, but was carried out in

cooperation with a project partner in Norway. The work revealed legacy effects of former agricultural management on the change in SOC stocks after afforestation. The work will be finished after the CAR-ES period. Fact Sheet 3 was published to synthesize afforestation effects on SOC in Northern Europe (*6. Other practical inputs*). Within focus area D., much of the work took place in projects utilizing a geothermal warming gradient in Iceland (e.g., Maljanen et al. 2017, 2018, 2020; Poeplau et al. 2020). The work is still on-going in the Future Arctic project, and synthesis work will follow after the CAR-ES period.
Modeling work within the CAR-ES core group concentrated on what has been the most urgently lacking: an ecosystem model operating on forests on organic soils, where the high soil water-table level, and the consequent soil anoxia, is a major constraint for all soil processes and, consequently the whole ecosystem functioning. This work was carried on from an earlier funding period when the model was called FEMMA and the main focus was on understanding the impacts of ditch network maintenance. The updated version called SUSI can promote sustainable peatland management and help in avoiding unnecessary drainage operations and associated environmental effects, such as increased carbon emissions, peat subsidence, and nutrient leaching (Laurén et al. 2021, Forests 12(3), 293; https://doi.org/10.3390/f12030293). The source code is publicly available, and the modular structure allows model extension to, e.g., cost–benefit analyses and nutrient export to water courses.

5. Published outputs achieved as a consequence of the project (peer-reviewed articles, other publications)

More publications can be found in the annual reports. Peer-reviewed outputs included, e.g.:

*Clarke N, Kiær LP, Kjønaas OJ, Bárcena TG, Vesterdal L, Stupak I, Finér L, Jacobson S, Armolaitis K, Lazdina D, Stefánsdóttir HM, Sigurdsson BD (2021) Effects of intensive biomass harvesting on forest soils in the Nordic countries and the UK: A meta-analysis. Forest Ecology and Management 482, 118877.

* Kjønaas OJ, Bárcena TG, Hylen G, Nordbakken J-F, Økland T (2021) Boreal tree species change as a climate mitigation strategy: impact on ecosystem C and N stocks and soil nutrient levels. Ecosphere 12, e03826.

*Stupak I, Smith CT, Clarke N (2021) Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes. Energy, Sustainability and Society 11(1), 12 (correction in 18).

*Titus BD, Brown K, Helmisaari H-S, Vanguelova E, Stupak I, Evans A, Clarke N, Guidi C, Bruckman VJ, Varnagiryte-Kabasinskiene I, Armolaitis K, de Vries W, Hirai K, Kaarakka L, Hogg K, Reece P (2021) Sustainable forest biomass: a review of current residue harvesting guidelines. Energy, Sustainability and Society 11(1), 10.

Kriiska K, Lõhmus K, Frey J, Asi E, Kabral N, Napa Ü, Ostonen I (2021) The dynamics of mass loss and nutrient release of decomposing fine roots, needle litter and standard substrates in hemiboreal coniferous forests. Frontiers in Forests and Global Change 4, 686468.

Heiðarsson L, Sigurdsson BD, Davíðsson BÖ, Hrafnkelsdóttir B, Sigurgeirsson A, Skúlason B, Vest MD, Halldorsson G (2020) The effect of the pine woolly aphid (*Pineus pini*) on survival, growth and natural selection in Scots pine (*Pinus sylvestris*) in Iceland. Agricultural and Forest Entomology 22: 146-156.

Poeplau C, Sigurðsson P, Sigurdsson BD (2020) Depletion of soil carbon and aggregation after strong warming of a subarctic Andosol under forest and grassland cover. Soil 6: 115-129.

Baldvinsdóttir G, Jónsdóttir S, Sigurdsson BD (2020) Impact of different stocking densities of sheep on establishing stands of *Larix sibirica* in Iceland. Icelandic Agricultural Sciences 33: 89-101.

Maljanen M, Yli-Moijala H, Sigurdsson BD, Biasi C (2020) Stable isotope method reveals the role of abiotic source of carbon dioxide efflux from geothermally warmed soil in southern Iceland. Icelandic Agricultural Sciences 33:41-56.

Zhang J, Ekblad A, Sigurdsson BD, Wallander H (2020) The influence of soil warming on organic carbon sequestration of arbuscular mycorrhizal fungi in a sub-arctic grassland. Soil Biology & Biochemistry 147; 107826.

Kutcherov D, Slotsbo S, Sigurdsson BD, Leblans NIW, Berg MP, Ellers J, Mariën J, Holmstrup M (2020) Temperature responses in a subarctic springtail from two geothermally warmed habitats. Pedobiologia 78, 150606.

*Callesen I, Clarke N, Lazdinš A, Varnagiryte-Kabasinskiene I, Raulund-Rasmussen K (2019) Nutrient release capability in Nordic and Baltic forest soils determined by dilute nitric acid extraction – Relationships with indicators for soil quality, pH and sustainable forest management. Ecological Indicators 96: 540-547.

*Jauhiainen J, Alm J, Bjarnadottir B, Callesen I, Christiansen JR, Clarke N, Dalsgaard L, He H, Jordan S, Kazanavičiūtė V, Klemedtsson L, Lauren A, Lazdins A, Lehtonen A, Lohila A, Lupikis A, Mander Ü, Minkkinen K, Kasimir Å, Olsson M, Ojanen P, Óskarsson H, Sigurdsson BD, Søgaard G, Soosaar K, Vesterdal L, Laiho R (2019) Greenhouse gas exchange data from drained organic forest soils – a review of current approaches and recommendations for future research. Biogeosciences 16: 4687-4703.

*Parts K, Tedersoo L, Schindlbacher A, Sigurdsson BD, Leblans NIW, Oddsdottir ES, Borken W, Ostonen I (2019) Acclimation of fine root systems to soil warming: Comparison of an experimental setup and a natural soil temperature gradient. Ecosystems 22: 457–472.

Holmstrup M, Ehlers BK, Slotsbo S, Ilieva-Makulec K, Sigurdsson BD, Leblans NIW, Ellers J, Berg MP (2018) Functional diversity of Collembola is reduced in soils subjected to short-term, but not long-term, geothermal warming. Functional Ecology 32: 1304–1316.

Maljanen M, Bhattarai HR, Biasi C, Sigurdsson BD (2018) The effect of geothermal soil warming on the production of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitric oxide (NO) and nitrous acid (HONO) from forest soil in southern Iceland. Icelandic Agricultural Sciences 31: 11-22.

Marañón-Jiménez S, Soong JL, Leblans NIW, Sigurdsson BD, Peñuelas J, Richter A, Asensio D, Fransen E, Janssens IA (2018) Geothermally warmed soils reveal persistent increases in the respiratory costs of soil microbes contributing to substantial C losses. Biogeochemistry 138: 245-260.

Maljanen M, Yli-Moijala H, Biasi C, Leblans NIW, De Boeck HJ, Bjarnadóttir B, Sigurdsson BD (2017) The emissions of nitrous oxide and methane from natural soil temperature gradients in a volcanic area in southwest Iceland. Soil Biology & Biochemistry 109: 70-80.

*Ring E, Johansson J, Sandstrom C, Bjarnadottir B, Finer L, Libiete Z, Lode E, Stupak I, Saetersdal, M (2017) Mapping policies for surface water protection zones on forest land in the Nordic-Baltic region: Large differences in prescriptiveness and zone width. Ambio 46(8): 878-893.

6. Other practical outputs of the project (websites, policy recommendations, conferences, scientific meetings, large-scale project applications, research training etc.)

Following is a selection of some main outputs; more can be found in Annual Reports

Scientific meetings (more information on these at http://nordicforestresearch.org/car-es/events/):

CAR-ES final meeting and open conference Sustainable Forest Management Research in the Nordic/Baltic Region, Hallormsstaður, Iceland, October 5-7, 2021

Co-organized online workshop Dialogue on governance to develop sustainable forest landscapes for production of wood for energy and the bioeconomy, October 12, 13, 26, and 27, 2021 (more information and products available at https://nordicforestresearch.org/n2020-06/)

CAR-ES annual meeting, Ås, Norway, November 18-19, 2019

CAR-ES annual meeting and open seminars Soil greenhouse gas balance in drained organic forest soils, Utilization of wood ash in Nordic-Baltic forests, Helsinki, Finland, October 31 –November 2, 2018

Co-organized conference Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes, Copenhagen, Denmark, April 17-19, 2018

A joint CAR-ES and NB Nord meeting, Uppsala, Sweden, February 21 – 22, 2018

CAR-ES workshop Understanding forest management for enhanced environmental services: Soil carbon dynamics and functional biodiversity, Tartu, Estonia, June 30, 2017

CAR-ES kick-off meeting and open seminar Anthropogenic greenhouse gas emissions from organic forest soils Riga, Latvia, May 18-20, 2016

Co-organized workshop Landscape management and design for food, bioenergy and the bioeconomy: methodology and governance aspects, Gothenburg, Sweden, March 15 – 16, 2016

Spin-off projects and networks:

SNS-120 Anthropogenic greenhouse gas emissions from organic forest soils: improved inventories and implications for sustainable management

SNS-NKJ 03 Effects of bioenergy production from forests and agriculture on ecosystem services in Nordic and Baltic landscapes

LIFE18 CCM/LV/001158 OrgBalt, Demonstration of climate change mitigation potential of nutrient rich organic soils in Baltic States and Finland

Interreg projects WAMBAF and WAMBAF Tool Box, Water Management in Baltic Forests

ERA-NET project INVENT

H2020 ITN/ETN project Future Arctic, A glimpse into the Arctic future: equipping a unique natural experiment for next-generation ecosystem research

Baltic Research Programme project Sustainable use of soil resources in the changing climate

Fact sheets, policy briefs:

Centre of Advanced Research – Environmental Services (CAR-ES) (https://nordicforestresearch.org/wp-content/uploads/2021/04/CAR_ES_01.6.4.2021.pdf)

Effects of intensive biomass harvesting on soil organic carbon and nutrients (https://nordicforestresearch.org/wp-content/uploads/2021/04/CAR_ES_02.6.4.2021.pdf)

How much carbon is sequestered in soil after afforestation of agricultural land in Northern Europe? (https://nordicforestresearch.org/wp-content/uploads/2021/04/CAR_ES_03.8.4.2021_.pdf)

Forests and waters in the Nordic-Baltic region—highlights from the CAR-ES network (https://nordicforestresearch.org/wp-content/uploads/2021/04/CAR_ES_04.6.4.2021.pdf)

Key to soil quality: texture and mineralogy (https://nordicforestresearch.org/wp-content/uploads/2021/04/CAR_ES_05.6.4.2021.pdf)

Anthropogenic greenhouse gas emissions from drained organic forest soils – Why should we care? (https://nordicforestresearch.org/wp-content/uploads/2019/02/Anthrop.-greenh-gases.pdf)

Sustainability governance for bioenergy and the wider bioeconomy (submitted with the final report)

PhD theses supported by CAR-ES:

Arta Bardule (2019) Mikro- un makroelementu plūsmas īscirtmeta apšu hibrīdu (*Populus tremuloides* Michx. × *Populus tremula* L.) kokaugu stādījumā lauksaimniecības zemē, Silava/University of Latvia

Kaie Kriiska (2019) Variation in annual carbon fluxes affecting the soil organic carbon pool and the dynamics of decomposition in hemiboreal coniferous forests, University of Tartu

Kaarin Parts (2020) The impact of climate change on fine roots and root-associated microbial communities in birch and spruce forests, University of Tartu

Other outputs:

A communication package for forestry planning to protect surface water, including field courses, handbooks and films; e.g., Traceless, a film about forestry and water quality, prepared by Skogsforsk; Swedish: https://www.youtube.com/watch?v=Vw634g2Gxjo&list=PLQ5tSIRCHKPb4D1HM1_hTFgwW39kd1HEr and English: https://www.youtube.com/watch?v=xauLNORS4mo (More information in the fact sheet Forests and waters in the Nordic-Baltic region—highlights from the CAR-ES network)

Stupak I, Smith CT, Clarke N (Eds.) (2019-2021) Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes. Article collection in Energy, Sustainability and Society. https://www.biomedcentral.com/collections/sbbb

7. How and within which areas was the project beneficial for the Nordic countries?

The sustainability of forestry in our region depends on comprehensive, transparent, connected, and well-synthesized research, and that is what CAR-ES has been providing throughout its existence. One main benefit was systematic and persistent relief for fragmentation of research. Instead of each national team struggling to make sense of the overflow of individual research papers that we all are facing, we reviewed and synthesized information jointly, interpreting the specific national interests, peculiarities etc. to a wider, generalized understanding. Much of the modern research remains fragmentary and unconnected due to short project periods and limited funding. Also, there is an unfortunate tendency currently that in specific publications, uniqueness and strong conclusions are emphasized, instead of transparency, connectivity, and acknowledgement of the complex gradients in environmental conditions. CAR-ES successfully fought against these obstacles. There are clear environmental gradients also within the Nordic-Baltic region, but we frequently do not think outside of our familiar environments. Country-level updates, field trips in the participating countries, and scientists working at different scales open our eyes for the full scale of environmental spectra and processes, as well as different management options and their consequences.

We were able to initiate several research and outreach projects serving both regional and national purposes in an efficient and timely manner, recognizing where new information or comprehensive syntheses were urgently needed. CAR-ES network provided inspiration of where and how to proceed. When you already know people, it is easier to form research consortia, and also to find participants outside the core network with the help of the network and their connections.

Reflections in our final meeting unanimously emphasized that the long-term, supportive, and sharing network has been integral for the research on forest environmental services in the region, especially so for countries that have a relatively small forest sciences community. CAR-ES has created a scientific community that has been really helpful and an important personal support to the members. We learned a lot also from good initiatives and practices found in other countries.

In addition to direct and indirect research-mediated benefits, CAR-ES produced several practical benefits through its spin-off projects, e.g., guidance for water management and protection within forestry, training and information materials for forest owners and practitioners, improved emission factors for forests on drained organic soils, and fact sheets about selected topics. Dissemination and outreach to practitioners and decisionmakers was not included in the network work plan, network, but that has been done as part of the regular work of the members, and largely nationally. CAR-ES further contributed greatly to, e.g., Iceland's forest strategy 2021-2031 that was being prepared in 2020-2021.

8. Write a short (maximum 800 words) popular science piece for dissemination in SNS' various channels with *emphasis on application of results and benefits for the Nordic society*.

Provide pictures (size at least 500x500 pixels and resolution at least 72 pixels) as separate files (.jpg). Include caption to each picture and the name of the photographer.

15 years of CAR-ES networking has provided science-based knowledge on the provision of environmental services in managed forests for decision making

CAR-ES is an open network funded by SNS under the Nordic Council of Ministers that brought together Nordic and Baltic forest researchers, with the aim to provide the best scientific knowledge for informed decision-making on forest management, concerning provisioning of environmental services. CAR-ES worked actively for 15 years, focusing on carbon sequestration, water and soil quality and soil biodiversity, establishing itself as a nave for environmental research within the participating organizations and for the region.

The questions addressed in relation to provision of environmental services included, e.g., impacts of climate change, forestry and water, bioenergy policies, forest buffer zones, intensified harvesting, ash recycling, land-use change by afforestation, peatland forestry, and carbon fluxes and management in forests.

Over the years, a number of workshops and meetings were organized in all the Nordic and Baltic countries, where results were presented and discussed, and new joint research projects were initiated. Via the CAR-ES network a 'critical mass' of researchers was created in specific topics, which have supported local initiatives, as well as well-functioning joint participation in larger European-level projects and networks. The actual research work was mostly funded by both international and national projects.

The sustainability of forestry depends on comprehensive, transparent, connected, and well-synthesized research, and that is what CAR-ES has been providing throughout its existence. Our research outputs include for instance synthesis papers on the impacts of intensive biomass harvesting on forest soils, afforestation effects on soil C stocks, sustainability governance of the bioenergy supply chains, greenhouse gas exchange data from drained organic forest soils, and policies for surface water protection zones, as well as guidance for water management and protection within forestry.

Participation

9. Number of participants

Country	Young researchers / PhD students	Senior researchers	Stakeholders	Others (specify)	Gender			Total
					Women	Men	Other	
Denmark		12	26		16	22		38
Finland	6	33	2		24	17		41
Iceland	17	28	20		26	37		63
Norway					18	19		37
Sweden	3	55	5		24	39		63
Estonia	4	9	4		6	11		17
Latvia	5	9	4		10	8		18
Lithuania					3	4		7
Other	2	55	122		42	137		179
Total					169	294		463

Notes: First grouping is lacking for Norway and Lithuania, as not recorded; Journalists are included in stakeholders; Gender figures are not 100% accurate, e.g., since some screen names of distant participants were difficult to classify, and we did not ask participants to report their gender

10. List the participating institutes/sectors

These institutes participated in most activities throughout the funding period:
University of Copenhagen
Natural Resources Institute Finland (Luke)
University of Helsinki
Agricultural University of Iceland
University of Akureyri, Iceland
Icelandic Forest Service
Norwegian Institute of Bioeconomy Research
Skogforsk
University of Tartu
Latvian State Forest Research Institute (Silava)
Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry
Additionally, around 50 institutes altogether participated in some activities. These included, e.g., University of Eastern Finland, SYKE (FI), Estonian University of Life Sciences, University of Gothenburg, Lund University, SLU, Skogstyrelsen (SE), Havs- och vattenmyndigheten (SE), NMBU (NO), Oslo University, Landbruks- og mat-departementet (NO), Energistyrelsen (DK), Naturstyrelsen (DK), Skovdyrkerne (DK), Zemkopības ministrija (LV)

Economic report

11. Received grant from SNS in total (SEK):
2.250.000

12. Transfer of SNS funds to project partners

Country	Partner organization	Sum (SEK)
Denmark	University of Copenhagen	300,000
Finland	Natural Resources Institute Finland	712,500
Sweden	Skogforsk	300,000
Norway	Norwegian Institute of Bioeconomy Research	300,000
Iceland	Agricultural University of Iceland	300,000
Estonia	University of Tartu	112,500
Latvia	Latvian State Forest Research Institute	112,500
Lithuania	Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry	112,500
Total SUM		**2,250,000**

13. Costs

	SNS funding	External funds*	Total*
Travel and hotel	634,371	(1,281,444)	1,915,815
Meeting costs	128,930	(223,412)	352,342
Consumables	42,998	(1,573,229)	1,616,227
Salary	1,549,161	(25,773,399)	27,322,560
Communication	62,770	(6,628)	69,399
Other costs (specify)	48,786	(5,112,858)	5,161,644
Total SUM (SEK)	**2,467,017**	**33,970,969**	**36,437,986**

* If possible, provide details otherwise summarize the total sum for external funds and total.

14. Economic result (deficit or surplus):

-217 017

The deficit was covered by the participating institutes

Optional: Comments to the economic reporting:

We did not, unfortunately, classify the use of external funds for 2016; thus, in the table above, %-values based on classification during 2017-2021 were used to estimate the class values that are shown with (). The original cost data are available in the Excel file sent with the final report.

15. Submit a policy brief as a separate document. Provide pictures (size at least 500x500 pixels and resolution at least 72 pixels) in the policy brief as well as separate files (.jpg). Include caption to each picture, and the name of photographer.

I hereby declare that the above statements are true to the best of my knowledge

Main applicant's signature, place and date

(Signature)	Natural Resources Institute Finland	15/3/2022
	(Institution)	(Day / Month / Year)

Signature of the head of the main applicant's research institution

(Signature)	Natural Resources Institute Finland	15/3/2022
	(Institution)	(Day / Month / Year)

Sirpa Thessler, vice president

(Printed name, function)

Second applicant's signature, place and date

Agricultural University of Iceland
LANDBÚNAÐARHÁSKÓLI ÍSLANDS

Bjarni Sigurðsson AGRICULTURAL UNIV. OF ICELAND 16.08.2022

(Signature) (Institution) (Day / Month / Year)

Third applicant's signature, place and date

(Signature) (Institution) (Day / Month / Year)

Second applicant's signature, place and date

.....	.....	.....
(Signature)	(Institution)	(Day / Month / Year)

Third applicant's signature, place and date

.....	Skogforsk	16/3/22
(Signature)	(Institution)	(Day / Month / Year)

LARS Högbom