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NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

National GHG Projections for the LULUCF sector in Norway

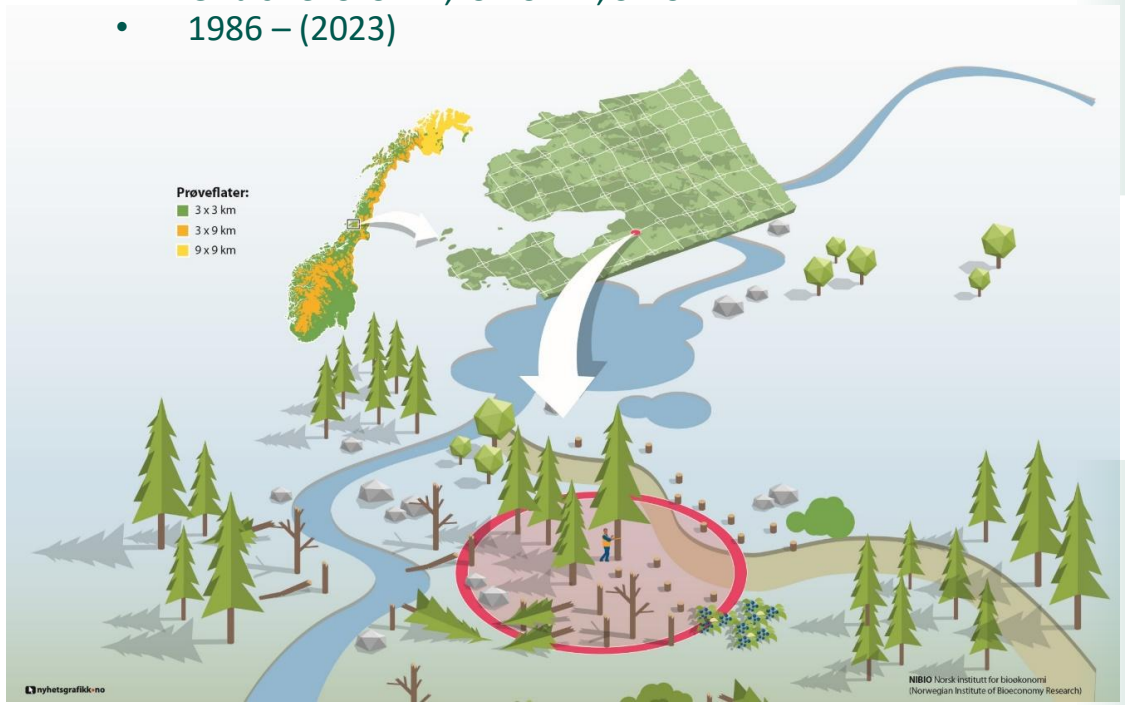
Christian W. Mohr • JRC LULUCF Workshop 2025 • 07/05/2025

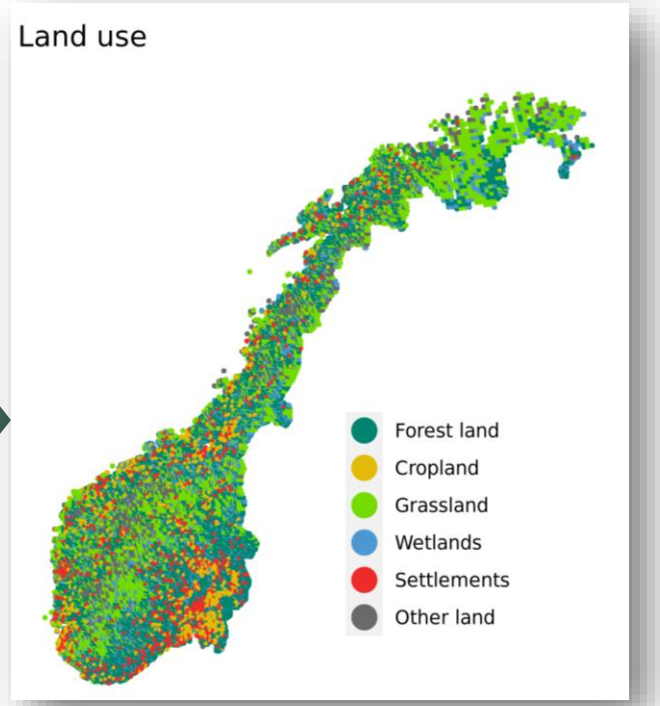
Photos: Christian W. Mohr

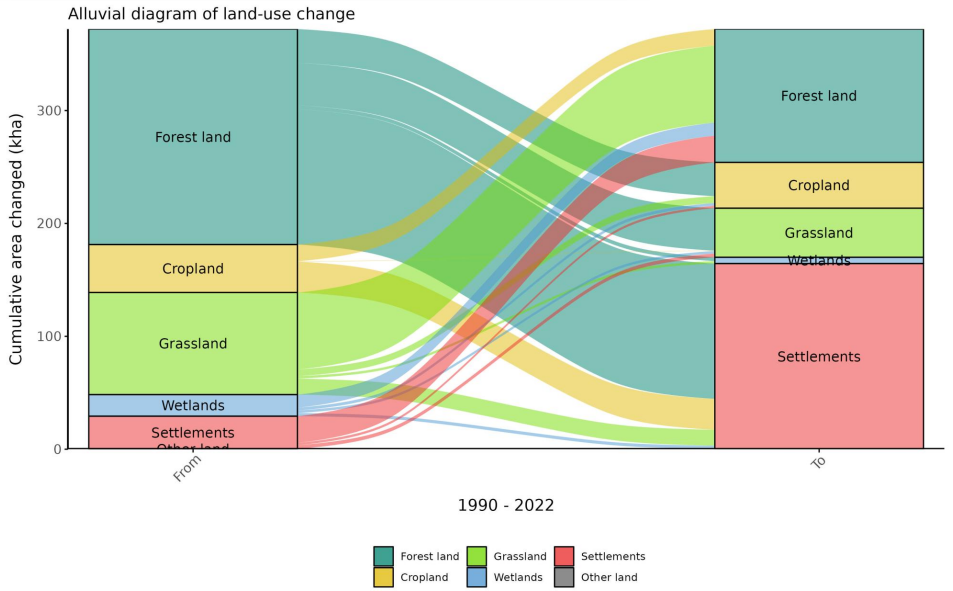
Activity data for NIR

National Forestry Inventory

- 22 008 permanent plots
  - Approx. 13 000 forest land plots
- 1/5th of plots monitored each year
  - aerial or field measurements (when there are trees)
  - Systematic even distribution of plot.
- Grid size: 3x3 km, 3 x 9 km, 9 x 9 km
- 1986 – (2023)

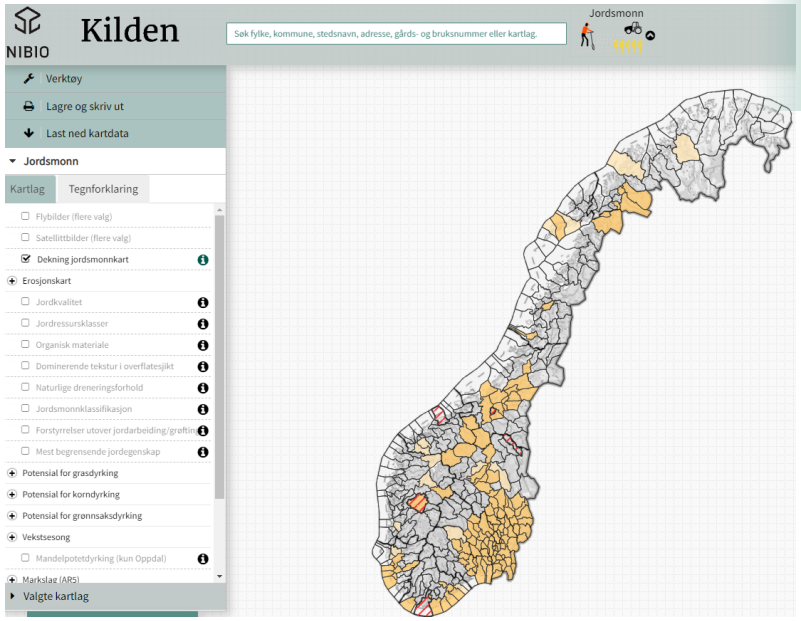






Activity data for NIR

National Forestry Inventory (22 008 plots)

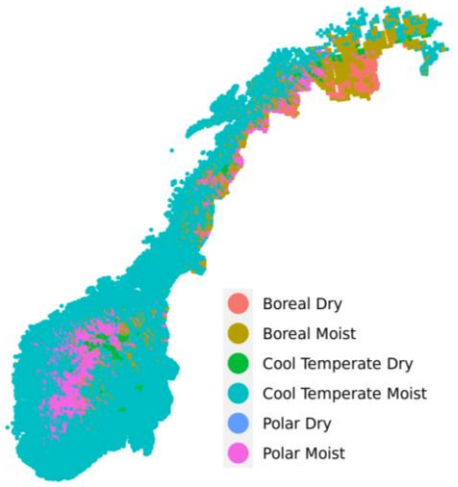


Statistisk sentralbyrå
Statistics Norway

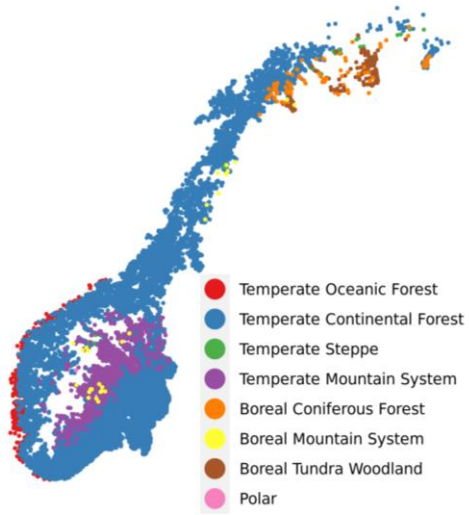
Meteorologisk institutt

Soil type

IPCC climate regions



FAO ecological zones



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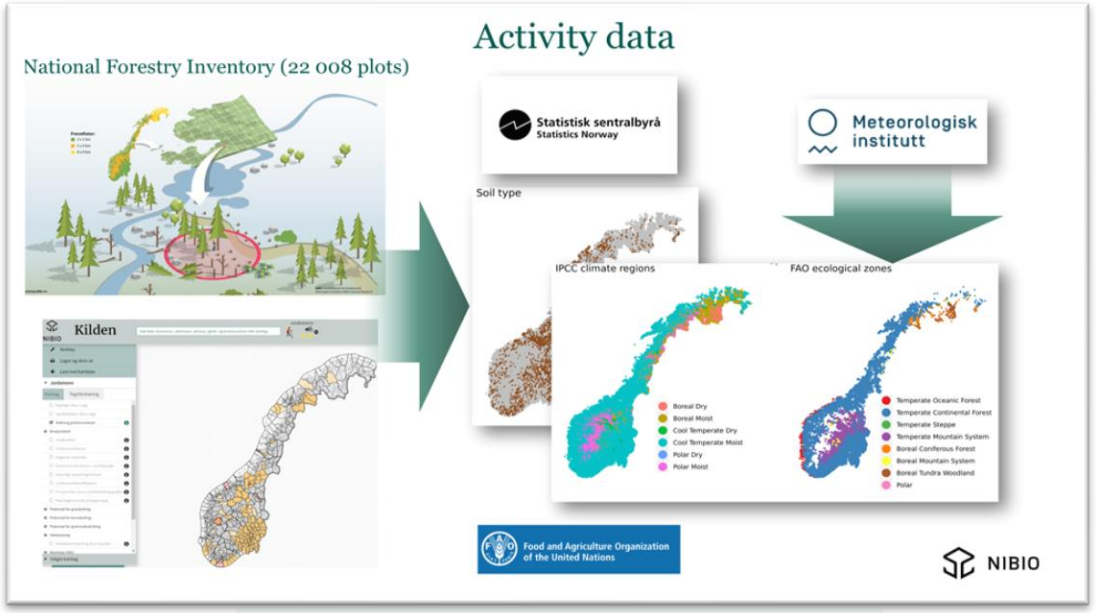
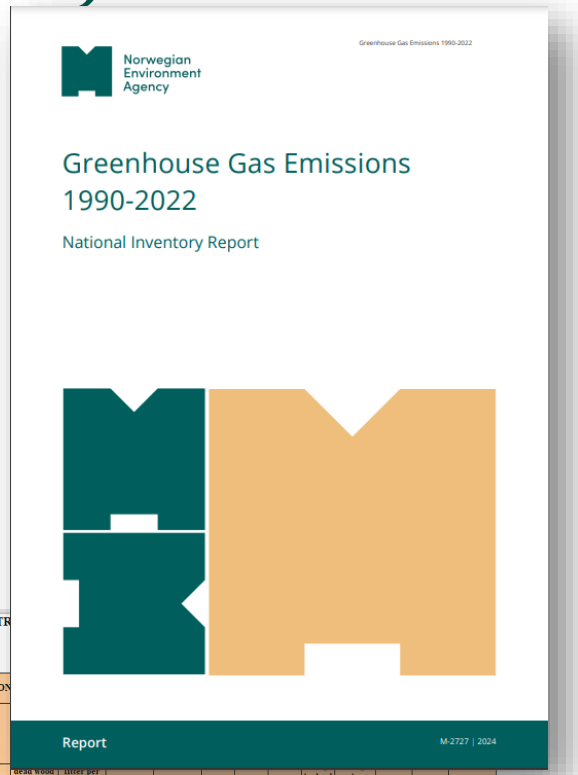
National Inventory Report (NIR)





IPCC guidelines

CRT tables

UNFCCC

TABLE 4.A SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTR
Forest land
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA			IMPLIED CARBON														
Land-use category	Subdivision[1]	Total area[2] (kha)	Area of mineral soil (kha)	Area of organic soil (kha)	Carbon stock change in living biomass per area[3] [4]			dead wood per area[4]	litter per area[4]	Mineral soils[5]	Organic soils				in dead wood[4]	in litter[4]	Mineral soils	Organic soils	
					Gains	Losses	Net change					Gains	Losses	Net change					
					(t C/ha)							(kt C)							(kt)
A. Total forest land		12127.86	11420.74	707.12	1.05	-0.73	0.32	0.03	0.12	0.00	-0.48	######	######	3898.68	354.29	1415.25	34.29	-342.94	-19651.79
1. Forest land remaining forest land		12048.00	11348.82	699.18	1.05	-0.73	0.32	0.02	0.11	0.00	-0.48	######	######	3858.69	256.76	1269.79	29.57	-337.22	-18617.78
Norway	Norway	12048.00	11348.82	699.18	1.05	-0.73	0.32	0.02	0.11	0.00	-0.48	######	######	3858.69	256.76	1269.79	29.57	-337.22	-18617.78
2. Land converted to forest land[6]		79.86	71.93	7.93	0.96	-0.46	0.50	1.22	1.82	0.07	-0.72	76.40	-36.40	40.00	97.53	145.46	4.72	-5.72	-1034.00
2.1 Cropland converted to forest land		8.70	6.57	2.13	2.24	-1.14	1.09	1.24	2.10	0.66	-2.60	19.44	-9.93	9.52	10.82	18.28	4.32	-5.53	-137.18
Norway	Norway	8.70	6.57	2.13	2.24	-1.14	1.09	1.24	2.10	0.66	-2.60	19.44	-9.93	9.52	10.82	18.28	4.32	-5.53	-137.18
2.2 Grassland converted to forest land		44.29	44.29	NO	0.72	-0.48	0.24	1.24	1.54	-0.02	NO	31.95	-21.30	10.64	54.77	68.42	-0.77	NO	-487.88
extensive	extensive	34.05	34.05	NO	0.30	-0.42	-0.12	1.20	1.59	NO	NO	10.19	-14.34	-4.15	40.85	54.18	NO	NO	-333.24
intensive	intensive	10.24	10.24	NO	2.13	-0.68	1.44	1.36	1.39	-0.08	NO	21.76	-6.96	14.79	13.92	14.23	-0.77	NO	-154.64
2.3 Wetlands converted to forest land		7.90	2.10	5.80	0.64	-0.03	0.61	1.23	1.98	NO	-0.03	5.07	-0.24	4.83	9.72	15.64	NO	-0.19	-109.99
Unmanaged wetlands - Norway	nmanaged wetlands - Norway	7.83	2.10	5.73	0.65	-0.03	0.62	1.23	1.98	NO	NO	5.07	-0.24	4.83	9.63	15.54	NO	NO	-110.01
Managed wetlands - Norway	Managed wetlands - Norway	0.07	NO	0.07	NO	NO	NO	1.18	1.35	NO	-2.60	NO	NO	NO	0.09	0.10	NO	-0.19	0.02
2.4 Settlements converted to forest land		18.97	18.97	NO	1.05	-0.26	0.79	1.17	2.27	0.06	NO	19.95	-4.94	15.01	22.23	43.12	1.17	NO	-298.95
Norway	Norway	18.97	18.97	NO	1.05	-0.26	0.79	1.17	2.27	0.06	NO	19.95	-4.94	15.01	22.23	43.12	1.17	NO	-298.95
2.5 Other land converted to forest land		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Norway	Norway	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

[1] Land categories may be further divided according to climate zone, management system, soil type, including whether the soil is drained, rewetted or categorized as other, vegetation type, tree species, ecological zone or national land classification. When Parties estimate emissions and removals or carbon stock change on dry and wet soils separately, they are encouraged to use this column to provide this disaggregation. When a Party reports emissions and removals from coastal wetlands areas that are not part of the total land area of the country, a Party may use

[2] The total area of the subcategories, in accordance with the subdivision used, should be entered here. For lands converted to forest land report the cumulative area remaining in the category in the reporting year. The total area should equal the area of mineral soil plus the area of organic so

[3] Carbon stock gains and losses should be listed separately except in cases where, due to the methods used, it is technically impossible to separate information on gains and losses.

[4] The signs for estimates of gains in carbon stocks are positive (+) and of losses in carbon stocks are negative (–).

[5] When Parties cannot estimate carbon stock changes for organic and mineral soil separately, these should be reported under mineral soils.

[6] Parties who wish to do so may report annual on-site CO2-C emissions/removals and off-site CO2-C emissions from drained and rewetted organic soils here.

[7] Where Parties directly estimate emissions and removals rather than carbon stock changes, they may report emissions/removals directly in this column and use notation keys in the stock change columns.

[8] A Party may report aggregated estimates for all conversions of land to forest land when data are not available to report them separately. A Party should specify in the documentation box which types of land conversion are included.

LULUCF: from NIR to Projections

- Majority of projected emission estimates are derived from aggregated data similar to the data is reported in the CRTs.
  - NOT spatially explicit
  - Uses the area rate of land-use change from the reference period and projects the area for the land use classes forward.
  - Implied emission factor from the reference period are combined with the projected area.

Rate of area change for land with mineral soil (ha/yr)

		To				
		Cropland	Forest land	Intensive Grasslands	Settlements	Manged Wetlands
From	Cropland		351 ± 155		838 ± 267	
	Forest land	1181 ± 302		1451 ± 334	3100 ± 447	
	Extensive Grasslands	108 ± 108	3316 ± 941	54 ± 54	270 ± 145	90 ± 90
	Intensive Grasslands	171 ± 107	261 ± 140		243 ± 128	
	Settlements	90 ± 90	667 ± 216	234 ± 138		
	Unmanged Wetlands				81 ± 56	
	Other land				36 ± 36	

Rate of area change for land with organic soil (ha/yr)

		To				
		Cropland	Forest land	Intensive Grasslands	Settlements	Manged Wetlands
From	Cropland			27 ± 27	36 ± 18	
	Forest land	90 ± 90			99 ± 77	90 ± 90
	Intensive Grasslands	63 ± 63				
	Unmanged Wetlands	27 ± 27	559 ± 216	135 ± 101	90 ± 90	90 ± 90

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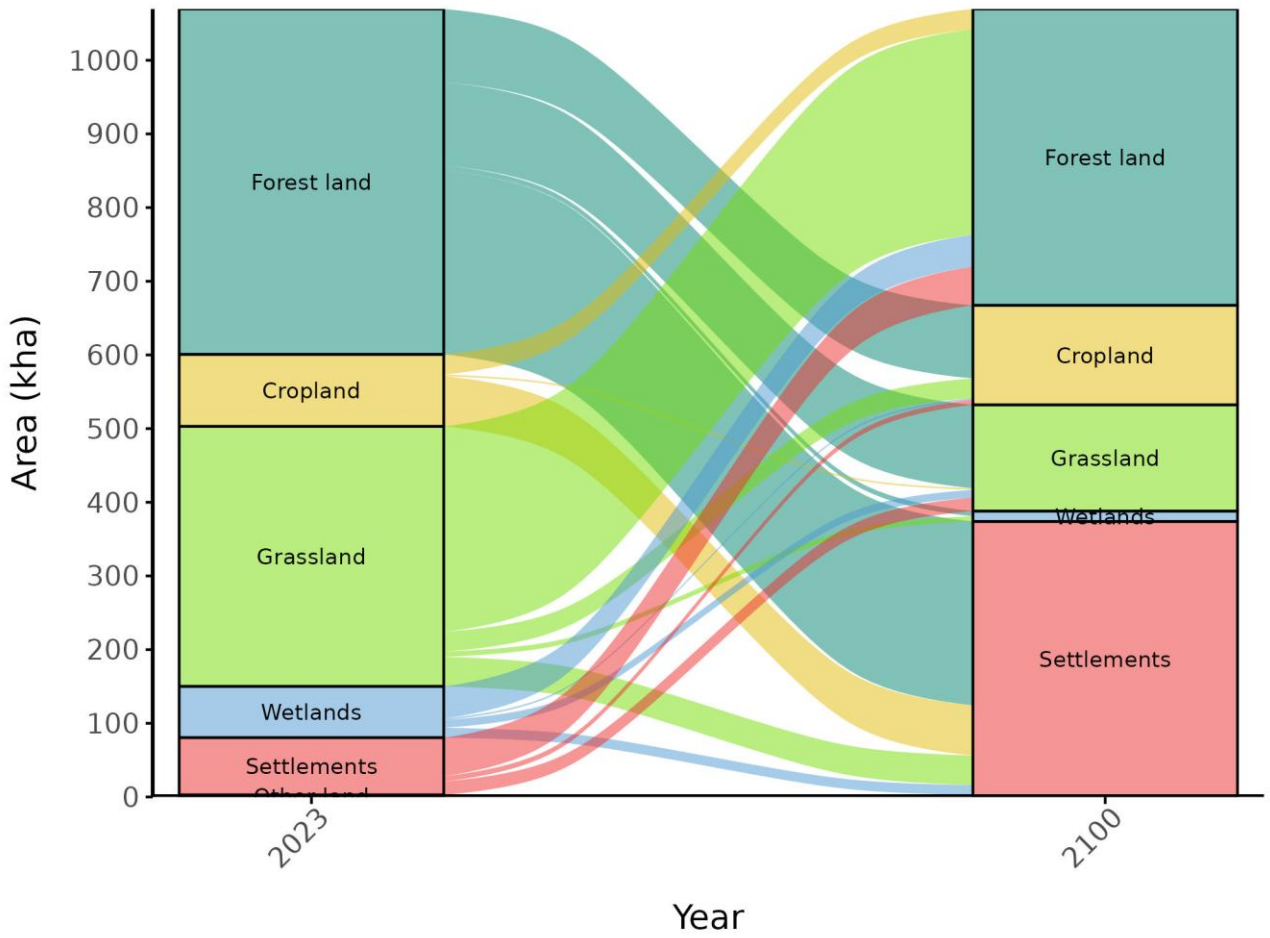

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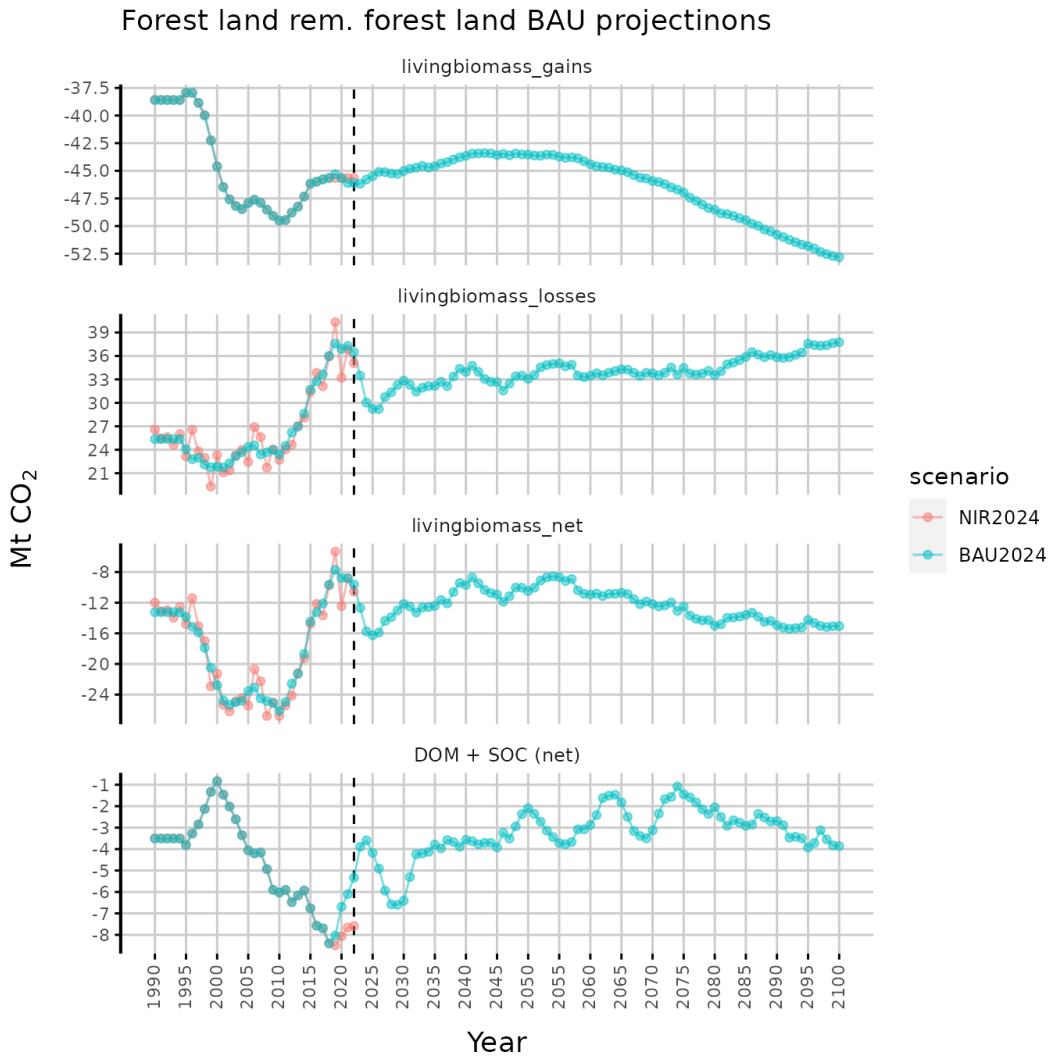
- Forest management (forest land remaining forest land)
  - Forest simulation tool SiTree with soil model Yasso07



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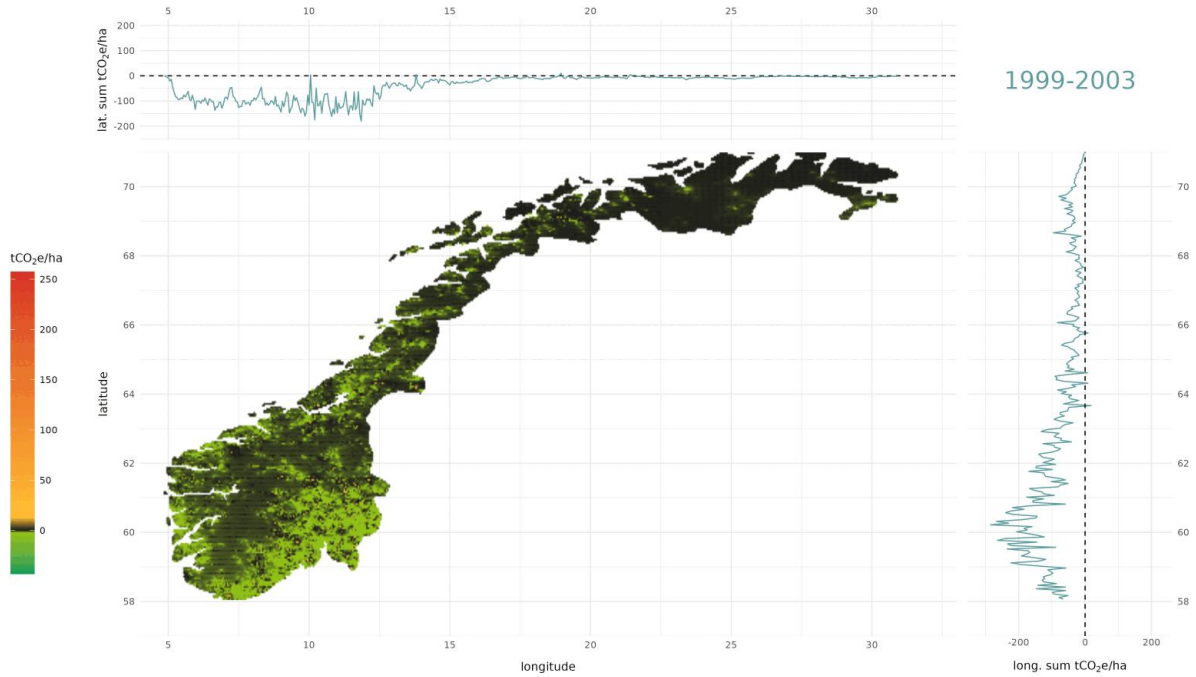
  - Spatially explicit projections:
    - tree growth
    - Ingrowth
    - natural mortality
    - harvest

Living biomass net emissions/removals



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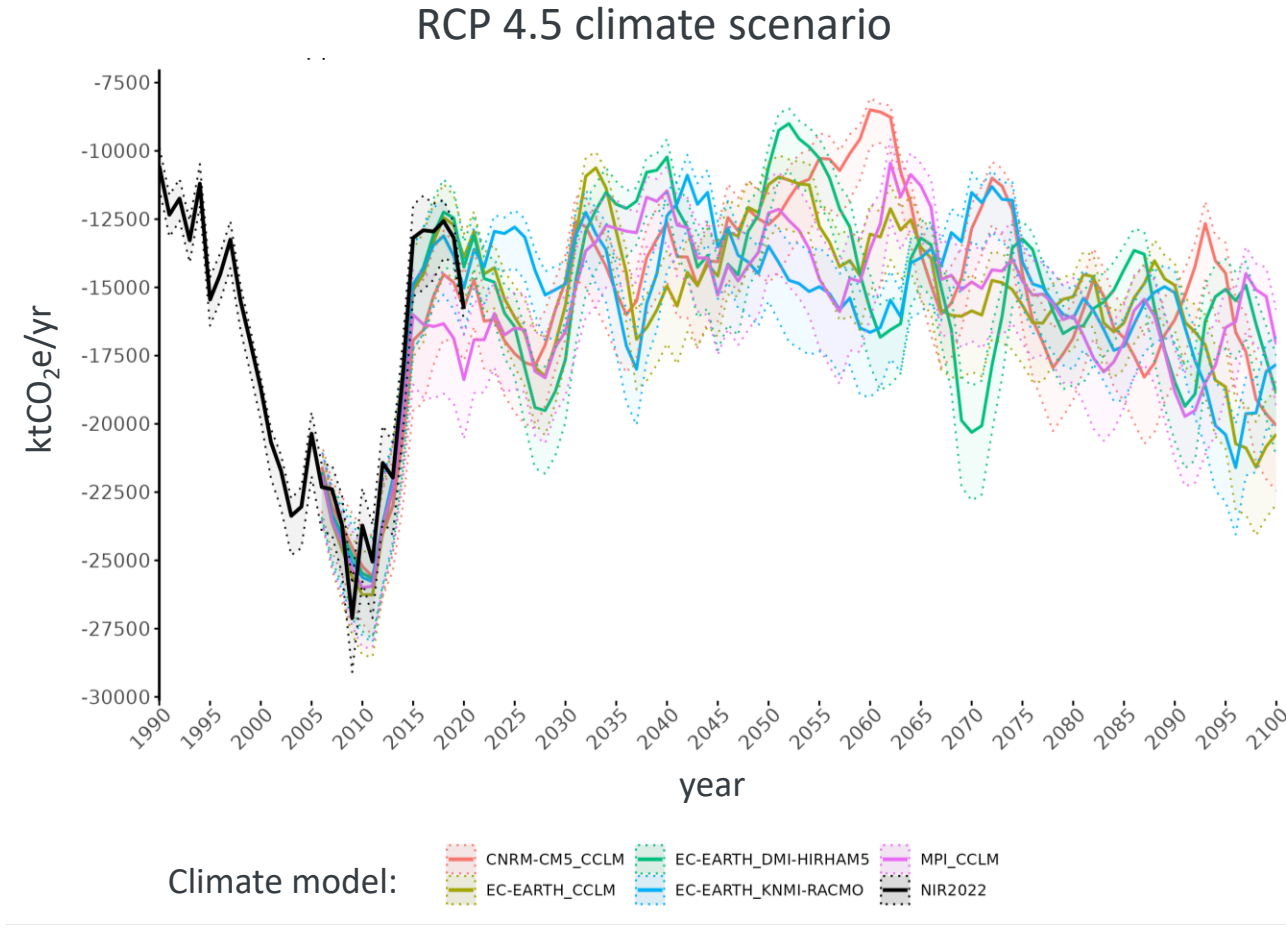
    - harvest
  - Advanced features: climate scenarios (RCP4.5, RCP8.5, etc.), harvest regimes, forest protection, and other forest management aspects.



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    - Ingrowth
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    - harvest
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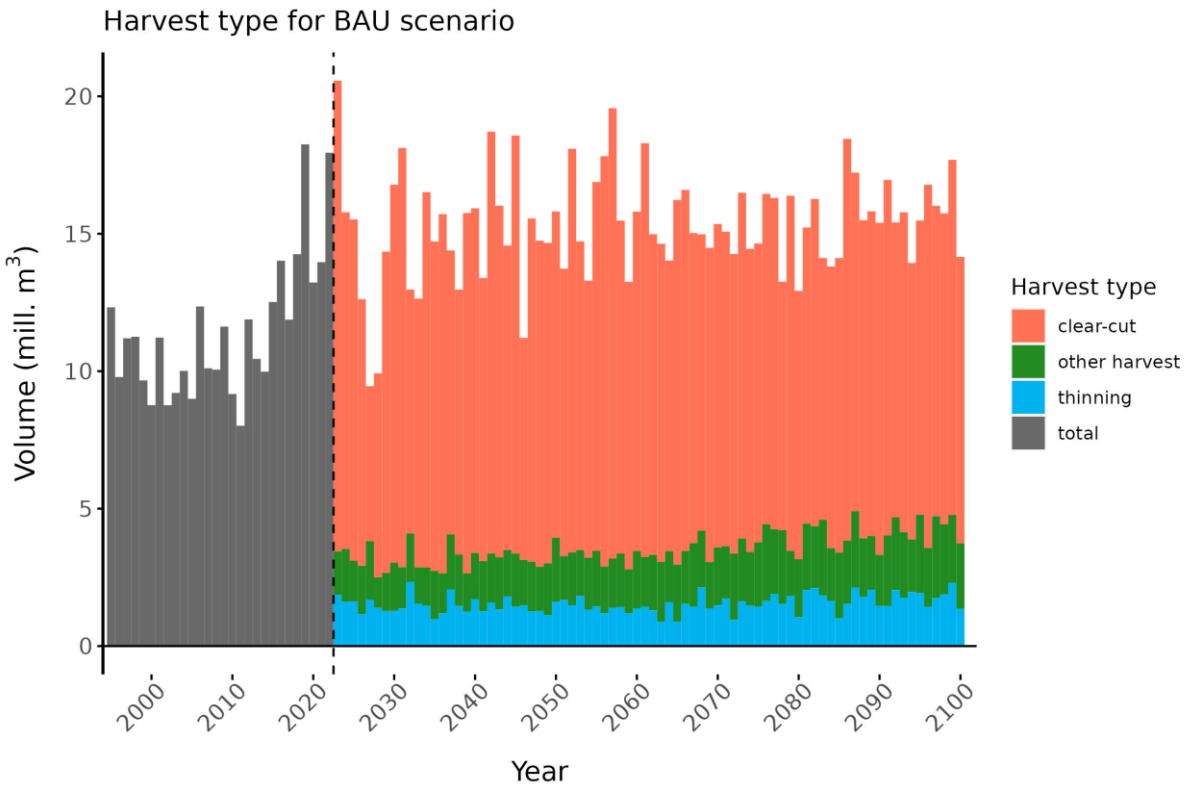
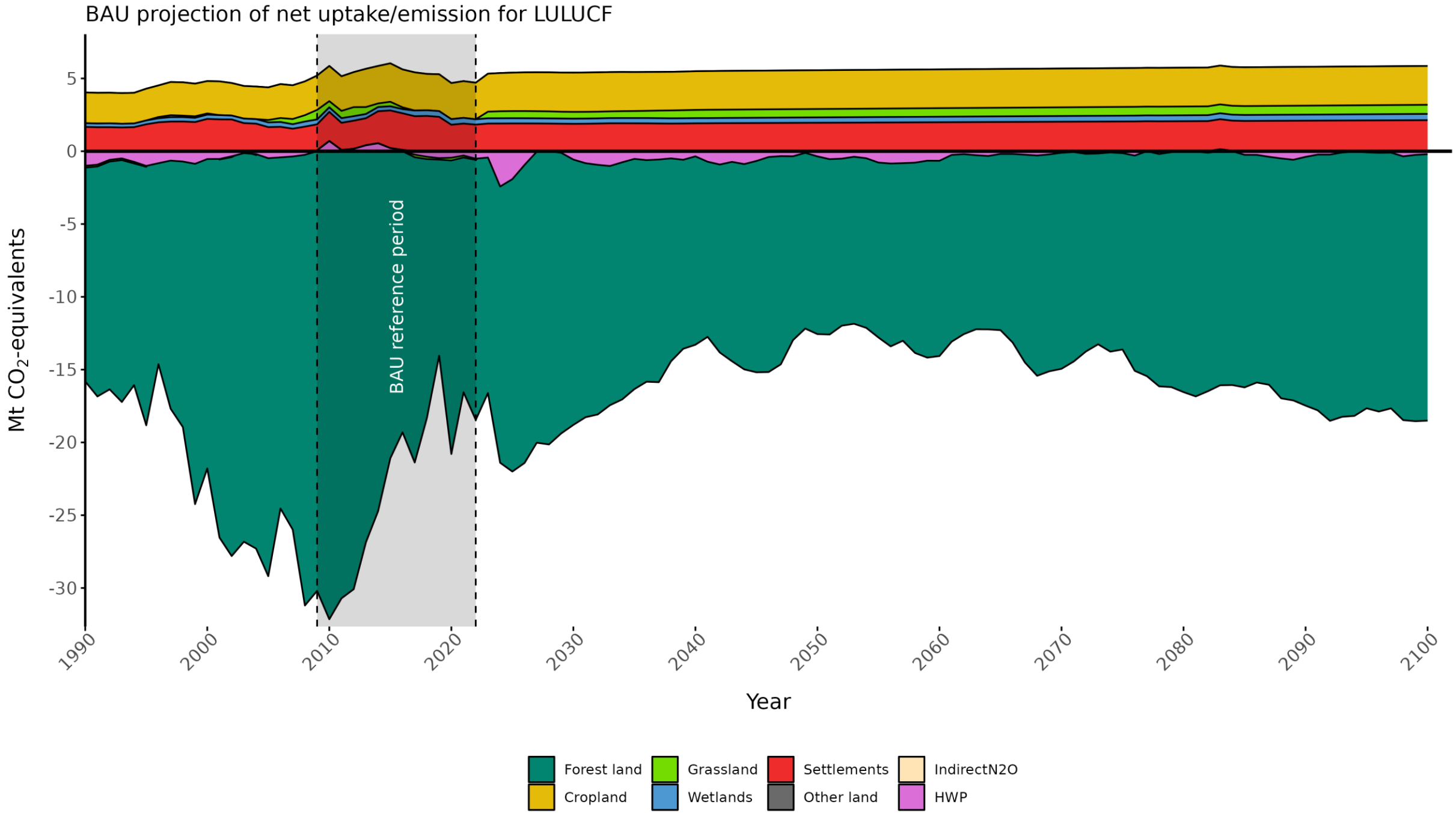
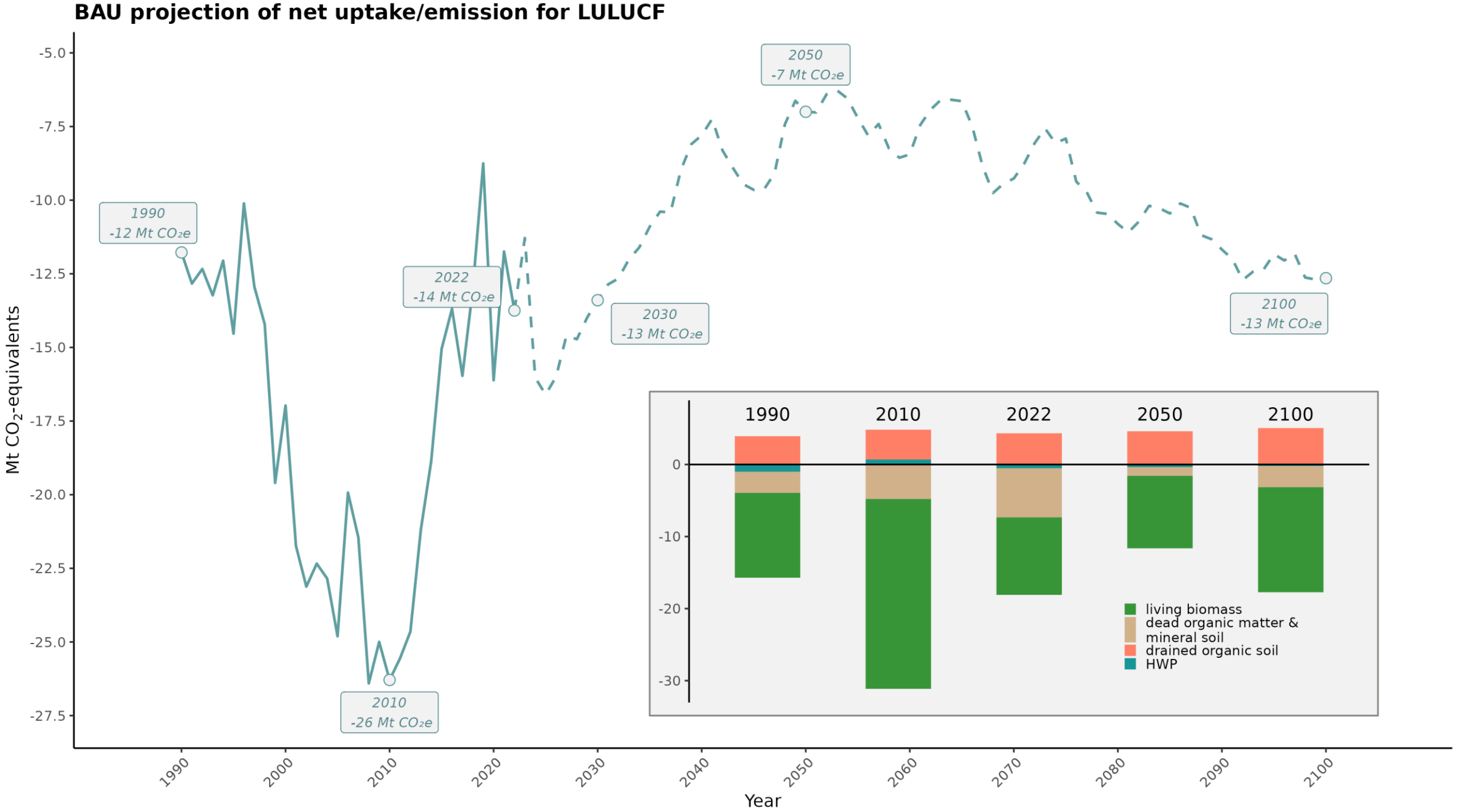
  - Harvest Wood Product projections are linked to projected harvest scenarios.



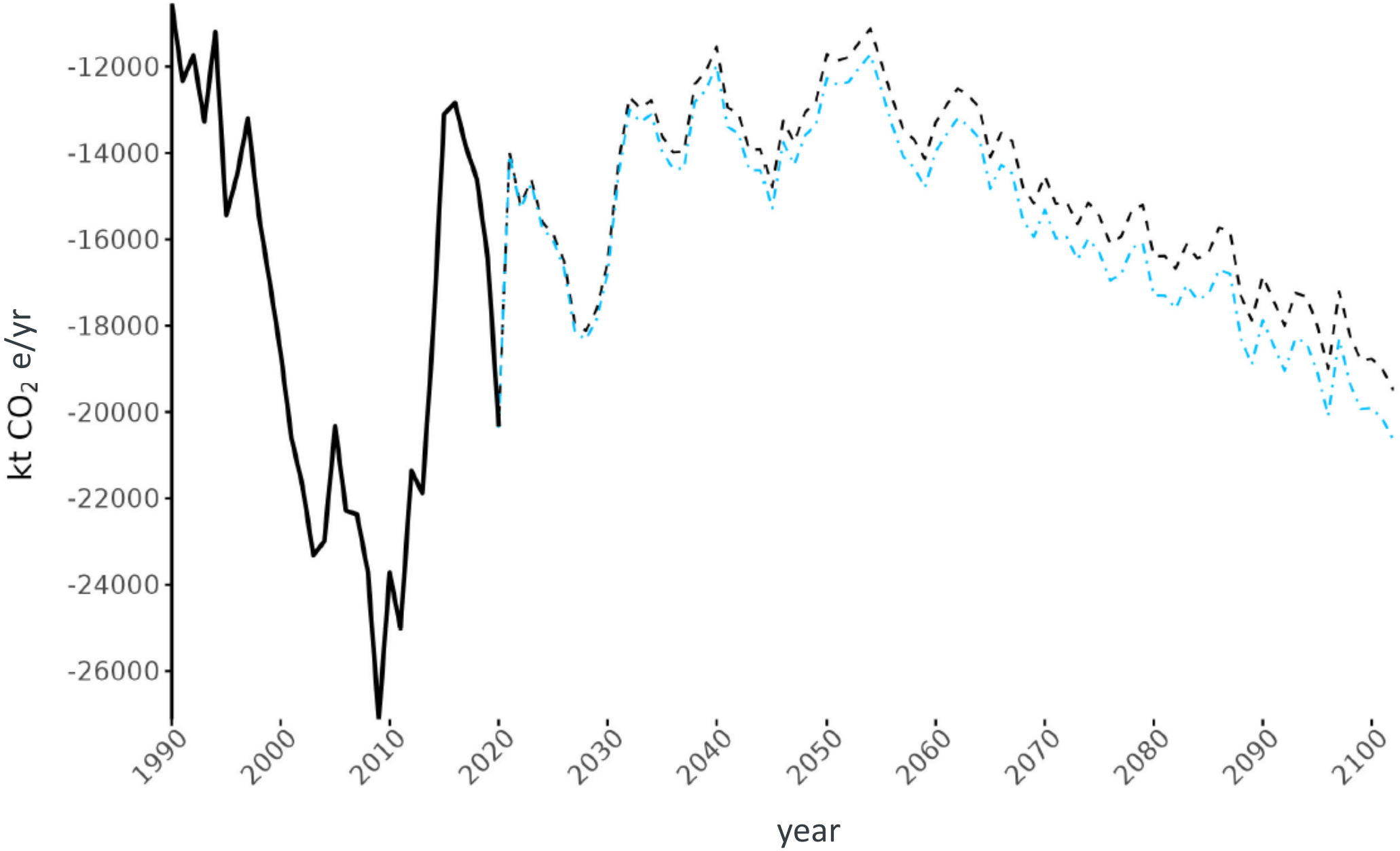

BAU projection of net uptake/emission for LULUCF
Mt CO2-equivalents
5
0
-5
-10
-15
-20
-25
-30
BAU reference period
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year
Forest land
Cropland
Grassland
Wetlands
Settlements
Other land
IndirectN2O
HWP


BAU projection of net uptake/emission for LULUCF
1990
-12 Mt CO₂e
2010
-26 Mt CO₂e
2022
-14 Mt CO₂e
2030
-13 Mt CO₂e
2050
-7 Mt CO₂e
2100
-13 Mt CO₂e
Mt CO2-equivalents
Year
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
1990
2010
2022
2050
2100
0
-10
-20
-30
living biomass
dead organic matter & mineral soil
drained organic soil
HWP

Advantages of projection methodology

Land-use changes:

- Simple methodology for land-use change:
  - Altering land-use change rates makes it easy to run many scenarios to assess potential impacts of policies related to regulating land-use change.



BAU

Abatement action: Immediate halt to converting mires and forest land with organic soil to other land-uses

NIR2022

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Advantages of projection methodology

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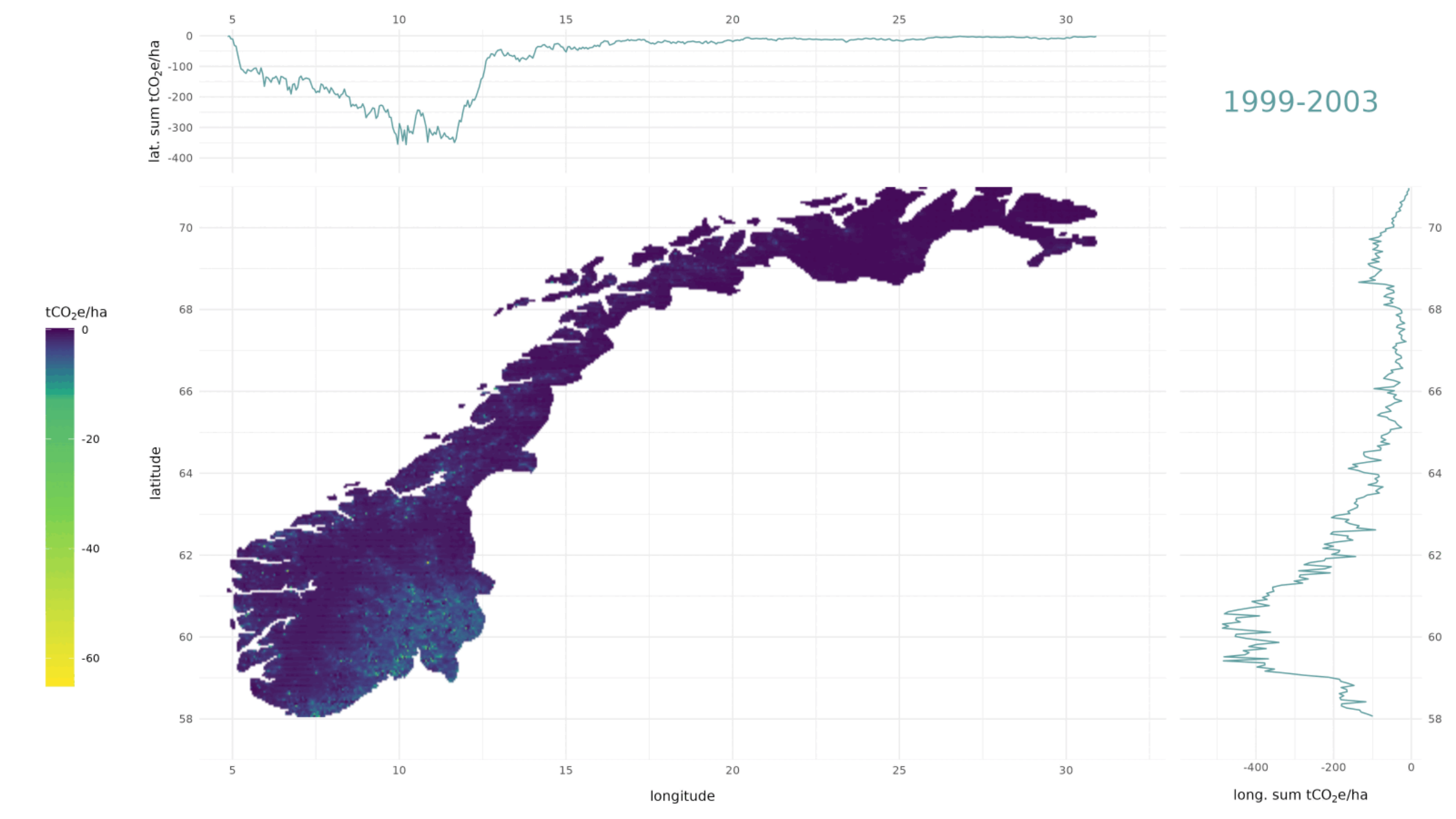
Forest management:

- SiTree with Yasso07 can provide deep insight into regional variation and underlying factors governing the uptake and emission from forest land.


1999-2003
lat. sum tCO2e/ha
0
-100
-200
-300
-400
5
10
15
20
25
30
tCO2e/ha
0
-20
-40
-60
latitude
70
68
66
64
62
60
58
longitude
long. sum tCO2e/ha
-400
-200
0

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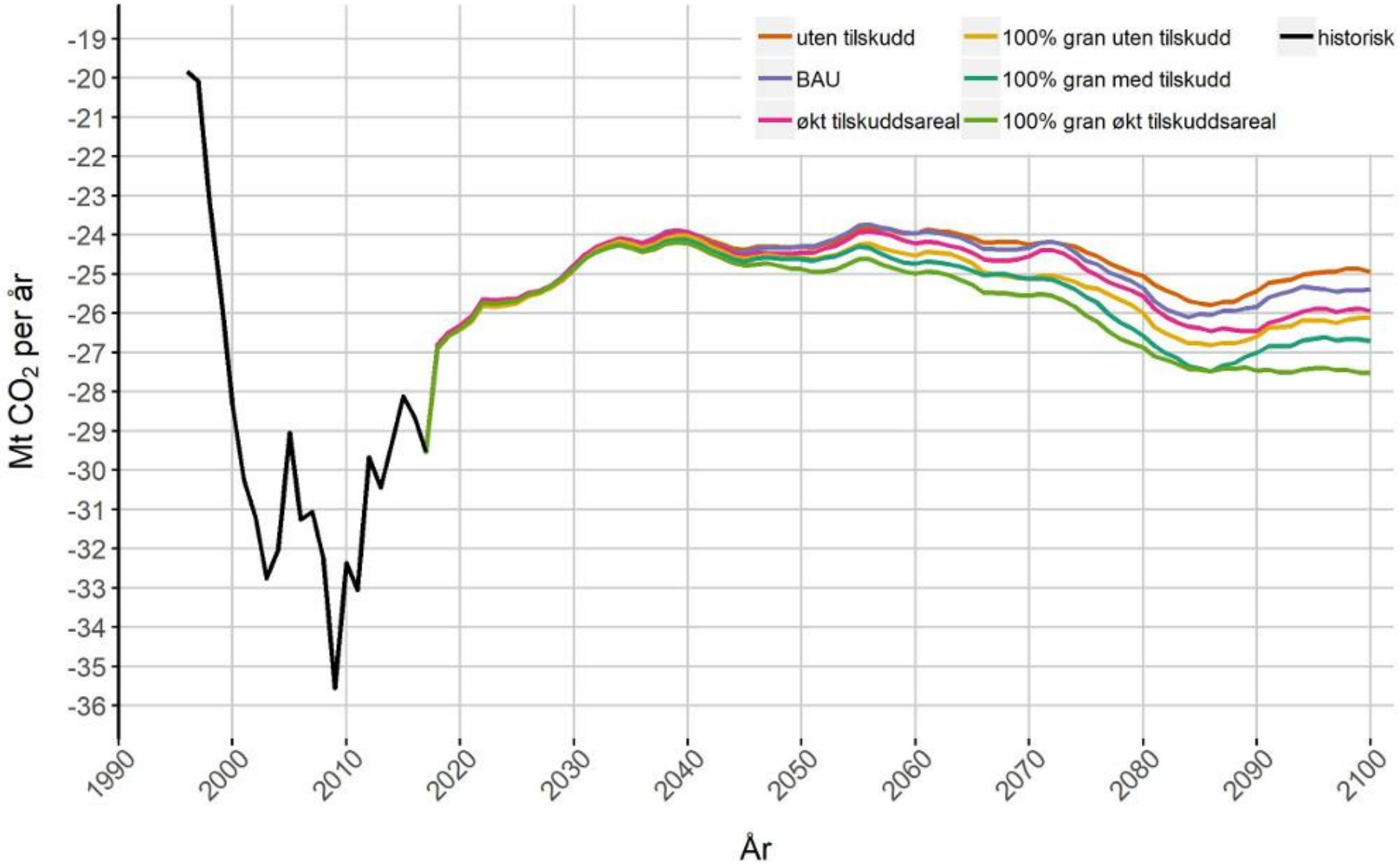
uten tilskudd
100% gran uten tilskudd
historisk
BAU
100% gran med tilskudd
økt tilskuddsareal
100% gran økt tilskuddsareal
Mt CO_2 per år
-19
-20
-21
-22
-23
-24
-25
-26
-27
-28
-29
-30
-31
-32
-33
-34
-35
-36
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
År

NIBIO

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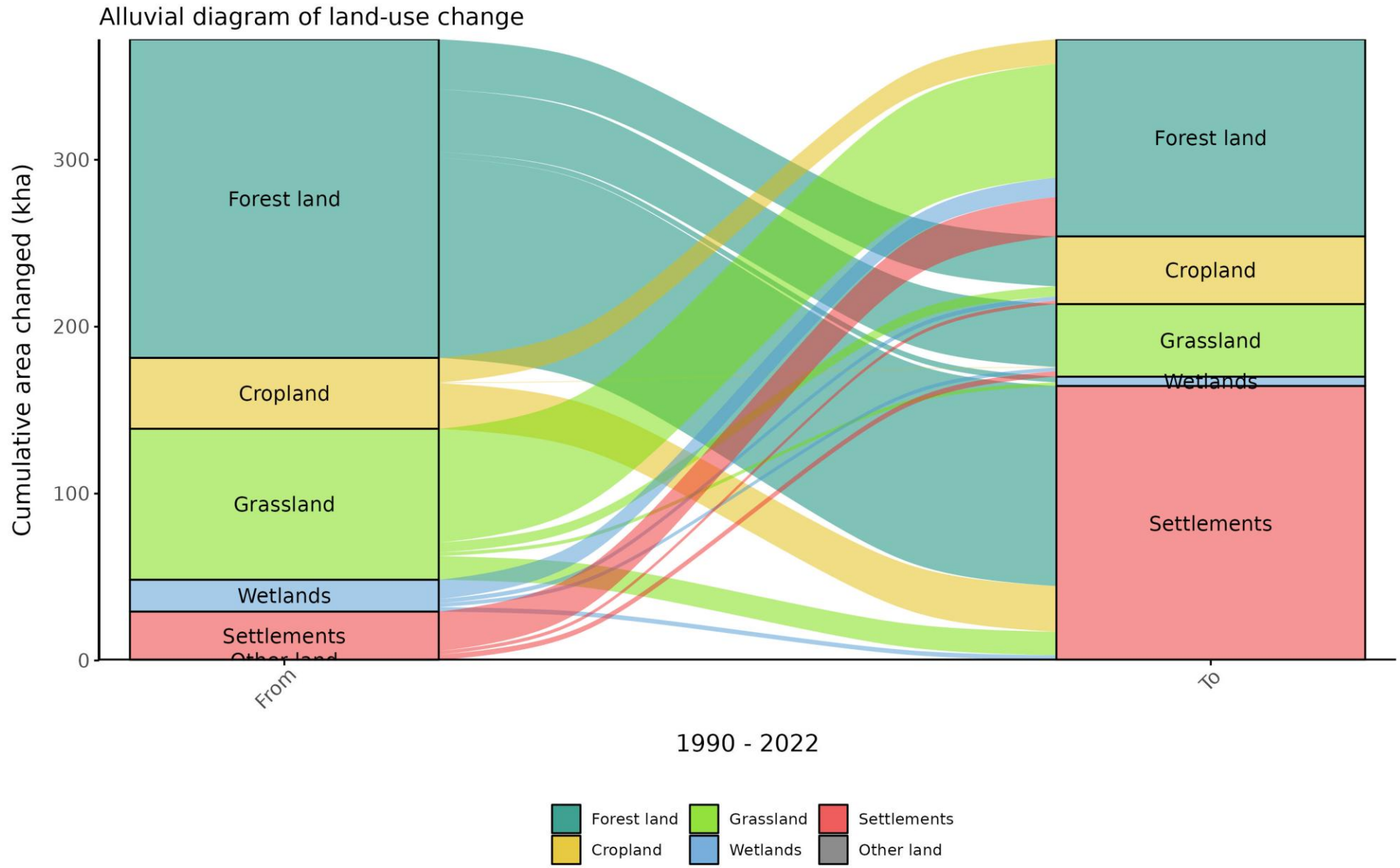
General: Strongly linked to the National GHG Inventory report

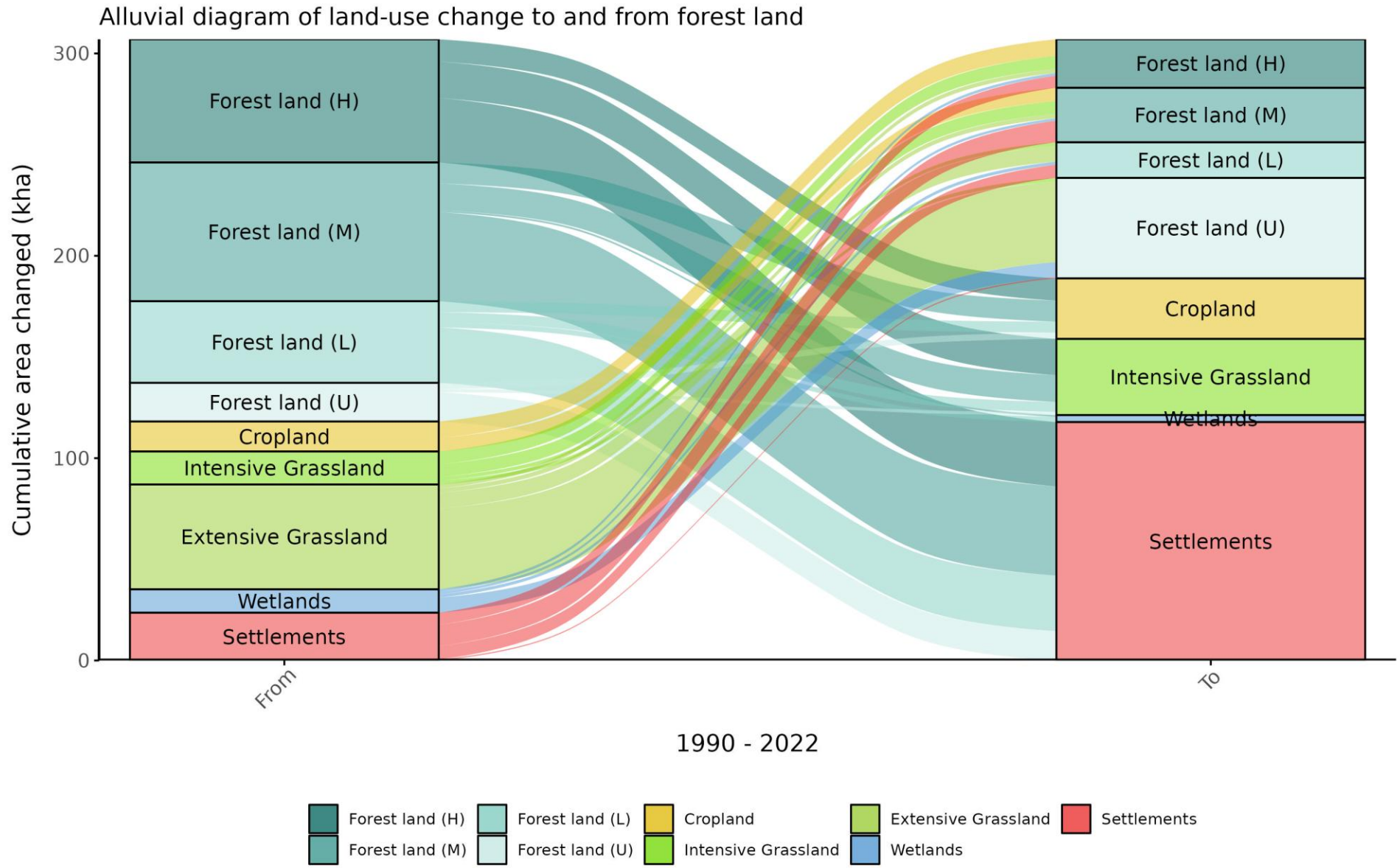
- The updates in the NGHGI methodology are reflected in the projections

Disadvantages of projection methodology

Land-use changes:

- Simple methodology for land-use change:
  - Difficult assess how policies can affect land-use change rates accurately
  - The lack in spatially-explicit land-use change projections means that we lack insight into;
    regional land-use competition and pressures
    spatial impact of afforestation and deforestation on forest management projections


Alluvial diagram of land-use change
Cumulative area changed (kha)
300
200
100
0
Forest land
Cropland
Grassland
Wetlands
Settlements
Forest land
Cropland
Grassland
Wetlands
Settlements
From
To
1990 - 2022
Forest land
Cropland
Grassland
Wetlands
Settlements
Other land


Alluvial diagram of land-use change to and from forest land
Cumulative area changed (kha)
300
200
100
0
Forest land (H)
Forest land (M)
Forest land (L)
Forest land (U)
Cropland
Intensive Grassland
Extensive Grassland
Wetlands
Settlements
From
To
1990 - 2022
Forest land (H)
Forest land (M)
Forest land (L)
Forest land (U)
Cropland
Intensive Grassland
Extensive Grassland
Wetlands
Settlements

Disadvantages of projection methodology

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Forest management:

- Difficult to know how the forest will actually develop for a future climate where the amplitude and frequency of climate extremes will likely change.

Disadvantages of projection methodology

Land-use changes:

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Forest management:

- Difficult to know how the forest will actually develop for a future climate where the amplitude and frequency of climate extremes will likely change.

General:

- No coupling between with projections from other sectors.

Acknowledgement:

Collaborators:
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and many more.

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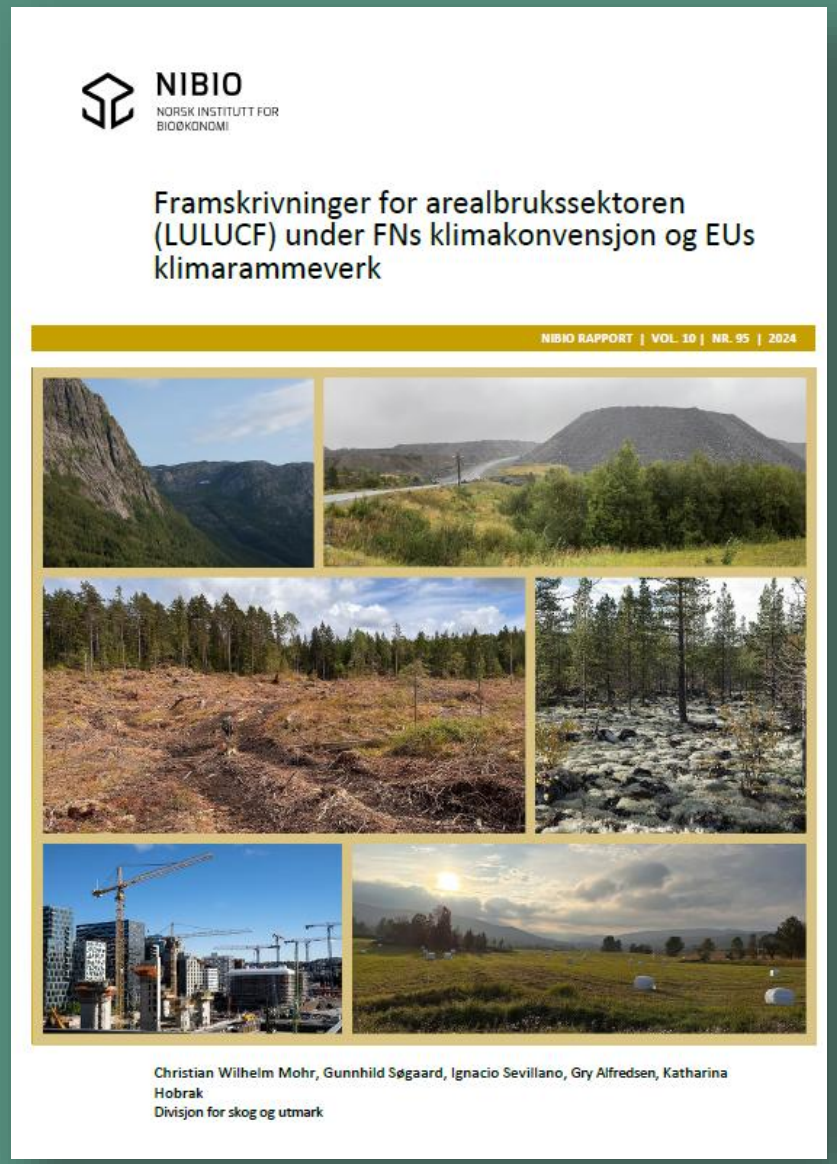
https://www.linkedin.com/company/nibio-forest-and-climate/

www.nibio.no/en



Thank you for your attention!

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https://www.linkedin.com/company/nibio-forest-and-climate/

www.nibio.no/en