Training seminar on QA/QC procedures in LULULCF

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Riga, Lativa.18.05.2015

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Norwegian Forest and
Landscape Institute

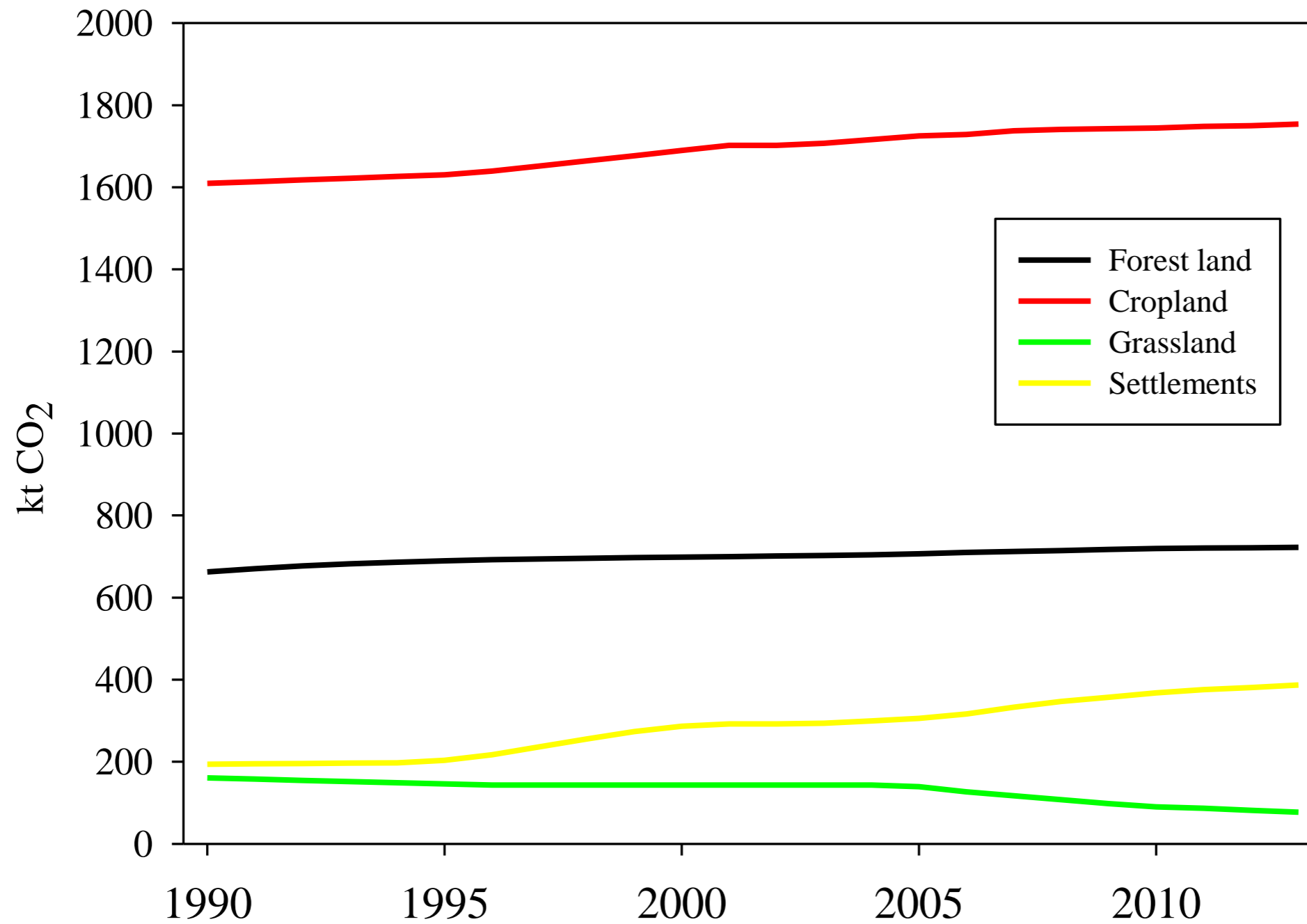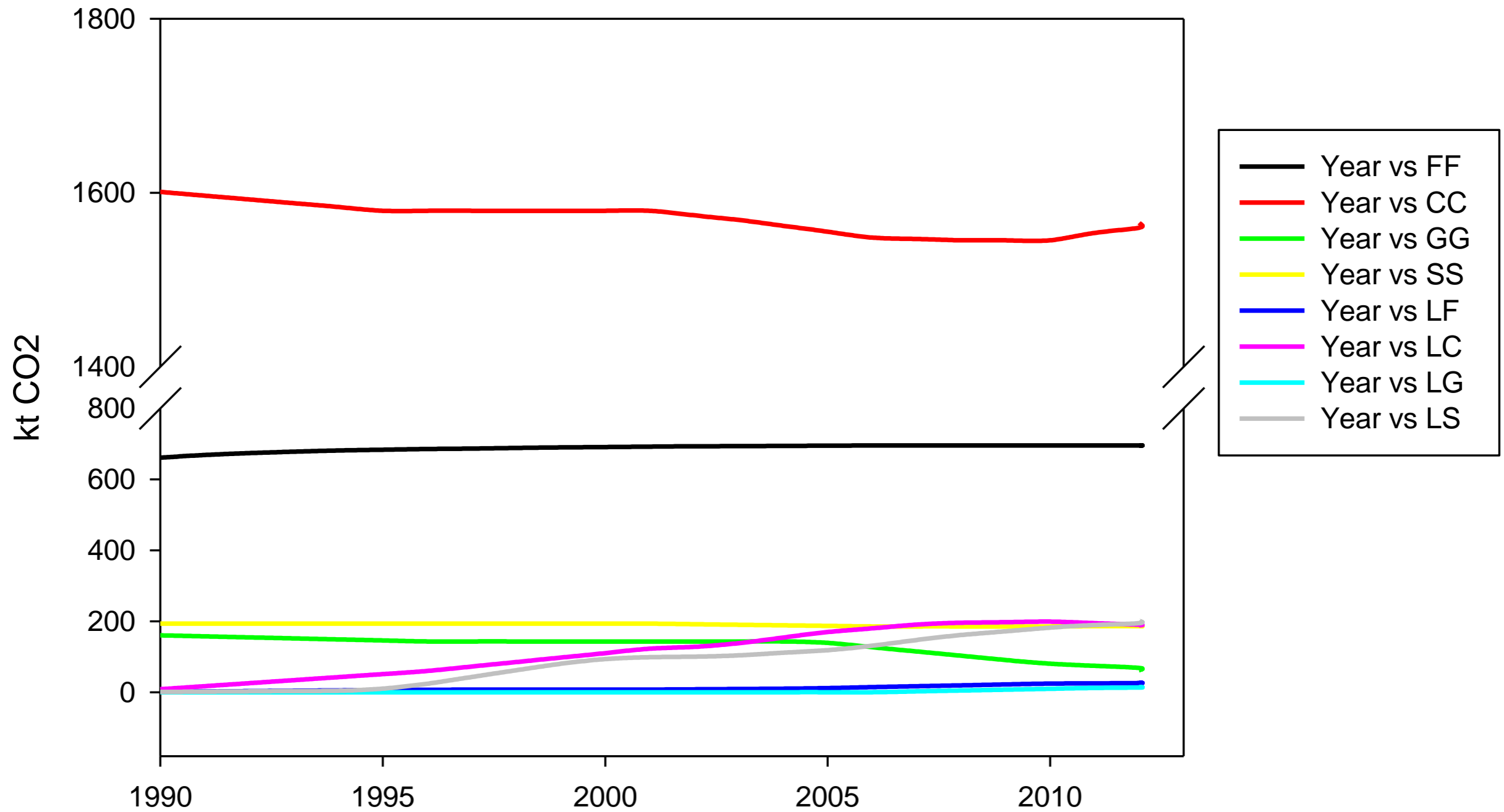# Key issues of implementing 2006 & 2013 guidelines

Drained organic soils

Main Norwegian challenges:

- No country-specific emissions factors for drained organic soils on any of the land-use classes (forest, cropland, grassland, settlements, peat extraction).
- Needed to use the 2013 Wetlands supplement emission factors as they represent most up to date research.
- Activity data (areas of drained organic soils) was not spatially specific.
  - Needed to merge the NFI plots tracking land-use change with soil and resource maps.
  - Area of drained organic forest soils only from external data.
- General decision on how to apply the 2013 WS emission factors:
  - All Norwegian forest is in the boreal **vegetation** zone and 79/21% nutrient rich/poor
  - Grasslands in the temperate climate / vegetation zone and nutrient rich.
  - Cropland (in the temperatue climate / vegetation zone.
- Effect of new guidelines – comparing estiamtes of 2014 and 2015 NIR
  - Area of cropland & grassland on organic soil 5 kha smaller but EF larger = little effect on CO_2 but inclusion of CH_4
  - Area of drained organic soils in forests was the same but EF smaller = reduction in CO_2 but inclusion of N_2O and CH_4 increased total emission

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CO$_2$ emissions (kt) from drained organic soils

kt CO$_2$

Legend:
- Forest land (black)
- Cropland (red)
- Grassland (green)
- Settlements (yellow)

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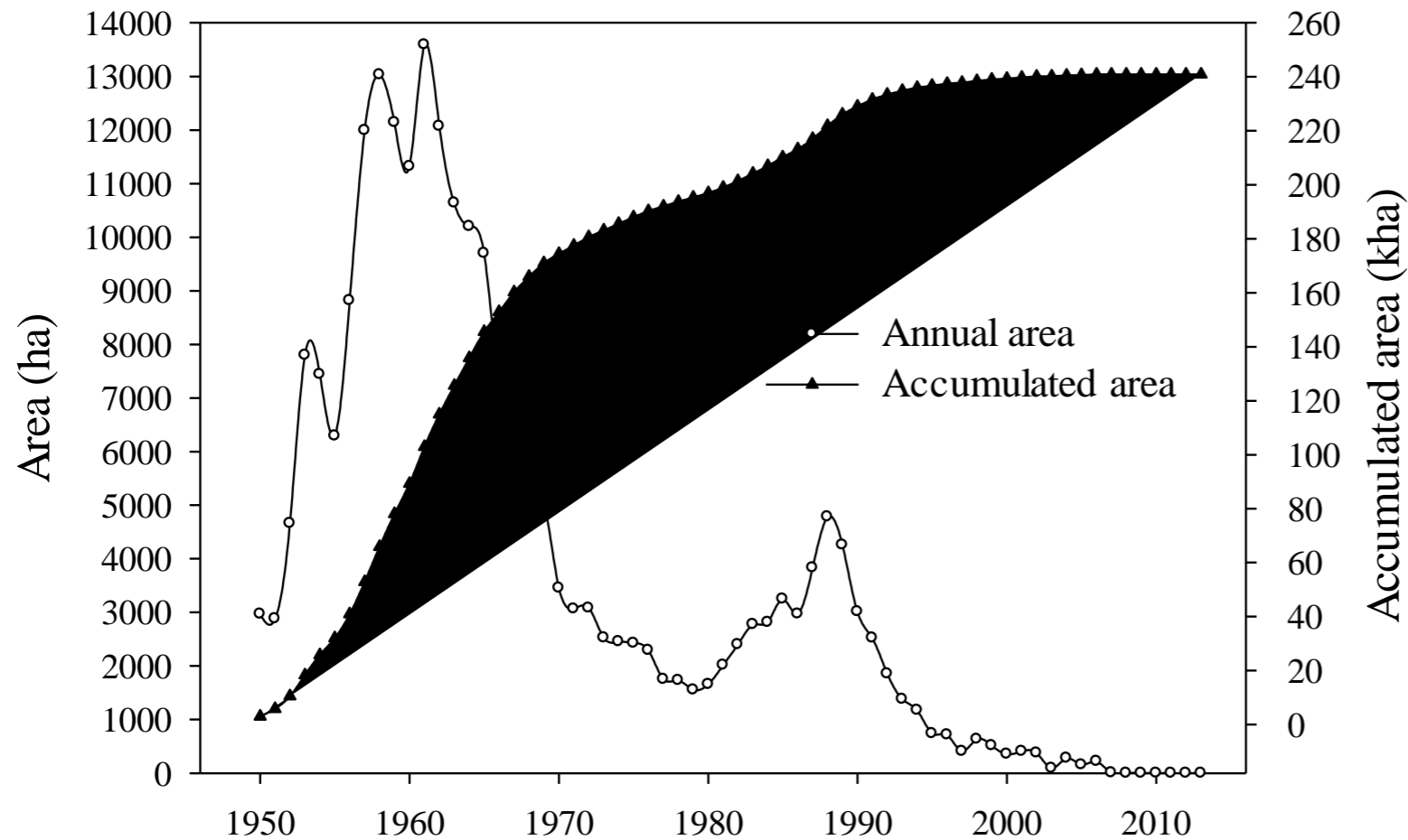
CO2 emissions - drained organic soils

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Methane and nitrous oxide emission from drained organic soils
(N2O from cropland and grassland reported under agriculture)

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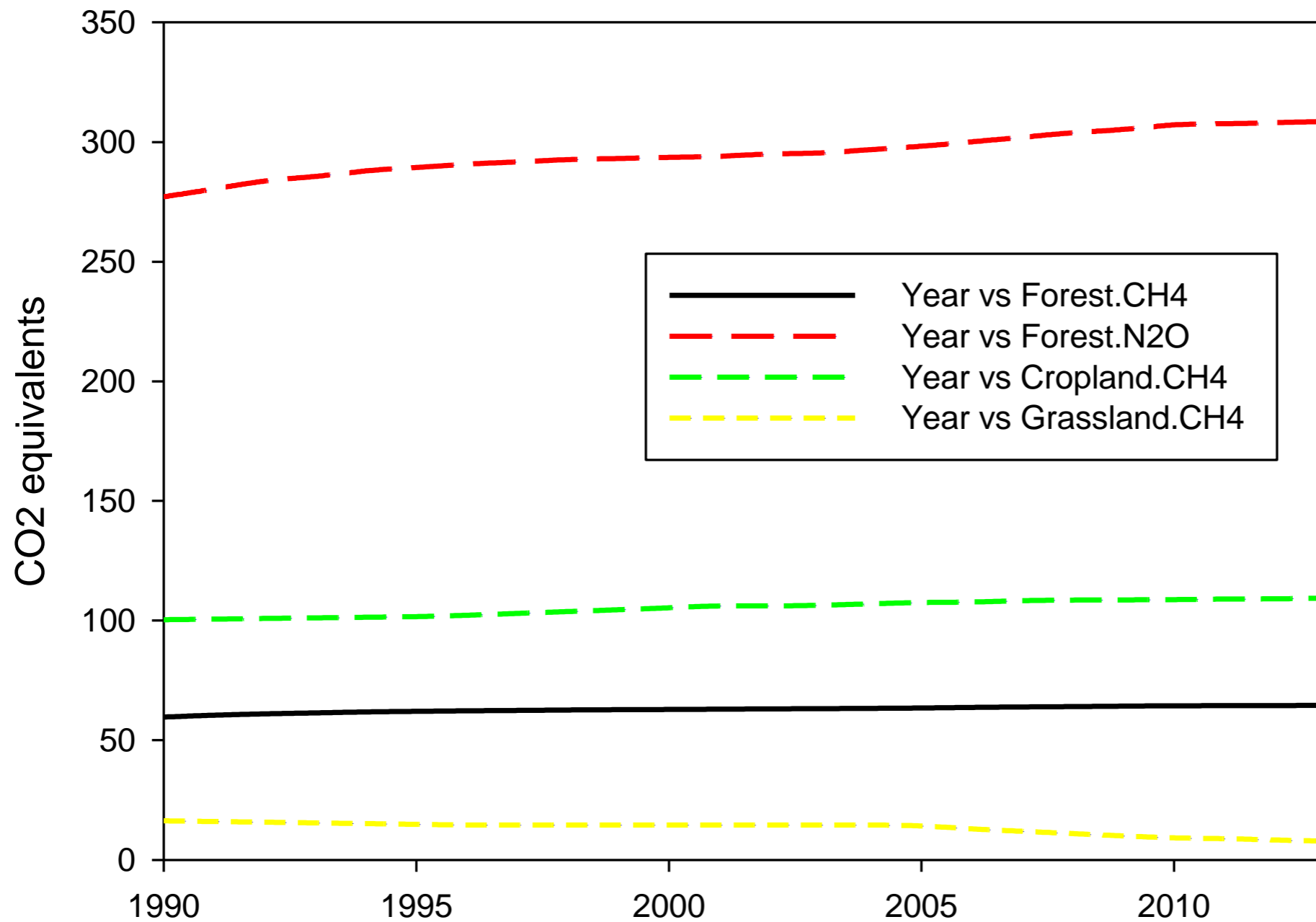
Subsidy statistics on the area of forest ditches

*Could include mineral soils – data not coupled to soil map*

Assumptions:

All forest in boreal vegatation zone.
79% nutrient rich
21% nutrient poor

Questions:

For how many years should soil be accounted for if ditches are no maintained?

Figure 1 Forest area drained in Norway from 1950 to 2013; annual area in ha (blank circles; left side axis) and accumulated area in kha (filled triangles; right side axis)

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Difference between using vegetation or climate zones to assign 2013 Wetland supplement emission factors
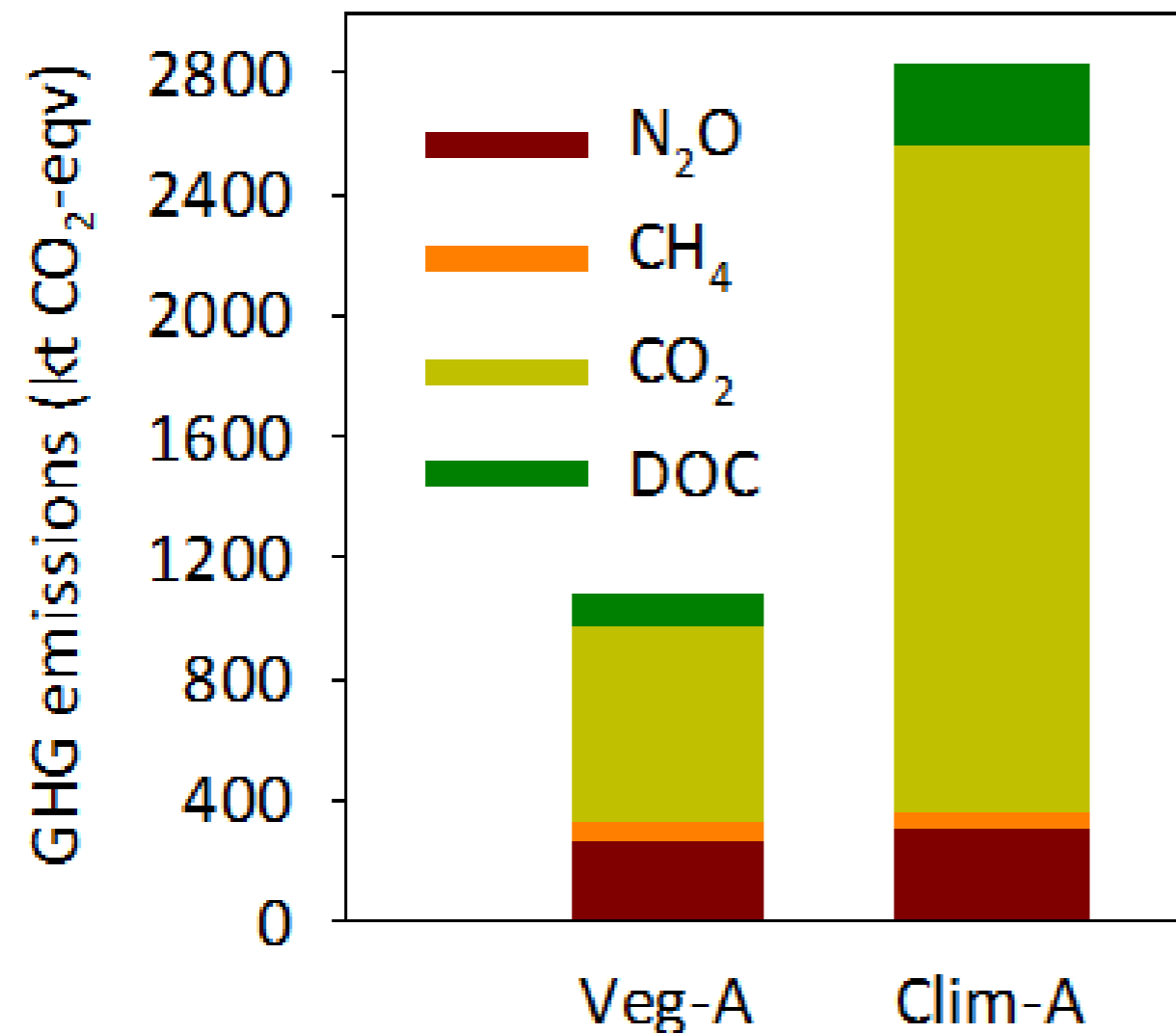
Structure of the NIR
LULUCF chapter

- Follow Decision 24. CP.19
- Point 6.4 repeated for
  - All «remaining» land-use classes 4.A.1-4.F.1
  - All «land converted to» classes 4.A.2-4.F.2
  - Harvested wood products 4.G
  - Direct N2O emissions 4(I)
  - Emissions and removals from drainage and rewetting 4(II)
  - Direct N2O from N mineralization adn immobilization 4(III)
  - Indirect N2O from managed soils 4(IV)
  - Bimass burning 4(V)

Headings:
- Methodlogical issues
  - Acitvity data
  - Emission facors
- Uncertainties
- QA/QC and verification
- Recalculations
- Planned improvements
- Completeness

Conference of the Parties

Report of the Conference of the Parties on its nineteenth session, held in Warsaw from 11 to 23 November 2013

Addendum

Part two: Action taken by the Conference of the Parties at its nineteenth session

Contents

Decisions adopted by the Conference of the Parties

Chapter 6: Land use, land-use change and forestry (CRF sector 4)

6.1. Overview of sector (e.g. quantitative overview and description, including trends and methodological tiers by category, and coverage of pools)

6.2. Land-use definitions and the classification systems used and their correspondence to the land use, land-use change and forestry categories (e.g. land use and land-use change matrix)

6.3. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

6.4. Category (CRF category number)

6.4.1. Description (e.g. characteristics of category)

6.4.2. Methodological issues (e.g. choice of methods/activity data/emission factors, assumptions, parameters and conventions underlying the emission and removal estimates and the rationale for their selection, any specific methodological issues (e.g. description of national methods and models))

6.4.3. Uncertainties and time-series consistency

6.4.4. Category-specific QA/QC and verification, if applicable

6.4.5. Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

6.4.6. Category-specific planned improvements, if applicable (e.g. methodologies, activity data, emission factors, etc.), including those in response to the review process

Structure of the NIR

KP-LULUCF chapter

- Decision 2/CMP.8, Annex II all sub-paragraphs §1-5
- For HWP: 2/CMP.7 Annex, §16 and 27-32
- Technical corrections: 2/CMP.7 Annex, § 17

Not relevant for Norway

- Natural disturbance: 2/CMP.8, Annex II, § 2(f) & 2/CMP.7, Annex, § 33-34
- Conversion of natural forest to planted forest
- Harvest and conversion of forest plantations to non-forest land.

Conference of the Parties serving as the meeting
of the Parties to the Kyoto Protocol

Report of the Conference of the Parties serving as the
meeting of the Parties to the Kyoto Protocol on its eighth
session, held in Doha from 26 November to 8 December 2012

Addendum

Part Two: Action taken by the Conference of the Parties
serving as the meeting of the Parties to the Kyoto Protocol at
its eighth session

Contents

Decisions adopted by the Conference of the Parties serving as
the meeting of the Parties to the Kyoto Protocol

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Things we try to rememeber when writing NIR

- Keep it as short as possible – no repeating – instead section-based referencing.
- Must be easy to find all information (e.g. Method, emission factor, acitivty data) in one place.
- Try to avoid tables and figures that need annual updating (although this cannot be completely avoided).
- Don't promise too much in Planned improvements.
  - From 2015 we focus on responding to ERT review comments.

- KP-LULUCF (chap 11) and LULUCF (chapter 6)
  - We describe all methods in detail in chapter 6 and only refer to there in chapter 11.
  - Only describe if there are methodological differences betwen KP and Convention reporting (e.g. Due to different stock change rates for human-induced vs non-human induced land-use change.
  - In KP chapter refer to Decisions and their paragraphs.

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Consistent reporting of N_2O emissions from managed organic soils and other sources

What is reported under LULUCF and what is reported under Agriculture?

	LULUCF	Agriculture
Direct N_2O from N fertilizer in CRF Table 4(I)	N fertilizer (organic & synthetic on forest land, wetland & settlements. (Norway: sewage sludge on parks, road sides)	N fertilizer on cropland and grasslands
N_2O from managed organic and mineral soils in CRF Table 4(II)	N_2O, CH_4 and CO_2 from forest land & peat extraction. CO_2 and CH_4 from cropland & grassland. CO_2 from settlements	N_2O from croplands and grassland
Indirect N_2O from N inputs in CRF Table 4(IV)	Atmospheric deposition from N fertilizer applied on forests, settlements & wetlands. Leaching + runoff from N fertilizer on forest, settlements & wetlands, N min/imm (not for KP).	Atm. Dep from N fertilizer to cropland + grassland & urine+dung from animals. Leaching + runoff from urine+dung, crop residues, N fertilizer on croplands + grasslands.

Defining Management systems for cropland and grassland

- Does not cover all management system in the country – but the ones most important for affecting the stock change factor (impact factor).
- Systems with different levels of residue input and tillage level – simplify!
- Suitable for the type of data available; in Norway:
  - Cropland based on 3 crop types: cereals, grass ley in rotation, and root crops.
  - Grassland based on 2 management systems (high input and low input)

1	Cont. grain straw removed
2	Cont. grain straw returned
3	1:2 root crops-grain
4	1:2 root crops-ley
5	1:2 Ley-grain
6	1:1 Ley-grain
7	2:1 Ley-grain
8	Cont. ley
+	Manure added

- Rotations are based on reasoning – not farmer surveys or reality!

- How to estimate the areas under the different rotations?

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Splitting total area into management systems

- Define a reasonable sub-region (county level?) where areas per crop type is available.
- For each sub-region determine the prominant and only type of ley-grain rotation based on the percentage of grain of total cropland area:
  - \> 65% grain → 1:2 ley-grain rotation
  - 35-65% grain → 1:1 ley-grain rotation
  - < 35% grain → 2:1 ley-grain rotation
- Calculate the area of the ley-grain rotation.
- If root crops, put in rotation with what is left (either grain or ley).
- Area that is left of either grain or ley is either continuous grain or ley cropping.

- Caluculation is programmed in R where areas per crop type is input and output is areas per management system.
- Remember that area of CC (or GG) must be the same (constant) for the inventory period you are estimating, i.e. Carbon stock change values for 2000 is based on the area of CC for 1990 to 2000 and so on. Only the managment systems change – not the area.

Tier 1 defined stock change factors

$$F = F_I \times F_{MG} \times F_{LU}$$

- Specific to management system, but same for all climate zones

Assign input level (F_I) based on national statistics:

Low: < 2 Mg C ha^{-1}yr^{-1} (0.92)

Medium: 2-2.5 Mg C ha^{-1}yr^{-1} (1.00)

High: 2.5-3 Mg C ha^{-1}yr^{-1} (1.11)

Very high: > 3 Mg C ha^{-1}yr^{-1} (1.44)

Tillage factor (F_{MG}) estimated:

Full/annual: grains or root crops (1.00)

Reduced: grain-ley or ley (1.08)

Land-use factor (F_{LU}):

Long-term cultivation (0.69)

	Crop rotation	Mean input (Mg C ha^{-1})	Tier 1 levels Input	Tillage
1	Grain (- straw)	1.55	Low	Full
2	Grain (+ straw)	2.83	High	Full
3	1:2 root-grain	2.35	Medium	Full
4	1:2 root-ley	1.93	Low	Full
5	1:2 ley-grain	2.56	High	Red
6	1:1 ley-grain	2.61	High	Red
7	2:1 ley-grain	2.54	High	Red
8	Leys	2.25	Medium	Red
1+	Grain (- straw)	2.85	High	Full
2+	Grain (+ straw)	4.13	Very high	Full
3+	1:2 root crops-grain	3.65	Very high	Full
4+	1:2 root crops-ley	3.23	Very high	Full
5+	1:2 ley-grain	3.86	Very high	Red
6+	1:1 ley-grain	3.91	Very high	Red
7+	2:1 ley-grain	3.84	Very high	Red
8+	Leys	3.55	Very high	Red

\+ 1.3 Mg C /ha yr manure added

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Norwegian QA/QC plan
Specific for LULUCF

- The LULUCF-specific QA/QC plan was developed in 2013.
- Objectives of the QA/QC plan:
  - Ensure that emissions estimates and data are of high quality
  - Facitilate and assessment of the invetnory in terms of quality and completeness.
- Two parts: Internal QC activities and external QA elicitation.

- Part 1: Internal QC activites include two check lists
  - One for the source-category responsible (person making estimates on a specific source/sink)
  - One for the LULUCF inventory compiler (the coordinator)
  - Both check list are compined and included in the Annex V of NIR about the Norwegian National Inventory system.

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Internal quality checking (QC list)

Source responsibles:

- Developed specific check lists for each source responsible.
- Debatable how well it works in the rushed time up to submission.
- Continuously up for discussion how to improve the list and system for better efficiency.

- LULUCF compiler:
- A check list for the LULUCF compiler
- Constructed and executed by the same person.
- In reality, little time to follow up when documentation QC is not performed according to the plan by source responsibles.

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Source responsible check list

Checks made when emission estimates are entered in LULUCF excel for CRF:	Done (x)
1) Evaluate a representative unit level of emissions calculations, e.g. Mg CO_2 /ha	
2) Check for unit labeling, conversions and correct spatial and temporal up-scaling: - Install automated checks in model codes	
3) Evaluate emission factors or model parameter values: - Consult representative literature and NIRs of the Nordic countries if relevant	
4) Note in excel sheet where emissions are reported: - Has the time series been recalculated? If yes, why? - What is the range of appropriate values? - Reason for extreme emissions/removals in certain years if relevant?	
5) Evaluate the uncertainty estimate (assumptions or method used)	
Checks made when finishing the source/sink section of the NIR:	
1) Provide documentation for the methodology used, including assumptions and information related to activity data and emission factors (cf. # *1 Documenting and archiving*)	
2) Check for transcription errors and that citations are properly referenced	
3) Ensure documentation of method and/or assumptions for uncertainty estimation	

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LULUCF compiler check list

Task	
1. Check if documentation is provided for all source categories	
2. Check NIR chapter for proper used citations and references	
3. Check that representative sample size emission estimate is provided	
4. Review documentation of primary database	
5. Check for consistency in area estimates of cultivated organic soils	
6. First quality check of CRF tables	
7. Check that all source categories have associated uncertainty emissions estimates	
8. Check for times-series and general completeness within all source categories: - Emissions, uncertainties, complete times-series, recalculations and justification, documentation and QA/QC check list	
9. Check that total recalculation for LULUCF are made: - Reported in LULUCF recalculation chapter sent to NEA before 1 April	

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LULUCF QC list

Official part of NIR Annex V

Performed on 12 points (2005 IPCC):

1. Documentation of assumptions and selection criteria
2. Transcription errors
3. Emission calculations
4. Labeling of parameter units, conversion factors and unit transfer
5. Database integrity
6. Consistency within sectors and source categories
7. Transfer of estimated emissions between inventory staff
8. Uncertainty estimation and calculations
9. Review of internal documentation
10. Time-series consistency
11. Completeness
12. Comparison to previous estimates

Check performer	Type of check
	Checks for errors in time-series, units, computational and human errors
All source-responsible	Evaluate emission from the whole time series by providing 1) range of appropriate values, 2) red color on extraordinarily large inter-annual variation, and 3) explanation of why in the LULUCF excel sheet.
Area responsible	Analyse area changes in land use and provide a range of appropriate annual changes.
LULUCF compiler	Ensure that drastic annual changes are commented and that all reported C changes are within the range provided in the LULUCF excel sheet.
	Completeness checks
LULUCF compiler	Automated completeness is checked by Statistics Norway in the CRF reporter. NFLI awaits the results before final CRF and NIR are approved.
LULUCF compiler	Of inclusion of all emission/removal sources.
LULUCF compiler	All LULUCF and KP tables in CRF are inspected for missing annual values.
	Checks for errors in time-series, units, computational and human errors
NFLI & Statistics Norway	Two cross-checks with Statistics Norway: 1) areas of cultivated organic soils and 2) areas of N-fertilized forests.
Qualified NFLI person*	Consistency check of areas reported in CRF tables for convention and KP.
Source-responsible	Living biomass in forest is used as model input for estimating C stock changes in forest soils and DOM. The biomass estimates are cross-checked.
LULUCF compiler	It is checked that the area of drained forest is used both for estimating CO_2 and N_2O emissions.
	Recalculations
LULUCF compiler	All recalculations made are described in the NIR in chapter 7 and 11 *LULUCF* and *KP-LULUCF* and repeated for LULUCF in chapter 9 *Recalculations.*
All source-responsible	Sink/source category reporters explain in the LULUCF excel sheet when recalculations have been made.
LULUCF compiler	CRF recalculations are made for 1990, 2000, and the last year of the inventory period and inspected manually. Percent changes larger than 50% are explained in the CRF reporter.
	Documentation
LULUCF compiler	Check that new methods are described in detail and that the documentation is stored properly and can be made available upon request during review.
All source-responsible	Store all source/sink specific information on: B:\30-I\35\341110-1_Rapportering LULUCF\Rapportering

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Quality Assurance and verification

- Two types of QA:
  - «Quick» elicited QA done on new method implementation. Performed by LULUCF reporters from other countries or other experts familiar with the method. Mostly on Tier 1 and 2 methods.
  - Longer-term QA projects with the objectives to verify (or test) a model. Can be done before or after implementation of the method. Mostly on or to develop Tier 3 methods.
- The general rule is that when a new method is implemented it must be checked by a second person perferable from another insitution (international).
  - Both method description and calculations are checked.
  - Works well – highly recommended.
  - We are looking for more partners to offer this mutual service to!
  - Sometimes you have to pay and sometimes not.
- Examples of elicited QA
  - All cropland methods. (2012). Several methods revised in a review.
  - Tier 1 method for mineral soil on grassland remaining grassland – lead author of guidelines. (2013)
  - Tier 2 for HWP – Swedish HWP reporter. (2014)
  - Tier 2 method for mineral soils, dead wood and litter for land-use changes evaluated by several qualified colleagues at NFLI.

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Verification projects: Tier 3 soil models

Yasso07 on forest mineral soils

- Two year project including soil sampling to obtain measured stock changes on two sites in Norway.
- Model testing using Yasso07 and ROMUL.
- Two seminars held with three contracted external experts from Norways, Finland and Denmark.
- Writing of an extensive report.

- Project started after Tier 3 method implemented.
- Time-consuming and costly but fairly easy to finance.

ICBM on cropland mineral soils

- Norway has elected cropland management for the 2nd KP period.
- One year project testing ICBM against one long-term trail (60 years) and evaluating «Norwegian» parameterization.
- Testing and evaluating estimates for cropland using different levels of scale for input data (crop yields and areas, and climatic data). Fx 4 sub-regions or county level?
- Evaluate the appropriate scale to report emissions. Mean carbon stock changes for the invnetory period may be more correct that annual fluctuations.
- Tier 3 method not implemented yet.

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