Present readiness of, and white spots in the Dutch National System for greenhouse gas reporting of the Land Use, Land-Use Change and Forestry sector (LULUCF)

This study was carried out for NOVEM on behalf of the ministry of Housing, Physical Planning and the Environment through contract nr. 1331-02-02-01-08-008

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Alterra-rapport 774

Alterra, Green World Research, Wageningen, 2003

REFERAAT

Nabuurs[1] G.J., W.P. Daamen[4], G.M. Dirkse[1], J. Paasman[3], P.J. Kuikman[1], A. Verhagen[2], 2003. *Present readiness of and white spots in the Dutch National System for greenhouse gas reporting of the Land Use, Land-Use Change and Forestry sector (LULUCF).* Wageningen, Alterra, Green World Research. Alterra-rapport 774. Alterra-rapport 774. 97 blz. 2 fig.; 13 tab.; 14 ref.

Current LULUCF greenhouse gas reporting by the Netherlands is incomplete. The few sections that are included in the current reporting are done at lower Tiers. Thirty nine existing monitoring systems or databases were identified as possibly relevant for setting up a national system. The systems are grouped as follows :
1: systems for land use and area (mapping), including soil maps (13);
2: data on agricultural and forestry practices that may serve to derive emission factors (16)
3: data on emission factors including weather and groundwater data (8)
4: modelling systems (2).
Based on the identified exisiting systems, the report concludes on the main discrepancies between the ongoing reporting/current monitoring systems and the requirements as set out by the Marrakesh Accords and the 1st draft of the Good Practice Guidance.

Keywords: Kyoto protocol, national system, carbon sinks, greenhouse gases

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ISSN 1566-7197

This report can be ordered by paying € 23,- into bank account number 36 70 54 612 in the name of Alterra, Wageningen, the Netherlands, with reference to rapport 774. This amount is inclusive of VAT and postage.

Contents

Preface

This report is part of the track that The Netherlands follows towards implementation of its National System for LULUCF Greenhouse gas reporting. The current study aims at identifying current gaps that the Netherlands is facing in comparison to requirements as set by the Marrakesh accords. The current study was financed by NOVEM contract 1331-02-02-01-08-008. We wish to thank the people in the Steering Committee: Gijs van Tol, Bas Clabbers, Eveline Trines, Harry Vreuls, Christiaan Abeelen, Ivo Rooze, and Sandra Greeuw

Summary

One of the consequences for the Netherlands of being a Party to the *United Nations Framework Convention on Climate Change* (UNFCCC) is the obligation to design and operationalise a national system for greenhouse gas reporting for the LULUCF sector.
Current LULUCF greenhouse gas reporting by the Netherlands is incomplete; while new demands for reporting have been brought forward to the Parties through the Marrakesh Accords. Reporting will comprise national level reporting (UNFCCC), and reporting for those pieces of land that fall under the Kyoto Protocol.

The aim of the current study is to obtain insight in the current functioning of the inventory, monitoring and reporting of the Dutch LULUCF sector to UNFCCC, and to have insight in all ongoing/operational/available monitoring systems and/or databases that could be of any value for a National system. Discrepancies between the ongoing reporting/current monitoring systems and the requirements as set out by the Marrakesh Accords and the 1st draft of the Good Practice Guidance are identified as well.

Current LULUCF greenhouse gas reporting by the Netherlands is incomplete. The few sections that are included are done at lower Tiers.

Thirty nine monitoring systems or databases were identified as possibly relevant for setting up a national system. The systems are grouped as follows :
1: systems for land use and area (mapping), including soil maps (13);
2: data on agricultural and forestry practices that may serve to derive emission factors (16)
3: data on emission factors including weather and groundwater data (8)
4: modelling systems (2).

A road map to reporting under Tier 2 and 3 includes:
- formal Key category analysis in LULUCF sector
- choice for an area and area change system
- choice on land use changes and emission factors to be improved;
- definition of area organic soils – mineral soils (C stocks) and definition of agricultural soils versus wetlands versus other;
- decision on required reporting level and reporting scheme of CO_2 and on non-CO_2 greenhouse gases
- design of national system with minimum and maximum demands.

Based on the points mentioned above, and the detailed information in appendices, chapter six concludes on the main discrepancies between the ongoing reporting/current monitoring systems and the requirements as set out by the Marrakesh Accords and the 1st draft of the Good Practice Guidance.

1 Introduction and Aim

One of the consequences for the Netherlands of being a Party to the *United Nations Framework Convention on Climate Change* (UNFCCC) is the obligation to design and operationalise a national system (Article 5 of the UNFCCC). One of the elements of such a system is an inventory system for greenhouse gases, including those related to the Land Use, Land-Use Change and Forestry sector (LULUCF, Art 5.1 of Kyoto Protocol). Good Practice Guidance (GPG) for such an inventory, monitoring, and reporting system is now being prepared by the Intergovernmental Panel on Climate Change (IPCC) and will include both guidance for reporting under the Convention, as well as under the Kyoto Protocol.

Currently the Netherlands reports only some land use types and activities to the UNFCCC (Olivier et al. 2003, Spakman et al. 1997). These are changes in forest biomass, and N_2O and CH_4 emissions from agricultural soils. It is clear that this current level of reporting will not suffice the new requirements.

It is therefore essential to have the insight in the current functioning of the inventory, monitoring and reporting of the Dutch LULUCF sector to UNFCCC, and to have insight in all ongoing/operational/available monitoring systems and/or databases that could be of any value for a new design of the national system. We limit ourselves here to the domestic national inventory system, i.e. excluding any requirements that are a results of JI or CDM projects elsewhere. We also exclude aspects from animals and manure that are dealt with in the Agricultural section of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (96GL) (IPCC 1996).

Discrepancies between the ongoing reporting/current monitoring systems and the requirements as set out by the Marrakesh Accords and the 1st draft of the GPG will be identified.

2 Present functioning of the Dutch National System for Greenhouse gas balances of the LULUCF sector

Regarding the LULUCF sector, the Revised 1996 IPCC Guidelines (96GL) provide guidance on a number of components of a full greenhouse gas budget of the LULUCF sector (IPCC 1997). The LULUCF sector is numbered IPCC category 5. Components for which guidance was supplied in the 96GL were:

5A. Changes in Forest and Other Woody biomass stocks
   1. Annual growth minus harvest (corrected for off site burning);

5B. Forest and Grassland conversion;
   1. Immediate release from burning (distinguished by on site and off site burning), including non-CO_2 trace gases;
   2. Delayed release from decay over 10 years;

5C. Removals of CO2 from abandonment of managed lands over 20 years;

5D. Other: CO_2 emissions and uptake by soils from land use change and management.
   1. CO_2 emissions and removals from soils over 20 years

The Dutch annual National Inventory Report (NIR) is executed by the National Institute for Public Health and Environment (RIVM) in co-operation with TNO, Novem and CBS (Olivier et al. 2003). Methodological sub projects underlying the national reporting are summarised in the reports "Methods for calculation of greenhouse gas emissions" adopted by the Co-ordination Committee Targetgroup Monitoring (CCDM) (Spakman et al. 1997, 2003).

The current reporting of the Dutch LULUCF sector (excluding animals and manure), includes for (Figure 2.1):

5A. CO_2 sink from changes in forest (tree) biomass is reported (one average for volume increment based on national forest inventory minus harvest with one simple Biomass Expansion Factor);

5C. The ongoing forest area expansion can be seen as a form of abandonment of managed lands and is reported annually or as a 3-years average;

5D: N_2O direct agricultural soil emissions from different kinds of fertilisers (based on few emission factors), and indirect background emissions are reported[1]; the latter with exception of indirect emissions from atmospheric deposition. However, he reporting of N_2O is incomplete; no data for crop residues or N fixed, nor are emissions from cultivation of organic soils included.

[1] The agricultural N_2O emissions from manure are outside the scope of the current report.

CH_4: only an estimate for the background flux is given for CH_4 from moist soils (this is assumed non anthropogenic and is thus not reported) based on few emission factors. CO_2 emissions and removals for soils are not reported.

All other possible components of a full greenhouse gas budget for the LULUCF sector are not reported.

In The Netherlands all pollutants emissions are registered in the so called 'Emission Registration' (ER). In collaboration with research institutes as National Institute for Public Health and Environment (RIVM), Energy Research Center Netherlands (ECN), Statistics Netherlands (CBS), and funding agencies as Netherlands Agency for Energy and Environment (NOVEM) emission data are gathered and stored. Two types of data are distinguished: those that can be traced back to an individual source: individual (ER-I), and those that are derived from e.g. statistics for a whole sector: collective (ER-C). The LULUCF data are not included in the Emission Registration, but collected for the NIR.

The data for categories 5A and 5C mentioned above were derived by Foundation Bosdata based on the Dutch Forest Inventory for the period 1990-2000 (Daamen, 2002). No new data for 2001 onwards are available (Olivier e.a. 2003) For these categories the suggested approach of the 96GL is used. However national specific data for increment and harvest are used. Also slightly different values than suggested in the 96GL are used for the biomass expansion factor and for basic wood density. It is not clear where the latter two come from.

For 5D (N_2O) Kroeze (1994) carried out several specialist studies. For 5D (CH_4 from wet soils) Amstel (1994) carried out overview studies for natural, non anthropogenic emissions (App H in Spakman et al. 1997). Latest developments are maps of soil C stock by Kuikman et al. (2003), and updates regarding the forest map (Dirkse et al. 2001). It is undecided yet whether data of these latter two studies will be incorporated in future inventories.

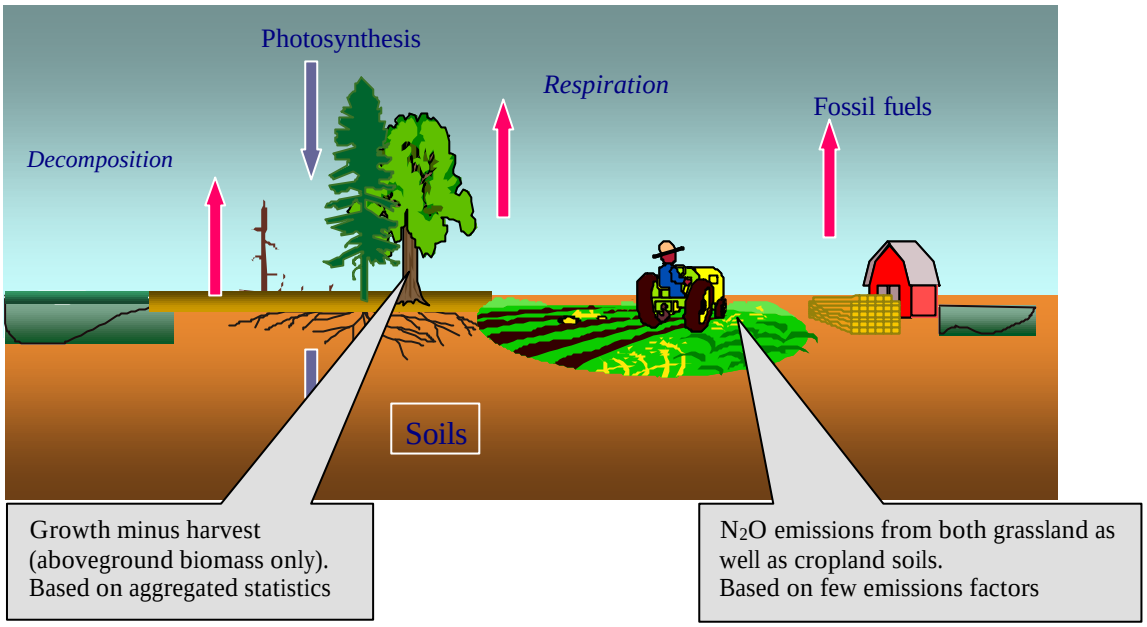

Figure 2.1. Current reporting of the Netherlands for the LULUCF sector (excl animals and manure). Of the many land use types, area changes, processes, and pools only the biomass change in forests, and N_2O emissions from agricultural soils are reported.

3 Requirements for a National System for greenhouse gas balances as set by the Marrakesh Accords and as specified by the IPCC Good Practice Guidance (GPG)

3.1 Introduction

Following the UNFCCC, all Parties are obliged to report annually on their emissions of anthropogenic greenhouse gases by sources and removals by sinks. In addition to this, the Kyoto Protocol (UNFCCC 1997) and the follow-up conference in Marrakesh (UNFCCC 2001) specified for the Land use, Land-Use Change and Forestry Sector (LULUCF) that each Party included in Annex I shall have in place no later than one year prior to the start of the first commitment period, a national system for the estimation of the anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol. Thus reporting for the LULUCF sector will comprise two levels: 1) full national coverage (so called UNFCCC reporting), and as a subset: 2) the reporting under the Kyoto Protocol.

Following up on this, the IPCC was asked to prepare Good Practice Guidance for inventory, monitoring and reporting on emissions and removals associated with the LULUCF sector. This chapter summarises the good practice guidance as presently available.

3.2 UNFCCC reporting

3.2.1 Areas and area changes

Good practice guidance suggests six main groups of land use types: Forest, Cropland, Grassland, Wetland, Settlements, and Other lands. The areas and gross area changes between these vegetation types from last year to this year are required for the years of the commitment period (2008-2012). The geographical locations of these areas do not need to be reported for UNFCCC, but gross area changes are necessary for reporting requirements given in sections 3.2.2 and 3.3 (see Table 3.1).

The GPG indicates three approaches to arrive at estimates for areas and gross area changes between land use types. Approach 1) Basic land use data from e.g. agricultural statistics, 2) survey of land use and land-use change, and 3) geographically explicit land use data

The result of using either one of the approaches is called the land use change matrix (Table 3.1).

- This land-use change matrix per inventory year is at the minimum set up for the main land use types. These main types can be sub divided according to national classifications, chosen Tier (§ 3.2.2), and desired level of accuracy, etc.
- This matrix is required for every reporting year (this does not mean that measurements need to be made every year), but also for the base year 1990. However, GPG suggests that if a land use types originates from another use, then it must be followed in that 'changed use' status for 20 years. This means that in order to be able for 1990 to either assign a piece of forest to 'forest remaining forest' or to 'forest coming from e.g. cropland', the land use matrix needs to be available for 1970 as well.
- It is required that all managed lands shall be covered.
- The area and area changes quantification does not need to be done in a geo-referenced way under UNFCCC reporting, but the main land use classes need to be sub divided to a level allowing the chosen Tier to be executed with sufficient accuracy. The resolution at which areas are identified is not set by Marrakech Accords for UNFCCC reporting; only for the Kyoto part (§ 3.3).

Table 3.1. Example of an area and area changes matrix.

Reporting year	Previous year Forest	Cropland	Grassland	Wetland	Settlement	Other lands
Forest						
Cropland	*		*			
Grassland	*					
Wetland	*					
Settlements	*		*			
Other lands	*		*			

* : the ' forest and grassland conversion' section of the 96GL

3.2.2 Emissions by sources and removals by sinks (CO_2 and non-CO_2)

GPG suggests an inventory-based stock change approach which consists (for carbon) of a combination of areas (or changed areas) multiplied with an emission factor per unit of area (equation 3.1). For non-CO_2 gases a flux approach is suggested.

$$\Delta C = A * E \qquad 3.1$$

where

ΔC = carbon stock change
A = area
E = emission factor

An emission factor is a hectare scale carbon flux rate specific for land use and management at the chosen level of detail. GPG suggests three levels of detail 'Tiers' (Box) to arrive at a national reporting system for all greenhouse gases related to the LULUCF sector. These Tiers should not be seen as strictly separable; intermediate forms as well as mixed forms (between Tier 2 and 3) can be thought of.

Box 3.1

The **Tier 1** approach employs the basic method provided in the IPCC Guidelines (Workbook) with its elaboration in the Good Practice Guidance report and the default emission factors provided in either the IPCC Guidelines or the Good Practice Guidance. For land uses and pools not elaborated in the IPCC Guidelines, guidance is provided in GPG on constructing first-order estimates and default emission factors (for a global coarse resolution). Implicitly, the 1996 guidelines had these pools and activities incorporated as well, but either the uncertainty was too large to include them, or it was assumed that the source or sink size was very small. A Tier 1 methodology is likely to use activity data that are spatially coarse such as globally available estimates of deforestation rates, and agricultural and forestry production statistics.

Tier 2 uses the same methodological approach as Tier 1 but applies emission factors and activity data defined by the country for the most important land uses/activities. Country-defined emission factors/activity data are more appropriate for the climatic regions and land use systems in that country. Higher resolution activity data are typically used in Tier 2 to correspond with country-defined coefficients for specific regions and specialised land use categories

At **Tier 3**, higher order methods are used, including complex models and repeated (over time) inventory measurement systems, which are driven by high-resolution activity data, dis-aggregated at sub-national to fine grid scales. These higher order methods provide estimates of greater certainty than lower tiers and have a closer link between biomass and soil dynamics. Examples of such systems are being developed in several countries.

GPG further suggests to calculate and compile by pool (above-, belowground living biomass, dead wood, litter and soil organic matter) for reasons of consistency with reporting under the Kyoto Protocol. However, reporting by pool for UNFCCC reporting is not a requirement as specified in the Marrakesh accords.

Reporting for UNFCCC according to GPG gives the situation as sketched in Table 3.2.

Table 3.2. Rough compilation format for e.g. net CO2 eq. sinks for one column of Table 3.1

Previous land use:	Current land use					
Forest	Forest	Cropland	Grassland	Wetland	Settlement	Other
Aboveground						
Belowground						
Litter						
Soil organic carbon						
Dead wood						
Non-CO2						

3.3 Reporting under the Kyoto Protocol

This reporting needs to be done by Annex I countries only. It is divided into: 1) reporting related to Afforestation, Reforestation and Deforestation (ARD, Art 3.3; obligatory), 2) reporting and accounting related to additional activities as selected on a voluntary basis by individual countries (Art 3.4), 3) reporting and accounting related to Joint Implementation (JI) if relevant to the particular country (Art 6), and 4) reporting and accounting related to the Clean Development Mechanism (CDM) if relevant to the particular country (Art 12).

For reporting under the Kyoto Protocol the GPG suggests that higher Tiers should be used. However if e.g. some type of grassland management is elected by a Party to be reported under Kyoto Protocol Article 3.4, this does not mean that all grasslands must be reported according to higher Tiers under UNFCCC reporting.

Re 1, ARD)

- Eligible are those direct human induced Afforestation, Reforestation and Deforestation activities that meet requirements set forth in the Marrakesh Accords and that started on or after 1 January 1990 and before 31 December of the last year of the commitment period.
- A country must define 'forest'
- A country must geo-reference the area of ARD since 1990;
- A country must show how a clearcut is distinguished from deforestation
- Annual reporting of all GHG's during the first commitment period (CP1) [2]
- Stock changes of all pools (above- belowground living biomass, dead wood, litter and soil organic matter), if a pool is not reported, then you must show it is not a source;
- Assessment unit not larger than 1 ha
- Information whether or not emissions by sources and removals by sinks under Article 3.3 factor out removals from a) elevated carbon dioxide concentrations, b) indirect nitrogen deposition, and c) dynamic age class effects.

Re 2, additional activities)

- Policy decisions by individual Parties are needed on whether to include forest management, grazing land management, cropland management and/or revegetation in CP1.
- If the latter three are selected, then 1990 base year emission or sink is needed.
- For all four activities show that they have taken place since 1990, and are human induced
- Quantify emissions/removals per 3.4 activity area (if elected). Special accounting (see second dot) and caps (for Forest management) are calculated by the Registry;

[2] See footnote 3 on page 22 of FCCC/CP/2001/13/Add.3 'It is recognised in the IPCC 1996 Revised Guidelines that the current practice on land use, land use change and forestry does not in every situation request annual data collection for the purpose of preparing annual inventories…'

- Information whether or not emissions by sources and removals by sinks under Article 3.4 factor out removals from a) elevated carbon dioxide concentrations, b) indirect nitrogen deposition, and c) dynamic age class effects.
- Following principle should govern the treatment of LULUCF activities: 'implementation of LULUCF contributes to the conservation of biodiversity and sustainable use of natural resources' (11/CP7).

Re 3, JI)

- In principle all art. 6 activities are subject to the same rules as 3.3 and 3.4 activities, conform the decision 11/CP7
- Baseline required in case the Party serves as a host country (Netherlands is not likely to become a host country for JI).

Re 4, CDM)
Under the Clean Development mechanism, only projects that fall under Afforestation or Reforestation are eligible (17/CP7). Further requirements are mostly undecided yet. Two sections in Marrakesh accords provide:

- Accounting methods and issues as baselines, leakage etc. are still to be decided, but are mostly relevant to the national registry only.
- A project which has started already, may still be eligible provided it is registered before 31 December 2005. (17/CP7, section 13 says: '....project activity starting as of the year 2000, and prior to adoption of this decision, shall be eligible....if submitted for registration before 31 dec 2005'.

3.4 Verification and uncertainty analysis

The selection of the Tier at which the reporting is going to be carried out is an important part of the national system. To select a tier, a 'Key category assessment' must be carried out at the main land use type level: This consists of several analyses and considerations:

- how important (quantitatively) are the LULUCF emissions per land use type and their trends in time in the national total emissions;
- for reporting under the Kyoto Protocol, the GPG suggests that higher Tiers should be used. However if e.g. some type of grassland management is elected by a Party to be reported under Kyoto Protocol Article 3.4, this does not mean that all grasslands must be reported using higher Tiers under UNFCCC reporting.
- what can reasonably be expected from a country (already available data, man power, etc);
- in which emissions (or LULUCF vegetation type) is the largest uncertainty still present.

Based on analyses as given above, the Tier can be identified. It is expected that Annex I countries will move to higher Tiers in the future. Tier levels can certainly differ per land use type, but in practice probably also by pool within land use types.

However, there is still considerable freedom in selecting Tiers. Neither the Marrakesh Accords nor the GPG specifies a strict uncertainty range that must be achieved. GPG only gives uncertainty ranges for most default (Tier 1) data. Moving to higher Tiers may (sometimes) yield the same average result, but will reduce the uncertainty ranges, and will make reporting more transparent. The highest Tier provides more freedom in the set up of the national system, but will also be more costly. Further, national emission factors should be used when the GPG defaults are assumed to be incorrect for the national situation.

Further requirements:

- uncertainty analyses shall logically be a part of a national system
- material must be documented and archived
- consistency in time series needs to be adhered to (if a change in method is applied, then recalculation of past years needs to be done)
- verification needs to be done (either independent inventory based data sets, or other methods as remote sensing, modelling, towers, planes, etc).
- Quality Assessments and Quality Controls (QA/QC) must be carried out and documented. QC is a system of routine technical activities to measure and control the quality of the inventory as it is being developed. QA activities include a planned system of review procedures conducted by personnel not directly involved in the inventory and compilation process.

4 General outline of ongoing monitoring systems that are of relevance to the National System

Thirty nine monitoring systems or databases were identified as possibly relevant for setting up a national system for greenhouse gas reporting of the LULUCF sector. The tables below list the systems with a first main indication of usefulness for a National System for LULUCF. Whether these individual databases are useful (+) or less useful (-) was tested on the bases of criteria given below. If a system meets all criteria, then it was given the rating 'useful'. When it failed on one or more, it was given the rating 'less useful'. However, in the latter case a database may still contain useful information on certain aspects, or for certain regions.
Criteria are:

- full coverage of The Netherlands for at least one land use type,
- updated on a regular basis, and/or still ongoing
- detailed at sub regional to 1:10,000 level or lower level
- in case of emission factors: directly applicable/available to derive emission factors for important land use types.

The systems are grouped as follows :
1: systems for land use and area (mapping), including soil maps (13);
2: data on agricultural and forestry practices that may serve to derive emission factors (16)
3: data on emission factors including weather and groundwater data (8)
4: modelling systems (2).

Ad 1. Table 4.1 provides an overview of the area assessment systems, which are available/operational for the Netherlands. For a detailed description see appendix 1, and an analyses of pros and cons see chapter 5. In Table 4.1, databases are listed that may be used in estimating and quantifying land use and land use change.
Since GIS-technology is mainly developed since 1990, GIS-based databases describing land-use in 1970 are scarce if available at all. Additional effort is needed to describe the situation in 1970. Note that several of the systems (partly) rely on each others data (e.g. CBS, Top-10, and LGN).
For the future, the Basis Registratie Percelen (BRP) (mentioned in Table 4.2) is very promising as well, since the aim of the BRP is to register all agricultural, nature- and forestland on a parcel level on a continuous basis. Continuity of the registration-system is ascertained by law. The major forest databases relate to 1980-1983 and 2000-2002. The situation in 1990 area has to be interpolated as this is not available.

A country must geo-reference the area of ARD since 1990; this means identify either exact location or roughly the area where an activity has taken place. Based on a combination of the current systems this can be realized for afforestation, reforestation, and deforestation in a complete GIS for the Netherlands.

Deforestation is also available for some parts of the Netherlands in statistics, but not on an annual base since 1990. The latter can be covered by interpolation of data.

Table 4.1. The identified area assessment systems. The number refers to the number of the sheet in the appendices

	Name	Promising tool +: yes, -: to lesser extent	Remark
1.1	CBS-Land use 1989-2000	-	The database required to assign land use within Top-10 vector. Given a '-' here because of its representation in Top–10 (system 1.2).
1.2	Top-10 vector	+	Topographical maps based on aerial photos. No further sub classes for e.g. forest
1.3	Historical land use Netherlands 1890-1930 (HGN)	-	Development of maps for historic land use (Historisch grondgebruik NL) is in progress. However it will represent the situation 1890-1930, so not directly applicable.
1.4	LGN 1993-2000	+	So far, LGN (Land Use the Netherlands) is the most detailed operational information system (TOP 10 based) in NL on past and actual land use, yet info is sampled every 5 or so years;
1.5	Kadaster	-	may provide more exact area estimates but at significant higher cost
1.6	4e bosstatistiek (1983)	-	more promising for emission factors, because the tree species, parcel, and age in 1980 is given per stand. Later forest area statistics are given in Dirkse et al. (2001)
1.7	Nieuwe kaart 2000	-	Only promising for estimation of land use change
1.8	PELCOM	-	Coarse, because of European scale
1.9	Soil maps	+	Soil type maps, but at rather high resolution (1:50,000). Only in its kind.
1.10	PiriReis	+	Crop maps, could be relevant for emission factors at high resolution as well
1.11	Compensation nature and forest Province Gelderland	-	Maps of loss of forest area; Only in its kind, but not consistent across country
1.12	1ste Bosstatistiek 1939-1942	-	Historic forest map. It represents the situation 1939-1942, so not directly applicable.
1.13	Laser Forest law: Compensation of forest loss	-	Not consistent across country

Concluding it can be stated that the area assessment systems are well developed for the Netherlands. Only problems can arise from lack of consistency in time (systems being developed one after the other) and from differences in classifications of land use types.

Ad 2. Table 4.2 provides an overview of monitoring systems of agricultural and forestry practices that may serve to derive emission factors for defined activities and/or land uses.

In general, the statistics on areas and activities within agriculture, forestry and nature area are relatively advanced though many databases are available with data on a limited or short time frame. The Netherlands is definitely a country which is

intensively monitored with regard to agriculture as a results of high intensity agriculture and necessity of environmental monitoring of emissions of ammonia, nitrate and the use of manure and fertilizer in relation to (international) environmental and farmlegislation.

In the nineties of the last century a first statistically sound analyses of soil characteristics was made in the Soil Monitoring Network (2.4); if shaped into a programme that is repeated on a 5 – 10 year interval, this may provide adequate soil data for all land uses in the Netherlands.

Table 4.2a. Four identified agricultural databases or monitoring systems (see for details on parameters and data, accessibility, ownership, cost, etc in Appendix). The number refers to the number of the sheet in the appendices

Name		Promising tool +: yes, -: to lesser extent	Remark
2.1	Basisregistratie percelen LNV (BRP)	+	this registration system has recently been implemented. The implementation is not complete and is continuously improved and extended. However, BRP is already under severe budget cuts again. For the future the BRP is meant to become the single window for all land use related information to the administration.
2.2	CBS statistics	-	Operational system with mainly agricultural and forestry production statistics; is relevant at Tier 1, and probably at higher Tier levels; statistics lack specified farm or field management
2.3a,b	GIAB (Alterra) and Landbouw telling (LEI)	-	Geografisch Informatiesysteem Agrarische Bedrijven (GIAB) and Landbouwtelling (census) are coupled to the Farm accountancy network and CBS (system 2.2) with data on manure and on activities on farms with a minimum of 3 life stock units and operational since 2000 and 1970
2.4	Soil quality data + soil monitoring network	+	Soil organic matter content available, but at rather high resolution. Soil monitoring network provides data on soil organic matter on representative soils in a statistically designed stratified network of 1433 field measurements; network sampled only once (1 plot per km^2)

Table 4.2b. Twelve identified databases or monitoring systems for forest ecosystems in the Netherlands (see for details on parameters and data, accessibility, ownership, cost, etc in Appendix). The number refers to the number of the sheet in the appendices

Name		Promising tool +: yes, -: to lesser extent	Remark
2.5	HOSP	-	Stopped in 1999, carried through in MFV (2.6) and operational from 1985 – 1999; highly accurate data on wood volume and area and connected to 4^{th} forest inventory (1.6)
2.6	Meetnet functievervulling (MFV)	+	the national forest inventory, started recently and funding interrupted; intention to monitor 2000 – 2004 and 2008 – 2012 to assess growth, removal and harvest of wood, including dead wood (no other carbon stocks)
2.7	SYHI	-	Restricted to forest of the State Forest Service of the Netherlands; monitor of standing biomass and growth no removals, ongoing
2.8	WOODSTOCK	-	Restricted to forests of private owners, communities and other,

			discontinued (added value to SYHI)
2.9	Sample 4e bosstatistiek	-	Data for 1980 – 1985 and of historical use. Continued in 2.5
2.10	Programma Beheer	-	Only useful in combination with the forest law; registers activities of those nature owners who desire to receive subsidy
2.11	SBB spoor 12	-	Too much organisation specific
2.12	Natuurmonumenten	-	Different forest definition, organisation specific
2.13	Boscertificaten	-	Few projects only
2.14	CBS Hout	+	National coverage of wood consumption, production, import and export
2.15	BIS	-	Enquiries to wood working industry, related to CBS hout (2.14)
2.16	Growth and yield plots	+	No maintenance of the plots, but still very relevant for deriving emission factors

For Dutch forest ecosystems, twelve databases or monitoring systems were identified. Most of the systems are in fact based on identical methods and parameters, are improved version of older versions or only cover a part of the country for specific organisations or purposes.

Though the number of systems suggests a high accuracy, non of the systems will entirely comply with the requirements of the Kyoto Protocol or a national reporting system even at tier 1 level. This is due to scattered data availability throughout the many inventory-systems and the poor consistency in frequency and stability of the data collection and management. The Good Practice Guidance requirements on frequency, consistency, verification are far from what is realised.

The current National Forest Inventory is carried out covering a time span of four years and is halfway. The National forest inventory (2.6) was set up to improve the situation for the first commitment period but funding has stopped and activities are discontinued and a gap in data exists. Generally, the stemwood volume and harvesting statistics are the most well developed and will easily meet the demands of tier 3 (related to specification at tree species level).

Ad 3. Data on emission factors including weather and groundwater data

Table 4.3. provides an overview of systems that (may) contain readily available emission factors. Data on emission factors for CO_2 and non CO_2 (N_2O and CH_4) in relation to management activities are scarce; in most agricultural activities no monitoring is done on soil organic matter. The TAGA archive (3.1) with data, descriptions and in some cases soil samples of several hundreds of field trials in the past century may provide entries to extract emission factors for specific land uses, land use changes or management practices. For forest, hardly any emission factors are directly available. In the past emission factors for forests have been derived from systems like mentioned in Table 4.2b, but most of these systems have not been systematically explored for options to derive emission factors from them. Emission factors may be derived from databases on old experiments or plots that are not being maintained (concerning growth and yield).

Table 4.3. Overview of databases with readily available emission factors. The number refers to the number of the sheet in the appendices

Name		Promising tool +: yes, -: to lesser extent	Remark
3.1	TAGA	+	Very promising
3.2	Height map Netherlands	-	Maybe useful to derive vegetation height pre-deforestation
3.3	KNMI weather data	-	For model input
3.4	Ground water depth records	-	For model input
3.5	Peelbemesting (fertilization trial)	-	Local fertilisation experiment, followed for five years only, availability uncertain
3.6	ICP	-	Limited number of plots, 180 level I (=general) plots, 12 level II plots = intense monitoring every 5 years of chemistry and forest dynamics.
3.7	Forest reserves	+	60 plots in unmanaged forests, but very intensive monitoring of these sites, rotational and ongoing every 10 years
3.8	Tree biomass data	-	Scattered; to be derived from literature, partly done

Ad 4. Modelling systems

Dynamic simulation models will be useful in assessing emission factors from data on agricultural and forestry practices derived from systems mentioned in Tables 4.2. The models can help to quantify emission factors in relation to practices and e.g. climate and weather conditions at the time of execution of practices. They can also help to extrapolate experimental data to other circumstances and projections in the future.

Criteria for model use in the national inventories under Tier 3 are not all clear; GPG only mentions that they should be based on sound science and reduce uncertainties. In this way (when validated) a higher degree of accuracy may be achieved. The models should be transparent in their data requirements and process description. Whether a model is suited for the National reporting largely depends on the availability of the input data and the required spatial resolution of the reporting and the modeling scale.

The models are lumped into two groups: agro-ecological models and forest models. For each model qualitative information on included greenhouse gasses, complexity level, scale and data requirements are provided. Some of the models use data from other modelling efforts, i.e. INITIATOR uses the output of STONE on Nitrogen distribution in the Netherlands. A final evaluation in terms of ‘useful’ or ‘less useful’ is not given for these models, because this totally depends on the scale of desired assessment, crop type, etc.

Table 4.4. Few identified modelling systems with qualitative information that may be part of a National reporting System. The number refers to the number of the sheet in the appendices

	CO_2	CH_4	N_2O	Model structure	Scale	Data requirement
4.1 Agro-ecological models						
CENTURY	+	-		Complex	Point	High
RothC	+	-	-	Complex	Point/plot	Medium
MOTOR	+	-		Complex	Point/plot	High
CESAR	+	-	-	Simple	Plot/field	Low
MITERRA	-	+	+	Simple	Region/field/farm	Low
INITIATOR	-	+	+	Moderate	Region/field/farm	Medium
4.2 Forest models						
FORGRA	+	-	-	Complex	Plot	High
CO2FIX	+	-	-	Simple	Hectare	Medium
FORSPACE	+	-	-	Complex	Landscape	High
EFISCEN	+	-	-	Moderate	European forests, tree species by province, country	Medium

5 Analysis of gaps between GPG and ongoing monitoring systems

5.1 Present reporting of the LULUCF sector

In this chapter an analysis of the ongoing monitoring in the Netherlands is presented versus the requirements as set in the Good Practice Guidance of IPCC. So far, the reporting of the LULUCF sector by the Netherlands does not even meet the simplest default requirements as set by the 96GL (see table 5.1, and chapter 2); several categories proposed in the 96GL are not reported. Figures 5.1 visualises the main gaps that can be identified compared to the requirements as set by Marrakesh Accords. The text of the next sections goes into options how to address the gaps when moving towards compliance with the GPG (and higher Tiers).

Table 5.1. The current reporting by the Netherlands for emissions and removals in LULUCF

Category 5A		Tier 1	Comment
Forest			
	Aboveground	Done	Possibly a key sink, but with incorporation of net wood products import possibly a key source
	Belowground	Not done	
	Litter	Not done	
	Forest Soil	Not done	In future possibly based on Kuikman et al., 2003
	Dead wood	Not done	
Grassland		Not done	grassland on organic soils possibly a key category
Wetland		Not done	Small area, because most wetlands are classified as agricultural use of organic soils.
Category 5B Forest and Grassland conversion		Partly, see next row	Most conversions not reported so far (e.g. grassland to cropland and vice versa)
Category 5C out of production		Partly	Afforestation is reported as change in area; other land use changes not reported.
Category 5D emissions and removals in soils upon management		Not done for CO_2, partly for non-CO_2	Maybe in the future based on Kuikman et al., 2003. hardly any data on non-CO_2 GHG's available

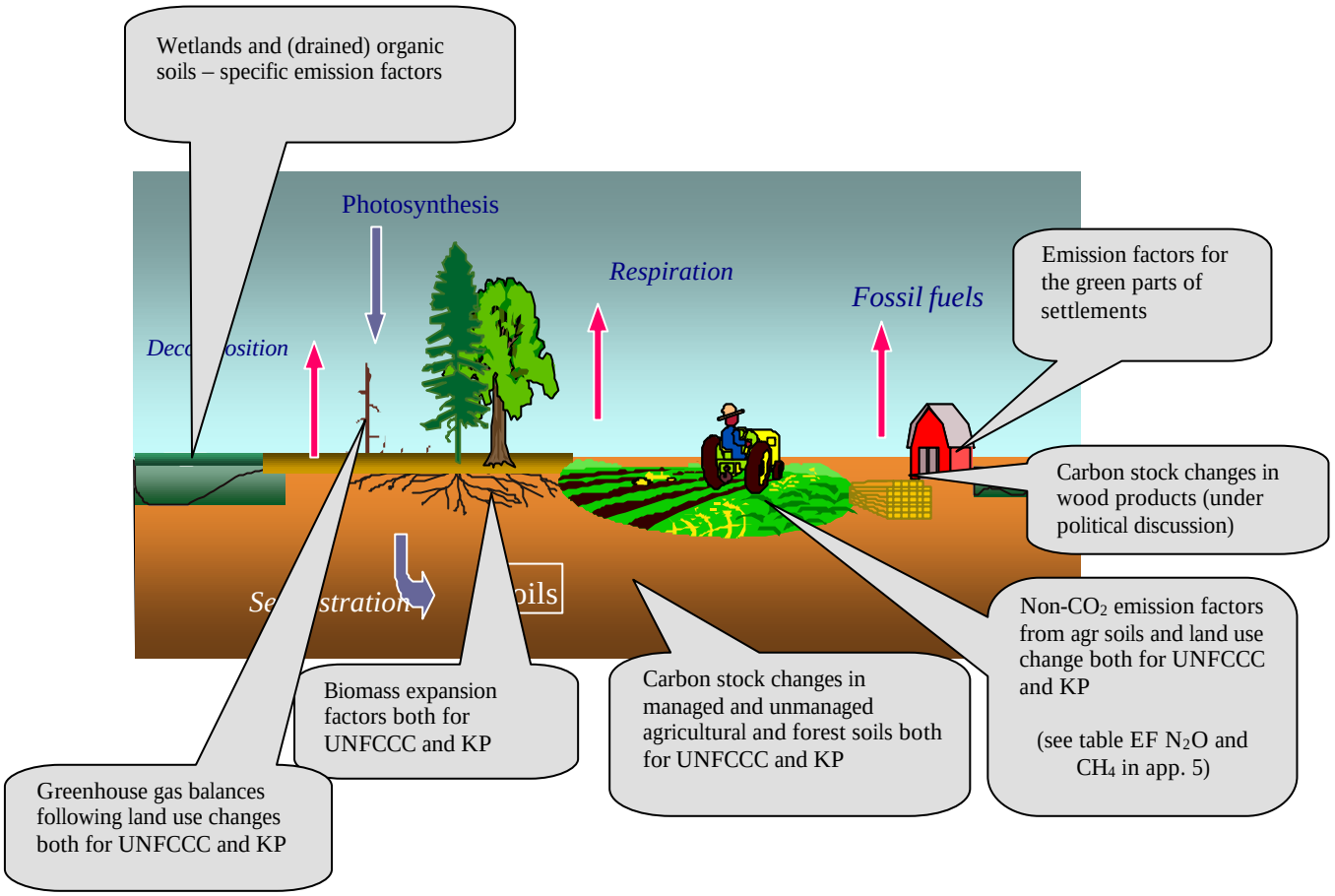

Figure 5.1. The LULUCF sector with land use types, pools, and emissions for which country specific emission factors and activity data are required for UNFCCC and /or Kyoto reporting and are not or hardly available. E.g. there is no box for forest-stemwood data, because this is covered rather well in monitoring systems. For most boxes in this Figure, more and better data may be available than what is being used now. Boxes provided here are addressed in the sections below by land use type.

5.2 Readiness for Key category analysis

A systematic LULUCF key category analysis has never been done for the Netherlands. It would involve a thorough analysis of available emission data for each land use type and for land use changes. For area and area changes ample data are available. These area data are a first indication whether a land use type (change) may be a key category. E.g. it is highly unlikely that the dunes (few thousand ha) are a key category. Then, for the land use types covering larger areas (cropland, grassland (on organic soils), and forest and nature), the currently available national emission factors (or activity data or emission factors from neighbouring countries) should be used to obtain a first indication of potential emissions. E.g. appendix five provides the N_2O release as a fraction of the application of Nitrogen fertiliser in different forms. These

11 data points can serve as a first approximation of potential emissions[3]. Looking at the data sheets in appendix one to four, and taking into account the high intensity of monitoring, it can be concluded that The Netherlands will certainly be able to make a first approximation of potential emissions for all land use types, including imports of animal fodder and wood products. Of course the risk of bias and large uncertainty exists when using data from few or single measurement campaigns.

5.3 Readiness for reporting

5.3.1. Land use and Land use changes (areal assessment)

Table 5.2. gives the most promising area systems useful for LULUCF reporting. In principle the Netherlands has sufficient systems to report annually land use and land use changes at high resolution, both for UNFCCC reporting, as well as under the Kyoto Protocol (see point 4 below). A choice on which system will be used as the basis for reporting has to be made. Criteria for such a choice may be:

1 regular updates in the future
2 verifiable definitions of landuse-classes
3 costs
4 accuracy of area estimate: minimum size of gridcells or area-unit
5 accuracy of landuse classification
6 delay in final product

1. regular updates
TOP10-vector, CBS-bodemstatistiek and Land register (Kadaster) are maps with a great certainty of regular updates (products of institutions who do have the task to produce the maps). MFV2000 and LGN are intended to be regularly updated and most likely will be updated , but these have to be financed separately. In addition, the Basis Registratie Percelen (BRP, 2.1) is promising for the future since all agricultural land must be registered on a parcel level on a continuous basis. Furthermore, BRP is promising since it is foreseen that all nature- and forest land will be registered in this same system in the future as well. Continuity of the registration-system is ascertained by law, but is under severe budget cuts at the moment.

2. verifiable definitions of land-use
MFV-2000 is focused on forest land according to FAO definition, so this is the best system on this matter. CBS-bodemstatistiek and Top10 vector do have a fairly verifiable definition on the distinguished land-use classes. Kadaster registers the land-use only at the moment of legal change of owner; what happens afterwards is not recorded and is therefore no option for LULUCF. The grid-based maps do have fairly verifiable definitions of land-use but misclassifications are a problem. BRP does not have a verifiable definition on land-use category of agricultural-, nature- and forest land.

[3] note that these emission factors are part of GPG agriculture, and are not part of the LULUCF sector.

3. Costs
TOP10-vector map is expensive but is used at shared costs within the Ministery of Agriculture (LNV). In addition the CBS Bodemstatistiek is for free in combination with the TOP10-vector. The kadaster map and database is very expensive (about 1-2 euro for information per area section). Availability of the map is not investigated: only one institution of Min.of Agriculture (Dienst Landelijk Gebied) does have an agreement regarding the use of the map. The forest-map MFV2000 uses TOP10vector and CBS bodemstatistiek. Costs of LGN are unknown. Availability of BRP database is free.

4. Accuracy of area estimate: minimum size of gridcells or area-unit
For national reporting of LULUCF the minimum size of the area-unit is not very important: all maps can be used for these purposes. But for Kyoto-protocol a maximum size of the assessment unit of 1 ha means that CBS-bodemstatistiek is not appropriate: the minimum size of the area-unit is also 1 ha in this map. LGN seems to be more appropriate for this: 16 pixels per ha. Also the BRP database can be used for agriculture- nature- and forestland. With great accuracy. The areas reported to BRP are restricted to the strict productive area. This means that all borders, edges, patches, and ditches enclosed in a parcel are not reported. This implies that for example area of parcels reported in BRP is roughly up to 20% less then the same parcels on other maps based on topography. The use of BRP as an area estimate - although very accurate- is restricted

5.Accuracy of land-use classification
For grid-based maps the accuracy of land classification is a special problem. The satellite image has to be converted to land-use classes. Each update has the risk that slightly different classification-rules are used (the same pixel-values do not have the same meaning on different satellite-images). For UNFCCC this is probably not very important. For Kyoto protocol a very careful check of the ARD-activities has to be made. E.g. in case of LGN it is known that of the land use changes according to this products, only 76% is a true change. This means that the costs of comparing maps for land-use change purposes costs a lot more than only the maps as such. Ground truthing will always be needed. BRP is in the case of detecting land-use**-change** very useful although the vague definitions on land-use-categories in BRP requires verification

6. Delay in final product
Most map products face a delay between initial assessment and delivery of final product. This delay can amount to 3 to 4 years for most map systems. BRP has a delay of not more than 1 year.

Table 5.2. overview on the usefulness of some land use systems for estimating land use and land use change

Name	Classes [1]	Updates	Verifiable definitions	Accuracy and minimum size	Accuracy land use classification	Delay of final product
1.1. CBS	FCGWSO	3-4 years	Yes	Min area:1 ha	High	2-4 years
1.2 TOP10-vector	FCGWSO	4-6 years	Yes	< 10 m^2	High	2-4 years
1.4 LGN	FCGWSO	3-4 years	No: Pixel classification	Pixel 25x25 m	Verification needed	2-4 years
2.1. BRP	FCG	1 year	No	Underestimate of area up to 20%,	Verification needed	<1 year
2.6 MFV	F	4-6 years	Yes	Forestland 0.5 ha	High	2-4 years

1: F: Forest, C: Cropland, G: Grassland, W: Wetland, S: settlement, O: Other lands

It must further be noted that land-use classes as used by the available maps should readily be applicable to the LULUCF categories Forest, Culture, Grassland, Wetland, Settlement and Other land-use.

1 A land-use class from the map should be classified uniquely into a FCGWSO class.
2 Available expansion factors and conversion factors should be applicable to a land-use-class of the map. If factors are applicable to parts of land-use classes, they still should be classified into one of FCGWSO classes. This means also that the distinguished land-use classes in the maps should be subdivided using other sources.

5.3.2. Agriculture

For the Netherlands area data on land use type are available at great precision. Activity data on emissions and removals and stocks are more difficult to obtain. As a consequence data bases need to be maintained in such a way that re-calculation is possible for the 1990 to present period at least and if possible for the period 1970-90.

A database containing emissions and removals and emission factors that are relevant for Dutch conditions should be created. For C changes, recently an inventory was made on relevant long term experimental measurements from which emissions factors for C (CO_2 and possibly CH_4) can be extracted. For CH_4 and N_2O this has not been done yet in a systematical way. However, recent ROB[4] research has listed relevant documentation of experiments that can be used for extraction of specific Dutch emission factors *(TAGA database sheet 3.1*). The current datasets do not cover all key categories, but are a basis for a clear link between activities and emissions (see colour overview sheet in appendix 6). For certain systems and areas, such as grasslands and more specifically the fen meadows, additional information on emissions in relation to land management maybe necessary.

[4] Reduction plan other greenhouse gases

For emission factors, specific research programmes and measurement campaigns are required. So far campaigns have not been designed to systematically monitor the three relevant greenhouse gases. Kroeze (1994) and Spakman et al. (1997, updated in 2002) provide the emission factor used for reporting to the UNFCCC to date, and make use of default IPCC values as provided in the 96GL and few specific emission factors (see table emission factors (EF's), app 5). No systematic inventory on emissions factor specific to Dutch environmental and agricultural or forestry management has been undertaken. Yet, such an inventory may help to define those areas where new or additional information is needed. A starting point for such an effort is in the results of the research programme in the 'Reduction plan non-CO_2 Greenhouse Gases' (ROB) (see www.robklimaat.nl or www.greenhousgases.nl).

Table 5.3.Additional steps needed when moving to higher Tiers for agriculture

	Approach		
Land use	Tier 1	Tier 2	Tier 3
Agriculture: grassland	Area data based on CBS – LEI data bases; EF from IPCC default values; agriculture is often more specific than default categories in GPG suggest, i.e. most if not all Dutch grassland is improved managed grassland (fertilisation); stock changes are estimated from one cycle of actual measurements of organic matter across land uses, soil types and groundwater tables in the Netherlands (1433 data points) multiplied with default emissions factors	Detailed information on land use and activities is available in CBS – LEI databases for 1990 and later and likely for 1970 – 1990; specific Dutch emission factors are NOT available for all relevant activities from sufficient long-term measurement campaigns (www.robklimaat.nl); - limited efforts are being undertaken to fill this gap and wil be needed to further fill this gap: Impact of management on SOM, CH4, N2O. Measure emission factors in representative sites and for adequate time frames to capture annual variations (build on TAGA database for CO_2, ROB research for non-CO_2) Distinguish forms of grassland management (permanent, rotation, renovation) and water management to report under KP3.4 (include in "Perceelregistratie")	Several simulation models (C: CESAR, MOTOR for C; no model for CH_4, $N(N_2O)$: FUSSIM coupled to land use database) are available for estimating changes in soil C; - no systematic validation of these models has been undertaken. - Input data on area, productivity, rainfall and temperature are available from actual measurements across the country and allow for uncertainty analyses; - difficult to validate these models against sufficiently long term measurement series - many more measurement campaigns will be needed to fill the large variety of conditions and sites
Cropland	See above	See above	See above

5.3.3. Forests

In general, sufficient systems are in place to monitor forest volume, growth, and harvest at a representative sample. Still, in respect to the GPG there are several problems concerning the forest databases and monitoring systems:

- Consistency, frequency and possibility of verification has to be improved
- All systems deliver parts of data, these may need harmonisation
- Missing Data on deforestation
- Missing 1990 and 1970 situation

Specific for the Netherlands are the small scale landscape-(forest) elements <0,5 ha, which are out of scope by present monitoring systems, but are vulnerable in terms of land use change. A Tier 3 will have to deal with a situation lacking this information.

Regarding the other pools, branches, roots, litter, and SOC information is poor, or at least scattered. Emission factors for specific management activities have not systematically been assessed.

Table 5.4. Additional steps needed when moving to higher Tiers for forests

	Approach		
Land use	Tier 1	Tier 2	Tier 3
Forest	Not applied by The Netherlands	Current reporting in national inventory. In reasonably good shape: based on MFV (national forest inventory). However, only in reasonable shape for stemwood volume and total national harvest. One IPCC default is used for biomass expansion factor. Nothing reported on forest soils, litter and deadwood. Afforestation representing abandonment of managed lands is incorporated by one area change and one growth rate. Nothing for deforestation. This Tier 2 can be improved significantly by using the more detailed data from MFV, certainly for reporting under Kyoto Protocol. Deforestation needs to be followed as well as afforestation in more detail. All other components of forests (branches, roots, foliage, undergrowth) will need at least some national expansion factors. Few national emission factors for harvest, and some types of management will be needed (growth and yield plots). Improved litter, deadwood, and soil information will be needed, where possible based on ongoing measurements in e.g. ICP, and forest reserves.	High resolution reporting can be the aim with detailed models for emission factors. Geo referencing only needed for Kyoto reporting. For C stocks and other GHG's same Tier as applied for UNFCCC reporting can be applied. All major management processes, emission factors will be needed and can partly be based on ongoing systems together with modelling systems as identified in Ch 4. Land use change will have to be monitored intensively, with detailed measurements on slash and soil dynamics.

5.3.4. Other land-use types (wetland (not under grass), heathland, dunes, inland sand dunes, green areas in settlements, roadsides, swamp and reed vegetation, mud flats)

Table 5.5. Additional steps needed when moving to higher Tiers for other land uses

	Approach		
Land use	Tier 1	Tier 2	Tier 3
Other land uses	Not reported	Some emission factors will have to be assessed for e.g. heathland, dunes and wetlands not under grass e.g. peat. Some campaigns have been done, e.g. growth and litter studies in acidification research. For peat some restoration studies are ongoing. Roadside grass production and tree coverage in urban areas are for some sites available.	Not likely to be relevant. If relevant, then only some ad hoc studies will be available, although most vegetation types are covered in national scale assessments like a soil map. Specific measurement campaigns in combination with modelling exercises will be required.

5.3.5. Emission factors for land use changes

Table 5.6. Additional steps needed when moving to higher Tiers for land use changes.

Approach Land use	Tier 1	Tier 2	Tier 3
Other land uses	Not reported, with exception of afforestation	Few emission factors for deforestation can be estimated. More will be needed. Deforestation and land use changes may be an overlooked (key) category. Area changes are available from ongoing systems. Carbon content is available by means of average content per hectare based on a sample of 1 plot per 100 ha. Scattered local information can be used for more local information. (Tier 2)	Land use change between all land use types will have to be monitored in terms of area, with detailed measurements on slash and soil in main land use changes. Modelling will further increase insight in emission factors The use of AHN (height) and the model FORSPA (crown-coverage on Landsat images) is possible, but not operational yet. The AHN and FORSPA give information on height/crown coverage of the forest. Both methods imply development of models. (Tier 3). Situation in 1970 and 1990 for estimate of ARD and carbon content will take extra effort: a separate investigation of the old maps (1st`Bosstatistiek, Historisch bestand Nederland) and overlays is needed.

5.4 Readiness for verification

Verification is the collection of activities and procedures that can be followed during the planning and development, or after the completion of an inventory, that can help to establish its reliability for the intended application of the inventory.
In the Netherlands there are few independent measurement series available that can be used in independent verification procedures for activities and emission factors. Where possible such verification against independent data have been carried out with ambiguous success. The general conclusion for all land use types is that the Netherlands is not ready for verification.

5.4. Readiness for uncertainty analysis

For the Netherlands, most relevant data bases on activities and area for specific land use or land use changes provide sufficient number of data to allow for a form of uncertainty analyses as the data inventories have been set up using statistical lay outs. Examples are:

- forest inventory, 1984 - today;
- land use - LGN has an uncertainty estimate on the basis of the level of resolution and interpretation errors of satellite images;
- soil C inventories are based on statistically stratified designs over land use, soil type and groundwater level.

Many other data sources like ad hoc studies, however, were not set up to carry out uncertainty analyses. Decision on key categories may therefore be based on biased results. This is especially the case for pools that may seem of lesser importance to the Netherlands.

5.5. Readiness for archiving

Most formal databases mentioned in appendices 1 to 4, carry out their own archiving. Present national emission reporting is being archived at RIVM, Bilthoven. The latter practically excludes the LULUCF sector. Otherwise no central archiving is currently operational.

5.6. Readiness for Quality Assurance (QA) and Quality Control (QC)

QC is a system of routine technical activities to measure and control the quality of the inventory as it is being developed. QA activities include a planned system of review procedures conducted by personnel not directly involved in the inventory/ compilation process. For those LULUCF categories that have been part of the Dutch annual inventory, no QA/QC is applied. Also for (higher) Tiers in the LULUCF sector no specific QA/QC procedures are set up (Olivier et.al. 2003, Olsthoorn and Pielaat 2003).

6 Conclusions

The main conclusions are:

- Current LULUCF greenhouse gas reporting by the Netherlands is incomplete. The few sections that are included are done at lower Tiers. No actual data then for the year 2000 are collected.

Thirty nine monitoring systems or databases were identified as possibly relevant for setting up a national system. The systems are grouped as follows :
1: systems for land use and area (mapping), including soil maps (13);
2: data on agricultural and forestry practices that may serve to derive emission factors (16)
3: data on emission factors including weather and groundwater data (8)
4: modelling systems (2).

- data availability on areas of land use and land cover are well available, although consistent time series may be a problem due to differences in classifications. Geo referencing of Kyoto lands is possible with current systems. For C stock changes (and other GHG's) on these Kyoto lands, the same Tier can be applied as was used for UNFCCC reporting;
- Data on practices in agriculture are also very good; Their precision is much better than the precision of emission factors.
- Emission factors may not be available at all for many required emission factors for specific Dutch conditions, and certainly not for higher Tiers (see overview in appendix 6).
- There is no system or database that will deliver all data; many systems will provide part of the necessary data and harmonisation may be necessary
- There is a major lack of data on changes in soil carbon stocks for both agriculture systems and forest and nature ecosystems
- Consistency and frequency between different databases may not be as required and lead to inaccuracies
- Data on emission factors for deforestation are missing
- Data on the 1990 situation are not available in a consistent manner

For changes in soil organic matter as a result of agricultural practices of land use changes, recently an inventory was made (system 3.1). A further increase in precision of reporting would be achieved by using simulation models to assess emissions and removals such as INITIATOR (for N_2O and CH_4) or CESAR (for CO_2). Despite their availability, the precision of these models in providing better data on emissions is hampered by the lack of emission factors for specific areas or activities of land use and land cover in the Netherlands.

For reporting under Tier 1, activity data are available for the larger part and default emissions factors can be applied. For smaller landscape elements (i.e. ditches or

roads in agricultural land) satellite image may need calibration. Smaller landscape elements may be missing due to the forest definition of 'larger than' 0,5 ha.

For reporting under Tier 2 (or Tier 3) country specific emission factors may be required; such emission factors for specific conditions and practices in the Netherlands are in many cases not available. For reporting under Tier 3 emission factors are often missing. This is very apparent with regard to the required data on soil carbon.
A road map to reporting under Tier 2 and 3 includes:

- formal Key source analysis in LULUCF sector
- choice for an area and area change system
- choice on land use changes and emission factors to be improved;
- definition of area of organic soils – mineral soils (C stocks) and definition of agricultural soils versus wetlands versus other;
- decision on required reporting level and reporting scheme of CO_2 and on non-CO_2 greenhouse gases
- design of national system with minimum and maximum demands.

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Appendices.

Detailed descriptions of databases and monitoring systems

1. ***Systems for land use and areas, including soil maps***
2. ***Data on agricultural and forestry practices that may serve to derive emission factors***
3. ***Data on emission factors including weather and groundwater data***
4. ***Modelling systems***
5. ***Some readily available emission factors***
6. ***Overview sheet of Tiers, land use types, pools, and their associated readiness and gaps.***

Appendix 1 Systems for land use and areas, including soil maps

1.1 CBS Land use statistic

Aim / general set up of monitoring system
CBS carries out a Landuse classification on a national scale.

Application to
Definitions are given for all land use categories. Forest definition has a minimum area of 1 ha and a minimum crown coverage of 20%

Representativity / area of application
Netherlands, GIS coverage (since 2000 based on geometry Top10Vector)
Minimum unit of scale of applicability (resolution or support site)
Minimum area 1 ha

Variables measured
Top10-vector information, Aerial photo interpretation, other sources

Distinguished land use types	
1 Traffic	5 Agriculture
10 Railways	50 glashouse horticulture
11 main roads	51 other agricultural use
12 airfields	6 Forest and Nature areas
2 Build up areas	60 forest
20 residential areas	61 dry natural lands
21 stores / horeca	62 natural wetlands
22 public services	7 Inland waters
23 social,cultural,medical services	70 IJssel lake
24 industrial areas	71 cutoff estuary
3 Other 'buildup'areas	72 Rijn&Maas
30 dumping grounds	73 Randmeer
31 wreckage yards	74 water reservoir
32 cemeteries	75 recreational water bodies
33 minreals yielding	76 water in mineral yieldingarea
34 building site	77 water in purification plant
35 other areas	78 other inland water
4 Recreation areas	8 Water bodies
40 parks	80 Waddenzee, Eems, Dollard
41 sportfields	81 Oosterschelde
42 allotments	82 Westerschelde
43 non-residential recreation	83 North sea
44 residential recreation	90 non-territorial areas

Accuracy per variable
Minimum area per GIS-unit 1 ha,width > 6m.

Periodicity
1989,1993,1996,2000 (Note: method change in 2000)
Operational since / still ongoing ?
On regular basis 3-4 years update
Changes in time in assessment
Change landuse classes

Availability / contact person + address / costs of data
CBS no costs (included ìn costs of Top10 vector)
Alterra / Centre Geo information-wageningen UR / at disposal with shared costs
Storage of data (paper / digital, what system)
CD-ROM

Which variables and parameters for the National System can be derived
Land use types FCGWSO. See separate comparison of definitions in Table App 1.
Land use changes: A,D

1.2. TOP 10-vector

Aim / general set up of monitoring system Landuse classification and detailed topographical map on a regular basis
Application to Coverage of the Netherlands Point, line and area elements in GIS-database
Representativity / area of application Netherlands, GIS coverage **Minimum unit of scale of applicability (resolution or support site)** Min area < 10 m2
Variables measured Aerial photo interpretation, field observation, other sources
Variables derived Landuse classification and topographical point / line-elements Codes 01000-1850 buildings Codes 02000-03950 traffic, roads, pavements Codes 04000-04810 railroads, emplacements Code 05000 Tree Codes 05020-05060, 05080 forest Code 05070 short rotation forest Codes 05110-05190 tree rows and hedges Code 05200 arable land Code 05210 grassland Code 05220-05230 orchard / nursery Code 05240 heather Code 05250 bare sandsoil without vegetation Code 05260-05460 other soils Codes 06000-06020 ditches Code 06100-06210 water Code 7100-07290 dams, embankment
Accuracy per variable Minimum area per GIS-unit <10m2
Periodicity Update on regular bases period 4-6 years **Operational since / still ongoing ?** Ongoing **Changes in time in assessment** Change landuse classes, changes topography
Availability / contact person + address / costs of data TDN` Topografische Dienst Bendienplein 5 Postbus 115 7800 AC Emmen : 0591 69 69 11 Alterra / CGI / at disposal at shared costs **Storage of data (paper / digital, what system)** CD-ROM
Which variables and parameters for the National System can be derived Land use types: FCGWSO. See separate comparison of definitions, Table app 1. Land use changes A,D,RV

1.3 Historical land use Netherlands (HGN) 1890-1930

Aim / general set up of monitoring system
Historical Landuse classification and topographical map

Application to
Coverage of the Netherlands through a Raster database, for period around 1900. Currently being extended for the situation around 1970. The latter based on topographical maps of that period.

Representativity / area of application
Netherlands, GIS coverage raster
Minimum unit of scale of applicability (resolution or support site)
grid area 50x50 m

Variables measured
Topographical / Bonne maps

Variables derived
Landuse classification
Gras
Akker
Heide
Loofbos
Naaldbos
Bebouwing en wegen
Water
Moeras
Stuifzand
Overig

Accuracy per variable
Unknown

Periodicity
Once only
Operational since / still ongoing ?
Not completed yet
Changes in time in assessment
No

Availability / contact person + address / costs of data
http://geodesk.girs.wau.nl/geokey/select.htm Contact: Wim Knol, ALTERRA
Storage of data (paper / digital, what system)
Digital

Which variables and parameters for the National System can be derived
Land use around 1900 and in 1970 : FCGWSO. See separate comparison of definitions
Land use change since 1900 and since 1970: A,D and EF for soils

1.4 LGN 1,2,3,4

Aim / general set up of monitoring system
Landuse classification on a regular basis

Application to
Coverage of the Netherlands in 39 landuse classes (Agriculture (10), Forest(2),Build-up areas (8), Nature areas(17), Water (2 classes).

Representativity / area of application
Netherlands, grid size 25mx25m

Minimum unit of scale of applicability (resolution or support site)
Min are 25x25m
The database uses a GRID structure with a cell size of 25 meter, the scale is about 1:50.000. The nomenclature of the LGN4 database contains 39 classes covering urban areas, water, forest, various agricultural crops and ecological classes. LGN is created for an important part on the base of satellite imagery, but also other data is integrated into the database. Currently 4 versions exist LGN1 - LGN4 which span a time period of 1986 to 2000.

Variables measured
Pixel-values Landsat Thematic Mapper, TOP10-vector bestand, PIPO kaart (LASER), NIS, local information

Variables derived Land use category	
O geen data	24 kale grond in bebouwd buitengebied
1 gras	25 hoofdwegen en spoorwegen
2 mais	26 bebouwing in agrarisch gebied
3 aardappelen	30 kwelders
4 bieten	31 open zand in kustgebied
5 granen	32 open duinvegetatie
6 overige landbouwgewassen	33 gesloten duinvegetatie
8 glastuinbouw	34 duinheide
9 boomgaarden	35 open stuifzand
10 bloembollen	36 heide
11 loofbos	37 matig vergraste heide
12 naaldbos	38 sterk vergraste heide
16 zoet water	39 hoogveen
17 zout water	40 bos in hoogveengebied
18 stedelijk bebouwd gebied	41 overige moerasvegetatie
19 bebouwing in buitengebied	42 rietvegetatie
20 loofbos in bebouwde kom	43 bos in moerasgebied
21 naaldbos in bebouwde kom	44 veenweidegebied
22 bos met dichte bebouwing	45 overig open gegroeid natuurgebied
23 gras in bebouwd gebied	46 kale grond in natuurgebied

Accuracy per variable
Minimum area 25x25 m. Accuracy 80-95%

Periodicity
1986,1992,1995-1997,1999-2000

Operational since / still ongoing ?
On regular basis 3-4 years update

Changes in time in assessment
Change landuse classes

Availability / contact person + address / costs of data
Alterra / CGI / at disposal at shared costs
Contact alterra / http: / / www.lgn.nl /

Storage of data (paper / digital, what system)
Files and maps for the 1986 – 2000 period
Digital GIS

Which variables and parameters for the National System can be derived
Land use: FCGWSO. See separate comparison of definitions in Table app 1.
Land use change: A,D, RV

1.5 Kadaster

Aim general set up of monitoring system
Landownership registration

Application to
Coverage of the Netherlands by ownership

Representativity / area of application
Netherlands

Minimum unit of scale of applicability (resolution or support site)
Integral assessment, min. area <<10m2

Variables measured
Area of kadastral section, land owner

Variables derived,
Section area,owner, landuse at moment off registration
Code 0 unknown
Code 11-19 bewoning
Code 21-39 bedrijfsgebouwen evt in comb met bewoning
Code 41-49 transport, (spoor)wegen, vliegvelden, leidingen
Code 51-sportterreinen
Code 52 volkstuinen
Code 53 verblijfsrecreatie
Code 54 recreatie objecten
Code 55 parken en plantsoenen
Code 56 bos met recreatieve hoofdfunctie
Code 57 erf en tuin
Code 61 bos
Code 62 akkerbouwland
Code 63 grasland
Code 64-65 tuinbouw
Code 66 boomgaard
Code 67 bloembollen
Code 68 boomkwekertij, kerstdennen
Code 71-79 sociaal-culturele voorzieningen
Code 81-89 wateren (84=meren plassen,ven)
Code 91 braak terrein
Code 92-96 bouwterreien, opslagterrein
Code 97 droog natuurlijk terrein
Code 98 nat natuurlijk terrein
Code 99 overige gronden

Accuracy per variable
Error << 1% area.

Periodicity
Ongoing , administrative

Operational since / still ongoing ?
ongoing

Changes in time in assessment
Change ownership classes, landuse classes

Availability / contact person + address / costs of data
Kadata/ Postbus 9046, 7300 GH Apeldoorn Telefoon: (055) 528 50 00
Consultation very expensive

Storage of data (paper / digital, what system)
Digital GIS since/ Paper archive

Which variables and parameters for the National System can be derived
Historical land use data, certainly for 1990

1.6 Oppervlaktestatistiek 4de Bosstatistiek (4th National Forest Survey)

Aim / general set up of monitoring system Forest area according to FAO definitions 1980 (NOTE 20% crown-coverage)
Application to Applied to total forest area in The Netherlands according to Forest definition FAO 1980. Delineation per stand
Representativity / area of application Netherlands, area census on forest land **Minimum unit of scale of applicability (resolution or support site)** Min area 0.5 ha
Variables measured, Per parcel 1 description: ownership, parcel area, forest type, crown coverage, stand-age, dominant height, mean diameter, species-composition site history.
Variables derived Ocular estimate standing volume
Accuracy per variable Total assessment of Forest area. Unit of inventory :Parcel
Periodicity Unique, 1980-1983 **Operational since / still ongoing ?** No **Changes in time in assessment** No
Availability / contact person + address / costs of data Available for free **Storage of data (paper / digital, what system)** Digital. ORACLE dbs Available at: CBS / EC-LNV; http: / / geodesk.girs.wau.nl / geokey / select.htm
Which variables and parameters for the National System can be derived Land use change since 1980: A,R,D, secondary source for emission factors for e.g. deforestation

1.7 Nieuwe Kaart Nederland

Aim / general set up of monitoring system Registration and mapping of future plans in land use 2010-2030
Application to Landuse classification
Representativity / area of application Netherlands
Variables measured Through enquiries at local counties, the projects affecting land use were mapped.
Variables derived Land use change 2010-2030 by classes: • Wonen • Werken • Voorzieningen • Natuur & Recreatie • Infrastructuur • Water • Herstructurering
Accuracy per variable None (physical planning)
Periodicity Since 2000 **Operational since / still ongoing ?** Regular updates **Changes in time in assessment** No
Availability / contact person + address / costs of data www.nieuwekaart.nl **Storage of data (paper / digital, what system)** CD-ROM
Which variables and parameters for the National System can be derived Future projection of A, R, D Secondary source for emission factors

1.8. PELCOM, Pan-European land use and land cover monitoring.

Aim / general set up of monitoring system
Vegetation and land use mapping of Europe, based on satellite data

Application to
Europe

Representativity / area of application
Europe to Ural
Minimum unit of scale of applicability (resolution or support site)
1 km resolution

Variables measured
NOAA AVHRR data

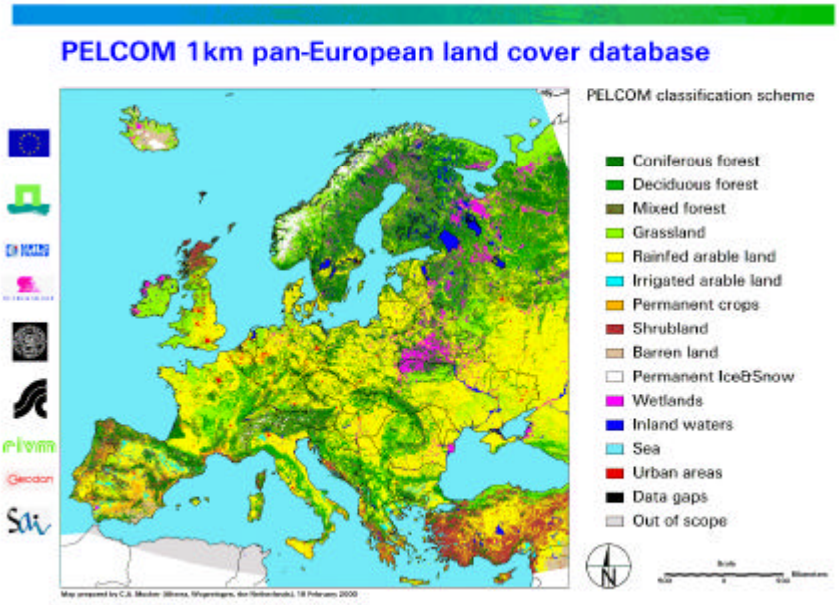
Variables derived
Land use at 1 km resolution

Accuracy per variable
Overall classification accuracy varies between 73 and 48%, containing only pixels that are more than 75% homogeneous, quoted from PELCOM final report.

Periodicity
Once only, PELCOM was a fourth Framework shared cost project. Follow up projects are likely
Operational since / still ongoing ?
1999, once only.
Changes in time in assessment
No

Availability / contact person + address / costs of data
Sander.mucher@wur.nl
Http://cgi.girs.wageningen-ur.nl/cgi/projects/eu/pelcom/public/index.htm
Storage of data (paper / digital, what system)
Digital

Which variables and parameters for the National System can be derived
Land use



1.9. Soil map of The Netherlands 1:50,000

Aim / general set up of monitoring system Soil map of the Netherlands, coupled with soils information system based on sampling scheme on 1342 points
Application to Netherlands, basic source of information
Representativity / area of application Netherlands, Scale 1:50 000 Classification based, static. **Minimum unit of scale of applicability (resolution or support site)** Soil map 1:50,000
Variables measured Map is based on once only profile descriptions made at every 500 m in the field for the whole of Netherlands Measurements at sampling points: Soil organic matter 0-30 cm, (no C!) and pH in horizons
Variables derived Soil C via estimated soil organic matter
Accuracy per variable Unknown to current project (see Gruyter et al in prep)
Periodicity First round made 1990-2001, next round uncertain **Operational since / still ongoing ?** Yes, ongoing **Changes in time in assessment** No
Availability / contact person + address / costs of data Reind.visschers@wur.nl **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Soil organic C data

1.10 PiriReis, crop maps of The Netherlands

Aim / general set up of monitoring system
"PiriReis", are digital crop maps of The Netherlands covering the year 2000 onwards, each map indicating what crop was grown on a particular parcel of land. PiriReis can effectively be used for questions and issues in water management, water quality, agriculture, land and environment and is specifically targeted at the following types of organisation: water authorities, hydrographical organisations, local and national government bodies and agri-businesses.

Application to
Land cover mapping mainly focussing on agricultural land use

Representativity / area of application
Crop maps per parcel
Minimum unit of scale of applicability (resolution or support site)
Parcel a used by land owner

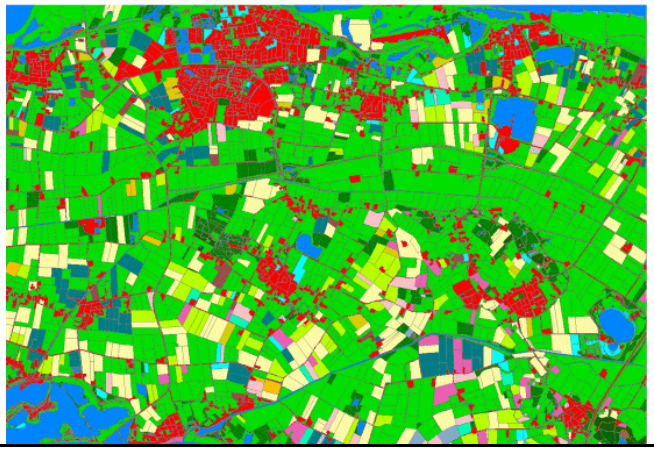
Variables measured
grass - corn - potatoes - sugar beets - wheat - barley - other cereals - flax – onions rapeseed - vegetables (such as beans, cabbages, peas) - flower bulbs orchard - farm yards - urban areas
acreage information on land use, crop rotation information.

Variables derived
Crop type

Accuracy per variable
Unknown to current project

Periodicity
every year
Operational since / still ongoing ?
Yes, 2000
Changes in time in assessment
Crop rotation level

Availability / contact person + address / costs of data
http://www.synoptics-pirireis.com
Storage of data (paper / digital, what system)
Digital



1.11. Richtlijn Compensatie Natuur en Bos Provincie Gelderland

Aim / general set up of monitoring system:
When forest or nature areas are lost e.g. due to urban sprawl, then compensation is required by law. This system (through enquiries and Kadaster (1.5)) tracks these changes and compensations.

Application to
Forest and nature areas with the destination 'forest' or 'nature' in the destination plans of municipalities.

Representativity / area of application
The area of application depends on the application by the owner.
Minimum unit of scale of applicability (resolution or support site)
A timber stand of 0.1 ha or more, or 20 trees in a row plant.

Variables measured:
- location of forest or nature area being cut
- number of lost hectares
- location of compensated forest area
- number of compensated hectares
- information about quality of the forest or nature area (species, vegetation, soil)
- 'replacement category' (high value forest must be compensated by more than the destroyed number of hectares)
- financial guaranties for compensation

Variables derived
Same as measured

Accuracy per variable
- location of forest or nature area being cut: exact location
- number of lost hectares: exact figure
- location of compensated forest area: exact location
- number of compensated hectares: exact figure
- information about quality of the forest or nature area (species, vegetation, soil): descriptive information
- 'replacement category' (high value forest must be compensated more an original destroyed hectares): percentage
- financial guaranties for compensation: descriptive information

Periodicity
Every application is being checked by the municipality and by a provincial forest inspector.
Operational since / still ongoing ?
1998, still ongoing.
Changes in time in assessment
In time several systems of tracking the change of forest areas in the Province Gelderland have been developed and carried out. Since 1998 a new and improved system is put into practice and is evaluated in 2000.

Availability / contact person + address / costs of data
Province Gelderland
Dienst Ruimte Economie en Welzijn
Afdeling Landelijk Gebied
Dhr. G.F.E. Schut
Storage of data (paper / digital, what system)
Paper and digital: GIS

Which variables and parameters for the National System can be derived
Land use changes: A, D, RV

1.12. 1ste Bosstatistiek 1939-1942

Aim / general set up of monitoring system Forest survey, area statistic
Application to Forest land and 'waste' land inventory
Representativity / area of application Netherlands, forest and wasteland
Variables measured Topographical maps
Variables derived Areas of forest area and roadside trees
Accuracy per variable Raster 15x15 m, accuracy 80-95%
Periodicity None **Operational since / still ongoing ?** mid 1930's, not ongoing **Changes in time in assessment** No
Availability / contact person + address / costs of data Alterra, H. Dijkstra, J. Clement **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Land use change since 1930's

1.13. Laser: Boswet / compensation province

Aim / general set up of monitoring system Control system for maintaining the Boswet (Forest Act) in the province. Four categories are being distinguished each controlled in a different way. Aim of the system is the maintenance of the forest area in the Netherlands.
Application to Forests, croplands and rangelands
Representativity / area of application Landowners, parcels **Minimum unit of scale of applicability (resolution or support site)** One single tree
Variables measured Trees
Variables derived Trees
Accuracy per variable Areas of loss and compensation are measured accurately (<1% error). However, the actual compensation may take four years.
Periodicity ongoing **Operational since / still ongoing ?** Still ongoing **Changes in time in assessment** No
Availability / contact person + address / costs of data Laser Dordrecht, www.minlnv.nl/laser, Mr. Benjamin Schulp. Data are free of charge. **Storage of data (paper / digital, what system)** Digital (Gis) and paper (applications and correspondence)
Which variables and parameters for the National System can be derived Land use changes: A, D, RV

Table Appendix 1. Overview land use classifications

	LandUse and Landuse change categories					
	Forest	Culture	Grassland	Wetlands	Settlement	Other
Meetnet FunctieVervulling Bos 2000	11-99 forest > 0.5 ha	no forest				
CBS Bodemstatistiek	60 bos >1 ha	5 agriculture		62 natural wetlands	2,3 buildings, 1 traffic,	7 waters, 8 water
	61 natural drylands					
	4 recreational areas					
TOP10-vector	05020-05060, 05080 forest, 05070 short rotation forest	05200 arable land	05210 grassland		01000-1850, 2000-3950,4000-4810, bebouwing en wegen	05260-05460 other soils, 06100-06210 water 7100-07290 dams, embankment
	05240 heather					
	05250 bare sandsoil without vegetation, 05260-05460 other soils, 05110-05190 tree rows and hedges					
						05220-05230 orchard/nursery
	06000-06020 ditches					
Historisch grondgebruik Nederland (HGN) 1890-1930	Loofbos Naaldbos	Akker	Gras		Bebouwing en wegen	Water,Overig
	Heide,Moeras					
	Stuifzand					
	Forest	Culture	Grassland	Wetlands	Settlement	Other
LGN 1,2,3,4	11 loofbos, 12 naaldbos,20 loofbos in bebouwde kom 21 naaldbos in bebouwde kom,40 bos in hoogveengebied,43 bos in moerasgebied	2 mais, 3 aardappelen 4 bieten 5 granen 6 overige landbouwgewassen, 10 bloembollen	1 gras	30 kwelders, 31 open zand in kustgebied,39 hoogveen 41 overige moerasvegetatie 42 rietvegetatie 43 bos in moerasgebied 44 veenweidegebied	18 stedelijk bebouwd gebied 19 bebouwing in buitengebied,25 hoofdwegen en spoorwegen 26 bebouwing in agrarisch gebied	8 glastuinbouw,9 boomgaarden,16 zoet water 17 zout water
	22 bos met dichte bebouwing				22 bos met dichte bebouwing	
			23 gras in bebouwd gebied		23 gras in bebouwd gebied	
		24 kale grond in bebouwd buitengebied				
			32 open duinvegetatie 33 gesloten duinvegetatie 34 duinheide 36 heide 37 matig vergraste heide 38 sterk vergraste heide			35 open stuifzand,45 overig open gegroeid natuurgebied 46 kale grond in natuurgebied
	Forest	Culture	Grassland	Wetlands	Settlement	Other
Kadaster	56 bos met recreatieve hoofdfunctie, 61 bos	62 akkerbouwland, 64-65 tuinbouw, 67 bloembollen	63 grasland		11-19 bewoning 21-39 bedrijfsgebouwen evt in comb met bewoning 41-49 transport, (spoor)wegen, vliegvelden, leidingen, 71-79 sociaal-culturele voorzieningen,	57 erf en tuin, 66 boomgaard, 68 boomkwekertij, kerstdennen, 81-89 wateren (84=meren plassen ven), 99 overige gronden
	91 braak terrein					

Appendix 2 Data on agricultural and forestry practices that may serve to derive emission factors

2.1. Basisregistraties Percelen (BRP)

Aim / general set up of monitoring system Collect and distribute land use information at the field level. Aims are to: = reduce administrative burden for the agricultural sector = increase the efficiency and effectiveness of Min Agr. by generic use of basic information. = develop one information system for the registration of basic information = develop one entry point for accessing the data.
Application to Field level registration of net productive area of owners: farmers > 3 life stock units, or registered in McSherry-subsidy. Registration of nature and forest land not included yet.
Representativity / area of application All agricultural land, and in future nature areas and forests. Not on areas of settlement, infrastructure, water and recreational areas **Minimum unit of scale of applicability (resolution or support site)** Unit is parcel with 1 crop, 1 owner or tenant, 1 manure-registration number Strictly productive area of a parcel: borders, ditches, paths within the parcel are excluded
Variables measured: agricultural land use and nature (users, crop, area, location, mineral input and history)
Variables derived users, crop, area, location, mineral input and history
Accuracy per variable Numbers obtained by enquiries, accuracy unknown to present project
Periodicity Continuously (mutations notified within 30 days) **Operational since / still ongoing:** Starting up, Operational since 2000 Changes in time in assessment No
Availability / contact person + address / costs of data Dienst Basisregistratie Percelen, Dhr. Huis LNV Assen **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Area, land use and landuse change, and activity information
The implementation is not complete and is continuously improved and extended. The "perceelsregistratie LNV" is the *single* window for all land use related information to the administration and primarily focussed on manure legislation. The current system requires land users to provide information on the actual land use (crops which are finally split up in grassland, cropland, fallow, nature or maize) and on area, planting date and location). Though this system is still under development, it is the most promising system for activities and land management (production, groundwater management, fertilization and manure). The system was not available in 1990. Several additions to the system would be required to comply with the requirements of the Climate Convention and the Kyoto Protocol such as manure application and fertilizer rates, soil and residue management and grazing regimes. This information would then be available for the 1.3 million parcels of agricultural land and nature and provide more detailed information than the manure administration (MINAS). The additions however, may put a heavy administrative load on farmers land managers and land owners and as a consequence may not easily be accepted by farmers and others unless this is associated with subsidies or economic gain from forms of specific management. See http://www.minlnv.nl/lnv/algemeen/dbr/percelen

2.2. CBS Statistieken / Statline

Aim / general set up of monitoring system Collect (agricultural) data at the regional level to compile overviews.
Representativity / area of application Netherlands **Minimum unit of scale of applicability (resolution or support site)** Region, county, data at private farm level are not public.
Variables measured Basic statistical data on land use and productivity.
Variables derived Income levels, production level, number of animals, manure use, etc.
Accuracy per variable Unknown to current project
Periodicity Annual **Operational since / still ongoing ?** Yes **Changes in time in assessment** Continuously changes in variables and assessments are made
Availability / contact person + address / costs of data http://statline.cbs.nl/StatWeb/start.asp?lp=Search/Search **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Land use practices mainly: grazing land management, forest management, cropland management

2.3. Farm Accountancy Data Network carried out by LEI (connected to CBS)

Aim / general set up of monitoring system
Connected to the CBS data (2.2), but focusing on agriculture. Incl GIAB + census ,
Data are gathered by enquiries, and interviews

Application to
All types of farms

Representativity / area of application
Netherlands

Minimum unit of scale of applicability (resolution or support site)
Region, county, type of owner, data at private farm level are not public.

Variables measured
Economic information at the farm level:
Main categories:
Agricultural farms (excl. horticulture)
Arabele farms
Dairy farms
Pig farms
Poultry farms
Combined farms
Horticulture (excl agriculture)
Field vegetable growers
Horticulture under glass
Vegetables under glass
Cut flower under glass
Pot plants under glass
Flower bulb growers
Mushroom growers
Fruit growers
Tree nurseries
Regional division is possible e.g for arable farms
- Northern clay region
- Central clay region
- Southern clay region
- Veenkolonien and the Northern sand region

Periodicity
From 1986 - present, Annual

Operational since / still ongoing ?
Yes

Changes in time in assessment
Improvements are made continuously

Availability / contact person + address / costs of data
http://www.lei.nl/

Storage of data (paper / digital, what system)
Digital , and paper archives

Which variables and parameters for the National System can be derived
No clear link with carbon monitoring, livestock numbers and mineral balance can be a basis to estimate N2O and CH4 emissions.

2.3A Geografisch Informatiesysteem Agrarische Bedrijven (GIAB)

Aim general set up of monitoring system Location and address of farms
Application to All farms registered with > 3 life stock units or registered by Animal Health Service (GD) In total about 170.000 locations
Representativity / area of application Netherlands, nearly all agricultural area **Minimum unit of scale of applicability (resolution or support site)** Co-ordinates of the main address of the farm
Variables measured No other measurements. All data from the annual census of farms and farmers (Landbouwtelling) are matched and available
Variables derived location
Accuracy per variable Some delay in updating likely
Periodicity Update annually **Operational since / still ongoing ?** since 2000, ongoing **Changes in time in assessment** Change in number of farms and farmers
Availability / contact person + address / costs of data Database owned by Min of Agriculture(LNV) and Alterra. LNV-projects free (privacy restrictions on use of the database) Auke de Bruin Auke.deBruin@wur.nl/ Edo Gies Alterra Edo.Gies@wur.nl **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Secondary source of information for C,G

2.3B Landbouwtelling, Annual census on farms and farmers

Aim general set up of monitoring system Annual Statistical information on farms and farmers with data about the farmer, labour, area, crops and cattle
Application to All farms registered with > 3 life stock units
Representativity / area of application Netherlands, nearly all agricultural area **Minimum unit of scale of applicability (resolution or support site)** Country, region private farm data are not public.
Variables measured Through enquiries: Cattle: number of cows and calves, milk-, meat-, equipment (cowhouses etc.) Pigs: number of pigs in weightclasses, equipment (pigshed etc) Chicken: number of chicken by age-classes, egg- or meat-, equipment (henhouses etc) Also horses, sheep, goat, rabbits, furbearers Agriculture Land in use by the farmer (owned or rent) divided in Grain, beans, coleseed, potatoes etc., maize, onions, Horticulture in open air or under glas divided in Vegetables, fruits, flowers, treeorchards Mushroom, tuberous plants, chicory Agricultural land divided in Grassland, horticulture, fallow, natural grassland and forest area
Variables derived See variables measured
Accuracy per variable. Unknown to current project
Periodicity Update annually **Operational since / still ongoing ?** since < 1970, ongoing **Changes in time in assessment** Change in all aspects of agricultural land use
Availability / contact person + address / costs of data Database owned by Min of Agriculture(LNV) LASER, restrictions on privacy of the data **Storage of data (paper / digital, what system)** digital
Which variables and parameters for the National System can be derived C,G, emission factors

2.4. National Monitoring Network Soil Quality (RIVM)

Aim / general set up of monitoring system Soil quality data, mostly ground water data
Application to Pollution data from soils from a sampling scheme in top soil (0-10 cm)
Representativity / area of application Scale 1:50 000 **Minimum unit of scale of applicability (resolution or support site)** 390 sampling points for groundwater + annually 2 combinations of land use and soil type sampled at 20 points for each combination.
Variables measured Concentrations of heavy metals, polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides and triazines in the topsoil (0-10 cm) and the litter layer of the forest sites have been reported. Concentrations of macroparameters, nutrients and heavy metals in the upper groundwater are also presented
Variables derived See measured
Accuracy per variable Unknown to current project
Periodicity 5 year scheme stratified by land use and soil group **Operational since / still ongoing ?** 1993, ongoing **Changes in time in assessment** No
Availability / contact person + address / costs of data Institute for Public Health and Environment, Bilthoven Reports in RIVM series See e.g. http://www.rivm.nl/bibliotheek/rapporten/714801017.html **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Probably not relevant for national system

2.5. HOSP 1988-1999

Aim / general set up of monitoring system Forest growth and Removals (Standing (dead or alive) volume) on a national scale. Re-measurement of the sample 4th National Forest Inventory 1985 (see 1.6)
Application to Forest land 1980 according to FAO definitions with land use category 'Forest'. New forest area after 1980 not accounted for. Deforestation accounted for.
Representativity / area of application about 300000 ha 'forest land' according to FAO definitions Minimum unit of scale of applicability (resolution or support site) Plot size about 314 m2. Densitiy 1 plot per km2: 3000 plots
Variables measured Unit Tree: species diameter, height Unit: plot: stand information according to 4th National Forest Survey area census (see 1.6) Unit plot: site description, litter layer thickness, accessibility for recreational use (No Soil type) Note no vegetation description
Variables derived Volume, growth, removal, harvest
Accuracy per variable About 10% for volume, <10% area-change
Periodicity Rounds of every 5 years. **Operational since / still ongoing ?** 1985,1988-1999. Stopped in 1999 **Changes in time in assessment** Changes in 5 years time are estimated
Availability / contact person + address / costs of data SBH, P.O. Box 253, 6700 AA Wageningen, 0317-466555. Data free, costs for queries and delivery only **Storage of data (paper / digital, what system)** Digital (ORACLE database)
Which variables and parameters for the National System can be derived Area: F,AR partly Volume: FM, art 3.3, art3.4, D, A

2.6. Meetnet FunctieVervulling Bos 2000 (MFV)

Aim / general set up of monitoring system Forest area estimate according tot FAO definition, site-quality , forest / vegetation type Estimate standing / lying volume, dead or alive
Application to Forest definition according to FAO, all owners.
Representativity / area of application Netherlands all forest land **Minimum unit of scale of applicability (resolution or support site)** Plot size about 314 m2, density 1 plot per km2, 3600 plots
Variables measured Unit: forest stand, ownership, forest type, accessibility for recreational use Unit: Tree, species diameter, height Unit: plot, site description, soil type, age, dominant height, dominant tree species, pollution (litter, noise), vegetation description, (tree-, shrub-, herbs- and moss layer)
Variables derived Volume, after 2008 also: growth, removal , harvest Vegetation type
Accuracy per variable Area 10% on national scale Volume s.e. <10 % on national scale, removal >10% on national scale
Periodicity Rounds of 10 years **Operational since / still ongoing ?** 2000-2004 next period not certain probably 2008-2012 **Changes in time in assessment** MFV is the follow up of system 2.5 (HOSP), the MFV was re designed compared to HOSP
Availability / contact person + address / costs of data EC-LNV, Hilgen Postbus 306700 AA Wageningen tel: 0317-474801 Alterra / Dirkse / Postbus 47, 6700 AA Wageningen, The Netherlands tel+31 317 474700 No cost **Storage of data (paper / digital, what system)** Digital (ORACLE database)
Which variables and parameters for the National System can be derived Area: F, FM,ARD partly art6 Volume FM, art3.4, D

2.7. SYHI 1990-

Aim / general set up of monitoring system Standing (dead or alive) (wood)volume. Growth (not Removals) on forest land managed by State Forest Service (Staatsbosbeheer, SBB)
Application to Forest land managed by SBB
Representativity / area of application 'forest land' within management unit **Minimum unit of scale of applicability (resolution or support site)** Plot size about 314 m2. Density 6 to 100 plot per km2
Variables measured Unit: Tree, species diameter, height Unit: plot, site description with main species, age, possibly other information like vegetation description (not standardised)
Variables derived Volume, growth,
Accuracy per variable About 10% for volume, <10% area-change
Periodicity 10 year for every management unit within SBB **Operational since / still ongoing ?** Ongoing **Changes in time in assessment** Unknown to current project
Availability / contact person + address / costs of data SBB Dienstverlening Princenhof Park Postbus 1300,3970 BH Driebergen,Tel 030-6926111 **Storage of data (paper / digital, what system)** Digital (ORACLE / DB4)
Which variables and parameters for the National System can be derived Volume FM, art 3.4, D, A

2.8. WOODSTOCK

Aim / general set up of monitoring system Woodstock is a software product for private forest owners, to keep track of forest and management planning. Standing (dead or alive) (wood)volume. Growth (Not Removals) on forest land owned by private forest owners, communities and others
Application to Forest land owned by private owners
Representativity / area of application 'forest land' within management unit **Minimum unit of scale of applicability (resolution or support site)** Plot size about 314 m2. Density 6 to 100 plot per km2
Variables measured Unit: Tree, species diameter, height Unit: plot, site description with main species and age Possibly other information like vegetation (not standardised)
Variables derived Volume, growth,
Accuracy per variable About 10% for volume, <10% area-change.
Periodicity Incidental **Operational since / still ongoing ?** Incidental **Changes in time in assessment** Unknown to current project
Availability / contact person + address / costs of data Forest owners and owner groups, no central availability ! **Storage of data (paper / digital, what system)** Digital (DB4)
Which variables and parameters for the National System can be derived Volume FM, art3.4, D, A

2.9. Sample forests 4th national Forest inventory 1985

Aim / general set up of monitoring system Standing (dead or alive) (wood)volume. Growth and Removals on a national scale, vegetation and site description (this is the assessment part of system 1.6)
Application to Forest land 1980 according to FAO definitions with land use category 'Forest'. New forest area after 1980 not accounted for. Deforestation accounted for.
Representativity / area of application about 300000 ha 'forest land' according to FAO definitions **Minimum unit of scale of applicability (resolution or support site)** Plot size about 314 m2. Density 1 plot per km2: 3000 plots
Variables measured Unit Tree: species diameter, height Unit plot: stand information according to 4th National Forest Survey area census (see 4th National Forest Survey, system 1.6) Unit: plot: site description: Soil type, litter, accessibility for recreational use Vegetation description: plant species and abundance
Variables derived Volume, growth, removal, harvest, Vegetation type
Accuracy per variable About 10% for volume, <10% area-change
Periodicity Once only, 1985 **Operational since / still ongoing ?** vegetation description was repeated in 1989, see also HOSP **Changes in time in assessment** This system was followed up by HOSP and MFV
Availability / contact person + address / costs of data SBH, Postbus 253, 6700 AA Wageningen,0317-466555. Data free, costs for queries and delivery only. **Storage of data (paper / digital, what system)** Digital (ORACLE database)
Which variables and parameters for the National System can be derived Area: F,A R partly Volume FM, art 3.4, D, A

2.10 Programma Beheer

Aim / general set up of monitoring system Administrative and GIS system to monitor subsidies and their effectiveness
Application to Applied tot management regimes in forests, semi natural grasslands
Representativity / area of application Landowners wishing to receive subsidies (excl State Forest Service and Min Defense)
Variables measured Parcel with management agreement (subsidy)
Variables derived Land use: Plas en ven, poel Moeras Rietcultuur (half)natuurlijk grasland / weidevogel- akkers heide, nat / droog struweel hoogveen bos hakhout griend middenbos stuifzand further the achievement of nature values: certain plant groups, amount of dead wood etc.
Accuracy per variable exact location of parcel, management achievement is semi quantitative and is monitored by owner himself
Periodicity Annual **Operational since / still ongoing ?** 2000, ongoing **Changes in time in assessment** No
Availability / contact person + address / costs of data www.minlnv.nl / laser **Storage of data (paper / digital, what system)** digital
Which variables and parameters for the National System can be derived Art.3.4: F, G, C

2.11. Staatsbosbeheer spoor12

Aim / general set up of monitoring system Administrative and GIS monitoring system in use by State Forest Service
Application to Applied tot management regimes
Representativity / area of application Area under management of Forest State Service
Variables measured Vegetation map, number animals / birds / species
Variables derived Types of coverage
Accuracy per variable exact location parcel, manager monitors his own piece of forest, or grassland
Periodicity Annual **Operational since / still ongoing ?** 2000, Regular update **Changes in time in assessment** Yes
Availability / contact person + address / costs of data Www.staatsbosbeheer.nl, Jasper Kuipers / Harry Hekhuis-410247 **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Art.3.4: FM, G

2.12. Natuurmonumenten

Aim / general set up of monitoring system Administrative and GIS monitoring system for areas in ownership by a large nature conservation organisation 'Natuurmonumenten'
Application to Applied to monitor management regimes
Representativity / area of application Area under management of Natuurmonumenten
Variables measured Vegetation map, number animals / birds / species
Variables derived Types of cover by71 classes
Accuracy per variable exact location parcel, management is monitored by regional manager
Periodicity Annual **Operational since / still ongoing ?** 2000, Regular update **Changes in time in assessment** Yes
Availability / contact person + address / costs of data www.natuurmonumenten.nl **Storage of data (paper / digital, what system)** digital
Which variables and parameters for the National System can be derived Art.3.4, FM, G

2.13 Bosccertificaten Groenfonds

Aim / general set up of monitoring system:
For new (planted in 2000 or later) forest the CO2-fixation is being calculated for a period of 50 years. After the calculation the new forest will be monitored and inspected to see whether the forest grows according to the calculation by the model.

Application to
New forest areas planted after 2000, of which the owners have asked for a carbon subsidy by the Nationaal Groenfonds.

Representativity / area of application
The area of application depends on the application by the owner.

Minimum unit of scale of applicability (resolution or support site)
Minimum area is 2,5 hectares if connected to existing forest, 5 hectares when it is a solitaire forest unit. There is no maximum limit.

Variables measured

depends on procedure:

Calculation variables	delivery control	monitoring[5]	process control[5]
Soil	soil	tree species	tree species
Tree species	planting distance	diameter	management
Ground water level	tree species	height	
Acidity	health of planted trees	planting distance	
Vision on management			
Afforest plan			
Recreation			

Variables derived

Calculation variables	delivery control	monitoring[5]	process control[5]
Tons CO2	if the forest is planted correctly	Tons CO2 recalculated	management

Accuracy per variable
Area very accurate
Monitoring in field: s.e. < 5%

Periodicity

Calculation	delivery control	monitoring[5] and process control
Once, at the start	once, at the start	several times (not yet known how many) during 50 years

Operational since / still ongoing ?
2000, still ongoing

Changes in time in assessment
No

Availability / contact person + address / costs of data
Nationaal Groenfonds: www.groenfonds.nl

Storage of data (paper / digital, what system)
Paper (application forms, reports and correspondence) and digital: excel and explorer files of calculation

Which variables and parameters for the National System can be derived
FM art 6
FM art 3.4
A
RV

[5] Is still in development

2.14. CBS Houtstatistieken

Aim / general set up of monitoring system Each year the UNECE / Timber committee sends out a Joint Questionnaire to the national correspondents of the UNECE timber committee. The Netherlands fills out this questionnaire based on the import en export statistics of wood. Aim of the questionnaire is to monitor the change in production, trade, and use of species and forest products between countries.
Application to Netherlands
Representativity / area of application Netherlands **Minimum unit of scale of applicability (resolution or support site)** Netherlands
Variables measured Roundwood removal for: roundwood, wood fuel, industrial roundwood, sawlogs and veneer logs, pulpwood and other industrial roundwood Production of wood products (charcoal, chips and particles, residues, sawnwood, wood-based panels, wood-pulp, other pulp, recvered paper and paper and paperboard) Trade of wood products (charcoal, chips and particles, residues, sawnwood, wood-based panels, wood-pulp, other pulp, recvered paper and paper and paperboard) Import and export of roundwood sorted by tree species
Variables derived See measured
Accuracy per variable 1000 M3 or 1000 metric tonnes
Periodicity Annually **Operational since / still ongoing ?** 1950's , Still ongoing **Changes in time in assessment** Changes in classes of commodities
Availability / contact person + address / costs of data Data is available at the UNECE Timber Committee, Mr. E.K. Pepke ; 390 Palais des Nations CH-1211 GENEVE 10; tel: 00 41 2 29172872; Switzerland And for Dutch data only: www.sbh.nl **Storage of data (paper / digital, what system)** Digital, Excel spreadsheets, MS Access
Which variables and parameters for the National System can be derived Maybe in future once a political decision has been made on wood products accounting.

2.15 BIS

Aim / general set up of monitoring system Since 1988 Stichting Bos en Hout carries out an annual enquiry among companies which together form the woodworking industries in the Netherlands. Aim of the inquiry is to get a complete picture of the use of (Dutch) round wood, based on the general production figures, in order to get a better perspective of the trends and developments.
Application to Wood working sector
Representativity / area of application Approximately 100% of the wood working industry is being asked for there figures. **Minimum unit of scale of applicability (resolution or support site)** Single company, although these data are not public
Variables measured M3 roundwood used M3 chips used M3 of a certain product produced
Variables derived See measured
Accuracy per variable Unknown to current project: enquiry sheets are filled out by companies
Periodicity Annually **Operational since / still ongoing ?** Operational since 1988 till present **Changes in time in assessment** No
Availability / contact person + address / costs of data SBH, Wageningen, 0031 317 466555 www.SBH.nl **Storage of data (paper / digital, what system)** Paper (returned questionnaires) and digital (outcome in Excel spreadsheets)
Which variables and parameters for the National System can be derived Maybe in future once a political decision has been made on wood products accounting.

2.16. Long term growth and yield plots (Dorschkamp archives) for biometrical studies

Aim / general set up of monitoring system Plots (some 1200) were in permanent monitoring to study management, and wood production of 25 tree species in Netherlands. Much of the information is published in some 300 titles amongst which the growth and yield tables.
Application to The plots were concentrated in stands of tree species that were of economic value (e.g. black pine)
Representativity / area of application There is a bias in representativity (see previous point) **Minimum unit of scale of applicability (resolution or support site)** Hectare
Variables measured Tree height, diameter, number of stems, management, thinning, site assessment (chemical analyses)
Variables derived Volume, increment, site-growth relations
Accuracy per variable Very accurate, but with possible bias
Periodicity Most stands were recorded every time when the forest owners wanted to carry out a measure **Operational since / still ongoing ?** Some plots were operational since 1920's, only few are still being measured **Changes in time in assessment** Unknown, probably rare
Availability / contact person + address / costs of data Plots were being monitored by Dorschkamp (now ALTERRA cees.vandenberg@wur.nl) and Dep. Forestry (now Group Forest Ecology and Forest Management-WUR; Leo Goudzwaard and Hans Jansen). New analyses will be time consuming **Storage of data (paper / digital, what system)** Most data are digitised, but on old systems.
Which variables and parameters for the National System can be derived The dataset is extremely valuable for Forest Management (art 3.4)

Appendix 3 Data on emission factors including weather and groundwater data

3.1. TAGA (Alterra) and other long term experiments (Wageningen-UR)

Aim / general set up of monitoring system Archived information on concluded (long term) experiments in agriculture and upon land use changes and database for ongoing long term experiments in the Netherlands
Application to Soil experiments in various soil types in The Netherlands
Representativity / area of application Plot, field experiments **Minimum unit of scale of applicability (resolution or support site)** Several square meters to ha.
Variables measured soil chemical characteristics
Variables derived Soil C changes in relation to management
Accuracy per variable Will vary per project in the archive
Periodicity Depending on experiment, some long term >10 years **Operational since / still ongoing ?** No **Changes in time in assessment** Will vary per experiment
Availability / contact person + address / costs of data Kooistra & Kuikman, 2003 The report provides a list of 19 long term experiments related to carbon sequestration in agricultural soils. Data base is on Www.carboninsoil.alterra.nl **Storage of data (paper / digital, what system)** Mainly a paper archive, Soils samples (not all) are stored and can be re-examined for soil C if necessary; extraction of emission factors and relation to activities and management or land use; most on arable land, fewer on grassland
Which variables and parameters for the National System can be derived Useful to determine emission factors. Arable, grassland and forests

3.2. Algemene Hoogtekaart Nederland (AHN)

Aim / general set up of monitoring system Detailed height above NAP (= certain base level) raster 16m2
Application to Netherlands, detailed heights including vegetation height
Representativity / area of application Netherlands, grid size 4x4m **Minimum unit of scale of applicability (resolution or support site)** Min are 4x4 m
Variables measured Height by Laser altimetry
Variables derived Height above NAP
Accuracy per variable raster 4x4 m, accuracy unknown
Periodicity Unique , 1996-2003 **Operational since / still ongoing ?** Update every 10 years **Changes in time in assessment** No
Availability / contact person + address / costs of data Rijkswaterstaat: RWS-MD, ownership database yet not clear Alterra / Centre Geo information at disposal **Storage of data (paper / digital, what system)** Digital GIS
Which variables and parameters for the National System can be derived This could be an important source to determine after a deforestation event, the emission factor (based on the height of vegetation)

3.3. KNMI Weather data

Aim / general set up of monitoring system Collect basic weather information
Application to National scale weather forecasts, station data
Representativity / area of application Netherlands **Minimum unit of scale of applicability (resolution or support site)** Location of weather stations
Variables measured Temperature, precipitation, wind speed, etc..
Variables derived See measured
Accuracy per variable Known at KNMI
Periodicity Hourly / daily **Operational since / still ongoing ?** Depend on station, some since 150 years **Changes in time in assessment** Several improvement, extensions made
Availability / contact person + address / costs of data http: / / www.knmi.nl / product / **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived = basic info needed for understanding processes mainly decomposition of soil organic matter under different management.

3.4. Ground water depth records

Aim / general set up of monitoring system Groundwater depth information
Application to National scale, thousands of measuring points
Representativity / area of application Netherlands **Minimum unit of scale of applicability (resolution or support site)** Sample point
Variables measured Ground water depth
Variables derived See measured
Accuracy per variable Few cm
Periodicity Bi weekly **Operational since / still ongoing ?** Several decades for most points, Yes **Changes in time in assessment** More measuring points added
Availability / contact person + address / costs of data http://www.nitg.tno.nl/ned/appl/g_resources/groundwater/actgwst/index.shtml **Storage of data (paper / digital, what system)** digital
Which variables and parameters for the National System can be derived = basic info needed for understanding processes mainly decomposition of soil organic matter under different management..

3.5. Peelbemestingsonderzoek (fertiliser trials)

Aim / general set up of monitoring system During acid rain era, an extensive fertilization experiment was set up and monitored for 10 to 15 years
Application to Mainly young stands in south east of Netherlands
Representativity / area of application Forests on poor sandy soils **Minimum unit of scale of applicability (resolution or support site)** Hectare
Variables measured Tree height and diameter, all chemical analyses on soil: organic matter, P, K, N, Mg, Ca, etc.
Variables derived Tree growth, base saturation, SOM development in time
Accuracy per variable 5 to 10%
Periodicity Every 5 years **Operational since / still ongoing ?** No, the experiment was stopped in 1992 / 1993 **Changes in time in assessment** No
Availability / contact person + address / costs of data Dorschkamp archives, contact ad.olsthoorn@wur.nl **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Mostly relevant to FM,

3.6. International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP forests)

Aim / general set up of monitoring system

ICP (International Co-operative Programme) was established as a European wide forest health monitoring system. 200 forest sites in The Netherlands are in the level I (basic) health monitoring, 12 sites are in the intensive monitoring programme (Level II). Data are stored in the database FIMCI.

Application to

Forests of the higher parts of the Netherlands, mostly sandy sites

Representativity / area of application

Netherlands, forests

Minimum unit of scale of applicability (resolution or support site)

Sampling scheme was set up for European scale analyses. Very coarse resolution for the Netherlands. Level II may be too coarse to draw conclusions for the Netherlands

Variables measured

In Level I plots, forest health is assessed visually once every year, foliar and soil chemistry has been analysed at these sites once up to now.
In addition in the 12 level II plots following is recorded (only relevant ones):
Soil (solid phase) every 10 years all plots
Soil solution continuous part of the plots
Foliage every 2 years all plots
Meteorology continuous part of the plots
Forest height and diameter every 5 years all plots (second round of recordings was done in 2001/2002)
Ground vegetation every 5 years all plots

Variables derived

Forest health per country, forest growth, soil and foliage chemistry

Accuracy per variable

Data quality checks are continuously carried out. Harmonisation of data gathering is continuously under improvement
Not all uncertainties are published; Chemical analyses: few percent; visual assessment of health: much larger

Periodicity

Some variables (health) annually, others, every 5 to 10 years

Operational since / still ongoing ?

Since 1984, ongoing

Changes in time in assessment

Small differences between countries still occur, full harmonisation between countries is aim

Availability / contact person + address / costs of data

Data remain in property of each country. Access to data is therefore time consuming, because each country has to agree to a data request . http://www.icp-forests.org/

Storage of data (paper / digital, what system)

http://www.icp-forests.org/
Digital, dataportal is FIMCI http://www.fimci.nl/

Which variables and parameters for the National System can be derived

In the long term, this monitoring network could mainly provide data on soil development (litter, dead wood, and SOM). FM under Article 3.4. However, the number of sampling plots is very limited.

3.7. Bosreservaten (Forest reserves)

Aim / general set up of monitoring system
Dutch Forest Reserves is an intensive forest monitoring programme aimed at studying natural dynamics in Dutch forests. 60 forest sites (from few hectares to some tens of hectares) are intensively monitored.

Application to
Unmanaged forest sites, both characteristic ones as concerns the vegetation for the site and un-characteristic ones

Representativity / area of application
Forests of the Netherlands, the 60 sites represent Dutch forest conditions very well

Minimum unit of scale of applicability (resolution or support site)
Forest dynamics processes are studied, and are thus applicable at patch scale (400 m2)

Variables measured
Several hundreds:
Tree: height, diameter, position, species
Shrub layer: height, diameter, position, species
Understorey: cover, species
Soil map, litter layer thickness, dead wood volume, decay state,

Variables derived
Increment, forest dynamics and changes in time for unmanaged sites.

Accuracy per variable
Recordings are done following a protocol, and field manual. Cross checks are done sometimes. Uncertainty analyses are not done

Periodicity
Every reserve is recorded every 5 years

Operational since / still ongoing ?
First reserves were established late 1980's, still ongoing

Changes in time in assessment
The recordings and analyses have been done according to a standard methodology since the beginning

Availability / contact person + address / costs of data
Contac person Sandra Clerkx, ALTERRA. Sandra.clerkx@wur.nl data can be obtained against a handling fee. If analyses are required, costs will rise.

Storage of data (paper / digital, what system)
Digital, MS Access

Which variables and parameters for the National System can be derived
Mainly valuable for forest management (art 3.4), forest growth, impacts of non-management, mortality rates, litter layer dynamics.

3.8. Tree Biomass data (scattered databases)

Aim / general set up of monitoring system Literature collection for forest modelling (hundreds of studies)
Application to Mostly European tree species , but from sites all over the world.
Representativity / area of application Site and tree species specific **Minimum unit of scale of applicability (resolution or support site)** Site
Variables measured Diameter, height, bole form, dry wood density, whole tree biomass weight
Variables derived Whole tree biomass, allocation to tree compartments
Accuracy per variable Varies, s.e. usually less than 5 to 10%
Periodicity Sometimes single analyses, sometimes multi year measurements **Operational since / still ongoing ?** Varies per study **Changes in time in assessment** Yes, and subtle differences between studies
Availability / contact person + address / costs of data Data are scattered in literature databases, and mostly not complete , contact martjan.schelhaas@wur.nl **Storage of data (paper / digital, what system)** Mostly on paper, some digital
Which variables and parameters for the National System can be derived Data relate to land use, are relevant to FM, A, R, and D; carbon stock and stock changes can be derived.

Appendix 4 Modelling systems

4.1. Group of agricultural crop / soil models

Aim / general set up of monitoring system Understanding and projecting agricultural crop production and or agricultural soil dynamics at various scales. Examples are CENTURY, RothC, MOTOR, CESAR MITERRA INITIATOR
Application to Agricultural systems
Representativity / area of application Usually parameterised for Dutch circumstances **Minimum unit of scale of applicability (resolution or support site)** Plot, or parcel
Variables measured Input can consist of weather variables, and soil variables, and management regimes
Variables derived Crop production, soil carbon
Accuracy per variable Will vary per model
Periodicity Some calculate at daily basis, others at monthly basis **Operational since / still ongoing ?** Will vary per model **Changes in time in assessment** Will vary per model
Availability / contact person + address / costs of data CESAR: Jan Verhagen, PRI, Wageningen MITERRA: Peter Kuikman, Alterra, Wageningen **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Emission factors for various management regimes in cropland and grassland

4.2. Group of forest models (FORGRA, FORSPACE, CO2FIX, Decision support systems, EFISCEN)

Aim / general set up of monitoring system Understanding and projecting forest dynamics in relation to management at various scales and under various environmental influences
Carried out in, or applied to vegetation types or management regimes (definitions used in case of areal assessments) Dutch forest types, some forested regions, and European case studies and European full area coverage
Representativity / area of application Netherlands, Europe **Minimum unit of scale of applicability (resolution or support site)** Hectare
Variables measured These are modelling systems: input is either plant physiological characteristics or inventory data with management characteristics.
Variables derived Forest growth and dynamics, sometimes including soils and wood products, from case study scale to European scale
Accuracy per variable Highly variable
Periodicity Applications on project base **Operational since / still ongoing ?** Most systems are operational, and some have gone through a quality assessment. **Changes in time in assessment** Ongoing development of modelling systems.
Availability / contact person + address / costs of data Koen.kramer@wur.nl, or gert-jan.nabuurs@wur.nl, For EFISCEN also marcus.lindner@efi.fi **Storage of data (paper / digital, what system)** Digital
Which variables and parameters for the National System can be derived Emission factors in relation to management for FM, A, R, D

Appendix 5 Some readily available (frN_2O_{em}) emission factors

Table EF N_2O N_2O emission fractions due to different N inputs, as used by Kroeze (1994) for reporting by the Netherlands and Mosier et al. (1998) as used in IPCC.

Type of input	Differentiation	frN_2O_{em} (%)	
		Kroeze 1994	Mosier
Manure management (stables and storage)	Non Key source	0.1 (0.0-0.2)[1)]	0.1-2.0
Application of animal manures	Non key source – Surface application of organic manure to organic soils	2.0 (1.25-2.5)	1.25
	Non key source – Surface application to mineral soils (sand, clay)	1.0 (0.2-1.25)	1.25
	Key source – soil application manure through deep or shallow injection[2]	2.0 (1.25-2.5)	1.25
Grazing	Urine	2.0 (1.25-2.5)	2.0
	Faeces	1.0 (0.2-1.25)	2.0
Application of mineral fertilizer	Organische (veen) gronden	2.0 (0.2-1.25)	1.25
	Minerale (zand, klei) gronden	1.0 (0.2-1.25)	1.25
Crop residues	-	-	1.25
Nitrogen fixation	-	1.0 (0.2-1.25)	1.25
Indirect emissions of N_2O			
Deposition NH_3 (emission)[3]	10% van mest N en 20% van excretie N	1.0 (0.2-1.25)	1.0
Leaching nitrate (excess)	30% van aangevoerde N in mest	1.0 (0.2-1.25)	2.5
Soil cultivation of organic soils		-	5.0[3]
Waste management		-	1.0

1) Refers to anaerobic manure storage

2) In the period 1990 to 1995, the application of manure changed from 100% surface application to 100% injection, thus negatively affecting the N_2O emission from mineral soils (Spakman et al., 1997).

3) Emission for temperate regions at 5 kg N_2O per ha per year

Appendix 6 Overview sheet of Tiers, land use types, pools, and their associated readiness and gaps.

Legend (for sheets on following pages)

	not available; very few or none national activity data available
	partly available; usually a good degree of national activity data (and possibly some emission factors) is available, but often scattered and not used for reporting so far.
	operational; this pool can be reported based on 96GL defaults (for Tier 1), or national activity data are suffciently available to derive emission factors at the required degree of accuracy (Tier2)
	not relevant (impossible combination)
	reported or estimated by The Netherlands
	Tier 1 is shaded green when the 96GL provide the defaults.

		Tier1		Tier2		Tier 3
Forest	Aboveground	Not applied in practice. Reporting takes place on tier 2		Current NIR report table 5a. ARD needs to be geo-referenced for Kyoto. Missing are 1990 and 1970. National forest inventory (2.6.) stopped for this year.		More detail needed on landscape elements and activity data per forest ecosystem types. Scattered information in various databases/models.
	Belowground	Reporting possible on default 96GL and available LU data		Data and insight can be improved form international literature. Improvement also possible via ICP.		Highly accurate measurements at representative sampling scheme needed, in combination with ecosystem models
	Litter	No IPPC defaults but sufficient data on landuse		Data must be interpreted from Forest reserves, ICP, and international literature.		Highly accurate repetitive measurements at representative sampling scheme needed, in combination with ecosystem models
	Dead wood	No IPPC defaults but sufficient data on landuse, but can be reported in Tier 2		Can be derived from MFV, HOSP and Forest reserves network (in combination with international literature).		Repetitive measurements at representative sampling scheme can be derived from MFV. In combination with ecosystem models, the Tier 3 could be addressed
	SOC	on IPCC defaults		Can be derived from forest soil maps, e.g. Kuikman et al. 2003, in combination with ICP plots		Highly accurate repetitive measurements at representative sampling scheme needed, in combination with ecosystem models
	N2O	on IPCC defaults for combustion		N2O emissions from forest soils irrelevant unless low wet areas are re-forested		N2O emissions from forest soils irrelevant unless low wet areas are re-forested

		Tier 1	Tier 2	Tier 3
Cropland	Aboveground	On the basis of CBS-LEI database estimate for production and default IPCC emission factors	Can be derived from production statistics (2.2. and 2.3.). Area information is available via remote sensing (e.g. 1.10).	Detailed area information may come available via BRP (2.1). Crop growth models are available.
	Belowground	See 'aboveground' and using default FAO data for residues	Can be derived from yield information for most crops	
	Litter	Only relevant in cropland systems under no-tillage	Only relevant in cropland systems under no-tillage	Only relevant in cropland systems under no-tillage
	Dead wood	not relevant	not relevant	not relevant
	SOC	On the basis of IPCC and FAO default values for different soils; info on the basis of soils map is dated; see also Tier 2	On the basis of land use maps and measurements in soils at 1 per 25 km^2 stratified for soil type, landuse, groundwater (see Kuikman et al., 2003)	Country specific emission factors for C and CO_2 soil type, land use and groundwater management are needed but not available; models that include C (Cesar, MOTOR) are available though not validated
	N2O	IPCC defaults for emission factor and CBS-LEI for activity data (see NIR for reporting for N2O emission on basis of manure and fertilizer use but not related to LULUCF)	Country specific activity data are available (CBS) but country specific emissions factors are not	Detailed emission profiles for soil and crop management are needed but not available; no accepted and validated model for N_2O emissions available
	CH4	IPCC defaults for emission factor and CBS-LEI data (see NIR for reporting)	Country specific activity data are available (CBS) but country specific emissions factors are not; unlikely to be key-source	Detailed emission factors for soil and crop management are needed but not available; likely no key source; model for CH4 emissions available though not validated

		Tier 1	Tier 2	Tier 3
Grassland	Aboveground	On the basis of CBS-LEI (or FAO) database estimate for production and default IPCC emission factors	Production data is not reported, but can be derived from experimental data; distinguish grassland management from 2.1 "Basisregistratie" on parcel basis; otherwise from CBS-LEI database	Models on C dynamics (Cesar, MOTOR) are available but detailed area and activity data for defined grassland management is not available
	Belowground	See 'aboveground' and using default FAO data for residues	See 'aboveground' and using default FAO data for residues or part of SOC	See 'aboveground' and using default FAO data for residues or part of SOC
	Litter	Unclear whether this is relevant in grassland systems	Unclear whether this is relevant in grassland systems	Unclear whether this is relevant in grassland systems
	Dead wood	Not relevant	Not relevant	Not relevant
	SOC	On the basis of IPCC and FAO default values for different soils; info on the basis of soils map is dated; see also Tier 2	On the basis of land use maps and measurements in soils at 1 per 25 km^2 stratified for soil type, landuse, groundwater (see Kuikman et al., 2003)	Country specific emission factors for C and CO_2 soil type, land use and groundwater management are needed but not available; models that include C (Cesar, MOTOR) are available though not validated
	N2O	IPCC defaults for emission factor and CBS-LEI for activity data (see NIR for reporting for N2O emission on basis of manure and fertilizer use but not related to LULUCF) - NIR does report country specific background N_2O emission for NL	Country specific activity data are available (CBS) but country specific emissions factors are not - NIR includes an estimate for the NL background N_2O emission which is not validated	Detailed emission profiles for soil and crop management are needed but not available; no accepted and validated model for N_2O emissions available
	CH4	IPCC defaults for emission factor and CBS-LEI data (see NIR for reporting)	Reporting in the NIR is to some extent country specific; not all emission factors are country specific	Detailed emission factors for soil and crop management are needed but not available; likely no key source; model for CH4 emissions available though not validated

		Tier 1	Tier 2	Tier 3
Wetland	Aboveground	based on GPG defaults for peat growth	country specific data are rarely available	detailed plant growth models may be only option, scarce data, not likely to be key category
	Belowground	Include in SOC,	Include in SOC	Include in SOC
	Litter	Not relevant	Not relevant	Not relevant
	Dead wood	Not relevant	Not relevant	Not relevant
	SOC	Soil maps and C contents from defaults are available though out dated due to extensive land use change and soil management during the 1960-1990 period	On the basis of land use maps and measurements in soils at 1 per 25 km^2 stratified for soil type, landuse, groundwater (see Kuikman et al., 2003)	Country specific emission factors for C and CO_2 soil type, land use and groundwater management are needed but not available; models that include C (Cesar, MOTOR) are available though not validated
	N2O	Default IPCC emission factor and land use from CBS database and LGN (probably in NIR)	Activity data from LGN or 2.1 "Basisregistraties" though not yet operational for wetlands; country specific emissions factors are not available	Activity data from LGN or 2.1 "Basisregistraties" though not yet operational for wetlands; country specific emissions factors are not available
	CH4	Default IPCC emission factor and land use from CBS database and LGN (probably in NIR)	Activity data from LGN or 2.1 "Basisregistraties" though not yet operational for wetlands	Activity data from LGN or 2.1 "Basisregistraties" though not yet operational for wetlands

		Tier 1	Tier 2	Tier 3
Settlements	Aboveground	from IPCC defaults	IPCC defaults in combination with aerial photos of tree cover in urban areas	not likely to be key category; scarce national data
	Belowground	from IPCC defaults	not likely to be key category; scarce national data	not likely to be key category; scarce national data
	Litter	Not relevant	Not relevant	Not relevant
	Dead wood	Not relevant	Not relevant	Not relevant
	SOC	from IPCC defaults	not likely to be key category; scarce national data, conversion to settlement may be an important (key) category	general soil models could be used; not likely to be key category; scarce national data, conversion to settlement may be an important (key) category
	N2O	Not relevant	Not relevant	Not relevant
	CH4	Not relevant	Not relevant	Not relevant

		Tier 1	Tier 2	Tier 3
Other land	Aboveground	GPG states that this pool is not considered	GPG states that this pool is not considered	GPG states that this pool is not considered
	Belowground	GPG states that this pool is not considered	GPG states that this pool is not considered	GPG states that this pool is not considered
	Litter	Not relevant	Not relevant	Not relevant
	Dead wood	Not relevant	Not relevant	Not relevant
	SOC	GPG states that this pool is not considered	GPG states that this pool is not considered	GPG states that this pool is not considered
	N2O	Not relevant	Not relevant	Not relevant
	CH4	Not relevant	Not relevant	Not relevant