# National Submission by the Netherlands to the UNFCCC - credits through article 3.3 and 3.4 activities under the Kyoto Protocol

**August 1st, 2000**

**S. Brinkman**
**P.J. Kuikman**
**R.J. Wichink Kruit**
**G.J. Nabuurs**
**A.J. Dolman**

**Alterra-rapport 162.1**

**Alterra, Green World Research, Wageningen, 2001**

ABSTRACT

Brinkman, S., P.J. Kuikman, R.J. Wichink Kruit, G.J. Nabuurs en A.J. Dolman, 2001. *National Submission by the Netherlands to the UNFCCC - credits through article 3.3 and 3.4 activities under the Kyoto Protocol*. Wageningen, Alterra, Green World Research.. Alterra-rapport 162.1. 44 pp. 1 figs.; 1 tables; 16 refs.

The Netherlands submitted data on afforestation, reforestation and deforestation (article 3.3 of the Kyoto Protocol) as well as on additional activities (article 3.4 of the Kyoto Protocol), as requested by the UNFCCC per 1st of August 2000. Article 3.3 under the IPCC scenario gives a 0,011 Mt C sink for the first commitment period. The article 3.4 activities give a source of 12,7 Mt $CO_2$ due to grassland on peatlands, which are a large $CO_2$-source in the Netherlands. Non $CO_2$-gases and soil carbon are excluded.

Keywords: Agriculture, $CO_2$, Forestry, Netherlands, Sinks

ISSN 1566-7197

This report can be ordered by paying 30,00 Dutch guilders (€ 14,-) into bank account number 36 70 54 612 in the name of Alterra, Wageningen, the Netherlands, with reference to rapport 162.1. This amount is inclusive of VAT and postage.


P.O. Box 47, NL-6700 AA Wageningen (The Netherlands).
Phone: +31 317 474700; fax: +31 317 419000; e-mail: postkamer@alterra.wag-ur.nl



Alterra is the amalgamation of the Institute for Forestry and Nature Research (IBN) and the Winand Staring Centre for Integrated Land, Soil and Water Research (SC). The merger took place on 1 January 2000.

Project 10483 [Alterra-rapport 162.1 / HM / 05-2001]

# Contents

***Appendices***

# Preface

Alterra executed a number of small research projects, in support of the negotiations. These projects aimed that aimed at upgrading the existing knowledge on the areas of Afforestation, Reforestation, and Deforestation and the sequestration capacities of forest and forest management measures. The first project dealt with preparing the Dutch data for the EU 1 august 2000 submission on. This work is reported here. Another project was an extension of the model that was developed in the run-up to COP VI, Additional Country Specific Data (ACSD) which described the potential effects of different accounting modalities for article 3.4 additional activities. The upgrade was meant to turn potential use of paragraph 3.4 actions into actual more realistic estimates. A separate report describing the new ACSD model is in preparation. This report contains also the results of two supporting projects that aimed at analyzing the submissions of key countries. To achieve this, and to be able to calculate effects of particular definitions on the sink capacities of individual countries, the ACSD model was adapted to form the Kyoto article 3.3 and 3.4 Toolbox (KAT)..

We would like to thank two Dutch sink delegates Jeroen Vis (Ministry of Agriculture, Nature Management and Fisheries) and Hans Nieuwenhuis (Ministry of Housing, Spatial Planning and the Environment) for their support and advice during the preparation and execution of these projects.

# Summary

This report presents the National Submission by the Netherlands to the UNFCCC (United Nations Framework Convention on Climate Change) as requested in 2000. This submission provided data on the proposed definitions and activities that the Netherlands would like to use and obtain credits for under the Kyoto Protocol, articles 3.3 and 3.4.

***Article 3.3***
The Netherlands submitted data for afforestation, reforestation and deforestation (Appendix B) following the IPCC and FAO (activity, landbased I & II based) scenarios. For the first commitment period (2008-2012), an estimation is made. The high estimated value is based on recent policy on forest planting and forest management. The lowest estimate is based on expert opinion, because it is anticipated that the current policy goals for the next 10 years will not be fully implemented and reached by 2012. The IPCC senario gives a sink of 10,7 Mt C in the commitment period. The FAO activity based scenario gives a sink of 219 Mt C, the FAO landbased I scenario gives a source of 456 Mt C and FAO landbased II scenario a source of 119 Mt C in the commitment period.

The ARD data are without emissions of non-$CO_2$ gases (i.e. $N_2O$ or $CH_4$), without age classes for trees in forest stands and without soil carbon contents. For forests, non-$CO_2$ gases are considered of minor interest compared to $CO_2$. Many work is done on age class inventory at the moment. It will only become possible to implement an age class distribution in the nearest future. Further measures are needed on soil carbon, because it is very important to know what happens during afforestation and deforestation, though these insights are generally lacking. A first estimate is provided for those cases where forest is planted/ removed on/from arable land or e.g. urban land and considerable changes are anticipated in soil carbon. These numbers were obtained from literature and should be viewed as rough estimates.

***Article 3.4***
The Netherlands has chosen to deliver data on the level of three management activities (Appendix D), grazing land management (i.e. reseeding and/or ploughing old grassland to renew the vegetation, drainage of grassland on organic soils), cropland management (i.e. ploughing, fertilization) and forest management (i.e. thinning, elongation of rotation length and fire management). This is despite the policy of the Dutch government which is not to include article 3.4 of the protocol at this stage, because of to many and large uncertainties.

New managed forest areas since 1990 are used for forest management, in contradiction to many other countries, that include the total exploitable forest area. The Netherlands states that only new management since 1990 should be recorded. Cropland management has to be better monitored and more research has to be done,

because little is known about ongoing and new activities on croplands and their implications on carbon storage. Very important is to implement not only sinks, but also sources (e.g. tillage) from croplands. The Netherlands is considered to be different from other countries on grazing land management, because there is a large area of grazing land on peatlands. Drainage management is very important in these areas and is an important source of $CO_2$. Non-$CO_2$ gases are considered to be important for drainage management and for agriculture as a whole. Estimates on emissions of greenhouse gases from Dutch agriculture point at equal emission levels for $CO_2$, $N_2O$ and $CH_4$.. Research is going on on this subject of emission reductions and will be implemented when possible. Little is known on the other grazing lands in the Netherlands. Policywise it is decided to implement the grazing lands on peatland in the national submission.

The result is a forest management sink of 563 Mt $CO_2$, a cropland management sink of 230 Mt $CO_2$ and a grazing land management source of 13500 Mt $CO_2$ in the commitment period.

# 1 Introduction

In Kyoto, 1997, the Parties to the UN Framework Convention on Climate Change agreed to the text of the Kyoto Protocol (see below). This protocol deals with issues concerning $CO_2$ sequestration. Articles 3.3 and 3.4 in the Protocol are relevant for sequestration. In article 3.3 issues on afforestation, reforestation and deforestation (ARD) and in article 3.4 issues on additional (human induced) activities, such as forest/ cropland/ grazing land management and revegetation are dealt with.

Before ratification of the Kyoto Protocol, definitions and accounting systems concerning these articles 3.3 en 3.4 among other issues and articles would need to be specified and agreed upon among participating countries to the protocol. Therefore, each country was asked to propose their definitions and accounting systems on article 3.3 and 3.4 before the first of August. Finally, the Parties will negotiate these propositions on definitions and accounting systems during the Convention of Parties (COP-6) in The Hague, held from November 13-24$^{th}$, 2000. This would eventuall lead towards ratification of the Kyoto Protocol.

The Netherlands submitted data on all scenarios and on three additional activities to the UNFCCC. These data are presented in this report and are preliminary. Many uncertainties, expert judgements and estimates are in this submission and research might further minimise these uncertainties and fill missing data on some of the issues and activities.

# 2 Approach

Both official scientific and peer reviewed literature have been assessed and many non-peer reviewed (national) reports have been used to search for data. For further details see the reference list. For the 1st commitment period from 2008-2012, according to the Kyoto Protocol, expert judgement was used to provide estimates on areas and activities as well as on efficiencies when needed.

The UNFCCC made a table format for the articles 3.3 (table I) and 3.4 (table III), as well as for the background data (table II). This format is used in the national submission. Therefore, table I and II are in Mt C and table III in Mt $CO_2$.

The IPCC and FAO definitions on ARD are used as described in the IPCC SR on LUCF (2000). The additional activities are defined in cooperation with the Ministrie of Housing, Spatial Planning and Environment and the Ministry of Agriculture, Nature Management and Fisheries. All additional activities are narrow defined, which means only new application since 1990 is included. The Netherlands has chosen to include grasslands on peatland in grazing land management, which causes a major source of $CO_2$.

# 3 Submission to Article 3.3

## 3.1 Definitions and accounting

### 3.1.1 Forest definition used in this assessment:

Land with tree crown cover (or equivalent stocking level) of more than 20% and area of more than 0.5 ha. Trees should be able to reach a minimum height of 5 m at maturity in situ. Furthermore, in The Netherlands a forest must have a minimum average width of 30 meters. May consist of close formations where trees of various stores and undergrowth cover a high proportion of ground or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 20%. Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 20 percent or tree height of 5m are included under forest, as are areas normally forming part of forest area which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest. The Dutch forest law requires a tree crown cover of 20%, whereas the UN-ECE/FAO (2000) compilation of national forest inventory data uses only 10%. Dutch forest area statistics according to the 10% crown cover limit are not available.

### 3.1.2 Definitions and accounting approaches for afforestation, reforestation and deforestation, used in this assessment:

*Afforestation IPCC*: "Planting of new forests on lands that historically have not contained forests".
For the purpose of this assessment, we have assumed this land to be 0 ha, because practically all lands in the Netherlands were covered with forest in pre historic times (Buis 1985, Mather 1990, Rackham 1998). Therefore, all planting of new forests on lands that were in use for agriculture at the time of planting do not fall under this definition of afforestation. It is assumed that afforestation on reclaimed lands in the polders is also 0 ha. That is an underestimation. Data are available on polder areas which are afforested, but not accounted in this assessment.
If afforestation were defined as "land that did not have forest for 50 years" (as in the EU proposal), then IPCC afforestation would comprise almost the same number as we report under "FAO reforestation" (see below). I

*Reforestation IPCC*: "Planting of forests on lands that have previously contained forests but that have been converted to some other use."

The definition of 'Reforestation IPCC' in the Netherlands leads to similar results as 'Afforestation FAO'.

*Afforestation FAO*: "Artificial establishment of forest on lands that previously did not carry forest within living memory.": 5400 ha. The Netherlands has as part of its forest policy the aim to expand the current forest area with some 75,000 ha before the year 2020. However, up to now it seems that that goal will not be achieved (Edelenbosch 1996, Hinssen 1998). An ex post evaluation was carried out of the rate of forest expansion since 1990 (Edelenbosch 1996). He reports an area of new forests on previous agricultural lands of 5400 ha between 1990 and 1995. Since the annual rate of forest expansion is decreasing fast, we have assessed an additional forest area expansion of only 940 ha between 1996 and 1999 (Hinssen 1998).
For the period 1990-2012, it was assumed that the interest of the Dutch Government in forest area expansion would continue. According to the forest policy aim of 75000 ha between 1989 and 2020 this would imply a yearly expansion of 2420 ha. This is also the assumption of the National Climate Policy Implementation Plan. This results in a total area increase, since 1990, in 2012 of 55660 ha.
This expansion would be achieved through, inter alia, a system of "tradeable forest certificates". However, on the basis of the areal expansion in the second half of the 1990's as assessed by the ex post evaluation, this number of 2420 ha/yr may not be achieved. To reflect this projection-uncertainty, we have assumed, as the lower range of this projected area that the rate of forest expansion will be 300 ha per year (after 2000) yielding a total area increase of 10,240 ha since 1990 (see also Nabuurs et al. 1999, 2000).

*Reforestation FAO*: "Artificial establishment of forest on lands that carried forest before"
The current practice of final felling and replanting or seeding is carried out on some 2600 ha per year (Seubring 1997). For the period 1990-1995, this gives a total area of 2600*6 = 15,600 ha.
It was assumed that the same rate could be applied to the whole of the period 1990-1999. However, for the period 1999 to 2012, we assumed that the annual reforestation area will go down to 2000 ha per year, because forest owners may pay less attention to the timber production function of the forest in the future. This gives a total area of reforestation for the period 1990-2012 of 52,000 ha.

Activity based, Land based I, and Land based II accounting systems have been used in this assessment according to definitions in the IPCC Special reports p. 131.

*Deforestation IPCC/FAO*: Conversion of forest to non-forest.
UN-ECE/FAO (2000) report for the EU 15 countries an annual deforestation rate of 0.066%. We have applied this same annual value throughout each period (slow degradation, expansion of cities, road building etc. are going on in The Netherlands too), for more detailed data are lacking for the Netherlands. For the 3 periods this results in a total deforestation of 1323, 2204, and 5070 ha.

I.e. the carbon loss is reported for the total area loss in each accounting period. This in contrast to when you would give an annual balance of the sum of ARD in the commitment period. In that case the sum of areas of AR since 1990 is taken and only one year of D between 2008 and 2012 is taken.

### 3.1.3 Accounting approach:

Full carbon accounting is used for all three approaches (Activity based, Land based I, and Land based II) in a manner by which C-stock changes are based on area times an uptake factor.

Period 1990-1995: 6 years. The reported carbon stock changes are for the full period.
Period 1990-1999: 10 years The reported carbon stock changes are for the full period.
Period 1990-2012: 23 years. The reported carbon stock changes are only for the first commitment period i.e. 2008-2012: 5 years

## 3.2 Carbon pools included

All carbon pools are included for re- and afforestation: whole tree biomass (including roots), litter, slash, and wood products), except for soil carbon. Soil Carbon was excluded from afforestation and reforestation activities for consistency with deforestation , because no data are available on soil carbon losses during deforestation (see below). The stand level model CO2FIX was run (see fig 1). CO2FIX gives a dynamic C balance for a full rotation of any given forest type, including soil and products. The long term net resulting balance is used for the Dutch estimate, although we realise that products actually do not play a role in this short term (1990-2012) as required for the submission. Even in the long term, the role of products is very small, so the inaccuracy is very small.
In deforestation all pools (including loss of whole tree carbon content) but without soil carbon is taken into account (see below at 4c). We decided not to include soil carbon loss estimates here, because there are no data available. Deforestation in the Netherlands consists of gradual degradation, road building, city expansion etc. What happens to the soil varies a lot (sols may get covered by concrete, or are removed). The uncertainty is therefore very large.

## 3.3 Stratification

For the Dutch forest, the average carbon pools in the forest biomass and average regrowth rates are used. No further stratification, except for sampling (see 4b below), has been applied apart from regrowth rates for forests on agricultural lands and regrowth rates for the existing forest that is being harvested. For the subsequent periods simple assumptions were made for the regrowth rates times area per age class. We did not distinguish between forest growth rates (and soil carbon losses) on former cropland or pasture, or different soil types.

## 3.4 Methodologies and data

### 3.4.1 Data sources

See explanation for area estimates above and explanation of effectiveness estimates below under c.

### 3.4.2 Sampling techniques

Results of the Dutch National Forest Inventory are used (Seubring 1997). The Dutch forest inventory consists of 3000 permanent plots of which 1/5th is re-measured every year. The selection of plots has been done through a stratified systematic sampling scheme that was drawn from the area statistic that was done the last time in 1983 (CBS 1985). In each plot (usually consisting of some 25 trees) height, diameters, etc are recorded. Also harvesting is recorded. Together with harvesting accounts from mills, and forest owners, a full account of harvesting is gathered. Through repeated measurements of the plots in combination with growth models, the increment is assessed.

### 3.4.3 Models and key parameters

For the assessment of C stock changes in this table (Appendix B) we have multiplied the “areas” by an “uptake factor”. Below we describe the uptake factors used in the assessment.

*Afforestation FAO*
Because no soil carbon is included, there is no difference between the following three scenarios.

- Activity based: 3.0 Mg C $ha^{-1}$ $y^{-1}$ was used (this is the proceeding average as indicated in figure 3.1). This is based on simulations with the model CO2FIX (Mohren et al. 1999, Nabuurs and Mohren 1993a, 1993b, 1995). The long-term average sequestration rate was used, even through we realise that we’re dealing with young forest mostly here. Especially for the period 1990-1995, this sequestration rate may be too high.
- Land based I: previous land use was either pasture or cropland. In both cases carbon loss due to soil preparation is assumed. Exact loss is uncertain, but is expected to be higher under pasture than under cropland. We think the carbon loss is approximately 0,1 Mg C $ha^{-1}$ $y^{-1}$, but it is not taken into account to keep straight with deforestation (also no soil carbon taken into account, due to lack of data).
- Land based II: previous land use was either pasture or cropland. In both cases, some soil carbon loss due to soil preparation is assumed. Exact loss is uncertain, but is expected to be higher under pasture than under cropland. For the same reason as Land based I, no soil carbon losses are accounted.

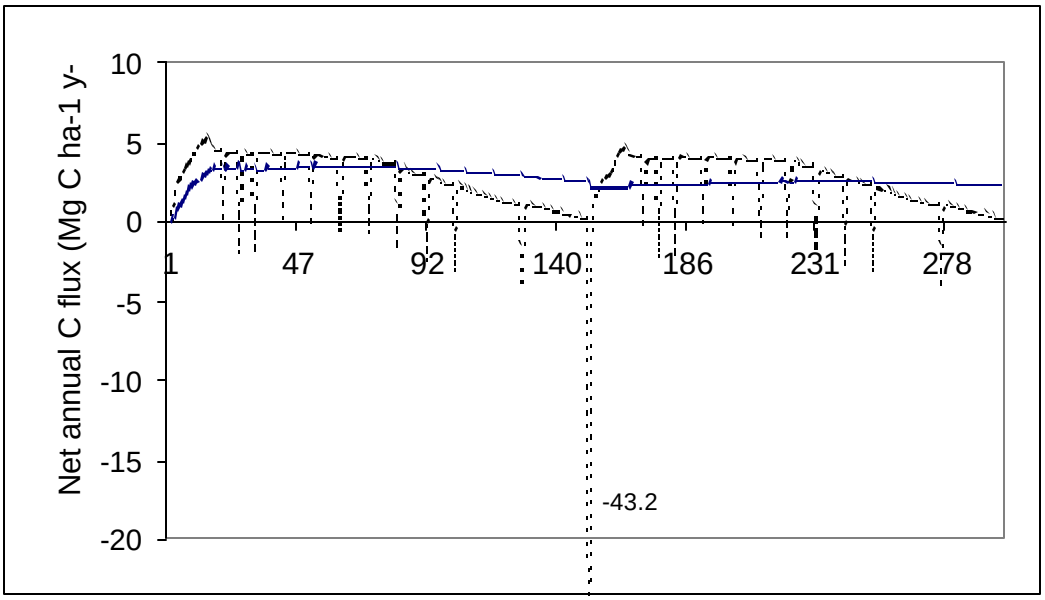


*Figure 3.1. Annual C flux (dashed line) in two oak rotations in The Netherlands. The continuous line presents the proceeding average of the annual flux.*

Reforestation IPCC is same as Afforestation FAO (*in practical terms for the Netherlands*)

*Reforestation FAO Activity based*: 0.8 tC $ha^{-1}$ $y^{-1}$ as a national average was used, because this activity is applied in the existing forest which, in the Netherlands, is situated on poor sites. Therefore regrowth is assumed to be much lower than in afforestation situations on former agricultural land. (Nabuurs and Mohren 1993b). This is used as an average value for each subsequent period, i.e. we do not take into account the ageing of forests and the effect that growth rates accelerate at higher ages. This is probably an overestimate because the 0.8 tC $ha^{-1}$ $y^{-1}$ is the national average sequestration rate for the current forest as it exists today in the Netherlands. In the periods up to 2012, the regrowing forests is on average some 11 years old in 2012. The growth rates of these young forests may be at about half of the sequestration rates mentioned above. This is highly uncertain because in inventories and in growth and yield measurements very little attention was paid to these young forest stages in the past.

*Reforestation FAO Land based I*: The full forest harvest has to be accounted, which means a loss of some 60 t C. It is assumed that the initial loss is only half of that (30 tC $ha^{-1}$), the other half being wood products and litter on the site (slash). The 30 tC slash will be lost within 10 years, so every year 3 tC $ha^{-1}$. Regrowth is assumed to be the same as afforestation: 0,8 tC $ha^{-1}$ $y^{-1}$.

*Reforestation FAO land based II*: From the start of activity we account, but then full accounting, therefore decaying slash (3 tC $ha^{-1}$ $y^{-1}$) and regrowth (0.8 tC $ha^{-1}$ $y^{-1}$) is taken into account, but no harvest.

Deforestation IPCC&FAO (*activity based and land based II*): accounting starts at the start of the activity. We assume that the total whole tree carbon content is lost due to deforestation, i.e. 60 Mg C $ha^{-1}$. Loss of forest soil organic matter is not taken into account here, although it may be another 20 t C $ha^{-1}$.

Deforestation IPCC&FAO (*land based I*): Accounting starts on 1 January 2008, irrespective of the start of the activity. Therefore, it is possible forests are standing until the year 2011, which gives some C-sequestration. That's why the effectiveness is less negative compared to the 'Deforestation IPCC & FAO (land based I)': a net loss of 59 Mg C $ha^{-1}$ is estimated. Loss of forest soil organic matter is not taken into account here, although it may be another 20 t C $ha^{-1}$.

**NB:** The uptake factors of afforestation and reforestation are divided by 2 for the period 1990-1995 and 1990-1999, because at the beginning of these periods no afforestation land existed; during the period this area is growing and only at the end of the period the full afforestation area is reached. So during the period the uptake factor can't be multiplied by the full area, but the average area during the period is half of the area. We have chosen to divide the uptake rate by a factor 2. This does not count for the 2008-2012 period, because in that period the full area almost exists during the whole period (Appendix A).
This correction is not applied to deforestation, because this is counted for only one year and thus has not to be corrected by dividing by 2.

### 3.4.4 Uncertainties

Forest inventories are usually reported to be very accurate. Uncertainties are less than 5% (Tomppo 1996). Main uncertainties are in assumptions for area estimates, and averaging of growth rates for the whole of the Netherlands that leads to the estimates on C stocks and fluxes.

## 3.5 Treatment of non-$CO_2$ greenhouse gases

Not treated; as water management during ARD activities is not changed, no fluxes are anticipated. In Dutch forest management in existing forests some fertilizer is being applied (mainly liming).We have assumed that that will not influence non CO2 emissions. In new afforestations fertilisation is usually not done.

## 3.6 Methods and key assumptions in projections for the first commitment period (2008-2012) and discussion, if possible, of trends beyond the first commitment period

For the period 1990-2012, it was assumed that the interest of the Dutch Government in forest area expansion would continue. According to the forest policy aim of 75000 ha between 1989 and 2020 this would imply a yearly expansion of 2420 ha. This is

also the assumption of the National Climate Policy Implementation Plan. This results in a total area increase, since 1990, in 2012 of 55660 ha.
This expansion would be achieved through, inter alia, a system of “tradeable forest certificates”. However, on the basis of the areal expansion in the second half of the 1990’s as assessed by the ex post evaluation, this number of 2420 ha/yr may not be achieved. To reflect this projection-uncertainty, we have assumed, as the lower range of this projected area that the rate of forest expansion will be 300 ha per year (after 2000) yielding a total area increase of 10,240 ha since 1990 (see also Nabuurs et al. 1999, 2000).

# 4 Submission to Article 3.4

## 4.1 Activity I: Forest management

### 4.1.1 Activity and accounting – *definition and description*

Managed forest: practically all Dutch forest was already managed in 1990.
This management includes thinning and normal harvest and regeneration cycle. Most of the forest area has been managed in even-aged stands as monocultures in regular rotations of 60 to 100 years. Managed is changing towards stand which are uneven-aged and mixes and more selective cutting and longer rotations (80-120 years). Management today does hardly include any drainage of sites or fertilization or liming except in cases of restoration of nutrient balances following acidification and/or eutrification. Forest fires are rare and management does not include pest control.
Only new areas of forest can be assumed to come into management after 1990. Therefore the area estimates for forest expansion are used here again. We use same effectiveness as for article 3.3, but now reported in t $CO_2$ (Appendix D). Here is a risk of double counting (Special Report p. 135) of new areas of forest which are also reported in article 3.3. We have clearly decided to take only the new forest areas, because there is no additional forest management since 1990 in the existing forest area in 1990. Thereby, few data are available on forest management activities in 1990.

### 4.1.2 Carbon pools included

All carbon pools are included: whole tree biomass (including roots), litter, soil organic matter, slash, and wood products)

### 4.1.3 Methodologies and data

For the Dutch forest, the average carbon pools in the forest biomass and average regrowth rates are used. No further stratification has been applied apart from regrowth rates for forests on agricultural lands and regrowth rates for the existing forest that is being harvested. For the subsequent periods simple assumptions were made for the regrowth rates times area per age class. We did not distinguish between forest growth rates (and soil carbon losses) on former cropland or pasture, or different soil types.
Data sources: see explanation for article 3.3 for area estimates and effectiveness.

### 4.1.4 Treatment of non CO2 greenhouse gases

Not treated

### 4.1.5 Methods and key assumptions in projections for the first commitment period (2008-2012) and discussion, if possible, of trends beyond the first commitment period.

For the period 1990-2012, it was assumed that the interest of the Dutch Government in forest area expansion would continue. According to the forest policy aim of 75000 ha between 1989 and 2020 this would imply a yearly expansion of 2420 ha. This is also the assumption of the National Climate Policy Implementation Plan. This results in a total area increase, since 1990, in 2012 of 55660 ha.
This expansion would be achieved through, inter alia, a system of "tradeable forest certificates". However, on the basis of the areal expansion in the second half of the 1990's as assessed by the ex post evaluation, this number of 2420 ha/yr may not be achieved. To reflect this projection-uncertainty, we have assumed, as the lower range of this projected area that the rate of forest expansion will be 300 ha per year (after 2000) yielding a total area increase of 10,240 ha since 1990 (see also Nabuurs et al. 1999, 2000).

## 4.2 Activities II: Cropland management

### 4.2.1 Activity and accounting – definition and description

Improved cropland management includes reduced tillage (more shallow and less frequent), improved management and application of crop residues (aimed at reducing the loss of residue N and thus of C), less bare-fallow (introducing cover crops), increased ley-arable farming on former arable land (as a result of expanding the area where biological farming principles are applied and no mineral fertilizer is applied).
Conventional cropland management is most likely a source for $CO_2$ (and $N_2O$) through conventional tillage, removal of crop residues, etcetera. Cropland management as broadly defined activity would cover both the increases and decreases of C stocks on the lands that are managed (both improved and conventional management). This is currently not reflected by the numbers reported in this table (Appendix D) for they only relate to improved management and disregard sources associated with conventional management. Source-data related to conventional management are currently incomplete and often lacking.

The rate of carbon gain is estimated from SRLUC table 4.5, page 203 to 1.1 $tCO_2$ (0.3 t C) per ha per year. The area to which this type of activities is applied in the Netherlands is not well known and estimated to 1% per year as of 1990 (1% of 909000 times 6 years gives 54540 ha). This will result in application on 20% in 2010 and is half of the estimated value in the SRLUC of 40% (p. 14). A large part of the Dutch cropland concerns crop rotations that require soil tillage at some point in time.

### 4.2.2 Carbon pools included

Carbon pools include, based on assumptions specified below, below-ground C in litter and soil.

### 4.2.3 Methodologies and data

Methodologies and data are scarce; calculations for the C stocks soil could be made based on model calculations and soil types. With these model exercises, $N_2O$ emissions for agriculture in the Netherlands have been estimated (ROB-Agro-Report, in prep).
The accounting approaches are based on statistical data from annual inventories on agricultural practices and farm management that are available from LEI-DLO and CBS as sources of statistical data; these are considered to be equal to FAO inventories.
Data on soil C contents are scarce especially concerning the change in soil C following (changes of) agricultural management.

### 4.2.4 Treatment of non CO2 greenhouse gases

Data on non $CO_2$-greenhouse gases from fertilizer use and direct and indirect $N_2O$ losses are scarce. The Netherlands report $N_2O$ emissions from mineral and organic fertilizers. Estimates on emissions should be available by autumn 2000 (ROB agro – report, Kuikman et al., in prep). Some of the measures will effect the emissions of nitrous oxide and of methane as well. Research is going on to provide measures of the (changes in) emissions following specific management practices.

### 4.2.5 Methods and key assumptions in projections for the first commitment period (2008-2012) and discussion, if possible, of trends beyond the first commitment period.

Projections for the first commitment period include a reduce application of mineral fertilizer due to improved fertilizer use efficiency and reduced losses of nitrate in the Netherlands. This alone will result in reduced $N_2O$ emissions (estimated at 0.5-1.7 Mt $CO_2$-equivalents in $N_2O$, ROB agro – report, in prep).

## 4.3 Activities III: Grazing land management

### 4.3.1 Activity and accounting – *definition and description*

According to the EU definition, permanent grassland is grassland that is not in rotation and that is continuous grassland for 5 or more consecutive years.

***- In the Netherlands, a large area of grassland is regularly subject to ploughing and reseeding to maintain productivity and introduce new and more productive grass varieties. This practice would qualify as grassland management.This form of management on permanent grassland will release soil organic carbon at an estimated rate of 3.5 t$CO_2$ per ha per year on the short term (estimated loss for N and $N_2O$ will be provided by September 2000 by ROB (Reductieplan Overige Broeikasgassen, reductionplan greenhouse gases other than $CO_2$)-project on the basis of IPCC default values for indirect emissions from nitrate leaching, ROB report, in prep). This management is repeated every 5-10 years to a large part of the grassland area and concerns on average 50000 ha per year. As for now, we assume that the losses of soil C will be compensated by the increased productivity in the years following ploughing and reseeding (on the long term: 5-10 years). This practice requires additional nitrogen fertilization to compensate for the nitrogen lost. Associated with this fertilization is emission of $CO_2$ (energy and transport) and $N_2O$ of unknown quantities***

As a consequence of the above, in 2012 most grassland on sand and 50% of grassland on clay is under this form of management (500000 ha and excludes the grassland area in the western, lower part of the Netherlands).

- In the Netherlands, peatlands are often covered by grazing land. Drainage management is very important on these areas. This causes a maximum source of $CO_2$ of 12 tons a year. The total area is 450.000 ha. An assumption is made that 450000*6 tons $CO_2$ a year is emitted. The area is constant between 1990 and 2012. This accounts for all of the numerical values included in Appendix D.
- The area of grassland is continuously decreasing due to urban and infrastructure development and due to conversion to cropland (mostly in rotation of grass-ley or for the production of flowers). The latter area is estimated to 5000 ha per year (data from "ROB – Herinzaai grasland" by Vellinga and Kuikman on the basis of CBS data (Van Eerdt, 1999). The rate of change of soil C is estimated to be –3.5 t $CO_2$ per ha per year and assumed constant for the period of 1990-2012. This will give 548365 t $C_{cp}$ = 115.000 ha $\times$ 5 (years 2008-2012) $\times$ –3.5 t$CO_2$ $ha^{-1}$ $year^{-1}$ $\times$ 1/3.67. However, this is not counted as grazing land management; it would be included in an activity such as "grassland conversion"
- Measures for improved grazing land management would include reducing the area and intensity of improving grassland productivity through ploughing and reseeding and replace with a practice where reseeding is done without ploughing "old" and permanent grassland or where ploughing and re-seeding is applied in spring and not in autumn. This would reduce the loss of soil C (and of soil N) and $N_2O$. No estimates as to the area in 2012 are available.

***Methods and approaches for estimation of non $CO_2$-greenhouse gasses***

No literature is available on gaseous losses of N from grassland following conversion to cropland or ploughing and re-seeding. The estimated loss of C is based on losses of N from soils and the $N_2O$ emission will be estimated using the N-loss and the default IPCC emission factor for indirect emissions of $N_2O$ of 2.5%. No information for $CH_4$ emissions is available.

### 4.3.2 Carbon pools included

Carbon pools include aboveground and based on assumptions specified below, below-ground C in litter and soil.

### 4.3.3 Methodologies and data

Methodologies and data are scarce; calculations for the C stocks soil could be made based on model calculations and soil types. With these model exercises, $N_2O$ emissions for agriculture in the Netherlands have been estimated (ROB-Agro-Report, in prep).
The accounting approaches are based on statistical data from annual inventories on agricultural practices and farm management that are available from LEI-DLO and CBS as sources of statistical data; these are considered to be equal to FAO inventories.
Data on soil C contents are scarce especially concerning the change in soil C following (changes of) agricultural management.

### 4.3.4 Treatment of non CO2 greenhouse gases

Data on non $CO_2$-greenhouse gases from fertilizer use and direct and indirect $N_2O$ losses are scarce. The Netherlands report $N_2O$ emissions from mineral and organic fertilizers. Estimates on emissions should be available by autumn 2000 (ROB agro – report, Kuikman et al., in prep). Some of the measures will effect the emissions of nitrous oxide and of methane as well. Research is going on to provide measures of the (changes in) emissions following specific management practices.

### 4.3.5 Methods and key assumptions in projections for the first commitment period (2008-2012) and discussion, if possible, of trends beyond the first commitment period

Projections for the first commitment period include a reduce application of mineral fertilizer due to improved fertilizer use efficiency and reduced losses of nitrate in the Netherlands. This alone will result in reduced $N_2O$ emissions (estimated at 0.5-1.7 Mt $CO_2$-equivalents in $N_2O$, ROB agro – report, in prep).

# 5 Background data

## 5.1 Description of land categories, including any land categories not covered

*Table 5.1 Description of land categories*

| Land system | Definition | Source | Anticipated change 1999 and 2012 | C-stock |
|---|---|---|---|---|
| Forest lands | Crown cover 20%, minimum area 0.5 ha, minimum average width 30 m.<br><br>CBS,1985, UN-ECE/FAO 2000 | CBS,1985, UN-ECE/FAO 2000 | Area will increase slightly (appr. 300 ha per year). Average growing stock per ha in existing forest will increase as well. | 60 t C/ha aboveground (+130 t C/ha below-ground incl. Soil) (Nabuurs and Mohren 1993, Seubring 1997) |
| Agriculture lands | see below | CBS,1998 | Assumed constant (CBS data confirm this for 1999 compared to 1990) | estimate of 50 t C/ha is based on carbon content of 1% in the top 50 cm layer at bulk density of 1.0 |
| Rangelands / grasslands | Including grasslands in low areas of the Netherlands | CBS,1998 | Area 1990 has decrease by 10% in 1999 and further decrease to 918000 ha in 2012 expected | Estimate of 100 t C/ha is based on carbon content of 2% in the top 50 cm layer at bulk density of 1.0 (excluding organic, peat layers, and organic carbon below 50 cm) |
| Wetland/tundra | see below | Wetland International | Area will slightly increase towards 2012 with 1000 ha per year | Estimate of 1500 t C/ha is based on carbon content of 30% in the top 50 cm layer at bulk density of 1.0 |
| Other | see below | CBS,1998 | Area expected to increase by appr. 150000 ha in 2012 | Estimate of 10 t C/ha is based on 0.2% C in the top 50 cm layer at a bulk density of 1.0. |

The area of agricultural lands include permanent crops, arable land, vegetables, greenhouses and flower cultivation; the area has remained constant between 1990-1998 (CBS, 1998) and is expected to remain constant until 2012.
The area of grassland in 1998 was 1032000 ha (CBS, 1998) and a further decrease is anticipated; linear extrapolation of the rate of change from 1990-1998 until 2012 will give an area of grassland in 2012 of 918000 ha.
The area of wetlands (Wetland International, 1998) includes designated areas in the Netherlands but does not include coastal zones (i.e. Waddensea).
The area of other land includes urban land, lakes, rivers and infrastructure for 449000 ha, nature areas for 141000 ha and 440000 ha for other land-use (CBS, 1998); the area is expected to increase with appr. 150000 ha from 1990-2012 (balancing the change in other land categories (estimate from expert opinion).

## 5.2 Carbon pools - distinctions and assumptions

The estimates for the size of the carbon stocks in forest vegetation (whole tree biomass) are based on widely applied conversions of forest inventory (stemwood volume) data to whole tree carbon. For the conversions international literature and IPCC reporting guidelines are used. For forest soil carbon, the distribution of Dutch forests over soil types was assessed. For each soil type, profile descriptions are used to assess organic matter content to 1 m depth. Those were converted to carbon.

The estimates for the size of the carbon stocks in agricultural vegetation types are largely based on assumptions and expert opinion; the estimates include standing crop, below-ground biomass, litter and soil organic matter. There is no extensive database available on the C-content of soils. Carbon stocks in soils are substantial and may differ significantly between soil types and land uses even within distinguished categories such as wetland, nature, other, etc. The specific assumptions and distinctions are presented in table 5.1.

## 5.3 Data sources

Inventories published by CBS (1998), Wetland International (1999). For the total area of forest in The Netherlands the Dutch Forest area statistic of 1983 was used (CBS 1985). These same values are also reported by FAOSTAT and by the UN-ECE / FAO (2000).

## 5.4 Methods

The estimates for the size of the carbon stocks in forest vegetation are based on widely applied conversions of forest inventory (stemwood volume) data to whole tree carbon. For the conversions international literature and IPCC reporting guidelines are used. For forest soil carbon, the distribution of Dutch forests over soil types was assessed. For each soil type profile descriptions are used to assess organic matter content. Those were converted to carbon. Though, no data on soil carbon are used, due to fex reliable data on this issue, especially for deforestation.

## 5.5 Possible changes in carbon stocks

Possible changes in carbon stocks would be largely based on changes in areas and less on changes in carbon content, that accompany changes in land-use. Estimates would be highly uncertain and no extensive database exist yet. Estimates could be made available in the next 3 years on the basis of model calculations using soil maps.

## 5.6 Uncertainties

The area estimate for land categories has a minor uncertainty (<5%). The estimates on carbon content have uncertainties in the order of 10-50% (A. van Amstel (2000) Monitoring CO2 sinks in the Netherlands. Proceedings, Wageningen University Research Centre, pp. 47)

# 6 Knowledge gaps

More accurate and complete data are needed in a number of areas and activities in the Netherlands:

- Soil carbon changes for afforestation and deforestation
- Age class distribution for ARD and forest management
- Effect of cropland activities on soil carbon
- Emissions of non-$CO_2$ gases for article 3.4, especially for grasslands on peatlands

# References


Buis, J. 985. Historia forestis. De Nederlandse bosgeschiedenis. The dutch forest history. Proefschrift Vakgroep Boshuishoudkunde, Landbouwuniversiteit Wageningen. Vol 1 & 2. Studia Historica No 14.

CBS 1985. Centraal bureau voor de Statistiek in samenwerking met het Staatsbosbeheer. 1985 De nederlandse bosstatistiek, deel 1: de oppervlakte bos, 1980-1983. The dutch forest statistics, part 1; the forest area. Centraal bureau voor de Statistiek, Hoofdafdeling Landbouwstatistieken.'s-Gravenhage, Staatsuitgeverij/ CBS-publikaties.

CBS (Centraal Bureau voor de Statistiek) (2000) CBS-landbouwdatabank 1980-2000 (CD-rom)

Edelenbosch, N.H. 1996. Ex post evaluatie van het bosuitbreidingsbeleid in Nederland 1990-1995. IBN rapport 230. Wageningen 62 p.

Hinssen, P.J.W. 1998. Achtergronden van de Natuurbalans 1998: Aspecten van het Natuurbeleid. Wageningen 172 p.

Kuikman, P.J. P. J. Kuikman, F.J.E. van der Bolt, W.J. Corré, J.G. Kroes, A. van den Pol-van Dasselaar, Th.V. Vellinga, G.L. Velthof (2000) Reductie van lachgasemissie door ontwikkeling van 'Best Management Practices': Samenvatting van systeemanalyses in ROB cluster 1. Alterra report 114 (in Dutch), pp. 38

Mather, A.S. 1990 Global forest resources. Chapter 3. Historical perspectives on forest resource use. Timber Press. Portland. OR pp. 30-57

Mohren, G.M.J., J.F. Garza Caligaris, O. Masera, M. Kanninen, T. Karjalainen and G.J. Nabuurs 1999 CO2FIX for windows: a dynamic model of the CO2 fixation in forests, version 1.2. IBN Research report 1999/3. Report Instituto de Ecologia de la UNAM, Centro Agronomico Tropical de Investigacio y Enseflanza (CATIE), European Forest Institute. Wageningen The Netherlands, Patzcuaro Mexico, Turrialba Costa Rica, Joensuu Finland. 33 p.

Nabuurs, G.J. & G.M.J. Mohren 1995 Modelling analysis of potential carbon sequestration in selected forest types. Canadian Journal of Forest Research 25: 1157-1172.

Nabuurs, G.J. & G.M.J. Mohren. 1993a Carbon fixation through forestation activities. A study of the carbon sequestering potential of selected forest types, commissioned by the Foundation Face. Face. Forests Absorbing Carbon dioxyde Emission. Arnhem. Institute for Forestry and Nature Research. Wageningen. IBN Research report 93/4. 205 pp.

Nabuurs, G.J. & G.M.J. Mohren. 1993b Carbon in Dutch forest Ecosystems. Netherlands Journal of Agricultural Science. 41 (4): 309-326.

Nabuurs, G.J., A.V. Dolman, E. Verkaik, A. Whitmore, W. Daamen, O. Oenema, P. Kabat and G.M.J. Mohren 1999 Resolving issues on terrestrial biospheric carbon sinks in the Kyoto Protocol. Report 410 200 030. Dutch National Research Programme on Global Air pollution and Climate Change. Bilthoven, The Netherlands. 100 p.

Rackham, O., 1998. Savanna in Europe. In: Kirby, K.J. & C. watkins (eds.), The ecological history of European forests. Cambridge University Press. Cambridge UK. P 1-24.

Seubring, A.M. 1997 Hout in het Nederlandse bos, analyse van de ontwikkelingen van voorraad, bijgroei en oogst van het Nederlandse bos in de periode 1988-1996. Stichting Bosdata, Wageningen 34 p.

Tomppo, E. 1996 Multi source national forest inventory of Finland In: R. Päivinen, J. Vanclay & S. Miina (eds.), New thrusts in Forest Inventory. EFI proceedings No 7. p. 27-41

UN-ECE/FAO 2000 Forest resources of Europe, CIS, North America, Australia, Japan and New Zealand Geneva Timber and Forest Study papers No 17. United Nations Economic Committee for Europe. Food and Agricultural Organisation. Geneva, Switzerland.

# Appendix A Uptake rate accountings

## Afforestation / reforestation

For all activities, except for deforestation, the uptake rate is divided by a factor 2 for the periods 1990-1995 and 1990-1999 for the following reason:

Example:

| | Planted (ha) | Total (ha) | Uptake rate (tC /ha/y) | tC/y |
|---|---|---|---|---|
| 1990 | 300 | 300 | 1 | 300 |
| 1991 | 300 | 600 | 1 | 600 |
| 1992 | 300 | 900 | 1 | 900 |
| 1993 | 300 | 1200 | 1 | 1200 |
| 1994 | 300 | 1500 | 1 | 1500 |
| 1995 | 300 | 1800 | 1 | 1800 |

Originally, 1800*1*6=10800 tC would be accounted. Reality shows it is only 6300 tC, which is approximately half of 10800tC.
This does not count for the period 2008-2012, because in that period the full area exists during the whole period. Neither does it count for deforestation, because deforestation is counted for only one year, in contradiction to afforestation and reforestation, and has thus not to be corrected by dividing by 2.

**Reforestation FAO:**

To distinguish the different scenarios (activity / land I and II based), we divide the uptake rates in planting (P), harvest (H) and slash (S).

Content scenarios:

| | |
|---|---|
| Activity based | P |
| Landbased I | P, H, S |
| Landbased II | P, S |

Activity based:

| | Plant/harv/slash | Accounting uptake rate ($tC\ ha^{-1}\ y^{-1}$)[1)] | Total uptake rate ($tC\ ha^{-1}\ y^{-1}$) |
|---|---|---|---|
| 1990-1995 | P | 0,8/2 | 0,4 |
| 1990-1999 | P | 0,8/2 | 0,4 |
| 1990-2012 | P | 0,8/2 | 0,4 |
| 2008-2012 | P | 0,8 | 0,8 |

[1)] The effectiveness is divided by years or factor 2 (see below)

**Landbased I:**

| | Plant/harv/slash | Accounting uptake rate (tC $ha^{-1}$ $y^{-1}$)[1)] | Uptake rate (tC $ha^{-1}$ $y^{-1}$) | Total uptake rate (tC $ha^{-1}$ $y^{-1}$) |
|---|---|---|---|---|
| 1990-1995 | P | 0,8/2 | 0,4 | |
| | H | -30/6 | -5 | -6,1 |
| | S | -3/2 | -1,5 | |
| 1990-1999 | P | 0,8/2 | 0,4 | |
| | H | -30/10 | -3,0 | -4,1 |
| | S | -3/2 | -1,5 | |
| 1990-2012 | P | 0,8/2 | 0,4 | |
| | H | -30/23 | -1,3 | -2,2 |
| | S | -3*10/23 | -1,3 | |
| 2008-2012 | P | 0,8 | 0,8 | |
| | H | -30/23 | -1,3 | -1,8 |
| | S | -3*10/23 | -1,3 | |

[1)] The effectiveness is divided by years or factor 2 (see below)

**Landbased II:**

| | Plant/harv/slash | Accounting uptake rate (tC $ha^{-1}$ $y^{-1}$)[1)] | Uptake rate (tC $ha^{-1}$ $y^{-1}$) | Total uptake rate (tC $ha^{-1}$ $y^{-1}$) |
|---|---|---|---|---|
| 1990-1995 | P | 0,8/2 | 0,4 | -1,1 |
| | S | -3/2 | -1,5 | |
| 1990-1999 | P | 0,8/2 | 0,4 | -1,1 |
| | S | -3/2 | -1,5 | |
| 1990-2012 | P | 0,8/2 | 0,4 | -0,9 |
| | S | 10*-3/23 | -1,3 | |
| 2008-2012 | P | 0,8 | 0,8 | -0,5 |
| | S | 10*-3/23 | -1,3 | |

1) The effectiveness is divided by years or factor 2 (see below)

# Appendix B Table 1

*Table I Preliminary data and information provided by Annex I Party on carbon stock changes and areas related to article 3.3 activities*

| Article 3.3 Country specific data | Definitions | Accounting framework | $a_I$(ha) (1995) | ? $C_I$(t C) | $A_{II}$(ha) (1999) | ? $C_{II}$(t C) | $a_{cp}$(ha) (2012) | ? $C_{cp}$(t C) | Methods and approaches | Data sources, data quality, and uncertainty (e.g. ranges) | Other information relevant to decision-making |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Afforestation[1)] | **IPCC** | ***Activity based*** | 0 | 0 | 0 | 0 | 0 | 0 | see chapter 2 | see chapter 2 | see chapter 2 |
| | | Land based[3)] | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | **IPCC** | ***Activity based*** | 5400 | 48600 | 6340 | 95100 | 10240-55660 | 76800-417450 | | | |
| Reforestation[1)] | | Land based[3)] | 5400 | 48600 | 6340 | 95100 | 10240-55660 | 76800-417450 | | | |
| Afforestation[1)] | FAO | Activity based | 5400 | 48600 | 6340 | 95100 | 10240-55660 | 76800-417450 | | | |
| | | Land based[2)] | 5400 | 48600 | 6340 | 95100 | 10240-55660 | 76800-417450 | | | |
| Reforestation[1)] | FAO | Activity based | 15600 | 37440 | 26000 | 104000 | 52000 | 208000 | | | |
| | | Land based I | 15600 | -570960 | 26000 | -1456000 | 52000 | -468000 | | | |
| | | Land based II | 15600 | -102960 | 26000 | -676000 | 52000 | -130000 | | | |
| Deforestation[1)] | IPCC/FAO | Activity based | 1323 | -79358 | 2204 | -132264 | 5070 | -66132 | | | |
| | | Land based | 1323 | -78036 | 2204 | -130060 | 5070 | -65030 | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sum of | IPCC | Activity based | | -30758 | | -37164 | | 10668 |
| Afforestation | | Land based | | -29436 | | -34960 | | 11770 |
| Reforestation | FAO | Activity based | | 6682 | | 66836 | | 218668 |
| and Deforestation[4)] | | Land based I | | -600396 | | -1490960 | | -456230 |
| | | Land based II | | -133718 | | -713164 | | -119332 |

[1)] Because no data on soil carbon losses during deforestation are available, soil carbon is excluded. Soil carbon sequestration due to afforestation and reforestation is assumed to be very small (0,1 tC / ha / y) and not accounted, to keep similarity

[2)] For The Netherlands afforestation FAO Land based is split up in Land based I and Land based II, with values for ?Gof 24300 and 32400, for ? $C_{II}$ of 47550 and 63400 and for ? $C_{cp}$ of 76800 and 102400 (all in t C), respectively; values presented in the table are averages of Land based I and Land based II. For further details on calculations please refer to explanatory material below.

[3)] Afforestation IPCC is zero for both Activity based and Land based in The Netherlands. Reforestation IPCC is the same as afforestation FAO (in practical terms for the Netherlands). It has been calculated the for activity based, land based I and land based II accounting approaches. The values presented in the table are the averages of Land based I and Land based II.

[4)] Sum includes 10240 ha (aff FAO / ref IPCC), and does not include the high estimated 55660 ha.

$a_I$ : Area (ha) afforested and reforested, or deforested since 1990 up to 1995 or possibly an earlier specific year.
? $C_I$ : Carbon stock change (t C) since 1990 up to the same year as used in $a_I$ on land afforested, reforested, and deforested.
$a_{II}$ : Area (ha) afforested and reforested, or deforested since 1990 up to 1999 or an earlier specific year.
? $C_{II}$ : Carbon stock change (t C) since 1990 up to the same year as used in $a_{II}$ on land afforested, reforested, and deforested.
$a_{cp}$: Projected area (ha) afforested and reforested, or deforested since 1990 up to 2012.
? $C_{cp}$: Projected carbon stock change (t C) over the first commitment period on land afforested, reforested, and deforested since 1990 up to 2012.

# Appendix C Table II

*Table II – Preliminary data and information provided by Annex I Party on carbon stocks and area estimates*

| Land system | Area (ha) 1990 | Carbon stock in 1990 (t C) |
|---|---|---|
| Forest lands | 339000 | 64410000 |
| Agriculture lands | 909000 | 45450000 |
| Rangelands / grasslands | 1097000 | 109700000 |
| Wetland / tundra | 22418 | 33627000 |
| Other | 1029582 | 10295820 |
| Total (as listed above) | 3397000 | 263482820 |

## Appendix D Table III

| Table III - Preliminary data and information provided by Annex I Party on Article 3.4 activities, related net GHG emissions, involved areas, and projected carbon stock changes (additional activities under Article 3.4) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Article 3.4 Country specific data | Accounting framework | $a_I$ (ha) (1995) | $CO_{2,\ I}$ (t $CO_2$)* | $CH_{4,\ I}$ (t $CO_2$ equiv.)* § | $N_2O_{,\ I}$ (t $CO_2$ equiv.)* § | (ha) 999) | $CO_{2,\ II}$ (t $CO_2$)* | $CH_{4,\ II}$ (t $CO_2$ equiv.)* § | $N_2O_{,\ II}$ (t $CO_2$ equiv.)* § | $a_{cp}$ (ha) (2012) | ?$C_{cp}$ (t C) | $CO_{2,\ cp}$ (t $CO_2$)* | $CH_{4,\ cp}$ (t $CO_2$ equiv.)* § | $N_2O_{,\ cp}$ (t $CO_2$ equiv.)* § | Methods and approaches | Data sources, data quality, and uncertainties (e.g. ranges) | Other information relevant to decision-making |
| Activity 1 | Land based | 5400 | 59400 | n.a. | n.a. | 6340 | 69740 | n.a. | n.a. | 10240 | 153600 | 563200 | n.a. | n.a. | see chapter 3 | expert judgement | |
| Forestry Improved management | Activity based | 5400 | 59400 | n.a. | n.a. | 6340 | 69740 | n.a. | n.a. | 10240 | 153600 | 563200 | n.a. | n.a. | | | |
| Activity 2 | Land based | 54540 | 59994 | n.a. | n.a. | 90900 | 99990 | n.a. | n.a. | 209070 | 62721 | 229977 | n.a. | n.a. | see chapter 3 | expert judgement | |
| Cropland | Activity based | 54540 | 59994 | n.a. | n.a. | 90900 | 99990 | n.a. | n.a. | 209070 | 62721 | 229977 | n.a. | n.a. | | | |
| Activity 3 | Land based | 2700000 | -16200000 | n.a. | n.a. | 4500000 | -27000000 | n.a. | n.a. | 2250000 | -3681818 | -13500000 | n.a. | n.a. | see chapter 3 | expert judgement | |
| Grazing land | Activity based | 2700000 | -16200000 | n.a. | n.a. | 4500000 | -27000000 | n.a. | n.a. | 2250000 | -3681818 | -13500000 | n.a. | n.a. | | | |
| Activity 4 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| Activity 5 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

Footnote 1 - this value is an overestimation - the area $a_{cp}$ in 2012 is likely to be not constant during the 5 years of the 1st commitment period (cp) and be less at the start of the 1st cp in 2008.

| | |
|---|---|
| ***** These columns would contain the sum over the years concerned of net annual emissions by sources and removals by sinks for the Article 3.4 activities proposed. A negative sign indicates either emissions by sources or a decrease in carbon stocks. A positive sign indicates either removals by sinks or an increase in carbon stocks. **To convert a carbon amount to $CO_2$ multiply it by 3.67.** | |
| **§** $CH_4$ and $N_2O$ emissions are converted to $CO_2$ equivalent emissions by using the global warming potential (GWP) values of 21 for $CH_4$ and 310 for $N_2O$ (Source: Second Assessment Report of the IPCC, 1995) | |
| **$a_I$** : | Area (ha) in 1995 or possibly an earlier specific year involved in the Article 3.4 activity since 1990. |
| **$CO_{2,\ I}$** : | Net $CO_2$ emissions (t $CO_2$) by sources and removals by sinks related to the Article 3.4 activity, accumulated from 1990 to the same year as used in $a_I$. |
| **$CH_{4,\ I}$** : | $CH_4$ emissions (t $CO_2$ equivalent) by sources related to the Article 3.4 activity, accumulated from 1990 to the same year as used in $a_I$. |
| **$N_2O_{,\ I}$** : | $N_2O$ emissions (t $CO_2$ equivalent) by sources related to the Article 3.4 activity, accumulated from 1990 to the same year as used in $a_I$. |
| **$a_{II}$** : | Area (ha) in 1999 or possibly an earlier specific year involved in the Article 3.4 activity since 1990. |
| **$CO_{2,\ II}$** : | Net $CO_2$ emissions (t $CO_2$) by sources and removals by sinks related to the Article 3.4 activity,accumulated from 1990 to the same year as used in $a_{II}$. |
| **$CH_{4,\ II}$** : | $CH_4$ emissions (t $CO_2$ equivalent) by sources related to the Article 3.4 activity, accumulated from 1990 to the same year as used in $a_{II}$. |
| **$N_2O_{,\ II}$** : | $N_2O$ emissions (t $CO_2$ equivalent) by sources related to the Article 3.4 activity, accumulated from 1990 to the same year as used in $a_{II}$. |
| **$a_{cp}$** : | Projected area (ha) in 2012 involved in the Article 3.4 activity since 1990. |
| **$?C_{cp}$** : | Projected carbon stock changes (t C) over the first commitment period related to the Article 3.4 activity since 1990. |
| **$CO_{2,\ cp}$** : | Projected net $CO_2$ emissions related contribution (t $CO_2$) of the Article 3.4 activity to the first commitment period assigned amount of the Party. |
| **$CH_{4,\ cp}$** : | Projected $CH_4$ emissions related contribution (t $CO_2$ equivalent) of the Article 3.4 activity to the first commitment period assigned amount of the Party. |
| **$N_2O_{,\ cp}$** : | Projected $N_2O$ emissions related contribution (t $CO_2$ equivalent) of the Article 3.4 activity to the first commitment period assigned amount of the Party. |