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Review of the LULUCF Sector of Switzerland's Greenhouse Gas Inventory 1990–2008

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1 Introduction

1.1 Background

The Subsidiary Body for Scientific and Technological Advice (SBSTA) confirmed on its twenty-fifth session in Nairobi (6–14 November 2006) for updated UNFCCC reporting guidelines on annual inventories (FCCC/SBSTA/2006/9) that Annex I Parties should implement quality-assurance (QA) procedures by conducting a basic expert peer review of their inventories in accordance with IPCC good practice guidance. The Federal Office for the Environment (FOEN) of the Suisse Confederation contracted the Institute for Agricultural Climate Research of the Johann Heinrich von Thünen-Institute (vTI), Federal Research Institute for Rural Areas, Forestry and Fisheries to provide a respective in-depth review on assigned sections of the Swiss NIR. The review was carried out by the Institute for Agricultural Climate Research (vTI-AK, leading institute), the Institute for Forest Ecology and Forest inventory (vTI-WOI) and the Institute for World Forestry (vTI-WFW) (Ref.: Contract Number 06.0091.PZ / J403-1890).

1.2 General Remarks

The review is explicitly restricted on chapter 7 and 11 (submission from 15.04.2010) with exclusion of chapter 7.2.4 (Methodological Issues – Spatial Extrapolation of Area). It comprises the verification of the operation mode of the respective data base, the evaluation of the Inventory Development Plan, and the general evaluation (search for faults) in accordance with the GPG. The review was carried out in October 2010 – January 2011. Institutes involved in the reporting process were visited by the review team in mid November 2010 in order to examine the applied procedures in detail.

2 Overview of LULUCF (7.1 NIR)

2.1 Introduction

Section "7.1 Overview of LULUCF" in the present NIR (Submission from 2010-04-15) summarizes the annual reporting 1990 - 2008 on emissions and removals of Swiss LULUCF sector. Furthermore, an overview on the reporting methodology is given. The emission factors and their development in the reporting period are described. The structure of this section follows the structure of section 7.1 (NIR).

Each section comprises a short summary, comments on the presentation and found information lacks, followed by general assessments of the chosen methodology and relevant issues and proposals. At the end of this section 2 the findings are concluded.

2.2 Methodology (7.1.1 NIR)

Summary:

The section describes the use of an IPCC GPG referenced methodology, the remote sensing data basis for derived activity data and the inventory data used for the development of country specific emission factors and carbon stock values. Furthermore, the implemented system for land-use classification and stratification is introduced.

Comments on Presentation:

The used inventory data sources should have been mentioned explicitly with similar intensity as was done for the AREA survey.

Methodological issues and proposals:

No further comments.

2.3 Emissions and Removal (7.1.2 NIR)

Summary:

The CO_2 emissions and removals from 1990 to 2008 are presented. Annual gains and losses in carbon stock of living biomass, net carbon stock changes in dead organic matter and a balance of carbon emissions and removals due to land-use and land-use change are presented and their order of magnitude is described. In addition, emissions and removals of CH_4 and N_2O in terms of CO_2 equivalents are mentioned in the text. One figure presents the comprehensive GHG balance over the time period 1990 to 2008 including CO_2 components as well as non-CO_2 components.

Comments on Presentation:

At the beginning of the chapter the presentation of the mean emission /removal should be added.

The total of sector 5 LULUCF should be presented at bottom of the respective Table 7-1 instead of top.

The presentation of CO_2 related results in Tab/Fig 7-1 is not directly comparable to the comprehensive presentation of Switzerland's net GHG balance of category 5 in Fig 7-2. A presentation of the non-CO_2 components in analogy with Tab/Fig 7-1 is missing.

Methodological issues and proposals:

The temporal development and assignment to respective stocks of Non-CO_2 emissions and removals should either be integrated in Tab/Fig 7-1 or be presented in a respective table and figure.

The integrated presentation of Switzerland's net GHG balance of category 5 in Fig 7-2 should have been discussed in more detail for better understanding and explanation of the observed development of the LULUCF sector from sink to source.

2.4 Approach for Calculating Carbon Emissions and Removals (7.1.3 NIR)

Summary:

The approach is defined by the description of the processing steps. An overview on the applied detailed land-use classification is given.

Furthermore, equations are specified which are used to calculate carbon fluxes due to the conversion of land-use. Weighting factors were introduced in order to compensate specific issues.

The aggregation of the results in the common reporting format (CRF) is described.

The need for the use of conversion delay times for changes in carbon pools in soil as well as in living biomass and dead organic matter in case of conversions to Forest Land is considered.

Comments on Presentation:

The description of the processing steps is made without references to the respective sections in the report in which a more detailed description is made. It would be useful to structure the entire section in accordance with the work steps.

- The first work step - definition of land-use categories - is presented in Table 7-2 NIR but more detailed annotations would be needed here.
- The second work step is not further described in this section.
- The third work step is described in section 7.1.4 NIR.
- The fourth work step is explained in detail in section 7.2 NIR (see below).
- The fifth work step is described in section 7.1.3.2 (carbon stock changes) and in section 7.1.3.4 (conversion delay time).

- The sixth work step is described in short in section 7.1.3.3 NIR.
- The implementation of weighting factors is not justified sufficiently and the approach is very much simplified. Maybe the reference for weighting the land-use change involving building and construction by 0.5 should be made at this place already.

A short equation showing the calculation of the Swiss total, as it is described in section 7.1.3.3 would support the comprehensibility.

The implementation of the conversion delay times is not described in detail.

Methodological issues and proposals:

On the one hand mean values of 20 years are assumed for the conversion to forest land and for changes in soil carbon pools. It is not specified in detail how this conversion delay time is implemented in the calculation process. The calculation processes should be described in more detail here, e.g. by equations and graphs. In addition, it should be stated that the applied methodology (e.g. the weighting factors, see below for details) does not lead to any bias and, in particular, in terms of conservative estimation, emissions are not to be under-estimated and removals are not to be over-estimated, respectively.

Furthermore, it is not specified if the gains and losses of the land-use category after the conversion may lead to an earlier or even later complete response of the respective carbon stock pool. The conversion to Forest Land is assessed by the land-use survey and, thus, may re-change with the subsequent survey. In case that an area which was converted into forest land is converted again before the end of the conversion period of 20 years into another class the use of mean factors for 20 years could be problematic. In order to fix this problem it is recommended to keep areas converted into land-use category CC11 ("afforestation") in this category for exactly 20 years as far as it remains in the main category "Forest land". In case that non-forest area is converted to land-use category CC12 ("productive forest") it is not clear how the 20 years conversion delay time is implemented in terms of annually changing stock and net change rates for this category.

The exclusive implementation of weighting factors of 0 (zero) in case of conversion to forest land-use categories is not justified sufficiently. This conservative approach is the result of much bigger stocks in forest land categories than in most former land-use classes. Without weighting these classes by factor zero this would result in a carbon sink in the year of change, but as a matter of fact this does not reflect the reality and results from methodological issues. Accordingly, the application of the weighting factor can be only an auxiliary method and should be finally replaced by more comprehensive methods during the process of photo interpretation of estimation of emission factors. This becomes obvious in the Swiss specific examples of high mountain grassland with single trees and groups of trees. Succession and tree growth may result in changing interpretation from meadow to forest by the AREA sample plot survey.

Under the assumption that the carbon stock on grassland contains the living biomass of grass and all wooden plants like trees and shrubs a weighting is not needed. This assumption is in line with the IPCC Guidelines and is also the approach we are using in Germany, encouraged by the In-country review of the German NIR in September 2010. For the given example the carbon stock in alpine grassland with trees would be much higher than the carbon stock of grasslands without trees. Further the open productive Forest in the high mountains is expected to have less stocking volume. Thus differences in productive forest stock and grassland stock will be small and reflect the real changes as result of forest growth. After land cover change the stocks and growth and removal values need to be adjusted. For the given example the growth of productive forest area after reinterpretation of sample plots which were formerly covered by grassland with trees may lead to a reduced carbon stock for grassland and forest. The presented emission figures for grassland do not seam to include the living carbon stock of wooden plants. A possible opportunity for solving this problem might be the (re)interpretation of non forest sample points affected by surrounding trees.

Similarly if instead of the 20 year average for forest growth a simulated linear annual growing stock include the long term changes of the former living biomass, like for example the reduction of grass by age, would be used no weighting is needed. So these weighting factors are dispensable. In case that those factors were introduced due to specific peculiarities during assessment of land-use categories a more detailed explanation is needed and respective processes must be described and implemented.

2.5 Carbon Stocks, Emissions Factors and Net Changes at a Glance (7.1.4 NIR)

Summary:

The carbon stocks of living biomass, dead organic matter, and in soils as well as gains and losses or net changes, respectively, are presented for all land-use categories and the respective spatial strata for NFI region, altitude and soil type in section 7.1.4. In general, those values are constant from 1990 to 2008. As an exception, it is emphasized that the respective values for productive forests (land-use category 12) are calculated year specific based on National Forest Inventories (NFI1-NFI3), harvest statistics and natural disturbances. Emission factors for other main categories except forest land are based on experiments, field studies, literature and expert estimates. Special attention is drawn on soil carbon and the assumption of 0 t carbon change for organic soils is explained.

Comments on Presentation:

The use of the codes for the main land-use classes makes the reading difficult; the name of the main land-use classes instead would simplify the reading. Further the type of sources like for example NFI, Literature or expert knowledge could be indicated by colour in Table 7-4. Highlighting of the NFI years in Table 7-5 would allow the reader to distinguish between measurements of the NFI and interpolated values by auxiliary data between. Further a short diagram showing the development of gains or losses in living biomass between 1990 and 2008 for few selected tree species and strata would support the reading.

Methodological issues and proposals:

Closer investigation of Table 7-4 raises some questions. Some values for stock or gain and loss are zero. Maybe further field studies or integration of expert knowledge could be taken for adjustment. Some values need to be improved or reference to later explanation should be given. For example the average annual gain in living biomass for afforestation in NFI region 1 and altitude zone 1 for the 20 year period is given as 2.63 t C ha^{-1} a^{-1} and all other changes are assumed to be zero in this stratum. This should lead to a stock of 52.6 t C ha^{-1} after 20 years or averaged over the period of 20 years 26.3 t C ha^{-1}, but a stock of 12.72 t C ha^{-1} is assumed in table 7-4.

By consideration of assumed uncertainties it needs to be evaluated with respect to the given accuracy if all the figures in Table 7-5 can really be separated from each other or if more general mean values could be taken instead.

2.6 Uncertainty Estimates (7.1.5 NIR)

Summary:

Uncertainty estimates for activity data and emission factors in the LULUCF sector are presented. Uncertainties for emission factors are generally higher than for activity data which rely on a large number of observations on sample plots. Methods for calculations are presented in later chapters.

Comments on Presentation:

For each IPCC category and error type a link for further explanation should be added.

Methodological issues and proposals:

The presentation in Table 7-6 is very much simplified. For example, the error for the activity data varies for each category and depends on the number of estimations/points in that category in the respective AREA repetition. Thus, the error varies over time and consists of process and interpolation components. Probably a mean error should be presented and its computation or assessment must be described. Further comments are given in the respective sections with the detailed explanation for error estimations.

2.7 Summary

The section 7-1 NIR concludes the applied methodology and presents the national results very precisely. It demonstrates the difficulty in combining various data sources, field investigation and expert knowledge for an annual national reporting. A proposed restructuring by the used work steps could further support the reading.

The used inventory data sources should have been mentioned explicitly with similar intensity as is done for the AREA survey. The implementation of the applied conversion delay times due to land-use change, the assessment of the photo interpretation error, and, linked to the latter point, the temporal variation in uncertainties of activity data should be described in more detail as well as the temporal development of the LULUCF sector from sink to source. In general, use of weighting factors could be further developed or revised.

All points mentioned above aim on further improvement of the Swiss Greenhouse Gas reporting. They do not affect in principle the reliability of the currently used methodology.

3 Activity Data - Land Areas (7.2 NIR)

3.1 Introduction

Section "7.2 Activity Data - Land Areas" in the present NIR (Submission from 2010-04-15) comprises the compilation and processing of the land-use data, their temporal inter- and extrapolation and respective uncertainties. The structure of this section follows the structure of section 7.2 (NIR).

Each section comprises a short summary, comments on the presentation and found information lacks, followed by general assessments of the chosen methodology and relevant issues and proposals. At the end of this section 3 the findings are concluded.

3.2 Information on Approaches Used for Representing Land Areas and on Land-use Databases Used for Inventory Preparation (7.2.2 NIR)

Summary:

A short overview on the used Swiss Land-use Statistics (AREA and ASCH) is given, where 1 sample point representing 1 ha of Switzerland is interpreted for three different points in time into 46 land-use categories and 27 land cover categories. From the total of 4 128 000 sample plot 47% were so far interpreted according to the current AREA interpretation. For the area comprising the 53% of sample points without AREA data available two earlier Swiss land-use statistics are available which were produced following the older ASCH methodology. Until 2013 a consistent national AREA interpretation covering the period 1979 to 2009 will be available. For the GHG reporting the assessed land-use/cover classes were reduces to 18 classes which are directly linked to the main reporting categories. As the inter survey period varies regionally and annual change rates are needed for reporting, a methodology for temporal inter- and extrapolation is presented.

Comments on Presentation:

A further explanation is missing on how the optimization of definitions of sub divisions with respect to optimal distinction of biomass density, carbon turnover and soil carbon content was done.

In the given example, linear interpolation between a first AREA1 and a second AREA2 assessment in 1990 is presented, but the AREA2 campaign started in 1992. The detailed understanding of the figure 7-3 takes time. Maybe figure 7-3 could be clarified. Interpolation 3 in figure 7-3, furthermore, is an extrapolation and should be distinguished form AREA1-3 which are results of aerial photo interpretations.

Methodological issues and proposals:

The applied methodology for randomly assigning land-use types for future development with the transition probability between AREA2 and AREA3 should be described in more detail. Especially as so far only 47% of Switzerland in the north-west is available for parameterization. Maybe this extrapolation into the future should not be done for the conversion matrix for each region and not on sample plot level.

Presented interpolation methods are working sufficiently for long term changes as they are found in the forestry sector, but short time changes like shifts between grassland and cropland as they may change annually are not assessed. This bias increases with the length of the inter survey period.

3.3 Land-use Definitions and the Classification Systems Used and their Correspondence to the LULUCF Categories (7.2.3 NIR)

Summary:

The stratification of the Swiss area according to altitude level (3 strata), NFI regions (5) and organic soil/mineral soil (2) is introduced. The calculated annual land-use statistics and resulting annual change matrices are described with examples.

Comments on Presentation:

It is described that from 30 possible strata in Switzerland only 20 were defined and used. A linkage to Figure 7-4 and the term "actually realized and applied" instead of "defined and used" could be more precise. A short explanation and reference to Table 7-4 should be given in addition in order to underline that the applied stratification depends on the land-use categories.

Also problems due to the overlay of geo-data are only introduced in short; the explanation of respective "artefacts" could be more precise and with a quantification in terms of the area of the respective artefacts. The given example can not be reproduced from the values in Table 7-7. As the respective data source (BEK) is relevant only for cropland and grassland one would expect no organic soil for other land-use categories (i.e. CC12 "productive forest"). Deviations should be explained.

The reduction of area of CC11 as depicted in Table 7-8 should be explained in relation to the increase of the area of CC12.

Table 7-9 seems to present examples of annual rates of land-use change for 1990 and 2008. The presentation of the "mean" annual rates in the period from 1990 to 2008 is missing. This information would be different to Table 7-8 in which only differences between 1990 and 2008 are presented in terms of "relative change".

Methodological issues and proposals:

As land-use change is based on AREA1-3 interpretations it is not clear how the 20 years conversion delay time was applied consistently.

Table 7-9 depicts among others also changes from non-forest categories directly to categories 12 or 13, respectively, without a prior conversion into category 11 "afforestation". As long as this is due to Swiss peculiarities and the presence of trees in non-forested area this should be explained. An integration of the presence of those trees in non-forested area - probably in terms of further sub-categories - could be helpful. In the German GHG inventory, for instance, hedges and wooded land that does not fall into the category "forest" is a sub-category of grassland (in line with the IPCC Guidelines).

In Table 7-8 linear development over the considered period is depicted for almost all categories. This seems to be plausible for long-term changes such as afforestation. Short term changes, e.g. between cropland and grassland, may be lost due to the relatively long periods between two subsequent remote sensing investigations. Thus, the respective change may be under-estimated.

However, it remains to be assessed to what extent such faster land-use changes occur and how they affect the calculated carbon stock changes. If carbon stock changes are calculated in a symmetrical way – the change from land-use A to B results in the same quantitative carbon stock change as the change from land-use B to A, or constant average C stocks for each land-use sub-category are used, – the linear development over the considered period can be considered robust over periods of decades. However, the magnitude and the timing of carbon stock changes may be biased or inaccurate over the time period of the Kyoto Protocol, in particular, in case of changes in land-use policies and changing dynamics in land-use change.

3.4 Methodological Issues – Spatial Extrapolation of AREA (7.2.4 NIR)

With respect to the contract "06.0091.PZ / J403-1890" between the Federal Office for the Environment (FOEN) and vTI on the review of the LULUCF sector of the Swiss NIR section 7.2.4 is excluded from the review.

3.5 Uncertainties and Time-series Consistency of Activity Data (7.2.5 NIR)

Summary:

The section 7.2.5 NIR describes the estimates on uncertainty of Activity Data (AD). The overall uncertainty is calculated based on sampling, extrapolation and substitution errors. Furthermore, peculiarities concerning emissions from forest fires and determination of organic soils on grassland and cropland, and agricultural lime applications are described in short. At the end Activity Data uncertainties for all Land-use change main classes are presented in Table 7-11.

As the extrapolation of AD is not part of the review process and will be obsolete with the finalization of the AREA investigation extrapolation error as well as substitution error will not be discussed in this review.

Comments on Presentation:

Four exceptions from the dependence of uncertainty estimates from the AREA uncertainty estimation are mentioned but only three respective paragraphs were introduced. The first paragraph is dealing with non-CO_2 GHG emissions due to wild fires. An explanation for the exclusion of CO_2 is missing. The third paragraph is dealing with a non-area related agricultural issue and should be discussed in the respective section.

The uncertainties are presented for the entire area of Switzerland as the change matrices were presented before. As the sampling error depends on the number of respective sampling points, land-use changes lead to variation in uncertainties over time. The reason for conservatively rounding up the overall AD uncertainties is missing.

Methodological issues and proposals:

Uncertainty estimates with respect to the land-use classification (AREA and ASCH) are missing. The "interpretation error" is not quantified and errors due to unclear class interpretation (i.e. distinction between CC32 "shrub vegetation" and CC13 "unproductive forest") are not discussed.

Results from independent control re-assessments could give an impression of the accuracy of the land-use classification. Respective QC measures during AREA and ASCH classifications are not described.

The sampling error should consider the standard deviation of the respective estimated land cover proportions for Land remaining under the same use and for land-use change.

The error of the temporal extrapolation is not discussed. This should include a reference to drivers of land-use change as extrapolation is only valid when the trends and drivers are stable.

3.6 QA/QC and Verification of Activity Data (7.2.6 NIR)

Summary:

A reference is given for the QA/QC activities with respect to the AREA survey. Additional studies on Tier 2 QC activities considering different data sources on agricultural land areas and deforestation are conducted.

Comments on Presentation:

No comments.

Methodological issues and proposals:

Descriptions of routine and consistency checks which aim on data integrity are missing. A short summary of verification of results from comparison with other data sources (i.e. NFI forest area vs. AREA) is missing.

3.7 Recalculations and Planned Improvements of Activity Data (7.2.7 and 7.2.8 NIR)

Summary:

The recalculation in the LULUCF sector due to the increased availability of AREA data (47% of Swiss area) is mentioned. Furthermore, recalculations were necessary due to the correction of coding errors (changes from "forests" in terms of CC12 and CC13, respectively, to CC11, "afforestation").

Due to the increasing coverage of the Swiss territory by the AREA activity data and the complete coverage in 2013 a reduction of extrapolation error and substitution error are expected and will converge to zero in 2013. In addition, the sampling error will be reduced.

Comments on Presentation:

A quantitative summary of the effects of the recalculations is missing.

As the ongoing AREA land-use classification is introduced already in other sections of the NIR the short statement seems to be sufficient.

Methodological issues and proposals:

The coding error mentioned in this section of NIR should be interpreted in terms of the interpretation error mentioned above in section 3.5 of this review.

3.8 Summary

The section 7-2 NIR describes the methods for the assessment of Activity data. Results from 3 remote sensing investigations are concluded to annual distributions of land-use categories and respective land-use changes in the period 1990 to 2008. In addition, errors and uncertainties are considered.

Linear interpolation between two subsequent land-use surveys for a single plot is presented but its implementation in the reporting is not described in detail. In addition, the applied methodology for randomly assigning land-use types for future development with the transition probability between AREA2 and AREA3 should be described in more detail.

Land-use changes may occur faster than the period between two subsequent land-use surveys. It remains to be assessed to what extent such faster land-use changes occur and how they affect the calculated carbon stock changes.

The error of the temporal extrapolation is not discussed. This should as well include a reference to drivers of land-use change as extrapolation is only valid when the trends and drivers are stable.

Routine and consistency checks which aim on data integrity especially with respect to the AREA survey would improve the description of the reporting process with respect to activity data.

Here again, all points mentioned above aim on further improvement of the Swiss Greenhouse Gas reporting. They do not affect in principle the reliability of the currently used methodology

4 Category 5A - Forest Land (7.3 NIR)

4.1 Introduction

Section "7.3 Category 5A – Forest Land" in the present NIR (Submission from 2010-04-15) describes the methodology to derive implied emission factors for calculating CO_2 emissions from the key categories "Forest Land remaining Forest Land" and "Land converted to Forest Land".

4.1.1 Carbon Stock of Forest Land remaining Forest Land

Productive Forests: Data for growing stock, gross growth as well as cut and mortality were derived from the first, second and third Swiss National Forest Inventories (NFI). In order to reduce the variance of the basic variables gross growth, biomass expansion factors, tree species, and inter-annual growth variability, the forest area was grouped according to NFI productive region (n = 5), altitude (3 classes), and tree species group (broadleaf, conifer). Annual values of all carbon pools have been derived by linear interpolation between the average values of subsequent inventories per spatial stratum. To calculate annual values of cut and mortality (CM_y) the average annual amount of cut and mortality from the NFI was weighted by the annual percentage of the harvesting amounts in a period taken from the annual forest statistics. Subsequently annual three-year moving averages (X, X_{-1} and X_{-2}) were derived in order to smooth out high inter-annual fluctuations. After calculating the growing stock, net annual increment and wood removals per stratum, they were multiplied with stratum specific biomass conversion and expansion factors (BCEF). BCEFs are ratios between stem-wood over bark including stock (m^3 ha^{-1}) and the total above- and below-ground biomass (t ha^{-1}). The IPCC default carbon content of solid wood of 50% was applied subsequently. In order to develop a consistent time series, annual growing stocks were calculated backward or forward starting from the growing stock 2005, determined from NFI 3.

Brush Forests: Calculating the carbon changes in brush forests from NFI data the following assumptions were made during the assessments of respective stocks: 4000 trees per ha, average height of 2.5 m and an average diameter at breast height (dbh) of 10 cm. Hence, an average growing stock (> 7 cm diameter) of 40 m^3 ha^{-1} was estimated and afterwards multiplied by the mean BCEF for coniferous trees and the IPCC default carbon content of 0.5.

Unproductive Forests: For unproductive forest no NFI data are available to derive growing stock. As those forests are assumed to grow preferably on poor site condition, an average growing stock (> 7 cm diameter) of 150 m^3 ha^{-1} was estimated. Multiplied by the mean BCEF for coniferous trees and using the IPCC default carbon content of 0.5, an average C-stock of 48.2 t C ha^{-1} was estimated. As no harvesting is conducted in unproductive forests, gross growth and cut and mortality of unproductive forest are assumed to be in balance.

4.1.2 Dead Organic Matter (DOM)

Dead Wood: In the course of the second and third NFI, the dbh of all dead trees (standing and lying) with a diameter of at least 12 cm was measured. Applying the biomass functions of living trees, the stem wood volume including bark was expanded to the additional compartments of tree-top and stump as well as dead roots. The volume of dead wood was converted to biomass by applying wood densities of living trees. Additionally, during NFI 3, the amount of dead wood between 7 and 12 cm was measured by the line intersect method. On basis of this dataset dead wood stock between 7 and 12 cm could also be estimated from NFI 2 data. Weighted annual changes in the dead wood pool in Swiss forests were calculated using additional data from the Sanasilva-monitoring network, which provided annual data on the relative basal area of lying and standing trees. All annual changes, derived from inter- and extrapolation of NFI 2 and 3 were averaged over a moving three-year period.

Litter: Annual litter carbon stocks were estimated for Swiss productive and unproductive forests. The estimates are based on different datasets. In a survey measurements of litter densities were conducted at 30 sites. At each site organic layer thickness as well as its weight per area was measured. The sampling accounted for intra-site variability. Total mean densities were calculated for the different organic layers. In a second step data of litter carbon concentration of 400 sites from a WSL soil profile database were used to calculate mean carbon concentrations for coniferous, mixed and for deciduous forests. In a third step the organic layer densities and stratified carbon concentrations were transferred to data of organic layer thickness and forest type from 870 sites from the same database and carbon stocks were calculated. Changes in litter carbon stocks were not estimated and thus no changes in litter carbon stocks were reported for all inventory years.

4.1.3 Carbon in mineral forest soils

Soil carbon stocks of mineral soils were derived from a soil survey. Data of 136 sites were used to estimate the mean carbon stocks of the five NFI production regions. Details of sampling, analyses and uncertainties due to the spatial variance were not stated within the NIR but references were given. Changes in soil organic carbon stocks were not estimated and no changes in carbon stocks were reported. The reporting of zero emissions was based on expert judgment. It was argued that emissions couldn't be expected, due increasing litter production caused by increasing growing stocks. Also it was stated that there were no changes in management practices within the last decades and that fertilization and drainage were prohibited. Changes in carbon stocks were modeled at two sites with the Yasso07 model. The modeling results were validated with continuous soil respiration measurements. The validation yielded that the model outcome and the measured respiration rates are comparable. At one site carbon sequestration was observed, at the other site no significant changes could be determined.

4.1.4 Carbon Stock of Afforestations

As the NFI 3 data have not yet been analyzed with respect to afforestations, the average growing stock and growth of afforestations were empirically assessed from NFI 1 (10 years old stands) and NFI 2 (20 years old stands) data. The growing stock of forest stands on good sites was 90 m^3 ha^{-1} (below 600 m). The growing stock on moderate sites (areas between 600 and 1200 m) was assumed to be one-third smaller than on good sites (60 m^3 ha^{-1}), and two-thirds smaller on poor sites (30 m^3 ha^{-1}, above 1200 m). The growing stock of 10 year old stands on good sites was assumed to be 2 m^3 ha^{-1}. This value seems to be relatively small. Within the first few years of stand age, the growing stock was assumed to develop exponentially. The development of the growing stock on good sites between 10 and 20 years was therefore simulated by calibrating an exponential growth function. The growing stock was assumed to develop one-third slower on intermediate, and two-thirds slower on poor sites. The annual growth was calculated as the difference between growing stocks of the two following years. These volumes were converted into C-stock by multiplying with the BCEF and the carbon conversion factor of 0.5.

4.1.5 Emissions from Wildfires

Subsection 7.3.4.13 describes the methodology for calculating CH_4- and N_2O-emissions resulting from wildfires. For N_2O the IPCC default emission factor was applied. For CH_4 the EEA (2006) emission factor was applied.

4.1.6 Uncertainties

In the forest sector, an overall uncertainty of 61% was calculated for the emission factors of living and dead biomass. For changes in living biomass, the following error sources were estimated or fitted by expert judgment: Growth as well as cut & mortality, carbon content in solid wood, assessment of carbon content in wood, wood density, biomass expansion. The total uncertainty of the annual changes in dead wood depends on several factors: Accuracy of the Sanasilva observations, spatial representativity of the Sanasilva plots, biomass expansion, accuracy of the estimations of dead wood, provided by the NFI data.

4.2 Discussion of implemented methods

4.2.1 Living Biomass

In the entire NIR a clarification is missing, which IPCC GPG method is used to calculate carbon stock changes; the stock change method or the default method? According to the stock change method for all reported carbon pools a linear interpolation between the carbon stocks in two points of time is used. Data like the harvesting statistics and the Sanasilva observations were used additionally, in order to derive annual values for carbon stock changes within an inventory period.

In subsection 7.3.4.4 of the NIR 2010 you can read: "Stem-wood *over bark* including stock was expanded to total biomass as described in Thürig et al. (2005) and by applying allometric single-tree functions to all trees measured at the NFI 3. Functions for twigs (diameter < 7 cm) and branches (diameter > 7 cm) were parameterized based on measurements from approximately 12'000 trees (Kaufmann 2001). *Bark volume was estimated* using the model by Altherr et al. (1978)." It is not clear, whether the last sentence refers to twigs and branches or also to stem-wood. If the latter is true the compartment bark will be estimated twice: a) converting stem-wood over bark and b) modelling the bark volume by Altherr et al. (1987). If the first case is true, it must be clarified that the estimates for twig and branch biomass do not include bark volume.

In order to get estimates of the root biomass per tree two biomass functions were applied in dependency of tree species-group; a) from Wirth et al. (2004a), but this is only about spruce and b) from Wutzler et al. (2008) which is only about beech. This fact has to be clarified. But there is much more literature on root biomass (shoot ratios or functions) available. Do you plan a further differentiation in future? In addition, it should be proven that Swiss spruce and beech fall within the "calibration frame" of the data used by Wirth et al. (2004a) and Wutzler et al. (2008).

Also in subsection 7.3.4.4 the methods are described in detail which were used to derive country specific BCEFs. It should be considered that actually a more general level of biomass estimation with an additional error source is used, although biomass of all tree compartments for each sampled tree is separately estimated. By adding all compartment biomass to total biomass of a single tree and setting this in relation to the stem-volume for all trees to derive the BCEFs subsequently, a differentiation between below and above ground biomass is not possible. Following this methodology it is not possible to report both compartments (below and above ground biomass) separately as described in the GPG. Thus, the columns in the CRF tables for below ground biomass must be filled out with "included elsewhere".

The biomass estimates of unproductive and brush forests are relatively high. Is there an artefact in the determination of brush forest dbh, a diameter measurement threshold for example?

4.2.2 DOM (Deadwood + Litter)

To derive the biomass of dead wood the same BCEFs are applied as for living trees. The use of "living" BCEFs to assess biomass of standing dead trees is correct only in the first year following tree death (if at all). After short time twigs, branches and stem parts will be lost. Dead and decaying tree boles will also lose C from hollow cores etc. In the case of broken stems e. g. due to wind throw this approach is completely inappropriate. In this context, the term "basal area" is used with reference to lying dead wood - this is misleading. Please expand the description of the field inventory and subsequent dead wood C stock calculations. If you use a 4 class system for decay states please show this in a table or figure.

For the estimation of litter carbon stocks a reproducible method was used. The method is based on three different datasets, which had to be combined (organic layer density, organic layer thickness and stratified carbon concentration). The combination of three independent factors increases the uncertainty. The standard error of the litter carbon stocks was not reported within the NIR, although this is necessary. Methods which estimate all parameters at one site within one survey decrease the uncertainty. This was done within the organic layer density study. It is recommended to extent this dataset. A discrepancy was found in the description of the stratification approach of litter carbon stocks (which is based on forest types) and the stratification in the result table (which is based on NFI regions). A statement should be added to resolve this discrepancy. Furthermore, it should be checked if changes in litter carbon stocks can be estimated by modelling studies (see discussion on mineral soils).

4.2.3 SOIL

Mineral Soils: For the description of methods of soil carbon stock estimation relevant studies were referenced and therefore, the methods could be reproduced. Nevertheless, the description of methods is short compared to other parts of the NIR and could be extended. It is recommended to include some details of the methods within the NIR. The methods which were used for soil carbon stock estimation comply with scientific standard.

Following the description in the NIR the efforts which had been undertaken to estimate the carbon emission factor for mineral soils seem to be insufficient. The argumentation why there should be no carbon emission from mineral soils is comprehensible but needs to be supported by measurements or modeling efforts. Only two case studies were quoted from which only one revealed that soil carbon sequestration occurred in mineral soils. Furthermore, it was stated that drainage was prohibited but this is probably only true for the last decades and soils which were drained earlier still can act as GHG sources.

Generally, it seems that in Switzerland there is the potential to report soil carbon emission factors on a higher level than Tier 1. Thuerig et al. (2005) presented modeling results for soil carbon sequestration including litter for 4400 NFI plots. The used model was Yasso. Furthermore, the study of Rühr and Eugster (2009) revealed that the use of Yasso07 yielded promising results. It is a promising task to pursue the modeling approach. In line with this, it should be tested if the available dataset for model parameterization (turn-over rates of litter components, chemical composition of litter, decomposition rates) is already sufficient for this approach. If necessary, it should be completed by domestic studies. Also a model validation study should accompany the modeling.

Organic soils: The NIR contains no information about emissions of organic forest soils. It needs to be stated if organic forest soils are insignificant in Switzerland. Otherwise, standard emission factors or domestic emission factors should be used. The inventory development plan indicates that respective actions already were started.

4.2.4 Afforestation and Deforestation

The implemented method to quantify carbon stock changes in both categories is in accordance with the IPCC GPG although very simple. A differentiated analysis of the NFI data with respect to these categories, especially for the land-use change from brush forest to forest and from forests to other land-use categories could provide better estimates and the respective uncertainties of carbon stock changes according to afforestation and deforestation could be derived.

Table 7-28 is misleading. Linear and exponential calculations were presented without proper identification thereof, leaving the reader prone to misunderstandings. The annual growth of living biomass calculated as mean over 20 years and multiplied by 20 and divided by 2 is 26,3 t C ha^{-1} instead of the 12,72 t C ha^{-1} which are depicted in Table 7-28. This seems to be the value of the exponential growth function at 10 years.

4.2.5 NMVOC Emissions

The Swiss method to estimate NMVOC is approved by the IPCC. NMVOC emissions have not been reported under the convention e.g. by Germany in former submissions. Germany is currently testing the methodology used in the Swiss reporting.

4.2.6 N_2O Emissions from N Fertilization and Drainage of Soils

Drainage of forests is not permitted in Switzerland. Therefore a reference to the respective legal regulation should be included in the text. In addition, it should be clarified if drainage was permitted in the past and if there are historically drained areas left. The reasons for not reporting those areas should be described in this case.

4.2.7 Emissions from Wildfires

The emission factor for CH_4 emissions due to wildfires is taken from the EEA 2006 report; the emission factor for N_2O emissions due to wildfire is taken from the IPCC GPG. Both references provide emission factors for CH_4 and N_2O. It should be discussed why different references were applied for both emission factors.

The mass of available fuel is described in a Swiss standard as "252'624 kg biomass ha^{-1}", not in an English standard. In addition, if following the presented calculation of the biomass, e.g. multiplying the mean growing stock (360.05 m^3 ha^{-1}) by the mean BCEF (0.7146) the result is 257.292 t ha^{-1}. The deviation to the depicted value of 252.624 kg biomass ha^{-1} could be clarified by a more detailed description of the applied calculations.

At present the available fuel is presented by the biomass derived from mean growing stock. To improve the reporting of emissions caused by wildfires also dead wood and litter should be considered and included in the calculations if relevant and reliable data are available.

4.2.8 Error budget

Compared to the complex methods used to estimate carbon stock changes the error budget is very simple. The different errors arise from various steps of calculation (estimation of carbon stocks in stem wood, bark, twigs and branches, etc.) and therefore, the overall error is the sum of errors weighted with their quantities. Mostly error values are taken from literature as a kind of expert judgment. But, for example for the biomass functions given in Wirth et al. (2004a) and Wutzler et al. (2008) specific errors are given.

4.3 Comments on Presentation

The NIR uses "coniferous" and "broadleaf" in terms of "species".

The values in some columns of Table 7-5 are not additive. The carbon stock at time t is calculated as carbon stock (t_{-1}) + increment (t_{-1}) - removals(t). It should be checked and clarified why this calculation does not match with the table values for the years 1991 to 2006.

5 Category 5B-F (NIR 7.4 to 7.8)

5.1 Summary

Beyond the explanations in sections 7.1 and 7.2 the sections 7.4 – 7.8 summarize the special methodology for calculating emissions from category 5.B Cropland, 5.C Grassland, 5.D Wetlands, 5.E Settlements and 5.F Other Land. For living biomass, organic and mineral soils and additionally in the cropland section for N_2O and agricultural lime application the calculation methods, the data sources, operators, emission factors and their derivation are described. Furthermore, explanations for uncertainties, recalculations and category-specific planned improvements are given, in accordance with the NIR outline from IPCC.

Mainly in these sections emissions or removals of CO_2 are calculated by determining the difference of carbon stocks in soil or biomass for areas of land subject to land-use change. Therefore, mean emission factors (EFs) are calculated for each combination category (CC). In addition, for CC 31 "grassland" the carbon stock EFs are calculated specifically for each altitude zone.

Carbon stock changes of mineral soils are calculated by multiplying the EFs with the areas of land-use change. For organic soils the emissions are calculated directly, by multiplying the area of organic soils with the respective EF.

5.2 Methodological issues and proposals

5.2.1 General

The Swiss reporting system on LULUC is as far as possible in compliance with the IPCC-Guidelines and the GPG. It is transparent, as far as possible consistent and complete. Only emissions from the agricultural sectors 5.B.1 and 5.C.1 are not reported. This is in accordance with the applied Tier 1 approach. Due to known gaps in data and knowledge Tier 2 methods are not applied yet though under preparation. Other data gaps were filled with data and factors by meaningful derivation (e.g. carbon stock in living biomass of vineyards, low-stem orchard and tree nurseries just as in the settlements section) or expert judgement (factors for soil in settlements or living biomass in CC 36). The reporting team obviously is aware of the gaps and in the chapters "category specific planned improvements" solutions are sought by adequate research projects. Nevertheless, there are a few points for which we suggest changes in presentation, in assignment of CCs, in scientific approach and in estimating uncertainties.

5.2.2 Comments on Presentation

In order to improve the readability and to elucidate the intention of the NIR, a small summary of the results should be given at the beginning or the end of every section (at least 7.3 - 7.8). The presentation of sections 7.4 - 7.8 is very short and understandable only in connection with sections 7.1, 7.2 and in parts 7.3. All necessary references are listed but cross references within the NIR are sometimes missing. Readability of the NIR would be improved much by respective cross references. For example: the equations 7.1 - 7.3 in chapter 7.1.3.2 are not comprehensible without Table 7-4 in section 7.1.4 but in the entire section no cross reference to that table is given.

Additionally, due to brevity of explanations the intricacy of some issues could not be illustrated in a comprehensible manner: for example equation 7.3 for calculating the C emissions and removals from soils. This equation is, as stated above, only understandable and valid in connection with the values from Table 7-4. While the emissions from organic soils are directly calculated with an emission factor, the emissions from mineral soils are estimated by calculating the difference of the soil C stocks before and after land conversion. Two simple equations for each kind of soil would improve the understanding and the readability, because a lot of numbers (zeros) are dispensable in the table and the equation. In this context: The C stock of organic soils in different CC´s is shown in Table 7-4 and cited again in the sections 7.4 and 7.5. These values are not needed for the calculation of emissions from organic soils because the emissions are calculated by multiplication of an emission factor with an area. Hence, the carbon stock values for organic soils are serving only to cancel the not needed parts in equation 7.3. Therefore the explanation in chapter 7.4 and 7.5 is causing confusion and is dispensable especially if the equation 7.3 is simplified.

Some important details are not presented. In particular, the method of tracing the transition time of 20 years or the derivation of the C stock of mineral soils in CC36 could be presented in more detail.

5.2.3 Biomass

The Swiss reporting system on emissions from living biomass is in compliance with IPCC rules. It can be approved that Switzerland calculates with skilfully derived meaningful C stocks. Respective research projects will lead to further improvements.

If possible, for section 7.4 and 7.5 the C stock of root biomass should be verified by specific investigations and/or by literature. This could be done indirectly via shoot/root - ratios.

As Switzerland has the obligation to submit its report annually, it should be discussed further (compare section 7.4.6 NIR) if annual data for living biomass and dead organic matter in the cropland and grassland section could be developed as it is done for the Forest sector. Switzerland justifies the use of constant carbon stocks in living biomass for major crops by a slight increase of 0.0242 t C ha^{-1} a^{-1}. If this value is already known it could be used in the inventory. For comparison only: In Germany the median of annual change in living biomass is more than ten times higher and oscillating in both directions. In Switzerland this changes in the period from 1990 – 2008 sum up to 0.46 t/ha or absolutely 210 Gg C for cropland. Put into other words: Assuming the biomass in the other land-use categories is constant, in 2008, 28.4 Gg CO_2 less would be emitted in the category land converted into cropland compared to 1990. That amounts to nearly 9 % of the emissions from total cropland. For grassland no further data and argument are given. Considering the cited passage from the review report, some facts should be given. Furthermore, the possible implementation of dead organic matter in the sections 7.4 - 7.8 should be discussed as actually there is no comment and reference concerning these matters.

5.2.4 Soils

5.2.4.1 Organic soils

As stated above in section 5.2.2 of this review, the carbon stocks are not used for the calculation of emissions from organic soils. Therefore, it is sufficient to mention once in section 7.1 that the C stocks of organic soils are based on the work of LEIFELD et al. (2003, 2005) without differentiation among cropland and grassland and the absolute stock value.

The approach of the Swiss estimation of emissions from organic soils works with an emission factor of 9.52 t C ha^{-1} a^{-1} without distinction of land-use. Recent investigations in organic soils of Germany affirmed that this emission factor is adequate for intensive grassland and cropland. The emission factors for these land-use types are very similar and amount on average to ca. 9 - 10 t C ha^{-1} a^{-1} (Drösler et al., in preparation). However, the emissions from organic soils under extensive land-use, regardless whether fen or bog, may be much smaller, ca. 2 - 5 t C ha^{-1} a^{-1} on average, depending on land-use type and drainage status (Drösler at al., in preparation). Therefore, the Swiss estimations of CO_2 emissions from organic soils are conservative and adequate. It should be clearly elaborated that actions for an implementation of higher Tiers are already in process.

5.2.4.2 Mineral soils

The Swiss method to estimate emissions from mineral soils due to land-use change is approved by the IPCC. Germany is planning to move to a similar approach. Nevertheless, some points could be considered during the future inventory and reporting processes, or as scientific support to the inventory:

1. The change in carbon stocks in mineral soils after land-use change is based on area weighted means of stocks that resulted from inventories. These are not results from special investigations. The incentive of farmers is the optimization of their production. Therefore they have always been thinking intensively about on which site they should establish cropland or grassland considering site conditions. Therefore, grassland is found on moister, steep and more elevated sites. All those site conditions lead to higher contents of organic C in soils. Thus it could be discussed if the differences in carbon stocks of mineral soils of Switzerland are due to e.g. topological variation among the land-use categories or caused by land-use itself or both. If site conditions dominate, the soil conditions on areas subject to land-use change do not necessarily match with the mean carbon stock of the original nor new land-use.

2. Referring to that, most investigations show that after a conversion of grassland to cropland the soil carbon stock decreases and vice versa. Most of these investigations are based on paired-site investigations. Even when the soils seemed to be equal there is the problem with the spatial heterogeneity and the facts stated in the first bullet point. In fact, we don't know which part of the difference is caused by spatial heterogeneity, by "site artefacts" or by land-use. Furthermore a lot of the investigation was carried out only in the top soil (mostly 10 - 20 cm in maximum only). However, a few of these older investigations show no differences in carbon stocks after land-use change just as recent investigations, which considered the total profile (DON et al. 2009). This domain requires further research. It is, however, premature to derive consequences for inventory calculation.

3. The transition time used in the Swiss NIR for mineral soils could be discussed in more detail. A recent analysis of corresponding studies for temperate regions (POEPLAU et al., in press) shows that in case of grassland converted to cropland the assumed transition time is too long (equilibrium is reached after 17 years). In case of cropland converted to grassland assumed transition delay time seems to be too short (the equilibrium is not reached within 100 years according to POEPLAU et al., in press). Nevertheless, we acknowledge that the national inventory method needs to remain practical and consistent.

4. All cited studies show that the rates of loss and sequestration of organic carbon in mineral soils differ from each other: "fast out, slow in". Therefore, it should be discussed whether one transition time for both processes or different transition times for each process or transition times at all are meaningful.

5. The conversion of CC36 to all other land-use categories (with exception of CC61, CC41, CC51) resulted nearly in a doubling or more of the organic carbon stocks in mineral soils. It should be discussed in more detail whether those relatively high effects are realistic, e.g. in shallow soils with coverage of 65 % stones, but this seems to be rather a scientific question and does not affect the reliability of the Swiss LULUCF reporting.

6. If it is expected to be relevant, the derivation of the soil carbon stock of unproductive wetlands should be verified: The assumption of unproductive wetlands being on organic and mineral soils, respectively, with a ratio of 50:50 may lead to a first approximation. Helpful and adequate would be

a differentiation of unproductive wetlands on organic and mineral soils, respectively.

5.2.4.3 Uncertainties

The estimation of uncertainties for soil carbon stocks remains unclear and cannot be verified. The values presented in sections 7.4.5 and 7.5.5 for soil organic carbon seem to be too small. In the referenced papers of LEIFELD et al. (2003, 2005) the uncertainties are higher than in the NIR, even if assuming that the uncertainties shown in the NIR are the standard deviation.

In general, more information should be presented about uncertainty analysis as in the NIR the derivation of uncertainties is unclear and intransparent. Concerning the emission factors in sections 7.4.5 - 7.8.5 the interested reader is confronted with remarks to uncertainty analysis procedures, uncertainty values and citations.

For example: In section 7.1.5 "Uncertainty Estimates" a reference is given to Table 7-6 showing the uncertainty estimates in the LULUCF sector. Additionally one can find general statements like "in general, AD uncertainty is lower than EF uncertainty" and the cross reference to the chapters in which the uncertainty estimates "are presented in detail". In the respective chapters on EFs (7.x.5), for example 7.4.5, uncertainty values are presented for each step of the calculation (e.g. 9 % for mineral soils, 23 % for organic soils and so on) with a respective reference (e.g. "Leifeld and Fuhrer 2005"). Abruptly the reader than is confronted with the statement "In the uncertainty analysis, a higher, conservative value of 50 % was chosen for the overall emission factor uncertainty in sector 5B2" in combination with the cross reference to Table 7-6. A respective explanation would be helpful here.

5.2.5 Other

5.2.5.1 Category 5.F Other Land

In section 7.8.1 of the NIR the category "land converted to other land" is identified as a key category by trend. Therefore, emissions should be defined to the category "other land". However, by definition, this category includes only unmanaged land. According to this, CC61 comprises only of areas with rock, sand, scree and glaciers lacking soil and vegetation. In general, managed land can't revert into unmanaged land again by definition. Even avalanches and mud flow could not lead to areas which are summarized in CC61. Following Table 7-9 mainly productive forest, permanent grassland and surface waters were converted into CC61. It must be expected that at least the first and the second category will be managed again after such a natural disaster or have to be converted to CC36. In the case of surface waters the effect of meandering or flooding might lead to the change in surface coverage. Affected areas could be reported under CC41 as long as e.g. agricultural management is affected by the rivers' activities.

Consequently, the definition of "Other Land" should be revisited. It should be clarified if it refers to "unmanaged land" only and if land-use changes from managed land can be re-allocated to other "managed" land categories. In Germany this issue was solved by using a very strict definition for Other Land that moves ambiguous land cover to grassland, and by avoiding land-use changes from managed land categories to "Other Land". This was explicitly requested by the reviewers in the In-country review of September 2010.

6 Overview KP-LULUCF (NIR 11)

Summary:

The introduction of section 11 (NIR) presents an overview of the Swiss Kyoto reporting. Switzerland has selected the option of accounting for forestry activities pursuant to Article 3.4 of the Kyoto Protocol. Table NIR1 gives an overview on the activity coverage for the pools and sources pursuant to Article 3.3 and 3.4 KP. Furthermore, this chapter provides an overview of key categories and emissions of KP-LULUCF.

6.1 General Information (NIR 11.1)

Summary:

Section 11.1 provides general information on definition of forest, elected activities, definitions of the respective activities and description of precedence conditions. Also specifics of KP reporting are presented. As long as the reporting methods are similar to LULUCF reporting under the convention it is referred to chapter 7 describing the general methodology.

Methodological issues and proposals:

Switzerland applies the condition of "direct human-induced" in relation to afforestation and deforestation very strictly. Only direct human-induced afforestation and deforestation are considered as such. For example natural forest regeneration is not considered as afforestation. The identification of these areas is assured by the interpretation of aerial photographs. However, in Germany every new afforestation or reforestation is considered as human-induced since also natural forest regeneration or succession result directly from an active decision. Therefore a more precise definition of "direct human-induced" by IPCC is needed to clarify these variations in interpretation. The advantage of the wider German definition is that there is no distinction between managed and unmanaged forest and that the same forest area for "forest management" can be used in accordance with Article 3.4 KP as in the UNFCCC reporting.

6.2 Land-related Information (NIR 11.2)

Summary:

This chapter gives an overview of the methodology for assessing the land area, including the spatial assessment unit, the land transition matrix with land-use changes as well as data used. Activity data are retrieved from the Swiss Land-use Statistics (AREA) described in detail in chapter 7.2.2.1. An exception is the determination of the deforestation areas which are derived from the Swiss Statistics of Deforestation, a deforestation database provided from the Swiss Federal Office for the Environment.

Comments on Presentation:

To fulfil the requirements of the Kyoto Protocol for the definition of deforestation changes in areas from forest to non-forest derived from AREA were evaluated in order to determine which conversions are in accordance with deforestation under the KP. The additional document

"Deforestations in Switzerland as reported under the Kyoto Protocol Art. 3.3" delivers detailed information on the methodology for assessing deforestation areas under the KP, AREA-data as data basis, the used categories and the extrapolation of the AREA-data. In this regard land cover (convention) is strictly distinguished from land-use (KP). Table 1 depicts a matrix of all possible combinations between the 46 land-use categories and 27 land cover categories. The combinations are consistent and comprehensible.

According to the definitions mentioned above not all changes from forest to non-forest are accounted for Kyoto-deforestation. Therefore specific criteria were determined. Table 2 lists the criteria and the resulting area excluded by those criteria from deforestation. The criteria described are understandable and comprehensible.

The document closes with a comparison of data between Swiss Statistics of Deforestation and the calculated Kyoto-deforestations and corresponding emissions. The area of Kyoto-deforestations is 2.1 times larger than the area provided by the Swiss Forest Statistics of Deforestation. The differences are mainly due to the application of different definitions of deforestation and are documented in detail. The presented method for the determination of deforestation is in line with the requirements of the Kyoto Protocol.

The method presented in the document "Deforestations in Switzerland as reported under the Kyoto Protocol Art. 3.3" is technically comprehensible and meets the requirements of the Kyoto Protocol.

Methodological issues and proposals

The comparison between deforestation areas of the convention and the Kyoto reporting revealed a large difference in area size. From 1990 to 2008 the LULUCF-deforestation as reported under the convention was 8.8 times higher than KP-LULUCF-deforestation. Even though KP-deforestation is higher if estimated with the method from document "Deforestations in Switzerland as reported under the Kyoto Protocol Art 3.3", large differences to results of the convention method are still to be expected. For both area estimates (convention and Kyoto) the same definition of forest is applied (see sections NIR 7.3.1 and 11.1.1). Many criteria for changes in the AREA-data, which are not considered to be deforestation (see section 3 in the document "Deforestations in Switzerland as reported under the Kyoto Protocol Art. 3.3") should be valid as well in case of LULUCF reporting. Therefore the application of a similar method should be considered for both reporting systems. However, differences between the deforestation areas will persist due to the criteria "direct human-induced" for KP reporting.

Germany had major difficulty in the in-country review of September 2010 to argue for different methodologies for KP-LULUCF and LULUCF because the reviewers felt that consistency between the two reports should be the priority. We decided to adopt the KP-LULUCF definitions for LULUCF reporting, too. Switzerland may consider this option, too, e.g. by finding sub-categories per land-use for the land-use changes that are not "direct human-induced" and thus maybe only transient unstocked area.

6.3 Activity-specific Information (NIR 11.3)

Summary:

The chapter "Activity-specific Information" comprises the applied methodologies (mainly referring to chapter 7), information on omitting carbon pools, changes of data or in applied methods (recalculations), uncertainty estimates and the year of the onset of the respective activities.

Comments on Presentation:

All subchapters include the required information and comply with the reporting obligations.

Regarding the submission 2011 all activities that have been started in 2009 should be mentioned in the NIR-chapter 11.3.1.7.

Methodological issues and proposals

In Table NIR 1 the activities drainage and liming (forest management) and disturbances associated with land-use conversion to cropland (deforestation) are described as "not occurring". In chapter 11.3.1.2 drainage of forest is described as "Drainage of forests is not a permitted practice in Switzerland and is thus not occurring". Supplementary, a reference should be included according to the fact that drainage of forests is not permitted.

No information on liming of forests can be found in the NIR. In Table NIR 1 it is mentioned as "NO", not occurring, according to forest management. In Germany the amount of limestone was about 150000 Mg in 2009.

In chapter 11.3.1.2 the conversion from forest to cropland is described as "Disturbance associated with land-use conversion to croplands: deforestation of forest for conversion into cropland is prohibited by Swiss forest law and adherent ordinances (Swiss Confederation 1991, 1992) and thus does not occur". This is not consistent with the LULUCF reporting since CRF-table 5 (III) provides an area of 20 ha forest converted to cropland resulting in an emission based on disturbance. Even though this area is very small and could be due to false interpretation of the area conversion, which is not discussed in the respective section on uncertainties, the areas reported for LULUCF and KP reporting should be consistent.

6.4 Article 3.3 (NIR 11.4)

Summary:

Section NIR 11.4 covers all required information regarding article 3.3 of the Kyoto Protocol.

Comments on Presentation:

In section NIR 11.4 it is proven that activities under article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are human-induced. Concerning this topic Switzerland strictly applies the definition of "direct human-induced" (see section 6.1 above). Also information is given on the distinction of deforestation from harvested or disturbed areas followed by re-establishment of forest. This includes information on the size and geographical location of these areas.

6.5 Article 3.4 (NIR 11.5)

Summary:

Chapter NIR 11.5 presents all required information regarding article 3.4 of the Kyoto Protocol.

Comments on Presentation:

As already shown for article 3.3 it is proven that the activities under article 3.4 occur within the commitment period and are human-induced. The subchapter "Information Relating to Forest

Management" gives a historical summary on forestry in Switzerland. Also the importance of forest protection is emphasised. The implementation in wood resource policy and the Swiss national forest programme is described which specifies different objectives, for example forest's protection, conservation of forest biodiversity.

6.6 Other Information (NIR 11.6)

Summary:

This chapter presents the key category analysis for activities under Article 3.3 and 3.4 of the Kyoto Protocol. For further results and explanations it is referred to chapter 1.5.

Comments on Presentation:

The presented results fulfil the requirements of the key category analysis.

7 Inventory Development Plan LULUCF (FOEN 2010a)

The "Inventory Development Plan LULUCF" in the "Description of the Quality Management System" (FOEN 2010a) summarizes the steps which were identified to be necessary for further improvement of the Swiss Greenhouse Gas Inventory. All projects are presented with the responsible partners, the status of the project and mention relevant internal documents. Those internal documents will not be discussed in detail. Almost all main issues recognized during the review process are mentioned in one or more of the planned actions and projects.

The fields to be improved could be sorted according to their relevance on the overall inventory error. It can be expected that the heads of inventory are aware of this relevance but a description of it was not presented.

The document underlines that the application of TIER2 methods is continuously improved and consolidated by the project partners. Some actions already aim on the application or further improvement of TIER3 methods in Swiss GHG reporting.

The following table gives on overview of reported potentials of improvement and the referring ID number of actions in the IDP for the LULUC sector. These are expert comments and need to be discussed further.

1 = very important 2 = important 3 = minor importance

n = needs improvement s = Swiss specific problem t = technically solved
a = affects an amount of carbon dioxide emission/removals in Switzerland on low level only

Identified Issue	Review Chapter	Action Nr. IDP	Comment
conversion delay time (20Years)	2.4	1,16,27	3an
use of weighting factors	2.4	1,8	2n
implementation of trees outside forest	2.4	1,13	2n
enhancement of Emission Factors (afforestation)	2.5	1,2	2n
Error model Emission Factors	2.6	1,16,17,21	2n
Error due to rapid changes	3.2,3.3	1,17	3na
appearance of productive forest without afforestation	3.3	1,13,26	2s
Error model Activity data	3.5	1,16,19,20,21	2stn
Calculation of bark biomass	4.2.1	1,18	3an
Root Biomass function	4.2.1	1,3	3an
enhancement of BEFS	4.2.1	1,1	3an
Biomass brush forest	4.2.1	1,13	3an

decay sates of deadwood litter	4.2.2	1,4,7	2n
mineral soils in forest	4.2.3	1,5,6,7	2n
Afforestation	4.2.4	1,2	2n
non forest mineral and organic soils	5.2.4	1,10,11	2n
non forest biomass and stock changes	5.2.4	1,9,12,11,14	2n
other land	5.2.5	1,12	2n
Overall Error budget	7	1,25	2n
Administrative	7	1,22,23,24	2n

8 Review on used Databases and applied analyse scripts

Summary:

During the visit in mid November 2010 applied data management systems and programmed analysis scripts were examined. R-Scripts are used by FOEN for exporting results into a required format of CRF tables. Furthermore, emission factors and basic calculations like e.g. forest parameters delivered by WSL are stored in Excel files by FOEN. Reported activity data are calculated by SQL Scripts and visual Basic programs within Microsoft ACCESS database system by SIGMAPLAN enterprise. METEOSAT finally computes reported emissions and removals of GHG by PHP analysis scripts.

Comments on Presentation:

Samples of applied scripts were investigated in detail. In general, the program code is well structured and traceable. Independent control of transcribed methods, for example on independent test data, is intricate and time consuming. Thus, it could not finally be reviewed here. An independent cross check of program code is recommended.

Methodological issues and proposals:

The use of several independent systems during data processing leads to an increase of risk due to potential data transmission errors. Furthermore, traceability and performance of data processing is limited in comparison with a single system. A single consistent and comprehensive system facilitates standardized overall error estimation, easy adaptation to method improvements, calculation of simulations, and implementation of advanced models. Especially the increased capability for model implementation can support further development on future reporting under TIER 3 and of higher TIER uncertainty analysis. Further comments have been classified as confidential. They have been delivered to the FOEN in a discrete message.

9 Summary

The Swiss reporting system on LULUC is as far as possible in compliance with the IPCC-Guidelines and the GPG. A detailed documentation allows for comprehensible understanding of the development of the applied methodology. The ongoing process of developing and improving the reporting of greenhouse gases by reducing estimation errors becomes apparent. Meaningful approaches for implementation of various data sources differing in temporal and spatial scale as well as in quality are presented. For further improvement the following sectors may be developed further.

- AREA activity data concerning GPG / KP regulations with respect to afforestation, land-use changes to other land and implantation of conversion delay time of 20 years.
- Discrepancy between very accurate conversion figures and high assumed errors.
- Overall error budget of all sectors including an analysis of most significant error sources on the Swiss specific land-use forms in order to increase effectiveness of implementation plan.
- Discussion of Swiss specific peculiarities like the conversion from no forest into productive forest without a stage of afforestation.

Technically different institutions are involved in the process, data interfaces are defined and quality checks are implemented in the process. Nevertheless different database engines and software systems for analysis are used. Integration into one system could allow for a reduction of potential error sources, an increase of traceability, improvements in error estimations and the reporting process.

Summarizing, the LULUC sector of the Swiss greenhouse gas inventory proved to be of superior quality, good applicatory characteristics and scientifically sound applied definitions and methodology. Some need for further improvement was identified during the review process. Most of those points are already addressed by the Inventory Development Plan.

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