CHAPTER 7

CROSS-CUTTING ISSUES AND REPORTING

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7 CROSS-CUTTING ISSUES AND REPORTING

7.1 INTRODUCTION

The *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands* (*Wetlands Supplement*) contains updated and new methodological guidance for greenhouse gas emissions and removals from drained and rewetted peatlands and organic soils, specific human-induced changes in coastal wetlands and inland mineral soil wetlands, and constructed wetlands used for wastewater treatment. These chapters give the supplemental guidance:

- Chapter 2 Drained inland organic soils,
- Chapter 3 Cross-cutting guidance on rewetted organic soils and restored peatlands
- Chapter 4 Coastal wetlands
- Chapter 5 Inland wetland mineral soils
- Chapter 6 Constructed wetlands - wastewater treatment.

The supplementary methodological guidance introduces changes to the estimation and reporting of emissions and removals according to the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (*2006 IPCC Guidelines*) in all land-use categories (Forest Land, Cropland, Grassland, Wetlands, Settlements, and Other Land), some sources of CH_4 and N_2O emissions from managed land in the Agriculture, Forestry and Other Land Use (AFOLU) Sector, and CH_4 and N_2O emissions from wastewater treatment (constructed wetlands) in the Waste Sector. The changes come from updated methodologies for existing categories and supplemental methodologies for categories not covered by the *2006 IPCC Guidelines*. The *2013 Wetlands Supplement* maintains the approaches for estimation of emissions and removals in Volume 4 (AFOLU) of the *2006 IPCC Guidelines.* The general guidance in Volume 1 of the *2006 IPCC Guidelines* is also applicable.

This chapter gives good practice guidance on cross cutting issues for the methodologies provided in Chapters 2 to 6 of this *Wetlands Supplement* by addressing the following cross-cutting issues:

- reporting and documentation
- uncertainty estimation
- key category analysis
- completeness
- time series consistency
- quality control and quality assurance.

The chapter also summarises the good practice guidance on these cross-cutting issues found in Volume 1 of the *2006 IPCC Guidelines,* but inventory experts need to refer to Volume 1 of the *2006 IPCC Guidelines* for detailed guidance. Cross-cutting issues specific to the categories and methodologies included in Chapters 2 to 6 are also addressed in those chapters. This chapter summarizes and complements the category-specific information.

7.2 REPORTING AND DOCUMENTATION

7.2.1 Changes to reporting categories in the 2006 IPCC Guidelines

Chapter 1 gives an overview of the purpose and scope of the *Wetlands Supplement* as well as a description of its contents (Section 1.7.2) including the specific guidance provided and the linkage to the guidance in the *2006 IPCC Guidelines* (see Table 1.4 in Section 1.7 in the *Wetlands Supplement*).

In the sections below, the information presented in Chapter 1 is complemented with more details on the reporting aspects of the *Wetlands Supplement*. The summaries of the methodologies of the *Wetlands Supplement* and how emissions/removals estimated using these methodologies should be reflected in reporting, as addressed in the sections below, are based on the Tier 1 methodologies in Chapters 2 to 6. The AFOLU and Waste sector reporting tables given in Volume 1, Annex 8A.2 of the *2006 IPCC Guidelines* are applicable without changes

also for reporting of emissions/removals for which methodologies are provided in this supplement. Contrary to this, the AFOLU Sectoral Table 3 and Background Tables 3.2, 3.3, 3.4 and 3.7, included also in the above-mentioned Annex 8A.2, have been updated to cover the new categories introduced in this *Supplement* (see Annex 7.2).

The guidance on reporting including a description of the changes made to the background tables are presented below by the chapters of this *Supplement*.

7.2.1.1 DRAINED INLAND ORGANIC SOILS

The guidance in Chapter 2 for estimation of CO_2 emissions from drained inland organic soils implies changes for all land-use categories compared to the guidance given in the *2006 IPCC Guidelines* where the Tier 1 methodology was simply a multiplication of areas of organic soils with appropriate emission factors by land-use category and climate zone (boreal/temperate/tropical). For peat extraction in boreal/temperate climatic temperature regimes, also data of the nutrient status of the lands drained was taken into account in the emission factors in the *2006 IPCC Guidelines*. The supplementary methodology in Chapter 2 uses the same approach as in the *2006 IPCC Guidelines* but provides updated CO_2 emission/removal factors according to land-use categories and climate domains. For some land-use categories, these are further disaggregated by the type of vegetation, nutrient-status of the organic soils (rich vs. poor) and depth of drainage. Nutrient status is however not anymore taken into account in the CO_2 emission factors for peat extraction lands. New guidance is provided for estimation of off-site CO_2 emissions from waterborne dissolved organic carbon (DOC) losses from drained organic soils and drained peatlands.

The *2006 IPCC Guidelines* did not provide a methodology for the estimation of CH_4 emissions associated with drainage whereas Chapter 2 provides a methodology to address CH_4 emissions from the land surface of drained organic soils as well as drainage ditches. The emission factors for CH_4 from the land surface are given by land-use category and climate zone. These are further disaggregated by the type of vegetation, depth of drainage and nutrient status of the soil in some cases. The emission factors for CH_4 from drainage ditches are given by land-use and climate domain and in some cases, by land-use intensity. The estimation of the CH_4 emissions from drained organic soils requires as activity data the area of organic soils and the fractional ditch area. This activity data needs to be stratified according to the level of disaggregation of the emission factors. These CH_4 emissions could be reported under the specific land-use categories where drainage occurs or alternatively under Category 3C8 *Other* under an appropriate heading highlighting the land-use category, peatland type as well as the source of the emissions (ditches).

The methodology for direct N_2O emissions from organic soils is the same as in the *2006 IPCC Guidelines* but the default emissions factors are updated. In accordance with the *2006 IPCC Guidelines* the N_2O emissions from organic soils should be reported as aggregated to N_2O emissions from managed soils and, if data are available, the emissions can be provided by land-use category. The N_2O emissions from drainage/management of organic soils are reported under Category 3C4 *Direct N_2O Emissions from Managed Soils*. An exception to this are direct N_2O emissions on peat extraction lands which are reported in category 3B4ai (*Peat Extraction Remaining Peat Extraction*[1]) or 3B4bi (*Land Converted for Peat Extraction*), depending if the peat extraction lands remain in the category, or are converted to it.

Chapter 2 provides also guidance on burning of drained organic soils. These emissions would be reported in the AFOLU category 3C1 *Biomass Burning* under relevant subcategories. Activity data and emissions by carbon pools should be provided in AFOLU Background Table 3.4, which is revised to include also emissions from soil burning (see Annex 7.2).

7.2.1.2 CROSS-CUTTING GUIDANCE ON REWETTED ORGANIC SOILS AND RESTORED PEATLANDS

Guidance on CO_2, CH_4 and N_2O emissions from rewetting is not included in the *2006 IPCC Guidelines*. Chapter 3 of this *Wetlands Supplement* provides this guidance for rewetted organic soils and restored peatlands Tier 1 methodologies are given for CO_2 emissions/removals from rewetted peatlands and organic soils with moss and/or herbaceous vegetation, and also for dissolved organic carbon. Tier 1 guidance is also given for CH_4 emissions from the rewetting. N_2O emissions from rewetted peatlands and organic soils are considered negligible and assumed to be zero under Tier 1. When rewetted lands contain perennial woody vegetation, the guidance in

[1] This category has been renamed (Peatlands Remaining Peatlands in the *2006 IPCC Guidelines*) to take into account the guidance on peatlands in this *Supplement*. The renaming is taken into account in the updated Table 3 AFOLU Sectoral Table and relevant AFOLU background tables in Annex 7.1.

Chapter 2, 4 and 5, Volume 4 of the *2006 IPCC Guidelines*, should be used to estimate the emissions from the woody biomass and DOM pools.

The reporting of emissions/removals from rewetting depends on the resultant land-use after the rewetting. Rewetted grassland could remain in the same land-use category, e.g. when agricultural land with organic soil is rewetted to form a grazing marsh. The rewetting could also involve a land-use change, e.g. when a forest with organic soil is rewetted and the tree coverage declines below the threshold of the national forest definition. It is *good practice* to report emissions/removals from rewetting in the relevant land-use categories (Table 3 in Volume 1, Annex 8A.2 of the *2006 IPCC Guidelines*). Additional information on C stock changes on these lands should be provided in the Background Table 3.2 and Table 3.3. CH_4 should be included in Table 3.9, under category 3C8 *Other* and specified as CH_4 from rewetting of organic soils and restoration of peatlands.

7.2.1.3 COASTAL WETLANDS

Guidance on CO_2, CH_4 and N_2O emissions from managed coastal wetlands is not included in the *2006 IPCC Guidelines* but provided in Chapter 4 of this *Wetlands Supplement.* This guidance covers emissions/removals from mineral and organic soils vegetated by vascular plants that are covered or saturated for all or part of the year by tidal freshwater or salt water (>0.5ppt). The guidance addresses emissions/removals from specific activities on ecosystems with mangrove forest, sea grass meadows and tidal marshes. Some of these activities include aquaculture, drainage and extraction, creation and restoration of coastal wetlands. New methods are presented for estimation of changes in soil carbon (Tier 1 level) whereas methods for biomass, dead organic matter and non-CO_2 emissions follow those of the *2006 IPCC Guidelines.*

These wetlands can occur in any of the six IPCC land-use categories. For example, a mangrove wetland with trees may be classified as forest, while a tidal marsh used for grazing may be classified as grassland. The precise details of this classification are specific to each country so it is not possible to say exactly how coastal wetlands may be classified. Appropriate subcategories should be used in the reporting, to reflect the specific land use and management.

The total emissions/removals from coastal wetlands should be reported under relevant land-use categories, and subcategories, of the AFOLU Sectoral Table 3. Additional information on C stock changes on these lands should be provided in the background Table 3.2 and Table 3.3. CH_4 and N_2O emissions from coastal wetlands should be included in Table 3.9, under category 3C8 *Other* and specified as CH_4 or N_2O emissions from coastal wetlands. For information to be included in the inventory report, see below 7.2.2 Documentation.

7.2.1.4 INLAND WETLAND MINERAL SOILS

In Volume 4 of the *2006 IPCC Guidelines*, generic guidance for estimating CO_2 emissions/removals from soils, including wet mineral soils, is provided in Section 2.3.3 and complemented with land-use category specific guidance in the Chapters 3 to 6 in the sections addressing emissions and removals from mineral soils. Chapter 5 of the *Wetlands Supplement* complements and updates this guidance with new default values for reference soil carbon stock values for wetland mineral soils under all climate regions and carbon stock change factors for land-use for long-term cultivation of Cropland with Inland Wetland Mineral Soils (IWMS). New default carbon stock change factors are provided for wetland restoration on Cropland with IWMS. In addition, Chapter 5 provides data on CH_4 emissions from IWMS under any land-use category that have undergone wetland restoration, and from mineral soils that have been inundated for the purpose of wetland creation. The guidance does not include emissions/removals from rice cultivation. The N_2O emissions from wet inland mineral soils are addressed in an appendix on future methodological development.

IWMS can occur in any of the six IPCC land-use categories. For example, a riverine wetland with trees may be classified as forest land, while a riverine wetland without trees may classified as wetlands. The precise details of this classification are specific to each country so it is not possible to say exactly how IWMS may be classified. Appropriate subcategories should be used in the reporting, to reflect the specific land use and management as specified by a country.

The total emissions/removals from IWMS should be reported under relevant land-use categories, and subcategories, of the AFOLU sector in the reporting Table 3 in Volume 1, Annex 8A.2. Additional information on C stock changes on these lands should be provided in the background Table 3.2 and Table 3.3. CH_4 emissions from wet inland mineral soils should be included in Table 3.9, under category 3C8 *Other* and specified as CH_4 emissions from IWMS. For information to be included in the inventory report, see below 7.2.2 *Documentation*.

7.2.1.5 CONSTRUCTED WETLANDS - WASTEWATER TREATMENT

Supplementary guidance on CH_4 and N_2O emissions from wastewater treatment and discharge is provided in Chapter 6 on Constructed Wetlands - Wastewater Treatment. Constructed wetland systems for wastewater treatment are human-made wetlands and engineered systems, which apply various technological designs, using natural wetland processes, associated with wetland hydrology, soils, microbes and plants to assist in treating wastewater. Methodologies are based on the load of nitrogen and organic carbon into the systems. The CH_4 emissions are calculated based on biological or chemical oxygen demand data and emission factors related to the flows in these constructed wetlands (free water surface, vertical subsurface flow and horizontal subsurface flow). The N_2O emissions are calculated based on the amount of nitrogen in the wastewater.

CH_4 and N_2O emission from constructed wetlands for wastewater treatment are reported under category 4D *Wastewater Treatment and Discharge*. The emissions should be divided into Categories 4D1 *Domestic wastewater treatment and discharge* and 4D2 *Industrial Wastewater treatment and discharge* according to source of wastewater treated in the constructed wetlands.

The areas of constructed wetlands would be reported as part of areas under settlements, or other land-use categories, as appropriate. If the establishment of the constructed wetland involves a land-use category conversion, the area changes should be reported under appropriate land-use categories and the notation key "IE" should be used for the CH_4 and N_2O emissions under the category to which the land is converted, as these emissions are reported in the Waste sector. Any changes in carbon stocks due to the land-use conversion, e.g. due to cutting of trees or removal of other vegetation, should also be reported under the category to which the land is converted. However, the areas of constructed wetlands for wastewater treatment are often small, and if thresholds for minimum areas for reporting are not exceeded, no reporting in the AFOLU sector is required.

No changes to the reporting tables and background tables in the *2006 IPCC Guidelines* are made for the inclusion of the emissions from constructed wetlands for wastewater treatment. The section 7.2.2 *Documentation* below addressed the information that should be included in the inventory report.

7.2.2 Documentation

Chapter 8 in Volume 1 of the *2006 IPCC Guidelines* provides guidance on reporting complete, consistent and transparent national greenhouse gas inventories. Category-specific guidance on documentation relevant to the supplementary guidance provided in this report is provided in Chapters 2 to 6.

Reporting in accordance with the *Wetlands Supplement* involves combining guidance from both this *Supplement* and the *2006 IPCC Guidelines*. The estimation of emissions and removals requires in some cases a combination of methodologies which, if care is not taken, can lead to double-counting or omission of emissions or removals. The reporting of emissions and removals from specific activities, e.g. rewetting and drainage, is disaggregated among land-use categories and/or generic categories for reporting of non-CO_2 emissions. National circumstances will also significantly affect the reporting. In some countries, the categories will have a significant impact on the national total emissions, in others they will be insignificant.

It is *good practice* to provide the following information specific to the guidance in this Supplement in the national inventory report:

- how the activities and land areas are identified;
- how the activities and land areas are classified in the reporting;
- disaggregated activity data and emission factors/parameters used by climate regime (temperature, precipitation), nutrient status, ecosystem type and activity/system, as relevant, and at the level which the emissions/removals are estimated
- information on how completeness has been assessed and double-counting avoided, i.e. in the following cases:
    - If the stock change method is used for a specific category/activity for estimation of CO_2 emissions/removals from soils and the default emission factors are used for dissolved organic carbon the latter emissions may be included in the stock change estimate.
    - If a country uses a country-specific method to estimate emissions/removals from dead organic matter or understorey (such as mosses) combined with default emission factors for drainage and rewetting there is a risk of double counting. The risk is due that fact that the flux based default emission/removal factors are based on the assumption that the carbon stock change for dead organic matter and understorey is zero or included in the default values.

- Documentation for constructed wetlands for wastewater treatment should show that total organics in wastewater includes but does not double-count the part of organics treated in these systems.

- When country-specific emission/removal factors or other parameters are used, documentation and references which justify their use should be provided. The documentation should show that the country-specific emission/removal factors or other parameters result in an improvement in the accuracy of the estimates.

7.2.3 Reporting tables

The *Wetlands Supplement* has minor impacts on the Reporting Tables in Annex 8A.2 of Volume 1 of the *2006 IPCC Guidelines*. The Sectoral AFOLU Table 3 and Background Tables 3.2, 3.3, 3.4 and 3.7 have been revised to take into account the changes introduced by the Wetlands Supplement (see sections above) and are provided in Annex 7.2.

7.2.4 Worksheets

Annex 7.1 provides also worksheets for each sub-category for which guidance is given in the Wetlands Supplement. The worksheets can be used to estimate emissions based on Tier 1 methods and appropriate emission/stock change factors and activity data.

7.3 UNCERTAINTIES

7.3.1 Overview of uncertainty analysis

Uncertainty is an expression of the degree to which the value of a variable is unknown (IPCC 2007). In greenhouse gas inventories, uncertainty derives from quantifiable errors and variation in methods and data.

For greenhouse gas inventories, quantification of uncertainty is important because it allows inventory agencies to ascertain if estimated changes in greenhouse gas emissions and removals over two or more years are larger than the uncertainty or range of possible estimates for an individual year. In wetlands, the magnitude of carbon stocks is often much larger than annual emissions or removals, so large uncertainties in carbon stock estimates may make it difficult to determine if estimated annual emissions or removals are real or a result of uncertainty. Uncertainty analysis can indicate areas for future improvement of inventory methods that can reduce the uncertainties.

In greenhouse gas inventories, major quantifiable sources of uncertainty include:

- field measurement errors
- remote sensing inaccuracies
- geographic and land cover map inaccuracies
- missing or incomplete data in time series
- misreporting or misclassification
- data bias or unrepresentative sampling
- random sampling error
- spatial variation
- spatial or temporal autocorrelation, when not properly considered
- model inaccuracies

Uncertainty analysis generally proceeds through these steps:

- Identification of primary sources of uncertainty.
- Estimation of uncertainties of individual variables.
- Combination of individual variable uncertainties into total uncertainty estimates of emissions or removals for a land-use category for a geographic area.

This section summarizes scientific methods for the two approaches to uncertainty analysis set forth in the *2006 IPCC Guidelines*. This section aims to summarize material from Chapter 3, Volume 1 and Chapter 7, Volume 4 of the *2006 IPCC Guidelines*, summarize new methods for the wetlands sub-categories described in Chapters 2 to 6 of this *Wetlands Supplement*, and assess the methods across the wetlands subtypes. To the extent possible, it provides published examples. Inventory compilers should consult the detailed information in the *2006 IPCC Guidelines* and this *Wetlands Supplement*.

7.3.2 Methods for quantifying uncertainty

The measure of uncertainty for national greenhouse gas inventories is the 95% confidence interval (CI). It is *good practice* to report the 95% CI for individual variables, including activity data, emissions factors, biomass densities, other parameters, and for total greenhouse gas emissions or removals from any key category or land-use category for a geographic area.

The *2006 IPCC Guidelines* set forth two approaches for quantifying uncertainty. Approach 1 is a basic approach that uses algebraic equations to combine individual variable uncertainties. Approach 2 is an advanced approach that uses Monte Carlo analysis.

Approach 1 - Use the measures of uncertainty for individual variables given in the default tables in this *Wetlands Supplement* and the *2006 IPCC Guidelines*. To combine individual variable uncertainties into total estimates of the uncertainty of emissions or removals for any key category or land-use category for a geographic area, use basic uncertainty combination methods (Mandel 1984), identified in Chapter 3, Volume 1 of the *2006 IPCC Guidelines*.

Use Equation 7.1 to calculate the uncertainty of a set of added variables:

EQUATION 7.1
COMBINING UNCERTAINTIES – ADDITION AND SUBTRACTION

$$U_{total} = \frac{\sqrt{\left(U_1 \times x_1\right)^2 + \left(U_2 \times x_2\right)^2 + \ldots + \left(U_n \times x_n\right)^2}}{\left|x_1 + x_2 + \ldots + x_n\right|}$$

Where:

U_{total} = uncertainty (95% CI) of the sum of the variables

U_i = uncertainty (95% CI) of a variable

x_i = value of a variable.

Use Equation 7.2 to calculate the uncertainty of a set of multiplied variables:

EQUATION 7.2
COMBINING UNCERTAINTIES – MULTIPLICATION

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2}$$

Where:

U_{total} = uncertainty (95% CI) of the product of a set of variables

U_i = uncertainty (95% CI) of a variable

Refer to the *2006 IPCC Guidelines* for detailed steps of basic uncertainty combination, including calculation of uncertainties of temporal trends.

This *Wetlands Supplement* presents guidance to take into consideration the sources of uncertainty, either in activity data or emissions factors that are important specifically for wetlands and organic soils. The definitions of wetland sub-categories and delineation of their surface areas can, by themselves, be sources of uncertainty. While the *2006 IPCC Guidelines* generally stratify land-use categories by ecological zone (Volume 4, Chapter 4) or climate zone, this *Wetlands Supplement* stratifies wetlands into sub-categories based on wetlands characteristics and human activities. Sources of uncertainty for the sub-categories and new tables that provide inventory compilers with default uncertainty values include:

- **Drained inland organic soils** – Surface areas and emissions factors are a function of drainage class, which requires estimates of the depth of the water table. CH_4 emissions from drainage ditches are a function of

ditch width, spacing, and management. For N_2O emissions from soils, the very high spatial variability can generate large standard errors relative to mean fluxes.

- Table 2.1 - Tier 1 CO_2 emission/removal factors for drained organic soils in all land-use categories
- Table 2.2 - Default dissolved organic carbon (DOC) emission factors for drained peatlands and organic soils
- Table 2.3 - Tier 1 CH_4 emission/removal factors for drained organic soils in all land-use categories
- Table 2.4 - Default CH_4 emission factors for drainage ditches
- Table 2.5 - Tier 1 N_2O emission/removal factors for drained organic soils in all land-use categories

- **Rewetting of organic soils and restoration of peatlands**
  - Table 3.1 - Default emission factors and associated uncertainty, for CO_2-C by rewetted peatlands and organic soils
  - Table 3.2 - Default dissolved organic carbon (DOC) emission factors for rewetted peatlands and organic soils
  - Table 3.3 - Default emission factors for CH_4 from rewetted peatlands and organic soils

- **Coastal wetlands** - The assumption that carbon stocks in dead organic matter are zero in non-forest land is not always justified. Underestimating the true initial dissolved organic matter stock will lead to overestimates of true accumulation rates. Litter and dead wood that may have otherwise accumulated can be exported through tidal advection, thus resulting in an overestimation of the carbon accumulation rate in the dead organic matter pool.
  - Table 4.3 - Carbon content of aboveground mangrove forest biomass
  - Table 4.4 - Aboveground biomass in mangrove forests
  - Table 4.5 - Aboveground biomass growth in mangrove forests
  - Table 4.6 - Ratio of belowground biomass to aboveground biomass in mangroves forests
  - Table 4.7 - Wood density of common mangrove tree species
  - Table 4.8 - Aboveground and belowground biomass for tidal marshes
  - Table 4.9 - Aboveground biomass for seagrass meadow
  - Table 4.10 - Ratio of belowground biomass to aboveground biomass for seagrass meadow
  - Table 4.11 - Carbon content of aboveground and belowground seagrass biomass
  - Table 4.13 - Tier 1 default values for litter and dead wood carbon stocks
  - Table 4.15 - Emission factors associated with construction of aquaculture, salt production, and extraction on organic soils at start of activity
  - Table 4.16 - Emission factors associated with construction of aquaculture, salt production, and extraction on mineral soils at start of activity
  - Table 4.17 - Annual emission factors associated with use of aquaculture on organic and mineral soils
  - Table 4.18 - Annual emission factors associated with abandonment after aquaculture or salt production under saturated conditions on organic and mineral soils and harvesting of aquatic resources in mangrove forests
  - Table 4.19 - Annual emission factors associated with nutrient enrichment on organic and mineral soils
  - Table 4.20 Annual emission factors associated drainage on organic and mineral soils
  - Table 4.21 - Annual emission factors associated with restoration or creation on organic and mineral soils after 20 years of vegetation reestablishment
  - Table 4.23 - Emission factors for N_2O emissions from aquaculture in coastal wetlands
  - Table 4.24 - Emission factors for CH_4 emissions from nutrient enrichment (agricultural run-off and aquaculture effluent)
  - Table 4.25 - Emissions factors for N_2O emissions from nutrient enrichment (aquaculture effluent)

- Table 4.26 - Emission factors for CH_4 from unmanaged coastal wetlands for Tier 1 estimation of rewetting and restoration

Inland wet mineral soils – Emissions are a function of time under management.

- Table 5.2 - Default reference soil organic carbon stocks for wetland mineral soilsa under native vegetation
- Table 5.3 - Relative stock change factors for land-use for long term cultivation on cropland with IWMS (over 20 years) and wetland restoration of cropland with IWMS (over 20 years and 40 years)
- Table 5.4 - Default emission factors for CH_4 from managed lands with IWMS where water table level has been raised

- **Constructed wetlands - wastewater treatment** – Emissions estimates require maximum CH_4 producing capacity, methane correction factor, human population (for estimating wastewater flow), and protein consumption (for estimating N_2O emissions). Sources of uncertainty include the quantity of wastewater treated, the fraction of organics converted anaerobically to CH_4 during wastewater collection, and the amount of industrial organic wastewater from small or medium industries discharged into constructed wetlands.
  - Table 6.5 - Default uncertainty ranges for domestic and industrial wastewater
  - Table 6.7 - Nitrous oxide methodology default uncertainties

It is *good practice* to use uncertainty estimates reported by or derived from the same data sources used for the emissions and removals estimates. For Tier 1 estimates, use the uncertainties given in the IPCC default tables. For Tier 2, the data sources of the country- or ecosystem-specific parameters would provide the most appropriate uncertainty estimates. In the absence of country- or ecosystem-specific uncertainty estimates, it is possible to use published uncertainty estimates for similar ecosystems or circumstances, such as listed in Table 7.1. These published uncertainty estimates can also provide useful data to verify country- or ecosystem-specific uncertainty estimates.

TABLE 7.1
EXAMPLES OF WETLANDS WITH PUBLISHED ESTIMATES OF UNCERTAINTIES OF PARAMETERS USED IN ESTIMATING GREENHOUSE GAS EMISSIONS AND REMOVALS

Continent	Country	Wetland	Reference
Africa	Botswana	Okavango Delta	Mladenov et al. 2005
	Madagascar	estuary	Ralison et al. 2008
	Senegal	estuary area	Sakho et al. 2011
Asia	China	constructed wetland	Chen et al. 2011
	Indo-Pacific	mangroves	Donato et al. 2011
	Indonesia	peat swamps and oil palms	Murdiyarso et al. 2010
North America	Canada	restored wetlands	Badiou et al. 2011
	Costa Rica	tropical inland wetlands	Bernal and Mitsch 2008
	USA	streams and rivers	Butman and Raymond 2011
South America	Argentina	river marsh	Vicari et al. 2011
	Brazil	Pantanal	Schöngart et al. 2011
	Peru	Amazonian peatland	Lähteenoja et al. 2012
Global	Global	coastal ecosystems	Mcleod et al. 2011
	Global	freshwater wetlands	Kayranli et al. 2010
	Global	freshwater wetlands methane	Bastviken et al. 2011
	Global	mangroves	Breithaupt et al. 2012
	Global	restored wetlands	Moreno-Mateos et al. 2012
	Global	seagrass	Fourqurean et al. 2012
	Global	tropical peatlands	Page et al. 2011
	Global	wetlands carbon and methane	Mitsch et al. 2010

Approach 2 – For an individual variable, calculate the 95% CI from the probability density function (PDF) of measurements of the variable. Derive the PDF from a random sample. Capture the principal forms of spatial and temporal variation in the sample or calculate different PDFs for the principal spatial and temporal strata. The *2006 IPCC Guidelines*, Volume 1, Chapter 3, Section 2.2.4, provide methods to develop PDFs.

To combine individual variable uncertainties into total estimates of emissions or removals for a land-use category or a geographic area, use the Monte Carlo method (Metropolis and Ulam 1949), set forth by the *2006 IPCC Guidelines* as Approach 2. The Monte Carlo method is a statistical technique that quantifies the uncertainty of a variable based on a large number of randomized realizations of the value of the variable based on its mean value, the standard error of the mean, and a PDF of the standard errors.

For example, the width of a ditch is an essential variable in estimating CH_4 emissions from drained organic soils (Equation 2.5). In a typical field survey, a person might measure the width of a ditch once and record the measurement. If the measurement were immediately repeated, the result may be slightly different due to the exact placement of the measuring device, judgment of the level of water, which defines the width, possible errors in transcribing or transmitting the value, and other factors. Repeating the measurement 100 or 1000 times would generate a PDF that might typically take the form of a normal distribution. The 95% CI of the distribution is a measure of the uncertainty of the ditch width measurement.

Monte Carlo analysis consists of running a calculation for a statistically significant number of replications, typically 100 to 10 000, producing a probability density function of the result, and calculating the 95% CI of the PDF. For any equation, the Monte Carlo form of a variable (Equation 7.3) can replace each of the variables in the equation. The large number of realizations effectively combines the uncertainties of individual variables.

EQUATION 7.3
MONTE CARLO ANALYSIS – GENERAL FORM OF A VARIABLE

$$x_i = mean_x + (random_i \times SE_x)$$

Where:

x_i = value of realization *i* of a variable,

i = statistically significant number of realizations, typically 100 – 10 000

$mean_x$ = mean value of a variable

$random_i$ = random number for realization *i*, from -1 to 1, taken from a set of random numbers that form a probability distribution function specific to the variable

SE_x = standard error of the mean value of the variable

Refer to the *2006 IPCC Guidelines* for detailed steps of Monte Carlo analysis, including selection of an appropriate PDF for a variable and its random numbers. Inventory agencies and scientists have quantified uncertainty in greenhouse gas inventories in a range of cases, including the national inventories of Austria (Winiwarter and Muik 2010), Finland (Monni et al., 2007), and the Netherlands (Ramírez et al., 2008) and high-biomass ecosystems in California, USA (*e.g.* Gonzalez et al., 2010) and Canada (*e.g.* Kurz et al., 2008).

Ways to reduce uncertainty in both Approach 1 and Approach 2 include:

- **Organic soils** – Spatially disaggregated CO_2 flux measurements can provide data to develop local emission factors, correcting for carbon losses through leaching of dissolved organic carbon or runoff. Quantification of impacts of land-use and management on emissions can improve emissions estimates. Examples include organic matter additions to agricultural land that can increase substrate supply for methane production in ditches, short-term pulses of ditch CH_4 emission associated with land-use change, and nutrient-enriched soils that are a legacy of past land use.
- **Rewetted peatlands** – CO_2 and CH_4 emissions are often a function of present vegetation composition and previous land use history, so stratification of an area by these properties can improve emissions estimates. Determination of spatial variation of peat type and depth, vegetation composition, soil temperature, mean water table depth, the provision by vegetation of substrates for CH_4 production, and transport by vegetation of CH_4 from saturated soil to the atmosphere can improve emissions estimates.
- **Coastal wetlands** – More detailed stratification of land by drainage and other management systems can improve emissions estimates. Quantification of the effects of coastal grassland management, including grazing, fire, liming, and fertilization, can improve emissions estimates.
- **Inland mineral soil wetlands** – Chapter 5 does not identify uncertainty reduction methods.
- **Constructed wetlands - wastewater treatment** – Provide separate estimates for domestic and industrial wastewater by type of constructed wetlands (surface flow (SF), horizontal subsurface flow (HSSF), and vertical subsurface flow (VSSF)).

7.4 IMPACT ON KEY CATEGORIES

7.4.1 Overview of key category analysis

Methodological choice for individual source and sink categories is important in managing overall inventory uncertainty. Generally, inventory uncertainty is lower when higher-tier methods are used to estimate emissions and removals. However, these higher-tier methods generally require extensive resources for data collection, so it may not be feasible to use these methods for every category. It is therefore *good practice* to identify those categories, which have the greatest contribution to the total magnitude of the inventory and/or to the overall inventory uncertainty, to make the most efficient use of available resources. By identifying the key categories in the national inventory, inventory compilers can prioritize their efforts and improve the overall estimates. The purpose, general rules and approaches for the key category analysis of the whole greenhouse gas inventory are presented in Chapter 4 of Volume 1 of the *2006 IPCC Guidelines*.

According to Section 4.2 in Volume 1 of the *2006 IPCC Guidelines* the general rules for performing the key category analysis are

- The key category analysis should be performed at the level of IPCC categories or subcategories at which the IPCC methods and/or decision trees are provided.
- Each greenhouse gas emitted from each category should be considered separately, unless there are specific methodological reasons for treating gases collectively.
- Emissions and removals from a category should also be considered separately, where possible and relevant to the methodology used.

The Table 4.1 in Section 4.2 in Volume 1 of the *2006 IPCC Guidelines* also gives a recommended level at which the key category analysis should be performed. Countries may however choose to perform the quantitative analysis at a more disaggregated level than suggested.

The key category analyses are performed using two approaches. Approach 1 is based on level and trend assessments. In the level assessment, categories of the inventory are listed in the order of absolute values of their contribution to the sum of the absolute value of emissions and removals, and the largest categories contributing 95 per cent to this sum are considered as key categories. The trend assessment analyses the contribution of a category to the trend as well as if the trend of the category is significantly different from that of the inventory. The categories contributing most and together up to 95 per cent of the trend are considered key categories. Approach 2 is based on similar assessments and takes the results of the uncertainty analysis into account. Countries are encouraged to undertake key category analysis using both Approach 1 and 2, because Approach 2 can provide additional insight, e.g. on the order with which to tackle categories identified in Approach 1.

7.4.2 Key category analysis including the categories affected by the Wetlands Supplement

According to Table 4.1 in Volume 1 of the *2006 IPCC Guidelines,* the appropriate aggregation level for land use related CO_2 emissions (carbon stock changes) in the AFOLU Sector is to distinguish the emissions or removals for lands remaining and lands converted to each of the six land-use categories. Thus, twelve categories need to be distinguished. In addition, the inventory compilers should determine which pools and subcategories are significant. This approach is considered appropriate, as the CO_2 emissions/removals from the land-use categories are generally estimated using the same or similar generic methodologies and also using the same activity data (area data).

The *Wetlands Supplement* introduces new subcategories and more detailed guidance for some categories in the AFOLU Sector. Also the wastewater treatment category in the Waste Sector is complemented with an additional treatment system (constructed wetlands). Despite these changes, the inventory compilers should continue to perform the key category analysis at the level suggested in Table 4.1 in Volume 1 of the *2006 IPCC Guidelines*. . The significance of the categories and subcategories affected by the *Wetlands Supplement* should be assessed using the generic rule that a subcategory is significant if it accounts for 25 to 30 per cent of the key category it is part of (see decision trees in Figures 1.2 and 1.3 in Chapter 1 of volume 4 of the *2006 IPCC Guidelines*).

In the quantitative key category analysis, when emissions/removals from a specific activity, such as deforestation, are estimated using the same methodology but spread out under the different land-use change categories, inventory compilers should identify and sum up the emission/removal estimates for this activity and compare its magnitude with the smallest category identified as key. If this sum is larger than the smallest category identified as key, the activity in question should be considered key. Countries should assess whether this rule would be applicable to their circumstance for categories addressed in this *Supplement.*

7.5 COMPLETENESS

Complete greenhouse gas inventories include estimates of emissions and removals from the sources and sinks for which methodological guidance is provided in the *2006 IPCC Guidelines* and the *Wetlands Supplement* unless the specific sources and sinks do not occur on the national territory. The decision tree in Figure 1.1 and Table 1.3 in Chapter 1 of this report provide guidance on the links between guidance in the *2006 IPCC Guidelines* and the *Wetlands Supplement* to help countries in ensuring complete coverage of all relevant categories in the inventory.

A country may consider that a disproportionate amount of effort would be required to collect data for a category or a gas from a specific category that would be insignificant in terms of the overall level and trend in national emissions. The *Wetlands Supplement* addresses sources and sinks for which the significance varies considerably by country. For instance, some wetland types occur only in some regions of the world, the amount of organic soils may be very small in some countries and tidal effects on the emissions are applicable only to coastal countries. In circumstances where the supplementary guidance is not applicable to a country or emissions/removals are not reported due to their insignificance, they should use the notation keys “NO” (not

occurring) and "NE" (not estimated) respectively. For details on the use of the notation keys, the inventory compilers should refer to Section 8.2.5 in Volume 1 of the *2006 IPCC Guidelines*. It is good practice to provide justification for each emission estimate for which the notation key "NE" is used.

7.6 TIME SERIES CONSISTENCY

7.6.1 Overview of time series issues

Greenhouse gas inventory methods should be consistent for an entire time series so that each year in the time series can be compared with other years. This provides countries with information to properly assess temporal trends in their greenhouse gas emissions and removals and the effectiveness of emissions reduction measures. Issues that will affect time series consistency include:

- changes and refinements to methods due to scientific advances
- addition of new categories
- technological change
- data gaps
- correction of errors

In a consistent time series, changes in emissions or removals over time are due to real phenomena in the field rather than any influence of the above set of circumstances in the calculations.

This *Wetlands Supplement* includes substantial changes to the *2006 IPCC Guidelines* methods for wetlands and refines the subcategories within the wetlands and other land-use categories. This may make necessary the recalculation of results from previous years to produce a consistent time series.

This section summarizes material from the *2006 IPCC Guidelines*, including Chapter 5, Volume 1 and Chapter 7, Volume 4. It also adds recent scientific information described in Chapters 2-6 of this *Wetlands Supplement.*

7.6.2 Methods for producing consistent time series

This section provides guidance for producing consistent time series of emissions and removals for the wetlands sub-categories in this *Wetlands Supplement*. It presents the information by the tiers that inventory compilers already use to estimate emissions and removals.

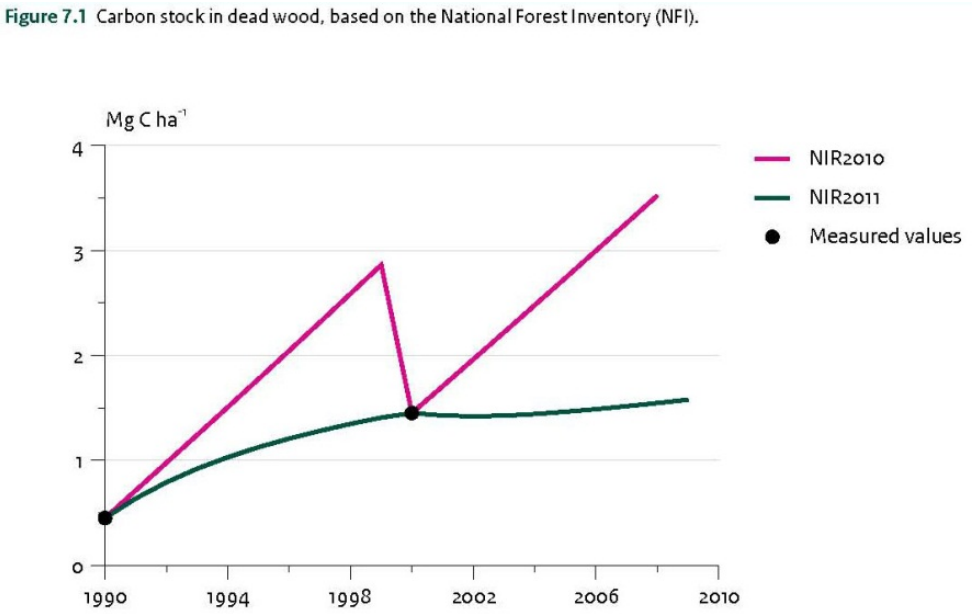
All tiers - Recalculate an entire data series when changing from the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Good Practice Guidance for Land Use, Land-Use Change and Forestry*, and *2006 IPCC Guidelines* to the *Wetlands Supplement*, when methods are refined due to scientific advances, new data become available, quality control finds errors in previous estimates, or a land classification changes (e.g. reporting mangroves as wetlands rather than forests). For data gaps, it is *good practice* to clearly report where an inventory presents measured or monitored results and where it presents model output.

Tier 1 – Use the activity data for years available in the default sources in the *Wetlands Supplement* and the *2006 IPCC Guidelines* and fill gaps using appropriate methods in Section 5.3, Volume 1 of the *2006 IPCC Guidelines*.

Tiers 2 and 3 - To fill data gaps, examine available historical sources, administrative records, aerial photographs, or remote sensing and use appropriate methods in Section 5.3, Volume 1 the *2006 IPCC Guidelines*.

Alternatively, interpolate using a function that models empirical trends or underlying processes. Identify years where the inventory presents measured or monitored results and where it presents model output. Some examples of producing consistent time series include field validation of model dead wood time series in the Netherlands national greenhouse gas inventory (van der Maas et al., 2011; Figure 7.1), data gap filling of CO_2 fluxes from Everglades National Park, USA (Barr et al., 2010), and filling of night-time gaps in ecosystem respiration in Lake Victoria wetlands, Uganda (Saunders et al., 2012). The case of the Netherlands is an example that illustrates recalculation of a time series to improve consistency. When field measurements of dead wood showed that modelled estimates were not accurate, the inventory agency revised the parameters in its dead wood model and recalculated the entire time series (van der Maas et al., 2011; Figure 7.1). Refer to Section 5.3, Volume 1 of the *2006 IPCC Guidelines* for detailed steps of filling historical gaps by splicing and for the use of surrogate parameters.

574 **Figure 7.1 Example of recalculation of a time series**



575

576 The national inventory report (NIR) for the Netherlands in 2011 (van der Maas et al. 2011) provided a more accurate time series of the
577 carbon stock in dead wood than previous inventories. Measured values of dead wood stocks in the Netherlands national forest inventory
578 (black dots) showed that national greenhouse gas inventories prior to 2011 (purple upper line) overestimated the build-up of the carbon stock.
579 Inventory compilers found that their model underestimated the removal of dead wood from forests. Adjustment of that parameter generated a
580 model time series (green lower line) that met the measured values.

581 7.7 QUALITY ASSURANCE AND QUALITY 582 CONTROL

583 7.7.1 Overview of quality issues

584 Quality assurance and quality control are procedures to improve the accuracy, transparency, consistency,
585 comparability, and completeness of inventories. Effectively implemented quality procedures can reduce
586 uncertainties of greenhouse gas inventories. Quality control (QC) is a system of routine technical activities to
587 assess and maintain the quality of the inventory as it is being compiled. Quality assurance (QA) is a planned
588 system of review procedures conducted by personnel not directly involved in the inventory. This section
589 summarizes material from the *2006 IPCC Guidelines*, including Volume 1, Chapter 6 and Volume 4, Chapter 7.
590 It also adds recent scientific information described in Chapters 2-6 of this *Wetlands Supplement*. This section
591 presents the information by the tiers that inventory compilers already use to estimate emissions and removals.

592 7.7.2 Quality assurance and quality control methods

593 **All tiers** – Provide routine and consistent checks to ensure data integrity, correctness, and completeness. Identify
594 and address errors and omissions. Document and archive inventory material and record all quality control
595 activities. Check labelling, transcription, and other clerical related to data entry (See complete list in Table 6.1,
596 Volume 1 of the *2006 IPCC Guidelines*). Double-check outlying values against data sources. Check final results
597 against previous years and published values. Compare inventories with results from similar ecosystems in other
598 countries. Conduct an area-balance for land-use category areas and, when applicable, a mass-balance for
599 greenhouse gas emissions and removals. Develop automated data control procedures. It is good practice to
600 prioritize key categories for more extensive quality assurance and quality control.

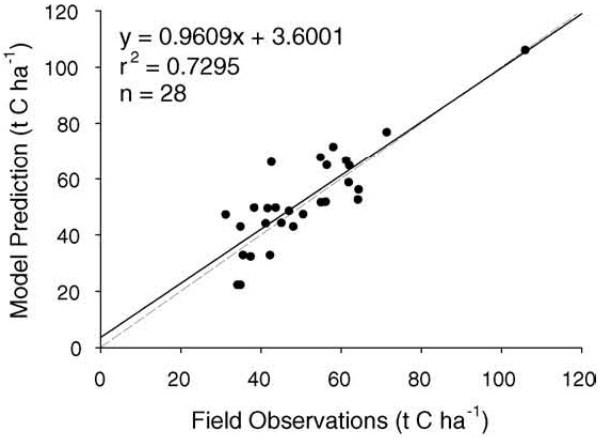
601 **Tier 1** - Double-check that correct default values were used.

602 **Tier 2** - Double-check data sheets against local data sources used for activity data, emissions factors, and other
603 variables.

604 **Tier 3** - Validate computer models against field measurements and include the error in the calculation of
605 uncertainty (Section 7.2.1). The validation measure can be a correlation of predicted and measured values
606 (Figure 7.2; Miehle et al. 2006), fractional agreement of modelled and observed data (Figure 7.3; Chadwick

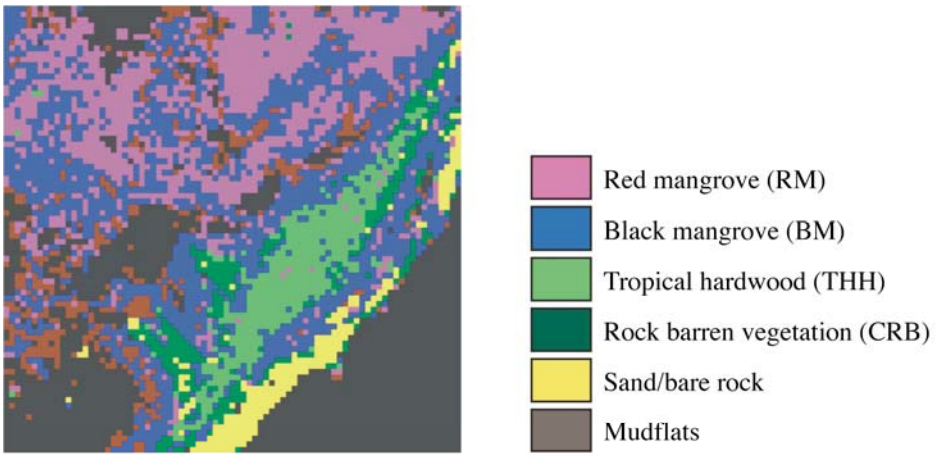
2011), or other variable. Separate the data set used for calibration of a model from the data set used for validation of the model. It is *good practice* to establish a system of repeated monitoring of permanent plots or benchmark sites for continued validation of model output against field data over time. When more than one model is available for a particular parameter, inter-comparison of model output can provide indications of the robustness of individual model output. Furthermore, comparison of Tier 3 models with estimates using Tier 1 and Tier 2 methods can serve that same purpose. IPCC (2011) provides numerous specific examples of model development, calibration, and validation.

Figure 7.2 Example of validation of a model for quality control



Values of aboveground biomass derived from field measurements of *Eucalyptus globulus* in Australia (x-axis) provide data to validate the accuracy of output from the Forest-Denitrification decomposition (DNDC) model (y-axis) (Miehle et al., 2006). The correlation coefficient (r) and significance probability (not shown) are validation measures of the model. More observed values and a wider range of carbon densities would improve the validation.

Figure 7.3 Example of validation of remote sensing data for quality control



Class	RM	BM	THH	CRB	Sand/ Rock	Mudflats	Asphalt	Omission (%)
(*a*) IKONOS classification: overall accuracy = 83.3%; kappa coefficient = 0.79								
RM	**82.0**	10.3	6.2	0.43	0	1.1	0	18.0
BM	3.6	**77.6**	2.3	9.9	0.33	6.3	0	22.4
THH	7.1	6.9	**73.8**	11.7	0.48	0	0	26.2
CRB	0	3.3	1.3	**93.4**	2.0	0	0	6.6
Sand/Rock	0	0	0	0	**100**	0	0	0
Mudflat	1.5	1.5	0	1.4	6.0	**89.6**	0	10.5
Asphalt	0	0	0	0	13.51	0	**86.5**	13.5
Commission (%)	9.9	27.2	11.4	22.3	10.3	28.6	0	

The map shows wetlands cover in Florida, USA derived from an Ikonos satellite image (Chadwick 2011). The table is an error matrix that shows the fraction of pixels (%) where the Ikonos-derived wetlands cover class (columns) matches the class directly observed in the field (rows). The overall accuracy (83%) is the validation measure. The column "omission" gives the fraction of observed pixels that the Ikonos

625 cover classification missed. The row “commission” gives the fraction of Ikonos-derived wetlands cover pixels that the classification
626 incorrectly identified.

627

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ANNEX 7A.1

WORKSHEETS

This annex provides worksheets that can be used to estimate greenhouse gas emissions and removals based on Tier 1 methods given in the *Wetlands Supplement*. Most of the worksheets included in this annex are new ones that are not included in Annex 1, Volume 4 of the *2006 IPCC Guidelines*. However, the following 6 worksheets are to update or replace the existing worksheets in Annex 1, Volume 4 of the *2006 IPCC Guidelines*.

- Worksheet for Land Remaining in a Land-use Category or Land Converted to a New Land-use Category: Annual On-site Carbon Emissions and Removals from Drained Inland Organic Soils (Page 7.22)

  This sheet is to replace the existing worksheets for Annual Change in Carbon Stocks in Organic Soils for the six land-use categories (e.g., existing worksheets on pages A1.23 and A1.27, Annex 1, Volume 4) in the *2006 IPCC Guidelines*.

- Worksheet for Direct N_2O Emissions from Managed Soils (Page 7.25)

  This sheet is to update the existing worksheet for Direct N_2O Emissions from Managed Soils on page A1.58, Annex 1, Volume 4 of the *2006 IPCC Guidelines*. The changes from the existing worksheet are highlighted in red font.

- Worksheet for Cropland Remaining Cropland: Annual change in carbon stocks in mineral soils (Page 7.41)

  This sheet is to update the existing worksheet for Annual Change in Carbon Stocks in Mineral Soils for Cropland Remaining Cropland on page A1.22, Annex 1, Volume 4 of the *2006 IPCC Guidelines*. The changes from the existing worksheet are highlighted in red font.

- Worksheet for Land (non-Cropland) remaininng in a Land-use Category: Annual change in carbon stocks in mineral soils (Page 7.42)

  This sheet is to update the existing worksheets for Annual Change in Carbon Stocks in Mineral Soils for land remaining in the same land-use category for land-use category other than Cropland (e.g., existing worksheet on page A1.28, Annex 1, Volume 4) in the *2006 IPCC Guidelines*. The changes from the existing worksheet are highlighted in red font.

- Worksheet for Land Converted to a Cropland: Annual change in carbon stocks in mineral soils (Pages 7.43-7.44)

  This sheet is to update the existing worksheet on Annual Change in Carbon Stocks in Mineral Soils for Land Converted to Cropland on page A1.26 Annex 1, Volume 4 of the *2006 IPCC Guidelines*. The changes from the existing worksheet are highlighted in red font.

- Worksheet for Land Converted to a New Land-use Category (non-Cropland): Annual change in carbon stocks in mineral soils (Page 7.45)

  This sheet is to update the existing worksheets for Annual Change in Carbon Stocks in Mineral Soils for land converted to a new land use category other than Cropland (e.g., existing worksheet on page A1.32, Annex 1, Volume 4) in the *2006 IPCC Guidelines*. The changes from the existing worksheet are highlighted in red font.

CHAPTER 2—DRAINED INLAND ORGANIC SOILS

Sector		**Agriculture, Forestry and Other Land Use**			
Category		**Land Remaining in a Land-use Category OR Land Converted to a New Land-use Category : Annual On-site Carbon Emissions and Removals from Drained Inland Organic Soils**			
Category code		**TO BE DECIDED**			
Sheet		**2 of 3 (earlier was 2 of 2)**			
Equation		**Equation 2.2 (2006 IPCC Guidelines)**	**Equation 2.3 (Wetlands Supplement)**		
Land-use category		Subcategories for reporting year	Land area of drained inland organic soils in a land-use category in climate domain c, nutrient status n, and drainage class d, ha	Emission factors for drained inland organic soils, by climate domain c, nutrient status n, and drainage class d, tonnes C ha^{-1} yr^{-1} [1]	Annual on-site CO_2-C emissions/removals from drained inland organic soils
Initial land use[2]	Land use during reporting year		(ha)	(tonnes C ha^{-1} yr^{-1})	(tonnes C yr^{-1})
				Table 2.1 of the Wetlands Supplement	**CO_2-$C_{soil\text{-}onsite}$ = A * EF**
			A	**EF**	**CO_2-$C_{soil\text{-}onsite}$**
		(a)			
		(b)			
		(c)			
Total					

[1] Sub-totals of emissions for each land pre-conversion land-use category will have to be calculated for conversion categories.

[2] For conversion categories, if data by initial land use are not available, use only "non-LU" in this column.

766

Sector		**Agriculture, Forestry and Other Land Use**			
Category		**Land Remaining in a Land-use Category OR Land Converted to a New Land-use Category : Annual Off-site Emissions from Drained Inland Organic Soils**			
Category code		**TO BE DECIDED**			
Sheet		**3 of 3**			
Equation		**Equation 2.2 (2006 IPCC Guidelines)**	**Equation 2.5 (Wetlands Supplement)**		
Land-use category		Subcategories for reporting year	Land area of drained inland organic soils in a land-use category in climate zone c and nutrient status n, ha	Emission factors for annual CO_2 emissions due to DOC export from drained inland organic soils, by climate zone c and nutrient status n	Annual off-site CO_2-C emissions from drained inland organic soils
Initial land use	Land use during reporting year		(ha)	(tonnes C ha^{-1} yr^{-1})	(tonnes C yr^{-1})
				Table 2.2 of the Wetlands Supplement	
			A	**EF**	**CO_2-C_{DOC} = A * EF**
		(a)			
		(b)			
		(c)			
Total					

767

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Sector		**Agriculture, Forestry and Other Land Use**					
Category		**Land Remaining in a Land-use Category OR Land Converted to a New Land-use Category[1]: Annual CH_4-C Emissions from Drained Inland Organic Soils**					
Category code		**TO BE DECIDED**					
Sheet		**1 of 1**					
Equation		**Equation 2.2 (2006 IPCC Guidelines)**	**Equation 2.6 (Wetlands Supplement)**				
Land-use category		Subcategories for reporting year	Land area of drained inland organic soils in a land-use category in climate zone c, nutrient status n and peatland type p, ha	Fraction of the total area of drained inland organic soil which is occupied by ditches	Emission factors for direct CH_4 emissions from drained organic soils, by climate zone c and nutrient status n,	Emission factors for CH_4 emissions from drainage ditches, by climate zone c and peatland type p,	Annual CH_4-C loss from drained inland organic soils
Initial land use[2]	Land use during reporting year		(ha)	(dimensionless)	(tonnes CH_4-C ha^{-1} yr^{-1})	(tonnes CH_4-C ha^{-1} yr^{-1})	(tonnes CH_4-C yr^{-1})
					Table 2.3 of the Wetlands Supplement	Table 2.4 of the Wetlands Supplement	
			A	$Frac_{ditch}$	EF_{CH4_land}	EF_{CH4_ditch}	$CH_4\text{-}C_{organic} = A * [(1-Frac_{ditch})*EF_{CH4\_land} + Frac_{ditch}*EF_{CH4\_ditch}]$
		(a)					
		(b)					
		(c)					
Total							

[1] Sub-totals of emissions for each land pre-conversion land-use category will have to be calculated for conversion categories.

[2] For conversion categories, if data by initial land use are not available, use only "non-LU" in this column.

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Sector		**Agriculture, Forestry and Other Land Use**						
Category		**Direct N_2O Emissions from Managed Soils**						
Category code		**3C4**						
Sheet		**2 of 2**						
Equation		**Equation 11.1 of 2006 IPCC Guidelines and Equation 2.7 of the Wetlands Supplement**						
Anthropogenic N input type[1,2]		Annual area of managed/drained organic soils	Emission factor for N_2O emissions from drained/managed organic soils	Annual direct N_2O-N emissions produced from managed organic soils	Amount of urine and dung N deposited by grazing animals on pasture, range and paddock	Emission factor for N_2O emissions from urine and dung N deposited on pasture, range and paddock by grazing animals	Annual direct N_2O emissions from urine and dung inputs to grazed soils	Annual direct N_2O emissions from urine and dung inputs to grazed soils
		(ha)	(kg N_2O-N ha^{-1} yr^{-1})	(kg N_2O-N yr^{-1})	(kg N yr^{-1})	[kg N_2O-N (kg N input)$^{-1}$]	(kg N_2O-N yr^{-1})	(kg N_2O-N yr^{-1})
			Table 11.1 (2006 IPCC Guidelines) and Table 2.5 (Wetlands Supplement)	$N_2O\text{-}N_{OS} = F_{OS} * EF_2$		Table 11.1	$N_2O\text{-}N_{PRP} = F_{PRP} * EF_{3PRP}$	$N_2O_{Direct}\text{-}N = N_2O\text{-}N_{N\ input} + N_2O\text{-}N_{OS} + N_2O\text{-}N_{PRP}$
		F_{OS}	**EF_2**	**$N_2O\text{-}N_{OS}$**	**F_{PRP}**	**EF_{3PRP}**	**$N_2O\text{-}N_{PRP}$**	**$N_2O_{Direct}\text{-}N$**
Managed organic soils	CG, Temp							
	CG, Trop							
	F, Temp, NR							
	F, Temp, NP							
	F, Trop							
Urine and dung inputs to grazed soils	CPP							
	SO							
Total								

[1] The area must be disaggregated by Cropland and Grassland (CG), Forest (F), Temperate (Temp), Tropical (Trop), Nutrient Rich (NR), and Nutrient Poor (NP) categories, respectively, see Equation 11.1.

[2] The amount must be disaggregated by CPP and SO, which refer to Cattle, Poultry and Pigs, and Sheep and Other animals, respectively. See Equation 11.1.

[3] The Equations 11.1 in the 2006 IPCC Guidelines can be modified to suit boreal conditions as well by adding terms $F_{OS,\ CG\ Bor\ NR}$; $F_{OS,\ CG,\ Bor\ NP;}$ $F_{OS,\ F,\ Bor,\ NR}$, and $F_{OS,\ F\ Bor\ NP}$ (the subscripts CG, F, Bor, NR and NP refer to Cropland and Grassland, Forest Land, Boreal, Nutrient-Rich, and Nutrient-Poor, respectively) and their respective emissions factors.

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Sector		**Agriculture, Forestry and Other Land Use**							
Category		**Emissions from Burning of Drained Inland Organic Soils in a Land-use Category (Land Remaining in a Land-use Category OR Land Converted to a New Land-use Category)**							
Category code		**TO BE DECIDED**							
Sheet		**1 of 1**							
Equation		**Equation 2.2 (2006 IPCC Guidelines)**	**Equation 2.8 (Wetlands Supplement)**						
Land-use category			Area burnt	Mass of fuel available for combustion[3]	Combustion factor[3]	Emission factor for each GHG		CO_2 emissions from fire	CH_4 emissions from fire	CO emissions from fire
Initial land use[1]	Land use during reporting year	Subcategories for reporting year[2]	(ha)	(tonnes ha^{-1})	(-)	[g GHG (kg dm burnt)$^{-1}$]		(tonnes CO_2)	(tonnes CH_4)	(tonnes CO)
				Table 2.6 of the Wetlands Supplement	Table 2.6 of the Wetlands Supplement	Table 2.7 of the Wetlands Supplement		L_{fire}-CO_2 = $A * M_B * C_f * G_{ef} * 10^{-3}$	L_{fire}-CH_4 = $A * M_B * C_f * G_{ef} * 10^{-3}$	L_{fire}-CO = A * MB * Cf * Gef * 10^{-3}
			A	**M_B**	**C_f**	**G_{ef}**		**L_{fire}-CO_2**	**L_{fire}-CH_4**	**L_{fire}-CO**
		(a)				CO_2				
						CH_4				
						CO				
		(b)				CO2				
						CH_4				
						CO				
Total						CO_2				
						CH_4				
						CO				

[1] For conversion categories, similar tables should be completed separately for each initial land use, and subtotals must be added up. If data by initial land use are not available, use only "non-LU" in this column.

[2] For each subcategory, use separate lines for each non-CO_2 greenhouse gas.

[3] Where data for M_B and C_f are not available, a default value for the amount of fuel actually burnt (M_B * C_f) can be used (Table2.6 of Wetlands Supplement). In this case, M_B takes the value taken from the table, whereas C_f must be 1.

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CHAPTER 3—CROSS-CUTTING GUIDANCE ON REWETTED ORGANIC SOILS AND RESTORED PEATLANDS

Sector		**Agriculture, Forestry and Other Land Use**						
Category		**Annual carbon emissions or removals in rewetted organic soils and peatlands**						
Category code		**TO BE DECIDED**						
Sheet		**1 of 2 : CO_2-C**						
Equation				**Equation 3.3 (*Wetlands Supplement*)**		**Equation 3.4 (*Wetlands Supplement*)**		**Equation 3.2 (Wetlands Supplement)**
Land-use category		Subcategories for reporting year	Area of rewetted peatland or organic soil by peatland and climate type	Emission/removal factor for on-site CO2-C by peatland and climate type	On-site CO_2-C emissions or removals in rewetted organic soils	Emission factor for DOC	Off-site CO_2-C emissions from DOC in rewetted organic soils	Annual CO_2-C emissions or removals by rewetted peatlands and organic soils
Initial land use	Land use during reporting year		(ha)	(tonnes CO_2-C ha^{-1} yr^{-1})	(tonnes CO_2-C yr^{-1})	(tonnes CO_2-C ha^{-1} yr^{-1})	(tonnes CO_2-C yr^{-1})	(tonnes CO_2-C yr^{-1})
				Table 3. 1	**= A * EF_{CO2}**	Table 3. 2	**= A * $EF_{DOC\_REWETTED}$**	**= CO2-$C_{composite}$ + CO2-C_{DOC}**
			A	**EF_{CO2}**	**CO_2-$C_{composite}$**	**$EF_{DOC\_REWETTED}$**	**CO_2-C_{DOC}**	CO_2-**$C_{rewetted\ org\ soil}$**
		(a)						
		(b)						
		(c)						
Total								

779

Sector		**Agriculture, Forestry and Other Land Use**			
Category		**Annual carbon emissions or removals in rewetted organic soils and peatlands**			
Category code		**TO BE DECIDED**			
Sheet		**2 of 2 : CH_4-C**			
Equation				**Equation 3.7 (*Wetlands Supplement*)**	
Land-use category		Subcategories for reporting year	Area of rewetted peatland or organic soil by peatland and climate type	Emission factor for CH_4-C by peatland and climate type	On-site CH_4-C emissions or removals in rewetted organic soils
Initial land use	Land use during reporting year		(ha)	(tonnes CH_4-C ha^{-1} yr^{-1})	(tonnes CH_4-C yr^{-1})
				Table 3. 3	**= A * EF_{Ch4}**
			A	**EF_{CH4}**	**CH_4-C_{soil}**
		(a)			
		(b)			
		(c)			
Total					

780

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782 **CHAPTER 4—COASTAL WETLANDS**

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Sector		**Agriculture, Forestry and Other Land Use**						
Category		**Coastal wetland with forest or Forest Land**						
Category code		**TO BE DECIDED**						
Sheet		**1 of 5**						
Equation			**Equation 2.9 (*2006 IPCC Guidelines*)**	**Equation 2.10 (*2006 IPCC Guidelines*)**			**Equation 2.9 (*2006 IPCC Guidelines*)**	
Land-use category		Subcategories for reporting year	Area	Average annual above-ground biomass growth	Ratio of below-ground biomass to above-ground biomass	Average annual biomass growth above- and below-ground	Carbon fraction of dry matter	Annual increase in biomass carbon stocks due to biomass growth
Initial land use	Land use during reporting year		(ha)	(tonnes dm ha^{-1} yr^{-1})	[tonnes bg dm (tonne ag dm)$^{-1}$]	(tonnes dm ha^{-1} yr^{-1})	[tonnes C (tonne dm)$^{-1}$]	(tonnes C yr^{-1})
			National statistics or international data sources	Table 4.5	Table 4.6	G_{TOTAL} = GW * (1+R)	Table 4.3	$\Delta C_G = A * G_{TOTAL} * CF$
			A	**G_W**	**R**	**G_{TOTAL}**	**CF**	**ΔC_G**
		(a)						
		(b)						
		(c)						
Total								

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Sector		**Agriculture, Forestry and Other Land Use**					
Category		**Coastal wetland with forest or Forest Land : Loss of carbon from wood removals**					
Category code		**TO BE DECIDED**					
Sheet		**2 of 5**					
Equation			**Equation 2.12 (*2006 IPCC Guidelines*)**				
Land-use category		Subcategories for reporting year	Annual wood removal	Biomass expansion factor and wood density for conversion of removals in merchantable volume to total biomass removals (including bark)	Ratio of below-ground biomass to above-ground biomass	Carbon fraction of dry matter	Annual carbon loss due to biomass removals
Initial land use	Land use during reporting year		(m^3 yr^{-1})	BEF * wood density = [tonnes of biomass removals (m^3 of removals) $^{-1}$]	[tonnes bg dm (tonne ag dm)$^{-1}$]	[tonnes C (tonne dm)$^{-1}$]	(tonnes C yr^{-1})
			National statistics or international data sources	Table 3A.1.10 (*2003 GPG*) and Table 4.7	Table 4.6	Table 4.3	$L_{wood\text{-}removals}$ = H * $BCEF_R$ * (1+R) * CF
			H	**BCEF**	**R**	**CF**	**$L_{wood\text{-}removals}$**
		(a)					
		(b)					
		(c)					
Total							

787

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Sector		**Agriculture, Forestry and Other Land Use**							
Category		**Coastal wetland with forest or Forest Land: Loss of carbon from fuelwood removals**							
Category code		**TO BE DECIDED**							
Sheet		**3 of 5**							
Equation		**Equation 2.2 (*2006 IPCC Guidelines*)**	**Equation 2.13 (*2006 IPCC Guidelines*)**						
Land-use category		Subcategories for reporting year	Annual volume of fuelwood removal of whole trees	Biomass expansion factor and wood density for conversion of removals in merchantable volume to total biomass removals (including bark)	Ratio of below-ground biomass to above-ground biomass	Annual volume of fuelwood removal as tree parts	Basic wood density	Carbon fraction of dry matter	Annual carbon loss due to fuelwood removal
Initial land use	Land use during reporting year		(m^3 yr^{-1})	BEF * wood density = [tonnes of biomass removals (m^3 of removals) $^{-1}$]	[tonnes bg dm (tonne ag dm)$^{-1}$]	(m^3 yr^{-1})	tonnes m^{-3}	[tonnes C (tonne dm)$^{-1}$]	(tonnes C yr^{-1})
			FAO or other statistics	Table 3A.1.10 (*2003 GPG*) and Table 4.7	Table 4.6	FAO or other statistics	Table 4.7	Table 4.3	$L_{fuelwood}$ = [FG_{trees} * $BCEF_R$ * (1+R) + FG_{part} * D] * CF
			FG_{trees}	**BCEF**	**R**	**FG_{part}**	**D**	**CF**	**$L_{fuelwood}$**
		(a)							
		(b)							
		(c)							
Total									

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Sector	Agriculture, Forestry and Other Land Use						
Category	Coastal wetland with forest or Forest Land: Loss of carbon from disturbance						
Category code	TO BE DECIDED						
Sheet	4 of 5						
Equation		**Equation 2.14 (*2006 IPCC Guidelines*)**					**Equation 2.11 (*2006 IPCC Guidelines*)**
Land-use category		Area affected by disturbances[1]	Average above-ground biomass of areas affected	Ratio of below-ground biomass to above-ground biomass	Carbon fraction of dry matter	Annual other losses of carbon	Annual decrease in carbon stocks due to biomass loss
Initial land use	Land use during reporting year	(ha)	(tonnes dm ha^{-1})	[tonnes bg dm (tonne ag dm)$^{-1}$]	[tonnes C (tonne dm)$^{-1}$]	(tonnes C yr^{-1})	(tonnes C yr^{-1})
		National statistics or international data sources	Table 4.4	Table 4.6	Table 4.3	$L_{disturbances} = A * B_W * (1+R) * CF * fd$	$\Delta C_L = L_{wood-removals} + L_{fuelwood} + L_{disturbances}$
		$A_{disturbance}$	**B_W**	**R**	**CF**	**$L_{disturbances}$**	**ΔC_L**
	(a)						
	(b)						
	(c)						
Total							

Note: fd = fraction of biomass lost in disturbance (eg. aquaculture, salt production, extraction); a stand-replacing disturbance will kill all (fd = 1) biomass while an insect disturbance may only remove a portion (e.g. fd = 0.3) of the average biomass C density.

[1]in year of start of aquaculture, salt production or extraction activity

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Sector		**Agriculture, Forestry and Other Land Use**								
Category		**Coastal wetland with tidal marsh or seagrass meadow or non-Forest Land category (for aquaculture, salt production and extraction-D and extraction-I for seagrass meadow only)**								
Category code		**TO BE DECIDED**								
Sheet		**5 of 5**								
Equation			**Equation 2.8 (*2006 IPCC Guidelines*)**							
Land-use category		Sub-categories for reporting year	Area	Average annual above-ground biomass stock after disturbance	Average annual above-ground biomass stock before disturbance	Ratio of below-ground biomass to above-ground biomass for seagrass	Average annual below-ground biomass stock before disturbance for tidal marsh	Average annual biomass stock above- and below-ground - tidal marsh	Carbon fraction of dry matter - seagrass meadow	Annual change in carbon stocks in biomass (tidal marsh and seagrass meadow)
Initial land use	Land use during reporting year		(ha)	(tonnes dm ha^{-1})	(tonnes dm ha^{-1})	[tonnes bg dm (tonne ag dm)$^{-1}$]	(tonnes dm ha^{-1})	(tonnes dm ha^{-1} yr^{-1})	[tonnes C (tonne dm)$^{-1}$]	(tonnes C yr^{-1})
			National statistics or international data sources	**0**	Tables 4.8 (tidal marsh), 4.9 (seagrass meadow)	Table 4.6	Tables 4.8 (tidal marsh)	C_{TOTAL} = (0 - AG-B_{BEFORE} + BG-B_{BEFORE})/(t_2-t_1)	Table 4.11	$\Delta C_{B\ (tidal\ marsh)}$ = (A * C_{TOTAL}) or $\Delta C_{B\ (seagrass\ meadow)}$ = (0 - AG-B_{BEFORE}/t_2-t_1) * (1 + R_{SG}) * CF
			A	**0**	**AG-B_{BEFORE}**	**R_{SG}**	**BG-B_{BEFORE}**	**C_{TOTAL}**	**CF**	**ΔC_{TOTAL}**
		(a)								
		(b)								
		(c)								
Total										
SG=seagrass meadow										

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Sector		**Agriculture, Forestry and Other Land Use**				
Category		**Coastal wetland with forest or Forest Land (for aquaculture, salt production and extraction-D)**				
Category code		**TO BE DECIDED**				
Sheet		**1 of 1**				
Equation			**Equation 2.18 or 2.19 (*2006 IPCC Guidelines*)**			
Land-use category		Subcategories for reporting year	Area under aquaculture, salt production or extraction	Dead wood/litter stock after disturbance	Dead wood/litter stock before disturbance	Annual change in carbon stocks in biomass (tidal marsh and seagrass meadow)
Initial land use	Land use during reporting year		(ha)	(tonnes C ha^{-1})	(tonnes C ha^{-1})	(tonnes C yr^{-1})
			National statistics or international data sources	**0**	Table 4.13	$\Delta C_{DOM} = (0 - DOM_{out})/(t_2 - t_1)$
			A	**0**	**DOM_{out}**	**ΔC_{DOM}**
		(a)				
		(b)				
		(c)				
Total						

799

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Sector	Agriculture, Forestry and Other Land Use											
Category	CO_2-C emissions from managed coastal wetlands (AQ, SP)											
Category code	TO BE DECIDED											
Sheet	1 of 4											
Equation		Equation 4.2 (*Wetlands Supplement*)										
Land-use category		Area of land in the construction/ extraction phase in aquaculture	Emission factors for CO_2-C at in year of construction/ extraction in aquaculture	Area of land in the construction/extraction phase in salt production	Emission factors for CO_2-C at in year of constructio n/extraction in salt production	Area of land in the use phase	Emission factors for CO_2-C in use phase	Area of land in the abandon-ment phase in aquaculture	Emission factors for CO_2-C in abandon-ment phase in aqua-culture	Area of land in the abandonm ent phase in salt production	Emission factors for CO_2-C in abandonme nt phase in salt production	CO_2-C emission s from AQ, SP
Initial land use	Land use during report-ing year	Sub-categories for reporting year (ecosystem type)	(ha)	(tonnes C ha^{-1})	(ha)	(tonnes C ha^{-1})	(ha)	(tonnes C ha^{-1} yr^{-1})	(ha)	(tonnes C ha^{-1} yr^{-1})	(ha)	(tonnes C ha^{-1} yr^{-1})	Gg C yr^{-1}
				Table 4.15 or Table 4.16 (organic or mineral soil)		Table 4.15 or Table 4.16 (organic or mineral soil)		Table 4.17 (mineral and organic soil)		Table 4.18 (mineral and organic soil)		Table 4.18 (mineral and organic soil)	[a]CO_2-$C_{soil\text{-}AQ,\ SP}$ = $\sum i(A_{CONSTRi} * EF_{CONSTRi} + A_{USEi} * EF_{USEi} + A_{ABANDi} * EF_{ABANDi}) * 10^{-3}$
			AQ-A_{CONSTR}	**AQ-EF_{CONSTR}**	**SP-A_{CONSTR}**	**SP-EF_{CONSTR}**	**AQ-A_{USE}**	**AQ-EF_{USE}**	**AQ-A_{ABAN}**	**AQ-EF_{ABAN}**	**SP-A_{ABAN}**	**SP-EF_{ABAN}**	**CO_2-$C_{soil\text{-}AQ,\ SP}$**
		Mangrove forest											
		Tidal Marsh											
		Seagrass Meadow											
Total													

[a]sums the emissions for all relevant phases for each activity (i) - aquaculture or salt production

Note: black fill indicates where emissions are not reported at Tier 1

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Sector	Agriculture, Forestry and Other Land Use					
Category	CO_2-C emissions from managed coastal wetlands (EXT)					
Category code	TO BE DECIDED					
Sheet	2 of 4					
Equation		Equation 4.2 (*Wetlands Supplement*)				
Land-use category		Subcategories for reporting year (ecosystem type)	Area of land under direct extraction	Emission factors for CO_2-C under direct extraction	Area of land under indirect extraction	Emission factors for CO_2-C under indirect extraction	CO_2-C emissions from EXT-D,EXT-I
Initial land use	Land use during reporting year		(ha)	(tonnes C ha^{-1})	(ha)	(tonnes C ha^{-1})	Gg C yr^{-1}
				Table 4.15 (organic soil) or Table 4.16 (mineral soil)[a]		Table 4.15 (organic soil) or Table 4.16 (mineral soil)[a]	[b]CO_2-$C_{soil-EXT-D,EXT-I}$ = (EXT-D-A * EXT-D-EF + EXT-I-A * EXT-I-EF) * 10^{-3}
			EXT-D-A	**EXT-D-EF**	**EXT-I-A**	**EXT-I-EF**	**CO_2-$C_{soil-EXT-D,EXT-I}$**
		Mangrove forest					
		Tidal Marsh					
		Seagrass Meadow					
Total							

[a]organic and mineral soils are reported separately for EXT

[b]sums the emissions for direct and indirect EXT

Note: black fill indicates where emissions are not reported at Tier 1

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Sector		**Agriculture, Forestry and Other Land Use**					
Category		**CO_2-C emissions from managed coastal wetlands (HARV[1], NUTR[2], DIV[3])**					
Category code		**TO BE DECIDED**					
Sheet		**3 of 4**					
Equation			**Equation 2.6 (*2006 IPCC Guidelines*)**				
Land-use category		Subcategories for reporting year (ecosystem type)	Area of land in harvesting of aquatic resources	Emission factors for CO_2-C in harvesting of aquatic resources	Area of land in in nutrient enrichment	Emission factors for CO_2-C in nutrient enrichment	CO_2-C emissions from HARV, NUTR, DIV[3]
Initial land use	Land use during reporting year		(ha)	(tonnes C ha^{-1} yr^{-1})	(ha)	(tonnes C ha^{-1} yr^{-1})	Gg C yr^{-1}
				Table 4.18		Table 4.19	$CO_2\text{-}C_{soil\text{-}HARV,\ EXT} = (A_{HARV} * EF_{HARV} + A_{NUTR} * EF_{NUTR} + A_{DIV} * EF_{DIV}) * 10^{-3}$
			A_{HARV}	**EF_{HARV}**	**A_{NUTR}**	**EF_{NUTR}**	**$CO_2\text{-}C_{soil\text{-}HARV,\ EXT}$**
		Mangrove forest					
		Tidal Marsh					
		Seagrass Meadow					
Total							

[1] $CO_2\text{-}C_{SO\text{-}HARV}$ applies in the case of mangrove forest only; CO_2-C emissions = 0 in tidal marsh and seagrass meadow

[2] $CO_2\text{-}C_{SO\text{-}NUTR}$ applies in the case of seagrass meadow only; CO_2-C emissions = 0 for mangrove forest and tidal marsh

[3] $CO_2\text{-}C_{SO\text{-}DIV}$ is NA for seagrass meadown and CO_2-C emissions = 0 for mangrove forest and tidal marsh

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Sector		**Agriculture, Forestry and Other Land Use**					
Category		**CO_2-C emissions from managed coastal wetlands (DR[1], RES/CRE)**					
Category code		**TO BE DECIDED**					
Sheet		**4 of 4**					
Equation			**Equation 4.3 (*Wetlands Supplement*)**		**Equation 4.4 (*Wetlands Supplement*)**		
Land-use category		Subcategories for reporting year (ecosystem type)	Area of land in drainage	Emission factors for CO_2-C in drainage	Area of land in restoration/creation	Emission factors for CO_2-C in restoration/creation	CO_2-C emissions from DR & RES/CRE
Initial land use	Land use during reporting year		(ha)	(tonnes C ha^{-1} yr^{-1})	(ha)	(tonnes C ha^{-1} yr^{-1})	Gg C yr^{-1}
				Table 4.20		Table 4.21	$CO_2\text{-}C_{soil\text{-}DR,\ RES/CRE} = [(A_{DR} * EF_{DR}) + (A_{RES/CRE} * EF_{RES/CRE})] * 10^{-3}$
			A_{DR}	**EF_{DR}**	**$A_{RES/CRE}$**	**$EF_{RES/CRE}$**	**$CO_2\text{-}C_{soil\text{-}DR} + CO_2\text{-}C_{soil\text{-}RES/CRE}$**
		Mangrove forest					
		Tidal Marsh					
		Seagrass Meadow					
Total							

[1] $CO_2\text{-}C_{SO\text{-}DR}$ only applies in the case of mangrove forest and tidal marsh only; NA in seagrass meadow

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Sector	**Agriculture, Forestry and Other Land Use**		
Category	**N_2O emissions from aquaculture use**		
Category code	**TO BE DECIDED**		
Sheet	**1 of 2**		
		Equation 2.6 (*2006 IPCC Guidelines*)	
Anthropogenic N input to estimate annual direct N_2O-N emissions produced from aquaculture	Amount of fish production (F) or N applied (I)[a]	Emission factor for N2O emissions from fish produced (F) or N applied (I) in aquaculture use	Annual N2O emissions from aquaculture use
	(kg N yr-1)	[kg N2O-N (kg fish)-1] or [kg N2O-N (kg N input)-1]	(kg N_2O yr^{-1})
		Table 4.23	N_2O-N_{AQ} = F * EF
	F_F or F_I	**$EF_{F\ or}\ EF_I$**	**N_2O_{AQ}**
Total			

[a]choice of factor and EF depends on available data; when both types are available, use amount applied

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Sector		**Agriculture, Forestry and Other Land Use**			
Category		**N_2O emissions from nutrient enrichment due to aquaculture effluent**			
Category code		**TO BE DECIDED**			
Sheet		**2 of 2**			
			Equation 2.6 (*2006 IPCC Guidelines*)		
Land-use category		Subcategories for reporting year	Area of land under aquaculture effluent	Emission factor for nutrient enrichment due to aquaculture effluent	Annual N2O emissions from aquaculture effluent
Initial land use	Land use during reporting year		(ha)	(kg N_2O-N ha^{-1} yr^{-1})	(kg N_2O yr^{-1})
				Table 4.25 (organic and mineral soils)	N_2O_{NUTR} = (A * EF_{N2O})
			A	**EF_{N2O}**	**N_2O_{NUTR}**
		Mangrove forest			
		Tidal marsh			
		Seagrass meadow			
Total					

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Sector		**Agriculture, Forestry and Other Land Use**			
Category		**CH_4 emissions from nutrient enrichment**			
Category code		**TO BE DECIDED**			
Sheet		**1 of 2**			
			Equation 2.6 (*2006 IPCC Guidelines*)		
Land-use category		Subcategories for reporting year	Area of land under nutrient enrichment	Emission factor for nutrient enrichment	Annual CH_4 emissions from nutrient enrichment
Initial land use	Land use during reporting year		(ha)	(tonnes CH_4-C ha^{-1} yr^{-1})	(tonnes CH_4 yr^{-1})
				Table 4.24 (organic and mineral soils)	$CH_{4NUTR} = (A * EF_{CH4})$
			A	**EF_{CH4}**	**CH_{4NUTR}**
		Mangrove forest			
		Tidal marsh			
		Seagrass meadow			
Total					

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Sector		**Agriculture, Forestry and Other Land Use**			
Category		**CH_4 emissions from restoration/creation**			
Category code		**TO BE DECIDED**			
Sheet		**2 of 2**			
			Equation 2.6 (*2006 IPCC Guidelines*)		
Land-use category		Subcategories for reporting year	Area of land under restoration/creation	Emission factor for restoration/creation	Annual CH_4 emissions from restoration/creation
Initial land use	Land use during reporting year		(ha)	(tonnes CH_4-C ha^{-1} yr^{-1})	(tonnes CH_4 yr^{-1})
				Table 4.24 (organic and mineral soils)	$CH_{4NUTR} = (A * EF_{CH4})$
			A	**EF_{CH4}**	**CH_{4NUTR}**
		Mangrove forest			
		Tidal marsh[a]			
		Seagrass meadow			
Total					

[a]Disaggregated based on salinity type (tidal fresh, oligohaline/mesohaline, poyhaline)

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CHAPTER 5—INLAND WETLAND MINERAL SOILS

Sector	Agriculture, Forestry and Other Land Use										
Category	Cropland Remaining Cropland: Annual change in carbon stocks in mineral soils										
Category code	TO BE DECIDED										
Sheet	1 of 4										
Equation	Equation 2.2 (2006 IPCC Guidelines)	Equation 2.25, Formulation A in Box 2.1 of Section 2.3.3.1 (2006 IPCC Guidelines)									
Land-use category		Sub-categories for reporting year	Area in the last year of an inventory period	Area at the beginning of an inventory period	Reference carbon stock in the last year of an inventory period	Reference carbon stock at the beginning of an inventory period	Time dependence of stock change factors (D) or number of years over a single inventory time period (T)	Stock change factor for land-use system or sub-system	Stock change factor for management regime	Stock change factor for input of organic matter	Annual change in carbon stocks in mineral soils
Initial land use	Land use during reporting year		(ha)	(ha)	(tonnes C ha^{-1})	(tonnes C ha^{-1})	(yr)	(-)	(-)	(-)	(tonnes C yr^{-1})
					Table 2.3 of *2006 IPCC Guidelines* for non-IWMS; Table 5.2 of *Wetlands Supplement* for IWMS[1, 3]	Table 2.3 of *2006 IPCC Guidelines* for non-IWMS; Table 5.2 of *Wetlands Supplement for IWMS*[1, 3]	(default is 20 yr; if T>D then use the value of T)	Table 5.5 of *2006 IPCC Guidelines* for non-IWMS; Table 5.3 of Wetlands Supplement for IWMS[2,3]	Table 5.5 of *2006 IPCC Guidelines*	Table 5.5 of *2006 IPCC Guidelines*	$\Delta C_{Mineral}$ as in Equation 2.25 (*2006 IPCC Guidelines*)
			$A_{(0)}$	$A_{(0-T)}$	$SOC_{ref(0)}$	$SOC_{ref(T-0)}$	D	F_{LU}	F_{MG}	F_I	$\Delta C_{Mineral}$
$CL_{non-IWMS}$	$CL_{non-IWMS}$	(a)					20				
		(b)					20				
		(c)					20				
		Subtotal									
CL_{IWMS}	CL_{IWMS}	(a)					20				
		(b)					20				
		(c)					20				
		Subtotal									
Total											

[1] Table 5.2, Chapter 5 of the 2013 Wetlands Supplement contains the revised default reference SOC stocks (SOC_{REF}) for Inland Wetland Mineral Soils.

[2] Table 5.3, Chapter 5 of the 2013 Wetlands Supplement contains the new values of stock change factors for land-use (FLU) for Inland Wetland Mineral Soils.

[3] IWMS = Inland wetland mineral soils

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Sector	Agriculture, Forestry and Other Land Use									
Category	Land (non-Cropland) remaininng in a Land-use Category : Annual change in carbon stocks in mineral soils									
Category code	TO BE DECIDED									
Sheet	2 of 4									
Equation	Equation 2.2	Equation 2.25, Formulation A in Box 2.1 of Section 2.3.3.1								
Land-use category	Sub-categories for reporting year	Area in the last year of an inventory period	Area at the beginning of an inventory period	Reference carbon stock in the last year of an inventory period	Reference carbon stock at the beginning of an inventory period	Time dependence of stock change factors (D) or number of years over a single inventory time period (T)	Stock change factor for land-use system or sub-system	Stock change factor for management regime	Stock change factor for input of organic matter	Annual change in carbon stocks in mineral soils
Initial land use / Land use during reporting year		(ha)	(ha)	(tonnes C ha^{-1})	(tonnes C ha^{-1})	(yr)	(-)	(-)	(-)	(tonnes C yr^{-1})
				Table 2.3 of 2006 IPCC Guidelines for non-IWMS; Table 5.2 of Wetlands Supplement for IWMS[1, 2]	Table 2.3	(default is 20 yr; if T>D then use the value of T)	Table 5.5	Table 5.5	Table 5.5	$\Delta C_{Mineral}$ as in Equation 2.25
		$A_{(0)}$	$A_{(0-T)}$	$SOC_{ref(0)}$	$SOC_{ref(T-0)}$	D	F_{LU}	F_{MG}	F_I	$\Delta C_{Mineral}$
LU / LU	(a)					20				
	(b)					20				
	(c)					20				
Total										

[1] Table 5.2, Chapter 5 of the 2013 Wetlands Supplement contains the revised default reference SOC stocks (SOC_{REF}) for Inland Wetland Mineral Soils.

[2] IWMS = Inland wetland mineral soils

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Sector	Agriculture, Forestry and Other Land Use											
Category	Land Converted to a Cropland: Annual change in carbon stocks in mineral soils											
Category code	TO BE DECIDED											
Sheet	3 of 4											
Equation	Eq. 2.2 *(2006 IPCC Guidelines)*	Equation 2.25, Formulation B in Box 2.1 of Section 2.3.3.1 (*2006 IPCC Guidelines*)										
Land-use category		Subcategories of unique climate, soil, land-use change and management combinations	Area for land-use change by climate and soil combination	Reference carbon stock for the climate/soil combination	Time dependence of stock change factors (D) or number of years over a single inventory time period (T)	Stock change factor for land-use system in the last year of an inventory time period	Stock change factor for management regime in last year of an inventory period	Stock change factor for C input in the last year of the inventory period	Stock change factor for land-use system at the beginning of the inventory time period	Stock change factor for management regime at the beginning of the inventory time period	Stock change factor for C input at the beginning of the inventory time period	Annual change in carbon stocks in mineral soils
			(ha)	(tonnes C ha^{-1})	(yr)	(-)	(-)	(-)	(-)	(-)	(-)	(tonnes C yr^{-1})
Initial land use[1]	Land use during reporting year			Table 2.3; Chap 2, Sec. 2.3.3.1 of 2006 IPCC Guidelines & Table 5.2 of Wetlands Supplement for IWMS[2, 4]	(default is 20 yr; if T>D then use the value of T)	Table 5.5 of 2006 IPCC Guidelines & Table 5.3 of Wetlands Supplement for IWMS[3,4]	Table 5.5 of 2006 IPCC Guidelines	Table 5.5 of 2006 IPCC Guidelines	Table 5.10 of 2006 IPCC Guidelines	Table 5.10 of 2006 IPCC Guidelines	Table 5.10 of 2006 IPCC Guidelines	$\Delta C_{Mineral}$ as in Equation 2.25 (2006 IPCC Guidelines)
			$A_{(0)}$	SOC_{ref}	D	$F_{LU(0)}$	$F_{MG(0)}$	$F_{I(0)}$	$F_{LU(0-T)}$	$F_{MG(0-T)}$	$F_{I(0-T)}$	$\Delta C_{Mineral}$
FL	CL	(a)			20							
		(b)			20							
Sub-total												
GL	CL	(a)			20							
		(b)			20							
Sub-total												
WL	CL	(a)			20							
		(b)			20							
Sub-total												

SL	CL	(a)			20							
		(b)			20							
Sub-total												
OL	CL	(a)			20							
		(b)			20							
Sub-total												
Total												

[1] If data by initial land use are not available, use only "non-CL" in this column.

[2] Table 5.2, Chapter 5 of the 2013 Wetlands Supplement contains the revised default reference SOC stocks (SOC_{REF}) for Inland Wetland Mineral Soils.

[3] Table 5.3, Chapter 5 of the 2013 Wetlands Supplement contains new values of default stock change factors for land-use (F_{LU}) for Inland Wetland Mineral Soils.

[4] IWMS = Inland wetland mineral soils

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Sector	**Agriculture, Forestry and Other Land Use**											
Category	**Land Converted to a New Land-use Category (non-Cropland): Annual change in carbon stocks in mineral soils**											
Category code	**TO BE DECIDED**											
Sheet	**4 of 4**											
Equation	**Equation 2.2**	**Equation 2.25, Formulation B in Box 2.1 of Section 2.3.3.1**										
Land-use category		Subcategories of unique climate, soil, land-use change and management combinations	Area for land-use change by climate and soil comb-ination	Reference carbon stock for the climate and soil combination	Time dependence of stock change factors (D) or number of years over a single inventory time period (T)	Stock change factor for land-use system in the last year of an inventory time period	Stock change factor for management regime in last year of an inventory period	Stock change factor for C input in the last year of the inventory period	Stock change factor for land-use system at the beginning of inventory time period	Stock change factor for management regime at the beginning of the inventory time period	Stock change factor for C input at the beginning of the inventory time period	Annual change in carbon stocks in mineral soils
Initial land use[1]	Land use during reporting year		(ha)	(tonnes C ha^{-1})	(yr)	(-)	(-)	(-)	(-)	(-)	(-)	(tonnes C yr^{-1})
				Table 2.3; Chap. 2, Sec. 2.3.3.1 of 2006 IPCC Guidelines & Table 5.2 of Chapter 5 of the Wetlands Supplement for IWMS[2, 5]	(default is 20 yr; if T>D then use the value of T)	Table XX[4] of 2006 IPCC Guidelines	Table 6.2	Table 6.2	Table 5.5 and Table 5.3 of the Wetlands Supplement[3] (Cropland); 1 for other uses	Table 5.5 (Cropland); 1 for other uses	Table 5.5 (Cropland); 1 for other uses	$\Delta C_{Mineral}$ as in Equation 2.25
			$A_{(0)}$	**SOC_{ref}**	**D**	**$F_{LU(0)}$**	**$F_{MG(0)}$**	**$F_{I(0)}$**	**$F_{LU(0-T)}$**	**$F_{MG(0-T)}$**	**$F_{I(0-T)}$**	**$\Delta C_{Mineral}$**
L	non-CL	(a)			20							
		(b)			20							
		(c)			20							
Sub-total												
Total												

[1] If data by initial land use are not available, use only "non-GL" in this column.

[2] Table 5.2, Chapter 5 of the Wetlands Supplement contains the revised default reference SOC stocks (SOC_{REF}) for Inland Wetland Mineral Soils.

[3] Table 5.3, Chapter 5 of the Wetlands Supplement contains new values of default stock change factors for land-use (F_{LU}) for Inland Wetland Mineral Soils.

[4] Relevant tables from the Land-use category Chapters in the 2006 IPCC Guidelines

[5] IWMS = Inland wetland mineral soils

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Sector		**Agriculture Forestry and Other Land Use (AFOLU)**		
Category		**Annual CH4 emissions from restored and created wetlands on managed lands with IWMS[1]**		
Category code		**TO BE DECIDED**		
Sheet		**1 of 1**		
Equation		**Eq. 2.2 (*2006 IPCC Guidelines*)**	**Equation 5.1 *(Wetlands Supplement)***	
Initial land use	Land use during reporting year	Subcate-gories for reporting year[2]	Area of managed lands with IWMS	Emission factor from managed lands with IWMS where water level has been raised in climate region
			(ha)	(kg CH_4 ha^{-1} yr^{-1})
				Table 5.4 (*Wetlands Supplement*)
			A_{IWMS}	**$EF_{CH4-IWMS}$**
		(a)		
		(b)		
		(c)		
Total				

[1] IWMS = Inland wetland mineral soils

[2] Can be stratified according to climate domains for Tier 1 methods.

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CHAPTER 6—CONSTRUCTED WETLANDS—WASTEWATER TREATMENT

Sector	**Waste**
Category	**Domestic Wastewater Treatment and Discharge**
Category Code	**4D1**
Sheet	**1 of 3 Estimation of Organically Degradable Material in Domestic Wastewater Treated in Constructed Wetlands**

STEP 1

Type of constructed wetland	A Population whose wastewater treated in constructed wetlands (P) cap	B Degradable organic component (BOD) (kg BOD/cap/yr) [1]	C Correction factor for industrial BOD discharged in sewers (I) [2]	D Organically degradable material in wastewater (TOW) (kg BOD/yr) D = A x B x C
Surface Flow				
Vertical Subsurface Flow				
Horizontal Subsurface Flow				
			Total	

1 g BOD/cap/day x 0.001 x 365 = kg BOD/cap/yr

2 Correction factor for additional industrial BOD discharged into sewers, (for collected the default is 1.25, for uncollected the default is 1.00) (see page 6.14).

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Sector	**Waste**		
Category	**Domestic Wastewater Treatment and Discharge**		
Category Code	**4D1**		
Sheet	**2 of 3 Estimation of CH_4 Emission Factor for Domestic Wastewater Treated in Constructed Wetlands**		
STEP 2			
Type of constructed wetland	A Maximum methane producing capacity (B_0) (kg CH_4/kg BOD)	B Methane correction factor (MCF_j)	C Emission factor (EF_j) (kg CH_4/kg BOD) C = A x B
Surface Flow			
Vertical Subsurface Flow			
Horizontal Subsurface Flow			

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Sector	**Waste**		
Category	**Domestic Wastewater Treatment and Discharge**		
Category Code	**4D1**		
Sheet	**3 of 3 Estimation of CH_4 emissions from Domestic Wastewater Treated in Constructed Wetlands**		
STEP 3			
Type of constructed wetlands	A Emission Factor (EF_j) (kg CH_4/kg BOD) Sheet 2 of 3	B Organically degradable material in wastewater (TOW) (kg BOD/yr) Sheet 1 of 3	C Methane emissions (CH_4) (kg CH_4/yr) C=A x B
Surface Flow			
Vertical Subsurface Flow			
Horizontal Subsurface Flow			
		Total	

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Sector	Waste		
Category	Industrial Wastewater Treatment and Discharge		
Category Code	4D2		
Sheet	1 of 3 Total Organic Degradable Material in Industrial Wastewater Treated in Constructed Wetlands		
	STEP 1		
	A	B	C
Type of constructed wetland	Yearly flow rate of industrial wastewater treated by constructed wetland (W) (m^3/yr)	Chemical Oxygen Demand (COD_i) (kg COD/m^3)	Total organic degradable material in industrial wastewater treated in constructed wetland (TOW_i) (kg COD/yr) C=A x B
Industrial sector 1			
Industrial sector 2			
Industrial sector 3			
add as needed			
		Total	

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Sector	**Waste**		
Category	**Industrial Wastewater Treatment and Discharge**		
Category Code	**4D2**		
Sheet	**2 of 3 Estimation of CH_4 Emission Factor for Industrial Wastewater Treated in Constructed Wetlands**		
STEP 2			
	A	B	C
Type of constructed wetland	Maximum methane producing capacity (B_0) (kg CH_4/kg COD)	Methane correction factor (MCF_j) (-)	Emission Factor (EF_j) (kg CH_4/kg COD)
			C = A x B
Surface Flow			
Vertical Subsurface Flow			
Horizontal Subsurface Flow			

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Sector	**Waste**			
Category	**Industrial Wastewater Treatment and Discharge**			
Category Code	**4D2**			
Sheet	**3 of 3 Estimation of CH_4 Emissions from Industrial Wastewater Treated in Constructed Wetlands**			
STEP 3				
		A	B	C
Type of constructed wetlands	Type of constructed wetlands	Emission Factor (EF_i) (kg CH_4/kg COD) Sheet 2 of 3	Organically degradable material in wastewater (TOW) (kg COD/yr) Sheet 1 of 3	Methane emissions (CH_4) (kg CH_4/yr) C=A x B
Industrial sector 1				
Industrial sector 2				
Industrial sector 3				
add as needed				
			Total	

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Sector	**Waste**					
Category	**Domestic Wastewater Treatment and Discharge**					
Category Code	**4D1**					
Sheet	**1 of 2 Estimation of Nitrogen in Effluent Treated in Constructed Wetlands**					
STEP1						
	A	B	C	D	E	F
Type of constructed wetlands	Population whose wastewater treated in constructed wetlands (P) (people)	Per capita protein consumption (Protein) (kg/person/ year)	Fraction of nitrogen in protein (F_{NPR}) (kg N/kg protein)	Fraction of non-consumption protein ($F_{NON-CON}$) (-)	Fraction of industrial and commercial co-discharged protein ($F_{IND-COM}$) (-)	Total nitrogen in effluent ($N_{EFFLUENT}$) (kg N/year) F = A x B x C x D x E
Surface Flow						
Vertical Subsurface Flow						
Horizontal Subsurface Flow						
					Total	

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Sector	**Waste**			
Category	**Domestic Wastewater Treatment and Discharge**			
Category Code	**4D1**			
Sheet	**2 of 2 Estimation of N_2O Emissions from Domestic Wastewater Treated in Constructed Wetlands**			
STEP 2				
Type of constructed wetlands	A	B	C	D
	Total nitrogen in effluent ($N_{EFFLUENT}$) (kg N/year) Sheet 1 of 2	Emission Factor (EF_j) (kg N_2O- N/kg N)	Conversion factor 44/28	Total N_2O emissions (kg N_2O/year) D= A x B x C
Surface Flow				
Vertical Subsurface Flow				
Horizontal Subsurface Flow				
			Total	

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Sector	**Waste**		
Category	**Industrial Wastewater Treatment and Discharge**		
Category Code	**4D2**		
Sheet	**1 of 2 Estimation of N in Effluent Treated in Constructed Wetlands**		
STEP 1			
	A	B	C
Type of constructed wetland	Total nitrogen concentration in industrial wastewater treated by constructed wetlands (TN) (kg N/m^3)	Yearly flow rate of industrial wastewater treated by constructed wetland (W) (m^3/yr)	Total nitrogen effluent ($N_{EFFLUENT,IND}$) (kg N/yr) C=A x B
Industrial sector 1			
Industrial sector 2			
Industrial sector 3			
add as need			
		Total	
Note: Indirect N_2O emissions from N leaching and runoff from agricultural land are considered in Chapter 11, Volume 4 of the 2006 IPCC Guidelines and the amount of nitrogen in collected runoff from agricultural land treated in CWs must be subtracted to avoid double counting			

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Sector	**Waste**				
Category	**Industrial Wastewater Treatment and Discharge**				
Category Code	**4D2**				
Sheet	**2 of 2 Estimation of N_2O Emissions from Industrial Wastewater Treated in Constructed Wetlands**				
STEP 2					
		A	B	C	D
Type of constructed wetlands	Type of constructed wetland	Total nitrogen in effluent ($N_{EFFLUENT}$) kg N/year) Sheet 1 of 2	Emission Factor (EF_i) (kg N_2O- N/kg N)	Conversion factor 44/28	Total N_2O emissions (kg N_2O/year) D= A x B x C
Industrial sector 1					
Industrial sector 2					
Industrial sector 3					
add as need					
				Total	

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ANNEX 7A.2

REPORTING TABLES

The *Wetlands Supplement* has only minor impacts on the Reporting Tables in Annex 8A.2 of Volume 1 of the *2006 IPCC Guidelines*. This annex includes the reporting tables, namely the Sectoral AFOLU Table 3 and Background Tables 3.2, 3.3, 3.4 and 3.7, which have been updated to take into account the methodological guidance in the *Wetlands Supplement*. The revisions are marked in red and any deletion or changes can be seen in strike-through mode. The reasoning for the changes is presented in Section 7.2.1

Table 3 AFOLU Sectoral Table (1 of 2)

Categories	Net CO_2 emissions/ removals	Emissions				
		CH_4	N_2O	NO_x	CO	NMVOCs
	(Gg)					
3 AFOLU						
3A Livestock						
3A1 Enteric Fermentation						
3A1a Cattle						
3A1ai Dairy Cows						
3A1aii Other Cattle						
3A1b Buffalo						
3A1c Sheep						
3A1d Goats						
3A1e Camels						
3A1f Horses						
3A1g Mules and Asses						
3A1h Swine						
3A1j Other (please specify)						
3A2 Manure Management [(1)]						
3A2a Cattle						
3A2ai Dairy Cows						
3A2aii Other Cattle						
3A2b Buffalo						
3A2c Sheep						
3A2d Goats						
3A2e Camels						
3A2f Horses						
3A2g Mules and Asses						
3A2h Swine						
3A2i Poultry						
3A2j Other (please specify)						
3B Land						
3B1 Forest Land						
3B1a Forest Land Remaining Forest Land						
3B1b Land Converted to Forest Land						
3B1bi Cropland Converted to Forest Land						
3B1bii Grassland Converted to Forest Land						
3B1biii Wetlands Converted to Forest Land						
3B1biv Settlements Converted to Forest Land						
3B1bv Other Land Converted to Forest Land						
3B2 Cropland						
3B2a Cropland Remaining Cropland						
3B2b Land Converted to Cropland						
3B2bi Forest Land Converted to Cropland						
3B2bii Grassland Converted to Cropland						
3B2biii Wetlands Converted to Cropland						
3B2biv Settlements Converted to Cropland						
3B2bv Other Land Converted to Cropland						
3B3 Grassland						
3B3a Grassland Remaining Grassland						
3B3b Land Converted to Grassland						
3B3bi Forest Land Converted to Grassland						
3B3bii Cropland Converted to Grassland						
3B3biii Wetlands Converted to Grassland						
3B3biv Settlements Converted to Grassland						
3B3bv Other Land Converted to Grassland						

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Table 3 AFOLU Sectoral Table (2 of 2)

Categories		Net CO_2 emissions/ removals	Emissions				
			CH_4	N_2O	NO_x	CO	NMVOCs
		(Gg)					
3B4	**Wetlands**						
3B4a	Wetlands Remaining Wetlands						
3B4ai	~~Peatlands Remaining Peatlands~~Peat Extraction remaining Peat Extraction						
3B4aii	Flooded Land Remaining Flooded Land						
3B4aiii	Other Wetlands Remaining Other Wetlands						
3B4b	Land Converted to Wetlands						
3B4bi	Land Converted for Peat Extraction						
3B4bii	Land Converted to Flooded Land						
3B4biii	Land Converted to Other Wetlands						
3B5	**3B5 Settlements**						
3B5a	Settlements Remaining Settlements						
3B5b	Land Converted to Settlements						
3B5bi	Forest Land Converted to Settlements						
3B5bii	Cropland Converted to Settlements						
3B5biii	Grassland Converted to Settlements						
3B5biv	Wetlands Converted to Settlements						
3B5bv	Other Land Converted to Settlements						
3B6	**3B6 Other Land**						
3B6a	Other Land Remaining Other Land						
3B6b	Land Converted to Other Land						
3B6bi	Forest Land Converted to Other Land						
3B6bii	Cropland Converted to Other Land						
3B6biii	Grassland Converted to Other Land						
3B6biv	Wetlands Converted to Other Land						
3B6bv	Settlements Converted to Other Land						
3C	**Aggregate Sources and Non-CO_2 Emissions Sources on Land** [(2)]						
3C1	**Biomass Burning**						
3C1a	Biomass Burning in Forest Land						
3C1b	Biomass Burning in Cropland						
3C1c	Biomass Burnings in Grassland						
3C1d	Biomass Burnings in All Other Land						
3C2	**Liming**						
3C3	**Urea Fertilization**						
3C4	**Direct N_2O Emissions from Managed Soils** [(3)]						
3C5	**Indirect N_2O Emissions from Managed Soils**						
3C6	**Indirect N_2O Emissions from Manure Management**						
3C7	**Rice Cultivations**						
3C8	**Other (please specify)**						
3D	**Other**						
3D1	**Harvested Wood Products**						
3D2	**Other (please specify)**						

(1) Indirect N_2O emissions are not included here (see category 3C6).

(2) If CO_2 emissions from Biomass Burning are not already included in Table 3.2 (Carbon stock changes background table), they should be reported here.

(3) Countries may report by land categories if they have the information.

* Cells to report emissions of NO_x, CO, and NMVOC have not been shaded although the physical potential for emissions is lacking for some categories.

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Table 3.2 AFOLU Background Table: 3B Carbon stock changes in FOLU (1 of 2)

Categories		Activity data		Net carbon stock change and CO_2 emissions										Net CO_2 emissions
				Biomass				Dead organic matter			Soils			
		Total area	Thereof: Area of organic soils[4]	Increase	Decrease	Carbon emitted as CH_4 and CO from fires [(1)]	Net carbon stock change	Net carbon stock change	Carbon emitted as CH_4 and CO from fires [(1)]	Net carbon stock change	Net carbon stock change in mineral soils [(2)]	Net carbon loss/gain ~~from drained~~ in organic soils[5]		
		(ha)		(Gg C)										(Gg CO_2)
3B Land														
3B1	**Forest Land**													
3B1a	Forest Land Remaining Forest Land													
3B1b	Land Converted to Forest Land													
3B1bi	Cropland Converted to Forest Land													
3B1bii	Grassland Converted to Forest Land													
3B1biii	Wetlands Converted to Forest Land													
3B1biv	Settlements Converted to Forest Land													
3B1bv	Other Land Converted to Forest Land													
3B2	**Cropland**													
3B2a	Cropland Remaining Cropland													
3B2b	Land Converted to Cropland													
3B2bi	Forest Land Converted to Cropland													
3B2bii	Grassland Converted to Cropland													
3B2biii	Wetlands Converted to Cropland													
3B2biv	Settlements Converted to Cropland													
3B2bv	Other Land Converted to Cropland													
3B3	**Grassland**													
3B3a	Grassland Remaining Grassland													
3B3b	Land Converted to Grassland													
3B3bi	Forest Land Converted to Grassland													
3B3bii	Cropland Converted to Grassland													
3B3biii	Wetlands Converted to Grassland													
3B3biv	Settlements Converted to Grassland													
3B3bv	Other Land Converted to Grassland													
3B4	**Wetlands [(3)]**													
3B5	**Settlements**													

872

873

Table 3.2 AFOLU Background Table: 3B Carbon stock changes in FOLU (2of 2)

Categories		Activity data		Net carbon stock change and CO_2 emissions									Net CO_2 emissions
				Biomass				Dead organic matter			Soils		
		Total area	Thereof: Area of organic soils[4]	Increase	Decrease	Carbon emitted as CH_4 and CO from fires (1)	Net carbon stock change	Net carbon stock change	Carbon emitted as CH_4 and CO from fires (1)	Net carbon stock change	Net carbon stock change in mineral soils (2)	Net carbon loss/gain ~~from drained~~ in organic soils[5]	
		(ha)		(Gg C)									(Gg CO_2)
3B5a	Settlements Remaining Settlements												
3B5b	Land Converted to Settlements												
3B5bi	Forest Land Converted to Settlements												
3B5bii	Cropland Converted to Settlements												
3B5biii	Grassland Converted to Settlements												
3B5biv	Wetlands Converted to Settlements												
3B5bv	Other Land Converted to Settlements												
3B6	**Other Land**												
3B6a	Other Land Remaining Other Land												
3B6b	Land Converted to Other Land												
3B6bi	Forest Land Converted to Other Land												
3B6bii	Cropland Converted to Other Land												
3B6biii	Grassland Converted to Other Land												
3B6biv	Wetlands Converted to Other Land												
3B6bv	Settlements Converted to Other Land												

874

875 (1) Where the carbon contained in the emissions of CH_4 and CO is significant part of the sectoral emissions, this should be copied from the corresponding columns in the Sectoral Background Table 3.4.
876 This amount of carbon emitted as CH_4 and CO is then subtracted from carbon stock change to avoid double counting (see Volume 4, Section 2.2.3).

877 (2) The activity data used for this column correspond to the difference between the column Area and the Area of organic soils.

878 (3) CO_2 Emissions from Wetlands are reported in a separate background table (Table 3.3) that includes all gases emitted from Wetlands.

879 (4) Areas of organic soils include drained, rewetted and restored organic soils as well as coastal wetlands with organic soils. Details of the subdivision should be given in the national inventory report.

880 (5) The net loss/gain from all types of organic soils should be reported here (see also footnote 4).

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Documentation box:

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Table 3.3 AFOLU Background Table: Emissions in Wetlands (3B4)

Categories		Activity data	Net emissions/removals	Emissions	
		Area	CO_2	CH_4	N_2O
		(ha)	(Gg)		
3B4 Wetlands					
3B4a	Wetlands Remaining Wetlands				
3B4ai	~~Peatlands Remaining Peatlands~~Peat Extraction remaining Peat Extraction				
3B4aii	Flooded Land Remaining Flooded Land				
3B4aiii	Other Wetlands Remaining Other Wetlands[1]				
3B4b	Land Converted to Wetlands				
3B4bi	Land Converted for Peat Extraction				
3B4bii	Land Converted to Flooded Land				
3B4biii	Land Converted to Other Wetlands[1]				

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886 (1) Detailed information on Other Wetlands should be included in the national inventory report.

887

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Table 3.4 AFOLU Background Table: Biomass Burning (3C1) (1 of 2)

Categories [1]	Activity data			Emissions									Information item: Carbon emitted as CH_4 and CO [5]	
	Description[2]	Unit	Values	CO_2[3]	CH_4[4]			N_2O	CO[4]			NO_x	Biomass	DOM
					Biomass	DOM	SOM[6]		Biomass	DOM	SOM[6]			
		(ha or kg dm)		(Gg)									(C Gg)	
3C1 Biomass Burning														
3C1a Biomass Burning in Forest Land														
Controlled Burning														
Wildfires														
3C1b Biomass Burning in Cropland														
Biomass Burning in Cropland Remaining Cropland														
Controlled Burning														
Wildfires														
Biomass burning in Forest Land Converted to Cropland														
Controlled Burning														
Wildfires														
Biomass Burning in Non Forest Land Converted to Cropland														
Controlled Burning														
Wildfires														
3C1c Biomass Burning in Grassland														
Burning in Grassland Remaining Grassland														
Controlled Burning														
Wildfires														
Burning in Forest Land Converted to Grassland														
Controlled Burning														
Wildfires														
Burning in Non Forest Land Converted to Grassland														
Controlled Burning														
Wildfires														
3C1d Biomass Burning in All Other Land														
Biomass Burning in Other Land Remaining All Other Land														
Controlled Burning														
Wildfires														

889

Table 3.4 AFOLU Background Table: Biomass Burning (3C1) (2 of 2)

Categories [1]	Activity data			Emissions									Information item: Carbon emitted as CH_4 and CO [5]	
	Description[2]	Unit	Values	CO_2 [3]	CH_4 [4]			N_2O	CO [4]			NO_x	Biomass	DOM
					Biomass	DOM	SOM[6]		Biomass	DOM	SOM[6]			
		(ha or kg dm)		(Gg)									(C Gg)	
Biomass Burning in Forest Land Converted to All Other Land														
Controlled Burning														
Wildfires														
Biomass Burning in Non Forest Land Converted to All Other Land														
Controlled Burning														
Wildfires														

(1) Parties should report both Controlled/Prescribed Burning and Wildfires emissions, where appropriate, in a separate manner.

(2) For each land type data should be selected between area burned or biomass burned. Units for area will be in hectare (ha) and for biomass burned in kilogram dry matter (kg dm).

(3) If CO_2 emissions from biomass burning are not already included in Table 3.2 (Carbon stock changes background table), they should be reported here. Carbon stock changes associated with biomass burning should not also be reported in Table 3.2 to avoid double counting.

(4) CH_4 and CO emissions from biomass burning and DOM are reported separately.

(5) Where the carbon contained in the emissions of CH_4 and CO is a significant part of the sectoral emissions this should be transferred to the corresponding columns in the Sectoral Background Table 3.2. This amount of carbon emitted as CH_4 and CO is then subtracted from carbon stock change to avoid double counting. The conversion factors to convert CH_4 and CO to C (as input to Table 3.2) are 12/16 for CH_4 and 12/28 for CO. (see Volume 4, Section 2.2.3).

(6) Emissions from soil organic matter are occurring when organic soils and peatlands are burned but are not be relevant for mineral soils.

Documentation box:

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Table 3.7 AFOLU Background Table: Direct N_2O emissions from Managed Soils (3C4)

Categories [1]	Activity data	Emissions
	Total amount of nitrogen applied	N_2O
	(Gg N/yr)	(Gg)
3C4 Direct N_2O Emissions from Managed Soils		
Inorganic N fertilizer application		
Forest Land		
Cropland		
Grassland		
Wetlands		
Settlements		
Other Land		
Organic N applied as fertilizer (manure and sewage sludge)		
Forest Land		
Cropland		
Grassland		
Wetlands		
Settlements		
Other Land		
Urine and dung N deposited on pasture, range and paddock by grazing animals [2]		
N in crop residues		
	Area	
	(ha)	
N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils		
Drainage/management of organic soils (i.e., Histosols)		

904

905 (1) Countries will report at the aggregation level if their activity data allows them within each category. If country has disaggregated data by land use, reporting is also
906 possible using this table.

907 (2) Only for Grassland.

908 (3) Only for Cropland.