

1 **2013 SUPPLEMENT TO THE 2006**
2 **IPCC GUIDELINES FOR**
3 **NATIONAL GREENHOUSE GAS**
4 **INVENTORIES: WETLANDS**

5 Methodological Guidance on Organic and Wet Soils
6 across IPCC Land-use Categories

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18 OVERVIEW

19 1 INTRODUCTION

20 The *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*
21 (*Wetlands Supplement*) provides methods for estimating anthropogenic emissions and removals of greenhouse
22 gases from wetlands (lands that are saturated by water for all or part of the year). The *Wetlands Supplement* does
23 not provide guidance on permanently flooded lands such as reservoirs¹. It supplements the guidance contained in
24 the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*² (*2006 IPCC Guidelines*) which provide
25 methodologies for estimating national anthropogenic emissions by sources and removals by sinks of greenhouse
26 gases not controlled by the Montreal Protocol. While the *2006 IPCC Guidelines* include a chapter on wetlands, it
27 is restricted to peatlands drained and managed for peat extraction, and some guidance for drained organic soils,
28 and is therefore incomplete; it does not cover all wetlands types and does not characterize all of the significant
29 activities occurring on the wetlands that it does cover (e.g., rewetting of peatlands is not included).

30 This supplement covers inland peatlands and other wetlands on mineral soils, coastal wetlands including
31 mangrove forests, tidal marshes and seagrass meadows, and constructed wetlands for wastewater treatment.

32 The *2006 IPCC Guidelines* divide all national land into six broad land-use categories: Forest Land, Cropland,
33 Grassland, Settlements, Wetlands and Other Land (see Chapter 3, Volume 4 of the *2006 IPCC Guidelines* and
34 Box 1 below). The lands covered in the *Wetlands Supplement* may occur in any of the IPCC land-use categories.
35 The land-use category that a parcel of land is reported under depends on national land-use category definitions,
36 data collection systems and tracking of land transitions. For example, forested peatland can be classified as
37 Forest Land, plantations on peatland may be classified as Forest Land or Cropland depending on national forest
38 definitions, and mangrove forests may be classified as Forest Land or Wetlands. Chapter 1 provides a decision
39 tree to follow (Fig 1.1) to assist in determining which chapters apply for any land whatever the IPCC land-use
40 category for that land. Emissions and removals from constructed wetlands for wastewater treatment are reported
41 under the waste sector; constructed wetlands are not a land-use category.

42 1.1 BACKGROUND

43 The *Expert Meeting on HWP, Wetlands and Soil N₂O* held on 19th-21st October, 2010 in Geneva, concluded that:

44 *Since the 2006 IPCC Guidelines were completed much new scientific information is now*
45 *available about various wetlands that enable emissions and removals to be estimated from*
46 *wetland restoration and rewetting especially for peat lands. The meeting recommended that*
47 *the IPCC provide additional methodological guidelines for the rewetting and restoration of*
48 *peat land; emissions from fires, ditches and waterborne carbon; and constructed wetlands*
49 *for waste water disposal, to fill gaps in the existing guidelines.*

50 This *Wetlands Supplement* has been produced in response to the conclusions of this expert meeting and also in
51 response to an invitation from the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the
52 United Nations Framework Convention on Climate Change (UNFCCC) at its 33rd session, held in December
53 2010 in Cancun, which invited the IPCC to prepare additional guidance on wetlands, focusing on the rewetting
54 and restoration of peatlands. Document FCCC/SBSTA/2010/13, paragraph 72 states:

¹ An IPCC Expert Meeting concluded that “The participants did not agree that there was now sufficient new information available to produce new and additional guidelines based on the latest literature. They did, however, agree on the need to discuss a range of associated issues, such as the impact of reservoirs on total emissions from watersheds, allocation of emissions to specific drivers and how emissions may be related to specific reservoir typologies.” see IPCC 2011, IPCC Expert Meeting on HWP, Wetlands and Soil N₂O eds: Eggleston H.S., Srivastava N., Tanabe K., Baasansuren J., and Fukuda M. Meeting Report of the IPCC Expert Meeting on HWP, Wetlands and Soil N₂O, Geneva, Switzerland, 19-21 October, 2010, Pub. IGES, Japan 2011

² Intergovernmental Panel on Climate Change (IPCC) (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

55 *The SBSTA took note of the summary of the co-chairs of the IPCC expert meeting on*
56 *harvested wood products, wetlands and N₂O emissions from soils. Noting that science has*
57 *developed in some areas with regard to wetlands, the SBSTA invited the IPCC to undertake*
58 *further methodological work on wetlands, focusing on the rewetting and restoration of*
59 *peatland, with a view to filling in the gaps in the 2006 IPCC Guidelines for National*
60 *Greenhouse Gas Inventories (hereinafter referred to as the 2006 IPCC Guidelines) in these*
61 *areas and to complete this work for the thirty-ninth session of the SBSTA.*

62 In response to this SBSTA invitation, the IPCC held a scoping meeting in Geneva, Switzerland, from 30th
63 March to 1st April, 2011. This meeting produced a draft Terms of Reference (ToR), including annotated chapter
64 outline that were approved by the IPCC at its 33rd Session in Abu Dhabi (10th-13th May 2011).

65 This *Wetlands Supplement* aims to supplement the *2006 IPCC Guidelines* by filling gaps in the coverage of
66 wetlands and organic soils.

67 The *2006 IPCC Guidelines* themselves were prepared in response to an invitation by the Parties to the UNFCCC.
68 They aim to assist Parties in fulfilling their commitments under the UNFCCC to prepare national inventories of
69 anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal
70 Protocol. The *2006 IPCC Guidelines* are in five volumes. Volume 1 describes the basic steps in inventory
71 development and offers the general guidance in greenhouse gas emissions and removals estimates based on the
72 authors' understanding of accumulated experiences of countries over the period since the late 1980s, when
73 national greenhouse gas inventories started to appear in significant numbers. Volumes 2 to 5 offer the guidance
74 for estimates in different economic sectors.

75 Previously the IPCC had developed the *Revised 1996 IPCC Guidelines for National Greenhouse Gas*
76 *Inventories*³ (*1996 IPCC Guidelines*), together with the *Good Practice Guidance and Uncertainty Management*
77 *in National Greenhouse Gas Inventories*⁴ (*GPG2000*) and the *Good Practice Guidance for Land Use, Land-Use*
78 *Change and Forestry*⁵ (*GPG-LULUCF*). Taken together, these provide internationally agreed⁶ methodologies
79 that countries currently have been using to estimate national greenhouse gas emissions and removals to report
80 under the UNFCCC. The three-volume *1996 IPCC Guidelines* define the coverage of the national inventory in
81 terms of gases and categories of emissions by sources and removals by sinks, and the *GPG2000* and *GPG-*
82 *LULUCF* provide additional guidance on choice of estimation methodology, improvements of the methods, as
83 well as advice on cross-cutting issues, including estimation of uncertainties, time series consistency and quality
84 assurance and quality control (QA/QC). The Conference of the Parties to the UNFCCC at its 17th session
85 decided that, starting from the inventory submissions due in 2015, Annex I Parties shall use the methodologies
86 provided in the *2006 IPCC Guidelines*, unless stated otherwise in the UNFCCC Annex I inventory reporting
87 guidelines. (FCCC/CP/2011/9/Add.2)

³ Intergovernmental Panel on Climate Change (IPCC) (1997). Houghton J.T., Meira Filho L.G., Lim B., Tréanton K., Mamaty I., Bonduki Y., Griggs D.J. and Callander B.A. (Eds). *Revised 1996 IPCC Guidelines for National Greenhouse Inventories*. IPCC/OECD/IEA, Paris, France.

⁴ Intergovernmental Panel on Climate Change (IPCC) (2000). Penman J., Kruger D., Galbally I., Hiraishi T., Nyenzi B., Emmanuel S., Buendia L., Hoppaus R., Martinsen T., Meijer J., Miwa K., and Tanabe K. (Eds). *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. IPCC/OECD/IEA/IGES, Hayama, Japan.

⁵ Intergovernmental Panel on Climate Change (IPCC) (2003). Penman J., Gytarsky M., Hiraishi T., Krug, T., Kruger D., Pipatti R., Buendia L., Miwa K., Ngara T., Tanabe K., and Wagner F (Eds). *Good Practice Guidance for Land Use, land-Use Change and Forestry* IPCC/IGES, Hayama, Japan.

⁶ See the Report of the Fourth Session of the Subsidiary Body for Scientific and Technological Advice (FCCC/SBSTA/1996/20), paragraph 30; decisions 2/CP.3 and 3/CP.5 (UNFCCC reporting guidelines for preparation of national communications by Parties included in Annex I to the Convention, part I: UNFCCC reporting guidelines on annual inventories), decision 18/CP.8, revising the guidelines adopted under decisions 3/CP.5, and 17/CP.8 adopting improved guidelines for the preparation of national communications from Parties not included in Annex I to the Convention, and subsequent decisions 13/CP.9 and 15/CP.10.

88 **2 LAND CLASSIFICATION**

89 In this *Wetlands Supplement* the IPCC provides guidance for wetland types (except permanently flooded lands)
90 regardless of how the land is classified. For example, forested peatlands are usually classified as Forest Land
91 when using the *2006 IPCC Guidelines* but guidance given here is applicable to these forested peatlands.
92 Inventory compilers therefore need to consult this *Wetlands Supplement* whenever the land they are considering
93 is either wet (saturated by water for all or part of the year), organic or drained.

94 The term wetlands in this *Wetlands Supplement* refers to lands where the soils are either wet (saturated for all or
95 part of the year), or organic or drained. This is broader than the coverage in the *2006 IPCC Guidelines*, where
96 managed wetlands are defined as lands where the water table is artificially changed (e.g. drained or raised) or
97 those created through human activity (e.g. damming a river) and that are not Forest Land, Cropland, Grassland or
98 Settlements.

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BOX 1 - IPCC LAND-USE CATEGORIES

The land-use categories for greenhouse gas inventory reporting are defined in the *2006 IPCC Guidelines* as follows:

(i) Forest Land

This category includes all land with woody vegetation consistent with thresholds used to define Forest Land in the national greenhouse gas inventory. It also includes systems with a vegetation structure that currently fall below, but in situ could potentially reach the threshold values used by a country to define the Forest Land category.

(ii) Cropland

This category includes cropped land, including rice fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category.

(iii) Grassland

This category includes rangelands and pasture land that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastoral systems, consistent with national definitions.

(iv) Wetlands

This category includes areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g., peatlands) and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions.

(v) Settlements

This category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with national definitions.

(vi) Other Land

This category includes bare soil, rock, ice, and all land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available. If data are available, countries are encouraged to classify unmanaged lands by the above land-use categories (e.g., into Unmanaged Forest Land, Unmanaged Grassland, and Unmanaged Wetlands). This will improve transparency and enhance the ability to track land-use conversions from specific types of unmanaged lands into the categories above.

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137 3 COVERAGE OF THE WETLANDS 138 SUPPLEMENT

139 Table 1 shows the contents of the *Wetlands Supplement*.

Chapter	Contents
1. Introduction	Introduction and Scope of this document. A brief discussion of the types of lands covered and how to identify the appropriate guidance within this supplement.
2. Drained Inland Organic Soils	Guidance for managed organic soils including land drained for forestry, croplands, grazing, settlements etc.
3. Cross-cutting Guidance on Rewetted Organic Soils and Restored Peatlands	Guidance on rewetted organic soils, including peatland restoration.
4. Coastal wetlands	Covers all coastal areas from the inland tidal limit to the seaward extent of vascular plants. This includes mangroves, salt marshes and seagrass meadows.
5. Inland Wetland Mineral Soils	Guidance for managed inland wetland mineral soils, including lands used for forestry, cropland, grazing, and settlements, and rewetted mineral soils, such as in wetland restoration and creation.
6. Constructed Wetlands – wastewater treatment	Guidance on wetlands constructed for wastewater treatment.
7. Cross-cutting Issues and Reporting	Provides overall guidance on how to report emissions and removals from these lands in the framework of the <i>2006 IPCC Guidelines</i> . Also gives general good practice guidance on cross-cutting issues (key category and uncertainty analysis, times series consistency and QA/QC) to supplement that given in Volume 1 of the <i>2006 IPCC Guidelines</i> .

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141 Estimation methods are provided for CO₂, CH₄ and N₂O: the three greenhouse gases emitted and removed by
142 wetlands.

143 The *Wetlands Supplement* updates and extends the coverage of the *2006 IPCC Guidelines*. Updating may have
144 changed emission factors from the *2006 IPCC Guidelines*.

145 **Peatlands and organic soils.** In this supplement guidance, peatlands are included along with organic soils.
146 Drainage and restoration are both covered. Restoration means activities including rewetting aimed at restoring
147 the original vegetation and functions of the peatlands or organic soils. Restoration can reduce the CO₂ emissions
148 caused by drainage, though emissions of CH₄ may increase. The *2006 IPCC Guidelines* included some guidance
149 on drainage, but not restoration.

150 **Coastal wetlands.** Coastal wetlands include mangrove forests, tidal marshes and seagrass meadows. They can be
151 a substantial carbon reservoir but are often affected by human activities including development (e.g. aquaculture
152 or conversion to agriculture or settlements); use (e.g. fishing, collection of wood, grazing) or impacts such as
153 dredging and changes in water level. The *2006 IPCC Guidelines* provided no specific guidance for coastal
154 wetlands and new guidance is given in Chapter 4 on how to treat emissions and removals associated with human
155 activities which affect them.

156 **Inland wetland mineral soils.** Not all wetlands have organic soils. Mineral soil wetlands include riparian
157 wetlands, forested swamps and marshes and can occur in all climate zones. These wetlands can be affected by
158 activities such as agriculture, grazing, forestry, drainage, and rewetting as part of wetland restoration or creation.
159 Chapter 5 covers methodologies for quantifying emissions and removals from managed land on wetland mineral
160 soils.

161 **Saline inland wetlands.** These are also known as playads, pans, salt lakes, brackish wetlands, salinas, and sabkhas.
162 Saline wetlands are important parts of otherwise arid landscapes across the globe. Little information is available
163 in the literature to assess potential greenhouse gas emissions or removals from these lands and so default factors
164 cannot be given. Where available, country-specific data may be used to estimate carbon pools and fluxes from
165 saline inland wetlands.

166 **Rice cultivation.** Additional emission factors for lowland rice production on drained tropical peatlands are given
167 in Chapter 2.

168 **Constructed wetlands for wastewater treatment.** These are wetlands that have been designed and constructed to
169 use natural processes involving vegetation, soils, and associated microbial assemblages to treat wastewater. The
170 guidance supplements Volume 5 of the *2006 IPCC Guidelines on Waste*.

171 **Peatland managed for peat production.** Peat production is covered in the *2006 IPCC Guidelines* (Chapter 7,
172 Volume 4) and additional guidance is given here.

173 Permanently flooded lands are not covered by this *Wetlands Supplement*. The *Expert Meeting on HWP, Wetlands*
174 *and Soil N₂O*⁷ concluded that insufficient new information has become available, since the production of the
175 *2006 IPCC Guidelines*, to enable new and additional guidelines to be produced. The available measurement data
176 do not cover a sufficiently wide geographic or climatic range, and the *Expert Meeting on HWP, Wetlands and*
177 *Soil N₂O* agreed that before guidance could be developed there needed to be consensus on issues including the
178 impact of reservoirs on total emissions from watersheds, allocation of emissions to specific drivers and how
179 emissions may be related to specific reservoir typologies. The *IPCC Special Report on Renewable Energy*
180 *Sources and Mitigation of Climate Change*⁸ also noted that due to the lack of widespread measurement data it
181 was not possible to make global estimates of the size of emissions from reservoirs.

182 4 MANAGED LAND AND 183 ANTHROPOGENIC EMISSIONS

184 The *2006 IPCC Guidelines* aim to provide methods to estimate anthropogenic emissions and removals as
185 required for reporting under the UNFCCC. Many wetlands on managed land have significant non-anthropogenic
186 fluxes of greenhouse gases. In practice, it is difficult to separate anthropogenic and natural emissions, and so in
187 the *2006 IPCC Guidelines* it is *good practice* to report emissions and removals from managed land as a proxy for
188 anthropogenic emissions and removals (Pages 1.4-1.5, Chapter 1, Volume 4 of the *2006 IPCC Guidelines*). An
189 expert meeting⁹ held in May 2009 in Brazil, reconsidered the issue and concluded that, although suitable
190 methods for a better quantification of anthropogenic emissions and removals had been demonstrated in specific
191 circumstances, there was no suitable, globally applicable alternative to the use of managed land as a proxy for
192 anthropogenic emissions and removals.

193 The authors considered that the use of managed land as a proxy for anthropogenic emissions and removals
194 should continue. They also noted that the *2006 IPCC Guidelines* restricted managed wetlands to wetlands where

⁷ IPCC 2011, *IPCC Expert Meeting on HWP, Wetlands and Soil N₂O* eds: Eggleston H.S., Srivastava N., Tanabe K., Baasansuren J., and Fukuda M. Meeting Report of the IPCC Expert Meeting on HWP, Wetlands and Soil N₂O, Geneva, Switzerland, 19-21 October, 2010, Pub. IGES, Japan 2011

⁸ IPCC, 2011: *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Prepared by Working Group III of the Intergovernmental Panel on Climate Change* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1075 pp.

⁹ IPCC 2010, *Revisiting the Use of Managed Land as a Proxy for Estimating National Anthropogenic Emissions and Removals*, eds: Eggleston H.S., Srivastava N., Tanabe K., Baasansuren J. Meeting Report, 5 -7 May, 2009, INPE, São José dos Campos, Brazil, Pub. IGES, Japan 2010

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195 the water table is artificially changed (e.g., drained or raised). This *Wetlands Supplement* extends this coverage
196 to also include wetlands created, or where emissions and removals are directly influenced, by human activity.

197 **5 THE WETLANDS SUPPLEMENT AND** 198 **THE 2006 IPCC GUIDELINES**

199 The *2006 IPCC Guidelines* themselves are an evolutionary development starting from the *1996 IPCC Guidelines*,
200 *GPG2000* and *GPG-LULUCF*. This evolutionary approach helps ensure continuity, and allows for the
201 incorporation of experiences with the existing guidelines, new scientific information, and the results of the
202 UNFCCC inventory review process. The most significant changes occurred in Volume 4, which consolidated the
203 approach to *Land Use, Land-Use Change and Forestry (LULUCF)* in *GPG-LULUCF* and the Agriculture sector
204 in *GPG2000* into a single *Agriculture, Forestry and Other Land Use (AFOLU)* Volume. This *Wetlands*
205 *Supplement* adds to the guidance given in Volume 4, and provides updates where science has advanced, but does
206 not replace it. This *Wetlands Supplement* also adds to the guidance given in Volume 5, Waste.

207 The *2006 IPCC Guidelines* retain the definition of *good practice* that was introduced with *GPG2000*. This
208 definition has gained general acceptance amongst countries as the basis for inventory development. According to
209 this definition, national inventories of anthropogenic greenhouse gas emissions and removals consistent with
210 *good practice* are those, which contain neither over- nor under-estimates so far as can be judged, and in which
211 uncertainties are reduced as far as practicable. These requirements are intended to ensure that estimates of
212 emissions by sources and removals by sinks, even if uncertain, are *bona fide* estimates, in the sense of not
213 containing any biases that could have been identified and eliminated.

214 The *Wetlands Supplement*, like the *2006 IPCC Guidelines*, generally provides guidance on estimation methods at
215 three levels of detail, from Tier 1 (the default method) to Tier 3 (the most detailed method). The guidance
216 generally consists of mathematical specification of the methods and equations for estimating emissions/removals
217 and, information on emission factors or other parameters to use in generating the estimates, and sources of
218 activity data to estimate the overall level of net emissions (emission by sources minus removals by sinks).
219 Properly implemented, all tiers are intended to provide unbiased estimates, and accuracy and precision should, in
220 general, improve from Tier 1 to Tier 3. The provision of different tiers enables inventory compilers to use
221 methods consistent with their resources and to focus their efforts on those categories of emissions and removals
222 that contribute most significantly to national emission totals and trends.

223 The *Wetlands Supplement* follows the approach in the *2006 IPCC Guidelines* by guiding the application of the
224 tiered approach by means of decision trees. A decision tree within each methodological chapter (Chapters 2-6)
225 guides the user to the appropriate tier to use for estimating emissions and removals of greenhouse gases from the
226 category or sub-category under consideration, given national circumstances. National circumstances include the
227 availability of required data, and contribution made by the category to total national emissions and removals and
228 to their trend over time. The most important categories, in terms of total national emissions and the trend, are
229 called *key categories*¹⁰. Decision trees generally require Tier 2 or Tier 3 methods for *key categories*. This
230 approach to the use of different tiers allows limited resources to be focused on those areas of the inventory that
231 contribute significantly to the overall total or trend in emissions.

232 Within Chapter 7 of the *Wetlands Supplement* advice is also provided on:

- 233 (i) ensuring data collection is representative and time series are consistent,
- 234 (ii) estimation of uncertainties,
- 235 (iii) guidance on quality assurance and quality control procedures to provide cross-checks during inventory
236 compilation, and
- 237 (iv) information to be documented, archived and reported to facilitate review and assessment of inventory
238 estimates. Reporting tables and worksheets for Tier 1 methods are provided.

¹⁰ In the *GPG2000* and *GPG-LULUCF* these were called *key sources* or *key categories* where there could be removals.

239 **6 SUMMARY**

240 The *Wetlands Supplement* fills gaps in the coverage of wetlands, organic soils, and drained lands contained in the
241 *2006 IPCC Guidelines*. Permanently flooded lands are not addressed.

242 This increased methodological guidance will allow an additional range of potentially significant emission
243 sources, removals and mitigation strategies to be covered by the *2006 IPCC Guidelines* and improve the
244 complete land coverage of the guidelines.

245 The guidance follows the same form as that contained in the *2006 IPCC Guidelines*, in particular it incorporates
246 good practice guidance, including: tiered approaches; key category analysis; Tier1 default parameters; guidance
247 on higher tiers; uncertainty analysis; QA/QC and documentation.

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