

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

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5 Methodological Guidance on Lands with Wet and  
6 Drained Soils, and Constructed Wetlands for  
7 Wastewater Treatment

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18 **OVERVIEW**

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<sup>1</sup> Until February, 2013.

## 39 1 INTRODUCTION

40 The *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*  
41 (*Wetlands Supplement*) provides methods for estimating anthropogenic emissions and removals of greenhouse  
42 gases from wetlands. The term *wetlands* is taken to refer to lands with wet and drained soils, and constructed  
43 wetlands for wastewater treatment. This is broader than the coverage in the *2006 IPCC Guidelines for National*  
44 *Greenhouse Gas Inventories*<sup>2</sup> (*2006 IPCC Guidelines*), where managed wetlands are defined as lands where the  
45 water table is artificially changed (e.g. drained or raised) or those created through human activity (e.g. damming  
46 a river) and that are not Forest Land, Cropland, Grassland or Settlements. The emissions and removals from  
47 wetlands addressed in the *Wetlands Supplement* can occur under any land-use category or other relevant category  
48 of the *2006 IPCC Guidelines*.

49 The guidance provided is supplementary to that contained in the *2006 IPCC Guidelines*, which provide  
50 methodologies for estimating national anthropogenic emissions by sources and removals by sinks of greenhouse  
51 gases not controlled by the Montreal Protocol.<sup>3</sup> The content of the *2006 IPCC Guidelines* on wetlands is  
52 restricted to peatlands drained and managed for peat extraction, conversion to flooded lands, and some guidance  
53 for drained organic soils. It is therefore incomplete; it does not cover all wetlands types and does not characterize  
54 all of the significant activities occurring on the wetlands that it does cover (e.g., rewetting of peatlands is not  
55 included).

56 This *Wetlands Supplement* supplements the *2006 IPCC Guidelines* by filling in gaps in the coverage and  
57 providing updated information reflecting scientific advances. This includes updating of default emission factors.  
58 It covers inland peatlands and other wetlands on mineral soils, coastal wetlands including mangrove forests, tidal  
59 marshes and seagrass meadows, and constructed wetlands for wastewater treatment. For the reasons described  
60 subsequently, the *Wetlands Supplement* does not provide guidance on permanently flooded lands such as  
61 reservoirs<sup>4</sup>.

### 62 1.1 BACKGROUND

63 The *Expert Meeting on HWP, Wetlands and Soil N<sub>2</sub>O* held on 19th-21st October, 2010 in Geneva, concluded that:

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

70 This *Wetlands Supplement* has been produced in response to the conclusions of this expert meeting, and in  
71 response to an invitation from the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the  
72 United Nations Framework Convention on Climate Change (UNFCCC) at its 33<sup>rd</sup> session, held in December  
73 2010 in Cancun, which invited the IPCC to prepare additional guidance on wetlands, focusing on the rewetting  
74 and restoration of peatlands. Document FCCC/SBSTA/2010/13, paragraph 72 states:

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<sup>2</sup> 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.

<sup>3</sup> Greenhouse gases addressed in this Supplement are: CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O.

<sup>4</sup> Regarding permanently flooded lands, participants at an IPCC Expert Meeting "... 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 N<sub>2</sub>O* 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 N<sub>2</sub>O, Geneva, Switzerland, 19-21 October, 2010, Pub. IGES, Japan 2011

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75           ...the SBSTA invited the IPCC to undertake further methodological work on wetlands,  
76           focusing on the rewetting and restoration of peatland, with a view to filling in the gaps in the  
77           2006 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as  
78           the 2006 IPCC Guidelines) in these areas and to complete this work for the thirty-ninth  
79           session of the SBSTA.

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

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## 87 2 COVERAGE OF THE WETLANDS 88 SUPPLEMENT

89 The *2006 IPCC Guidelines* classify all land area into six broad land-use categories: Forest Land, Cropland,  
90 Grassland, Settlements, Wetlands and Other Land (see Chapter 3, Volume 4 of the *2006 IPCC Guidelines*). The  
91 lands covered in the *Wetlands Supplement* may occur in any of the IPCC land-use categories. The land-use  
92 category that land is reported under depends on national land-use category definitions, data collection systems  
93 and tracking of land transitions. For example, forested peatland can be classified as Forest Land, plantations on  
94 peatland may be classified as Forest Land or Cropland depending on national forest definitions, and mangrove  
95 forests may be classified as Forest Land or Wetlands. Due to its function, Constructed Wetlands are not  
96 considered as a land-use category. The coverage of the *Wetlands Supplement* is briefly summarized in Table 1.

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<b>Chapter</b>	<b>Coverage</b>
1. Introduction	Introduction of this report. Guidance on this report usage and Generic information application of the managed land proxy in wetlands, the linkages between the <i>2006 IPCC Guidelines</i> and the supplementary guidance presented in this document.
2. Drained Inland Organic Soils	Guidance for managed inland organic soils including land drained for forestry, croplands, grazing, and settlements across climate zones.
3. Rewetted Organic Soils	Guidance on rewetted organic soils including boreal, temperate, and tropical wetlands occurring in any land-use category.
4. Coastal Wetlands	Guidance for specified management activities in coastal areas of mangroves, tidal 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.
6. Constructed Wetlands for Wastewater Treatment	Guidance on wetlands constructed for wastewater treatment.
7. Cross-cutting Issues and Reporting	Overall guidance on how to report anthropogenic emissions and removals from wetlands 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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99 A summary of the main methodological updates to the *2006 IPCC Guidelines* is provided below. Chapter 1  
100 provides a decision tree to help inventory compilers determine which chapters of this supplement to apply and  
101 describes the coverage and definitions of the wetland types.

102 **Peatlands and organic soils.** The *2006 IPCC Guidelines* included some guidance on drainage (Chapter 4,  
103 Volume 4) and peat extraction (Chapter 7, Volume 4), but not on rewetting. In this supplement, peatlands are  
104 included along with organic soils and both drainage and rewetting are covered. Updated default emission factors  
105 and methods are provided for both drained and rewetted organic soils including for off-site carbon dioxide (CO<sub>2</sub>)  
106 emissions via waterborne carbon losses. Guidance on methane (CH<sub>4</sub>) emissions from rewetting of organic soils  
107 (Chapter 3), ditches on drained inland organic soils and CO<sub>2</sub>, CH<sub>4</sub> and carbon monoxide (CO) emissions from  
108 peat fires are also provided (Chapter 2).

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- 109 **Peatland managed for peat production.** Peat production is covered in the *2006 IPCC Guidelines* (Chapter 7,  
110 Volume 4) and no additional guidance is given here except some updated emission factors in Chapter 2.
- 111 **Rice cultivation.** Rice cultivation is covered in the *2006 IPCC Guidelines* (Chapter 5, Volume 4) and additional  
112 emission factors for lowland rice production are given in Chapter 2.
- 113 **Coastal wetlands.** The *2006 IPCC Guidelines* provided no specific guidance for coastal wetlands and new  
114 guidance is given in Chapter 4 on how to treat anthropogenic emissions and removals associated with specified  
115 human activities that affect them. Coastal wetlands in this supplement include mangrove forests, tidal marshes  
116 and seagrass meadows. Default emissions factors and methodologies are provided for management of mangrove  
117 forests (i.e. harvesting), rewetting and revegetation, aquaculture and drainage.
- 118 **Inland wetland mineral soils (IWMS).** The *2006 Guidelines* provided limited data on soil C in wetland mineral  
119 soils. Chapter 5 provides updated default soil carbon factors and covers methodologies for quantifying emissions  
120 and removals of CO<sub>2</sub> and emissions of CH<sub>4</sub> from (i) artificial drainage of IWMS (ii) subsequently rewetting of  
121 artificially drained IWMS and (iii) the artificial flooding of mineral soils for the purposes of wetland creation.  
122 Mineral soil wetlands<sup>5</sup> include riparian wetlands, forested swamps and marshes and can occur in all climate  
123 zones.
- 124 **Saline inland wetlands.** Saline wetlands are important parts of otherwise arid landscapes across the globe but  
125 little information is available in the literature to assess potential greenhouse gas emissions or removals from  
126 these lands. Thus default factors cannot be given and no guidance is provided for these wetland types. These  
127 are also known as playas, pans, salt lakes, brackish wetlands, salinas, and sabkhas.
- 128 **Constructed wetlands for wastewater treatment.** The guidance supplements Volume 5 of the *2006 IPCC*  
129 *Guidelines* on Waste (Chapter 6). These are wetlands that have been designed and constructed to use natural  
130 processes involving vegetation, soils, and associated microbial assemblages to treat wastewater. New guidance is  
131 also provided on semi-natural treatment wetlands.
- 132 **Permanently flooded lands.** No new guidance on permanently flooded lands is provided. The *Expert Meeting on*  
133 *HWP, Wetlands and Soil N<sub>2</sub>O*<sup>6</sup> concluded that insufficient new information has become available<sup>7</sup>. The *IPCC*  
134 *Special Report on Renewable Energy Sources and Mitigation of Climate Change*<sup>8</sup> also noted that it was not  
135 possible to make global estimates of the size of emissions from reservoirs.

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<sup>5</sup> Wetlands do not all have organic soils. Wetland Mineral Soils are classified as Aquic soil (USDA) or Gleysols (World Reference Base), and are described as having restricted drainage leading to periodic flooding and anaerobic conditions (Table 2.3, Chapter 2 of the *2006 IPCC Guidelines*).

<sup>6</sup> IPCC 2011, *IPCC Expert Meeting on HWP, Wetlands and Soil N<sub>2</sub>O* 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 N<sub>2</sub>O, Geneva, Switzerland, 19-21 October, 2010, Pub. IGES, Japan 2011

<sup>7</sup> The attendees of the *Expert Meeting on HWP, Wetlands and Soil N<sub>2</sub>O* agreed that, before additional guidance could be developed for permanently flooded lands, there needed to be consensus on 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.

<sup>8</sup> 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.

### 136 3 MANAGED LAND AND ANTHROPOGENIC 137 EMISSIONS

138 Parties to the UNFCCC have committed to report anthropogenic emissions and removals of greenhouse gases  
139 not covered by the Montreal Protocol.<sup>9</sup> In practice, it is difficult to separate anthropogenic and natural emissions  
140 in Agriculture, Forestry and Other Land-Use (AFOLU). Thus, the *2006 IPCC Guidelines* provides that it is *good*  
141 *practice* to report emissions and removals from managed land as a proxy for anthropogenic emissions and  
142 removals (Pages 1.4-1.5, Chapter 1, Volume 4 of the *2006 IPCC Guidelines*). An expert meeting<sup>10</sup> held in May  
143 2009 in Brazil, reconsidered the issue and concluded that, although suitable methods for a better quantification  
144 of anthropogenic emissions and removals had been demonstrated in specific circumstances, there was no suitable,  
145 globally applicable alternative to the use of managed land as a proxy for anthropogenic emissions and removals.

146 The authors agree that the use of managed land as a proxy for anthropogenic emissions and removals should  
147 continue. They also noted that many wetlands on managed land have significant non-anthropogenic fluxes of  
148 greenhouse gases. The *2006 IPCC Guidelines* restricted managed wetlands to those lands where the water table  
149 is artificially changed (e.g., drained or raised). This *Wetlands Supplement* extends this coverage also to include  
150 wetlands created (e.g., constructed), or where emissions and removals from coastal wetlands are attributed to  
151 specified human activities. The focus on human activities such as drainage or construction of aquaculture ponds  
152 maintains the justification for the managed land proxy. In the case of seagrass meadows the guidance estimates  
153 emissions and removals associated with changes linked to a specific human activity, rather than estimating  
154 emissions and removals from that coastal wetland type as a whole. Application of the supplement will maintain  
155 consistency with previous estimates so long as these activities can be recognised as subsets within the broader  
156 definition of managed land. The application of new emission factors will not introduce inconsistency so long as  
157 the historical time series is updated, consistent with long-standing IPCC advice.

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<sup>9</sup> UNFCCC Article 4.1 (a).

[http://unfccc.int/files/essential\\_background/background\\_publications\\_htmlpdf/application/pdf/conveng.pdf](http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf)

<sup>10</sup> 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

## 158 4 THE WETLANDS SUPPLEMENT AND THE 159 2006 IPCC GUIDELINES

160 The *Wetlands Supplement* follows the same approach to estimating emissions and removals as the *2006 IPCC*  
161 *Guidelines*. The *2006 IPCC Guidelines* themselves are an evolutionary development starting from the *1996*  
162 *IPCC Guidelines*, *2000 IPCC Good Practice Guidance (GPG2000)* and *Good Practice Guidance – Land Use,*  
163 *Land-use Change and Forestry (GPG-LULUCF)*. This evolutionary approach helps ensure continuity, and  
164 allows for the incorporation of experiences with the existing guidelines, new scientific information, and the  
165 results of the UNFCCC inventory review process. An important structural change occurred in Volume 4, which  
166 consolidated the guidance for *LULUCF* in *GPG-LULUCF* and the Agriculture sector in *GPG2000* into a single  
167 Agriculture, Forestry and Other Land Use (AFOLU) Volume. This *Wetlands Supplement* adds to the guidance  
168 given in Volume 4 of the *2006 IPCC Guidelines*, and provides updates where science has advanced, but does not  
169 replace it. This *Wetlands Supplement* also adds to the guidance given in Volume 5 (Waste). Where the *Wetlands*  
170 *Supplement* provides guidance that updates emission factors for land areas, categories, gases, and pools covered  
171 directly by Volumes 4 and 5, the guidance in the *Wetlands Supplement* should take precedence.

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

179 The *Wetlands Supplement*, like the *2006 IPCC Guidelines*, generally provides guidance, usually with decision  
180 trees, on estimation methods at three levels of detail, from Tier 1 (the default method) to Tier 3 (the most  
181 detailed method; Chapter 1, Volume 1). The Tier 1 guidance generally consists of mathematical specification of  
182 the methods and equations for estimating emissions/removals, information on emission factors or other  
183 parameters to use in generating the estimates, and sources of activity data to estimate the overall level of net  
184 emissions (emission by sources minus removals by sinks). Properly implemented, all tiers are intended to  
185 provide unbiased estimates, and accuracy and precision are expected to improve from Tier 1 to Tier 3. The  
186 provision of different tiers enables inventory compilers to use methods consistent with their resources and to  
187 focus their efforts on those categories of emissions and removals that contribute most significantly to national  
188 emission totals and trends.

189 National circumstances include the availability of data and knowledge, and contribution made by the category to  
190 total national emissions and removals and to their trend over time. The most important categories, in terms of  
191 total national emissions and the trend, are called *key categories*<sup>11</sup>. The decision trees generally require Tier 2 or  
192 Tier 3 methods for *key categories*. This approach to the use of different tiers allows limited resources to be  
193 focused on those areas of the inventory that contribute significantly to the overall total or trend in emissions.

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

- 195 (i) ensuring time series are consistent,
- 196 (ii) estimation of uncertainties,
- 197 (iii) guidance on quality assurance and quality control procedures to provide cross-checks during inventory  
198 compilation,
- 199 (iv) information to be documented to achieve transparent reporting, avoiding double-counting and  
200 omissions, to facilitate review and assessment of inventory estimates, and
- 201 (v) reporting tables and worksheets for Tier 1 methods are provided as well as mapping between the  
202 categories and guidance in the *2006 IPCC Guidelines* and the changes to those introduced by the  
203 *Wetlands Supplement*.

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<sup>11</sup> In the *GPG2000* and *GPG-LULUCF* these were called *key sources* or *key categories* where there could be removals.